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# FDZ-METHODENREPORT

Methodological aspects of labour market data

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# Smoothing the Turmoil: Harmonization of the 1988 Occupation Codes over Time

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Die FDZ-Methodenreporte befassen sich mit den methodischen Aspekten der Daten des FDZ und helfen somit Nutzerinnen und Nutzern bei der Analyse der Daten. Nutzerinnen und Nutzer können hierzu in dieser Reihe zitationsfähig publizieren und stellen sich der öffentlichen Diskussion.

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# Zusammenfassung

Dieser Bericht adressiert die Herausforderungen, die die Einführung der Klassifikation der Berufe (KldB) 2010 für eine konsistente Analyse von Erwerbsbiografien in Deutschland mit sich brachte. Das offizielle Umcodierungsschema zwischen der alten KldB 1988 und der neuen KldB 2010 ist bislang zu ungenau, was zu strukturellen Brüchen in der Entwicklung berufsspezifischer Beschäftigungsanteile führt. Diese Strukturbrüche erschweren die Forschung zu Erwerbsbiografien, da sie Ergebnisse möglicherweise verzerren und den Analysezeitraum einschränken. Zur Lösung dieser Probleme entwickle ich einen Algorithmus, der die KldB 1988 auf Basis der Stichprobe der Integrierten Arbeitsmarktbiografien (SIAB) harmonisiert. Dazu werden 1988er-Berufe mit divergierenden Trends zusammengefasst und bestimmte 2010er-Berufscodes passenderen 1988er-Berufen neu zugeordnet. Der Harmonisierungsalgorithmus reduziert den Beschäftigungsanteil der 1988er-Berufe, die von starken Strukturbrüchen betroffen sind, von 34 auf etwa ein Prozent und ermöglicht eine konsistente Analyse von Erwerbsbiografien über mehr als 30 Jahre.

## Abstract

This report addresses the challenges that the introduction of the 2010 occupational classification system poses for consistent analysis of employment biographies in Germany. The official transcoding scheme between the old classification of 1988 and the new classification of 2010 has so far been too imprecise, causing structural breaks in the evolution of occupation-specific employment shares. These structural breaks complicate research on employment biographies, potentially biasing results and restricting the analysis period. To tackle these issues, I propose an algorithm that harmonizes the 1988 occupation codes, based on the Sample of Integrated Labor Market Biographies (SIAB). It involves aggregating the 1988 occupations with diverging trends and reassigning specific 2010 occupation codes to more applicable 1988 occupations. The harmonization algorithm reduces the total employment share of the 1988 occupations with severe structural breaks from 34 to about one percent, allowing for a consistent analysis of employment biographies for over 30 years.

## Keywords

KldB 1988, KldB 2010, Occupations, Sample of Integrated Labour Market Biographies (SIAB)

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# 1 Introduction

In 2010, a new occupational classification system was introduced in Germany. A modern classification that mirrors contemporary occupational patterns and fosters comparability to the current International Standard Classification of Occupations from 2008 (ISCO-08) was long overdue. Over time, there have been regular updates to the classification system, each accompanied by an official transcoding scheme between the new and old occupation codes. This transcoding scheme allows occupations to be harmonized over time, either to the old classification of 1988 or to the new classification of 2010.<sup>1</sup> However, with the most recent update, the classification system changed in such an inherent way that the official transcoding scheme was condemned to be very imprecise. The imprecision becomes evident when analyzing annual occupation-specific employment shares for the officially harmonized 1988 classification. Over one-third of employees are in occupations that seem to have experienced a structural break after 2010, highlighting the stark inconsistencies in the current harmonization and an urgent need for improvement.

These structural breaks are highly problematic for research analyzing employment biographies. First, they could directly distort occupation fixed effects or other occupation-specific controls, consequently biasing estimation results. Second, they limit the potential analysis period. To date, examining individuals' occupations consistently and without distortions over a period extending beyond the introduction of the 2010 classification has been challenging. As a result, most studies either investigate the period before (e.g., Böhm et al., 2024; Jarosch, 2023; Bächmann et al., 2022) or after 2010 (e.g., Damelang and Otto, 2024).

In this report, I suggest an algorithm that harmonizes the 1988 occupation codes over time. I developed the algorithm based on the Sample of Integrated Labor Market Biographies (SIAB) provided by the Institute for Employment Research (IAB), but it is also applicable to other data sets for which time-consistent 1988 occupation codes are desirable. First, I document the evolution of occupation-specific employment shares in Germany from 1985 to 2017 based on the officially harmonized 1988 occupation variable that the SIAB already contains.<sup>2</sup> This analysis allows me to identify problematic 1988 occupations with structural breaks after 2010.

Second, I establish an algorithm that transcodes the underlying 2010 occupations to more suitable 1988 occupations if appropriate. Through aggregation, I can further mitigate the structural breaks in the data while reducing the potential for misclassification. The proposed harmonization algorithm reduces the total employment share of 1988 occupations with severe structural breaks to about one percent. Although the algorithm cannot fully dissolve the turmoil after 2010, it significantly mitigates the structural breaks for most afflicted occupations and makes employment biographies comparable for over 30 years.

In the following, Section 2 outlines the underlying reasons for the structural breaks in the data. Section 3 describes the data used to develop the algorithm. Section 4 illustrates the status quo, i.e., the evolution of occupation-specific employment shares without the suggested

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<sup>1</sup> In German, the occupational classification system is called 'Klassifikation der Berufe' (KldB). The KldB 1988 and KldB 2010 refer to the classification system of the respective year.

<sup>2</sup> In the SIAB this variable is called `beruf`. It is at the 3-digit level and encompasses about 330 different occupation codes. According to Antoni et al. (2019, p. 45), "[e]mployment notifications with an end date later than 30 November 2011 are reported using the new occupation code 2010 [...]. These values are transcoded to the [1988 classification] via a priority switch."

harmonization algorithm. Section 5 describes the algorithm. Section 6 illustrates the evolution of employment shares after implementing the algorithm. Section 7 concludes.

## 2 Background

In Germany, employers must submit occupational (and other) information to the social security authorities. Up until 2011, employers still reported their employees' occupations using the 1988 classification. They officially switched to the new classification from December 2011 onward. During the transition period in 2011 and 2012, employers were granted time to adjust their reporting scheme to the new classification, resulting in significant gaps in occupational information (Bertat et al., 2013).

In principle, the newly reported 5-digit 2010 occupation codes can be converted back to the old 3-digit 1988 occupation codes following the official transcoding scheme provided by the Federal Employment Agency (FEA, 2011a). However, there are two reasons why the FEA's transcoding scheme was less successful than in preceding reclassifications.

First, the conversion from a given 2010 occupation code to its corresponding 1988 occupation code is sometimes unclear and could have multiple alternatives, i.e., one could assign the same 2010 occupation to several different 1988 occupation codes. For instance, *unskilled technical occupations in paper making, processing, or packaging (23101)* could be assigned to three different 1988 occupations: *paper makers (161)*, *packaging makers (162)*, and *other paper producers (164)*. Although converting the granular 5-digit 2010 occupations into more aggregated 3-digit 1988 occupations is less prone to misspecification than striving for more detailed occupation codes, the issue of multiple alternatives still plays an essential role. To address this ambiguity, the official transcoding scheme assigns a given 2010 occupation to the 1988 occupation that occurs most frequently, which may cause inaccuracies. These inaccuracies would be even stronger when transcoding the more aggregate 1988 occupations into the granular 2010 occupations for the period before 2010. Therefore, the 1988 classification is better suited for harmonization over time. However, compared to preceding occupational classification systems, the changes made in the 2010 classification are much more drastic. For instance, the inclusion of the skill requirement in the new classification allows for differentiation within the same occupation.<sup>3</sup> Another novelty is the distinction between specialists, supervisors, and executives. These new possibilities for differentiation increase ambiguity and thus lead to more inaccuracies in the official transcoding scheme.

Second, the introduction of the 2010 classification caused updating effects. According to Dreyer-Tümmel et al. (1997), incorrect reports of occupations do not lead to financial consequences for employers. Therefore, occupational information should be taken with a grain of salt. The high number of cases in residual categories, such as *assistants without further specification (531)* or *other engineers (607)* in the 1988 classification, also suggests that employers did not assign occupations to their employees without flaws. Inaccuracies and confusion were likely. Furthermore, it is questionable whether employers report occupation changes within the same job match/employment relation. The authors attribute this to the Data Collection and Transmission

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<sup>3</sup> The 2010 classification distinguishes between the following requirement levels: (1) unskilled or semi-skilled activities, (2) specialist activities, (3) complex specialist activities, and (4) highly complex activities.

Ordinance<sup>4</sup>, which does not clearly indicate whether updating employees' occupations is prescribed (Dreyer-Tümmel et al., 1997). According to Ganzer et al. (2020), "the introduction of the new occupation code prompts employers to check and, if necessary, to update the information they have so far reported about their employees" (p. 15). Moreover, the FEA's online tool made it reasonably easy for employers to research their employees' correct 2010 occupation code.<sup>5</sup> Thus, it is unsurprising that the introduction of the 2010 classification led to updating effects.

Instead of an imprecise transcoding scheme based on frequencies, it would be desirable to exploit data-driven machine learning methods to predict an individual's 1988 occupation after 2010 based on her (job) characteristics while minimizing the mean squared error. There are two problems regarding this approach. First, there is no year in which the reporting according to both occupational classification systems overlaps. As a result, validation with true 1988 occupation codes after the introduction of the 2010 classification is not possible. Second, even when conditioning on job stayers at the same establishment between the last valid year of the 1988 classification and the first valid year of the 2010 classification to infer corresponding occupations, there are not enough relevant predictors available. While an individual's gender, age, education, wage, tenure, part-/full-time employment status, industry, and her (5-digit) 2010 occupation code are important predictors, they do not have enough predictive power to outperform the FEA's transcoding scheme.

Therefore, this report introduces a replicable algorithm that harmonizes 1988 occupation codes over time through manual aggregation and reassignment. Although the algorithm cannot fully dissolve the turmoil after 2010, it significantly mitigates the structural breaks and makes employment biographies comparable for over 30 years. The following section presents the data used to develop the algorithm.

### 3 Data

The developed harmonization algorithm builds on a two percent random sample drawn from all individuals registered in the German social security system, i.e., the Sample of Integrated Labor Market Biographies (SIAB) provided by the Institute for Employment Research (IAB). The SIAB is representative at the aggregate level of regions, industries, and occupations, permitting a detailed analysis of the occupational classification system in Germany. It comprises administrative records on workers' employment and earnings histories with daily precision and, thus, comes with high quality. In addition to employment status, wage, occupation, industry, and workplace region, the data also include individuals' demographic characteristics (gender, age, education, and nationality). As this analysis requires highly detailed occupational information, it relies on the weakly anonymous version of the SIAB.<sup>6</sup>

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<sup>4</sup> Commonly known as 'Datenerfassungs- und übermittlungsverordnung' (DEÜV) in German.

