

3 The problem of the measurement of sex segregation revisited

As pointed out in the introduction, one core aspect in the scientific literature on occupational sex segregation has been the question of how to measure this phenomenon adequately. As there is a variety of different single number indices, results of relevant studies (see Anker 1998, Blau and Hendricks 1979, Hakim 1979, 1993, Jacobs 1989b, Siltanen 1990) vary widely. Sometimes, even the use of the same index leads to different results (see for example Gross (1968) or Jacobs (1989a) for occupational sex segregation in the US-labour market). This is due to the fact that empirical results of segregation research are widely determined by methodological considerations, research preferences and the quality of data sets (Hakim 1992). In consequence, the question arises whether the amount of segregation has really been recorded in an adequate empirical and theoretical manner, or whether it would rather be necessary to modify existing theories and develop ‘new’ concepts and methods for a better understanding of the phenomenon.

To clarify these questions, particularly for a cross-national comparison, the following section first introduces common approaches to the measurement of occupational sex segregation. In this context, advantages and disadvantages of traditional as well as new segregation indices will be discussed with a focus on problems related to different definitions, classifications and data sets. In a second step, arguments for the hypothesis are presented that the methodological discussion in segregation research could profit substantially from solutions applied in social mobility research, where similar problems have arisen. Finally, it will be made clear that a clarification of the term segregation is necessary because it is used with different connotations and for different aspects of gender inequality.

3.1. The different approaches to the measurement of occupational sex segregation

A good starting point for the presentation of gender distributions across occupations and the understanding of segregation indices seems to be a cross-tabulation

which is typically used in empirical segregation research. The following cross-tabulation, showing an exemplary distribution of men and women across different occupations, presents possible topics on which an empirical analysis of segregation could focus.

Table 3.1: Constructed cross-tabulation of broad occupational groups by sex

sex	occupational groups			total
	1	2	3	
male	50	150	50	700
female	50	150	100	300
total	550	300	150	1000

occupational structure female share in employment

Even though the analysis could concentrate on four topics, only the last two of the following summary are of interest in segregation research:

- The share of females in all employed persons (column marginal)
- The size of occupational groups (row marginal)
- The share of females in the total number of employed persons in each occupation ('column percentages'/sex typing)
- The 'chances' of male and female employees to work in one of the occupational groups ('row percentages'/occupational chances)

Similar tables, based on 'real observed data', can be quite large and complex (depending on the number of occupations). A first extension of the cross-tabulation approach, therefore, are segregation indices trying to summarise the observable amount of segregation into *one* single number.

This raises the most important methodological problem, namely the question of the adequate measurement of occupational sex segregation. In this respect, various techniques and indices of inequality have been proposed by several researchers which all claim to measure 'pure' segregation. As a consequence, there has been a long and very disparate debate on how an index of segregation should be constructed.

3.1.1. *The traditional indices*

In spite of the discussion about the ‘best’ index, there is no doubt that in most macro-sociological work, the index of dissimilarity (D) - proposed 1955 by Duncan and Duncan - is most frequently used but also most frequently criticised.⁴³ This index has not only been used extensively in the analysis of occupational segregation by sex but also in various other types of inequality analyses such as poverty, schooling and housing (Gibbs 1965). The index is based on an understanding of sex segregation as a different distribution of women and men across occupational categories; the more equal the distribution, the less the segregation. In this respect, D measures the sum of the absolute differences in women’s and men’s distribution across occupations. From the mathematical formula (see below), it is evident that D equals 0 in the case of complete equality (where women’s employment is distributed similarly to men’s across occupational categories) and 1 in the case of complete dissimilarity (where women and men are in totally different occupational groups). Following Anker’s definition, it can moreover be interpreted as the proportion of women and men who would need to change jobs in order to remove segregation.

$$D = \frac{1}{2} \sum_{j=1}^J \left| \frac{F_j}{F} - \frac{M_j}{M} \right|$$

with

F total number of females in employment;

M total number of males in employment;

F_j number of employed females in occupation j ;

M_j number of employed males in occupation j ;

J number of occupations.

Irrespective of the widespread use and the easy interpretation of D, the index has come under criticism very soon as inappropriate for measuring occupational segregation by sex, especially over time (e.g. Hakim 1979, 1993, Watts 1990, 1995, Siltanen et al. 1995). The common critique is D’s dependence on the size of categories of the classification used. As a consequence, both changes in the occupational structure of the labour force, and the extent to which occupations are feminised, influence D. From a purely methodological perspective, however, a measure that is only sensitive to the sex composition of occupational groups and its changes would be more appropriate.

⁴³ Gross 1968, Blau and Hendricks 1979, Blossfeld 1984, Jonung 1984, James and Taeuber 1985, Watts 1990, 1992, 1994, Blackburn et al. 1993, Jacobs 1993.

