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Abstract

Following a national lockdown in response to the Covid-19 pandemic, state governments in Germany published lists of “essential” occupations that were considered necessary to maintain basic services such as health care, social care, food production and transport. Against this background, this paper examines working conditions and identifies clusters of similar jobs in these essential occupations. Differences across clusters are highlighted using detailed data on job characteristics, including tasks, educational requirements and working conditions. Two clusters with favourable or average working conditions account for more than three-quarters of jobs in essential occupations. Another two clusters, comprising 20% of jobs in essential occupations, are associated with unfavourable working conditions such as low pay, job insecurity, poor prospects for advancement and low autonomy. These latter clusters exhibit high shares of migrants. Further evidence suggests that this pattern is linked to educational requirements and how recent migrants evaluate job characteristics. It is argued that poor working conditions could affect the resilience of basic services during crises, notably by causing high turnover. Policies towards essential occupations should therefore pay close attention to working conditions, the role of migrant labour and their long-term implications for resilience.

Keywords

Essential occupations, essential workers, key workers, Covid-19, migrant workers, working conditions, job quality, resilience.

1. Introduction*

The Covid-19 pandemic has highlighted a number of “essential” or “system-relevant” occupations, which were exempted from the limitations that other occupations faced during the pandemic, notably during lockdowns. Because these occupations were chosen in a pragmatic emergency response to a major threat, they likely represent a useful approximation of the activities truly needed to sustain the provision of basic goods and services. Therefore, a better understanding of essential occupations can support countries’ efforts to weather such crises and help increase their resilience in the longer run.

While this newly emerged class of essential occupations has hardly been explored, it has been noted that they include many jobs with low pay and low prestige, comparatively often filled by migrants (Gelatt, 2020; Fasani and Mazza, 2020a; Koebe et al., 2020). This paper uses a range of indicators to take a closer look at the working conditions in essential occupations in Germany. The focus on working conditions is linked to the resilience of basic services during crises. For example, adverse working conditions in these occupations could lead to high employee turnover (Martin, 2003; Cottini et al., 2011), which would imply that occupation-specific knowledge is lost at a high rate and incentives to invest in occupation-specific human capital are undermined. Permanent staff shortages may arise – as is arguably the case for nursing and care occupations – which likely make an occupation more vulnerable to a crisis. While employers might consider a high-turnover work environment as one option among several human-resource strategies, this strategy may be dangerous in the case of essential occupations.

Job characteristics can also matter for employees’ performance under pressure from a crisis and for how they deal with unusual challenges. Mounting evidence on links between job satisfaction and productivity (e.g. Oswald et al., 2015; Bellet et al., 2019; ILO, 2020) implies that poor working conditions make a temporary rise in productivity and hours worked less likely to happen. Findings on the resilience of health services have stressed the importance of team efforts during a pandemic (Kruk et al., 2015) but poor working conditions could undermine this by reducing collaboration among employees. In addition, poor working conditions can expose employees to greater risks of contagion, which appear to be especially high in many essential occupations (Zhang, 2020).

The often high share of migrants in essential occupations has received considerable attention, as pointed out above (see also Fernández-Reino et al., 2020 and Khalil et al., 2020). The finding probably seems paradoxical: while it is a major concern with migration and integration that migrants might remain on the margins of the labour market and society more generally, they play an especially strong role in maintaining core functions of the economy and society. Further investigation of migrants’ roles in essential occupations can build an understanding to what extent essential services have become dependent on migrants, which could have far-reaching implications for policy (Anderson et al., 2020).

Through a Latent Class Analysis, this paper delimits clusters of jobs across essential occupations that share important job quality characteristics. This clustering approach reflects that working conditions are multi-dimensional, which requires using a number of indicators – not just the level of pay. The paper identifies salient features of these clusters and links the observed employment of migrants to the characteristics of their jobs. This analysis is performed for Germany, where rich data on job characteristics are available and migrants are likely to be observed comparatively well.¹ The overlap

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¹ The issue that undocumented employment of migrants is often poorly covered in the available data sources is probably comparatively small in the case of Germany, as the availability of various legal statuses for non-EU migrants and free mobility for EU migrants greatly reduce the estimated number of irregular migrants who would be ineligible for regular employment (Hosner, 2020).

between essential occupations designated by various countries implies that insights obtained here might generalise to other countries.

2. Background

During the first wave of the Covid-19 pandemic in spring of 2020, authorities in the German states published lists of occupations considered “essential” for the maintenance of basic services with the view to providing children of workers in these occupations with preferential access to emergency childcare (Koebe et al., 2020). This paper uses the first list drawn up by the state of Berlin on March 17 plus agricultural occupations that were included in more rural states (Table A1)². The resulting list aligns with a list of “systemically relevant sectors” eventually published by the Federal Ministry of Employment and Social Affairs (BMAS) on March 30, with the exception that it does not include the media.³ While such lists differ across countries, the overlap of lists for the United States, Italy and Spain highlights health care, social care, agriculture, energy supply, water and waste management, transport as well as wholesale and retail of certain goods, notably food (Table A2). This “core” matches the essential occupations in Germany.

In such essential occupations, migrants often appear to play a particular role. In major destination countries in Europe, migrants account for 10-20% of employees in essential occupations, and this share rises to 20-30% in Germany, Austria, Sweden and Ireland, for example (Fasani and Mazza, 2020a). In the United States, migrants are overrepresented in a number of “frontline” occupations (Gelatt, 2020). Kerwin and Warren (2020) estimate that 69% of migrant employees in the United States work in sectors that are considered “critical infrastructure” by the Department of Homeland Security.

