



GENDER EQUALITY INDEX OF THE AUTONOMOUS COMMUNITIES OF SPAIN: A MULTIDIMENSIONAL ANALYSIS

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Received 22 June 2018; accepted 16 March 2019

Abstract. The main aim of this document is to establish a diagnosis of inequality between men and women in the autonomous communities of Spain. This study proposes a multidimensional methodology composed of 25 variables and classifies them in four dimensions: education, labor market, social conditions, and empowerment, using the subjective preference model to determine the weight of each variable. Then the four dimensions are added with equal weight to obtain a general indicator for each of the autonomous communities. Therefore, this study presents an adequate diagnosis that allows comparing the gender gap for each of the autonomous communities in any of the different issues raised: both in every dimension and at a general level. The final goal is to establish a methodological reference framework to estimate how gender equality benefits the regional economy. This estimation will be done in our next research.

Keywords: gender equality, gender gap, multidimensional analysis.

JEL Classification: B54, D63, J16.

Introduction

During recent decades, women have waged many battles against discrimination based on gender. Gender equality is part of the social change in the world (Bericat, 2012), and one of the deepest forms of discrimination in today's society (Agarwal, 2018). In Spain, the Organic Law 3/2007, of March 22, for the effective equality of women and men (Official State Gazette, 2007), requires the implementation of new indicators which can improve our knowledge about the differences between women and men. Those indicators will monitor the progress made in different areas of society and territories. The design of indicators to measure this

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phenomenon is fundamental not only to analyze its evolution, but also to identify the most complex elements that hinder actions that make equality between men and women effective. The progress of countries or territories to reduce the gender gap is essential to promote development (Adina, 2014) and positive social changes. Although inequality is obvious everywhere, its nature and degree are heterogeneous (Dilli, 2018). But it has a negative impact on the economies as well as in politics and social institutions (Agarwal, 2018).

Public administrations should assume the challenge of achieving equality of duties, rights, and opportunities between men and women. The reasons are ethical, social or legal and many others with a high economic impact that needs to be identified. The approach to gender issue has gone beyond the strictly biological sense (Alvesson, 1998; Glick & Fiske, 2001; Connell & Messerschmidt, 2005; Redding, Ruiz-Cantero, Fernández-Sáez, & Guijarro-Garvi, 2017). Those approaches allow us to support public policies to guarantee real equality between men and women besides the quota systems. In order to establish a concise diagnosis of gender inequality, we need to quantify its level by measuring the asymmetry either from the percentage gap or by establishing ratios between men and women. In this case, many organizations have proposed different types of gender indicators (Adina, 2014; Bericat, 2012; Dilli, 2018) to monitor the progress of public policies against discrimination. The European Institute for Gender Equality (EIGE) monitors progress in gender equity since 2013 through the Gender Equality Index (European Institute for Gender Equality, 2017) with 31 variables that are classified in six dimensions (work, money, knowledge, age, power, and health). This indicator is the reference to check progress in the issues that establish an imbalance with negative effects on women in the countries of the European Union. However, it is necessary that countries harmonized comparable indicators to assess gender equity in their territories.

The negative effects of the gender gap also have a high economic impact, according to the recent report *Unrealized Potential: The High Cost of Gender Inequality in Earnings* (Wodon, & De La Briere, 2018) in which 141 countries are analyzed and which estimates in 160.2 trillion dollars the losses of human capital wealth, because of gender inequality. In this sense, it warns that women represent only 38 percent of human capital wealth compared to 62 percent for men, emphasizing two main factors that lead women to have less profit and, therefore, lower wealth of human capital than men: lower participation rates in the labor force and fewer hours worked in the labor market, and consequently lower wages. Therefore, the economic benefits and sustainable development of the countries are clearly demonstrated, estimating that the wealth of human capital could increase by 21.7 percent worldwide, and total wealth by 14.0 percent with gender equality in earnings.

The gender equality index presented in this paper is a new proposal that establishes a comparative indicator that measures gender asymmetries in different areas. This indicator is composed of 25 variables that measure the percentage gap between men and women and which, in turn, are classified into the following four dimensions: education, labor market, social conditions, and empowerment. Therefore, it is possible to establish different measures of equality between autonomous communities and compare the variables or dimensions with the global index. This indicator is relevant to design policies to reduce gender imbalances in each region. It shows the evolution of different variables in Spain autonomous communities, such as a diagnosis to identify the factors and elements that determine the gap between men and women effectively.

1. Gender equality

Nowadays the problem of discrimination based on gender is a priority in the agenda of public institutions. Therefore, it is necessary to clear up some of the important concepts related to this subject such as: sex, gender, equality and equity, which are generally included in gender studies. Sex refers to features that are determined biologically by birth, while gender is used to describe men and women features in social conditions. Therefore, the learning of this behavior composes gender identity and determines its roles. On the other hand, gender equality is the absence of discrimination based on the sex of the person in terms of opportunities, allocation of resources and benefits or access to services; while gender equity refers to the impartiality and justice in the distribution of benefits and responsibilities between women and men. The concepts recognize that men and women have different needs and power, and that these differences should be identified and addressed in a manner that rectifies the imbalance between the sexes (World Health Organization, 2002). To find and measure the gender gaps in multiple and diverse areas we need to establish thematic, multidimensional and comparative indicators to complement the gender studies. Although the index of gender equality of the communities of Spain proposed in this document, it is an important contribution to establish the differences between men and women, there are other indicators of great relevance that provide a deep vision on this subject.