The first attempt to avoid the marginal dependence of D and, consequently, control for changes over time in the relative size of an occupational group has been made by Gibbs (1965) who proposed the standardised index of dissimilarity (D_{st}).

$$D_{st} = \frac{1}{2} \sum_{j=1}^J \left| \frac{\frac{F_j}{T_j}}{\sum_{j=1}^J \frac{F_j}{T_j}} - \frac{\frac{M_j}{T_j}}{\sum_{j=1}^J \frac{M_j}{T_j}} \right|$$

with

T_j total number of males and females in the j th occupation ($T_j = M_j + F_j$) and all other parameters defined as before

The basic principle of D_{st} is to treat all occupations as equal in size. In this way the occupational structure is held constant, such that changes in D_{st} over time or between countries can only be due to differences in the sex composition of occupations. Hence D_{st} is not affected by occupational size effects and should measure 'pure' sex typing (England 1981). An often undesired consequence of this procedure is that it gives the same weight to changes in the percentage of female workers in all occupations - small and large occupations alike. As Kalter (2000: 7) underlines, this side effect should be questioned because changes in very small occupations have the same impact on the index as those with noticeable shares in the total population. Moreover, Charles and Grusky (1995) have shown that the standardisation procedure used for the construction of D_{st} is not successful in achieving the goal of 'marginal independence'.

Due to the presented critique of D and D_{st} , several other segregation indices have been proposed in recent years. To mention only well-known indices: there are the WE index, proposed by the OECD for a report on women and employment (OECD 1980), and the sex-ratio index (SR) developed by Hakim for the United Kingdom's Department of Employment (Hakim 1979). Both are based on D and thus give rise to similar problems.

Another example of a 'new index' is the IP index by Karmel and MacLachlan (1988) that, as Watts (1992) has shown, could also be seen as a weighted form of D .

$$IP = \frac{1}{T} \sum_{j=1}^J \left| \frac{M}{T} F_j - \frac{F}{T} M_j \right|$$

with

T total number of employed persons and all other parameters defined as before

In contrast to D, the IP index reflects the relative size of both sexes and takes into account the male and female share of all employed persons. As a consequence, the index should not be sensitive to variations in the female share in the labour force which is an important aspect of cross-national comparisons and changes over time. The interpretation of IP differs slightly from D: while D can be interpreted as the relative share of women plus men which would need to change jobs in order to remove segregation, the IP Index shows the percentage of all employed persons who would have to change occupations to reach an identical distribution of both sexes in the occupational structure.⁴⁴

As all presented measures are based on the logic of D, they share the dependency on the occupational structure of a given economy and the female share in employment. Blackburn et al. (1993, 1995) introduced an alternative inequality index. The Marginal Matching (MM) Index (later the Index of Segregation (IS)) was developed to measure changes over time in occupational sex segregation that result exclusively from changes in the sex composition of occupations. This approach involves a new definition of gendered occupations: “The female occupations are defined as those with the highest proportion of female workers for which the total number of workers equals the number of women in the labour force, and similarly the number of workers in male occupations equals the total number of men.” (see for detail Blackburn et al. 1993: 342-348 or Anker 1998: 78).⁴⁵ Accordingly, the MM-index treats the aforementioned dependence of segregation measures on the occupational structure and the female share of employment as an advantage rather than a disadvantage. Moreover, it bypasses the problem that D is affected by shifts in the occupational structure over time.

In sum, it has often been underlined in segregation research that the presented indices have the advantage of simplicity. They condense into one number all variations in the distribution of jobs between men and women. At the same time, the simplicity may be also a disadvantage. Single number indices often hide changes in inequality over time and may be difficult to understand and explain in common sense terms. A further weakness is that they, in fact, capture the overall amount of occupational sex segregation without allowing for a differentiation between the horizontal and the vertical dimension. In this respect,

⁴⁴ The IP index has also been used for the decomposition of changes in segregation into three basic elements: gender, occupation and interaction effects (Karmel and MacLachlan 1988, Watts 1992).

⁴⁵ The calculation is done by ordering occupations according to their female concentration: calculating the cumulative distribution of the employed labour force along this ordering starting at the ‘female’ end of the occupational ordering and moving along the cumulative distribution until the cumulative number of workers equals the number of women in employment. The level of female concentration at this point is the dividing point between ‘male’ and ‘female’ occupations. By doing so, marginal totals N_m and N_f are respectively ‘matched’ to M and F (i.e. $N_m = M$ and $N_f = F$).

international studies have shown that, within country-specific institutional contexts, high occupational sex segregation can be accompanied by a high gender inequality but also with more gender egalitarian wages (McCall 2001, Dolado et al. 2002).