The role of migrants in health professions has received significant attention already prior to the Covid-19 pandemic (e.g. Kingma, 2007). Across 26 OECD countries, foreign-born health professionals accounted for 27% of all doctors in 2016, and for 16% of all nurses (OECD, 2019). The interest in migrant health professionals likely reflects the particular importance of health services. This implies that the employment of migrants in other essential occupations might also deserve more attention.

A strong presence of migrant workers is often observed where working conditions are relatively poor (e.g. Ruhs and Anderson, 2010, Benach et al. 2010). Fasani and Mazza (2020b) find that also migrants in essential occupations in Europe earn relatively low wages and are more often in temporary employment, compared to native-born workers in essential occupations. Anderson et al. (2020) argue that, far from being an anomaly, bad working conditions in essential occupations may result from the institutional context and may be tolerated precisely because the work is essential.

On this background, and motivated by potential effects of working conditions on the provision of essential services, this paper analyses essential occupations by job characteristics. More common categories such as occupations and demographic groups are only used to describe the clusters that identified based purely on job characteristics. This approach allows for heterogeneous working conditions within a single occupation and within the demographic group of migrants. It therefore offers a “bottom-up” analysis of working conditions in the rather diverse essential occupations.

² Due to its limited sample size, the data do not offer observations on occupations in fishing (see Table A1).

³ The list of the BMAS is available at <https://www.bmas.de/DE/Schwerpunkte/Informationen-Corona/Kurzarbeit/liste-systemrelevante-bereiche.html> and includes the media, with an emphasis on news and crisis communication. These media occupations are not included here because they cannot be separated from editors, authors and writers in the occupational classification at three-digit level.

3. Data and methods

The analysis is based on a sample of the working population in Germany from the “Panel Study Labour Market and Social Security” (PASS). The PASS is a longitudinal survey conducted annually since 2006, covering about 10,000 households (Trappmann et al., 2013). The survey is specifically designed for the purpose of the labour market and the welfare issues research in Germany. A notable feature of the survey is that it collects detailed individual-level information on a range of objective and subjective indicators of job quality, combined with unusually rich information on professional aspirations. These variables allow for a more in-depth investigation than would be possible using labour force surveys, for example.

While the PASS data are representative for the overall population and the employed population in Germany, some parts of the population – notably migrants – were oversampled to allow for greater precision in these cases (see Bethmann et al., 2013).⁴ Gundert et al. (2020) use the PASS data for a general analysis of migrants’ job quality in Germany. However, it appears that these data have not been used before to identify clusters based on job characteristics nor to analyse employment in essential occupations.

This paper draws on the three most recent PASS waves (2016-2018) in order to approximate the situation at the onset of the Covid-19 pandemic while ensuring a sufficiently large sample. Given the panel dimension of the data, different waves largely contain the same persons. However, the sample in this paper includes each person only once (using the latest available observation). After limiting the sample to employees in essential occupations and restricting the sample to employees age 18-64, close to 2500 individual observations remain, 23% of which are first or second-generation migrants.⁵ Table 1 provides summary statistics and indicators of job quality for this sample. These statistics point to substantial differences between employees without migration background and migrants (especially recent migrants), while differences with second-generation migrants are comparatively small.

In addition, a second data set is used, with a dual objective: to include data on occupational tasks as well as educational requirements, and to cross-validate the results based on PASS. These data are obtained from Germany’s Federal Institute for Vocational Education and Training (BIBB).⁶ To match them to the PASS data, the individual-level survey data from 2018 is aggregated at the level of occupations, using the same classification as in PASS (the 2010 “Klassifikation der Berufe”, KldB). The list of essential occupations is given in Table A1 in the Appendix but some essential occupations – notably in agriculture – account for so little employment that they are hardly represented in the limited sample used here.

The empirical method used in this paper is a Latent Class (Cluster) Analysis (LCA), a technique that examines relationships among variables to explore the existence of underlying (“latent”) clusters. Any such clusters would consist of observations that are similar within the cluster and as different as possible between clusters, in terms of the variables whose relationships are examined. Against a null hypothesis of no latent clusters, so that the data represent a single “cluster”, models with several latent clusters are estimated and compared. The final model is then chosen based on the Bayesian Information Criterion and other goodness-of-fit indicators (see e.g. Goodman, 2002 for details).

The LCA in this paper examines relationships among seven important job characteristics: hourly wage, contract type (temporary or permanent), flexibility of working hours, unpaid overtime, job insecurity and indicators of bad work relations as well as bad working conditions (see Table 1 for descriptive statistics).⁷ Goodness-of-fit indicators point to a model with 6 latent clusters (see Table A3

⁴ Further efforts to cover the migrant population included the use of foreign languages in data collection.

⁵ So-called mini jobs – part-time jobs with monthly wages up to EUR 450, exempt from social security contributions – are not included in the analysis, due to data limitations.

⁶ For a description of the survey, see <https://www.bibb.de/en/15182.php>.

⁷ To improve model fit, also the variable for being a migrant was used in the regression adjustment.

in the Appendix). However, the model with 5 latent clusters is chosen because its clusters are more parsimonious while the goodness-of-fit indicators remain close to the values for the model with 6 latent classes, and the classification error is lower than for all other models.