<sup>5</sup> The applicable 2010 occupation code can be determined online at: <https://web.arbeitsagentur.de/taetigkeitsschluesel/>

<sup>6</sup> In its weakly anonymous version (DOI:10.5164/IAB.SIAB7517.de.en.v1), the 2010 occupation variable can be requested at the 5-digit level. Access to the SIAB data is provided by the Research Data Centre (FDZ) of the German Federal Employment Agency (FEA) at the Institute for Employment Research (IAB).



Notably, the SIAB comes with two different occupation variables containing the officially harmonized codes<sup>7</sup> according to the 1988 classification at the 3-digit level (`beruf`) and the 2010 classification at the 4-digit level (`beruf2010_4`). Combining the 4-digit 2010 occupation code with the required skill level (`niveau`) allows me to construct the corresponding 5-digit 2010 occupation variable (`beruf2010_5`). According to Antoni et al. (2019), `beruf` contains the reported 1988 occupation codes for employment notifications with an end date before 1 December 2011 and their transcoded version based on the 2010 occupation codes for employment relationships that ended after this cutoff date. Conversely, `beruf2010_5` contains the reported 2010 occupation codes for notifications with an end date after the cutoff and was transcoded from the 1988 occupation codes for employment relationships that ended earlier.

For comparability, this study focuses on West Germany—the primary research target in the past—from 1985 to 2017. In the Appendix, I replicate equivalent results for East Germany from 1992 to 2017.<sup>8</sup> I restrict the data to full- and part-time employed men and women aged 25 to 54 and construct an annual panel with each worker's main spell.<sup>9</sup> Additionally, I exclude observations from certain occupational categories that are not further specified or irrelevant to this analysis.<sup>10</sup>

In the data cleaning process, I closely follow the extensive SIAB guide provided by Dauth and Eppelsheimer (2020) with a few deviations. First, I modify the suggested wage imputation model in accordance with Dustmann et al. (2009), separating regressions by gender rather than education and exploiting a different set of covariates that interacts three education categories with six age categories. Second, due to a break in the part-time indicator in 2011, which led to an inconsistency in the data, I add the part-time correction of full-time spells developed by Fitzenberger and Seidlitz (2020) to the cleaning procedure. The part-time correction utilizes the imputed wage distribution, along with other characteristics, which is why it is important to emphasize the adjustments in the wage imputation. It allows me to generate (corrected) full-time equivalence weights, which I take into account when calculating occupation-specific employment shares.<sup>11</sup> Finally, I deal with missing observations for both occupation variables.

### Missing observations

According to Antoni et al. (2019, p. 45), "[t]here is a considerable increase in the number of missing values in 2011 due to the change in the occupation code". In the annual panel data of the SIAB, 97 percent of missing 1988 occupation codes concentrate indeed on the period after 2010. Overall, three percent of the officially harmonized 1988 occupation codes after 2010 are missing, 67 percent of them solely in 2011. Missing 1988 occupations after 2010 overlap entirely with missing

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<sup>7</sup> The official transcoding schemes from the 2010 classification to the 1988 classification and vice versa are provided by the Federal Employment Agency and available online after navigating to 'Tabellarische Umsteigeschlüssel zur KldB 2010 (erste Fassung)': <https://statistik.arbeitsagentur.de/DE/Navigation/Grundlagen/Klassifikationen/Klassifikation-der-Berufe/Archiv-KldB/KldB2010/KldB2010-Nav.html>

<sup>8</sup> Since the East German labor market administration had to be integrated into the West German administration after reunification, data for East Germany is only fully available from 1992 onward.

<sup>9</sup> I follow the SIAB data cleaning conventions and define the job with the longest tenure at the cutoff date (June 30 of each year) as the worker's main episode.

<sup>10</sup> I exclude observations with the following 1988 occupation codes: *disabled persons (555)*, *rehabilitants (666)*, *(unpaid) trainees and interns with recognized training occupation that is still to be specified (981 and 982)*, *workforce with occupation still to be specified (983)*, *workforce not further specified (991)*, *recipients of early retirement pension (995)*, *employees in partial retirement (996)*, and *recipients of compensations allowance (997)*.

<sup>11</sup> The corrected part-time indicator assigns a full-time weight between zero and one to each worker's annual main spell. Official part-time spells are weighted by 0.5, full-time spells by one, and corrected full-time spells take a value between zero and one (see Fitzenberger and Seidlitz, 2020). Then, I multiply the assigned full-time weight with the annual share of the actual employment duration in the potential employment duration. Hence, a worker employed full-time throughout the year will receive a full-time equivalence weight of one, whereas shorter employment spells will be given less weight.

2010 occupations. Thus, the gap in occupational information is clearly caused by unreported 2010 occupation codes that could not be transcoded into 1988 occupations. As pointed out by Bertat et al. (2013), the lack of reported 2010 occupation codes goes back to the granted transition period for employers.<sup>12</sup>

The absence of occupational reporting represents a different issue from the structural breaks analyzed below.<sup>13</sup> Nonetheless, it may lead to distortions. Therefore, I mitigate this problem by replacing an individual's missing occupation code in a given year with the occupation code of the previous employment episode, provided that the worker is still employed in the same establishment. If the previous occupation code is also missing, I replace it with the worker's following code that applies to the same establishment. Through this procedure, I can reduce the number of missing 1988 occupation codes in the overall sample by 75 percent and 95 percent in 2011 alone.

### Job-Stayer Sample

As part of the harmonization algorithm, it is also necessary to analyze the allocation of job stayers to occupations. The job-stayer sample further restricts the cleaned data to all workers employed at the same establishment in 2010 and 2012, i.e., those who most likely stayed in the same job when the new classification was introduced. While 2010 was the last year employers reported the 1988 occupations without interference from the introduction of the new classification system, 2012 marked the first year they reported the 2010 occupations without significant gaps. Although more restrictive, the evaluation results also apply to workers who did not switch establishments between 2010 and 2013.<sup>14</sup>

## 4 Status Quo

Figure 1 reports the status quo of the evolution of employment shares for officially harmonized 1988 occupations that are particularly problematic in the data, i.e., without the harmonization algorithm suggested in this report.<sup>15</sup> The structural breaks are striking. Figure 1 (a) displays that for 20 different 1988 occupations, the employment shares changed by more than 0.5 percentage points between 2010 and 2012. The severest structural break is visible for *office specialists (781)*, with a decrease in employment share of approximately three percentage points (22 percent). Notably, this occupation accounts for the largest employment share, with 10 to 14 percent over time. Figure 1 (b) illustrates the employment shares that dropped to zero after the introduction of the new classification system in 2010. In other words, it plots employment shares of those officially harmonized 1988 occupations to which none of the new 5-digit 2010 occupations codes were assigned. The number of occupations with sudden zero employment shares amounts to 56. Although their individual employment shares are comparatively low, with this large number of affected occupations, they add up to about 10 percent of full-time equivalence-weighted observations in the sample of workers in West Germany from 1985 to 2010. Until 2010, 34 percent of total employment belonged to those 1988 occupations that allegedly no longer exist (10

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<sup>12</sup> According to Antoni et al. (2019, p. 27), "[t]he test programs used in the notification procedure permitted missing details in the occupation code 2010 until the end of May 2012".

<sup>13</sup> It is not caused by the imprecise assignment of 2010 occupation codes to 1988 occupation codes in the Federal Employment Agency's transcoding scheme.

<sup>14</sup> 2013 is the first year without gaps in the reporting of 2010 occupation codes.

<sup>15</sup> As described above, the new 5-digit occupation codes after 2010 have already been transcoded to the 3-digit 1988 occupation codes according to the official transcoding scheme provided by the Federal Employment Agency (FEA, 2011a).

percent) or exhibit a severe structural break (24 percent) after 2010.<sup>16</sup> Thus, for empirical analyses of employment histories that span across 2010, it is inevitable to at least mitigate this problem.

**Figure 1: Evolution of Occupation-Specific Employment Shares in West Germany**



Notes: These figures depict the annual evolution of employment shares by 3-digit 1988 occupation in West Germany from 1985 to 2017. The sample includes both female and male workers covered by the social security system, aged 25 to 54. Annual employment shares are weighted using full-time equivalence weights. Official full-time spells are part-time corrected, following the procedure recommended by Fitzenberger and Seidlitz (2020). Figure (a) shows occupation-specific employment shares with a structural break of more than 0.5 percentage points between 2010 and 2012. Figure (b) shows occupation-specific employment shares, which drop to zero after 2010.

Source: Own calculations based on the SIAB provided by the IAB.

## 5 Harmonization Algorithm

This section describes the algorithm used to smooth out the turmoil. It focuses on the most problematic officially harmonized occupations with structural breaks of more than 0.5 percentage points or whose employment shares suddenly dropped to zero after 2010, as described in Section 4. Although I propose this harmonization algorithm as an additional data-cleaning step for the SIAB, it is also applicable to other data sets for which time-consistent 1988 occupation codes are required.<sup>17</sup>

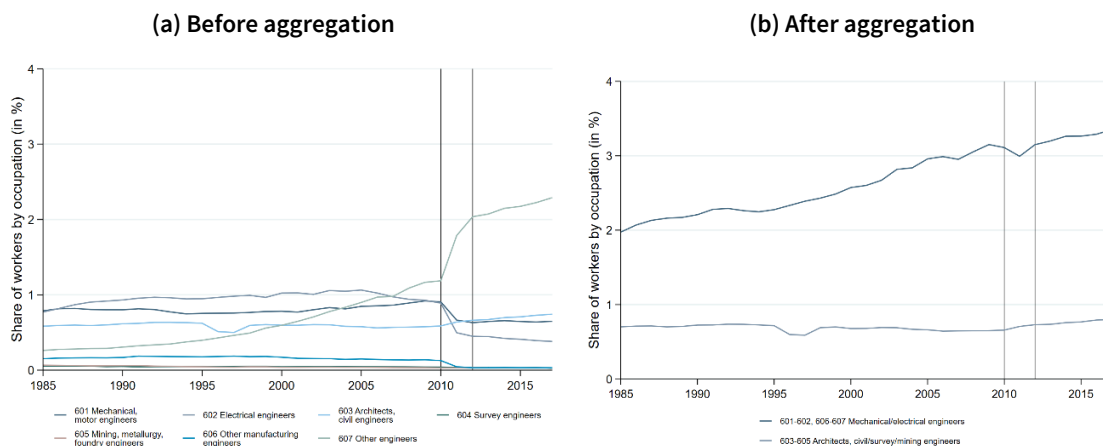
### 5.1 Aggregation of the 1988 Occupations

In the first step of this algorithm, I aggregate the officially harmonized 1988 occupations with diverging trends in their employment shares between 2010 and 2012 if they fit together in terms of content. Figures 2 (a) and (b) exemplify this method for different engineering occupations. While *other engineers' (607)* employment share increased by about one percentage point between 2010 and 2012 without aggregation in (a), the shares of *mechanical engineers (601)*, *electrical engineers (602)*, and *other manufacturing engineers (606)* decreased. As indicated in (b), aggregating *mechanical, electrical, and other engineers (601, 602, 606, and 607)*, and grouping engineers engaged primarily in construction-related tasks (603, 604, and 605) into a separate category, dissolves the structural breaks.

<sup>16</sup> Measuring the employment shares of afflicted occupations prior to the structural break is essential, as a relevant fraction of 1988 occupations vanishes from the data after 2010.

