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The dynamic of the gender gap in the European labour market in the years of economic crisis

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Abstract Closing the gender gap in the labour market is one of the main goals of European Union and part of a wider effort to eliminate social inequalities. In recent decades, all developed countries have suffered a deep global economic crisis, that has increased social and economic inequalities. In Europe, the crisis involved problems of European stability and growth, but the crisis did not affect the euro-area countries to the same extent, and the consequences and recovery were correspondingly asymmetrical. In this paper, we analyse the changes that occurred in the gender gap in the European labour markets from 2007 to 2012 to understand if the recession has further increased or reduced the gender differentials. At this aim, we combine the use of two different statistical methodologies. Through the composite indicator methodology, we test how the rank of countries in relation to gender equality has changed in these years. In addition, the Dynamic Factor Analysis allows us to identify the factors that drive these changes. Moreover, the contextual analysis of the measures that were utilized to face the crisis could give policy makers some useful suggestions on the most efficacious actions to take.

Keywords Gender gap · Labour market · Composite indicators · Dynamic factor analysis

JEL Classification J16 · J31 · J11

1 Introduction

The existence of gender differentials in the labour market in terms of participation and working conditions is one of the main pieces of evidence that social inequalities exist. The removal of gender differentials is an important goal for the European Union and is part of a

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wider effort concerning economic growth, as advocated by the Lisbon agenda. Many studies on gender inequality and economic growth, involving both developed and developing countries, have identified the crucial role of women in the economic development and, consequently, the opportunity to invest resources in the removal of inequalities (Abu-Ghaida and Klase 2004; Seguino and Floro 2003; Stotsky 2006). Gender economic equality refers to women and men working to the same extent in paid jobs and having an equal share of part-time work and self-employment (Löfström 2011, p. 5).

Reducing the gender gap can significantly improve per capita income and well-being, but it requires a comprehensive approach that accounts for the different nature of labour market challenges across countries and includes a range of measures to foster gender equality and enhance women's employment (OECD 2012).

Progress has been made to close the gender gap in *opportunities*, but substantial differences persist in labour market *outcomes* despite the fact that young women are more educated than young men in many countries (OECD 2014). Indeed, in the 1990s and in the first years of the 2000s, women in advanced and developing countries claimed higher levels of education. This increase in education for women tends to increase their participation in the labour market. However, in these last years, the economic crisis, which started in the United States' financial sector in 2007 and speedily involved European countries too, increased economic inequalities.

This paper examines the conditions of women in the labour market by estimating and analysing gender differentials in unemployment, participation, terms of segregation, and wages and education. In particular, in this sphere, we try to identify the aspect of the gender gap that is not explainable by easily observed characteristics which, consequently, includes its discriminatory component. During the recession, women experienced higher increases in temporary contracts and vertical segregation and were more exposed to skills obsolescence and reduced employability because of the more frequent career breaks in their working life and their general more vulnerable conditions in the labour market. Nevertheless, in some cases, women decided to work because their male counterpart had lost their job, which reduced the gap. Therefore, we want to determine if the recession further increased or reduced the gender differentials in the labour market. The first hypothesis can occur because in times of crisis the weakest categories of workers are more penalized, functioning as a buffer that protects the primary male labour force. However, the segregated nature of labour markets and the so-called "substitution effect" can lead to more penalizations for male employees. These effects occurred simultaneously, and we can reasonably assume that they were not uniform across countries.

Therefore, various specific indicators for years 2007 and 2012 were analysed and synthesized through the composite indicator methodology on the basis of new results of the Gender Gap in the Labour Market Index (GGLMI), a specific composite indicator on the gender gap in the labour market developed by the authors in a previous work (Castellano and Rocca 2014). This methodology allowed us to compare and rank countries by integrating large amounts of information aimed to measure a complex phenomenon. To rank countries with respect to the best global conditions for women, we evaluated female conditions in the labour market in relation to the male conditions, regardless of the national economic framework. Furthermore, we analysed the dynamics of gender inequalities in the labour market over the entire period (2007–2012) through the dynamic factor analysis (DFA) and highlighted countries that improved and those that worsened their condition. For the first time, these statistical methodologies are used together, so that, besides identifying the changes in gender gap, we obtain a new powerful information source to identify the determinants of these changes in a cross-countries comparative perspective.

The structure of the paper is as follows. Section 2 provides a brief overview on gender inequalities and the European economic framework; Sect. 3 describes the statistical methodology; Sect. 3.1 shows the gender gap indicators; Sect. 4 discusses the main results; and Sect. 5 presents the conclusion.

2 Some remarks on gender inequality

2.1 The gender gap in the labour market

The gender gap in the labour market is not uniform cross-nationally even in the European countries that have similar levels of social and economic development and growth. In a wider perspective, the gender gap can be considered as one aspect of economic inequality that embraces economic, cultural and social dimensions because it concerns the equal right to education, the equal right and opportunity to work in the market and the nature of women's work and pay.

In most places in the world, men and women have shown different roles and attitudes with respect to education and work. The differences in the labour market outcomes are in part the result of men and women's different behaviours and attitudes, but are also due to the different obstacles and treatment they receive.

In the last decades, despite the dramatic growth in female labour force participation and the significant increase in the economic opportunities reserved to women in terms of occupations and earnings, women's and men's access to jobs is likely to differ, either because of legitimate sources of labour market 'power' accorded by differential human capital or illegitimate prejudice or entrenched disadvantage (Becker 1957; Blau and Kahn 2000). However, the different attitudes and behaviours are in part the result of the influences and stereotypes suffered by women since childhood. Therefore, it is important to identify how the existing gender differences in the labour market are due to females' choices to invest less in their professional career than their male counterparts (Fernandez and Fogli 2009) or by employers' discriminatory behaviours (Mincer and Polacheck 1974; Mincer and Ofek 1982). Gender discrimination refers to the differential treatment of the genders for no justifiable reason—i.e., not due to their different characteristics in terms of human capital. Gender discrimination is difficult to identify because the portion of the gender gap that we are unable to explain is not due entirely to discrimination. Indeed, it can also derive from unobserved factors that we are unable to identify and measure. Moreover, the different behaviour and attitudes should be ascribed to an indirect form of discrimination because they depend on the socio-cultural influences that are connected with gender stereotypes, but these are very difficult to identify and measure too.

Disparity in wages is one of the biggest outcomes of gender inequality and depends in part on the imbalances and inequal sharing of household work among couples (Löfstrom 2011). Based on the human capital theory (Becker 1993), a proxy of discrimination in wages could be the share of the gap that is inexplicable by the observable characteristics. However, not all the characteristics are observable, and even when the gap is adjusted for many observable characteristics, any unexplained residual gap cannot be exclusively attributed to discrimination.

2.2 The changes in gender inequalities during the economic crisis

In these last years, the economic crisis and its repercussions have strongly affected the dynamics of gender inequalities in the labour market. Since 2007, when the economic and financial crisis began, female employment rates, which were increased in previous decades,

dropped, even if the responses of women's and men's activity patterns were different across European countries. At the EU level, gender perspective lost the prominence it had acquired in the past in most countries, and instead of promoting growth by mainstreaming gender into the stages of policy response, some countries reinforced with their polices the main male breadwinner model.

