The Puzzle of Gender Segregation and Inequality: A Cross-National Analysis

Robert M. Blackburn, Jennifer Jarman, and Bradley Brooks

Occupational gender segregation has generally been assumed to be a structure of gender inequality in the labour market; high levels of segregation are equated with high levels of gender inequality in a society. The paper questions this assumption. It examines, across a range of countries, the relations between United Nations development measures of gender equality and segregation levels. Contrary to conventional expectations, correlations are found to be positive. To explain these results it is argued that segregation, as measured by conventional segregation indices, is not necessarily indicative of gender inequality which operates to the advantage of men in national labour markets. The usual segregation measures are argued to be the resultant of two components: vertical segregation measuring inequality, and horizontal segregation measuring difference without inequality (here vertical and horizontal are used in their usual mathematical sense rather than the special senses sometimes found in segregation literature). It concludes that the relationship between segregation and inequality is far more complex than previously recognized.

There is a clear and universal tendency for men and women to be employed in different occupations from one another. The extent to which this occurs varies from country to country, and over time, but the differentiation is always present. As concern increased over inequalities between men and women, researchers began to focus attention on the gendering of the occupational structure as a causal explanation. Sidney Webb, in the first volume of Britain's *Economic Journal* published in 1891, was one of the first to argue that occupational segregation – or what Webb called 'non-competing groups' – was partly responsible for pay differences between men and women (Webb, 1891). Many other researchers have followed suit in subsequent years in explaining a broader range of gender inequalities as being intrinsically tied up with the pattern of gender segregation, to the point where today it has become a commonplace assumption that the existence of a gendered occupational structure may be equated with social inequality (e.g. Jones, 1983; Bradley, 1989; Crompton and Sanderson, 1990; Reskin and Roos, 1990; Armstrong and Armstrong, 1991; Yamagata *et al.*, 1997; Walby, 1997).

This paper challenges the orthodoxy which has grown up concerning this topic. After a brief explanation of concepts and measures, the paper presents an analysis of a recent International Labour Organization (ILO) cross-national dataset which provides much more detailed occupational categories than have been available to past researchers who have measured gender segregation trends in cross-national data. The analysis includes the application of a standardization procedure to control for the number of occupations in a dataset; without such control a segregation index tends to vary directly with the number of occupational categories. The association between three United Nations measures – the Human Development Index (HDI), the Gender-related Development Index (GDI), and the Gender Empowerment Measure (GEM) – and segregation is measured and some very surprising

results are obtained. Seeking to understand the puzzle these results present leads us to the conclusion that what has been commonly referred to in the literature as 'segregation' or often as 'horizontal segregation' (but that we describe as 'overall segregation') should not necessarily be accepted as a measure of inequality in itself. A new explanation is then presented, illuminating the manner in which segregation and inequality are related.

Clarification of Terminology and Choice of a Measure

In the first place we need to make it perfectly clear what we are talking about, as this is an area where a certain amount of terminological confusion persists (e.g. Walby, 1997). The tendency for women and men to be employed in different occupations is what we refer to as 'occupational gender segregation', or simply 'segregation' for short. The concept is symmetrical in that if women are segregated from men, men are equally segregated from women. A population composed entirely of monks and nuns would represent total segregation. Of course, national societies do not contain such simple extremes, but they do tend to polarize into male and female occupations (e.g. Bielby and Baron, 1986; Fox and Fox, 1987; Crompton and Sanderson, 1990; Boyd *et al.*, 1991; Jarman *et al.*, 1999).

Like James and Taeuber (1985), we distinguish between 'segregation' and 'concentration', where the latter refers to the proportion of workers in an occupation, or group of occupations, who belong to one sex – usually measured as the percentage of women in a particular occupation. For instance, in Britain 68 per cent of clerks are women, that is, the female concentration is 68 per cent. It is logically impossible for this measure to be symmetrical.[1] The two concepts are related, and some prefer to use the term 'segregation' to refer to both (e.g. Armstrong and Armstrong, 1978; Lewis, 1985; Walby, 1997), but we prefer the greater precision of keeping the two ideas distinct.[2]

There are several alternative measures of segregation. Probably the most widely used, particularly in the USA, is the Index of Dissimilarity (ID). Yet long ago Duncan and Duncan (1955) pointed out that it is seriously flawed, and others have reinforced the criticism (e.g. Tzannatos, 1990; Watts, 1992).[3] We have shown that it may be expressed as a simple difference of proportions in a 2×2 Basic Segregation Table (Blackburn, Jarman, and Siltanen, 1993). Furthermore, all other popular segregation indices (e.g. WE, introduced in the OECD 1980 report *Women in Employment* for analysis of European data, and the Sex Ratio (SR) introduced by Hakim, 1981, for the analysis of British data) are one or other of the two differences of proportions in the table, with or without some distorting weighting (Siltanen, Jarman, and Blackburn, 1995; Blackburn and Jarman, 1997). For instance WE is a weighted version of ID and SR is a weighted version of the other difference of proportions in the basic segregation table. Thus, at best the measures are subject to the weakness of using differences of proportion; in particular they are affected by variation in the marginal totals of the table – the gender distribution and the distribution of workers between 'male' and 'female' occupations.[4] It might be imagined that the odds ratio (Yule's Q in fashionable modern dress), usually used in log-linear analyses, has 'marginal independence' and so avoids these problems (Charles and Grusky, 1995). This is not so: changes in the marginal totals can alter the classification of occupations as 'male' or 'female'. Furthermore, the upper and lower limits (∞ and 0) do not correspond to total and zero segregation (Blackburn, Siltanen, and Jarman, 1995). To overcome these basic weaknesses we introduced the marginal matching coefficient, MM.[5]

The Basic Segregation Table is derived by dividing occupations into those that have a larger, or smaller, proportion of women than expected, i.e. than in the labour force under consideration. This division into 'male' and 'female' occupations is then cross-tabulated with the sex of workers. Obtaining the male/female division may be thought of as ordering all occupations in terms of gender concentration and choosing the cutting point where female concentration in the occupation equals that in the labour force. Although this seems reasonable it has the unfortunate consequences we have noted. By choosing the cutting point so that the number of workers in 'female' occupations equals the number of women in the labour force (i.e. the marginal totals of the segregation table are matched, as they must be in total segregation), the two differences of

proportions and several other statistics of association all coincide. We have given the name 'MM' to this resultant measure. As the numbers of men and women in the labour force change, this only affects MM in so far as there is also a change in the relative distribution across occupations; the effect from the marginal totals of the segregation table remains constant. Of course, no measure is ever perfect, but MM does overcome the basic weaknesses of the major alternatives. Accordingly, it is the measure used here. MM and the differences of proportions in the Basic Segregation Table, ID and SR*, have a range between 0 and 1 (sometimes expressed as percentages from 0 to 100 per cent).