Against this background, Jacobs (1999) proposed to take more than one index into account for getting a broad picture of the amount and pattern of occupational sex segregation on the labour market. In this vein, new studies supplement the analysis with measures of vertical aspects of occupational sex segregation (Seibert et al. 1997, Baunach 2002). They are based on socio-economic aspects, like status differentials or status and prestige scales, and capture the vertical aspect with an additional single number index (Fossett and South 1983, Fossett and Kiecolt 1991, Fossett 1991). Consequently, they are able to show which of the sexes can be found in a higher ranking occupational group. A further alternative is the so-called association index ‘Somers D’, where occupations are ordered on a ‘vertical’ dimension (status, income) and the ‘independent’ variable is gender with only two categories (Blackburn et al. 2001, 2002, Bridges 2003).

3.1.2. The log-linear approach

The most promising approach to the twin problem of measuring and explaining levels of occupational sex segregation across countries or over time is based on log-linear techniques (see Handl 1984, Charles and Grusky 1995, 2004, Xie 1997, Kalter 2000). In particular, Charles and Grusky (2004) are precursors in applying this method in the framework of occupational sex segregation. In their opinion, former research has been limited by three methodological weaknesses: first, the lack of scalar indices to capture the multidimensionality and the different patterns of sex segregation. Second the discussed sensitivity of most indices to temporal or inter-country differences. Third, they also criticise that most of the indices are relying on highly aggregated occupational categories and data, so that the appearance of cross-national variability in segregation regimes may merely be an artefact of differences in the composition of categories.

Log-linear modelling has for a long time been a standard procedure in stratification research, like social mobility analysis (Müller 1990, Erikson and Goldthorpe 1992, Ishida et al. 1995, Müller and Pollack 2004). The biggest advantage of log-linear approaches is that, while building up on odds and odds ratios, they are independent of the marginal distributions of a segregation table.

In consequence, they are perspective invariant, which means that they focus on both dimensions of the cross classification.

In earlier research by Handl (1984), log-linear techniques have been used to carry out a decomposition of changes in segregation, measured by D , into two parts: changes caused by variations in the size of occupational structures and changes caused by a reduction or a growth of the female share in occupations. Later, Charles (1992) and Charles and Grusky (1995) adopted ANOAS-models, originally developed for the analysis of social mobility tables, for the analysis of so-called 'segregation regimes'. These techniques which, in the meantime, have been applied in a series of international comparative studies (Nermo 1999, Chang 2000, 2004, Charles and Grusky 2004), allow not only for a description of patterns of 'segregation' but also for a thorough statistical analysis of changes in occupational sex segregation. Charles and Grusky (1995) underline that the purpose of using log-linear modelling in the field of sex segregation research is not the construction of a scalar index. As there seems to be a demand for summary measures in this research context, they nevertheless propose a scalar index (A) derived from a log-multiplicative model. A is defined as follows:

$$A = \exp \left(\frac{1}{J} \sum_{j=1}^J \left\{ \ln \left(\frac{F_j}{M_j} \right) - \left[\frac{1}{J} \sum_{j=1}^J \ln \left(\frac{F_j}{M_j} \right) \right] \right\}^2 \right)^{1/2}$$

With all parameters defined as before

A equals zero and $\exp(A)$ equals one when the labour market is perfectly integrated. One disadvantage of the index may be the less clear interpretation. A represents the standard deviation in the logged sex ratio, and can be interpreted as the multiplicative factor by which men or women are, on average, overrepresented in the occupational categories in question. Although the application of A does not seem to change the results and trends of traditional indices substantially, it might affect the understanding of the magnitude of change in a cross country comparison (Weeden 1998). Moreover, Nermo (2000) argues that log-linear modelling offers better possibilities to explain trends or cross-national variations in the association between sex and occupation.

Along the lines of the log-linear approach, another research strand has been developed on the basis of the common critique that segregation is not completely conterminous with inequality. Researchers (for example Semyonov et al. 2000) applying this strategy used separate measures of overall segregation and vertical differentiation, distinguishing between 'nominal' segregation (measured with D and the A -index) and 'ordinal' occupational differentiation (inequality

measured by the Index of net difference). The consideration of the two different measures (taking into account the ranking of occupations) is of utmost importance because they reflect these different aspects. As Bridges (2003: 546) underlines, "...every measure of 'nominal' segregation, like D, is a necessary, but not sufficient, condition for a high level of occupational inequality between the sexes. Therefore, approaches that allow for an explicit decomposition of 'total' segregation into its components need to be considered."