In general, the crisis increased the divergence between the Southern and the Northern European countries. Indeed, the Southern European countries recorded the largest drop in the employment rates and the largest increases in unemployment rates for both men and women while the Northern and Central European countries showed greater resilience (Smith and Villa 2014; European Commission 2013, pp. 17–22). In addition to these differences, the policy responses to the crisis were also strongly diversified.

However, even if the crisis hit European countries differently, as a result of the differences in the countries' macroeconomic situations and institutional environments, some common traits can be highlighted (Périvier 2014). In most countries, the crisis exacerbated the internal economic inequalities, but the repercussions from a gender perspective can be analysed by identifying three different approaches: the job segregation hypothesis, the buffer hypothesis and the substitution hypothesis. The job segregation hypothesis explains the main differences between men and women in the labour market in terms of gender segregation. Generally, male employees are more concentrated in the construction and manufacturing sectors, the first that was affected by the crisis, while women are more concentrated in the public and service sector; these last were affected by the economic crisis in a second stage (Karamessini and Koutentakis 2014; Karamessini and Rubery 2014). Therefore, women, who are over-represented in public and service sectors, remained quite sheltered from the quick drop in the demand for labour. Nevertheless, at the second stage, they were exposed to job losses too (Eydoux et al. 2014) because the measures that were taken by each State member to address the crisis strongly penalized women for various reasons. Austerity policies negatively impacted public sector jobs, slowing down the turnover and reducing the wages and the welfare expenditures, specifically those for work-life reconciliation. Further, the actions that were taken to promote employment were designed primarily for the male-dominated sectors, encouraging the restoration of the male main breadwinner model in most countries. Conversely, other factors such as the increased demand for a high-educated workforce helped to narrow the gender gap in employment.

Based on the buffer hypothesis, women in unstable jobs acted as a labour force buffer, i.e. a flexible reserve, to be drawn into the labour market in upturns and expelled in downturns, protecting men against job losses (Galli and Kucera 2008). Nevertheless, in many cases women, decided to work in response to the job loss or wage reduction of their partners. Finally, the substitution hypothesis suggests that during a recession, employers prefer women workers to men workers to support their large demand for cheap labour.

These hypotheses can occur simultaneously among different groups of women and with different degrees across countries. They allow us to identify the main changes that occurred among females and males in labour markets.

3 The composite indicator methodology and the dynamic factor analysis

The gender gap in the labour market is influenced by manifold and sometimes controversial aspects. For this reason, it is useful to analyse it through the composite indicator methodology.

The construction of a composite indicator is a complex process, involving many choices and therefore many sources of uncertainty and subjectivity. For a detailed description see OECD (2008). The main steps in composite indicators construction involve: (1) the conceptual framework definition; (2) the identification of the indicators and of their nested structure; (3) data imputation for missing values; (4) outlier treatment; (5) standardization; (6) aggregation of indicators into pillars; (7) aggregation of pillars into the composite indicator.

In this work, data were standardized through the *min–max method* and corrected for the direction, so that higher values for each indicator would denote better. The synthesis of the indicators into pillars is based on principal component analysis applied within each pillar while the synthesis of the pillars into the composite indicator involves the following alternative methods of aggregation (for a detailed description on the methodology used in the GGLMI construction, see Castellano and Rocca 2014; pp. 353–358):

(a) Arithmetic mean.
(b) Geometric mean.
(c) Wroclaw taxonomic approach, ranking countries according to the Euclidean distance from the "ideal country", that is the country with the best characteristics for each indicator.
(d) Borda's rule, based on the frequency matrix.
(e) Condorcet approach, which identifies the country that would win by majority rule in all pairings against the others.

These aggregation methods are applied using both the hierarchical structure of variables into pillars and directly synthesizing variables into the composite indicator.[1]

We obtain a country rank from each aggregation method. In order to get a unique and synthetic final ranking, we consider for each country the median of the ranks obtained through the various aggregation methods (Saisana et al. 2005; Hudrliková 2013). Further, in order to get a measure of the volatility of the results, we report the confidence interval for the median, obtained through bootstrap procedures that account for the variability of each country position (Castellano and Rocca 2015).

The comparison between the 2007 and 2012 index results highlights countries worsening and improving their condition in comparison with the other ones; in order to sketch the dynamics driving these changes over time, the Dynamic Factor Analysis (DFA) is applied on the same variables for years from 2007 to 2012.

DFA is a statistical multi-way analysis technique which allows the management of complex data structures, where three dimensions can be identified: observations, variables and time. Introduced by Coppi and Zannella (1978) and re-examined by Coppi (1986) and Corazziari (1997), DFA aims to study a complex phenomenon in both a structural and a dynamic way, summarizing its variability and highlighting similarities/dissimilarities among the "occasions" (the waves). Further, the principal components of the average behavior in the time interval allow to draw a dynamic path (Bolasco 1999; Kroonenberg 2007). Thus, DFA combines, from a descriptive point of view, the cross-section analysis through Principal Component Analysis (PCA) and the time series dimension of data through linear regression models.

DFA is very suitable when data matrix X is organized in the form of three way arrays, "units x variables x times", in order to analyze the data "volumes":

$$\mathbf{X(I, J, T)} = \{x_{ijt}\}, \quad i = 1, \ldots, I; j = 1, \ldots, J; t = 1, \ldots, T$$

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[1] For sake of brevity, the results obtained for each aggregation method are not reported, but are available on request by authors.

where i is the unit, j the variable and t the time.

X can be reduced to a matrix of dimensions IT × J, by sequencing the matrices $\{\mathbf{X}_t, t = 1,\ldots,T\}$, where $\mathbf{X}_t$ is the matrix units by variables observed in time t.

This methodology helps to decompose the variance and covariance matrix **S** related to **X**(IT,J), where the units are identified by the pairs "units-times", into the following variance and covariance matrices:

$$S = {}^*S_I + {}^*S_T + S_{IT}$$

where $^*\mathbf{S}_I$ is the matrix of the static structure of the units, i.e. for the average of the units with respect to time, reflecting the variability of the relational structure of the units, independently from the time dimension. Its generic element is:

$$_{i}s_{jj'}^* = \sum_i \left(\overline{x}_{ij.} - \overline{x}_{.j.}\right)\left(\overline{x}_{ij'.} - \overline{x}_{.j'.}\right)d_i$$

where d_i is a weight that can be attributed to units.