In measuring segregation, the observed value is affected by the number of occupations in a dataset. This is not an effect of the measure chosen, but only of the number of occupational units. At the extremes, with only one occupation there could not be any segregation, while a distinct occupation for every single worker would mean there was total segregation. The segregation values of 0 and 1 are not confined to these extreme situations. Between the extremes it is possible to have zero segregation, where every single occupation has the statistically expected gender composition, and total segregation, as illustrated above with the example of monks and nuns. However, these are situations of maximum deviation from the expected values of MM, whereas at the extremes (one occupation or one per person) the values are *necessarily* 0 and 1. Between these extremes the value of MM (or any other measure of segregation) tends to increase with the number of occupational categories.

We have, therefore, derived an equation to measure this effect. The equation gives the 'expected' value of MM as the number of occupations varies. For comparative purposes we standardize all the national datasets on a notional set of 200 occupations (Jarman *et al.*, 1999): these estimated values of MM are referred to as MM_{200}.[6]

International Comparisons

To explore the relationship between gender segregation and inequality we use an international dataset of men and women workers by occupations, provided by the ILO, and the UN measures of Human Development (HDI), Gender-related Development (GDI) and Gender Empowerment (GEM) (United Nations, 1996).

The ILO sought to collect occupational data from member countries for three separate years – 1991, 1981, and 1971 – or years as close to these as possible. However, this attempt to cover a 20-year interval was not particularly successful, as most countries did not provide data for the three years. Accordingly, we have chosen to limit ourselves to the most recent data available in each case. The dataset comprises, for each country, a set of occupational categories and the numbers of women and men in each category. The full set includes data for 40 countries but for a number of reasons we have excluded several, e.g. incomplete data (Germany), too few occupational categories (Mexico), diverse occupations grouped in one large category (Romania). This left us with the 32 countries of Table 1.

Occupations are classified to a variety of national schemes, or to ISCO68 or ISCO88. Even when the same ISCO scheme is used, some countries do not use all categories, so the classifications are not exactly the same. Of course labour markets in different countries are affected by varying levels of industrial development, welfare state development, and different cultural pressures, so that comparisons should be interpreted cautiously (e.g. Charles, 1990; Marquand, 1991; Charles and Grusky, 1995; DiPrete *et al.*, 1997). Nonetheless, there are also considerable similarities among countries in their actual occupations, even to the extent of similar occupational hierarchies (Stewart *et al.*, 1980; Grusky and Van Rompaey, 1992). These similarities are being reinforced by the growth of service employment and of global markets, especially in the industrial countries. So, with due caution, we can use comparisons to better understand particular labour-market patterns.

With the considerable variation across countries in the number of occupational categories, as shown in Table 1, it will be apparent why we considered it essential to devise a standardization procedure. Although the data are suitable for measuring segregation as they stand, in keeping with previous research practice, our standardization procedure greatly improves the cross-national comparability.

It will be apparent that the coverage of the world is, to say the least, patchy. Europe, or at least Western Europe, is well represented, together with the

Table 1. *MM_{200}, unstandardized MM, and the three UN measures*

	Occs	F%	MM_{200}	MM	MM Rank	HDI	HDI Rank	GDI	GDI Rank	GEM	GEM Rank
Sweden	52	48	0.683	0.601	8	0.933	7	0.929	1	0.779	2
Costa Rica	60	29	0.677	0.606	6	0.884	19	0.813	18	0.475	16
Angola	71	41	0.658	0.600	10	0.283	32	0.270	28	–	–
Kuwait	282	20	0.655	0.672	2	0.836	22	0.719	23	0.308	24
Finland	478	48	0.623	0.661	3	0.935	5	0.921	5	0.710	3
Bahrain	1050	16	0.622	0.689	1	0.866	20	0.726	22	–	–
Jordan	80	7	0.618	0.570	14	0.741	28	–	–	–	–
Canada	41	46	0.604	0.516	21	0.951	1	0.927	2	0.685	4
Norway	490	45	0.601	0.638	4	0.937	4	0.926	3	0.786	1
Luxembourg	78	35	0.600	0.552	16	0.895	17	–	–	0.590	10
UK	526	43	0.595	0.635	5	0.924	13	0.886	11	0.530	12
Australia	283	41	0.587	0.602	7	0.929	9	0.912	7	0.590	10
Hungary	126	44	0.583	0.561	15	0.855	21	0.835	16	0.507	13
Cyprus	383	37	0.574	0.601	8	0.909	15	–	–	0.359	21
Iran	24	10	0.569	0.450	28	0.754	27	0.618	25	0.239	28
Austria	77	41	0.566	0.520	20	0.928	10	0.887	10	0.641	7
Switzerland	541	36	0.557	0.595	11	0.926	12	0.869	12	0.594	8
France	454	42	0.552	0.584	12	0.935	5	0.913	6	0.437	18
USA	488	47	0.548	0.583	13	0.940	2	0.923	4	0.645	6
Tunisia	59	19	0.540	0.482	24	0.727	29	0.647	24	0.257	27
Spain	82	32	0.538	0.498	22	0.933	7	0.866	13	0.490	14
Haiti	70	42	0.528	0.481	25	0.359	31	0.354	27	0.349	23
Hong Kong	78	38	0.525	0.483	23	0.909	15	0.843	15	–	–
Bulgaria	47	47	0.520	0.452	27	0.773	26	–	–	0.486	15
New Zealand	305	41	0.512	0.528	18	0.927	11	0.906	8	0.685	4
Mauritius	386	30	0.511	0.535	17	0.825	24	0.740	21	0.357	22
Poland	373	45	0.500	0.522	19	0.819	25	0.802	19	0.431	19
Egypt	80	9	0.455	0.420	30	0.611	30	0.545	26	0.280	26
Japan	294	40	0.443	0.455	26	0.938	3	0.897	9	0.445	17
Italy	249	32	0.424	0.431	29	0.914	14	0.856	14	0.593	9
Korea, Rep of	44	37	0.357	0.308	32	0.886	18	0.816	17	0.282	25
Malaysia	80	32	0.343	0.316	31	0.826	23	0.772	20	0.425	20

Notes: Countries listed by MM_{200} (descending values).
'F%' is the proportion of the labour force who are female.
'Occs' is the number of occupations in the data for the country.
MM=marginal matching coefficient; HDI=Human Development Index; GDI=Gender-Related Development Index; GEM=Gender Empowerment Measure.
Source: UN 1996. Rankings apply to sample countries only. Occupational data supplied by the ILO.

