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Abstract

The aim of this paper is to study segregation in the Spanish labor market for both male and female workers, paying special attention to industrial segregation. As opposed to other studies, this article quantifies the segregation of each demographic group separately, rather than measuring overall segregation. For this purpose, it uses additively decomposable indices, together with local segregation curves, recently proposed in the literature, which allows us to go further in the empirical analysis.

JEL Classification: J71; J16; D63

Keywords: Industrial segregation; Local segregation curves; Gender

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1. Introduction

Most segregation studies existing in the literature focus on the case of two population subgroups (blacks/whites, high/low social position, women/men), either proposing ad hoc measures that are used for empirical analysis (as the popular index of dissimilarity introduced by Duncan and Duncan, 1955; the modified version proposed by Karmel and Maclachlan, 1988; and the Gini index of segregation proposed by Silber, 1989), or axiomatically deriving segregation indexes (Hutchens, 1991, 2004; Chakravarty and Silber, 2007, among others).[1] In this binary context, segregation measures usually compare the distribution of one demographic group across categories with the distribution of the other group. Thus, when studying school segregation by race, the distribution of black students across schools is usually compared with that of whites (Duncan and Duncan, 1955; James and Taeuber, 1985),[2] while when focusing on occupational segregation by gender the distribution of female workers is compared with that of males (Hutchens, 2001, 2004; Chakravarty and Silber, 2007). According to this literature, segregation exists so long as one distribution departs from the other, which should be better interpreted as overall or aggregate segregation since both demographic groups are jointly considered. In recent years, the study of overall segregation in the case of multiple population subgroups has received increasing attention among scholars (Reardon and Firebaugh, 2002; Frankel and Volij, 2007). This permits the study of overall segregation in a more complex context where the number of groups is higher than two.

However, one can be interested not only in measuring aggregate segregation, but also in exploring the segregation of a target group. Alonso-Villar and Del Río (2008) tackle this matter in a multigroup context by proposing an axiomatic framework in which to study the segregation of any population subgroup (local segregation). In a context of segregation in the labor market, they propose to compare the distribution of the target group among categories with the distribution of total employment. This approach permits one to emphasize the (labor) demand side, since the weight of each category (occupations/sectors) is measured in terms of total employment, i.e., the benchmark against which to compare the distribution of any demographic group is the job structure of the economy.

[1] For a revision of occupational segregation measures, see Flückiger and Silber (1999). James and Taueber (1985) also offer an interesting discussion of segregation indexes in the case of school segregation.
[2] Jenkins et al. (2006) also follow this approach to study social segregation in secondary schools.

Measuring the segregation level of a given group does not imply, however, that the segregation of that group can be determined without taking into account the remaining population subgroups. Segregation is indeed a phenomenon that requires considering the relative position of individuals with respect to others, as happens when measuring poverty according to a relative approach. In fact, both phenomena have more in common than one might expect at first sight. Thus, in order to quantify the relative poverty level of a country, the income level of the whole population is usually taken into account in order to calculate the poverty line (i.e., the income level of reference). Certainly, if the income level of a group changes, the poverty level of other groups may be altered because of the threshold shift. However, this interdependence among groups does not prevent one from finding out the poverty level that a target group suffers (by using, for example, the decomposability property of the popular family of indexes proposed by Foster, Greer, and Thorbecke, 1984). Analogously, if the distribution of a demographic group across organizational units varies, this change may affect not only the segregation level of this group, but also that of other groups, since the distribution of reference (that of the whole population) may have been modified. As in the case of relative poverty, we maintain that the segregation level of a target group can be calculated and that it is a powerful approach to go deeper in the study of segregation. In fact, the measurement of female segregation in the labor market is not a new topic in the literature since in a binary context there is a previous proposal. In this regard, three decades ago, Moir and Selby Smith (1979) offered a variation of the index of dissimilarity to measure the industrial segregation of female workers in the Australian labor market.[3] However, as far as we know, only Alonso-Villar and Del Río (2008) have explored this issue axiomatically in a multigroup case, while proposing new indices that satisfy basic properties.

The aim of this paper is to study segregation in the Spanish labor market for both male and female workers, paying special attention to industrial segregation. Therefore, as opposed to previous studies, such as Mora and Ruiz-Castillo (2003, 2004), and Otero and Gradín (2001), this paper measures the segregation of each demographic group separately, rather than measuring overall segregation. This allows us to determine the specific pattern of female and male employment structures.[4] For this purpose, this paper uses additively decomposable indices, together with local segregation curves, recently proposed in the literature (Alonso-

[3]By following the same reasoning, Lewis (1982) defined an analogous index to measure male segregation.

[4] This paper also departs from that of Del Río and Alonso-Villar (2009), since they do not take into account the industrial dimension.

Villar and Del Río, 2008; Del Río and Alonso-Villar, 2009), which allows us to go further in the empirical analysis.

The paper is structured as follows. Section 2 introduces several local segregation measures and their decompositions, whilst offering a reflection about this measurement. Section 3 presents the empirical analysis. In doing so, firstly, a classification of sectors in four large groups (agriculture-fishing, industry, construction and services), and a two-digit classification of occupations are used, which gives rise to over two hundred categories of jobs. Secondly, a deeper analysis of the occupational segregation within each large sector is undertaken. Thirdly, industrial segregation across branches of activity at a two-digit level is tackled. Finally, Section 4 presents the main conclusions.

2. Measuring local segregation

When segregation in the labor market is analyzed, the indexes commonly used quantify overall segregation. However, one can be interested not only in measuring aggregate segregation, but also in exploring the segregation of a target group. Alonso-Villar and Del Río (2008) tackle this matter in a multigroup context by proposing an axiomatic framework in which to study the segregation of any population subgroup. In this regard, a local segregation curve for each target group is put forward and new indexes consistent with it are proposed. In particular, a class of decomposable segregation indexes (related to the generalized entropy family) consistent with non-crossing local segregation curves is characterized in terms of basic axioms. In what follows, we present the notation and introduce these tools.

Consider an economy with $O \geq 1$ occupations, $P \geq 1$ sectors and $T > 1$ jobs so that vector $(t_{11}, t_{12}, ..., t_{OP})$ represents the distribution of jobs among occupations-sectors (i.e., a common occupation is considered a different category depending on the sector it belongs to) and $T = \sum_{o,p} t_{op}$. In other words, t_{op} is the number of jobs in the economy corresponding to occupation *o* and sector *p*. Assume that we are interested in analyzing the segregation of a target group that has the following distribution among occupation-sectors $(c_{11}, c_{12}, ..., c_{OP})$, and denote by *C* the total number of individuals belonging to this group. Then, $C = \sum_{o,p} c_{op}$ and $c_{op} \leq t_{op}$, since this group represents a subset of total workers. Distribution *c* could represent, for example, the number of women (or men) employed in each occupation-sector but also the number of individuals of an ethnic or social group or whatever group of citizens that interests us. For the sake of simplicity we rename the above vectors as follows: $t \equiv (t_1, t_2, ..., t_J)$ and $c \equiv (c_1, c_2, ..., c_J)$, where $J = O \times P$.