Table 1. Descriptive statistics for employment in essential occupations, by migration background

	No migration background	Recent migrants (duration of stay up to 5 years)	Settled migrants (duration of stay exceeds 5 years)	Second generation (with a migrant parent)	Total
Observations	1831	133	340	151	2455
Share in sample	77%	2%	14%	6%	100%
<i>Indicators used to define clusters in the Latent Class Analysis</i>					
Wage level: low	18%	19%	21%	15%	18%
Wage level: medium	53%	80%	60%	51%	55%
Wage level: high	29%	1%	19%	34%	27%
Contract: permanent	88%	59%	87%	83%	87%
Contract: temporary	12%	41%	13%	17%	13%
Hours: fixed	73%	98%	89%	66%	75%
Hours: flexible	27%	2%	11%	34%	25%
Overtime is common: yes	53%	33%	41%	63%	52%
Job insecurity: yes	15%	53%	24%	15%	17%
Bad work relations: yes	12%	26%	22%	14%	14%
Bad conditions: low	64%	18%	53%	71%	62%
Bad conditions: medium	24%	51%	16%	24%	23%
Bad conditions: high	12%	31%	31%	5%	15%
<i>Indicators used to describe clusters (PASS)</i>					
Share of women	63%	51%	50%	59%	61%
Mean age (years)	43,2	33,8	43,3	40,8	42,8
Children: No	59%	69%	39%	45%	56%
Children: 1	19%	14%	25%	29%	20%
Children: 2 – 3	18%	7%	21%	15%	18%
Children: >3	4%	10%	15%	11%	6%
Family status: single	28%	8%	12%	24%	25%
Family status: couple	56%	63%	74%	64%	59%
Family status: divorced/ widowed	16%	29%	14%	12%	16%
Education: low	23%	25%	44%	15%	26%
Education: medium	57%	24%	37%	66%	54%
Education: high	20%	51%	19%	20%	20%
Total work experience (years)	20,5	9,9	17,7	17,1	19,7
Tenure with current employer (years)	9,9	2,4	8,0	9,4	9,4
Part-time (< 35 hours per week)	42%	19%	37%	31%	40%
Public sector	33%	47%	29%	38%	33%
Temporary employment agency	2%	7%	5%	1%	2%
Bad work relations: with supervisor	9%	2%	18%	9%	10%

	No migration background	Recent migrants (duration of stay up to 5 years)	Settled migrants (duration of stay exceeds 5 years)	Second generation (with a migrant parent)	Total
<i>Indicators used to describe clusters (PASS) (continued)</i>					
Bad work relations: with colleagues	5%	24%	4%	5%	5%
Bad conditions: poor prospects for advancement	60%	82%	61%	64%	61%
Bad conditions: little autonomy	32%	39%	37%	28%	32%
Bad conditions: little learning	16%	50%	28%	10%	18%
Bad conditions: tasks not challenging	21%	60%	39%	11%	24%
Language skills: native or very good	100%	28%	40%	94%	89%
Language skills: good	0%	14%	34%	1%	5%
Language skills: average	0%	39%	24%	5%	5%
Language skills: low/ very low	0%	20%	1%	0%	1%
<i>Indicators used to describe clusters (BIBB)</i>					
Task: making repetitive motions	55%	54%	61%	54%	56%
Task: pace determined by equipment	27%	28%	23%	29%	27%
Task: bending or twisting	23%	27%	28%	22%	24%
Codified work	30%	27%	35%	27%	31%
Freedom to make decisions	31%	31%	24%	33%	30%
Task: advise and inform	63%	52%	51%	66%	61%
Task: convince	43%	43%	36%	46%	42%
Educational requirements: none	21%	32%	33%	20%	23%
Educational requirements: professional education	57%	47%	54%	57%	57%
Educational requirements: advanced professional education	6%	5%	5%	6%	5%
Educational requirements: university	16%	15%	9%	17%	15%
Required: project management	9%	8%	6%	10%	9%
Required: computer literacy	26%	16%	20%	28%	25%
Required: technical know-how	20%	15%	20%	20%	20%
Required: mathematics	12%	8%	9%	13%	12%

Notes: “Bad work relations” are observed when respondents indicate bad relations with either colleagues or their manager. “Bad conditions” aggregate information from 4 indicators of bad working conditions. “No migration background” refers to native-born persons with native-born parents. See Table A1 for the list of occupations included.

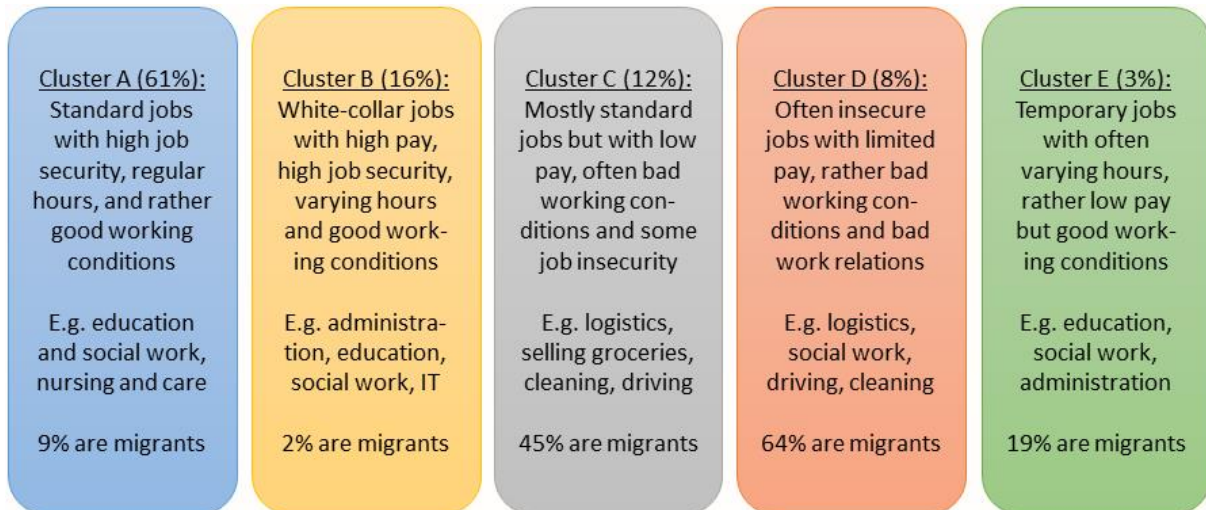
Source: Panel Study Labour Market and Social Security, 2016-2018