English-speaking countries of North America, Australia, and New Zealand. On the other hand, our sample restrictions mean that Central and South America are represented solely by Costa Rica and Haiti. Africa does little better, and there is only limited coverage of Asia. Clearly any interpretation of results for these countries must be done with caution. We cannot claim to be representing the whole world; nevertheless we shall see that there are some interesting patterns.

As noted above, the three measures we are using to compare countries are those developed for the United Nations. On each measure the countries are scored in the range from 0 (low) to 1 (high), though there are no countries scored at the actual extremes. The Human Development Index, or HDI, is

intended to 'capture as many aspects of human development as possible in one simple composite index' (United Nations, 1996: 28). It is measured by three components: life expectancy at birth, educational attainment (a composite measure of adult literacy and enrolment in primary, secondary, and tertiary education), and standard of living as measured by real GDP per capita (p. 106). Not surprisingly, the 'developed' countries of the 'West' score highly on this measure. Top in 1993, as recorded in the 1996 Report, was Canada, followed by the USA. Just behind came Japan, the Netherlands, and Norway. The other Scandinavian countries were also highly rated, as were most of Europe, Australia, and New Zealand. It is, perhaps, not surprising that the countries included in our sample tend to have high ratings (defined by the UN as HDI > 0.8), a few have medium ratings (0.5 to 0.8), while only Angola and Haiti have particularly low scores. This is by no means typical of the UN findings, where the majority of countries have medium to low scores, the median value being 0.701.

The GDI is a measure of 'Gender-related Development'. It is composed of the same elements as the HDI – life expectancy at birth, educational attainment, and standard of living as measured by real GDP per capita – but each element is adjusted 'in accordance with the disparity in achievement between men and women' (United Nations, 1996: 107). We do not present details of the actual procedure since it is too complicated to summarize neatly, but the general idea is clear. Because of its composition, the GDI is, inevitably, very similar to the HDI, though the scores are consistently lower, reflecting the pattern of gender inequality throughout the world. The two measures are rank correlated 0.95 (Spearman) for the countries in our sample, and it appears unlikely that the result would be very different for the whole UN set of countries. There are, nevertheless, some notable changes in our sample of countries. On the GDI Sweden moves up to first place ahead of Canada, and Norway moves ahead of the USA to occupy the third rank. Japan drops from 3rd to 9th. However the biggest declines in score from the HDI to the GDI are found in the Arab countries, clear leaders in the decline being Bahrain, Iran, and Kuwait in that order. This finding is intuitively unsurprising. The biggest drop among the high-scoring HDI countries is for Spain. This is only the 8th biggest drop, moving Spain down the rank order from 7th to 13th. Overall, the pattern of difference from the HDI to the GDI, as the emphasis moves to gender, appears to be one of gain in the Scandinavian countries and decline in Arab countries.

A more direct measure of gender equality is the 'Gender Empowerment Measure', GEM. It would more accurately be called the Women's Empowerment Measure, since it is designed to be a direct measure of the extent of women's empowerment. Like the HDI and GDI it is measured on a scale from 0 to 1, and in this case the value of 1 would indicate complete gender equality. Thus it is a measure of how closely a country approaches a situation of equality, or putting it differently, the shortfall from 1 measures the degree of gender inequality. There are three components of the measure: the extent of female representation in parliament; the proportion of senior jobs (administrative, professional, etc.) held by women; and the degree to which income approaches equality (United Nations, 1996: 108). Thus all three are measured against a standard of equality; the first two on the basis of representation in proportion to the female share of the population and the third on the basis of women's earned incomes being the same as men's. These are all concerned with participation in the public sphere, as is occupational segregation. Apart from income, the components are not directly concerned with gender equality, but with women's involvement at the top of the stratification structure, their empowerment.

It is not surprising to find that the GEM is quite strongly related to the other two measures, and the relationship is stronger with the more gender-related GDI than with the HDI. The Spearman rank correlations are 0.88 and 0.76 respectively. Since some readers may feel more comfortable with product-moment coefficients – though they are less appropriate here – we may note that they are somewhat lower at 0.73 and 0.58, while the corresponding value for the correlation of the HDI with the GDI is hardly changed at 0.97.

Gender Segregation and the Three UN Measures

Before presenting the actual data it will be useful to consider hypotheses suggested by the literature. To a

substantial degree it seems that everyone is in agreement on the importance of both segregation and gender inequality (e.g. Bradley, 1989; Crompton and Sanderson, 1990; Reskin and Roos, 1990; Armstrong and Armstrong, 1991; Charles and Grusky, 1995; Yamagata *et al.*, 1997; Walby, 1997), but we are advocating significant theoretical and methodological refinements (e.g. Blackburn and Jarman, 1997). The different nature and significance of our approach will be discussed in relation to the empirical findings. But first let us consider the orthodox position.

There is a general tendency in literature on gender segregation to assume that segregation itself is a form of gender inequality. Either it is argued (Blau and Hendricks, 1979; Boyd, Mulvihill and Myles, 1991; Walby, 1992; Buchmann and Charles, 1992), or more often assumed, that segregation is a direct measure of inequality, or it is regarded as a strong indicator of inequality. The direction of the inequality is not usually questioned. It is taken to operate to the disadvantage of women, and some authors have employed the notion of vertical segregation to represent this disadvantage; we shall return to this point later.

The question we must now consider is how segregation relates to the three UN measures of inequality characterizing the countries in terms of life chances, gender relations, and the national labour markets. It is not clear that we should expect any relationship between the HDI and segregation. Countries with high HDI values are more likely to have well-established feminist movements and to have enacted anti-discrimination legislation, which might lead us to expect a negative correlation, but there is nothing in the composition of the measure itself to suggest a positive or negative relation.