Some indices that have been proposed at a global or continental level to compare the countries in terms of gender equality are:

The GDI Gender Development Index and the Gender Empowerment Measure GEM was introduced in the Human Development Report presented by the United Nations Development Program (Pillariseti & McGillivray, 1998). The first one measures the gender gaps in human development, taking into account the gap between women and men in its dimensions: health, knowledge, and living standards. These dimensions use the same component indicators as in the Human Development Index HDI. The second one measures the degree of inequality, based on estimates of the relative economic income of women, participation in well-paid jobs with economic power and access to professional and parliamentary positions. However, these two indicators received a lot of academic criticism, therefore they were not considered.

The Gender Inequality Index was introduced by United Nations Development Programme (2015) to correct the flaws of the two previous indicators reflecting inequality in achievements between women and men in three dimensions: reproductive health, empowerment and the labor market.

The standardized gender equality index SIGE (Dijkstra, 2002) measures in each country the gender equality considering five components: education, life expectancy, participation in the labor market, share in management, services and techniques positions and quota in parliament.

The Gender Equality Index GEI (European Institute for Gender Equality, 2017) measures gender equality in six dimensions (work, money, knowledge, time, power and health) and 31 variables in the European Union and its member states.

The African Index of Gender Status AGSI (Economic Commission for Africa, 2004), is a two steps index. The first one is the Gender Status Index (GSI), that measures gender unequal-

ities on education and health; employment and access to resources; and formal and informal political representation. The second part is measured by the African Women's Progress Marker (AWPS) that takes into account progress in women empowerment and advancement.

Some authors have also proposed indicators that analyze and compare the problem of gender equality between regions or provinces. We find among them:

The status of the SWI women's index (Yllö, 1984) that is a composite indicator that measures gender equality in the United States and one of the pioneers in establishing this type of measurements.

The Gender Equality Index GEI (Sugarman & Straus, 1988), is an indicator that measures both at a general level and at the level of the economic, legal and political constructs, the state of gender equity comparatively in the U.S.A. fifty states.

The Gender Equality Index GHG (Harvey, Blakely, & Tepperman, 1990), implemented in Ontario, Canada between 1975 and 1984 measures gender equity taking into account seven variables (unemployment, labor force participation, salaries, enrollments) in full-time community college, full-time university enrollment, occupational segregation, and part-time employment).

The Norwegian Regional Gender Equality Index NGEI (Kjeldstad & Kristiansen, 2001), measures gender equality, based on three types of variables: demographic, socioeconomic and administrative. It demonstrates, as well, a wide range of interconnections between several local characteristics and equity of gender.

The Gender Equality Index of Mexican States GEIMS (Frias, 2008) measures, compares and quantifies the deviation of parity between men and women in thirty-two states of Mexico in four key dimensions of social life: economic, educational, political and legal

The Synthetic Index of Gender Inequality SIGI (Bericat & Sánchez, 2008) is a synthetic social indicator based upon twenty-three indicators of inequality, integrated into the educational, labor and power spheres applied in Spain at a regional level and specifically in the Spanish region of Andalusia.

The modified gender equity index IEGM (Fernandez-Saez et al., 2016) analyzes the temporal evolution of gender equity in the autonomous communities of Spain. This analysis facilitates a proper evaluation of the effectiveness of public policies implemented in the period analyzed.

Other proposed indicators are The Women's Economic and Social Rights Achievement Index WESHR (Apodaca, 1998), The Relative Status of Women RSW (Dijkstra & Hanmer, 2000), The European Union Gender Equality Index EUGEI (Plantenga, Remery, Figueiredo, & Smith, 2009). The Social Institutions and Gender Index SIGI (Branisa, Klasen, Ziegler, Drechsler, & Jütting, 2014).

2. Methodology

To measure the gender equality index of Spanish autonomous communities, the proposed methodology defines a multidimensional model that allows diagnosing equality both at a general level and in the areas defined as dimensions which are fundamental to correct the imbalances between men and women in Spanish society.

2.1. Dimensions

The goal of the multidimensional analysis is to calculate an indicator of gender equality, at a general level and based upon on the following areas:

Education: analyzes the access of men and women to higher education, as a substantial element to achieve higher economic levels, prestige, and empowerment in society. In this paper, this dimension is established analyzing the participation of men and women, either as enrolled or as graduates in any of the levels that make up higher education in Spain (1st and 2nd cycle, degrees, masters, and doctorates)

Labor market: labor segregation is one of the most complex problems in terms of gender since it has a direct economic impact on the personal and professional projects of the people. In this case, it is analyzed from the perspective of salary levels, working hours, job stability, self-employment and the volume of people who have managed to access a retirement pension.

Social conditions: the various favorable situations or not, in which people coexist within a society, determine the parameters that imply being on equal terms with other people to access opportunities and achieve higher levels of well-being. In many cases, situations such as single-parent households or the care of children and family members limit the options for the progress of a broad sector of society. On the other hand, indicators of well-being such as life expectancy and good health are the reflection of many factors that improve the quality of life of people.

Empowerment: refers to access to positions of decision-making and influence, as a key factor to correct gender imbalances. In this case, the position of women in relevant institutions is analyzed for the processes of change required by society, such as public administration, the private sector, education, and sports.