In this vein, researchers advocate a paradigm that distinguishes the vertical and horizontal dimensions of occupational sex segregation (see in more detail Hakim 1981, Blackburn and Jarman 1997, Blackburn et al. 2001, also chapter 1). They assume that overall segregation consists of two components (horizontal and vertical) that ought to be identified separately. Their suggestion for measuring these two dimensions is to compute 'Somer's D of association' under two varying circumstances: capturing the total and vertical segregation and assuming that horizontal segregation is the difference between both. The advantage of this approach is that the horizontal dimension can be assessed in its own right. However, it is limited because occupations can only be ordered by a single dimension at one point in time which may lead to an overestimation of the horizontal dimension. Charles and Grusky (2004) also point out the multidimensionality of segregation. They propose to identify inequality and horizontal dimensions by using a log-multiplicative model with two dimensions of association. This provides a measure of the relative sizes of 'vertical' and 'horizontal' segregation.

On the basis of these insights, Bridges (2003: 548) introduces a new log-likelihood ratio statistics called 'normed' G^2 which combines both methods presented above.⁴⁶ This approach is based on log-linear, but not log-multiplicative methods which characterise both the overall dependence of occupations on gender and the amount of that dependence that is associated with various hierarchical features of the occupation (earning, prestige etc.). Moreover, the overall measure is decomposed into different components. This ratio also varies between 0 (independence of gender and occupation) and 1 (extreme segregation).

Somewhat earlier, and apart from the discussion on how to capture horizontal and vertical segregation aspects, Kalter (2000) proposed a new 'adjusted index of dissimilarity' which combines the traditional concept of D with the log-linear approach. He avoids the serious problem that D is affected by structural conditions and, simultaneously, preserves its advantages. The index mainly focuses on structural changes by taking into account independent variables rather than changes in the variable of interest (dependent variable). Hence, Kal-

⁴⁶ $G^2 = 2 \sum f_i \cdot \log f_i / m_i$ with, $m_i =$ frequencies expected under the model of row and column independence and $f_i =$ observed frequencies.

ter (2000: 18) is able to "...analyse (macro) inequality structures, taking into account contextual and temporal differences in relevant (micro) determinants."

3.1.3. Further determinants on segregation indices

Even though the methodological weakness of single number indices seemed to have been solved by indices based on log-linear methods, there are further problems which particularly evolve in a comparative research design. These problems are, for example, related to the quality of data, the used classifications and the comparability of variables and definitions (see Charles and Grusky 1995, Anker 1998). It is beyond the scope of the present inquiry to survey all possible issues. Several major problems, however, need to be discussed in more detail: occupational classifications and concepts of 'occupations', the definitions of working-time and employment, and the sectoral sensibility of indices.

As to the first of these issues, it is to be considered that a first group of influencing factors is related to occupational classifications. In general, some sort of occupational or sectoral classification of employees constitutes the backbone of segregation research. However, the measurement of positions held by employees in the labour market raises difficult questions because the concept of 'occupation' may be country-specific and hard to compare across different nations. In order to solve this problem and to obtain the best basis for comparable international research, an International Standard Classification of Occupations (ISCO) has been developed by the International Labour Office in Geneva (ILO 1968 and 1988). The objective of this classification is to provide an instrument for a theoretically guided, very detailed arrangement of jobs and occupations in the labour force, i.e. to present a method for grouping all jobs into successively broader occupational categories.⁴⁷ The ISCO88 was designed along the lines of two main concepts: job (kind of work performed) and skill (complexity and specialisation), meaning that a 'lower' code implicates a higher skill which is defined as "the ability to carry out the tasks and duties of a particular job" (ILO 1990: 2). The classification distinguishes 390 unit groups on the most detailed level (4-digit level) and a set of 116 'minor group' categories on the 3-digit level which can be aggregated into 28 'sub-major' categories and nine 'major' categories (Ganzeboom and Treiman 1992, 1996).

⁴⁷ While a job comprises a set of tasks performed, or designed to be performed by one individual, an occupation contains similar jobs, i.e. similar according to skill level, skill specialisation and main tasks (Bakker 1993).

Although the creation and implementation of the classification has been improved, not all problems have been solved yet. The above-described logic, for example, loses consistency when changing from the 1-digit level to a more disaggregated 2- or 3-digit level: here some occupations in major group 7 (craft and related trade workers) obviously require higher degrees of skill and longer training than some of the occupations classified in group 5 (service workers). As a consequence, research results seem also influenced by the availability of detailed occupational classifications. Solutions for this problem are diverse. While Ganzeboom and Treiman (1996), for example, suggest the use of the most detailed 4-digit level, Elias (1997: 3) pointed out that “[...] coding/recoding studies indicate that the sub-major group [2 digit] level of ISCO-88 represents a useful level at which to undertake comparative analyses of occupational data.”