<sup>17</sup> Its prerequisites are 1988 occupation codes at the 3-digit level and 5-digit 2010 occupation codes from 2011 onward. Ideally, the 1988 occupations are already harmonized over time according to the official transcoding scheme.

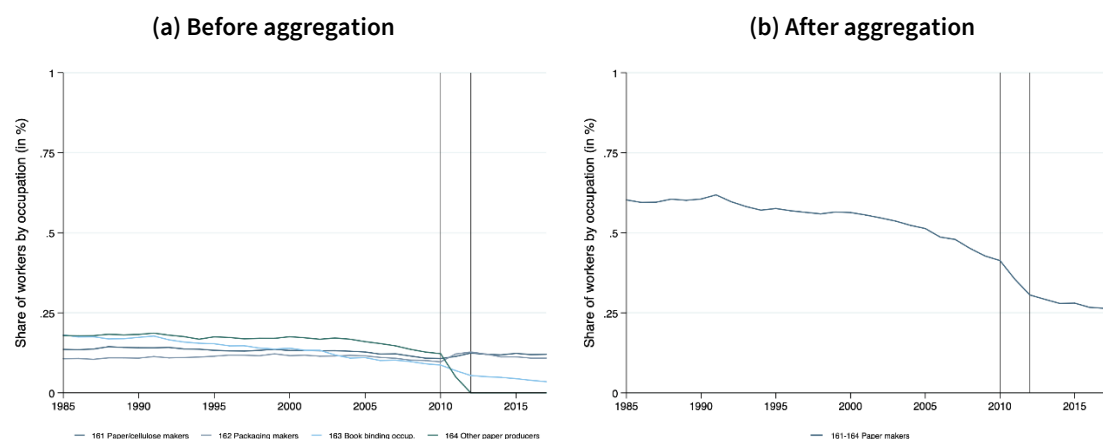
**Figure 2: Aggregation of the 1988 Occupations with Diverging Trends**



Notes: Figure (a) illustrates the evolution of employment shares of seven engineering occupations in the 1988 classification without the harmonization procedure suggested in this report. Figure (b) demonstrates how these shares changed after implementing the procedure. In this case, aggregating the 3-digit 1988 occupations 601-602 and 603-605 was sufficient to mitigate the structural breaks.

Source: Own calculations based on the SIAB provided by the IAB.

**Figure 3: Aggregation of the 1988 Occupations to Mitigate Zero Employment Shares**



Notes: Figure (a) depicts the evolution of employment shares of four paper manufacturing occupations in the 1988 classification without the harmonization procedure suggested in this report. Figure (b) illustrates how these shares changed after implementing the procedure. In this case, aggregating all 3-digit 1988 occupations (161-164) was sufficient to preserve the occupation with zero employment shares after 2010, i.e., *other paper producers* (164).

Source: Own calculations based on the SIAB provided by the IAB.

In contrast, when the evolution of employment shares is not diverging, and aggregation cannot dissolve the structural breaks, it can still be used to preserve the 1988 occupations to which none of the 2010 occupation codes is assigned. As demonstrated in Figure 3 (a), without the harmonization algorithm, the employment share of *other paper producers* (164) suddenly drops to zero after 2010. This sudden lack of employment is rooted in the official transcoding scheme, which does not assign any 2010 occupation to the 1988 occupation of *other paper producers* (164). Upon closer inspection, however, minor yet sudden changes in the time series for the remaining paper manufacturing occupations are also detectable after 2010.<sup>18</sup> These sudden interruptions could be caused by occupation switches within the same establishment, such as to a related

<sup>18</sup> This is the case, although the assignment from certain 2010 occupations to paper manufacturing occupations in the 1988 classification is sometimes even unique. For instance, *occupations in bookbinding and print finishing with complex tasks* (23423) are exclusively assignable to *bookbinding occupations* (163).

occupation within the same 2-digit category of paper manufacturing occupations. According to Dreyer-Tümmel et al. (1997), the employer was not explicitly obliged to report a worker's change in occupation. As a result, introducing the new classification system revealed workers' occupational changes.<sup>19</sup> As shown in Figure 3 (b), by aggregating all paper manufacturing occupations (161, 162, 163, and 164), I can mitigate these updating effects and prevent the employment share of *other paper producers (164)* from dissolving after 2010. Furthermore, misspecification is less likely to occur with aggregation, which justifies the loss of more granular (but potentially misclassified) information.

## 5.2 Manual Reassignment of the 2010 Occupations

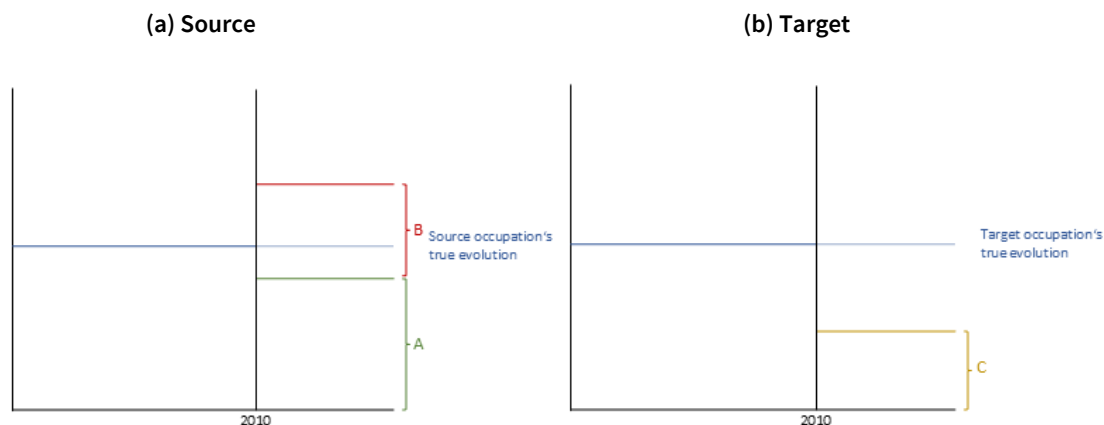
If aggregating the officially harmonized 1988 occupations does not mitigate the structural breaks, I analyze the more granular level of 5-digit 2010 occupations instead. More precisely, I revise the official transcoding scheme by reassigning certain 5-digit 2010 occupations to more suitable 3-digit 1988 occupations after 2010, provided that the resulting evolution of employment shares becomes smoother and the reassignment is plausible.

As illustrated in Figure 4, the aim is to smooth the evolution of both the source occupation to which the 2010 occupation code was initially assigned and the target occupation to which it should be reassigned. Ideally, the source occupation in (a) exhibits increased employment shares after 2010. Then, I can remove (some) of its assigned 2010 occupations to preserve the source occupation's true evolution of employment shares. For instance, occupation B in (a) would be a suitable candidate. In contrast, the target occupation in (b) should decrease after 2010, allowing me to preserve the true evolution by reassigning occupation B from the source to the target occupation. Unfortunately, the true evolution of employment shares remains unknown. To improve the harmonization of the 1988 occupation codes over time, I assume the true evolution after 2010 continues along its initial trend. In Appendix Table A.1, I document the reassigned 2010 occupations and their respective source and target occupations. I selected suitable 2010 occupations that could be reassigned based on three evaluation methods.

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<sup>19</sup> As part of the transition process to the new classification system, employers reviewed their employees' (outdated) occupational details and corrected them if necessary (Bertat et al., 2013).

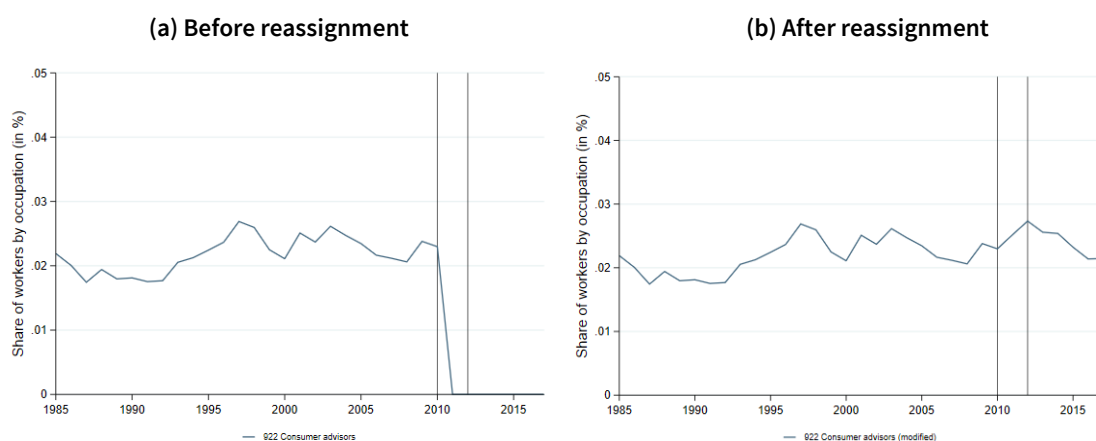
**Figure 4: Illustration of Manual Reassignment**



Notes: This figure illustrates the ideal evolution of employment shares of the 1988 source occupation to which the selected 2010 occupation code was initially assigned and the target occupation to which it should be reassigned.

Source: Own illustration.

**Figure 5: Manual Reassignment for Consumer Advisors (922)**



Notes: Figure (a) displays the evolution of consumer advisors' employment share in the 1988 classification without the harmonization procedure suggested in this report. Figure (b) illustrates how the share changed after implementing the harmonization procedure. In this case, reassigning the 5-digit 2010 *occupation with complex tasks in environmental protection administration and consulting (42313)* from the 3-digit 1988 occupation of *other technicians (628)* to *consumer advisors (922)* was necessary to mitigate the severe structural break after 2010.

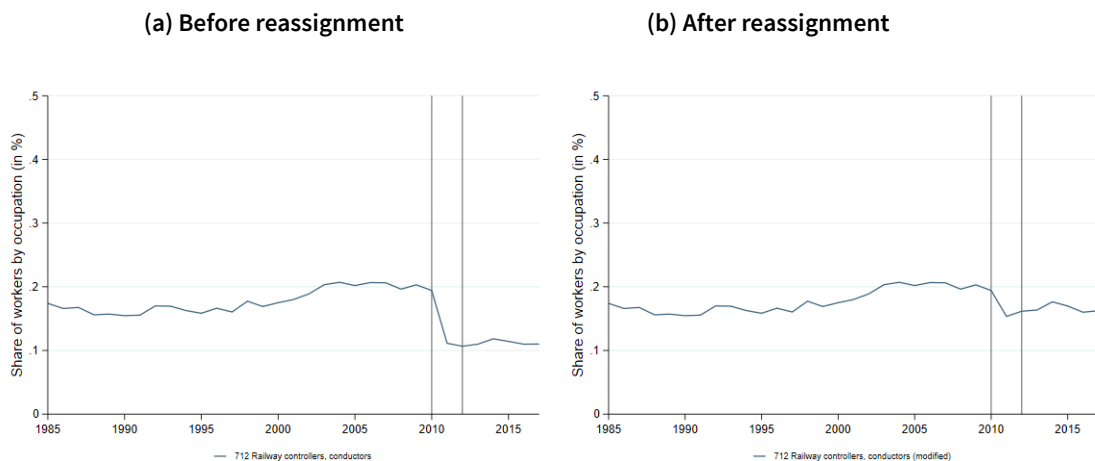
Source: Own calculations based on the SIAB provided by the IAB.