4. Results

Based on the LCA of job characteristics, five clusters of widely different sizes emerge (Figure 1). Standard jobs with rather good working conditions (Cluster A) alone account for 61% of jobs in essential occupations. White-collar jobs with good working conditions account for another 16% (Cluster B). Mostly standard jobs with bad working conditions account for still 12% (Cluster C), and a cluster of often temporary jobs with rather bad working conditions makes up 8% (Cluster D). Another cluster of generally temporary jobs (Cluster E) exhibits better working conditions but accounts for only 3% of jobs in essential occupations.

In Cluster A, around 90% of employees have a permanent contract and have fixed working hours (see Tables A4 and A5 for all detailed results). Almost two-thirds of employees in this cluster are women, and more than two-thirds work in the private sector. Only 5% of employees in Cluster A indicate having job insecurity. Frequent occupations include education and social work (18% of employees in Cluster A), nursing (15%), warehousing and logistics (14%) and geriatric care (9%). Large majorities report having opportunities to learn (83%) and to solve difficult tasks (80%), while 33% report a lack of autonomy. Tasks in Cluster A often include giving advice or information (63%) or convincing others (44%) but also often involve repetitive movements (56%).

Figure 1. Clusters resulting from the Latent Class Analysis



Note: See Table A4 for a detailed description of the clusters. Migrants with a duration of stay up to 5 years are considered recent migrants, and settled migrants otherwise.

Source: Own analyses based on the Panel Study Labour Market and Social Security, 2016-2018

Employees in Cluster B often enjoy high wages (70%) and virtually all have a permanent contract. At the same time, working hours are generally flexible and 78% report that overtime is common. Men and women are roughly equally frequent in this cluster, and half work in the public sector (52%). The main occupations are public administration (30%), education and social work (24%), driving (8%) as well as IT (7%). Very few (4%) report a lack of autonomy in their work, virtually everyone reports having opportunities to learn and to solve difficult tasks. To advise and inform is a task for two-thirds in this cluster, and only 25% report that their tasks are strongly codified.

While employees in Cluster C also exhibit high shares with permanent contracts (82%) and fixed working hours (99%), low hourly wages are far more frequent in Cluster C (83%) than in other clusters. Half of the jobs in this cluster are part-time (less than 35 hours per week), and 86% work in the private sector. The most frequent occupations are warehousing and logistics (20%), selling groceries (19%), cleaning (16%) and driving (11%). Most report poor prospects for advancement (75%), lack of challenging tasks (64%) and a lack of autonomy at work (63%, by far the highest of all clusters). Tasks are especially often codified (38%) and involve repetitive movements (66%).

Cluster D features almost exclusively medium-level wages (95%). While only 36% of jobs are part-time, two in five contracts are temporary and the share of insecure jobs (64%) is higher than in all other clusters. Most employees (70%) work in the private sector, half of them are women, and especially many have children (61%). Frequent occupations include warehousing and logistics (28%), education and social work (24%), driving (13%) and cleaning (8%). Two in five do not find their tasks challenging, close to half (47%) report having little autonomy, and many see poor prospects for advancement (73%). In Cluster D, far more employees than in other clusters have poor work relations with their supervisor (48%) or colleagues (26%).

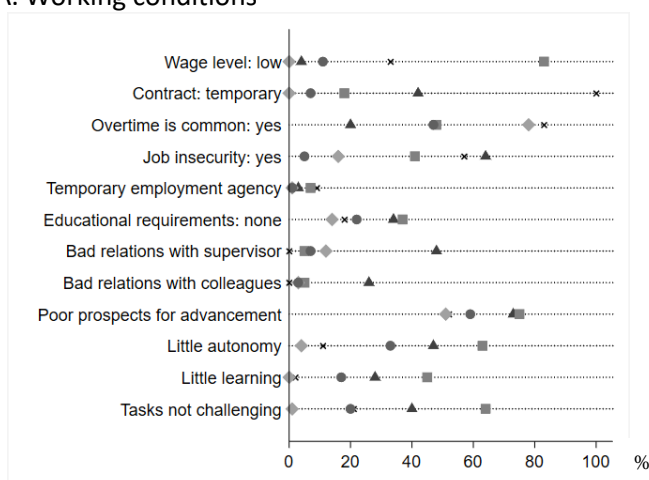
Finally, employees in Cluster E have virtually always temporary contracts, and half of them work part-time. Overtime is especially frequent (83%) and one-third of wages are low although almost half of the jobs are in the public sector. Main occupations are education and social work (26%), public administration (23%), warehousing and logistics (16%) as well as farming (7%). Only 11% report having little autonomy and very few (2%) report a lack of opportunities to learn. While these employees are also often expected to advise and inform (65%), the pace of their work is comparatively often determined by equipment (31%) and repetitive movements are rarer than in most other clusters (52%).