The Gender Equality Index is the result of adding the four dimensions that include different weighted variables, according to the importance they represent within each dimension, taking into account the opinion of different experts.

2.2. Variables

The variables that make up each of the dimensions are statistical measures, classified by sex and allow to establish objective measurements on the level of asymmetry between men and women. These variables have been selected taking into account the following criteria:

- Classification by sex.
- Classification by autonomous communities.
- Origin of official sources.
- Regular publication.
- Update in the last two years. In the event the data of the variable for the last year is not available, the one of the immediately preceding year will be taken into account.
- When there are no data representative of the analyzed year, in some cases the average of the periods published during the year will be taken in account or, in other cases, the value of the last published period that includes the month of December.

- In all the variables for amounts of people, the value assigned to Spain is the sum of all the amounts. In other variables, like wages or pensions, the average assigned to Spain is the amount taken.

These variables reflect, in general terms, the situations in which levels of gender inequality are more latent and contribute to maintaining the imbalances of society in this area.

2.3. Analysis of equality in variables

For each of the variables, the percentage ratio between men and women was calculated:

$$\% \text{ of women} = \frac{\text{women}}{\text{men} + \text{women}}; \quad (1)$$

$$\% \text{ of men} = \frac{\text{men}}{\text{men} + \text{women}}. \quad (2)$$

The two values that we have obtained are complementary to the unit, therefore % of women + % of men = 1.

Then we calculate the gender gap, which corresponds to the percentage difference between men and women for cases in which the favorability increases the higher the value of the variable and it is calculated like this:

$$\text{GAP} = \% \text{ of women} - \% \text{ of men}. \quad (3)$$

In cases in which the favorability increases the lower the value of the variable, it is calculated as:

$$\text{GAP} = \% \text{ of men} - \% \text{ of women}. \quad (4)$$

The positive values in the gap show a favorability in the variable for women and the negative values show a favorability for men.

2.4. Weightings

The analysis of the dimensions composed of different variables implies developing a multicriteria model in which each of the variables obtains a relative weight. For this case, the variables are compared in pairs, identifying the level of importance of one over the other according to the following scale of qualifications (Saaty, 1977):

- | | |
|-----------------------------|-------------------------------|
| 1: Equally important. | |
| 3: Slightly more important. | 1/3: Slightly less important. |
| 5: More important. | 1/5: Less important. |
| 7: Quite important. | 1/7: Quite less important. |
| 9: Much more important. | 1/9: Much less important. |

The values 2, 4, 6 and 8 represent intermediate values of the scale when one variable is more important with respect to another.

The values 1/2, 1/4, 1/6 and 1/8 represent intermediate values of the scale when one variable is less important with respect to another.

Therefore, the previous values come from the comparison of the pairs of objects or variables, by means of a quotient that determines the times that one object is preferred to the other. Such that:

$$u_{ij} = \frac{f_i}{f_j}, \tag{5}$$

and consequently,

$$u_{ji} = \frac{f_j}{f_i} = \frac{1}{u_{ij}}, \tag{6}$$

where, u_{ij} and u_{ji} , are the relevance assigned by experts, according to the grading scale, as a result of comparing the variables f_i with f_j and vice versa.

The result is a matrix of subjective preferences (Gil Aluja, 1999; Saaty, 1977) obtained from the opinion of experts. For example: let $C = \{c_1, c_2, c_3, c_4\}$ be a set of variables for a given dimension. The values of preferences established in a matrix that we will call $[M]$ are:

$$[M] = \begin{bmatrix} & c_1 & c_2 & c_3 & c_4 \\ c_1 & 1 & u_{12} & u_{13} & u_{14} \\ c_2 & 1/u_{12} & 1 & u_{23} & u_{24} \\ c_3 & 1/u_{13} & 1/u_{23} & 1 & u_{34} \\ c_4 & 1/u_{14} & 1/u_{24} & 1/u_{34} & 1 \end{bmatrix}.$$

Therefore, this matrix being symmetric and reciprocal, the values u_{ij} for the couple (c_i, c_j) , fulfill that:

$$u_{ii} = 1; \tag{7}$$

$$u_{ij} = \frac{1}{u_{ji}}, \tag{8}$$

where $u_{ij} \in R_0^+$, $i, j = 1, 2, \dots, n$.

On the other hand,

$$\begin{aligned} \forall i, j, k \in \{1, 2, \dots, n\}, \\ \frac{f_i}{f_j} * \frac{f_j}{f_k} = \frac{f_i}{f_k}, \end{aligned} \tag{9}$$

that is to say,

$$u_{ij} * u_{jk} = u_{ik}. \tag{10}$$

So, the matrix is coherent or consistent and reciprocal, fulfilling the following two properties:

The first refers to:

$$\sum_{j=1}^n u_{ij} * f_j = \sum_{j=1}^n \frac{f_i}{f_j} * f_j = n * f_i. \tag{11}$$

The second property refers to the fact that all rows and columns are proportional to the first row and column respectively, with each row and column equal to another row or column as the case may be, multiplied by a quotient. So that:

$$\begin{aligned} \forall i, j, k = 1, 2, \dots, n, \\ \frac{u_{ij}}{u_{kj}} = \frac{\cancel{f_i} / f_j}{f_k / \cancel{f_j}} = \frac{f_i}{f_k}, \end{aligned} \tag{12}$$

and also:

$$\frac{u_{ij'}}{u_{kj'}} = \frac{f_i / f_{j'}}{f_k / f_{j'}} = \frac{f_i}{f_k} \tag{13}$$

This same argument is valid for columns.