$^*\mathbf{S}_T$ is the matrix of the average dynamic of the system, showing the variability due to the time dimension for the average of each variable over the units, independently from the dynamic of the single units, whose generic element is:

$$_{t}s_{jj'}^* = \sum_t \left(\overline{x}_{.jt} - \overline{x}_{.j.}\right)\left(\overline{x}_{.j't} - \overline{x}_{.j'.}\right)l_t$$

where l_t is a weight that can be attributed to time and $\overline{x}_{.jt}$ is the dependent variable of the following regression model: $\overline{x}_{.jt} = a_j + b_j t + e_{jt}$, $j = 1,\ldots,J$; $t = 1,\ldots,T$ where the residuals satisfy the condition:

$$cov\left(e_{jt}, e_{j't'}\right) = \begin{cases} w_j & j = j'; t = t' \\ 0 & otherwise \end{cases}$$

assuming importance also because the relationship between the j variables is explained only by the PCA relative to S_T matrix. In other words, it implies that the average dynamic of the system is distinct from the average dynamic of the single variables.

$\mathbf{S}_{IT}$ is the matrix of the differential dynamic of the single units, highlighting the interaction between units and times, of the values: $\left(x_{ijt} - \overline{x}_{ij.} - \overline{x}_{.jt} + \overline{x}_{.j.}\right)$.

Thus, DFA is a powerful instrument consisting in the decomposition of the total variability of X(IT,J) into its three components highlighting the different aspects of the tridimensional phenomenon. Furthermore, it allows obtaining an explorative modeling of these components through the joint use of Principal component analysis and Regression analysis. In this paper, we applied DFA to the indicators forming the composite indicator using the Stata procedure developed by Federici and Mazzitelli (2005).

3.1 The gender gap in the labour market indicators

Figure 1 shows structure of the GGLMI. The first pillar describes the labour market conditions in terms of labour force composition and contractual forms. Gender differences in participation and unemployment rates denote the different propensities and obstacles met by men and women to find a job. Further, the differences in the distribution across genders of voluntary and involuntary part-time work and temporary contracts allow capturing the different conditions reserved to female and male workers in terms of flexibility and precariousness.

Pillar 1: *Labour market participation and conditions*
1.1 female unemployment rate/ male unemployment rate
1.2 female harmonised unemployment rate / male harmonised unemployment rate, age class 15-24
1.3 female activity rate / male activity rate
1.4 part-time work as percentage of total employed (females/males)
1.5 involuntary part-time work as percentage of total part-time (females / males)
1.6 temporary employees as percentage of total number of employees (females / males)
Pillar 2: *Labour market integration*
2.1 women in the highest decision making body member (%)
2.2 women as national parliament members (%)
2.3 size standardized horizontal segregation index (Gibbs, 1965)
2.4 size standardized vertical segregation index (Gibbs, 1965)
Pillar 3: *Employment return and discrimination*
3.1 regression coefficients for experience (females / males)
3.2 regression coefficients for education (females / males)
3.3 difference between male and female mean income in logs /male mean income in logs
3.4 discrimination part of wage gap on the basis of the Oaxaca-Blinder decomposition (Heckman et al., 2003; Oaxaca, 1973; Blinder, 1973)
3.5 dr_0 index (Foster et al., 1984)
3.6 dr_2 index
3.7 years in education (females / males, mean values)
3.8 graduated employees, % (females/males)

Fig. 1 Structure of the GGLMI: pillars and variables included in each of them

The second pillar concerns horizontal and vertical segregation, i.e. the different distribution of female and male employees across the economic activity sectors and professions (Blackburn 2009; Gibbs 1965). A specific focus is also reserved to the share of women occupying particular top positions in the career. Finally, the third pillar measures the different rewards reserved to human capital, i.e. the work experience and education remuneration, the portion of wage gap which persists after controlling for the observable factors, and therefore in part ascribable to discrimination (Heckman et al. 2003; Oaxaca 1973; Blinder 1973; Foster et al. 1984), and the attained education (for a detailed description, see Castellano and Rocca 2014, pp. 350–353).[2]

In order to measure the gap, most of the indicators were calculated as ratios between female and male values, showing in this way the female condition in comparison with the male one (with the exceptions of the indicators of pillar 2 and the discrimination indexes).

GGLMI differs from the other composite indexes on gender gap already proposed in literature (Hausmann et al. 2008/2012; Gaye et al. 2010), such as the GGGI constructed by the Swiss World Economic Forum, the Social Institutions and Gender Index proposed by

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[2] The indicators choice was inspired to the need of considering all the measurable differences between female and male employees arising from labour market, in terms of presence and condition reserved them. In this view, no compensatory effects have been considered, for example, between horizontal and vertical segregation indexes. Also the possible overlapping between the different contractual forms, for example who has both a part-time and a temporary job contract, is not controlled for, because they measure two different aspects of the labour condition.

the OECD and the Gender Inequality Index developed by the United Nations. Indeed, GGLMI focuses specifically on disparities arising from the labour market. For a more exhaustive description of the characteristics of gender gap indexes, see Staveren (2012); for a comparison with the GGLMI, Castellano and Rocca (2014, pp. 347–348).

Data come from Eurostat on-line database (http://ec.europa.eu/eurostat/data/database) and from ad hoc elaboration on EU-SILC data, the European Survey on Income and Living Conditions.

4 The changes in the years of economic crisis

In European countries, the general labour market conditions and the levels of the gender gap in the years preceding the economic crisis were very different. On the one hand, we have the most developed Northern countries where, even with medium levels of gender pay gap and gender segregation, the good mix of social policies favoured the highest levels of female participation. Moreover, the active labour policies and the generally favourable economic conditions drove toward the lowest unemployment rates. On the other hand, in the Southern countries, the lack of appropriate labour policies and the generally precarious economic conditions favoured high levels of unemployment for both females and males. In addition, the lack of flexibility and the persistence of social welfare and family strategies that are associated with the male main breadwinner model, which is characterized by the lack of childcare and other services needed to reconcile work and family life, produced the lowest female participation rates. In the Eastern European countries, whose economies were still affected by the recent transition from a planned economy (which favoured a wide female participation to labour market) to a market economy, many problems in terms of market functioning still exist (Heinegg et al. 2007; Liptàk 2012; United Nations 2012). Finally, since the 1990s, the countries of central Europe experimented with many strategies the increase in female participation and the reduction in the wage gap and Anglo-Saxon countries stood out for their high female participation and for the lowest levels of gender segregation and the unexplained portion of wage gap (OECD 2004).

The analysis of the GGLMI indicators[3] in 2007 highlights the complexity of the phenomenon and the inconsistency of any generalization. Note that in the GGLMI the indicators are expressed as ratios between female and male values, so they are influenced by the differences that exist between females and males instead of by the general level that these indicators assume in each country. Unemployment rates range from 11.2 % in Greece to 1.4 % in Iceland for females and from 8.2 % in Slovakia to 1.2 % in Iceland for males. Other substantial differences concern the share of employees who work part-time, ranging from 4.5 % in Slovakia to 75 % in the Netherlands for females. Strong differences also occur in the gender wage gap, varying from 2 % in Slovenia to 32 % in Estonia. The portion of wage gap not due to observable characteristics ranges from the 0.7 of the Netherlands to values greater than 3 in countries such as Slovenia and Poland with absolute low gender wage gaps. The percentage of graduated employees reaches the highest levels in Belgium for both females and males and reaches its lowest point in the Czech Republic for females and in Portugal for males.