The results across clusters appear to confirm a central concern in the context of essential occupations: comparatively poor working conditions in clusters C and D coincide with comparatively low job tenure, a signal for high employee turnover. While the average tenure with the current employer reaches 10 years in Cluster A and almost 13 years in cluster B, it is around 6 years in clusters C and D (see Table A4). It is unlikely that the relatively small number of recent migrants – who naturally tend to have lower tenure due to their recent arrival – can explain this rather large difference. Temporary contracts are substantially more frequent in Cluster C and especially Cluster D than in clusters A and B. They might per se explain much of the difference in job tenure but might also contribute to higher voluntary employee turnover, alongside similar effects from other unfavourable job characteristics. The very low average job tenure in Cluster E (under 3 years) likely reflects the virtual absence of permanent contracts in this cluster, and possibly also the tendency for employees in Cluster E to be younger and more often single than employees in other clusters.

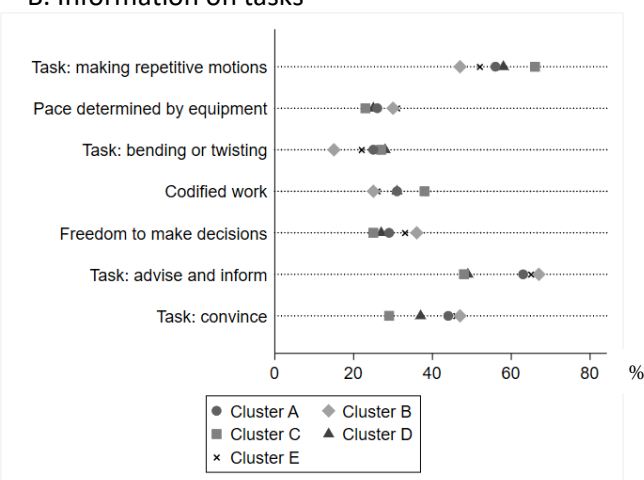
From a comparative view of the results for identified clusters (Figure 2), a number of further patterns emerge. Indicators for poor working conditions (Panel A) nearly always apply to more jobs in cluster C than in clusters A and B. Cluster D also exhibits worse working conditions than clusters A and B, with the notable exceptions of wages and overtime. While clusters C and D therefore both exhibit comparatively poor working conditions, Cluster C fares better than Cluster D on some indicators but worse on others. Results are mixed for Cluster E: while it is close to clusters A and B on many indicators, it exhibits poor working conditions in terms of contract duration and job security.

Figure 2. Patterns emerging from clusters

A. Working conditions



B. Information on tasks



Note: See Table A4 for detailed results.

Source: Own analyses based on the Panel Study Labour Market and Social Security, 2016-2018 (Panel A) and BIBB data on tasks (Panel B).

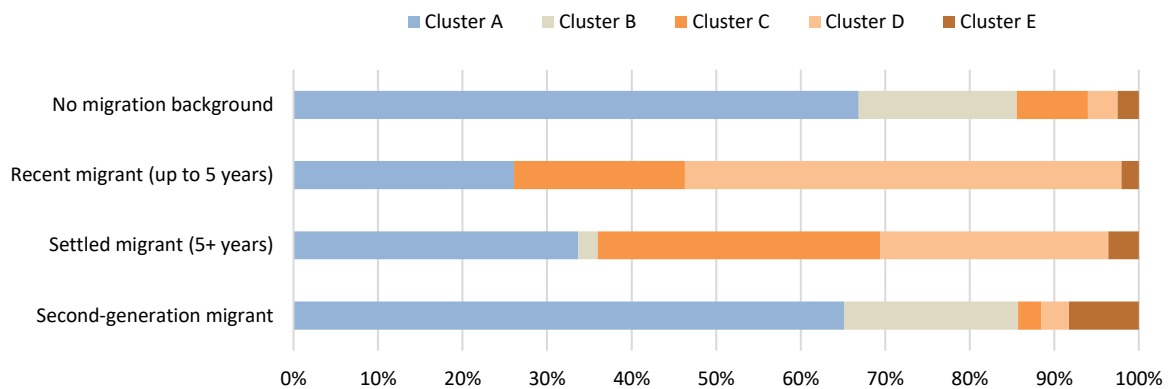
Relative to other clusters, clusters C and D typically exhibit the highest shares of jobs that involve repetitive motions, bending or twisting (Panel B of Figure 2). At the same time, clusters C and D exhibit the lowest shares of jobs that leave workers the freedom to make decisions or involve such tasks as convincing, advising or informing. The “dull” nature of these jobs does not appear to be driven by the requirements of equipment such as machines, which appear to shape jobs in clusters C and D slightly

less often than in other clusters. The results on tasks in Panel B therefore broadly align with the results in Panel A, although the two panels are based on different data sets.

5. The role of migrants

From the cluster analysis, it emerges that migrants are especially frequent in clusters with rather bad working conditions (C and D) compared with native-born persons, including second-generation migrants (Figure 3). Earlier findings that migrants are overrepresented where working conditions are unfavourable (e.g. Ruhs and Anderson, 2010, Benach et al., 2010, Gundert et al., 2020) and tasks are more often manual (Cassidy, 2019) therefore seem to extend to essential occupations. The detailed data here also point to potential drivers of this pattern. Firstly, 37% of jobs in cluster C and 34% in cluster D do not require any professional qualification (Table A4), compared with 14-22% in other clusters. Jobs in clusters C and D therefore appear much more accessible to workers without formal professional qualifications, and migrants fall comparatively often into this category (Table 1).