Taking into account the above, a square, reciprocal and coherent matrix is of rank 1, since it has an eigenvalue, unique and equal to n , since the remaining $n - 1$ is equal to 0. On the other hand, if the eigenvalues of a matrix $[M]$ are $\lambda_1, \lambda_2, \dots, \lambda_n$, you have to:

$$\sum_{i=1}^n \lambda_i = tr[M], \tag{14}$$

where $tr[M]$ is the trace of $[M]$, that is the sum of the elements of the main diagonal. As in the case of square, reciprocal and coherent matrices $tr[M] = n$, therefore, if a value is equal to n the rest will be null. However, a reciprocal matrix is not necessarily coherent, but when its dominant eigenvalue λ is very close to n it can be considered almost coherent and will meet the objectives. In this case, it is common to use the relationship as coherence index:

$$I_c = \frac{\lambda - n}{n} \tag{15}$$

A preference matrix with an $I_c \leq 0.10$ is often considered as consistent.

After we obtain the weights, the calculation of the gender equality for the dimensions and the general index for each autonomous community is calculated according to the following formulas:

$$IG = 0.25 \sum_k X_{dim}^k; \tag{16}$$

$$X_{dim}^k = \sum_{i=1}^n w_i^k * z_i^k, \quad i = 1, 2, \dots, n. \tag{17}$$

IG : is the index of general gender equality for each autonomous community;

X_{dim}^k : is the gender equality for the dimension k ;

w_i^k : is the weighting of the variable i for the dimension k ;

z_i^k : is the value of the gender gap (% of women - % of men or % of men - % of women) of the variables a_i, b_i, c_i , and d_i for the corresponding k dimension;

k : refers to the dimensions of education, labor market, social conditions, and empowerment;

n : is 8, 6, 5, or 4, according to with the number of variables that the k dimension includes.

In the aggregation of the variables for this indicator the weighted arithmetic mean is used, because there are variables with zero value. Since, if the geometric mean is used with some variable that has zero value, the partial result of the dimensions and the result of the general index will be distorted.

For the calculation of the general equality index, the four dimensions are added with a weight equal to 25% each, being the four pillars of gender equality quite interrelated. The results obtained in both the general index and the dimensions vary between -1 and 1 , with negative values unfavorable for women, positive values unfavorable for men and 0 when there is equality.

3. Data

The calculation of the indicator of gender equality for the autonomous communities of Spain (2016), is developed from the aggregation of 25 variables classified into four dimensions: education, labor market, social conditions, and empowerment. These variables are statistics compiled from different official sources and classified by sex that are described in Table 1.

Table 1. Dimensions and variables

Dimensions	Variables	Description	Source
A. Education	a_1 : registered 1st and 2nd cycle	Number of students registered in 1st and 2nd cycle.	Ministry of Education, Culture, and Sports
	a_2 : registered degree	Number of students registered in degree.	Ministry of Education, Culture, and Sports
	a_3 : registered master	Number of students registered in master.	Ministry of Education, Culture, and Sports
	a_4 : registered doctorate	Number of students registered in doctorate.	Ministry of Education, Culture, and Sports
	a_5 : graduates 1st and 2nd cycle	Number of graduates in 1st and 2nd cycle.	Ministry of Education, Culture, and Sports
	a_6 : graduates degree	Number of graduates in degree.	Ministry of Education, Culture and Sports
	a_7 : graduates master's degree	Number of graduates in master's degree.	Ministry of Education, Culture and Sports
	a_8 : doctoral theses	Number of doctoral theses approved.	Ministry of Education, Culture and Sports
B. Labor market	b_1 : occupation	Thousands of people aged 16 or over who, during the reference week, had a job as an employee or have carried out an activity on their own.	National Institute of Statistics (INE)
	b_2 : full-time occupation	Thousands of employed people aged 16 or over with a working week of more than 30 hours.	National Institute of Statistics (INE)
	b_3 : occupation with an indefinite contract	Thousands of employed people aged 16 or over with an indefinite employment contract.	National Institute of Statistics (INE)
	b_4 : self-employed workers	People registered in the different schemes for own account of the Social Security.	National Institute of Statistics (INE)
	b_5 : retirement pensions	Thousands of people with a contributory retirement pension.	National Institute of Statistics (INE)
	b_6 : average gross monthly salary	Average gross monthly salary of employed persons in euros.	National Institute of Statistics (INE)

End of Table 1

Dimensions	Variables	Description	Source
C. Social conditions	c_1 : life expectancy	Years of life expectancy.	Key Indicators of the National Health System
	c_2 : life expectancy in good health	Years of healthy life expectancy.	Indicators of Sustainable Development. (Eurostat)
	c_3 : occupational leave for the care of children and relatives	Number of working leave for caring for children and relatives.	Ministry of Employment and Social Security
	c_4 : single-parent households	Thousands of nuclear families that are composed of only one parent (father or mother) and one or more children.	National Institute of Statistics (INE)
	c_5 : average amount of pensions	Average amount in euros of total pensions.	National Institute of Statistics (INE)
D. Empowerment	d_1 : participation in regional governments	Number of presidents and councilors in autonomous governments.	Institute for Women and Equal Opportunities
	d_2 : participation in autonomous parliaments	Number of autonomous deputies.	Institute for Women and Equal Opportunities
	d_3 : mayoralties	Number of mayors.	Institute for Women and Equal Opportunities
	d_4 : teaching and research staff	Number of teachers and researchers in universities.	Institute for Women and Equal Opportunities
	d_5 : directors and managers	Thousands of people affiliated with social security as directors and managers.	National Institute of Statistics (INE)
	d_6 : federated sport licenses	Number of athletes who have a current state federation license or autonomous license approved.	Institute for Women and Equal Opportunities