Table 3.2: Major categories of ISCO88 (1-digit):

High skills  Low skills	1	Legislators, Senior Officials and Managers
	2	Professionals
	3	Technicians and Associate Professionals
	4	Clerks
	5	Service Workers and Shop and Market Sales Workers
	6	Skilled Agricultural and Fishery Workers
	7	Craft and Related Trade Workers
	8	Plant and Machine Operators and Assemblers
	9	Elementary Occupations

The aggregation of occupations in broader categories is optional. It can be done by using the ISCO88 2-digit or 1-digit, or by classifying occupations into female-dominated, male-dominated and integrated occupations. The main problem arises from the inconsistency of the selected threshold for ‘typical’ occupations. For example, some authors define the limit for integrated occupations based on the assumption that men and women are equally represented in society. Consequently, they set the limit at 40% (Jacobs 1989b, Reskin and Roos 1990) and 50% ignoring the fact that the female employment rate is often below 50% (Hakim 1993). Other scholars use the female employment rate as a starting point and relate the threshold to this mean.⁴⁸ However, theoretical arguments for a ‘specific’ threshold are still missing.

⁴⁸ Also here the definitions are very inconsistent: some researchers use a threshold between $\pm 10\%$ (like Blau et al. 1998a) or $\pm 15\%$ (see Hakim 1993, 1998). A good overview of this discussion is provided by Anker 1998.

A further problem, related to occupational classifications, refers to the concept of 'occupation'. Different national and cultural contexts might create country-specific occupational classifications which follow quite different principles of construction and have to be transferred into the ISCO88. In this context, Elias (1997) argues that the transformation of national classifications into the ISCO88 improves the opportunities for a country comparison. However, he also underlines that in some countries, like France and the United Kingdom, the comparison is not guaranteed. Therefore, it should always be considered whether in a specific country, at a certain point in time, the data based on the ISCO88 code fulfil minimum standards of reliability and comparability.

Moreover, it should be underlined that some researchers hold the view that occupational classifications are 'gender blind' (Beckman 1996, Tijdens 1996). As classifications devote attention to developments on the labour market only with some delay, important changes, like the dramatic increase in the service sector, are not captured adequately. In this often female-dominated sector, many new occupations evolve which, by most classifications, are allocated to few and heterogeneous occupational groups. The rigidity of statistical classifications has been pointed out appropriately by Rubery et al. (2002a: 47): "New classifications tend only to be brought in when replacement has become absolutely essential. As the EU Member States, despite efforts towards harmonisation are still developing at different speed and directions, the conservatism of the classification system means that the classification of occupations and sectors may be more satisfactory for some countries than for others."

As a consequence, changing labour market conditions of women are not necessarily represented adequately by traditional classifications. This problem is intensified in an international comparison where jobs, included in occupational categories, could differ from country to country.

A further group of determinants relates to general definitions of terms like employment and working time, which can be defined differently across countries. This is especially a problem when focusing on female workers who are often incompletely enumerated (and therefore often invisible) in official statistics. Furthermore, the clarification of these terms is more important for certain occupations (e.g. agriculture) and certain types of jobs (e.g. informal sector jobs). To solve the problem and increase the comparability across countries, some authors (Anker 1998, Rubery et al. 2002a) recommended, for example, excluding the agricultural sector from the analysis. This seems plausible because reasons for gender segregation in non-agricultural and agricultural occupations can be quite different. A large proportion of agricultural employment is family labour which does not enter the labour market (Anker 1998: 59). The high aggregation of the agricultural sector and its gender blindness can also be demon-

strated by the sensibility of segregation indices for sectoral compositions (see Rubery et al 2002a: 61, 72). This is confirmed by own calculations comparing results for D and D_{st} with and without the agricultural sector for the year 2004. Some of the EU Member States, particularly in Southern and Eastern Europe, are changing their position (see table A3.1 in the appendix). The change is not very large at an overall level but more significant for individual Member States. As agriculture is a sector with only few defined occupational categories, the exclusion can have an increasing or decreasing effect on the index. If a decrease comes to the fore it reflects the importance of the sector in the countries but also the predominance of men (Rubery and Fagan 1993).

Finally, it can be stated that none of the presented approaches provides an entirely satisfactory method of measuring occupational sex segregation over time or between countries. Changes in the distribution of women and men across occupations are unlikely to happen in a context where either the occupational structure remains stable or the female share of the labour force remains constant. Furthermore, a comparison of occupational sex segregation across EU countries will always suffer from further problems, like the identification of an adequate classification of occupations/sectors which allows a country comparison and includes not only differences in the occupational structure but also differences in the scale of women's employment.

3.2. Learning from advances in mobility research - the multi-dimensionality of occupational sex segregation

Besides the debate about an appropriate index and the described related determinants, a central ambiguity in segregation research has not been tackled so far. A thorough review of the literature shows that the essential problem of the traditional index-based approach is not so much the decision for the 'one right' index. Instead, the presented methodological discussion, especially with respect to an international and historical comparison, concentrates too much on the aspect of a 'marginal free' measurement but fails to define the concept of 'segregation' precisely. Most of the indices have been proposed with varying connotations.