Figure 3. Sample distribution over clusters, by migration background



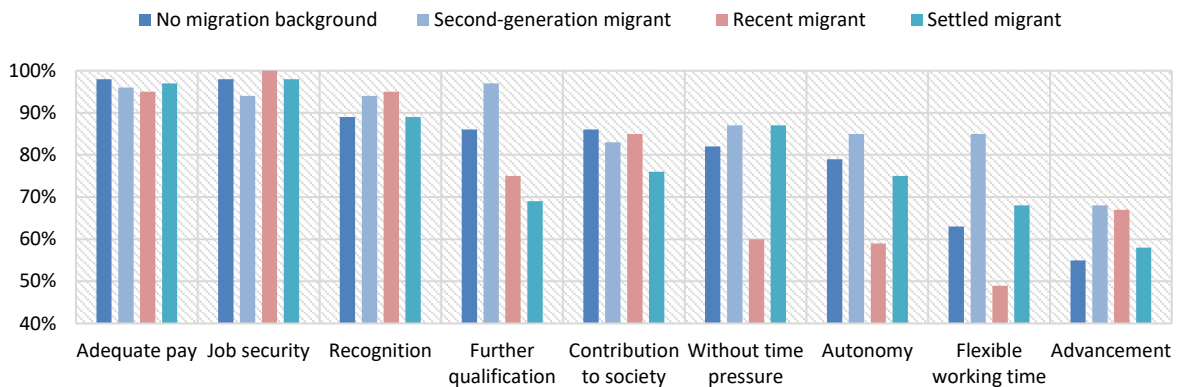
Note: Migrants with a duration of stay up to 5 years are considered recent migrants, and settled migrants otherwise. A native-born person with at least one migrant parent is considered a second-generation migrant.

Source: Own analyses based on the Panel Study Labour Market and Social Security, 2016-2018

Secondly, it is worth noting that half of the recent migrants work in Cluster D, which in many respects offers the worst working conditions. Clusters C and D together account for more than 70% of recent migrants in essential occupations. In contrast, they virtually never work in Cluster B, which arguably offers the best working conditions. Recent migrants can be under particular pressure to work, in order to earn a living, send remittances or meet the conditions for staying. In addition, the terms of their residence permit might make changing employer or occupation difficult. They might therefore be more willing to accept bad working conditions than settled migrants who have a more long-term residence status, fewer limitations in their job choice and better access to social benefits.

The survey data used here include direct evidence on which job characteristics workers consider important (Figure 4): working without time pressure, autonomy and flexible working time appear comparatively less important for recent migrants. This matches the comparatively high shares of jobs with little autonomy in clusters C and D, confirmed by comparatively limited freedom to make decisions and codified and repetitive work being frequent (Table A4). This suggests that recent migrants might especially often work in clusters C and D partly because they more readily accept some aspects of these jobs.

Figure 4. Survey responses on which job characteristics are considered important, by migration background



Note: Migrants with a duration of stay up to 5 years are considered recent migrants, and settled migrants otherwise. A native-born person with at least one migrant parent is considered a second-generation migrant.

Source: Own analyses based on the Panel Study Labour Market and Social Security, 2016-2018

While this reasoning is limited by the possibility that responses in Figure 4 also reflect expectations of which jobs are attainable, Zwysen and Demireva (2020) have recently reported a related finding: ethnic minorities and especially migrant men in the United Kingdom appear more likely to accept a bad job instead of not working, compared with white British workers. However, it is not clear to what extent their finding is driven by recent migrants.

Finally, it is worth noting that results for second-generation migrants are close to the results for persons without migration background, much closer than to the results for migrants. Second-generation migrants exhibit a similar distribution over clusters to persons without migration background (Figure 3), with the exception that they are more frequent in Cluster E (where they make up 17%). Also their responses in Figure 4 are typically close to those of persons without migration background. However, second-generation migrants stand out from all other groups in their interest in opportunities for further qualifications and flexible working time.

6. Conclusions

Most jobs in essential occupations in Germany are standard jobs with average or good working conditions, including most jobs in health services. Bad working conditions and routine tasks mostly arise in a few occupations, notably cleaning, logistics/warehousing, social work and certain forms of care. However, the analysis has gone beyond occupations, showing that “good” and “bad” jobs coexist within the same occupation.

Among jobs in essential occupations, those with bad working conditions exhibit relatively high shares of migrants, which aligns with findings on migrant employment more generally. This pattern likely reflects educational requirements and job search priorities of recent migrants, among other factors. Such “bad” jobs may be especially problematic in this context: by generating high staff turnover or permanent shortages, they could undermine the resilience of the services that essential occupations provide during crises.

This implies that policies seeking to ensure resilience during crises should pay close attention to low-quality jobs in essential occupations: do these jobs have lower quality because they can rely on migrants and notably recent migrants to put up with it? Or do such jobs necessarily arise in essential services, and ensuring that they are filled includes recruiting migrants? The answer would not only inform migration policy but also policies and institutions that shape essential occupations.