Local segregation curves

In the context of segregation by sex, traditional segregation curves represent the cumulative proportion of female workers corresponding to the cumulative share of male workers, once the categories (occupations, industries, etc.) have been ranked by increasing gender ratios (the number of women divided by the number of men in each category). Therefore, these curves actually measure overall segregation, rather than female segregation. To analyze the segregation of any demographic group, Alonso-Villar and Del Río (2008) propose to use what they call a local segregation curve. Thus, to calculate this local segregation curve, first, the categories (occupations-sectors) have to be ranked in ascending order of the ratio $\frac{c_j}{t_j}$ ($j = 1, ..., J$) and, second, the cumulative proportion of employment, $\sum_{i \le j} \frac{t_i}{T}$, is plotted on the horizontal axis and the cumulative proportion of individuals of the target group (female workers, for example), $\sum_{i \le j} \frac{c_i}{C}$, is plotted on the vertical axis. Therefore, this curve can be written as

$$S^*_{(c;t)}(\tau_j) = \frac{\sum_{i \le j} c_i}{C},$$

where $\tau_j \equiv \sum_{i \le j} \frac{t_i}{T}$ is the proportion of cumulative employment represented by the first j categories. Therefore, the first decile of the distribution represents 10% of the less-feminized jobs of the economy (that is, those belonging to occupations-sectors with the lowest $\frac{c_j}{t_j}$ ratios). The second cumulative decile represents 20% of the less-feminized jobs, and so on. If the segregation curve of a population subgroup dominates that of another (i.e., if the segregation curve of the former lies at no point below the latter and at some point above), we may say that it has lower segregation.[5]

In what follows we show several examples in order to compare local segregation with overall segregation. In the first example, we consider an economy with 100 female workers and 300 jobs distributed among categories according to vector $(c;t)=(10,40,50;90,60,150)$. In Figure 1, we plot the segregation curve $S^{*}_{(c;t)}$ obtained from comparing the female distribution *c* with the employment distribution *t*. From these distributions we can also obtain the number of male workers in each category and compare that distribution with the female distribution, so that we can obtain the traditional segregation curve S. This curve is also plotted in Figure 1, even though in this case the horizontal axis represents the cumulative proportion of male workers instead of total employment. We observe that S^{*} is closer to the equity line, which is reasonable since it compares the female distribution to the employment distribution, which includes female workers, while S compares the former with the male distribution. Therefore, the local segregation curve of a given target group gives rise to lower segregation than the overall segregation curve of the economy.[6]

[5] Intuition suggests that in the binary case, if one group has more members than the other, the segregation curve of the former cannot be dominated by that of the latter. This matter seems less problematic when there are more than two target groups. In any case, we should note that, even in the binary case, we cannot conclude which group suffers more segregation by just knowing its weight in the economy, since segregation curves can cross (see the Appendix).

[6] In the case of segregation by sex, total employment is the result of adding female and male workers, so that curve S can be obtained by calculating S^{*} for distribution $(c;t-c)$. In example 1 vector $(c,t-c)=(10,40,50;80,20,100)$. However, if we were interested in other types of segregation involving more than 2 groups of individuals--for instance female segregation by age, or race segregation, etc.--both approaches would substantially differ.

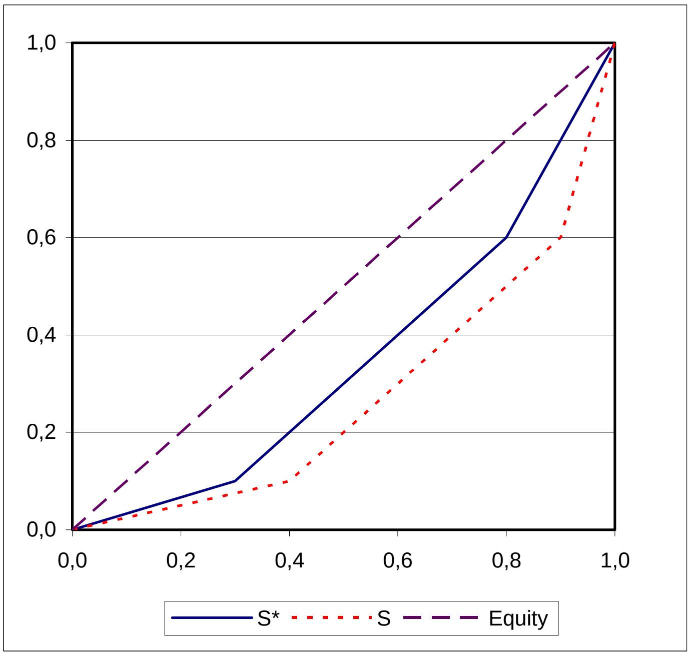

Figure 1. Segregation curves S^* and S in example 1.

To understand better the differences between these curves, example 2 posits that the number and distribution of jobs, in addition to the distribution of female workers, are the same as in example 1, but now there are 120 women. Thus, $(c';t')=(12,48,60;90,60,150)$. In this scenario the distribution of total employment among categories and that of female workers have not changed; therefore, S^* does not vary (see Figure 2). In other words, female segregation remains the same because there have been changes neither in their distribution nor in the employment structure. However, S has varied, since there has been a change in the distribution of male workers among categories, which moved from representing 40% in the first category, 10% in the second and 50% in the third, to 43%, 7% and 50%, respectively. We cannot deny that the economy has experienced a change when moving from example 1 to 2, but we find it interesting to distinguish between changes that affect the target group from those that do not. Female segregation should not vary so long as the employment and female labor force structures remain unaltered. If we are interested in other target groups (for example that of male workers), it is possible to measure their segregation by using the corresponding segregation curve.

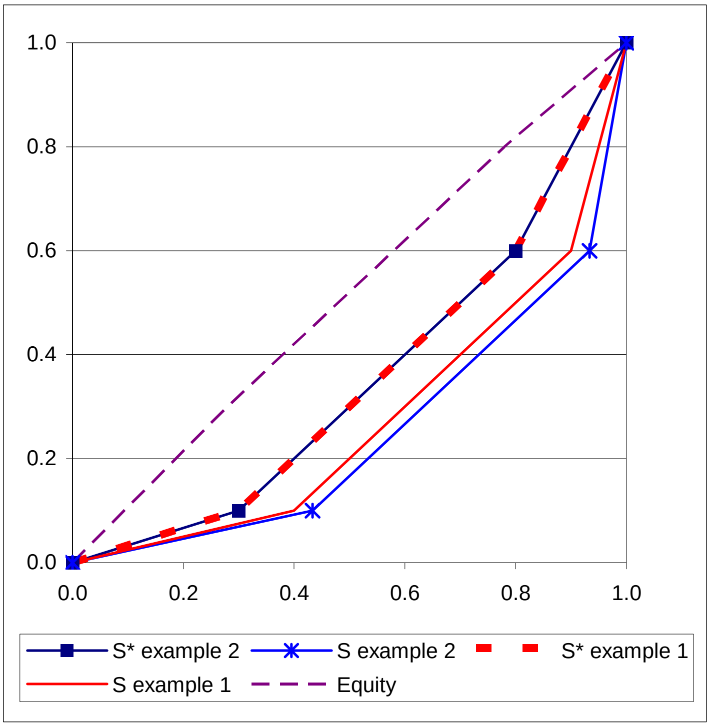

Figure 2. Segregation curves *S** and *S* in examples 1 and 2.