Turning to the other two measures, the position is clearer, as both concern gender directly. The Gender-Related Development Index (GDI) represents the extent of economic progress for women, so the higher the value, the less the disadvantage in employment. Therefore, within orthodox approaches, the predicted relationship with the measure of segregation is clearly negative. Since the GDI is so strongly related to the HDI, this should strengthen the expectation of a negative correlation between MM (in its raw or standardized form) and the HDI. We may also predict that the HDI correlation will be numerically lower (less negative) than the GDI correlation.

For the Gender Empowerment Measure, GEM, the position is even clearer. GEM is an attempt to measure directly the degree of gender equality in the labour market (in the sense of measuring the limitation of inequality). If segregation is a measure of gender inequality, we should expect a high negative correlation. Indeed, if segregation really is a measure of gender inequality, only measurement imperfections will prevent a correlation of −1.

Data Analysis

We conduct the analysis of the data in two forms. In the first place we use the data directly as it was supplied to the ILO. That is to say, we calculate MM for each country without any correction for the number of occupations in each national dataset. This gives measures that are comparable with all previous measurements of segregation, in the sense that no one else has standardized for the number of occupations. It is true that different segregation measures, such as the Index of Dissimilarity (ID) and the Sex Ratio (SR), show different trends over time, and the various national datasets are equally vulnerable to the different measurement procedures.[7] This is a problem, especially for those measures, like the SR, which incorporate a weighting for the proportion of the labour force who are women (Blackburn, Jarman, and Siltanen, 1993). However, the unweighted differences of proportions, ID and the standardized Sex Ratio SR*, show less marked deviation from our measure. Therefore, the range of differences across countries is rather greater than the inconsistencies resulting from the use of the unweighted measurement procedures. A roughly similar, if less accurate, picture would emerge using the unweighted differences of proportions, ID or SR*.

The second analysis uses the standardized MM_{200}. As noted earlier, this is where every country has the observed segregation level adjusted to an estimated value for a notional set of 200 occupational categories. There is, of course, a potential element of error in each estimate, and this is particularly so where the actual number of occupational categories for a country is low. Nevertheless, this procedure makes the various national levels of measured

segregation as comparable as possible. Since this standardization procedure is new, it is interesting to compare the results of our analysis with those from the unstandardized measures. This is a further reason for conducting the two analyses. However, it is the results from the standardized MM_{200} measures that provide the definitive cross-national comparative analysis.

Looking first at the unadjusted MM scores, Table 2 presents the correlations of MM with the three measures characterizing societies. The levels of statistical significance are also given. Here and throughout the analysis, unless otherwise indicated, correlations are Spearman rank correlations, since the distribution of values is quite inappropriate for a product-moment correlation. However, the story using Pearson product-moment coefficients would be essentially the same.

The first point to note is that all the correlations are *positive* and significant at the 10% level or better.[8] This is the opposite of what we predicted on the basis of orthodox approaches. We also see that the highest correlation of MM is with GEM, followed by the correlation with the GDI, which in turn is marginally higher than the correlation with the HDI.[9] This is the predicted order, on the basis of the relevance of the measures to gender differences. However, the positive signs make it exactly the reverse of the predicted pattern of relationships.

How are we to explain this 'unexpected' result? The first possibility to consider is that the result is in some degree spurious. Countries with higher levels of 'human development' also tend to have more developed organizations for recording statistics. We have already noted the tendency for the countries of our sample, i.e. those supplying usable statistical data to the ILO, to score relatively highly on the HDI. Taking this a step further, we find that even within the sample the countries with higher levels on the HDI tended to supply more detailed data. There is a positive correlation between the number of occupations specified in the dataset and the value of the HDI (ρ=0.364). Similarly the GEM and GDI are positively correlated with the number of occupations (0.319 and 0.287 respectively). The relation with the GDI is significant at the 10% level and the others at the 5% level.

None of this would matter if it were not for the fact, noted earlier, that the value of MM tends to increase with the number of occupations in a dataset (as is the case with all other measures of segregation). Across countries, the number of occupations is significantly correlated (0.55) with MM. While it is possible that the countries providing more detailed data also tend to be more segregated, we know this is by no means the whole explanation (Jarman *et al.*, 1999). Here we see one of the advantages of the standardized measure MM_{200}, as this provides the only way forward.

The standardizing process reduces the correlation of the segregation level (MM_{200}) with the number of occupations to 0.018. This is far from being statistically significant, though it is positive, much as we would expect. The product-moment correlation shows the same pattern with a small but slightly larger value of 0.151. We see, therefore, that the standardization has removed any unwanted effect from the ability of some countries to supply more detailed statistics. Countries with higher values on the HDI, GDI, and GEM do tend to use more occupational

Table 2. *Association between segregation, MM, and measures of national social development and equality (HDI, GDI, and GEM): Spearman rank correlations*

	HDI	GDI	GEM
	0.283	0.296	0.449
Number	32	28	28
Significance	0.059	0.063	0.008

Notes: HDI = Human Development Index;
GDI = Gender-Related Development Index;
GEM = Gender Empowerment Measure.
Significance levels are for the one-tailed test.

Table 3. *Association between standardized segregation measure, MM_{200}, and measures of national social development and equality (HDI, GDI, and GEM): Spearman rank correlations*

	HDI	GDI	GEM
	0.124	0.204	0.422
Number	32	28	28
Significance	0.250	0.149	0.013

Notes: HDI = Human Development Index;
GDI = Gender-Related Development Index;
GEM = Gender Empowerment Measure.
Significance levels are for the one-tailed test.

categories, which creates an element of spurious correlation with MM, but not with the standardized MM_{200}.

As expected we see a drop in all values from those recorded in Table 2. The smallest drop is in the value for the GEM, which is now the only statistically significant relationship. The important points remain. All the relationships are still positive, rather than significantly negative, as we would expect from the literature. Also the strengths of the relationships are in the same order as before, i.e. the order of the correlations corresponds to the size of the gender component in the three UN measures.