First, I take guidance from the *reversed* transcoding scheme that assigns 3-digit 1988 to 5-digit 2010 occupations after 2010 (FEA, 2011b). The *reversed* transcoding scheme provides a list of 1988 occupations related to a given 2010 occupation and indicates whether the assignment is unique or ambiguous. If ambiguous, I can justify reassigning the 2010 occupation to mitigate a structural break, as it may have a more suitable target occupation. For instance, consider *occupations with complex tasks in environmental protection consulting (42313)*, initially assigned to *other technicians (628)* according to the official transcoding scheme (FEA, 2011a). According to the *reversed* transcoding scheme (FEA, 2011b), five different 1988 occupations are related to the 2010 *occupation with complex tasks in environmental protection consulting (42313)*. Among them is the source occupation of *other technicians (628)* and the potential target occupation of *consumer advisors (922)*, with a structural break that reassignment could mitigate. Since the *reversed* transcoding scheme lists both, reassigning *occupations in environmental protection consulting (42313)* from *other technicians (628)* to *consumer advisors (922)* is justifiable. Figure 5 (a) illustrates

consumer advisors' structural break in employment shares under the initial assignment and how it changes to a much smoother development after reassignment in (b).<sup>20</sup>

Second, I select suitable 5-digit 2010 occupations for reassignment based on the allocation of job stayers. The job-stayer sample includes only workers employed at the same establishment in 2010 and 2012, i.e., workers who most likely remained in the same occupation (see Section 3 for more details). I analyze these job stayers' 3-digit 1988 occupations in 2010 (the last year without interference from the new classification) and their 5-digit 2010 occupations in 2012 (the first year without significant reporting gaps). For instance, the largest fraction (18 percent) of job stayers among the target occupation of *railway controllers or conductors (712)* in 2010 were employed as *supervisors in traffic surveillance and control (51593)* in 2012. Moreover, 56 percent of *supervisors in traffic surveillance and control (51593)* in 2012 had been employed as *railway controllers or conductors (712)* in 2010. In contrast, only 16 percent were employed as *other traffic controllers or conductors (713)*. The fraction that belonged to other occupations, including *master mechanics (629)* to which it was initially assigned, was even smaller. Figure 6 (a) illustrates the structural break in employment shares of *railway controllers or conductors* after 2010 and how its evolution smooths after reassignment in (b).

**Figure 6: Manual Reassignment for Railway Controllers or Conductors (712)**



Notes: Figure (a) displays the evolution of the railway controllers' employment share in the 1988 classification without the harmonization procedure suggested in this report. Figure (b) illustrates how the share changed after implementing the harmonization procedure. In this case, reassigning the 5-digit 2010 occupation of *supervisors in traffic surveillance and control (51593)* from the 3-digit 1988 occupation of *foremen and master mechanics (629)* to *railway controllers or conductors (712)* was necessary to mitigate the severe structural break after 2010.

Source: Own calculations based on the SIAB provided by the IAB.

Finally, I list two 5-digit 2010 occupations in Appendix Table A.1, for which neither the reversed transcoding scheme nor the allocation of job stayers justifies their reassignment. Instead, I selected these occupations because they are closely related to the respective target occupation, and reassigning them leads to a smoother evolution of employment shares. In particular, I reassign the 2010 occupation of *management assistants in wholesale and foreign trade with complex tasks (61213)* from the 1988 occupation of *wholesale and retail trade buyers (681)* to *office specialists*

<sup>20</sup> For completeness, reassigning *occupations with complex tasks in environmental protection consulting (42313)* not only mitigates the structural break in the target occupation (922) but also leads to a slightly more pronounced structural break in the source occupation (628). This issue was resolved by aggregating 628 with other 1988 occupations (621, 622, 629, and 635), following the algorithm explained in Section 5.1. For illustration purposes, these mixed approaches are extensively discussed in the next section.

(781). This reassignment changes little for *office specialists* (781) but mitigates the structural break for *retail trade buyers* (681) tremendously. Furthermore, I reassign *supervisors in education and social work* (83193) from *nursery teachers* (864) to *social (care) workers* (861). This reassignment smooths the evolution of employment shares for *nursery teachers* (864), particularly in East Germany, but it slightly exacerbates the structural break after 2010 for *social (care) workers* (861). I resolve this issue by aggregating *social (care) workers* (861) with *home wardens and social work teachers* (862), following the algorithm explained in Section 5.1. In the next section, I describe another mixed application in more detail.

### 5.3 Combining Manual Reassignment and Aggregation

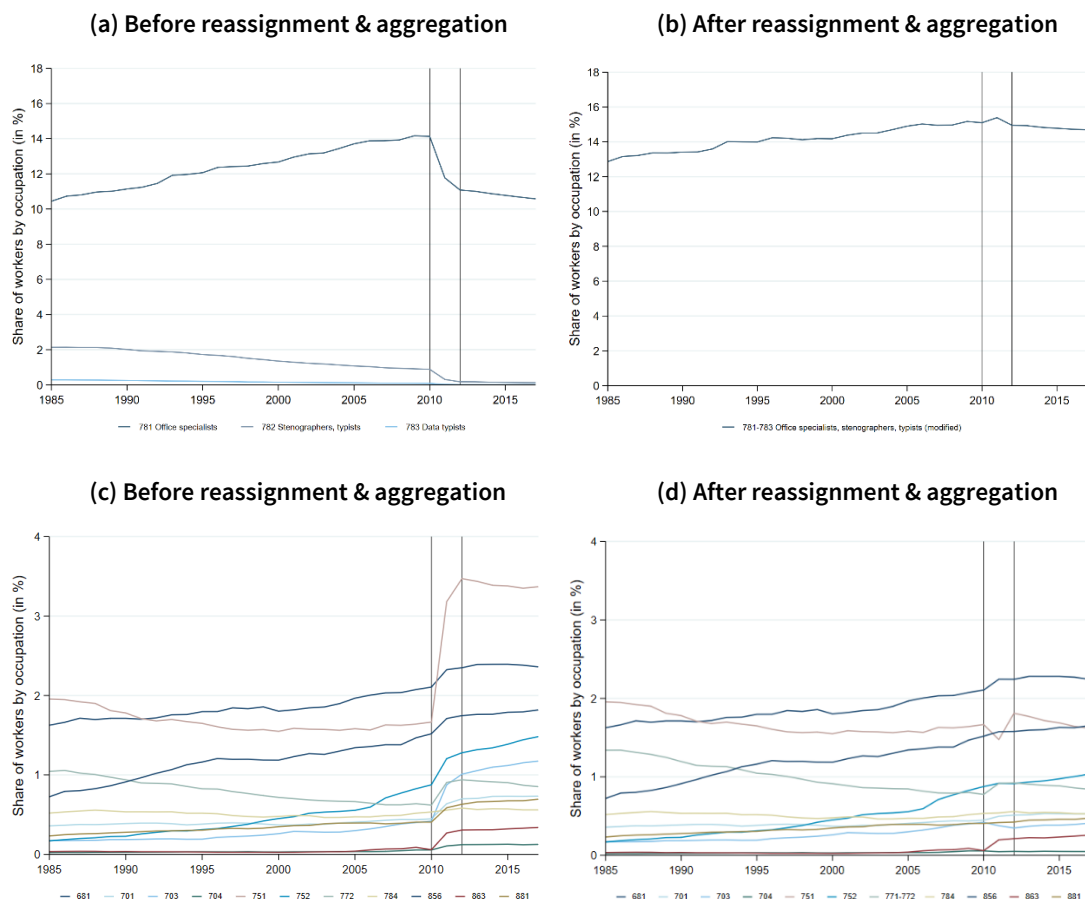
As described in the previous section, reassigning a 5-digit 2010 occupation changes the employment shares for both source and target occupation. However, the initial setting is often more complex and less ideal than in Figure 4. For instance, imagine that the employment shares of source and target occupations decrease after 2010. In this scenario, reassignment might still be beneficial if it smooths the target occupation's evolution of employment shares, and the exacerbated decline in the source occupation's employment shares can be addressed through aggregation, as described in Section 5.1. Therefore, combining the manual reassignment of 2010 occupations and the aggregation of the resulting 1988 occupations with other occupations that have diverging trends is sometimes necessary. In the following, I describe a setting of a more complicated interplay of both methods.

Figure 7 (a) shows the initial evolution of employment shares of three administrative occupations, i.e., 781, 782, and 783, without the suggested harmonization algorithm. One of this algorithm's main goals is to mitigate the most decisive structural break in occupational employment shares observed in the data, i.e., the one of *office specialists* (781). *Office specialists'* employment share increased by almost four percentage points over time, reaching 14 percent in 2010. However, following the introduction of the new occupational classification system, their employment share suddenly dropped back to its 1985 level. The 5-digit 2010 occupations assigned to *office specialists* after 2010, based on the official transcoding scheme, sum up to an employment share nowhere near its 2010 level. Structural breaks are also evident in the remaining administrative occupations. The decline in *stenographers'* (782) employment share amounts to one percentage point, putting them closer to zero after 2010. Although the share of *data typists* (783) was already low initially, the fact that it fell to zero after 2010 is no coincidence.

To some extent, the shrinkage of *stenographers'* and *data typists'* employment shares over time is plausible, given the increasing degree of computerization that renders these occupations obsolete. However, a sudden shrinkage is not plausible and may partially originate from updating effects due to the new classification system. Although some workers may have switched their occupation, e.g., from *stenographer* to *office specialist*, earlier than 2010 because their former job became obsolete, employers were not explicitly obliged to report occupational changes if they occurred within the same establishment (Dreyer-Tümmel et al., 1997). As a result, introducing the new classification system caused sudden updating effects.



**Figure 7: Combining Manual Reassignment and Aggregation for Office Specialists (781)**



Notes: Figure (a) displays the evolution of employment shares of three administrative occupations in the 1988 classification without the harmonization procedure suggested in this report. Figure (b) illustrates how these shares changed after implementing the harmonization procedure. In this case, reassigning 18 different 5-digit 2010 occupations to the three aggregated 3-digit 1988 occupations (781-783) was necessary to mitigate the severe structural breaks after 2010. Figure (c) shows the employment shares of the source occupations to which these 18 different 2010 codes were initially assigned without the harmonization procedure. Figure (d) depicts their evolution after implementing the harmonization procedure, i.e., after reassignment.

Source: Own calculations based on the SIAB provided by the IAB.