In what follows we show another scenario in which changes in the distributions lead to changes in the segregation level when using S^*, but not when using S. Imagine now that the number of jobs in the economy remains constant, but that category one loses 6 jobs in favor of category two. This means that the employment share decreases in category one, which represented 30% of jobs in example 1 and 28% now, and increases in category two (20% against 22%). Assume also that there are 120 female workers, like in example 2, with a distribution among categories that keeps the same female shares as before, so that the first category still represents 10% of female jobs, the second represents 40%, and the third, 50%. Thus, $(c'';t'')=(12,48,60;84,66,150)$. If we calculate curve S^* for examples 1 and 3, we observe that they are different (see Figure 3). In particular, $S^*_{(c'';t'')} > S^*_{(c;t)}$, which implies that female segregation is higher in the first example. How can we explain this fact? When comparing $(c;t)$ with $(c'';t'')$, we note that there has been a job reduction in category 1--where female workers had a low presence--and a growth in category 2--where women had a higher presence. Thus, the female segregation level decreases, since distribution *c''* is closer to distribution *t''* than *c* to *t*. It follows, then, that this segregation measurement does not care about situations where a category has a high female employment share while another has a low female share so long as they are consistent with the overall job distribution.

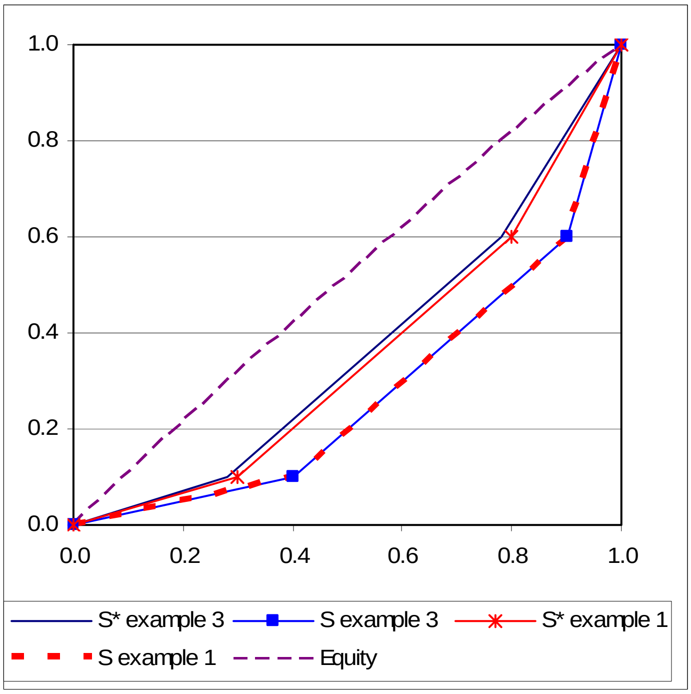

Figure 3. Segregation curves S^* and S in examples 1 and 3.

Del Río and Alonso-Villar (2009) offer a form of decomposing local segregation curves according to a partition of categories into several classes, which parallels the one proposed by Bishop *et al.* (2003) to decompose the Lorenz curve by population subgroups.

Without loss of generality, let occupations-sectors be classified into two mutually exclusive classes, so that $(c;t)=(c^1,c^2;t^1,t^2)$. Define indicator G_1^j so that $G_1^j=1$ if category *j* belongs to class 1 and $G_1^j=0$ otherwise. Indicator G_2^j can be defined analogously. By using vector c^1, vector $\tilde{c}^1$ can be built as the one resulting from enlarging c^1 with zero-values for those occupations-sectors that are not included in class 1, i.e. $\tilde{c}^1=(c_1G_1^1,...,c_JG_1^J)$. Analogously, we can build vector $\tilde{c}^2$. The expression:

$$SC_k=\frac{C^k}{C}\frac{\tilde{S}^*_{(\tilde{c}^k;t)}(\tau_j)}{S^*_{(c;t)}(\tau_j)} \tag{1}$$

measures the contribution of class k ($k=1,2$) to the value of the segregation curve S^* in the corresponding percentile, where the first quotient represents the proportion of individuals of the target group who work in class k, and $\tilde{S}^*_{(\tilde{c}^k;t)}\left(\tau_j\right)=\frac{\sum_{i\le j}c_iG_k^i}{C^k}$ represents the pseudosegregation curve for fictitious distribution $(\tilde{c}^k;t)$ once categories have been ranked according to ratios $\frac{c_j}{t_j}$.[7] For instance, assume that we focus now on the occupational-industrial segregation of female workers, and consider that the categories are classified into four large classes: agriculture-fishing, industry, construction, and services. The above decomposition allows us to calculate the contribution of each class to each cumulative decile. In other words, we can determine the proportion of jobs in the first decile belonging to agriculture, industry, construction, and services; the proportion of jobs in the second cumulative decile that corresponds to each large sector, and so on. Moreover, function $S^*_{(\tilde{c}^k;t)}$ also enables us to determine how individuals of the target group working in categories included in class k are distributed among cumulative and non-cumulative deciles. In this regard, expression

$$\tilde{S}^*_{(\tilde{c}^k;t)}(\tau_j + 0.1) - \tilde{S}^*_{(\tilde{c}^k;t)}(\tau_j) \qquad (2)$$

indicates the proportion of the target individuals working in class k in each non-cumulative decile. In the above example, this analysis permits us to find out whether the distribution of service employment across non-cumulative deciles of total employment, ranked from low- to high-feminization rates, differs from that of industry employment.

Local segregation indexes

Alonso-Villar and Del Río (2008) also propose several segregation measures consistent with non-intersecting S^* curves so that when comparing two different distributions, if the segregation curve of one of them dominates that of the other, then any segregation index of the target group satisfying some axiomatic properties (*scale invariance, symmetry in groups, movement between groups, and insensitivity to proportional divisions*) would take a higher value when it is evaluated at the dominated distribution.[8] This makes the use of these curves a quite robust procedure. However, if one is interested in quantifying the extent of segregation, the use of indexes satisfying the above basic properties seems the most appropriate. In particular, in the aforementioned paper the following measures are proposed:

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[7] Note that $\tilde{S}^*_{(\tilde{c}^1;t)}$ does not represent the segregation curve of the distribution $(c^1;t^1)$, nor that of fictitious distribution $(\tilde{c}^1;t)$, since the ranking of occupations-sectors is that of the original distribution $(c;t)$.