An analysis of the ratios between female and male indicators for 2007 shows that the gender gap in unemployment rates is highest in the Mediterranean countries of Greece,

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[3] For sake of brevity, the values assumed by indicators are not reported here, but they are available by Authors on request.

Spain and Italy and the gap is moderate in most Eastern, Central and Northern countries. Moreover, countries such as Cyprus, Slovakia, Estonia and Luxembourg highlight a very complex scenario because they rank at the top of classification for some indicators and low for others. For example, Estonia shows good performance for the gap in unemployment rates, in temporary contracts and involuntary part-time work, but Estonia also has high levels of the gender wage gap and its unexplained share. In addition, Cyprus presents higher gaps in temporary contracts and vertical segregation, but Cyprus also has the best values for remuneration in education.

An analysis of the same indicators in 2012 shows the effects of the crisis across European countries. A decrease in the economic growth measured by GDP was most concerning. The decrease in GDP was more severe in the Mediterranean countries of Greece, Italy and Portugal, for the Eastern countries of Latvia and Estonia and for Denmark and Ireland; however, Poland and Slovakia continued to increase their GPD (Eurostat on line database).

At a national level, the responses in terms of policies and actions undertaken to contrast the crisis were very different. Some countries devoted attention to gender inequalities in the labour market; in others, the restrictions that were imposed to address the economic crisis reduced the efforts to contrasting gender discrimination. Indeed, to face the crisis, most European countries were committed to reduce their budget toward gender equality and social policies, negatively affecting women. Some countries such as Portugal, Slovenia and Sweden decided not to reduce the resources devoted to gender equality (Bettio et al. 2012); other countries, such as Poland and the Slovak Republic, reallocated gender equality tasks between institutions for a more efficacious action. Iceland directly used the economic crisis as an opportunity for radical change in gender equality machinery and made gender equality policies the priority as a policy issue in the hands of a female Minister of Social Affairs.

An analysis of the values for the indicators in 2012 shows that in Belgium and Austria, the female unemployment rate decreased, but in Greece, Cyprus, Spain, Estonia, Lithuania and Ireland, the female unemployment rate more than doubled. The analysis shows similar scenarios for male employees. Excluding Germany, unemployment rates increased everywhere but with more severity in Denmark, Ireland, in all the Mediterranean area and in the Eastern countries of Estonia, Latvia, Lithuania and Slovenia. Italy had the minimum female participation rate for the entire period while Denmark and Ireland suffered a decrease. With the exception of Belgium, Austria, Germany, Estonia, Latvia and Norway for females and Belgium, Germany and Estonia for males, the share of involuntary part-time work increased in all countries. Generally, during the crisis, temporary contracts were not renewed; therefore, in some countries, the reduction in the share of employees with temporary contracts could reasonably be related to the increase in the levels of unemployment.

Data on segregation indexes highlight a reduction in horizontal segregation but an increase in vertical segregation, which is probably due to the access that women had in those years to the less qualified professions. This phenomenon was more widespread across the sectors of economic activity and could confirm the substitution hypothesis. Even if the gender pay gap decreased in all countries, with the exception of Germany, France and Italy, its share due to unobservable characteristics increased in about one-half of the analysed countries, which highlights that during economic downturns the weakest categories of workers are penalized more than the others even if they have the same characteristics.

Finally, the percentage of graduated employees increased in all countries, excluding Belgium, where they were already very high in 2007.

A comparison of the ratios between female and male indicators for 2012 and 2007 highlights substantial changes in part-time work; with the exception of Lithuania, Poland

and Slovenia the gap between female and male ratios increased in all countries, but for most of the countries, the share of females and males working part-time, separately considered, also increased. The Czech Republic and Austria improved their rankings for reduction of the unexplained share of the wage gap, and Latvia performed better in 2012 for this aspect and for gender segregation, but Latvia fell in the rankings for young unemployment and working experience remuneration. In the Czech Republic, the moderate effects of the economic crisis favoured the introduction of a subsidized short time working scheme (similar to the German one) and the introduction of programmes aimed to promote an increase in training and formation activities.

Additionally, France improved its ranking reducing horizontal segregation, for the major presence of women in the highest decision making positions and the decrease in the unexplained share of the gender pay gap, but it fell in the rankings for part-time, gender pay gap and remuneration for education. Here the employment and unemployment of women and men have recorded contrasting evolutions since 2008, especially because of the gender segregated labour market, which spared women from the recession but also caused more female expulsions from the labour market than men and exposed women to the cheaper, less secure and less paid jobs (Rubery 1988).

Before analysing the composite indicators for 2007 and 2012, it is useful to look at the rankings referred to the pillars (Table 1).

We cannot identify the countries where female economic conditions in the labour market in comparison with the male conditions worsened overall, nor can we identify the countries where the economic conditions are improved overall. The rankings that are related to each pillar account only for how the condition is changed when compared to the other countries. Thus, the dynamics that drive these results cannot be immediately captured. Only Iceland improved its positioning for all the pillars, gaining 13 positions in the GGLMI. In addition to the cited radical change in the organization of the gender equality machinery, Iceland also increased its ranking because the crisis specifically affected the traditional male dominated occupational groups and sectors (construction and industrial sector, Danish Technological Institute 2011).

Latvia, with an increment of 13 positions for the second and third pillar, is certainly the country that showed the best general performance, producing an overturning in the ranks of GGLMI. In these years, although Latvia suspended the majority of the activities and measures for the Gender Equality Program (Smith and Villa 2014), it also experienced severe labour market contractions, especially in sectors that were dominated by men, while female-dominated jobs were in part protected by the crisis because foreign investors did not withdraw from it (Fodor and Nagi 2014).

Italy and Portugal's improvement in the ranks is also significant. They both gained 8 positions, but for these countries, which were strongly hit by the crisis, the loss of job for many employees and the consequent shift in many cases from dual to female breadwinner couples also contributed to the reduction in the gender gap (European Union 2013). However, Poland and Germany lost positions in the GGLMI ranking of 9 and 6 positions, respectively, but an analysis of the absolute values of the single indicators shows that the economic crisis produced the lowest effects for men. Therefore, in Germany, even if women lost positions compared with their male counterparts, all employees were less affected by the economic crisis. This was due to the successful mix of labour market policies developed in the earlier stage of the recession that provided more support to male-dominated sectors and to the male labour force (Eydoux 2014).