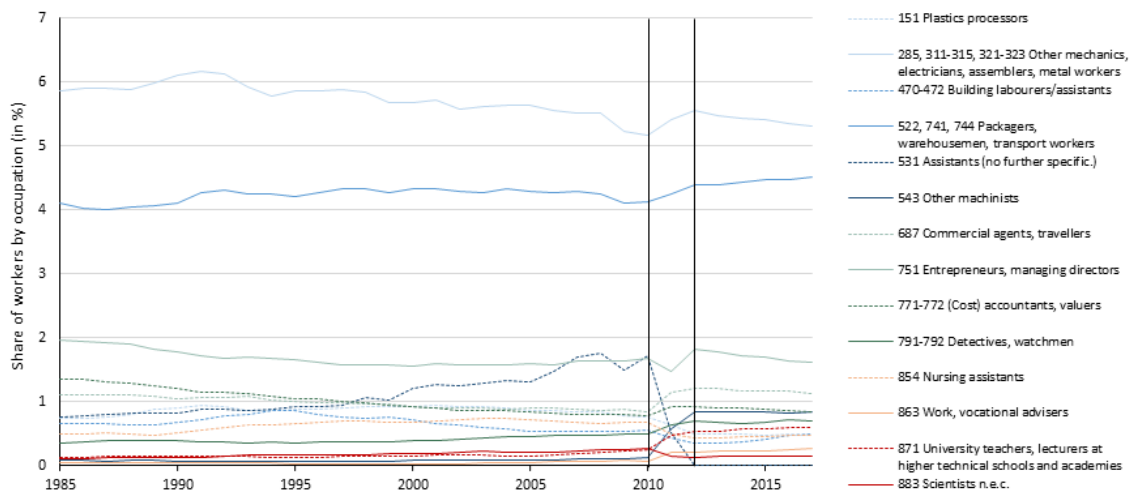
Given the likely regrouping within these three occupations and their close relation, it is justifiable to aggregate them all to minimize misclassification. As visible from the consistently decreasing employment shares after 2010 in Figure 7 (a), this decline will be even more substantial after aggregation. However, the advantage is that workers are no longer assigned to their possibly outdated occupation but to an aggregated administrative occupation that most likely contains the correct one. To mitigate the intensified structural break after 2010, 18 different 5-digit 2010 occupations are reassigned to the aggregated administrative occupation. Figure 7 (b) depicts the resulting evolution of employment shares. Figure 7 (c) shows the evolution of the source occupations' employment shares, i.e., the occupations to which the 18 selected 5-digit 2010 codes were initially assigned. Figure 7 (d) illustrates their annual employment shares after reassignment. For further improvement, I aggregated cost *accountants and valuers (771)* with *accountants (772)*. In sum, the harmonization algorithm clearly leads to a smoother evolution of employment for all occupations.

## 5.4 Remaining 1988 Occupations with a Structural Break

The main goal of the harmonization procedure is to mitigate the severest structural breaks after 2010, highlighted in Figure 1. Unfortunately, it is not possible to fully resolve the turmoil. Occupations with imprecise descriptions, primarily serving as a catch-all for related occupations—such as *other machinists* (543) or *scientists not elsewhere classified* (883)—are particularly challenging to harmonize over time. In the final step, the algorithm tags those harmonized 1988 occupations that cannot be (entirely) smoothed and, consequently, retain a structural break after 2010. Depending on the research context, the tagged occupations may require extra care. For instance, they could be excluded as a robustness check or separately analyzed.

Figure 8 plots the evolution of employment shares for the tagged occupations. While the harmonization algorithm mitigates the structural break for most of them, *assistants without further specification* (531) and *other machinists* (543) still exhibit fluctuations of more than 0.5 percentage points between 2010 and 2012.

**Figure 8: Remaining Occupations with a Structural Break in West Germany**



Notes: This figure illustrates the evolution of employment shares for the 1988 occupations that exhibit a (minor) structural break even after implementing the harmonization procedure for West Germany. Only two occupations exhibit severe structural breaks of more than 0.5 percentage points between 2010 and 2012: *assistants without further specification* (531) and *other machinists* (543). The harmonization procedure tags the depicted occupations so that they can be easily removed if desired.

Source: Own calculations based on the SIAB provided by the IAB.

Table 1 illustrates to what extent the observations in the sample of workers in West Germany from 1985 to 2010 belong to occupations with remaining structural breaks after applying the harmonization algorithm.<sup>21</sup> It shows the number of observations (worker × year cells) weighted by full-time equivalents for the tagged occupations and their respective percentage shares. Harmonized occupations that still exhibit severe structural breaks of more than 0.5 percentage points, i.e., *assistants without further specification* (531) and *other machinists* (543), account for only 1.19 percent of observations. Together with occupations that exhibit only minor fluctuations of less than 0.5 percentage points, i.e., all 14 occupations covered in the table, they account for 18 percent of observations. This outcome constitutes a considerable improvement compared to 34

<sup>21</sup> As demonstrated in Section 4, a relevant fraction of 1988 occupations vanishes from the data after 2010 if the harmonization algorithm is not applied. Therefore, I measure the afflicted employment shares prior to the structural break, i.e., from 1985 to 2010. After implementing the harmonization algorithm, there is only one harmonized 1988 occupation whose employment share drops to zero after 2010: *assistants without further specification* (531). This occupation has a relatively small employment share before 2010. Consequently, the afflicted employment shares are very similar when considering the entire period up to 2017.

percent of observations that belonged to occupations with severe structural breaks or zero employment shares after 2010 if the harmonization algorithm is not applied.

**Table 1: Extent of the Remaining Structural Breaks in West Germany**

Harmonized 1988 Occupation	Number of Observations	Percentage Shares
151 Plastics processors	54,784.8	0.86
285, 311-315, 321-323 Other mechanics, electricians, assemblers, metal workers	365,307.1	5.76
470-472 Building labourers/assistants	42,414.6	0.67
522, 741, 744 Packers, warehousemen, transport workers	267,870.8	4.22
531 Assistants (no further specific.)	70,323.7	1.11
543 Other machinists	4,915.1	0.08
687 Commercial agents, travellers	61,871.2	0.97
751 Entrepreneurs, managing directors	106,213.2	1.67
771-772 (Cost) accountants, valuers	64,327.7	1.01
791-792 Detectives, watchmen	25,382.9	0.40
854 Nursing assistants	40,029.7	0.63
863 Work, vocational advisers	2,468.3	0.04
871 University teachers, lecturers at higher technical schools and academies	9,707.0	0.15
883 Scientists n.e.c.	10,890.7	0.17
<b>Remaining Observations with Structural Break</b>	<b>1,126,506.9</b>	<b>17.75</b>
<b>Total Number of Observations</b>	<b>6,347,018.0</b>	<b>100.00</b>

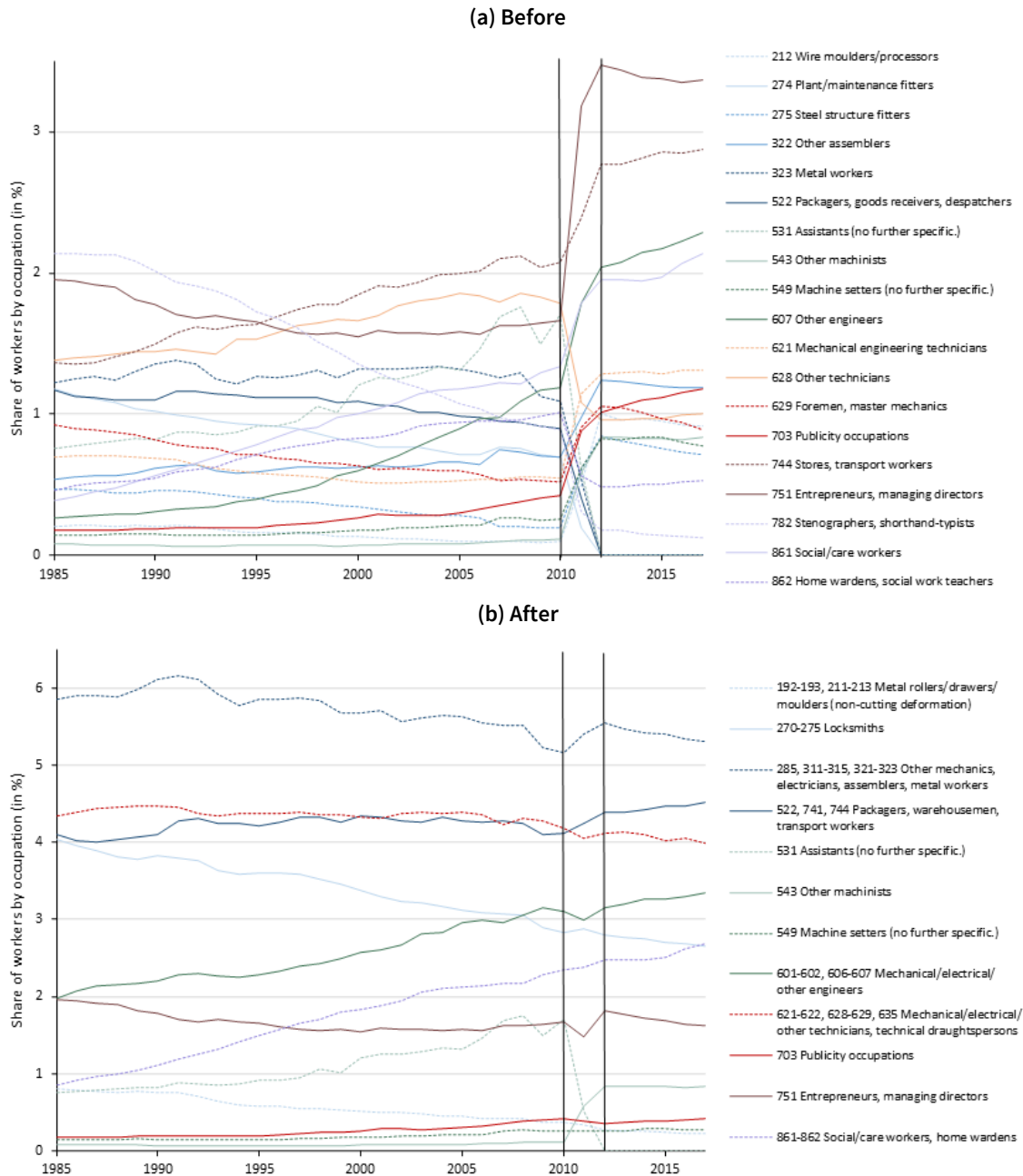
Notes: This table shows the number of full-time equivalence-weighted observations (worker × year cells) for the harmonized 1988 occupations that still exhibit a (minor) structural break after implementing the harmonization algorithm and their respective percentage shares in the sample of workers in West Germany from 1985 to 2010.

Source: Own calculations based on the SIAB provided by the IAB.

## 6 Harmonization Results

This section summarizes the harmonization results. Figure 9 (a) displays the employment shares of 19 different 1988 occupations with structural breaks of more than 0.5 percentage points under the status quo (see Section 4), i.e., before the harmonization algorithm was applied. The exclusion of *office specialists (781)* allows a more detailed inspection of the remaining problematic occupations than in Figure 1.

Figure 9: Structural Breaks Before and After Implementing the Harmonization in West Germany



Notes: Figure (a) illustrates the evolution of employment shares for the 1988 occupations that exhibited severe structural breaks of more than 0.5 percentage points between 2010 and 2012 before implementing the harmonization procedure in West Germany. Figure (b) displays the corresponding employment shares after implementing the harmonization procedure.