We need to be cautious in interpreting the precise results. The samples of countries involved in the three measures are not exactly the same. All countries for which the UN has data are included in the HDI, but different ones are missing for the other two measures. Unfortunately, the countries for which data are missing are not randomly related to the level of gender segregation. Consequently, as the number of countries is only 32 at the most, the effects of missing countries can be quite large. However, the essential pattern stays much the same; the main differences with selective inclusion or exclusion of countries is in the correlations of the GDI and HDI with MM_{200} (and to a lesser extent with MM). Limiting countries to the 25 for which all measures are available, the correlation of MM_{200} with the GEM increases slightly to 0.444, while the correlations with the GDI and HDI increase substantially to 0.413 and 0.326, with 5% and 10% significance levels, respectively. Whether we use the Spearman or Pearson correlations, and whether or not we exclude any countries from the analysis, we always obtain a statistically significant positive correlation between MM_{200} and the measure of Gender Empowerment. The correlations with the GDI and HDI are consistently lower, in that order, ranging from approximately zero[10] to significantly positive.

Since the positive relation between gender segregation and female empowerment is far from absolute, we may usefully consider whether there are any different patterns according to types of countries. Our data are too limited for a detailed exploration of these issues. However, there are no obvious groupings that suggest a reversal of the pattern. We saw earlier that the Arab countries tend to have lower rankings on the GDI than the HDI, and the rankings on the GEM tend to be lower again. Indeed they have low rankings on the GEM even where segregation is high; nevertheless the relationship still appears to be positive, at least for the few countries for which we have data.

We can at least see how the relationships hold for the industrialized countries, since these are much more adequately represented in our sample. For Table 4 we include all the industrial countries for which there are values on all the measures. This means all the Western European countries in the dataset (Table 1) apart from Luxembourg, together with Poland and Hungary from Eastern Europe, Canada and the USA from North America, and Australia, New Zealand, and Japan. On the measures of segregation virtually the whole range of values is covered, especially for MM_{200}, which runs from 0.683 for Sweden to 0.424 for Italy. However, the range is more restricted on the measures of GEM, GDI, and HDI, as the lowest values are now excluded. If this has any effect it will be to reduce the levels of correlation, but there is more than this involved, as may be seen from Table 4.

For this group of countries the correlations are still all positive, but there are some interesting changes from the earlier tables. For these countries the correlations of two of the three UN measures (HDI and GEM) with MM are lower than for the larger sample. This may be due, at least in part, to the restricted ranges on the UN measures correlated with MM, as noted above. On the other hand, the correlations with the standardized MM_{200} are notably higher than those observed for the full sample,

Table 4. *Association between segregation measures, MM and MM_{200}, and measures of national social development and equality (HDI, GDI, and GEM): Spearman rank correlations for industrialized countries*

	HDI	GDI	GEM
MM	0.072	0.427	0.414
Significance	0.395	0.050	0.056
MM_{200}	0.284	0.618	0.603
Significance	0.143	0.005	0.007
Number	16	16	16

Notes: HDI = Human Development Index;
GDI = Gender-Related Development Index;
GEM = Gender Empowerment Measure.
Significance levels are for the one-tailed test.

despite any technical effects to lower the values (which would apply here the same as for MM).

As a result of these divergent changes from the earlier patterns, the correlations with the standardized measure are now appreciably higher than those with the unstandardized MM. We noted earlier that the tendency for 'developed' countries to have more developed statistical records produced a positive relation between scores on the development indices and the number of occupational categories in their datasets, and this in turn contributed to positive correlations with MM. In this subsample the relations between the number of occupations and the three UN measures tend to zero, indeed they are slightly negative (from −0.02 for GEM to −0.06 for the other two). Thus the correlations with the unstandardized MM are not spuriously inflated by the shared association with the number of occupations. The two measures are now directly comparable, and we see that the more consistent measurement of segregation by MM_{200} gives a more accurate picture of the true situation, and so is more highly correlated with the three development and gender measures.

The other change from the pattern for the whole sample is that the Gender-related Development Index is now the most strongly related to the segregation measures. This is a little surprising, especially as the HDI quite clearly remains the least related (having the only non-significant relationship with MM_{200}). However, the difference between the correlations with the two measures reflecting gender inequality is small, while both are substantially greater than the correlations found for the wider sample. This is still broadly in line with our general findings, showing very clear relationships in the opposite direction from predictions based on conventional theory, that is, that increasing segregation is associated with increasing gender empowerment.

Explaining the Puzzle

However we look at it, the results are directly opposed to predictions from orthodox approaches. How are we to explain this? On the face of it, it looks as though previous beliefs about gender segregation have been wrong: the inequality favours women rather than men. This would then mean that, across countries, greater Gender Empowerment (i.e. women's empowerment) and greater Gender-related Development are associated with greater gender segregation to the advantage of women (the higher the GEM and GDI values, the greater the tendency for women to have better occupations than men).

While such an interpretation is mathematically sound, it is not sociologically sound. The hostile reception it would receive, particularly among feminists, would be fully justified. The GEM and GDI are measures of declining female disadvantage; they are based on a conception of male advantage in the public sphere, and measure the extent to which women's circumstances approach gender equality from below.[11] It makes no sense to combine these measures with one based on a conception of female advantage. The areas are too closely related, theoretically as well as statistically, for women to be simultaneously disadvantaged and advantaged relative to men. We must find a different, more constructive explanation.

The Dimensions of Segregation

The way forward is to recognize that occupational gender segregation is not necessarily a measure of inequality. This is contrary to the almost universal assumptions about the subject, as noted earlier, but is the only way to provide a proper account of social reality. Segregation must be understood as having two orthogonal dimensions: a *vertical* dimension which does measure inequality, but also a *horizontal* dimension measuring difference without inequality. Segregation, as usually conceived and measured, is then the resultant of these two measures (Blackburn and Jarman, 1997). To assist clarity, we have termed this resultant *overall segregation*.

We recognize that the terms 'vertical' and 'horizontal' have been used before to describe segregation. It is important, therefore, to make clear that we are not following previous usage. We are using the terms with their usual mathematical and common-sense meanings.

In our analysis of the ILO data we have only been able to measure overall segregation. The data are not ordered on any stratification measure (one would

hardly expect this) and no income data are available. Thus, while the data are valuable for measuring overall segregation, it is impossible to measure the vertical or horizontal dimensions. However, the UN measures of GEM, GDI and HDI do provide vertical orderings of the countries, and the measures relate to gender inequality. Therefore, we have been able to see how overall segregation relates to inequality, and it is clear that the relevant dimension of segregation relating to these measures is the vertical dimension.