[8] In the Appendix, these properties are defined.

$$G^* = \frac{\sum_{i,j} \frac{t_i}{T}\frac{t_j}{T}\left| \frac{c_i}{t_i} - \frac{c_j}{t_j} \right|}{2\frac{C}{T}},$$

$$\Phi_a(c;t) = \begin{cases} \frac{1}{a(a-1)}\sum_j \frac{t_j}{T}\left[\left(\frac{c_j/C}{t_j/T}\right)^a - 1\right] & \text{if } a \neq 0,1 \\ \frac{1}{\mathrm{T}}\sum_j t_j\left[\frac{c_j/C}{t_j/T}\ln\left(\frac{c_j/C}{t_j/T}\right)\right] & \text{if } a = 1 \end{cases},$$

where the first measure is a variant of the classic Gini index and the second represents a family of indexes related to the generalized entropy family (a can be interpreted as a segregation aversion parameter).[9] These indexes, together with the index proposed by Moir and Selby Smith (1979)

$$D^* = \frac{1}{2}\sum_j \left| \frac{c_j}{C} - \frac{t_j}{T} \right|$$

will be used later in the paper to analyze female and male segregation in Spain.[10]

An advantage of the family of indexes Φ_a is that its members are decomposable. In particular, they are decomposable by subgroups of categories. Given a partition of categories in K classes, let us denote by C^k the number of individuals of the target group who work in class k ($k = 1,...,K$), and by c^k the distribution of the target group among the categories included in that class, so that $(c;t) = (c^1,...,c^K; t^1,...,t^K)$. Then, the generalized entropy family of indexes can be decomposed in two components:

$$\Phi_a(c^1,...,c^K; t^1,...,t^K) = \sum_k \left(\frac{C^k}{C}\right)^a \left(\frac{T^k}{T}\right)^{1-a} \Phi_a(c^k; t^k) + \Phi_a(C^1,...,C^K; T^1,...,T^K)$$

where the first addend of the above formula represents the *within* component, i.e. the weighted sum of segregation inside each class, while the second addend reflects the *between* component, i.e., the differences among classes.

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[9] Indexes $\Phi_a(c;t)$, where $a \neq 0$, are defined on the space of employment distributions $(c;t)$ where all components of vector c are positive. If all components were strictly positive, then another index could be used: $\Phi_a(c;t) = \sum_j \frac{t_j}{T}\ln\left(\frac{t_j/T}{c_j/C}\right)$ if $a = 0$.

[10] Both D^* and G^* take values within the interval $[0,1)$, while Φ_a can be easily transformed in order to take values within that interval.

3. Segregation in Spain

The data used in this paper comes from the Spanish Current Population Survey (EPA) conducted by the Spanish Institute of Statistics (INE), and corresponds to the second quarter of the year 2007. Occupations and industries are considered at a two-digit level of the CNO-1994 (*National Classification of Occupations*) and CNAE-1993 (*National Classification of Economic Activities*), respectively. The list includes 66 occupations and 60 branches of activity, [11] the latter can be aggregated into four large sectors: agriculture-fishing, industry, construction and services.[12]

First, we analyze the distributions of female and male workers when taking into account, simultaneously, differences in the 66 occupations and in the 4 aggregate sectors.[13] In this respect, a common occupation is considered a different category depending on whether it belongs to agriculture, industry, construction or services. Even though the cross between occupations and branches would lead to a larger number of categories (66 occupations multiplied by 4 sectors makes 264), we analyze only the 221 categories in which there is employment.

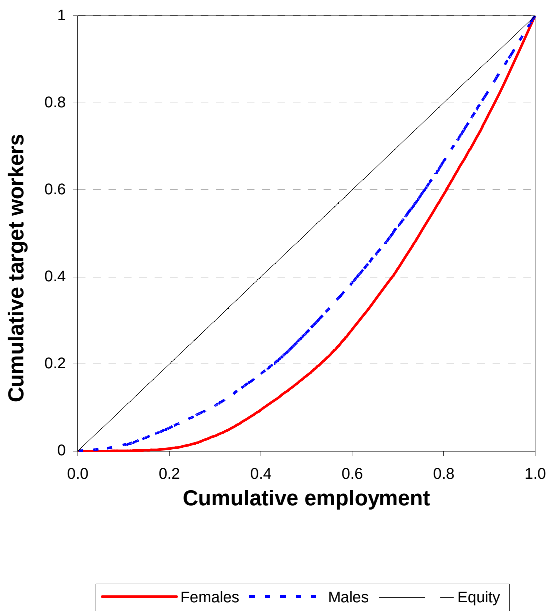

Figure 4. Occupational-industrial segregation curves (221 categories).

[11] The top 10 most feminized and masculinized occupations and branches are shown in the Appendix (Tables A3 and A4).
[12] Two out of sixty branches have been eliminated from the analysis since one of them had not employees (*extraction of uranium and thorium ores*), and the other had odd figures (*extraterritorial institutions*).
[13] In 2007, women represented 41% of workers, while men represented 59%.

	$\Phi_{0.1}$	$\Phi_{0.5}$	Φ_1	Φ_2	D^*	G^*
FEMALE WORKERS	0.73	0.46	0.34	0.28	0.33	0.43
MALE WORKERS	0.21	0.18	0.16	0.14	0.23	0.30

Table 1. Occupational-industrial segregation indexes (221 categories)

When considering these 221 categories, the local segregation curves show that the distribution of male workers dominates that of females, since the curve corresponding to the former is above that of the latter (see Figure 4). Therefore, the occupational-industrial segregation of female workers is higher than that of males for any segregation index consistent with these curves. In fact, all indexes in Table 1 show remarkable increases when comparing the male and female distributions. One of them even triples their value ($\Phi_{0.1}$), while others double it (Φ_a with $a = 0.5,\ 1,\ 2$). In any case, the analysis also suggests a non-negligible inequality in the distribution of men workers across occupations and sectors (even though the causes of this phenomenon may substantially differ from that of female segregation).

3.1 Partition by large sectors

By using the decomposition of index Φ_1 in the within-group and between-group components, shown in Section 2, we find that partitioning the 221 categories into 4 large sectors (agriculture-fishing, industry, construction and services) appears to be relevant in explaining segregation in Spain, since the between-group component represents 35.7% in the case of females and 26.6% in males (see Table 2). In other words, differences between the four large sectors explain about 36% and 27% of female and male segregation in the labor market, respectively.[14]

When decomposing the female segregation curve (as explained in Section 2, expression (2)) we find that the distribution of female workers across ventiles substantially differs among sectors (see Figure 5). In this regard, while agriculture-fishing and industry have important weights in the first three ventiles, which represent the less-feminized jobs of the economy, construction and services are mainly concentrated in the top ventiles, which represent the most-feminized jobs. In other words, women working in construction and services tend to concentrate in female-dominated occupations, while in industry and agriculture, the degree of concentration of women in female-dominated occupations is lower. In fact, 63.4% of the

[14] As can be seen in Table 2, 85.6% of females work in the service sector, while less than 10% works in industry. With respect to males, 52.8% of them work in services, while over 41.6% are evenly distributed between industry and construction.