With the statistical data obtained from the sources cited above for the autonomous communities of Spain except Ceuta and Melilla, which do not contain the data for all the variables, the gender gap has been calculated for each of the variables of the dimensions, which they are presented in Tables 2, 3, 4, 5.

Table 2. Gender gap for the variables of the education dimension

Autonomous Communities	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
Spain	-14.29%	9.77%	8.41%	-0.12%	-9.67%	20.41%	14.01%	0.84%
Andalusia	-16.19%	10.21%	11.95%	-2.33%	-2.90%	23.50%	19.34%	2.47%
Aragon	-38.46%	6.81%	7.53%	6.00%	-5.73%	17.06%	11.45%	14.94%
Principality of Asturias	1.58%	8.65%	3.09%	5.68%	-18.71%	20.33%	22.45%	2.05%
Balearic Islands	-96.00%	17.90%	23.74%	-0.59%	-15.38%	31.83%	32.56%	1.54%
Canary Islands	10.70%	14.39%	14.92%	-6.83%	29.91%	25.00%	14.38%	-5.26%
Cantabria	-42.37%	-0.06%	4.51%	-7.69%	-23.20%	17.13%	5.66%	-2.68%
Castile - La Mancha	100.00%	8.42%	-0.28%	-9.01%	-32.43%	21.71%	2.23%	-17.60%
Castile and León	-1.18%	11.69%	0.91%	-0.98%	2.36%	18.13%	1.96%	4.59%
Catalonia	7.88%	8.43%	9.70%	1.34%	-18.00%	18.40%	11.75%	2.42%
Valencian Community	-19.21%	10.70%	11.25%	-0.58%	-8.74%	17.60%	18.02%	-0.59%
Extremadura	-75.00%	9.31%	18.02%	1.89%	-2.02%	20.10%	15.84%	-4.20%
Galicia	-24.49%	10.82%	12.90%	4.11%	-11.46%	25.75%	21.95%	0.12%
Community of Madrid	-16.56%	8.04%	4.03%	-1.02%	-13.14%	19.11%	12.07%	-1.49%
Murcia	0.00%	10.97%	9.81%	-1.59%	-11.94%	21.26%	19.85%	-3.69%
Navarre	-42.86%	8.48%	-16.64%	-1.41%	-59.07%	14.04%	-21.43%	1.81%
Basque Country	-100.00%	7.06%	3.08%	5.46%	-17.15%	16.31%	10.64%	5.46%
The Rioja	0.00%	33.43%	18.66%	-0.83%	-1.67%	49.91%	22.27%	-20.93%

Table 3. Gender gap for the variables of the labor market dimension

Autonomous Communities	b_1	b_2	b_3	b_4	b_5	b_6
Spain	-9.00%	-18.59%	-4.80%	-30.30%	-25.38%	-13.33%
Andalusia	-13.66%	-24.47%	-8.15%	-31.01%	-28.55%	-13.77%
Aragon	-11.43%	-23.57%	-9.17%	-34.10%	-31.97%	-14.84%
Principality of Asturias	-2.10%	-11.71%	-1.40%	-18.36%	-32.12%	-16.70%
Balearic Islands	-7.61%	-14.20%	-0.98%	-33.15%	-16.16%	-9.07%
Canary Islands	-9.49%	-17.63%	-10.48%	-30.00%	-37.76%	-7.72%
Cantabria	-7.71%	-15.81%	-4.46%	-25.75%	-27.25%	-16.90%
Castile - La Mancha	-18.46%	-28.93%	-13.45%	-40.02%	-55.41%	-11.42%
Castile and León	-11.98%	-23.21%	-5.11%	-39.76%	-37.26%	-13.16%
Catalonia	-6.28%	-14.28%	-1.06%	-29.84%	-12.50%	-13.55%
Valencian Community	-9.56%	-21.70%	-5.47%	-28.11%	-24.45%	-14.64%
Extremadura	-18.49%	-30.37%	-14.73%	-38.36%	-45.89%	-11.53%
Galicia	-5.51%	-14.72%	-4.53%	-15.68%	-15.42%	-12.35%
Community of Madrid	-3.60%	-10.61%	0.12%	-31.44%	-23.26%	-11.07%
Murcia	-16.68%	-27.17%	-14.16%	-29.57%	-27.24%	-15.09%
Navarre	-8.71%	-22.06%	-8.58%	-32.47%	-27.46%	-16.56%
Basque Country	-6.10%	-18.56%	-5.61%	-28.21%	-27.20%	-13.82%
The Rioja	-10.11%	-21.72%	-5.75%	-35.17%	-27.30%	-13.33%