Vertical segregation has often been considered as a form of segregation representing inequality, and has it been argued by Hakim (1996: 5; 1998: 7) – quite reasonably in our view – that vertical segregation is more important than overall segregation (what she calls 'horizontal segregation'). Many others, particularly feminist researchers doing qualitative work, make reference to vertical segregation in understanding gender relations in society (e.g. Bradley, 1989; Wright *et al* 1995). However, there have been real difficulties over the conceptualization and measurement of vertical segregation, and the conceptualization used by Hakim and adopted by some others is rather different from that which we are advocating here. Their approach is to think in terms of sets of vertical dimensions for different occupational situses (Hakim, 1981, 1996).

Those who attempt to actually measure a single vertical dimension generally do so for only a few aggregated categories, normally less than ten (e.g. Treiman and Roos 1983; Faber 1990; Boyd 1990; Charles 1992, Jacobs and Lim 1992, Blau and Ferber 1992). We have found this sort of approach to be quite unreliable.[12] Fox (1989) and England (1979) do more detailed vertical analyses relating segregation to 'prestige' scales. However, finding very little relation, Fox (1989: 358) concludes "We believe (with England, 1979) that the failure of 'prestige' scales to capture profound occupational disparities between men and women suggests that the concept should be removed from its central role in research on stratification." They dismiss prestige scales as unsuitable for measuring gender inequality.[13] Charles and Grusky (1995) measure a vertical dimension with 45 categories, but treat it as an alternative to the overall dimension. Inevitably they find it measures less segregation than does overall segregation (being only a component) and do not take the analysis any further.[14] Since vertical segregation is a part of overall segregation, it does seem reasonable to assume that inequality varies directly with overall segregation, even where vertical segregation is seen as the direct measure.

No one (apart from ourselves) has paid any attention at all to what we term the horizontal dimension. Certainly the term 'horizontal' has been used, but it has been used to refer to the usual conception of segregation (e.g. Hakim 1979; Moore 1985; Crompton and Sanderson 1990; Rubery and Fagan 1995; Cousins 1999). That is, the term 'horizontal' has conventionally been applied to what we term overall segregation, which is the resultant of the vertical and horizontal components as we define them. We think this conventional terminology is extremely confusing; not only does the 'horizontal' dimension contain a vertical component, but it is frequently assumed to directly measure inequality, i.e. the 'horizontal' is the same as the 'vertical'. Of course, these strange conceptions are never spelt out, but most segregation research has either been confined to work on overall segregation or it has operated with its own idiosyncratic mathematical 'dimensions'.

As we saw earlier, when segregation (what we now refer to as overall segregation) is measured, it is conventional to use indices with ranges between 0 and 1. Since it is meaningless to think of negative amounts of separation, the lowest possible segregation value has always been taken to be zero. In practice, if only due to random factors, even the most egalitarian and gender-blind country may be expected to have some degree of segregation. This led Cortese, Falk and Cohen (1976a and b) to advocate measurement from an 'expected' value. (They were writing about ethnic segregation but the reasoning is the same.) While there is good logic in this point, the matter is not entirely straight-forward, as Taeuber and Taeuber (1976) pointed out.

However, it is essential to appreciate that our present concern is not solely with separation but also with inequality. It has always been assumed, understandably, that segregation entails gender inequality and that this works to the advantage of men. In other words, it is held that not only do men and women tend to have different occupations, but men tend to have *better* ones. The vertical dimension is specifically intended to measure this. Logically, however, there is also the possibility of the opposite, that women

have the better occupations and men have worse occupations. The magnitude of advantage or disadvantage may vary depending upon the measures used to represent the vertical dimension (e.g occupational values for pay, 'prestige', skill, social stratification, etc.). The crucial point is that when we introduce the idea of advantage – of better and worse occupations – for one sex, we introduce direction. The direction can only be represented by assigning positive and negative signs to the values of segregation.[15] The positive values of segregation may still be taken as measuring the familiar situation of the advantage lying with men. Negative values, therefore, represent segregation where women have the better occupations. We may note that on *random* principles any deviation from zero segregation is as likely to favour women as men, and this provides a clear reason – despite the argument of Cortese, Falk and Cohen (1976a) – to measure from the zero point. While this idea of negative values has not been discussed before, it makes perfectly good sense. We shall have reason to return to this point as the discussion develops.

Figure 1 illustrates the conception of segregation we are proposing. Previous conceptualizations of vertical and overall segregation have treated them as distinct measures. We, on the other hand conceive of vertical segregation and horizontal segregation as component dimensions of overall segregation. Thus an adequate understanding needs to take account of structural interrelationship of overall levels and the two components, as shown in the figure. We find that this conception makes sense of the data and arguments we have presented.

It will be seen that the horizontal dimension is only positive. The idea of negative difference makes no sense. If women's occupations are different from men's, then men's occupations are equally different from women's. This is the symmetrical point we made about segregation at the start, and the point remains correct in terms of the extent of occupational separation of men and women – the scalar quantity. However, we have introduced meaningful signs to the vertical dimension. Where segregation advantages men we give segregation a positive sign, in keeping with existing conventions; where the advantage lies with the women the sign is negative. In line with mathematical convention, in the first quadrant, where the vertical component is positive, overall segregation is positive; in the second quadrant vertical and overall segregation are both negative.

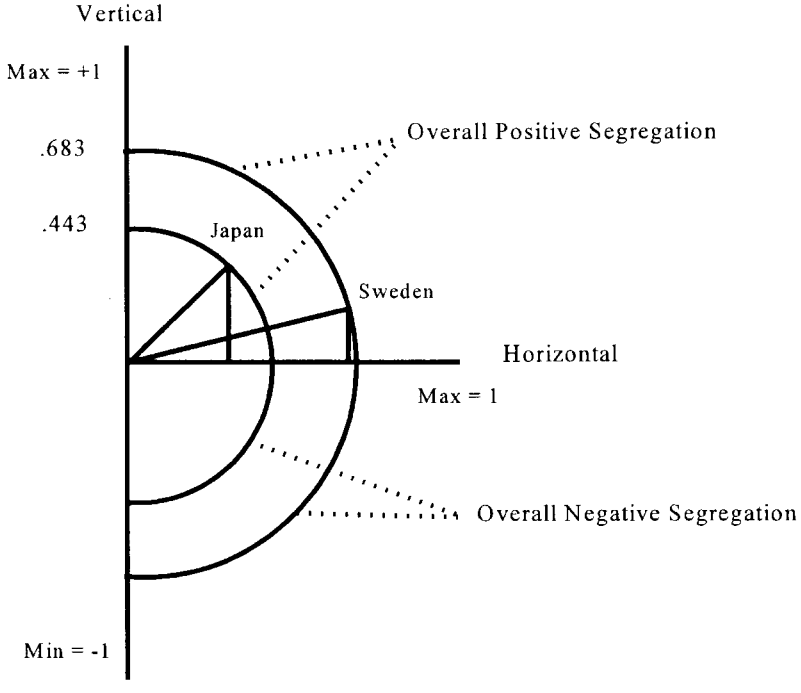

Figure 1. *The components of Overall Segregation, with illustrative values and hypothesized positions of Japan and Sweden*