Consequently, a clarification of the concept of segregation, like in mobility research, is necessary to avoid further misunderstandings in the interpretation of research results. On this basis, also the deviant indices would probably be very helpful - especially in the context of more politically-oriented research. To develop this argument, this section briefly summarises the theoretical and methodological developments in social mobility research and tries to relate them to the difficulties in sex segregation research. Moreover, it will be argued that the

methodological discussion in segregation research could profit substantially from solutions applied in social mobility research.

Social mobility and segregation research are based on data of a similar structure. In both areas, very simple cross-tabulations are the starting point of a more elaborate analysis. In social mobility, it is a cross classification of the current class position (using occupations and social status as a backbone) of sons or daughters by social class origin (e.g. social class position of the father). In segregation research, a similar occupational variable (mostly based on the ISCO88) is used, but split only by a dichotomous variable, namely 'sex' (see table 3.1).

At the beginning, mobility research focused on the measurement of the 'amount of mobility', summing up the number of persons outside of the main diagonal of the mobility table (upward and downward mobility). Very soon it was detected that, in international or historical comparisons, this indicator of the 'amount of openness in a society' was heavily influenced by the strength of changes in the occupational distribution between father and son/daughter generation. To solve the problem, a decomposition of 'total mobility' into 'structural' mobility, forced by changes in the social structure, and the so-called 'pure' or 'exchange' mobility has been proposed (Yasuda 1964, Rogoff 1966). This decomposition (similarly to the differentiation between upward and downward mobility) was obviously only a very rough analysis of the huge amount of information included in a detailed mobility table.

One strategy has been the summation of differences in the mobility chances of children with differing social origin into one single number (usually the index of dissimilarity). As a mobility table allows for $k(k-1)/2$ independent comparisons and the basis of the comparison remains arbitrary, this strategy has been rarely used.⁴⁹ More common has been a detailed inspection of the mobility patterns across the cells of the mobility table using different indices.

Also in mobility research, a long methodological discussion started because it was realised soon that not only the highly aggregated mobility rates, but also the indices used for the detailed comparisons are dependent on structural changes in the marginals of a mobility table (Yasuda 1964, Tyree 1973). Particularly, the so-called 'association-index' (Rogoff 1953, Glass 1954, Carlsson 1958) did not achieve the goals of marginal independence. This problem was finally solved by Goodman (1965, 1969, 1979) and Hauser (1978), who introduced log-linear modelling into mobility research which, subsequently, has been expanded by the development of log-multiplicative models (Hout 1983). However, only Goldthorpe (1987) and Erikson and Goldthorpe (1992) applied this

⁴⁹ In the analysis of a segregation table only one single comparison (between women and men) exhausts all the available information.

new advanced technique for intensive comparative research and introduced a clear theoretical distinction between ‘social mobility’ (absolute mobility) and ‘social fluidity’ (relative mobility). According to this theoretical refinement, ‘social fluidity’ means the degree of relative inequality, according to class origins, in a person’s chances of acquiring a better, rather than a poorer, class position. It is conceived as a measure of the permeability of a class system, independent of how many persons are found in each of the classes.⁵⁰ In consequence, ‘social mobility’ has been defined as the amount of directly observable mobility resulting from ‘patterns of fluidity’ and the size of different classes. In sum, the realised advantages in mobility research have two bases: one is the methodologically driven progress in statistical modelling; the other is the theoretical refinement of the term ‘mobility’ which now combines different measurement and modelling procedures with different theoretical concepts.

With respect to occupational sex segregation, central methodological improvements have been introduced, particularly by Charles and Grusky (2004) who propose a marginal free A-Index as well as the application of advanced log-multiplicative modelling. Nevertheless, a convincing conceptual clarification is still missing. This is an unsatisfactory situation for at least two reasons: first, it remains unclear which aspects are covered by the term segregation: Is the expression used for differences in the observed distributions between the sexes? Or for the description of the underlying structure of unequal treatment (which results in differences in sex typing of occupations)? Second, not only the marginal free but also the marginal dependent measures of changes and differences in the distribution between two groups could be of utmost importance, particularly in a politically driven analysis of occupational sex segregation in different countries. For political recommendations, it makes a difference whether the share of females rises in a very small or a large occupational group. Despite the fact that scholars have called for a marginal free measure, it has therefore to be asked whether this is always the adequate method. As Weeden (1998: 486) underlines, “...research should be aware of the central research question and the ‘best’ measurement before preferring ‘any’ index.”