Most of the countries that improved their rank for the first pillar fell in the rankings for the second one. This means that in countries where female conditions in terms of participation and

Table 1 Ranking of European countries with reference to the pillars and GGLMI. Years 2007 and 2012

Countries	2007(*)					2012				
	Pillars			GGLMI	Confid.	Pillars			GGLMI	Confid.
	1	2	3	Median	Interval	1	2	3	Median	Interval
BE	20	12	7	12	1–17	16	14	11	14	5–17
CZ	21	14	26	25	23–25	25	15	24	25	21–25
DK	11	3	13	4	3–6	13	8	9	8	6–12
DE	8	10	18	10	9–15	14	5	25	16	7–9
EE	1	17	15	7	1–14	4	19	14	10	10–15
IE	10	16	9	8	6–15	3	23	7	9	7–18
GR	26	24	10	25	23–26	23	24	5	23	20–24
ES	23	8	6	12	5–14	18	17	10	17	4–21
FR	16	25	2	13	8–22	19	12	17	19	2–22
IT	24	19	8	20	16–22	24	11	4	12	10–20
CY	18	22	17	23	21–24	11	26	26	25	23–26
LV	2	23	21	19	10–21	2	10	8	2	1–7
LT	3	7	5	2	1–9	1	16	3	1	1–7
LU	25	20	23	26	24–26	26	25	21	26	25–26
HU	6	21	14	17	14–19	10	22	12	20	16–21
NL	22	5	12	14	7–15	15	6	19	14	9–14
AT	19	9	22	21	15–21	20	18	23	23	15–24
PL	12	18	3	9	7–17	21	21	2	18	9–19
PT	14	26	4	19	13–23	12	20	6	11	7–19
SL	15	6	1	3	1–3	22	4	1	6	2–23
SK	13	13	25	22	20–22	17	9	18	21	13–24
FI	5	4	19	6	5–7	5	7	16	5	5–11
SE	7	2	20	6	4–9	9	3	13	4	1–6
UK	4	15	24	16	12–17	7	13	22	15	13–19
IS	17	11	16	16	11–19	6	2	15	3	1–4.5
NO	9	1	11	2	2–6	8	1	20	7	4–20

The rankings for the pillars are obtained through the synthesis of the first significant components of Principal Component Analysis weighted by the share of explained variability

The rankings for the GGLMI are derived from the median values of 8 different aggregation techniques. Confidence interval for the median obtained through a bootstrap procedure with 2500 simulations

Source Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

(*) In few cases the results reported for 2007 differ from those published in our previous work because the methods of aggregation used are not exactly the same and for the data updates occurred in the Eurostat online database

employment are improved compared to the male conditions, gender segregation is increased. This seems to confirm the hypothesis that the economic crisis increased the share of female employees compared to men in all countries but worsened their working conditions as measured by gender segregation. France, Cyprus and Norway lost many third pillar positions.

To achieve robust data, we enriched the final ranks for the composite indicator by including an estimate of the volatility of results, i.e. their attitude to change when some of

the choices occurred in composite indicator construction changes. In other words, the variability in the distribution of rankings for each country has to be taken into account. Thus, in Table 1, near the median rank the 95 % confidence interval for median is reported. It is based on bootstrap procedures according to Efron and Tibshirani (1998) and Saisana et al. (2011).[4] For countries such as Luxembourg, Iceland, Sweden and Greece the median is fully representative of their positioning because the corresponding confidence interval is small enough. France, Spain and Norway highlight the highest variability, i.e. the different aggregation methods drive toward different results. If we consider only aggregation techniques accounting for the pillar structure, these differences become negligible. In particular, the Borda's and Condorcet methods of aggregation are more affected by the composite indicator structure. The aggregation methods without the pillar structure position France and Spain in the first part of ranking, and the other methods position France and Spain in the second half. The opposite happens for Norway, which ranks first for the second pillar and 20th for the third one. The single indicators show an optimal position for some and less than optimal for others. Instead, France and Spain have medium performances for almost all the indicators.

To better understand the latent factors that characterize in these years the changes in the gender gap we project the country-points on the factorial axes through the Dynamic Factor Analysis. In this way, we highlight the static structure of the units, which is how countries performed on average in the 2007–2012 period. The large number of variables to synthesize suggests the examination of country-points for the first four axes. In this way, we account for almost 60 % of the total variability of the phenomenon.

The projection on the first two factorial axes contrasts,[5] from the left to the right (first axis), the Eastern countries of Latvia, Lithuania and Estonia to the Netherlands, Germany and Luxembourg while from the bottom to the top, Greece, Italy and Luxembourg to all the Scandinavian countries and to a less extent the Baltic countries (Fig. 2). An analysis of their characteristics and the correlations between the axes and the variables reveals that the first axis is related to education and its rewards, that for the Eastern countries and in some Mediterranean countries are in favour of women (Table 2). The second axis opposes the countries with the lowest female participation rates and the highest levels of unemployment for women compared to men to the most developed Scandinavian countries, where females can count on a more favourable global condition of the labour market.

When the projection of country-points is based on the third and fourth principal components (Fig. 3), we note the contraposition among Slovenia, showing the minimum wage gap, and Estonia, with the maximum wage gap. Also, involuntary part-time work is specifically related to this third component. Finally, the fourth component sets against Cyprus, with the maximum vertical segregation, and countries with low values of the vertical segregation index, namely, the United Kingdom, Slovenia, Ireland and Germany.

To identify the dynamics that drove the changes that occurred from 2007 to 2012 in each country (i.e., the differential dynamic of the unit-countries), we can observe the trajectories that each country has traced over time in relation to the components that were

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[4] The steps followed to bootstrap the 95 % confidence interval for the median value are: (1) To resample with replacement from the original data set, creating 2500 bootstrapped data sets. (2) To independently compute the median value for each bootstrapped data set. (3) To compute the 95 % confidence interval from the set of computed median values from the bootstrapped data sets using the normal approximation method (Xu and Long 2005).

[5] Note that in country projection through ACP we do not correct indicators for direction because, despite the composite indicator methodology, where compensatory issues could arise, here the interpretation of results is based on the contrapositions of country-points in the four quadrants of factorial plane.
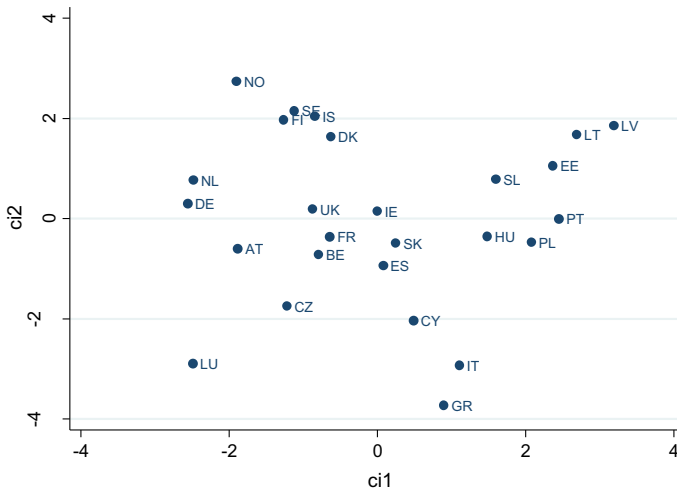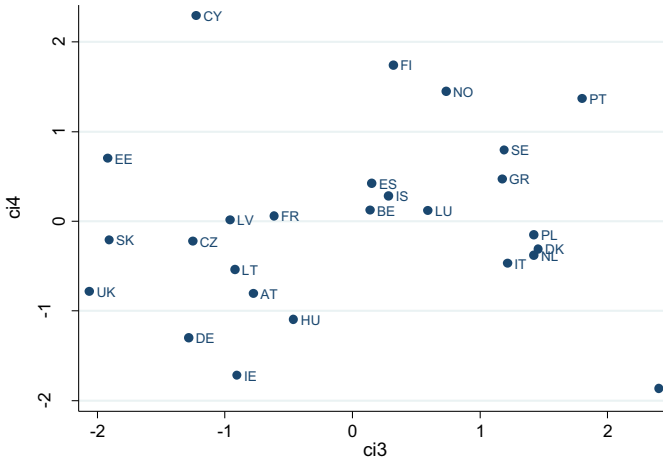
Fig. 2 Projection of country-points on the first two principal components of Dynamic Factor Analysis based on the GGLMI variables. Years from 2007 to 2012. *Software used* Stata-IC11 (64 bit). *Source* Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