Table 4. Gender gap for the variables of the social conditions dimension

Autonomous Communities	c_1	c_2	c_3	c_4	c_5
Spain	3.33%	-1.04%	-81.85%	-61.96%	-23.15%
Andalusia	3.28%	-1.58%	-83.57%	-58.11%	-20.09%
Aragon	3.62%	0.52%	-85.07%	-46.77%	-24.73%
Principality of Asturias	3.81%	-0.71%	-80.88%	-62.24%	-31.02%
Balearic Islands	2.92%	2.32%	-76.70%	-61.54%	-21.80%
Canary Islands	3.11%	-6.89%	-67.20%	-63.95%	-17.50%
Cantabria	3.60%	1.44%	-81.53%	-55.76%	-26.50%
Castile - La Mancha	3.21%	-4.30%	-81.70%	-54.26%	-17.91%
Castile and León	3.36%	0.44%	-86.61%	-65.01%	-23.04%
Catalonia	3.29%	-1.62%	-84.23%	-61.97%	-25.44%
Valencian Community	3.16%	0.61%	-85.57%	-65.75%	-22.65%
Extremadura	3.34%	-1.46%	-77.82%	-71.76%	-14.68%
Galicia	3.87%	-2.43%	-78.26%	-66.18%	-22.59%
Community of Madrid	3.06%	0.60%	-78.22%	-63.03%	-23.25%
Murcia	2.86%	-3.51%	-80.39%	-62.68%	-21.26%
Navarre	3.23%	-0.11%	-84.97%	-62.26%	-26.07%
Basque Country	3.56%	0.36%	-81.98%	-64.93%	-27.92%
The Rioja	3.12%	2.09%	-88.92%	-69.57%	-22.83%

Table 5. Gender gap for the variables of the empowerment dimension

Autonomous Communities	d_1	d_2	d_3	d_4	d_5	d_6
Spain	-14.97%	-9.42%	-61.82%	-18.33%	-37.66%	-56.96%
Andalusia	-14.29%	-0.92%	-54.18%	-23.24%	-39.97%	-66.29%
Aragon	-20.00%	-4.48%	-63.06%	-10.90%	-38.77%	-62.45%
Principality of Asturias	-11.11%	-2.22%	-53.85%	-19.57%	-16.29%	-57.08%
Balearic Islands	-9.09%	-5.08%	-61.19%	-16.97%	-38.78%	-47.93%
Canary Islands	9.09%	6.67%	-61.36%	-22.62%	-29.13%	-54.31%
Cantabria	-55.56%	-22.22%	-78.43%	-25.54%	-19.52%	-56.91%
Castile - La Mancha	-11.11%	-15.15%	-56.91%	-17.71%	-49.83%	-62.99%
Castile and León	0.00%	-16.67%	-67.48%	-13.12%	-42.92%	-60.27%
Catalonia	-38.46%	-21.48%	-62.62%	-17.40%	-36.76%	-53.13%
Valencian Community	0.00%	-11.11%	-56.09%	-20.88%	-44.55%	-61.51%
Extremadura	-33.33%	-4.62%	-60.82%	-26.30%	-16.94%	-64.55%
Galicia	-11.11%	-9.33%	-76.43%	-19.68%	-44.45%	-57.03%
Community of Madrid	-50.00%	-14.73%	-51.96%	-16.57%	-36.67%	-47.07%
Murcia	20.00%	-28.89%	-33.33%	-23.41%	-34.72%	-63.27%
Navarre	0.00%	-4.00%	-55.88%	-20.98%	-38.05%	-45.38%
Basque Country	-11.11%	6.67%	-49.60%	-10.65%	-36.34%	-52.03%
The Rioja	-33.33%	-9.09%	-71.26%	-0.30%	-35.09%	-55.25%

Weightings

As it was previously explained, there are methodologies developed from the opinions of experts to assign the weights to the variables, such as the hierarchical analytical process (Saaty, 1977) or the subjective preference model (Gil Aluja, 1999) applied in this indicator to establish the importance which has each of the variables within the four proposed dimensions. The results obtained are shown in Tables 6, 7, 8 and 9.

Table 6. Pairwise comparison matrix in the education dimension

	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	w_i^A
a_1	1	1	1/3	1/4	1/5	1/5	1/4	1/9	2.69%
a_2		1	1/3	1/4	1/5	1/5	1/4	1/9	2.69%
a_3			1	1/4	1	1	1	1/8	7.12%
a_4				1	5	5	1	1/5	18.86%
a_5					1	1	1/3	1/5	7.49%
a_6						1	1/3	1/5	7.49%
a_7							1	1/2	14.44%
a_8								1	39.22%

Consistency index = 0.0723.

Table 7. Pairwise comparison matrix in the labor market dimension

	b_1	b_2	b_3	b_4	b_5	b_6	w_i^B
b_1	1	1/3	1/3	1/3	3	3	11.26%
b_2		1	1	1	3	3	22.76%
b_3			1	1	3	3	22.76%
b_4				1	7	7	30.11%
b_5					1	1/7	4.31%
b_6						1	8.79%

Consistency index = 0.0292.

Table 8. Pairwise comparison matrix in the social conditions dimension

	c_1	c_2	c_3	c_4	c_5	w_i^C
c_1	1	1	1/3	1/3	1/5	7.04%
c_2		1	1/3	1/3	1/5	7.04%
c_3			1	1/3	1/3	15.62%
c_4				1	1/3	24.75%
c_5					1	45.54%

Consistency index = 0.0357.