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Appendix

Table A1. List of essential occupations in Germany and representation in the sample

KI dB group	Description	Sample size	Share of sample
111	Occupations in farming	25	2%
112	Occupations in animal husbandry	7	<1%
113	Occupations in horsekeeping	4	<1%
114	Occupations in fishing	0	<1%
115	Occupations in animal care	4	<1%
116	Occupations in vini- and viticulture	4	1%
343	Occupations in building services and waste disposal	31	1%
433	Occupations in IT-network engineering, IT-coordination, IT-administration and IT-organisation	36	2%
511	Technical occupations in railway, aircraft and ship operation	3	<1%
512	Occupations in the inspection and maintenance of traffic infrastructure	5	<1%
513	Occupations in warehousing and logistics, in postal and other delivery services, and in cargo handling	373	14%
515	Occupations in traffic surveillance and control	15	1%
521	Driver of vehicles in road traffic	197	8%
522	Drivers of vehicles in railway traffic	7	1%
531	Occupations in physical security, personal protection, fire protection and workplace safety	89	3%
532	Occupations in police and criminal investigation, jurisdiction and the penal institution	2	<1%
533	Occupations in occupational health and safety administration, public health authority, and disinfection	5	<1%
541	Occupations in cleaning services	251	4%
623	Sales occupations (retail) selling foodstuffs	203	7%
624	Sales occupations (retail) selling drugstore products, pharmaceuticals, medical supplies and healthcare goods	22	2%
732	Occupations in public administration	171	9%
811	Doctors' receptionists and assistants	94	4%
812	Laboratory occupations in medicine	21	2%
813	Occupations in nursing, emergency medical services and obstetrics	186	11%
814	Occupations in human medicine and dentistry	26	1%
818	Occupations in pharmacy	22	1%
821	Occupations in geriatric care	206	7%
831	Occupations in education and social work, and pedagogic specialists in social care work	446	18%
	Total sample size	2455	100%

Note: "KI dB group" refers to groups in the 2010 occupational classification in Germany ("Klassifikation der Berufe") at the 3-digit level. This selection of groups to operationalise the official list of essential occupations follows Koebe et al. (2020) but adds several occupational groups in agriculture, which were considered essential occupations in most states of Germany. Shares of the sample are the shares after weighting observations.

Table A2. Overview of essential sectors in the United States, Italy and Spain

Infrastructure and services				Agriculture and industry			
energy, water and fuels				agriculture	11	11	
wholesale and logistics			1	food processing			
retail of food products	3	1	1	textiles & clothes	12	12	12
transport incl. delivery services	4			wood and paper products			
vehicle repair				chemicals and pharmaceuticals			
machine installation and repair	2		(repair)	plastic and glass products	13		
IT and communications repair				medical equipment			
household appliance repair				hygiene products			
waste disposal			1	metal products			
civil engineering				building materials			
other construction	5	6		agricultural equipment			14
communications incl. call centres				generators, batteries, heatings			
emergency services and police			1	machines for packing/ dosing			
defense				IT/ communications hardware			9
financial services and insurance			7	firearms and ammunitions			
social security administration	8		1				
legal services							
real estate services							
business administration	2						
scientific and technical activities			9				
hotels							
temporary employment agencies		2					
healthcare							
social care services and clergy							
cleaning and security services							
education	10						
associations and trade unions							
domestic employment							
media							

Source: own analysis of the official documents published in March 2020 by the Cybersecurity & Infrastructure Security Agency of the U.S. Department of Homeland Security (<https://www.cisa.gov/publication/guidance-essential-critical-infrastructure-workforce>), the Government of Spain (*Boletín oficial del Estado* No. 73 of 18 March 2020 as well as the *Borrador de orden ministerial por la que se declaran determinadas actividades industriales como de especial consideración* of 14 March 2020 by the Ministry of Industry, Commerce and Tourism) and the Italian Minister of the Economy (<https://www.gazzettaufficiale.it/eli/id/2020/03/26/20A01877/sg>).

Table A3. Selection of the preferred model in the Latent Class Analysis

Number of clusters	LL	BIC(LL)	CAIC(LL)
1	-10811,8398	21740,7678	21755,7678
2	-10499,138	21193,423	21218,423
3	-10404,4319	21082,0696	21117,0696
4	-10354,9016	21061,0679	21106,0679
5	-10303,6429	21036,6093	21091,6093
6	-10283,8176	21075,0175	21140,0175
7	-10249,97	21085,3811	21160,3811
8	-10212,0847	21087,6694	21172,6694
9	-10195,1955	21131,9498	21226,9498
10	-10137,1866	21093,9907	21198,9907

Note: LL refers to the log-likelihood. BIC and CAIC refer to the Bayesian Information Criterion and the Copula Information Criterion, respectively.

Table A4. Detailed description of the clusters resulting from the Latent Class Analysis