Table 2 Correlations coefficients of Bravais-Pearson between the averages across time (years from 2007 to 2012) of the standardized values for the variables forming the composite indicator (constructed as ratios but not corrected for direction) and the first four principal components of DFA

Variables	Components			
	1st	2nd	3rd	4th
Unemployment (1.1)	−0.1179	−0.8028	0.2960	0.0446
Young unemployment (1.2)	0.1779	−0.6982	0.4864	0.1086
Participation to labour market (1.3)	−0.0326	0.9133	0.0449	0.2345
Part time work (1.4)	−0.6110	−0.4982	−0.0518	−0.1465
Involuntary part-time work (1.5)	−0.4701	0.0027	0.6069	0.2687
Temporary contracts (1.6)	−0.3838	−0.3152	0.1268	0.4758
Highest decision (2.1)	−0.2395	0.7355	0.0841	0.1923
Parlament members (2.2)	−0.5322	0.5195	0.3679	0.3073
Horizontal segregation (2.3)	−0.0428	0.4581	0.1268	0.1256
Vertical segregation (2.4)	−0.1156	−0.2282	−0.1009	0.6187
Experience coefficient (3.1)	0.5354	0.1171	0.0177	−0.3327
Education coefficient (3.2)	0.5849	−0.1602	−0.3037	0.1630
Gender wage gap (3.3)	0.3558	0.0195	−0.6738	0.2322
Discriminant share of wage gap (3.4)	0.5202	0.2101	0.5717	−0.3726
dr_0 index (3.5)	0.4238	−0.3118	−0.4877	0.3754
dr_2 index (3.6)	0.4727	0.1361	−0.0409	0.3695
Years in education (3.7)	0.7700	−0.0066	0.3952	0.3484
Graduated employees (3.8)	0.8565	0.1234	0.4031	0.1999

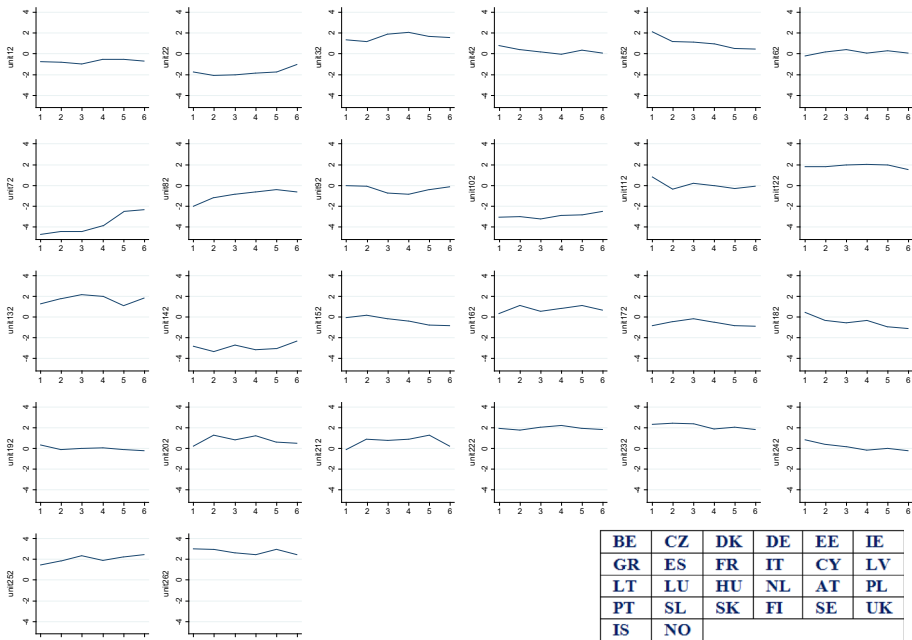*Source* Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

Fig. 3 Projection of country-points on the third and fourth principal components of dynamic factor analysis based on the GGLMI variables. Years from 2007 to 2012. *Software used* Stata-IC11 (64 bit). *Source* Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database
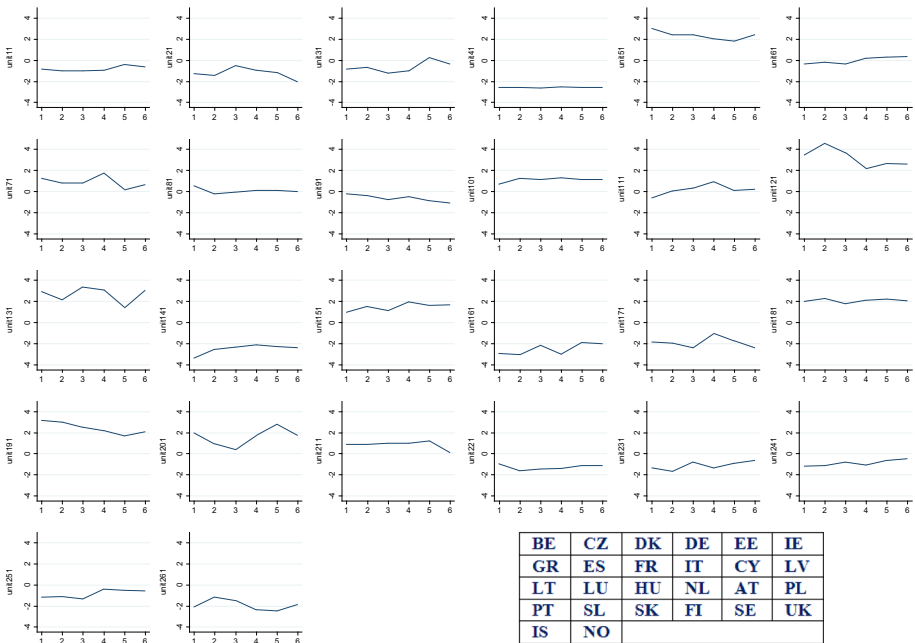
Fig. 4 Trajectories over time (2007–2012) of country-points with respect to the first principal component of Dynamic Factor Analysis on the GGLMI variables. *Software used* Stata-IC11 (64 bit). *Source* Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