Source: Own calculations based on the SIAB provided by the IAB.

Figure 9 (b) illustrates the employment shares after applying the harmonization algorithm. Through aggregation, the number of occupations decreases from the original 333 in the 1988 classification to 204 in its harmonized version. Consequently, the level of employment shares and the required scale increase from (a) to (b). The evolution of employment shares is much smoother after implementing the harmonization procedure. As described in Section 5.4, the only severe structural breaks observed after 2010 belong to *assistants without further specification* (531) and *other machinists* (543).

Appendix B depicts the evolution of employment shares for all 1988 occupations before and after implementing the proposed harmonization algorithm. Appendix C shows equivalent figures for East Germany. Although the occupations with the severest structural breaks under the status quo

do not entirely coincide for East and West Germany, the harmonization procedure smooths employment shares in an optimal way for both regions. Therefore, it can be universally applied to analyses of employment histories focusing on one of the regions individually or both regions together.

## 7 Conclusion

The transition to Germany's current occupational classification system created considerable challenges for analyzing long-term employment histories. The official transcoding scheme between the old classification of 1988 and the new classification of 2010 has so far been too imprecise, leading to structural breaks in the evolution of occupation-specific employment shares. These structural breaks are problematic as they may bias estimation results and limit the analysis period. Addressing these inconsistencies is crucial for maintaining the accuracy and comparability of employment biographies, which are vital for reliable labor market research.

To tackle this issue, I developed an algorithm that harmonizes the 1988 occupation codes over time based on the Sample of Integrated Labor Market Biographies (SIAB). However, it also applies to other data sets for which time-consistent 1988 occupation codes are desirable. The algorithm consists of two key steps: aggregation and manual reassignment. By aggregating 1988 occupations with diverging trends and reassigning 2010 occupation codes to more applicable 1988 codes, the algorithm mitigates the inaccuracies of the official transcoding scheme. This process ensures a more consistent classification of occupations over time.

The application of the proposed harmonization algorithm yields essential improvements. It smooths the evolution of employment shares of 1988 occupations, diminishing the impact of misclassification and updating effects. The algorithm effectively reduces the total employment share of 1988 occupations with severe structural breaks from 34 to about one percent, making employment biographies comparable for over 30 years. This improvement is vital for researchers examining long-term employment patterns in Germany, as it enhances the consistency of occupational data and allows for more accurate analyses of labor market dynamics. Enhanced comparability and reliability of occupational data pave the way for new insights and a deeper understanding of workforce trends, enabling researchers to address more complex questions about employment and occupational shifts over time.

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# Appendix A: Reassigned 2010 Occupations

**Table A 1: Reassigned 2010 Occupations**

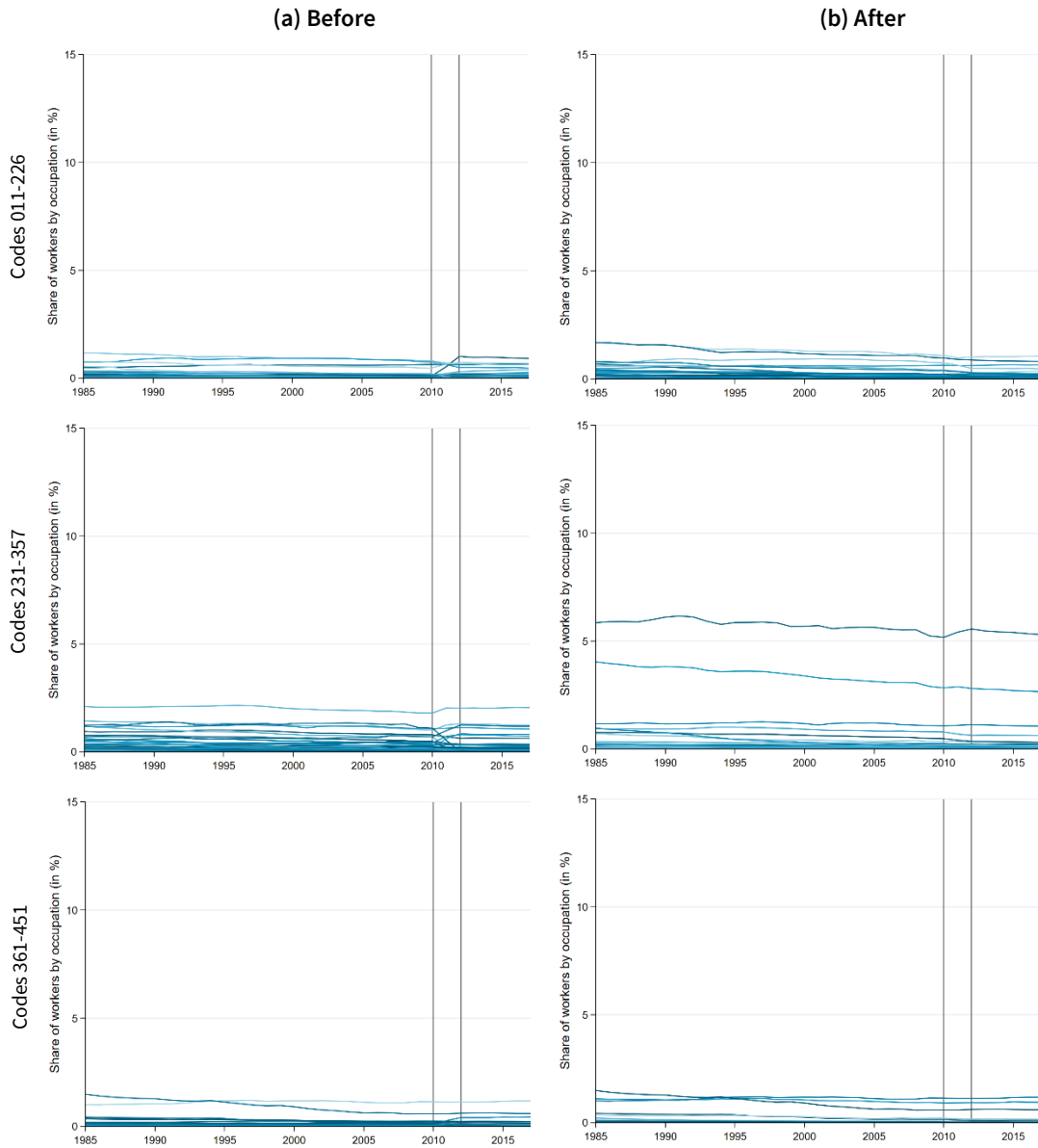
Reassigned 2010 Occupation		Initial 1988 Occupation	
<b>...reassigned to 1988 occupation "781-783 office specialists, stenographers, typists":</b>			
51623	Forwarding agents and management assistants in logistics (complex tasks)	701	Forwarding business dealers
51624	Forwarding agents and management assistants in logistics (highly complex tasks)	701	Forwarding business dealers
61112	Occupations in purchasing (skilled tasks)	681	Wholesale and retail trade buyers, buyers
61194	Managers in purchasing and sales	751	Entrepreneurs, managing directors, divisional managers
61213	Management assistants in wholesale and foreign trade-complex tasks	681	Wholesale and retail trade buyers, buyers
61283	Management assistants in trade (with specialisation, not elsewhere classified, complex tasks)	681	Wholesale and retail trade buyers, buyers
61313	Occupations in real estate marketing and administration (complex tasks)	704	Brokers, property managers
71303	Occupations in business administration and technical business management (without specialisation, complex task)	881	Economic and social scientists, statisticians
71393	Supervisors in business organisation and strategy	751	Entrepreneurs, managing directors, divisional managers
71514	Occupations in human resources development and personnel service (highly complex task)	881	Economic and social scientists, statisticians
71522	Occupations in recruiting and employment services (skilled task)	863	Work, vocational advisers
72212	Occupations in accounting (skilled tasks)	772	Accountants
72294	Managers in accounting, controlling and auditing	751	Entrepreneurs, managing directors, divisional managers
73201	Occupations in public administration (without specialisation, unskilled/semiskilled task)	784	Office auxiliary workers
73222	Administrative occupations in the welfare and health care system (skilled task)	856	Medical receptionists
92122	Occupations in dialog marketing (skilled task)	703	Publicity occupations
92113	Occupations in advertising and marketing (complex tasks)	703	Publicity occupations
92133	Occupations in customer management (highly complex tasks)	752	Management consultants, organisers
<b>...reassigned to 1988 occupation "270-275 Locksmiths":</b>			
25132	Technical service staff in maintenance and repair-skilled tasks	311	Electrical fitters, mechanics
<b>...reassigned to 1988 occupation "285, 311-315, 321-323 Other mechanics, electricians, assemblers, metal workers":</b>			
24201	Occupations in metalworking (without specialization, unskilled/semiskilled tasks)	212	Wire moulders, processors
24202	Occupations in metalworking (without specialization, skilled tasks)	549	Machine setters (no further specification)
<b>...reassigned to 1988 occupation "712 Railway controllers, conductors":</b>			
51593	Supervisors in traffic surveillance and control	629	Foremen, master mechanics
<b>...reassigned to 1988 occupation "856 Medical receptionists":</b>			
73223	Administrative occupations in the welfare and health care system (complex tasks)	861	Social workers, care workers
<b>...reassigned to 1988 occupation "861-862 Social/care workers, home wardens":</b>			
83193	Supervisors in education and social work, and of pedagogic specialists in social care work	864	Nursery teachers, child nurses
<b>...reassigned to 1988 occupation "922 Consumer advisors":</b>			
42313	Occupations in environmental protection administration and environmental protection consulting (complex tasks)	628	Other technicians

Notes: This table lists the 5-digit 2010 occupation codes I manually reassigned to the expressed 3-digit 1988 target occupations. It also lists their initially assigned 1988 source occupations according to the official transcoding scheme (FEA, 2011a).

Source: Own illustration.