As pointed out above, the term ‘segregation’ is used with very different connotations: some authors restrict their understanding of the term to the amount of ‘sex typing’ of occupations (mostly measured with D_{st})⁵¹. This aspect identifies the gender composition of an occupation or a sector, i.e. in how far it is typically male or female. Other researchers, however, focus on the unequal distribution of men and women over the whole occupational structure. This

⁵⁰ Analyses of this aspect are based on the marginal free parameters of log-linear or log-multiplicative models using odds ratios as the basic measure of social fluidity.

⁵¹ Nevertheless, there are several alternative proposals (e.g. Sex Ratio Index SR, MM-Index).

aspect studies the degree of *'sex-specific occupational chances'* (mostly measured with D) of male and female employees, taking into account the 'size'-aspect (or the weight) of each occupational category.⁵²

Hence, it becomes clear that the term 'segregation' is imprecise, and should be regarded as a generic term covering different aspects of sex-specific differences. Furthermore, a theoretical refinement can be derived from a comparison of the described aspects of occupational sex segregation with the different aspects of social mobility. As mentioned above, the terms 'social mobility' and 'social fluidity' are reserved for different theoretical and methodological perspectives and procedures. In segregation research, a comparable distinction could be drawn, differentiating between 'patterns of sex typing across occupations' (similar to social fluidity) and 'sex-specific differences in occupational chances' (similar to the concept of 'social mobility'). The measurement of these dimensions does not necessarily require the use of sophisticated log-linear procedures. The proposed approach could also be followed by using different indices. However, it should be critically underlined that before presenting results on the basis of indices, the selection should be based on the aforementioned specific dimensions of segregation.

Finally, there is a term that is not included in the concept of social mobility: *'sex-specific occupational inequalities'*. This aspect is restricted to the vertical dimension of occupational sex segregation and concerns the unequal distribution of men and women over occupations at different hierarchical levels. In this context, the ranking of occupations is assessed with the socio-economic status and the mean income by using indices like the status differential, the status and prestige scales or 'Somers D'. To provide a better overview of the different dimensions and measurements, the following table 3.3. sums up these considerations.

Table 3.3: Theoretical dimensions of occupational sex segregation

Theoretical Concept	Measured by	Used Classification
'Segregation' : generic term which includes the aspects of		
Sex-typing of occupations	Standardised index of dissimilarity (D_{ST})	ISCO88 2-digit
Sex-specific occupational chances	Index of dissimilarity (D)	ISCO88 2-digit
Sex-specific inequalities	Mean-differential, Somers' D, Variance	ISEI 2-digit

Source: The theoretical classification was developed in the European Commission funded project *Female Employment and Family Formation in National Institutional Contexts (FENICs)*

⁵² To perform this weighting process, the percentage of males and females, working in a specific occupation or sector, could be calculated.

A comparison of correlations between different index families and their associated aspects of segregation (i.e. sex-typing of occupations, occupational chances and sex-specific inequalities) confirms that a theoretical clarification of the concept of ‘segregation’ might overcome the long-lasting search for the ‘best’ single-number index. It could be assumed that the correlation between various segregation indices depends on the aspect of interest. Therefore, correlations are subsequently calculated on the basis of a series of different indices (see figure 3.1). They are selected according to the principle that they sum up rather ‘differences in chances’ or ‘differences in sex typing’.

To verify the measurement of D, the frequently used IP-index has been calculated. This index has not only become widespread in scientific literature, but is also used in the statistical monitoring system of the EU.⁵³ The measurement of the standardised index of dissimilarity (D_{st}) is compared with results for indices based on log-linear modelling. In this respect the A-Index would be one alternative log-linear based index which avoids the problem of marginal dependency.

However, in the framework of this inquiry, a newly developed so-called L-index⁵⁴ is used which is defined as follows:

$$L = \frac{1}{k} \sum_{i=1}^k |\lambda_{ij}^{OS}| \cdot 100$$

with

j 1 and 2 for sex

i 1,...,k (k = numer of occupational categories) and

λ_{ij}^{OS} as the interaction effect between occupation and sex

The advantage of the L-index in comparison to the A-index is that the calculation is directly based on effect parameters of a saturated, effect-coded log-linear model of a segregation table. The obtained lambda-interaction parameters λ_{ij}^{OS} (sex*occupation) correspond to the characteristics of the percentage differ-

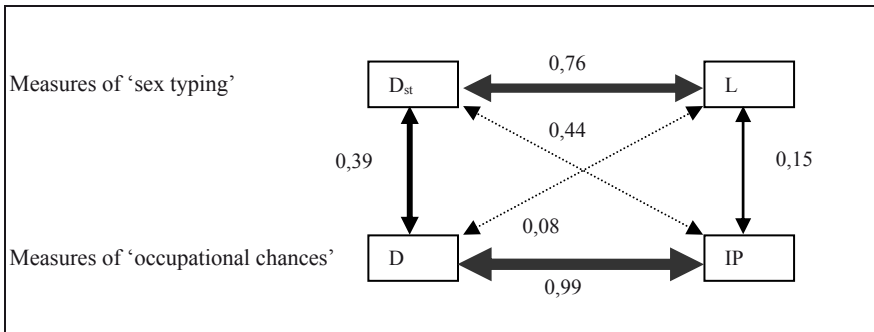
⁵³ It might be interesting that the European Commission (the EMCO indicators group) uses two indicators for measuring segregation. These are IP-indices: the EO3 (Index of gender segregation in occupations) and the EO4 (Index of gender segregation in sectors). However, it must be emphasised that, due to the above-discussed difficulties and insecurities of segregation indices, many practical and policy-related aspects could not be addressed by such an aggregated statistic.