Table 9. Pairwise comparison matrix in the empowerment dimension

	d_1	d_2	d_3	d_4	d_5	d_6	w_i^D
d_1	1	2	1/3	1	1/4	4	12.66%
d_2		1	1/3	1	1/5	4	10.08%
d_3			1	1	3	5	31.94%
d_4				1	1	2	15.72%
d_5					1	3	24.64%
d_6						1	4.96%

Consistency index = 0.0933.

The formulas for the estimation of the index of general equality and for the dimensions will be expressed in the following way:

$$IG = 0.25 \sum_k X_{dim}^k, \quad k = A, B, C, D; \tag{18}$$

$$X_{dim}^A = 0.0269a_1 + 0.0269a_2 + 0.0712a_3 + 0.1886a_4 + 0.0749a_5 + 0.0749a_6 + 0.1444a_7 + 0.3922a_8; \tag{19}$$

$$X_{dim}^B = 0.1126b_1 + 0.2276b_2 + 0.2276b_3 + 0.3011b_4 + 0.0431b_5 + 0.0879b_6; \tag{20}$$

$$X_{dim}^C = 0.0704c_1 + 0.0704c_2 + 0.1562c_3 + 0.2475c_4 + .04554c_5; \tag{21}$$

$$X_{dim}^D = 0.1266d_1 + 0.1008d_2 + 0.3194d_3 + 0.1572d_4 + 0.2464d_5 + 0.0496d_6. \tag{22}$$

4. Results

From the data of the variables represented by the gender gap in percentages shown in Tables 2, 3, 4 and 5, the results for each of the aggregated measures are presented with the weights resulting from the analysis of the experts from Tables 6, 7, 8 and 9, and at a general level applying equal weighting (25%) for the dimensions in each of the autonomous communities of Spain in 2016 in Table 10. In the gender gap 0% represents the total equity between men and women. Positive values are favorable for women and negative values are unfavorable.

The results for the general indicator of gender equality are shown in Figure 1.

An analysis about the gender equality of the communities of Spain has been made both at a general level and in a multidimensional way in this paper, through the measurement of the asymmetry between men and women with the gender gap calculated as the difference between the percentage of women and the percentage of men. From the results obtained we can infer that:

- In the education dimension, the indicators are favorable to women in most of the autonomous communities, except in the cases of Cantabria, Castile – La Mancha and Navarre that present negative gender gaps of -2.96%, -6.18% and -8.14% respectively. As for the rest of the communities, above the average for Spain, there are: Principality of Asturias Aragon, Balearic Islands, Galicia, Andalusia, Canary Islands, Catalonia, Castile and León, Valencian Community and Castile – La Mancha.

Table 10. Gender equality by dimensions and general for the autonomous communities of Spain 2016

Autonomous Communities		Education	Labor Market	Social Conditions	Empowerment	Index of Gender Inequality
1	Principality of Asturias	5.74%	-11.60%	-41.95%	-28.75%	-19.14%
2	Canary Islands	4.57%	-18.81%	-34.56%	-31.20%	-20.00%
3	Balearic Islands	6.01%	-15.79%	-36.77%	-35.81%	-20.59%
4	Murcia	2.81%	-22.69%	-37.80%	-26.40%	-21.02%
5	Basque Country	2.36%	-17.07%	-41.31%	-29.78%	-21.45%
6	Aragon	9.18%	-21.69%	-35.83%	-37.49%	-21.46%
7	Andalusia	5.56%	-20.74%	-36.47%	-35.99%	-21.91%
8	Galicia	5.61%	-11.48%	-38.79%	-43.63%	-22.07%
9	Community of Madrid	1.47%	-14.24%	-38.14%	-38.38%	-22.32%
-	Spain	3.61%	-17.73%	-38.50%	-37.58%	-22.55%
10	Valencian Community	3.50%	-18.07%	-39.69%	-36.34%	-22.65%
11	Catalonia	4.06%	-14.92%	-39.96%	-41.46%	-23.07%
12	Extremadura	1.87%	-26.89%	-36.47%	-35.62%	-24.28%
13	Castile and León	3.78%	-22.53%	-39.84%	-38.86%	-24.36%
14	The Rioja	0.69%	-20.33%	-41.14%	-39.33%	-25.03%
15	Navarre	-8.14%	-20.37%	-40.34%	-33.17%	-25.51%
16	Cantabria	-2.96%	-15.90%	-38.25%	-45.97%	-25.77%
17	Castile - La Mancha	-6.18%	-27.17%	-34.42%	-39.29%	-26.77%

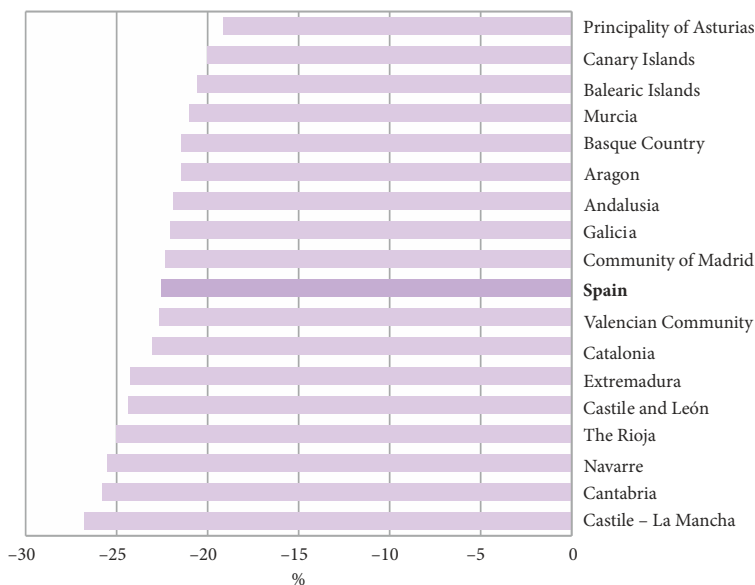


Figure 1. Index of general equality (gender gap)