# Appendix B: Figures for West Germany

Figure B 1: Evolution of Employment Shares Before and After the Harmonization in West Germany

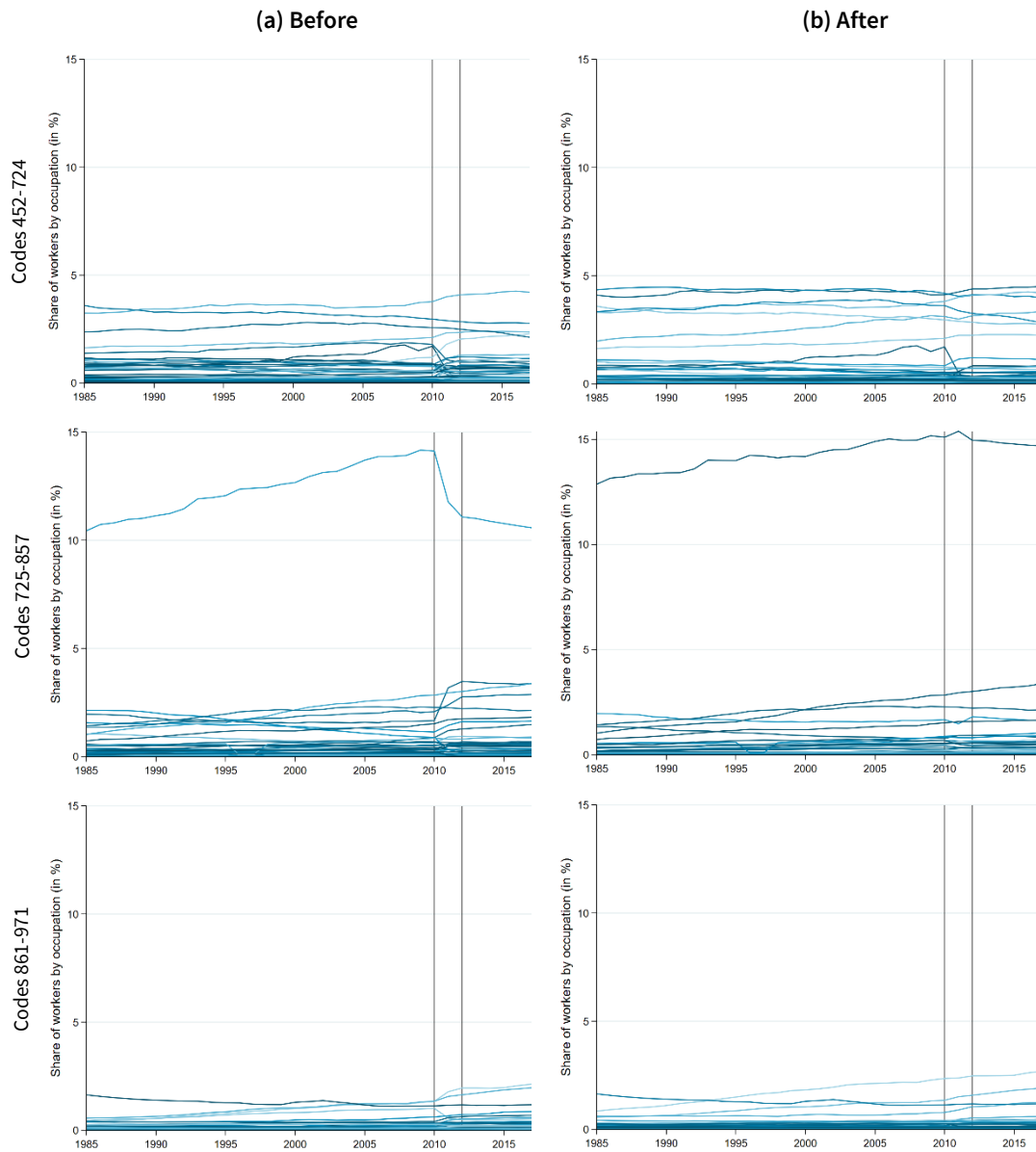


Notes: These figures depict the annual evolution of employment shares by 3-digit 1988 occupation in West Germany from 1985 to 2017 before and after implementing the harmonization procedure. The sample includes both female and male workers covered by the social security system, aged 25 to 54. Annual employment shares are weighted using full-time equivalence weights. Official full-time spells are part-time corrected, following the procedure recommended by Fitzenberger and Seidlitz (2020).

Source: Own calculations based on the SIAB provided by the IAB.



**Figure B 2: Evolution of Employment Shares Before and After the Harmonization in West Germany (cont'd)**

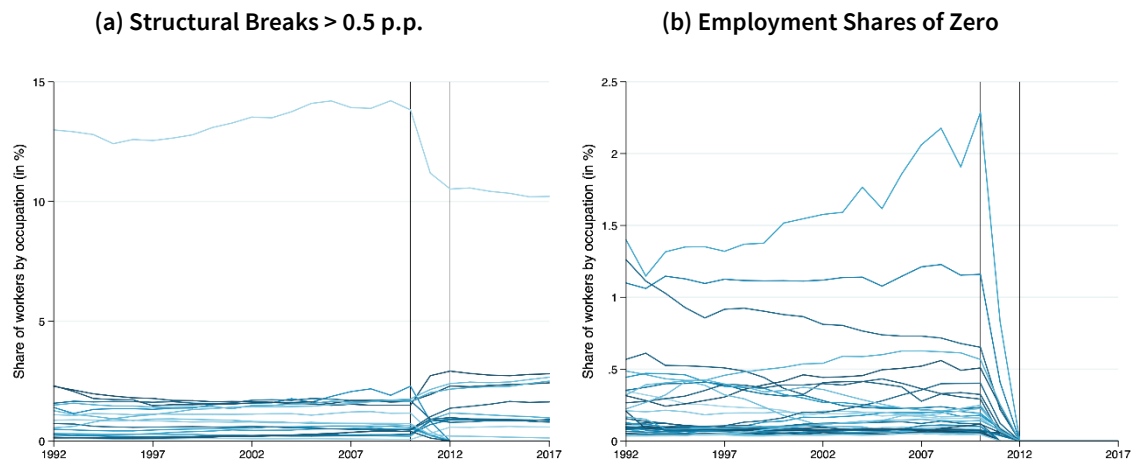


Notes: These figures depict the annual evolution of employment shares by 3-digit 1988 occupation in West Germany from 1985 to 2017 before and after implementing the harmonization procedure. The sample includes both female and male workers covered by the social security system, aged 25 to 54. Annual employment shares are weighted using full-time equivalence weights. Official full-time spells are part-time corrected, following the procedure recommended by Fitzenberger and Seidlitz (2020).

Source: Own calculations based on the SIAB provided by the IAB.

# Appendix C: Figures for East Germany

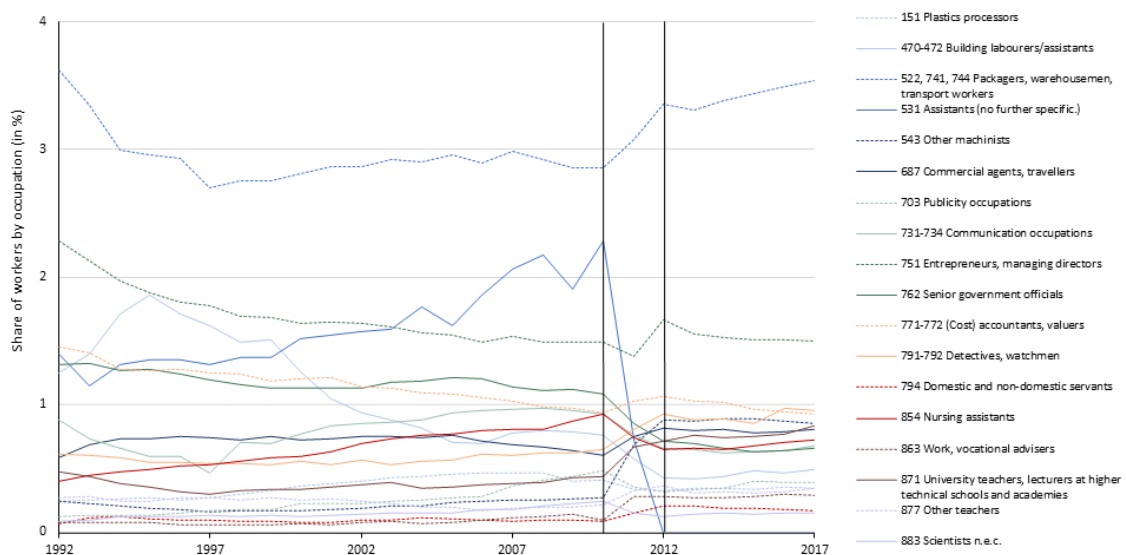
**Figure C 3: Evolution of Occupation-Specific Employment Shares in East Germany**



Notes: These figures depict the annual evolution of employment shares by 3-digit 1988 occupation in East Germany from 1992 to 2017. The sample includes both female and male workers covered by the social security system, aged 25 to 54. Annual employment shares are weighted using full-time equivalence weights. Official full-time spells are part-time corrected, following the procedure recommended by Fitzenberger and Seidlitz (2020). Figure (a) shows occupation-specific employment shares with a structural break of more than 0.5 percentage points between 2010 and 2012. Figure (b) shows occupation-specific employment shares, which drop to zero after 2010.

Source: Own calculations based on the SIAB provided by the IAB.

**Figure C 4: Remaining Occupations with a Structural Break in East Germany**

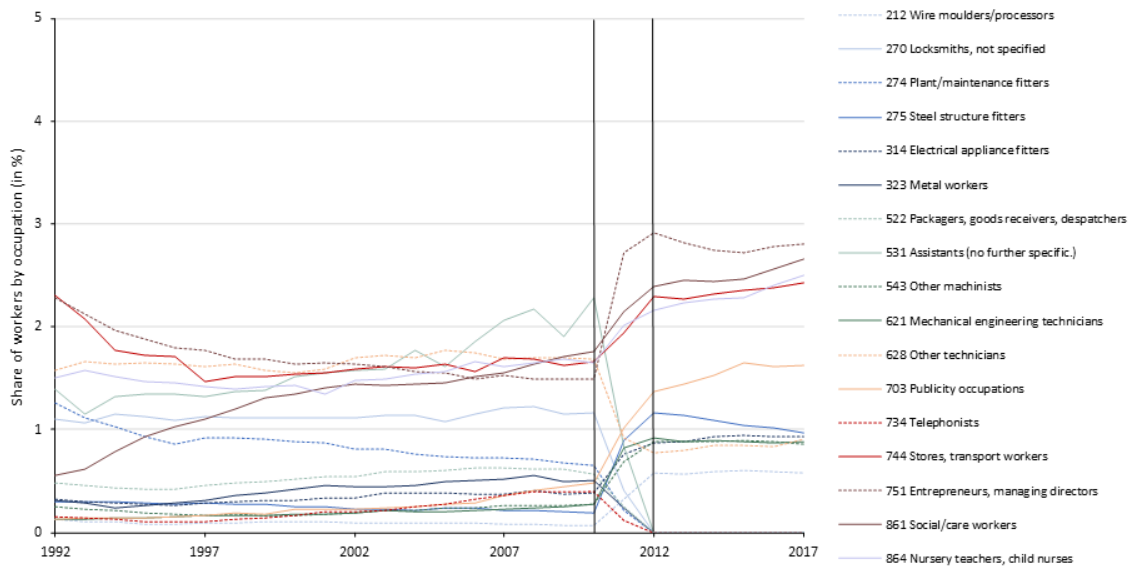


Notes: This figure illustrates the evolution of employment shares for the 1988 occupations that exhibit a (minor) structural break even after implementing the harmonization procedure for East Germany. Three occupations exhibit severe structural breaks of more than 0.5 percentage points between 2010 and 2012: *assistants without further specification* (531), *other machinists* (543), and *packagers, warehousemen, and transport workers* (522, 741, 744). The harmonization procedure tags the depicted occupations so that they can be easily removed if desired. Note that slightly more (and different) occupations remain with a structural break compared to the corresponding graph for West Germany in Figure 8.