female labor force employed in agriculture-fishing is in the third ventile of the female distribution (see Table A5 in the Appendix). This percentage rises to 93.7% if one is jointly considering the second and third ventiles, which suggests that there are not many feminized occupations within this sector. In industry, the third ventile also represents a high percentage of the female employment in this sector (45.2%), although the fourth and fifth ventiles have, in this case, higher values than in agriculture. On the contrary, a large proportion of the females working in construction and services concentrate in the most feminized occupations (36.9% and 44.8%, respectively).[15]

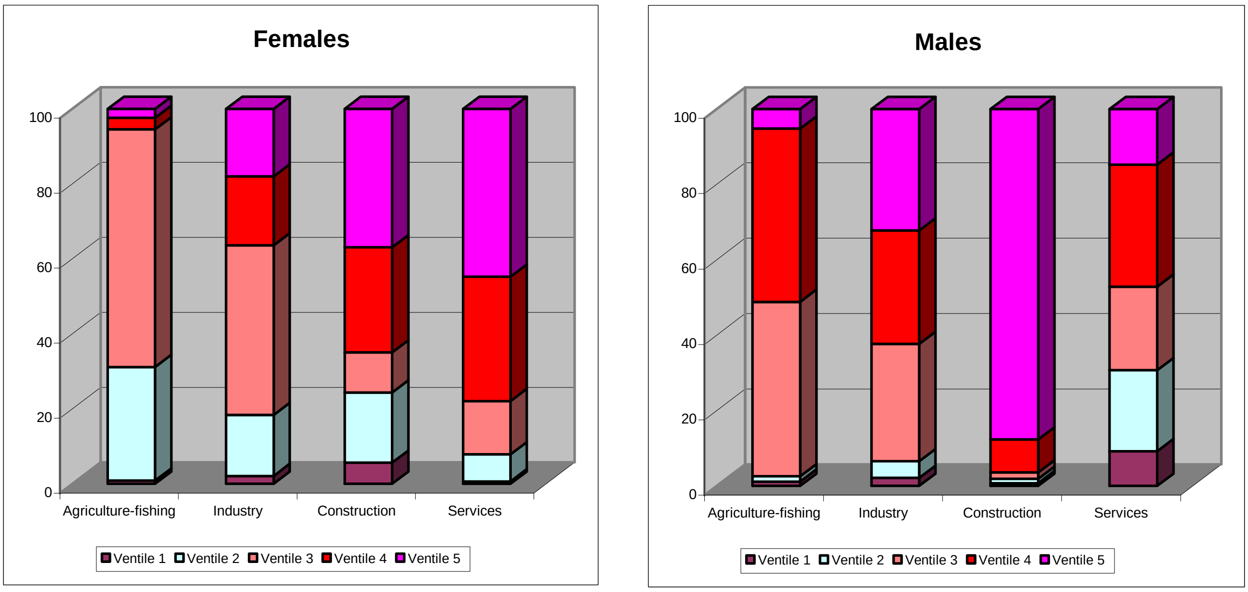

Figure 5. Distribution of each sector across non-cumulative ventiles (221 categories).

When studying the distribution of male workers, we find that most of the men who are in the first decile of the corresponding segregation curve, actually 93.9% of them, work in services (see Table A6 in the Appendix, which shows the decomposition of each cumulative decile by sector, as defined in Section 2, expression (1)). In other words, most of the men working in the most feminized occupations of the economy are in the service sector. On the other hand, the distribution of agriculture-fishing across non-cumulative ventiles (Section 2, expression (2)) shows that most of the male staff works in occupations with an intermediate-high level of masculinization (see Figure 5). In fact, the third and forth ventiles jointly represent 92% of the

[15] In the case of construction, the occupations are: *Domestic employees and other indoor cleaning personnel; Assistant clerks;* and *Administrative management support professionals*. In the case of services, these occupations are: *Domestic employees and other indoor cleaning personnel; Personnel services workers; Professions associated with a 1st cycle university degree in natural and health sciences, except in optics, physiotherapy and related services; Professions associated with a 1st cycle university degree in teaching; and Assistant clerks (with customer service tasks not classified previously).*

male employment in the sector (see Table A5 in the Appendix). Industry has a similar pattern, even though the fifth ventile represents now a higher value than in the case of agriculture. In construction, the situation is more extreme, since 87.7% of its male employment is concentrated in the most male-dominated occupations of the economy (in the fifth ventile). On the contrary, in the service sector, the distribution of male employment across ventiles is more equalitarian. This suggests that the degree of masculinization of this sector is lower.

3.2 Occupational segregation within each large sector

In what follows, the occupational segregation of each large sector is analyzed separately, i.e., the benchmark distribution for each sector is now the employment distribution of that sector across 66 categories. Figure 6 shows that occupational segregation of women is higher in construction, while male segregation is higher in the service sector (i.e., the corresponding segregation curve is dominated by the other curves).