⁵⁴ The L-index was developed by the research group of Prof. Handl in which the author worked in the framework of the European Commission funded project Female Employment and Family Formation in National Institutional Contexts (FENICs). The factor 100 has been additionally implemented to make the results of L clearer. Moreover, there is a slight positive correlation between A and L (0.114). See table A3.2 in the appendix.

ences used in calculating D_{st} .⁵⁵ Hence it is possible to handle the effect parameters in a similar way as the percentage differences. This is realised by simply adding all positive and negative interaction effects (without signs) for one selected sex and divide the sum by the number of categories of the used variable.

The following figure 3.1 illustrates correlations of the four selected indices on the basis of the ICO88 2-digit for EU Member States for the year 2004. As expected, the correlation coefficients for the four selected indices show a high and significant association between the values of D and IP (0,99) both measuring the differences in ‘occupational chances’, as well as between D_{st} and L (0,76) both measuring the amount of ‘sex typing’. All other correlations (D_{st} and D or L and IP), which measure different aspects of segregation, are much lower (for more details, see tables A3.2 and A3.3 in the appendix).⁵⁶ These findings confirm that the theoretically driven differentiation between ‘sex-typing’ and ‘occupational chances’ as distinct but correlated dimensions of segregation is justified. The distinction is not only supported by the traditional indices of dissimilarity, but also by the use of alternative indices of segregation. Taking this result into account, it should be possible to systematise previous and sometimes divergent findings concerning the development of sex segregation more adequately.

Figure 3.1: Correlation between different measures of occupational sex segregation (ISCO88 2-digit), 2004



Source: EULFS 2004/5, own calculations

⁵⁵ They sum up to zero. However, it is also possible to modify the index (L) by taking, for example, only the significant parameters into the summation.

⁵⁶ The correlations show that different indices are measuring the same aspect of occupational sex segregation.

3.3. Conclusion

The application of an index-based approach to analyse occupational sex segregation across countries or over time gives rise to various problems. The theoretical and methodological clarification of ‘occupational sex segregation’ along the lines of experiences in mobility research is conducive to addressing these problems adequately.

It has been demonstrated that social mobility and segregation research have comparable starting points. In both research strands, the focus is on social inequality between different groups in society. Also from a methodological point of view, parallels can be drawn: the aspects of ‘sex-typing’ and ‘occupational chances’ can be distinguished as distinct but correlated aspects of segregation, in analogy to ‘social fluidity’ and ‘social mobility’. The benefit of this theoretical clarification is that some of the disadvantages of traditional indices, particularly their marginal dependency, are no longer important. Instead, it becomes clear that the search for the ‘right’ measurement (i.e. the selection of the adequate index) largely depends on the focus of interest. Furthermore, in a political context, a marginal dependent approach seems to be more suitable to consider the multi-dimensionality of sex segregation and evaluate improvements in gender equality. Specifically, it has been argued that the size of the occupations or sectors in which gender inequality evolves, is not taken into account when focusing, for example, only on a comparison between the structure of ‘sex-typing profiles’ between countries. To obtain an estimate of the number of persons who are privileged by or suffer from the inequality relation, however, it also seems important to capture the size of occupational categories by examining the ‘occupational chances’. Nevertheless, ‘final’ certainty on whether this result has ‘empirical’ evidence or is an artefact of the methods used cannot be achieved with an index-based analysis. Here, thorough in-depth case studies using advanced multivariate methods are necessary which are better suited for a detailed examination of the relation between sex typing and occupational chances.⁵⁷

Finally, this chapter has shown that an index-based analysis of occupational sex segregation can be a useful starting point for the understanding of sex segregation patterns. However, as Charles and Grusky (2004) point out “...it is only rarely an appropriate end point”. This is of crucial importance, particularly when policy makers classify countries, using only one single number index to assess the ‘advantaged’ or ‘disadvantaged’ situation of women and base recommendations on such - often short-sighted - measures.

⁵⁷ It would be possible to summarise detailed occupational categories under specific themes, like female- and male-dominated occupations (Hakim 1993) or manual vs. non-manual occupations (Charles and Grusky 2004).