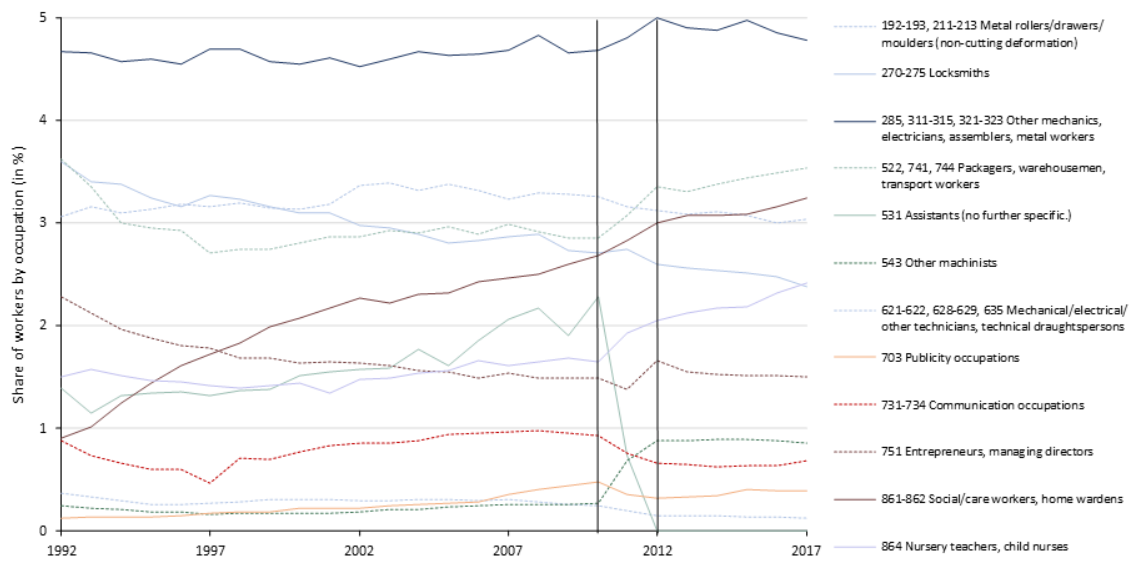
Source: Own calculations based on the SIAB provided by the IAB.

Figure C 5: Structural Breaks Before and After Implementing the Harmonization in East Germany

(a) Before



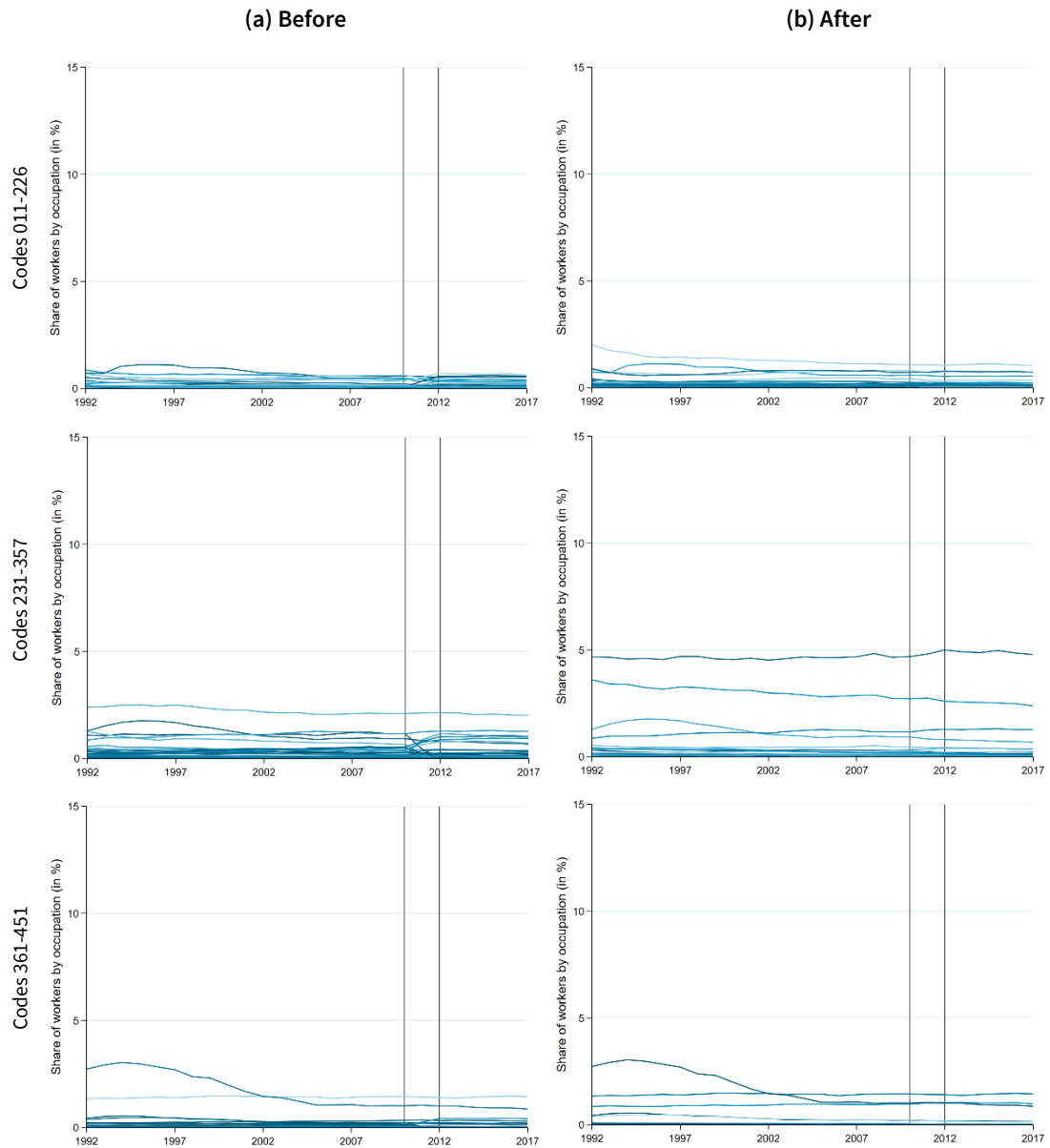
(b) After



Notes: Figure (a) illustrates the evolution of employment shares for the 1988 occupations that exhibited severe structural breaks of more than 0.5 percentage points between 2010 and 2012 before implementing the harmonization procedure in East Germany. Figure (b) displays the corresponding employment shares after implementing the harmonization procedure.

Source: Own calculations based on the SIAB provided by the IAB.

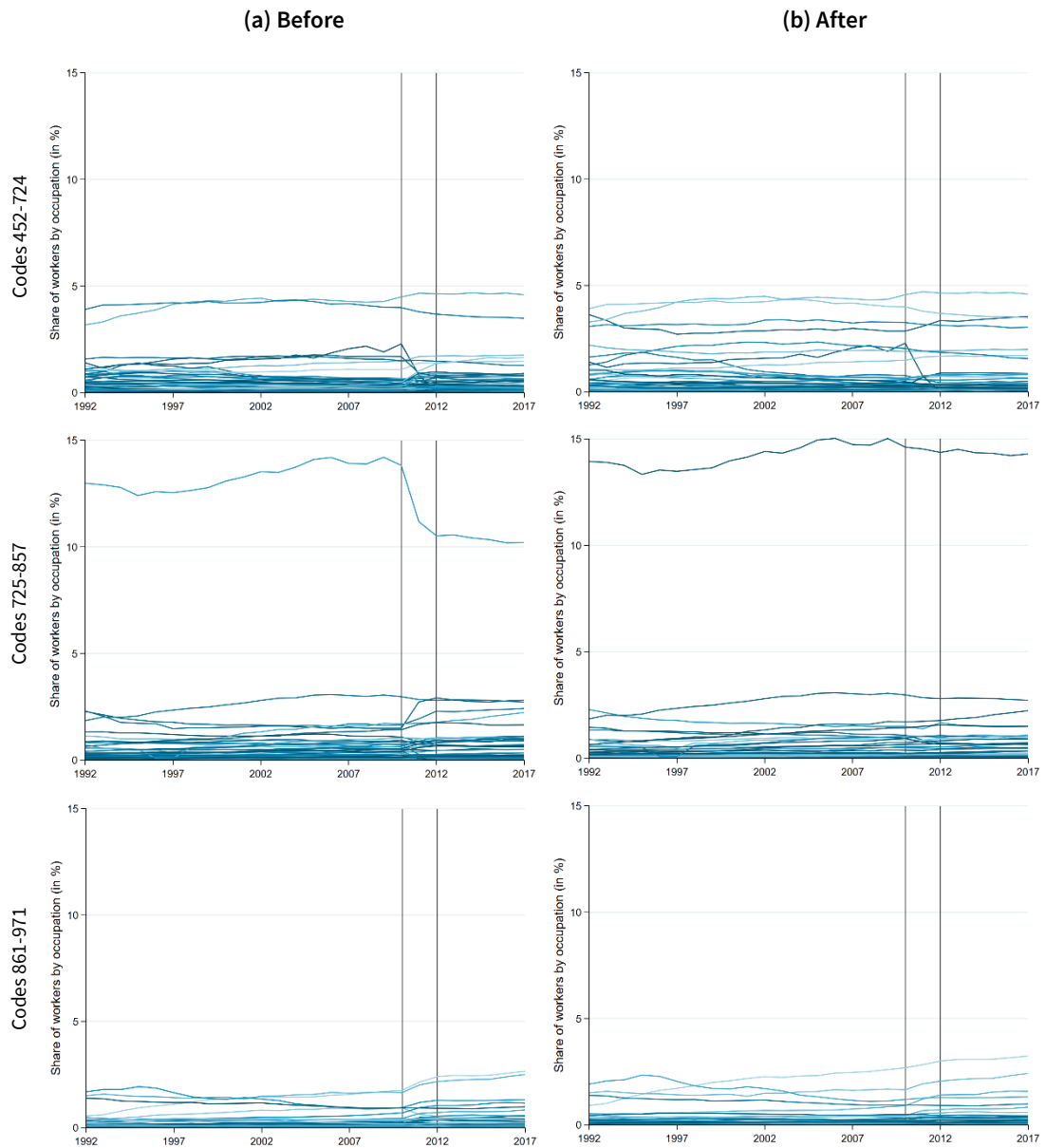
Figure C 6: Evolution of Employment Shares Before and After the Harmonization in East Germany



Notes: These figures depict the annual evolution of employment shares by 3-digit 1988 occupation in East Germany from 1992 to 2017 before and after implementing the harmonization procedure. The sample includes both female and male workers covered by the social security system, aged 25 to 54. Annual employment shares are weighted using full-time equivalence weights. Official full-time spells are part-time corrected, following the procedure recommended by Fitzenberger and Seidlitz (2020).

Source: Own calculations based on the SIAB provided by the IAB.

Figure C 7: Evolution of Employment Shares Before and After the Harmonization in East Germany (cont'd)



Notes: These figures depict the annual evolution of employment shares by 3-digit 1988 occupation in East Germany from 1992 to 2017 before and after implementing the harmonization procedure. The sample includes both female and male workers covered by the social security system, aged 25 to 54. Annual employment shares are weighted using full-time equivalence weights. Official full-time spells are part-time corrected, following the procedure recommended by Fitzenberger and Seidlitz (2020).

Source: Own calculations based on the SIAB provided by the IAB.

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