	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E
Share in sample	61%	16%	12%	8%	3%
<i>Indicators used to define clusters in the Latent Class Analysis</i>					
Wage level: low	11%	0%	83%	4%	33%
Wage level: medium	66%	30%	1%	95%	56%
Wage level: high	22%	70%	16%	1%	11%
Contract: permanent	93%	100%	82%	58%	0%
Contract: temporary	7%	0%	18%	42%	100%
Hours: fixed	89%	2%	99%	98%	47%
Hours: flexible	11%	98%	1%	2%	53%
Overtime is common: no	53%	22%	52%	80%	17%
Overtime is common: yes	47%	78%	48%	20%	83%
Job insecurity: no	95%	84%	59%	36%	43%
Job insecurity: yes	5%	16%	41%	64%	57%
Bad work relations: no	91%	86%	90%	32%	100%
Bad work relations: yes	9%	14%	10%	68%	0%
Bad conditions: low	63%	97%	17%	32%	96%
Bad conditions: med.	27%	3%	30%	40%	4%
Bad conditions: high	10%	0%	54%	28%	0%
<i>Indicators used to describe clusters (PASS)</i>					
Share of women	64,69%	48,05%	61,97%	49,27%	70,71%
Mean age (years)	43,2	43,7	43,5	39,8	35,9
Children: No	58%	58%	54%	39%	54%
Children: 1	19%	22%	21%	23%	21%
Children: 2 – 3	18%	16%	19%	17%	26%
Children: >3	6%	4%	7%	21%	0%
Family status: Single	28%	18%	22%	11%	43%
Family status: Couple	59%	63%	52%	68%	51%
Family status: Divorced, Widowed	13%	19%	26%	20%	6%
No migration background	84%	90%	54%	34%	64%
Recent migrant (up to 5 years)	1%	0%	4%	14%	1%
Settled migrant (5+ years)	8%	2%	41%	50%	18%
Second-generation migrant	7%	8%	1%	2%	17%
Education level: Low	26%	10%	41%	44%	16%
Education level: Medium	60%	43%	48%	34%	62%
Education level: High	15%	47%	10%	22%	22%
Total work experience (years)	20,8	21,2	17,4	14,8	10,1
Tenure with current employer	10,0	12,7	6,2	6,0	2,7
Part-time (< 35 h)	42%	28%	51%	36%	50%
Public sector	32%	52%	14%	30%	48%
Temporary employment agency	1%	1%	7%	3%	9%
Bad work relations: Supervisor	7%	12%	5%	48%	0%
Bad work relations: Colleagues	3%	3%	5%	26%	0%
Bad conditions: Poor prospects for advancement	59%	51%	75%	73%	52%
Bad conditions: Little autonomy	33%	4%	63%	47%	11%
Bad conditions: Little learning	17%	0%	45%	28%	2%
Bad conditions: Tasks not challenging	20%	1%	64%	40%	21%
Language skills: Native or very good	95%	99%	66%	59%	96%
Language skills: Good	3%	1%	14%	19%	2%
Language skills: Average	2%	0%	18%	17%	2%
Language skills: Low/ very low	0%	0%	1%	5%	0%

Table A4 (cont.). Detailed description of the clusters resulting from the Latent Class Analysis

	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E
<i>Indicators used to describe clusters (BIBB)</i>					
Task: Making repetitive motions	56%	47%	66%	58%	52%
Task: Pace determined by equipment	26%	30%	23%	25%	31%
Task: Bending or twisting	25%	15%	27%	28%	22%
Codified work	31%	25%	38%	31%	26%
Freedom to make decisions	29%	36%	25%	27%	33%
Task: Advise and inform	63%	67%	48%	49%	65%
Task: Convince	44%	47%	29%	37%	46%
Educational requirements: None	22%	14%	37%	34%	18%
Educ. requirements: Professional educ.	59%	52%	55%	52%	56%
Educational requirements: Advanced professional education	6%	6%	4%	5%	6%
Educational requirements: University	14%	27%	3%	9%	20%
Required: project management	8%	15%	5%	7%	11%
Required: computer literacy	24%	39%	16%	18%	30%
Required: technical know-how	19%	22%	21%	17%	18%
Required: mathematics	11%	16%	9%	8%	15%

Source: own analyses based on the Panel Study Labour Market and Social Security, 2016-2018 and BIBB data on tasks and educational requirements.

Table A5. Shares of essential occupations by cluster

	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E
<i>Shares of essential occupations (PASS)</i>					
Occupations in farming	1%	3%	2%	--	7%
Occupations in animal husbandry	--	1%	--	--	--
Occupations in horsekeeping	--	--	--	--	--
Occupations in fishing	--	--	--	--	--
Occupations in animal care	--	--	--	--	1%
Occupations in vini- and viticulture	1%	--	--	--	4%
Occupations in building services and waste disposal	1%	--	1%	5%	--
Occupations in IT-network engineering, IT-coordination, IT-administration and IT-organisation	1%	7%	--	--	--
Technical occupations in railway, aircraft and ship operation	--	--	--	--	--
Occupations in the inspection and maintenance of traffic infrastructure	--	--	--	--	--
Occupations in warehousing and logistics, in postal and other delivery services, and in cargo handling	14%	2%	20%	28%	16%
Occupations in traffic surveillance and control	1%	4%	--	--	--
Driver of vehicles in road traffic	8%	8%	11%	13%	--
Drivers of vehicles in railway traffic	1%	--	5%	--	--
Occupations in physical security, personal protection, fire protection and workplace safety	2%	6%	4%	2%	5%
Occupations in police and criminal investigation, jurisdiction and the penal institution	--	--	--	--	--
Occupations in occupational health and safety administration, public health authority, and disinfection	1%	--	--	--	--
Occupations in cleaning services	3%	--	16%	8%	1%
Sales occupations (retail) selling foodstuffs	6%	4%	19%	4%	3%
Sales occupations (retail) selling drugstore products, pharmaceuticals, medical supplies and healthcare goods	2%	--	1%	1%	1%
Occupations in public administration	6%	30%	--	--	23%
Doctors' receptionists and assistants	5%	--	6%	3%	1%
Laboratory occupations in medicine	2%	1%	--	--	--
Occupations in nursing, emergency medical services and obstetrics	15%	3%	5%	4%	6%
Occupations in human medicine and dentistry	2%	3%	--	--	--
Occupations in pharmacy	2%	1%	--	--	--
Occupations in geriatric care	9%	2%	6%	6%	5%
Occupations in education and social work, and pedagogic specialists in social care work	18%	24%	4%	24%	26%

Source: own analyses based on the Panel Study Labour Market and Social Security, 2016-2018 and BIBB data on tasks and educational requirements.

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