The UN measures of the GEM and the GDI invariably have values less than unity; indeed, they appear to be constructed on the assumption that the most advantaged situation women can hope to attain is one of equality, and the actual data bear this out. Thus the UN evidence supports the popular, common-sense idea that vertical segregation is positive in all countries. However, segregation can apply not only to national labour markets but to any definable sector of a labour market, and there could well be sectors with negative segregation.

In Figure 1 we have hypothesized the positions of two countries, Sweden and Japan. The semi-circles represent the degrees of overall segregation for the two countries. The outer circle represents Sweden, showing that Sweden has a substantially higher level of overall segregation than Japan. In each case the radius corresponds to the value of standardized overall segregation (MM_{200}) we have established and presented in Table 1; 0.683 for Sweden and 0.443 for Japan. The actual location of the countries on the curves depends on the values of the vertical and horizontal components.

As we have indicated, there is good reason to believe that segregation is positive in both countries. Therefore we have placed them in the first quadrant. Since Sweden has a substantially higher level of overall segregation, it must have a higher value on one or both components. Our evidence, in terms of scores on the GEM and the GDI, is that Sweden is an exceptionally egalitarian country with regard to gender. Furthermore, this evidence is entirely in keeping with the universally acknowledged reputation concerning the egalitarian character of Swedish society. Accordingly, we hypothesize a large horizontal component and a small vertical component for gender segregation in Sweden. Japan, on the other hand, does not share Sweden's egalitarian reputation, and its scores on GEM and GDI are much lower. Therefore, we hypothesize that although the level of overall segregation is lower than in Sweden, the vertical component is larger.

It has to be clearly understood that the vertical and horizontal dimensions are components of segregation, and not properties of particular occupations. Just as overall segregation is a property of a defined labour force, whether national or sub-national, so are its component dimensions.

Individual Occupations in a 'Segregation Space'

To some extent, however, we can locate individual occupations in a 'segregation space'. Indeed the only way we can measure the vertical dimension of segregation is by placing occupations on a vertical scale of inequality and relating their vertical position to the gender composition of the occupational workforces.[16] With suitable scaling adjustment, occupations can be represented on the same vertical dimension as segregation. However, we are now only able to give meaning to positive scale values. The horizontal dimension for individual occupations represents levels of concentration. This is because each occupation has a single vertical position so the contribution to segregation has to be at the same level for both women and men. While there is no way of directly measuring horizontal segregation itself (it can be deduced from overall and vertical segregation values), the equivalent for each occupation can be measured with the proportion of women in an occupation, ranging from 0 to 1, giving a result in the first quadrant. Slightly more instructive is to measure female concentration from −1 to +1, with appropriate scaling adjustments of negative and positive values so that the zero value corresponds to the female proportion in the labour force as a whole. This approach incorporates the fourth quadrant, where concentration is negative, meaning that the female concentration is less in the occupation than in the labour force (i.e. less than the expected value).

However, the interesting issue now is not the positive and negative values but the slope of the regression lines. A negative gradient indicates declining vertical positions (occupations become less desirable) as female concentration increases, which means that vertical segregation has its usual positive sign. On the other hand, a positive slope indicates the reverse, with a negative sign for vertical segregation.

Conclusion

By now the basic elements of the solution to the 'puzzle' should be clear. Only the vertical dimension of segregation measures inequality, and this

dimension does so directly. This means that the greater the vertical component, the greater the gender inequality in the occupational structure.

Overall segregation measures inequality in so far as it is partly a resultant of the vertical dimension. However, this does not mean that overall segregation and inequality vary together. The relation between the vertical dimension and overall segregation depends on the relative strengths of the horizontal and vertical dimensions. For any given level of overall segregation, the values on the two component dimensions vary inversely: the greater the horizontal component the less the vertical one. So far this explains why the popular assumptions are wrong. Since overall segregation has a vertical component of inequality, the obvious, and reasonable, expectation on a basis of probability is that gender inequality and overall segregation would vary together across societies. On the other hand, there is no necessary reason for there to be such a relation. However, it is not immediately obvious why there should be a firm tendency in the opposite direction. Yet this is our clear finding: the Gender Empowerment Measure and the Gender-related Development Index are positively related to overall segregation. To understand this it is necessary to recognize that *higher levels of overall segregation tend to reduce the vertical component*.[17] The point may seem counter-intuitive, but a little consideration of what is entailed will make it clear.

At the extreme, with complete segregation, the top jobs in female careers would necessarily be filled by women. This would not necessarily eliminate vertical segregation, as the careers of men (or women) might have more openings at the higher levels, but it would tend to reduce it. Segregation would be predominantly horizontal. Such a situation would have the disadvantage of denying many occupations to both men and women – those not of the appropriate gender. On the other hand, where predominantly female occupational careers are open to men, the men tend to be over-represented in the top jobs. For example, in Britain most nurses and most teachers in primary schools (teaching young children) are women, while senior nurses and headteachers are disproportionately men, and similar patterns may be observed in other countries. However, the reverse does not hold in occupations where men predominate; it is still the men who are likely to gain the higher ranks.[18]

Looking at trends more generally, segregation tends to increase women's career prospects: the more some occupations are dominated by women, the greater are the chances of women getting to the top in those occupations – vertical segregation declines. As overall segregation increases, the ratio of horizontal to vertical segregation also increases and inequality tends to decline.