identified in the previous step. In concordance with the general increasing trend of female engagement in higher education, most of the countries improved their conditions for education and rewards (Fig. 4). The few exceptions include Slovakia, France and the
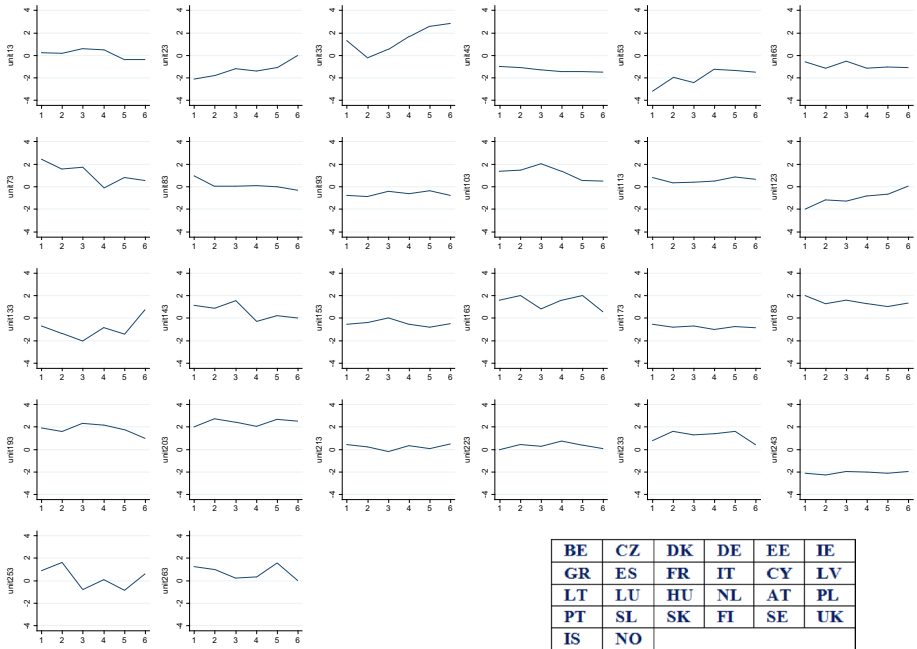
Fig. 5 Trajectories over time (2007–2012) of country-points with respect to the second principal component of Dynamic Factor Analysis on the of GGLMI variables. *Software used* Stata-IC11 (64 bit). *Source* Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

Czech Republic, while Lithuania and Slovenia highlight a more fluctuating course. In these years, in general, workers with tertiary education were comparatively shielded from dismissals from the crisis, but this does not hold for equally educated women in some Baltic and Mediterranean countries, where especially the middle-educated women suffered (European Union 2013). However, in these countries, the higher percentages of highly educated women and of unemployment rates favoured the strong levels of over-education for women (OECD 2013) and, consequently, lower wages than men and high shares of the unexplained pay gap.

The trajectories which refer to the second component show a more pronounced and increasing trend for Spain, the Czech Republic, Greece and Iceland, denoting a decrease in the gender gap related to the active presence on the labour market. While for Iceland this is due to the gender based reforms that were developed to address the recession, in the other countries, it is due in part to the added-worker effect: as men lose their jobs, their partners have a strong incentive to participate in the labour market (Périver 2014). Further, the higher share of highly educated female workers protected Spanish employees from the recession. Instead, the gap increased in Poland, the United Kingdom and Estonia (Fig. 5). In Poland, the extension of maternity leave was finalized to encourage higher fertility and in Estonia the abolition of paternity leave did not improve the participation of women in the labour market.

The trend described by countries with respect to the third component highlights a consistent improvement in female conditions for the aspects connected with the gender wage gap and involuntary part-time work for Latvia, Denmark and Estonia, denoting only

| BE | CZ | DK | DE | EE | IE |
GR	ES	FR	IT	CY	LV
LT	LU	HU	NL	AT	PL
PT	SL	SK	FI	SE	UK
IS	NO				

Fig. 6 Trajectories over time (2007–2012) of country-points with respect to the third principal component of Dynamic Factor Analysis on the GGLMI variables. *Software used* Stata-IC11 (64 bit). *Source* Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

that the impact of the crisis was higher for men, while many countries worsened their condition or remained stable (Fig. 6).

Finally, vertical segregation, the latent factor related to the fourth axis, shows an increase in most countries, with the exception of the Czech Republic where vertical segregation decreased with reference to the 2.1 and 2.2 indicators, and Lithuania, Denmark and Austria, which highlight a very irregular pattern over time (Fig. 7).

Finally, the regressions over time of each GGLMI indicator show that the only significant changes refer to the reduction of gap in female participation rates and in part-time and temporary contracts (Table 3). As the previous analyses suggested, the decrease in horizontal segregation was driven by an increase in vertical segregation, even if the significant increase in 2.1 and 2.2 indicators denotes a greater presence of women in these strategic positions. Therefore, it seems that the polarization of professions, (i.e., the contraction in middle job positions), concerned women in particular. In most of the countries, it was probably due to the introduction of laws promoting the gender balance in the workplace. Moreover, although the dynamics of unemployment rates confirmed that the repercussions of the economic crisis in Europe were stronger for men, the worsening in the female work rewards is confirmed by the indicators 3.1 and 3.2, which decrease over time. This should be associated with a general reduction of rewards for both males and females, because the gender pay gap is also significantly decreased over time, even if its unexplained share is increased.
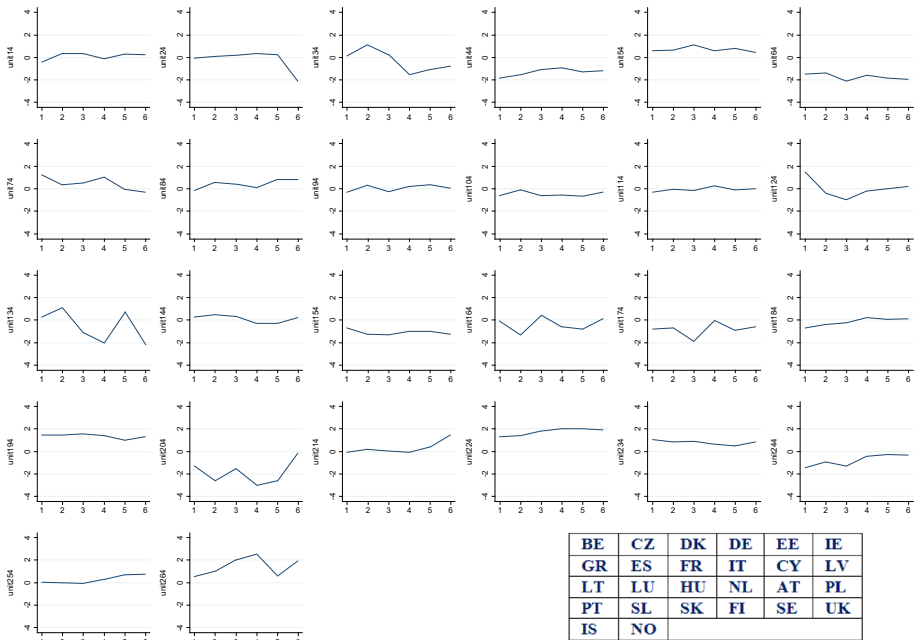
Fig. 7 Trajectories over time (2007–2012) of country-points with respect to the fourth principal component of Dynamic Factor Analysis on the of the GGLMI variables. *Software used* Stata-IC11 (64 bit). *Source* Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