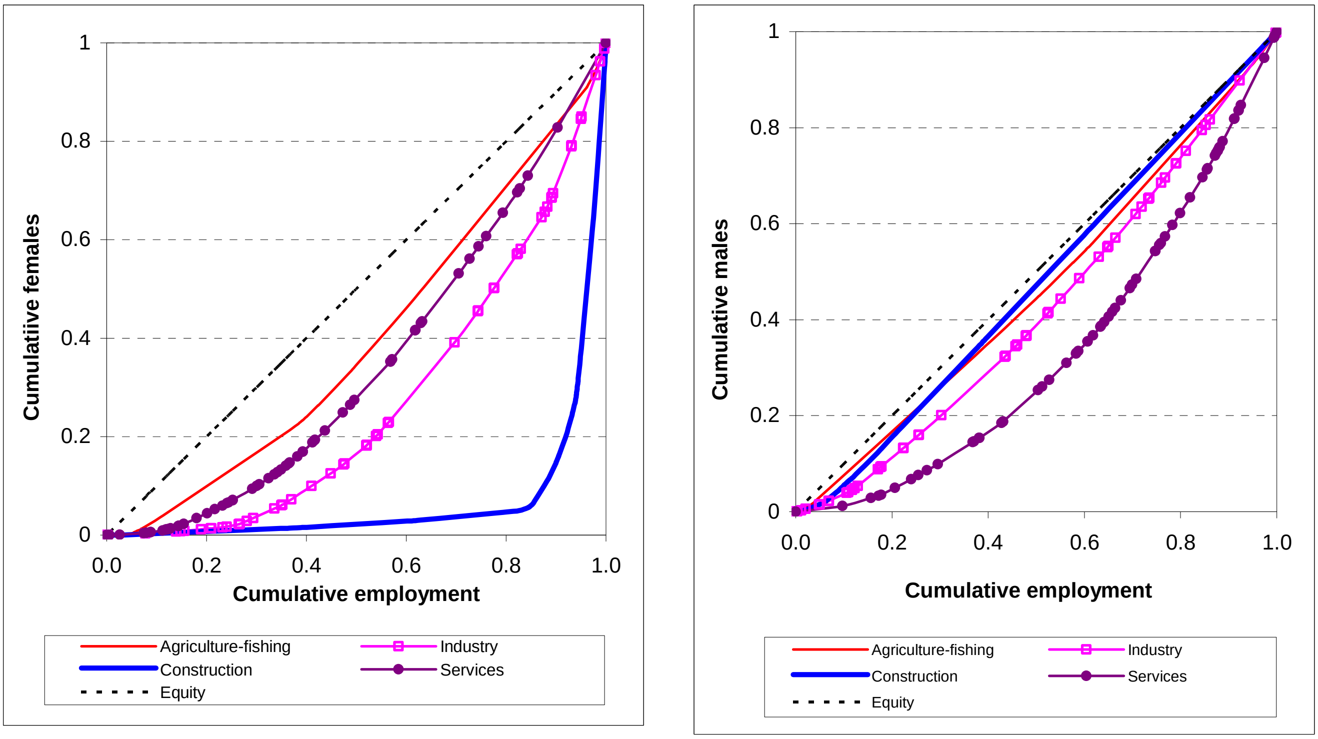

Figure 6. Occupational segregation within each sector (66 categories).

Most indices also suggest that the agriculture-fishing sector has the lowest occupational segregation level for both women and men, especially for the latter (see Table 2). Note that when comparing female and male occupational segregation, most indexes show that segregation in the service sector is slightly higher for men, while in the remaining sectors, including industry, segregation is much higher for women.

	$\Phi_{0.1}$	$\Phi_{0.5}$	Φ_1	Φ_2	D^*	G^*	**Within-Between decomposition of Φ_1**	**Distribution of female and male workers between sectors**
FEMALE WORKERS							64.31% - 35.69%	100%
Agriculture-fishing	0.46	0.14	0.10	0.09	0.16	0.21		2.93%
Industry	0.56	0.44	0.37	0.36	0.34	0.46		9.69%
Construction	2.23	1.77	1.87	4.25	0.79	0.87		1.84%
Services	0.30	0.21	0.17	0.14	0.22	0.30		85.55%
MALE WORKERS							73.47% - 26.53%	100%
Agriculture-fishing	0.02	0.02	0.01	0.01	0.06	0.08		5.63%
Industry	0.06	0.05	0.05	0.04	0.11	0.15		20.27%
Construction	0.03	0.03	0.02	0.02	0.05	0.05		21.32%
Services	0.24	0.21	0.19	0.18	0.25	0.34		52.77%

Table 2. Occupational segregation indexes (66 categories) and distribution of female and male workers between sectors.

3.3 Industrial segregation by branches of activity

This subsection provides a deeper analysis of industrial segregation by focusing on the distribution of employment across 58 branches of activity. The analysis suggests that industrial segregation within each large sector is also higher for women and, in fact, some indexes duplicate when comparing them with that of males (see Table 3). The industrial segregation level is, however, lower than that of occupational segregation (compare Tables 2 and 3). This result is in line with that obtained by Deutsch, Flückiger and Silber (1994) for Switzerland when using Oppenheimer's (1969) approach.

	$\Phi_{0.1}$	$\Phi_{0.5}$	Φ_1	Φ_2	D^*	G^*	**Within-Between decomposition of Φ_1**	**Distribution of female and male workers between sectors**
FEMALE WORKERS							39.12% - 60.88%	100%
Agriculture-fishing	0.01	0.01	0.01	0.01	0.04	0.04		2.93%
Industry	0.13	0.13	0.14	0.15	0.22	0.29		9.69%
Construction	-	-	-	-	-	-		1.84%
Services	0.09	0.08	0.08	0.07	0.14	0.20		85.55%
MALE WORKERS							55.96% - 44.04%	100%
Agriculture-fishing	0.00	0.00	0.00	0.00	0.01	0.01		5.63%
Industry	0.02	0.02	0.02	0.02	0.07	0.10		20.27%
Construction	-	-	-	-	-	-		21.32%
Services	0.11	0.10	0.09	0.09	0.16	0.23		52.77%

Table 3. Industrial segregation indexes (58 categories), decomposition of Φ_1, and distribution of female and male workers across sectors.[16]

[16] Table 3 does not show the values of the indexes for the construction sector because it has only one branch of activity. We should also note that the agricultural sector has only three branches.

Note that the classification of branches of activity into the four large sectors appears as relevant, since the decomposition of index Φ_1 into the between-group and within-group components shows that the former explains approximately 60.9% of industrial segregation of female workers (Table 3, column 7). This partition is also relevant for explaining male segregation, since the between-group component is 44%.

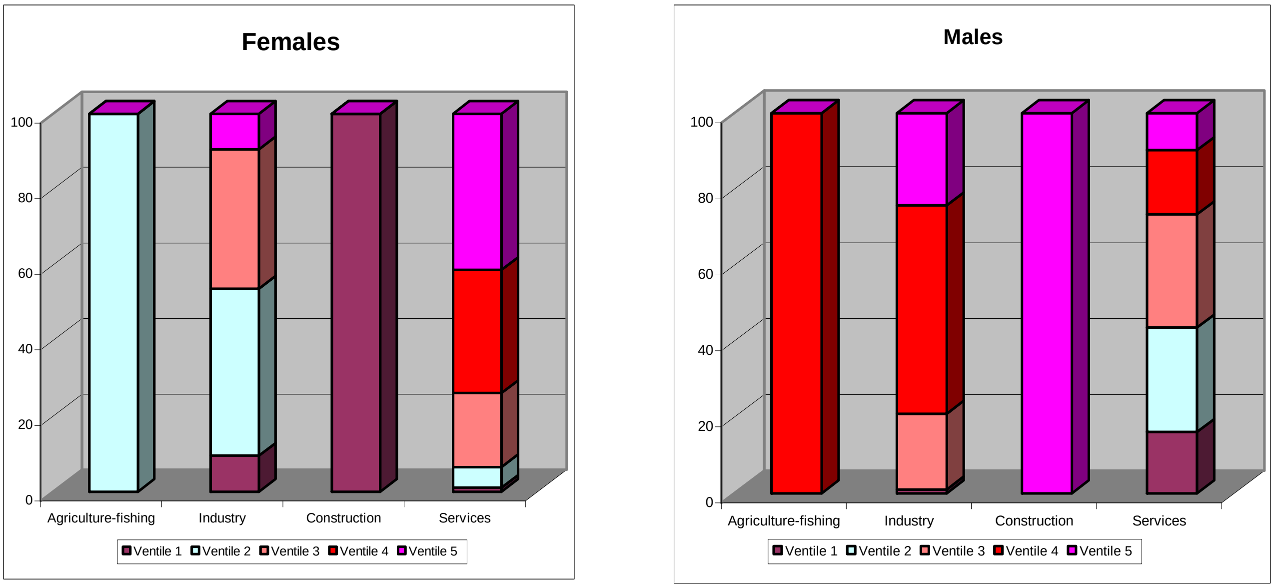

Figure 7. Distribution of each sector across non-cumulative ventiles (58 categories).