This is not a homogeneous pattern, as cultural and other factors also operate. In the industrial countries of Europe, North America, and Australasia, gender inequality tends to be lower than in Arab countries such as Kuwait and Bahrain. In the former we observed a strong relationship between overall segregation and the two measures of gender equality, the GEM and the GDI. Elsewhere our data are too limited for a confident conclusion to be drawn, but it appears that the positive relation still holds, though with a higher level of vertical segregation. Whether or not the relation holds for any particular set of societies depends on the mix of gender ideologies. A combination of countries like Kuwait and Italy would lead to a negative relation between segregation and equality. However, within sets of countries with broadly similar gender cultures we may expect the relation to be positive.

The fundamental point to recognize is that *only the vertical dimension of segregation measures inequality*; overall segregation is *not* a direct measure of inequality. Then, moving beyond this point, we need to appreciate that, as overall segregation increases (the hypotenuse of the triangle), the vertical dimension tends to decline. Hence high levels of segregation tend to be associated with low levels of inequality in the data.

Notes

1. It is, of course, possible for there to be equal numbers of men and women in a particular occupation, but symmetry throughout the labour force is impossible, apart from the limiting situation of equal numbers of men and women workers and zero segregation (every occupation has equal numbers of men and women).

2. For a fuller discussion of the concepts and their measurement see Siltanen, Jarman, and Blackburn (1995), Blackburn, Siltanen, and Jarman (1995).
3. It has become popular among some scholars to control for the number of workers in occupations, in a standardized segregation index (see e.g. England, 1981; Presser and Kishor, 1991; Jacobs and Lim, 1992). This may allow some interesting insights but it is no longer a measure of occupational segregation: the distribution of workers across occupations is as it is, and this determines the level of segregation. Furthermore, the standardization of ID creates more measurement problems than it solves (Siltanen, Jarman, and Blackburn, 1995; Charles and Grusky, 1995).
4. 'Female' occupations are defined as those having a proportion of female workers that is higher than the proportion in the labour force as a whole, and 'male' occupations are correspondingly defined.
5. MM was initially introduced to measure changing educational attainment by social classes (Blackburn and Marsh, 1991), and subsequently to measure gender segregation (Blackburn, Jarman, and Siltanen, 1993).
6. The relevant equation for country *i* is

$$MM_{200} = MM_{200E} \times MM_{ni}/MM_{nE},$$

where MM_{ni} is the observed value of MM in country *i* where the dataset has *n* occupations and MM_{nE} is the expected value for *n* occupations. The expected value MM_{nE} is determined by the formula:

$$MM_{nE} = 1 - 1/1 + 0.6(\log_{10}n)^{0.93}.$$

7. The problem is exactly the same for comparisons across countries and over time. Different gender compositions of the labour force give different marginal totals to the Basic Segregation Table, which in turn have different distorting influences.
8. Because we are dealing with a small sample of countries ($\leqslant 32$) it is certainly appropriate to consider statistical significance. However, it would be very demanding to expect a greater level than 10%.
9. The GDI and GEM values are not available for all countries measured on the HDI, so that the correlations with MM are not strictly comparable. As explained below, restricting correlations to common occupations affects the values but not the order of the coefficients.
10. With all the countries included, as in Table 3, the Pearson product-moment correlations of MM_{200} with the GDI and HDI are -0.016 and -0.031, but these are the only negative results and their magnitude is negligible.
11. Strictly speaking, this is only so for the GEM, as the GDI also contains an element for 'human development'. Gender equality would give GEM=1, and GDI=HDI, but HDI would still vary across countries.
12. Ideally we recommend 200 or more categories, though we have taken 20 as a useable minimum. Reliability increases at a declining rate as the number of occupations increases, with gains becoming quite small as the number approaches 200.
13. We think they are too hasty in dismissing prestige. What their results show is that while women may be disadvantaged on measures such as pay, they may be closer to parity with men on other measures of social inequality, as Hakim (1998) finds.
14. Many analyses relate pay to segregation, though not actually defining or measuring a vertical dimension. Generally they look at the difference between male and female pay, but vertical segregation must be measured on a single pay value per occupation, so that it is not compounded with sex discrimination in earnings. Many authors relate *concentration* to occupational inequality, often listing particular occupations by pay levels and the percentage of women workers. Although this is valuable in highlighting gender differences, and may provide complementary information, it is a fundamentally different matter which does not concern us here.
15. In more technical terms, while difference is a scalar quantity, inequality is a vector.
16. We are currently investigating the best way to measure the vertical dimension. Unfortunately there is no vertical equivalent of MM, so we will have to use continuous measures for overall segregation and its components. Most suitable for the vertical dimension is probably a composite measure of pay and a national stratification scale such as the Cambridge Scale (for the UK) or an international scale such as that of Ganzeboom and Treiman (1996). With gender providing the second dimension of a cross-tabulation of workers, Somers' D may be used to measure the vertical component. When occupations are reordered to maximize the value of Somers' D we obtain the Gini Coefficient (Blackburn, Siltanen, and Jarman, 1995; Blackburn and Jarman, 1997), which measures overall segregation (Silber, 1989; Lampard, 1994).
17. At the other extreme, where gender had no relevance to occupations, we would find little segregation of any sort, vertical or horizontal, and so low levels of overall segregation. There may be countries that approach this extreme, although we have reason to be extremely sceptical of the very low levels recorded for some countries because of irregularities in the

data themselves. If there are countries with genuinely low segregation, this suggests a curvilinear relation between the vertical and horizontal dimension – vertical low at the low and high extremes of horizontal segregation.

18. Blossfeld (1987) made similar arguments with respect to changes over successive cohorts of men and women workers in the Federal Republic of Germany – later cohorts of women increasingly used education as a lever into skilled occupations, semi-professions, and professions. Although the labour force was more highly segregated as time went on, Blossfeld reports that disadvantage had decreased.

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Authors' Addresses

R. M. Blackburn, Sociological Research Group, Faculty of Social and Political Sciences, University of Cambridge, Free School Lane, Cambridge CB2 3RQ, UK. Tel. +44 (0)1223 334549; e-mail: rmb1@cus.cam.ac.uk.

J. Jarman, Department of Sociology and Social Anthropology, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada. Tel +001 902 494 6593; e-mail: jarman@is.dal.ca.

B. Brooks, Sociological Research Group, Faculty of Social and Political Sciences, University of Cambridge, Free School Lane, Cambridge CB2 3RQ, UK. Tel. +44 (0)1223 334526; e-mail: beb20@cus.cam.ac.uk.

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