Table 3 Regression coefficients of the simple regression models where each indicator of GGLMI is regressed with respect to time (from 1 to 6 years)

Variables	Coeffic.	Adj R^2	Variables	Coeffic.	Adj R^2
Unemployment (1.1)	−2.66*	0.5476	Vertical segregation (2.4)	1.91	0.3454
Young unemployment (1.2)	−2.15*	0.4213	Experience coefficient (3.1)	−0.45	−0.1897
Particip. labour market (1.3)	11.13***	0.9609	Education coefficient (3.2)	−1.96	0.3617
Part time work (1.4)	−5.52***	0.8548	Gender wage gap (3.3)	−7.31***	0.99130
Involuntary part-time (1.5)	−2.65*	0.5465	Discriminant share (3.4)	2.63*	0.5430
Temporary contracts (1.6)	−5.25***	0.8416	dr_0 index (3.5)	−1.02	0.0084
Highest decision (2.1)	4.62***	0.8028	dr_2 index (3.6)	−1.80	0.3095
Parlament members (2.2)	3.85**	0.7345	Years in education (3.7)	−0.16	−0.2416
Horizontal segregation (2.3)	−1.75	0.2916	Graduated employees (3.8)	−0.30	−0.2223

Source Authors' ad hoc elaboration on EU-SILC data and Eurostat on-line database

* Significance at 10 %; **at 5 %; ***at 1 %

5 Conclusions

In this work, an analysis was finalized to understand how the global financial and economic crisis changed female and male conditions in the labour market and, consequently, the gender gap.

The crisis repercussions on the gender differentials are very different across countries, but some similarities can be highlighted. Women are more likely to be involved in the more disadvantaged job contracts, as temporary work, and, consequently, are more likely to suffer from retiring from work, under-payment and discrimination. The increase in female participation rates that occurred in these last years, which may be considered progress in gender equality, produced in many cases an increase in gender segregation and, consequently, a general worsening in female conditions in the labour market.

The economic crisis, which in many countries became the focus of all the policies and government's efforts, distracted politics from gender equality strategies, which were often cancelled or delayed. A large number of new measures were taken to address the economic crisis, which meant that gender mainstreaming was never actively applied. Therefore, Ireland and Denmark, which, in 2007, stood out for the ideal mix of favourable female conditions in the labour market, lost crucial elements in the gender equality infrastructure. This loss was sometimes characterized by cuts in public spending (for example for the early childhood supplement) and, consequently, losing positions in 2012 in the country ranking for GGLMI. Further, many restrictive policies of social support toward categories of workers with the weakest attachment to the labour market were abolished. Other countries, such as the Czech Republic and Spain, showed some progress to overcome their backwardness regarding gender equality while Scandinavian countries and Lithuania confirmed in these years their well-developed national policies and outcomes in the sphere of gender equality. The loss of some positions in the GGLMI for Scandinavian countries, especially for Norway, can be ascribed to the consolidated flexibility of the labour market, which allowed firms to fire during recession, but the stronger initial conditions of these countries in terms of GDP, welfare and active labour policies made the crisis less dramatic in terms of social costs.

When the results of GGLMI for 2007 and 2012 are compared, it is surprising that Iceland and Latvia totally overturn their positions.

In particular, the Latvian labour market showed already in 2007 a relatively strong position for women, highlighted by the first pillar. In the next five years, Latvia remarkably improved its position for the other two pillars; even in the absence of any specific anti-discrimination or gender equality law, with reference to the second pillar, all the indicators improved, denoting a reduction in gender segregation. For the third pillar, the efforts of policy makers to address the persistent pay gap produced a significant reduction in the gender pay gap and in the severity of discrimination (indicator 3.6) and a leading position for the little gap in gender education (Directorate-General for internal policies 2015). Again, in Latvia, male employment rates dropped more severely than the female unemployment rates, opening the door to the substitution and segregation hypotheses.

Southern European countries such as Greece and Italy gained positions in terms of GGLMI because of the more severe conditions for male employees. However, countries such as Germany and Poland, where policies that aimed to expand and emphasize the use of temporary instruments finalized to retain workers and avoid unemployment were widely applied, lost positions in GGLMI, showing that males have been only marginally involved, and less than their female counterparts in the financial and economic crisis.

The innovative joint use of composite indicators and DFA methodologies enriched the synthetic results from the GGLMI and allowed for a more complete analysis of the phenomenon. The analysis allowed us to identify the main driving factors occurred in these years in the changes in gender inequality in the labour market. In addition, the analysis of changes in country rank measured only by the differences in the positions that were occupied by each country over time in the composite indicator classification has little meaning if it is compared with a more robust index from principal component analysis.

More advancements in the methodology could be realized and are already the object of a study by the authors,

The most important factor that drives the changes in the gender gap in European countries in the years of global crisis is education. Only at a second instance we find the changes in female participation in the labour market, unemployment, involuntary part-time work and the wage gap. Education appears as a crucial factor in all instances, not only for activity and employment, but also for the reduction of the gender wage gap in the labour market. Skilled and highly educated workers have a higher opportunity cost, especially for women, whose attachment to the labour market depends also on other factors, such as family engagement.

The analysis shows that, besides the countries' structural economic issues, such as the levels of unemployment, the lack of flexibility or the inadequacy of the welfare regime, the gender gap in the labour markets depends primarily on cultural factors.

Pervasive views about differential gender roles are one of the factors underlying the persistence of the female labour market disadvantage. Even in the most advanced countries, strong gender stereotypes and gender imbalances in terms of segregation across fields of education, occupations and economic sectors and remuneration still persist. Therefore, promoting a cultural shift to avoid gender stereotyping will help address differences in the most important factor, education, which includes the choice of subject of study, limiting gender inequality in career opportunities and earnings progression. Thus, gender equality in future labour force participation crucially involves policies that enhance gender equality in education and help students make informed choices. This is a cultural issue, because it involves all aspects of society's influence on beliefs, opinions, choices and norms of living. It can lead to overcome the stereotypes that in many cases act as "prisons", which affect the social and economic conditions of individuals.

The results also confirm the importance of gender policies: countries such as Ireland, Greece, Spain, Italy and Portugal, where the prospects for gender equality are less favourable, are also those where gender gaps are relevant. They result totally in contraposition with the countries where these policies assume great importance, such as Iceland, Finland, the Netherlands, Latvia, Austria and Germany. Furthermore, measures supporting the reconciliation of work and family life are also critical for men and women and should be finalized to allow them to spend the same time for work.

Then, policy makers should not focus on the short term objectives that promote male employment at the expense of gender equality initiatives because in a long term perspective, gender equality is directly related to the per capita GDP and, consequently, to economic growth. The increase in per capita GDP and economic growth stimulates equality and social cohesion in a gender perspective. Conversely, austerity may be detrimental to both gender equality and gender equality policies.

In conclusion, gender polices, primarily in education and high training, can be considered the main drivers of gender gap reduction and the most powerful instrument to overcome the financial and economic crisis.

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