When decomposing the industrial segregation curves of women and men (which are not included in the text) by large sectors, we observe that (see Figure 7):

a) Females working in construction are all in the first ventile, since this is the most masculinized branch of the economy. Something similar happens in agriculture-fishing, since 100% of its female employment is in the second ventile. Women working in the industry also work in branches lowly feminized (especially in the second and third ventiles). On the contrary, in the service sector female workers concentrate in branches highly feminized (41.3% of them are in the fifth ventile).

b) Regarding males, the service sector is dispersed among branches, some more masculinized and others less. In the industry, the pattern is less even, since male employment is mainly concentrated in ventile 4.

4. Final remarks

Traditional analyses on gender segregation in the labor market focus on measuring overall segregation. This paper has offered a different perspective by measuring the segregation of women and men separately. Following this approach, we found that even though male workers are far from being homogeneously distributed across occupations and industries, unevenness is much higher for women. We have also shown that in the service sector, the occupational segregation of male workers is slightly higher than that of females, while in the remaining large sectors (industry, agriculture-fishing and construction) segregation is much higher for women. In addition, the analysis suggests that women working in construction and services tend to concentrate in the most female-dominated occupations, while in industry and agriculture, the degree of concentration in those occupations is lower, especially in the former sector. Regarding males, the study reveals that in the construction sector, male employment is concentrated in the most male-dominated occupations, while the service sector is more evenly distributed across jobs. This finding does not contradict, however, the fact that most of the men working in the most feminized jobs of the economy belongs to the service sector. Finally, the results regarding industrial segregation by branches of activity indicate that this phenomenon has a lower extent than occupational segregation, for both women and men.

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Appendix

A: A simple analysis of local segregation curves in a binary context

The following examples illustrate that even in the binary case, one cannot conclude either which group suffers more segregation, or the relative position of their local segregation curves, by just knowing their weights in the economy. Thus, these examples show that even though male workers represent over fifty percent of the labor force, the occupational segregation curve of this group does not dominate that of female workers (their curves cross). As a consequence, the use of local segregation indexes becomes necessary.

Example 1:

	Females	**Males**	**Total**
Occupations			
1	20	130	150
2	40	130	170
3	147	3	150
Total	207	263	470

Table A1. Distribution of workers across occupations (example 1)

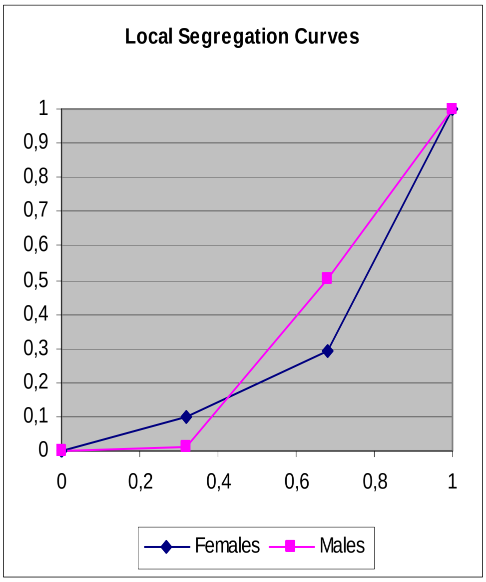

Figure A1. Female and male segregation curves in example 1.

In this example, male represent 56% of total employment, and that the slope of the female segregation curve is higher than that of males both at the origin and at the end. When calculating the entropy family of local segregation indexes, we observe that:

$$\Phi_1(c^F;t) = 0.3314 < \Phi_1(c^M;t) = 0.3326$$

$$\Phi_2(c^F;t) = 0.3563 > \Phi_2(c^M;t) = 0.2207 .$$

Therefore, according to index Φ_1 men are more segregated than women, but according to index Φ_2, the opposite holds.

Example 2:

	Females	Males	Total
Occupations			
1	20	160	180
2	160	70	230
3	70	30	100
Total	250	260	510

Table A2. Distribution of workers across occupations (example 2)

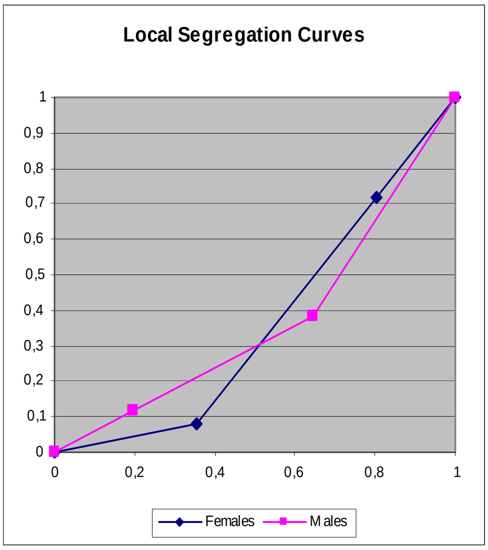

Figure A2. Female and male segregation curves in example 2.

In this case, the slope of the female segregation curve is lower than that of males both at the origin and at the end. Note that even though the proportion of male workers is higher than that of females (51% against 49%), we cannot conclude that the male group has lower segregation. In fact, when calculating the entropy family of local segregation indexes, we observe that:

$$\Phi_1(c^F;t) = 0.2050 > \Phi_1(c^M;t) = 0.1420$$

$$\Phi_3(c^F;t) = 0.1440 < \Phi_3(c^M;t) = 0.1678.$$

Therefore, according to index Φ_1 women are more segregated than men, but according to index Φ_3, the opposite holds.

B: List of axioms

In what follows, we show a list of desirable properties for any measure of local segregation, $\Phi: D \to \mathbb{R}$, where $D = \bigcup_{J>1} \left\{ \left(c^g; t \right) \in \mathbb{R}^J{}_{+} \times \mathbb{R}^J{}_{++} : c_j^g \le t_j \forall j \right\}$ and g represents the target group.

Axiom 1. *Scale Invariance*: Let α and β be two positive scalars such that when $\left(c^g; t \right) \in D$ vector $\left(\alpha c^g; \beta t \right) \in D$, then $\Phi\left(\alpha c^g; \beta t \right) = \Phi\left(c^g; t \right)$.

Axiom 2. *Symmetry in Groups*: If $\left(\Pi(1), ..., \Pi(J) \right)$ represents a permutation of occupations $\left(1, ..., J \right)$ and $\left(c^g; t \right) \in D$, then $\Phi\left(c^g \Pi; t\Pi \right) = \Phi\left(c^g; t \right)$, where $c^g \Pi = \left(c^g_{\Pi(1)}, ..., c^g_{\Pi(J)} \right)$ and $t\Pi = \left(t_{\Pi(1)}, ..., t_{\Pi(J)} \right)$.