- The labor market dimension is one of the fields in which the inequality between men and women with marked asymmetries in all the variables is more latent. Regarding the autonomous communities, although all have unfavorable results for women, they stand out above the average of Spain: Galicia, Principality of Asturias, Madrid, Catalonia, the Balearic Islands, Cantabria and the Basque Country. The worst results are obtained in Extremadura and Castile – La Mancha.
- The social conditions dimension is the one that presents the worst results, standing out above the average of Spain the autonomous communities of Castile – La Mancha, Canary Islands, Aragon, Andalusia, Extremadura, Balearic Islands, Murcia, Madrid, and Cantabria. The worst results are obtained in the Basque Country and Principality of Asturias. In this dimension, it is important to highlight the influence of the variables single-parent households and work leave for the care of children and relatives which, in addition to their inverse effect, show a clear imbalance to the detriment of women with gaps below 46% negative for households single-parent and 67% negative for work leave.
- The empowerment dimension is one of the most controversial issues in the inequality between men and women. Hence, in recent years, when referring to this area, it is explained in terms of glass ceilings, indicating the invisible barriers that women find to access positions of responsibility. The analysis shows the best result for the case of Murcia with a gender gap of -26.40% and the worst result for Cantabria with a gender gap of -45.97%. In addition to Murcia, the following communities stand out above the Spanish average: Principality of Asturias, Basque Country, Canary Islands, Navarre, Extremadura, Balearic Islands, Andalusia, Aragon, and Valencian Community.
- In the General Equality Index, which includes all the variables with the results obtained in each dimension, we infer that the community with the least inequality is Principality of Asturias with a gender gap of -19.14%. The community with greater inequality is Castile – La Mancha with a gender gap of -26.77%. The overall gender gap in Spain is -22.55%, ranking above this level the communities of Asturias, Canary Islands, Balearic Islands, Murcia, Basque Country, Aragon, Andalusia, Galicia, and Madrid. Below the global index of Spain are the communities of Valencian Community, Catalonia, Extremadura, Castile and Leon, The Rioja, Navarre, Cantabria, and Castile – La Mancha.
- In the general analysis, we can also observe that in the education dimension the results are very favorable for women in practically all the variables and most of the autonomous communities. However, in the analysis of the specific academic disciplines, greater imbalances, especially in technology can be found.
- The dimensions of the labor market, social conditions and empowerment are clearly unfavorable for women, being more critical in the case of the last two.
- The results obtained in the four dimensions are consistent with the synthetic index of gender inequality SIGI (Bericat & Sánchez, 2008) or the modified gender equity index IEGM (Fernández-Sáez et al., 2016), among others, which show a favorable situation for women concerning the educational environment and unfavorable for the other dimensions.

Conclusions

The gender equality index of the autonomous communities of Spain measures the equality between men and women in Spain for each of the autonomous communities. This indicator is a hierarchical and multidimensional approach to measure gender equality, taking as a reference a set of 25 variables that were classified into four dimensions (education, labor market, social conditions, and empowerment). These dimensions, in turn, make up a general index of equality for both Spain and each of the autonomous communities. For a better understanding and analysis, both the variables and the dimensions and the general indicator are calculated from the percentage gap between men and women.

Advances in gender equality are a crucial element for the economic and social development of countries and regions in a sustainable manner. That is why it is necessary to have objective indicators in different contexts of society where they can identify to what extent men and women enjoy the same rights and opportunities for their professional and personal development. In this way, the indicators presented in this article show in each of the autonomous communities of Spain advances in terms of equality for the dimensions analyzed and in turn can be compared with the rest of the communities in Spain. With these results, institutions can establish and prioritize public and private initiatives aimed at reducing the gender gap.

This study presents a general panorama regarding the situation of women in the regions of Spain. However, during the investigation, there are limitations regarding the statistical data available by sex and Autonomous Community, since the variables included in the dimensions have been selected from a limited number of indicators published in the official databases. Therefore, for a better diagnosis, it is expected to have additional statistical data classified by sex, to deepen in more detailed diagnoses of the dimensions.

The multidimensional indicator of gender equality for the communities of Spain will continue to be presented each year by the Economic and Financial Observatory of the Royal Academy of Economic and Financial Sciences of Spain to closely monitor the evolution of this issue in each of the variables selected, the dimensions and at a general level. In this project, similar indicators of territorial gender equality will be implemented for other Iberoamerican countries.

In future research, the causes of the inequalities in the variables and dimensions will be analyzed, as well as the differences in the results between the different territories of Spain.

Acknowledgements

Support from the Royal Academic of Economic and Financial Sciences of Spain is gratefully acknowledged.

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Critical revision: All authors discussed the results and commented on the manuscript.

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