Axiom 3. *Movement between Groups*: If vector $\left(c^g{}'; t \right) \in D$ is obtained from vector $\left(c^g; t \right) \in D$ in such a way that **a)** $c_i^g{}' = c_i^g - d$ and $c_h^g{}' = c_h^g + d$ $\left(0 < d \le c_i^g \right)$, where i and h are two occupations satisfying that $t_i = t_h$ and $c_i^g < c_h^g$; and **b)** $c_j^g{}' = c_j^g$ $\forall j \ne i, h$; then $\Phi\left(c^g{}'; t \right) > \Phi\left(c^g; t \right)$.

Axiom 5. *Insensitivity to Proportional Divisions*: If vector $\left(c^g{}'; t' \right) \in D$ is obtained from vector $\left(c^g; t \right) \in D$ in such a way that **a)** $c^g{}'_j = c^g{}_j$, $t'_j = t_j$ for any $j = 1, ..., J-1$; and **b)** $c^g{}'_j = c_J^g / M$, $t'_j = t_J / M$ for any $j = J, ..., J+M-1$, then $\Phi\left(c^g{}'; t' \right) = \Phi\left(c^g; t \right)$.

C: Tables

	Employment ratio (%)	Female employment ratio (%)
The 10 most-feminized occupations		
91. Domestic employees and other indoor cleaning personnel	6.59	93.73
51. Personnel services workers	3.97	86.67
27. Professions associated with a 1st cycle university degree in natural and health sciences, except in optics, physiotherapy and related services	1.08	84.21
28. Professions associated with a 1st cycle university degree in teaching	1.92	75.92
44. Assistant clerks (with custumer service tasks not classified previously)	2.76	74.88
45. Employees in direct contact with the public in travel agencies, receptionists, telephone operators	1.05	74.30
43. Assistant clerks (without custumer service tasks not classified previously)	2.07	73.33
46. Cashiers, tellers and other similar personnel in direct contact with the public	1.23	72.48
53. Retail workers and the like	5.00	70.70
32. Technicians in child education, flight instructors, vehicle navigation and driving	0.22	67.12
The 10 most-masculinized occupations		
70. Work site managers and foremen	0.58	0.63
71. Workers at structural construction works and the like	5.13	0.97
75. Welders, auto body workers, metal structure fitters, blacksmiths, tool manufacturers	1.69	1.16
73. Metallurgy and mechanical workshop foremen	0.24	1.22
76. Mechanics and adjusters for electric and electronic machinery and equipment	2.57	1.44
85. Locomotive machinist, operators of agricultural machinery and mobile heavy equipment, and seamen	1.32	1.71
72. Workers dedicated to finishing constructions and the like (painters and related workers)	3.76	1.98
96. Construction laborers	2.41	3.07
74. Extractive industry workers	0.14	3.61
86. Drivers of vehicles for urban or road transport	3.81	3.61

Table A3. The most- and least-feminized occupations: Employment share in each occupation, and proportion of female workers, with respect to total employment, in each occupation.

	Employment ratio (%)	Female employment ratio (%)
The 10 most-feminized branches		
95. Households that employ domestic personnel	3.77	92.10
93. Various personal services activities: washing, dry cleaning and dying of leather and cloth garments; hairdressing and other beauty treatments; physical fitness activities; funeral parlors and related activities	1.42	78.66
85. Health and veterinary activities; social services: includes medical, hospital, dentistry, and veterinarian activities and social work with or without accommodation	5.95	76.68
18. Clothing and fur industry: tailoring of leather clothes, work clothes and other outer and underwear and accessories; preparation and dying of furs for furriers and manufacture of furriery articles	0.49	75.49
80. Education: primary, secondary and higher education: also including driving schools, adult education, and other types of education	5.64	64.90
52. Retail trade except trade of motor vehicles, motorcycles and mopeds; repair of personal effects and household equipment: also includes the repair of footwear, electrical appliances, watches and clocks and jewellery and other small repairs	9.42	61.99
67. Activities auxiliary to financial intermediation: administration of financial markets and stock market activities; activities auxiliary to insurance and pension funds	0.24	58.29
55. Catering: includes hotels, motels, hostels, campsites, restaurants, bars, canteens	7.24	55.35
74. Other business activities: legal, accounting, bookkeeping and auditing activities, fiscal consultancy, market research and public opinion surveys, etc.	7.45	54.01
66. Insurance and pension plans, except compulsory social security	0.63	52.70
The 10 most-masculinized branches		
45.Construction	13.33	5.66
14. Extraction of non-metallic and non-energetic ores	0.23	7.46
27. Metallurgy	0.58	8.24
10. Extraction and agglomeration of coal, lignite and peat	0.04	10.10
60. Land transport; transport of pipes	2.99	10.89
20. Wood and cork industry, except furniture, basket making and wickerwork	0.47	11.98
28. Manufacture of metal products, except machinery and equipment	1.82	12.79
90. Public health activities	0.41	12.99
29. Machinery and mechanical equipment construction industry	1.31	14.39
41. Collection, purification and distribution of water	0.21	14.69

Table A4. The most- and least-feminized branches of activity: Employment share of each branch and proportion of female workers, with respect to total employment, in each branch.

	Ventile 1	Ventile 2	Ventile 3	Ventile 4	Ventile 5	Total
FEMALE WORKERS						
Agriculture-fishing	0.84	30.31	63.37	3.08	2.40	100
Industry	2.10	16.30	45.20	18.34	18.06	100
Construction	5.63	18.75	10.67	28.05	36.90	100
Services	0.66	7.22	14.22	33.10	44.80	100
MALE WORKERS						
Agriculture-fishing	1.13	1.42	46.32	45.94	5.19	100
Industry	2.12	4.40	31.15	30.11	32.22	100
Construction	0.69	1.16	1.72	8.74	87.69	100
Services	9.22	21.48	22.14	32.42	14.74	100

Table A5. Distribution of each sector across non-cumulative ventiles in percentages (221 categories).

FEMALE WORKERS	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Agriculture-fishing	3.70	2.27	16.41	9.21	15.20	9.73	6.62	4.83	3.76	2.93
Industry	37.04	22.73	21.21	18.02	26.66	21.63	15.86	13.42	12.12	9.69
Construction	14.81	11.36	6.06	4.55	3.12	2.25	1.61	1.96	2.26	1.84
Services	44.44	63.64	56.31	68.22	55.02	66.40	75.92	79.79	81.86	85.54
Total	100	100	100	100	100	100	100	100	100	100
MALE WORKERS	**Decile 1**	**Decile 2**	**Decile 3**	**Decile 4**	**Decile 5**	**Decile 6**	**Decile 7**	**Decile 8**	**Decile 9**	**Decile 10**
Agriculture-fishing	0.68	1.09	0.93	0.78	0.73	7.05	6.30	8.01	6.72	5.63
Industry	4.76	7.82	8.02	7.31	10.96	19.57	20.04	20.60	18.78	20.27
Construction	0.68	2.73	3.36	2.16	1.71	1.95	3.33	3.93	14.68	21.32
Services	93.88	88.36	87.69	89.75	86.60	71.43	70.32	67.46	59.82	52.78
Total	100	100	100	100	100	100	100	100	100	100

Table A6. Distribution of workers, in each cumulative decile, across sectors in percentages (221 categories).

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