The increase of the gender wage gap in Italy during the 2008-2012 economic crisis

Piazzalunga D., Di Tommaso M. L.

Frisch Centre, Gaustadalléen 21, 0349 Oslo, Norway. http://www.frisch.uio.no

Frisch Centre

The Journal of Economic Inequality
https://doi.org/10.1007/s10888-018-9396-8

The increase of the gender wage gap in Italy during the 2008-2012 economic crisis

Daniela Piazzalunga[1,2,3,4] · **Maria Laura Di Tommaso**[2,5,6]

Received: 4 January 2017 / Accepted: 23 July 2018 / Published online: 24 August 2018

Abstract

The Italian gender wage gap is lower than in other European countries, however it increased during the 2008-2012 economic crisis, while in most countries it decreased. This paper finds that the main cause of this increase is the 2010-11 public sector wage freeze, which was introduced as an austerity measure by the Italian government. We estimate the level of the gender wage gap as if the wage freeze had not been implemented, applying a counterfactual analysis. We find that the wage freeze accounts for more than 100% of the increase of the wage gap, while other factors in sum reduced the wage gap. The paper also examines the evolution of the gap from 2004 to 2012 using the Oaxaca-Blinder decomposition and a quantile decomposition. The gender wage gap is found to be unexplained by observed characteristics. After 2010 it is particularly high in the upper part of the wage distribution, indicating the existence of a glass ceiling in addition to a sticky floor.

Keywords Gender wage gap · Great recession · Public sector premium · Decomposition · Counterfactual analysis

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10888-018-9396-8) contains supplementary material, which is available to authorized users.

✉ Daniela Piazzalunga
daniela.piazzalunga@univr.it

Maria Laura Di Tommaso
marialaura.ditommaso@unito.it

1 Department of Economics, Università di Verona, via Cantarane, 24, 37129 Verona, Italy

2 CHILD, Collegio Carlo Alberto, Torino, Italy

3 IRVAPP, FBK, Trento, Italy

4 IZA, Bonn, Germany

5 Department of Economics and Statistics "Cognetti de Martiis", Università di Torino, Lungo Dora Siena 100, 10153, Torino, Italy

6 Frisch Center for Economic Research, Oslo, Norway

1 Introduction

The gender wage gap (GWG) in Italy is lower than in other European countries. The unadjusted gender wage gap was 5.5% in 2015, while the European average was 16.3% (Eurostat 2017b). However, while the Italian GWG had been decreasing until 2008, it increased during the economic crisis, when for most European countries decreased over the same period. The GWG is one of the dimensions of gender inequalities in the labour market and it also affects women's lives in different ways: e.g., it influences wealth and pension gender gaps, poverty risks, and bargaining power in the household. Therefore, the Italian decreasing trend until 2008 was an important signal of decreasing gender inequalities and one should pay attention to its trend inversion.

The Great Recession affected Italy through different channels, mainly in the 'real' economy, with a considerable reduction in household income. An overall analysis of the different effects until 2010 is provided by Brandolini et al. (2013), who defined the Great Recession as the "most severe recession experienced by Italy since the Second World War" (p. 130). Brandolini et al. (2013) argue that the crisis started in Italy in the context of a stagnating economy, modest income growth, job insecurity, and a large public debt. It propagated to households mainly through labour market trends, with total employment decreasing between 2008 and 2012, largely due to a reduction in recruitment (see also Banca d'Italia (2012, 2013)). Transitions out of employment also increased, mainly caused by the end of temporary contracts, which were neither replaced nor turned into permanent ones. At the same time, hours worked dropped, not only due to employment decreases, but also to a drop in overtime work and the use of short-time work subsidy schemes.[1] The fall in employment levels was relatively more pronounced among young people, who also had lower probabilities of finding a job, and among men, a pattern found also in the US and in Europe (Sierminska and Takhtamanova 2011; Bettio et al. 2013). In Italy, in 2016, the unemployment rate was still higher for women (12.8%) than for men (10.8%), but the difference has decreased since 2008 (Istat 2017b). Despite the large drop in real disposable income, the Great Recession had limited impact on aggregate income distribution and poverty, with instead substantial differences across different groups.

While the effects of the Great Recession on the labour market have been analysed in previous studies, which also consider differences by gender, less attention has been devoted to the changes in wage rates and especially to the gender wage gap. The gender effects of austerity measures have also been neglected by Italian policy makers. In general, in Italy there is no consideration of gender when evaluating economic policies (Villa and Smith 2010).

In recent years, there has been an increased monitoring of the gender wage gap by the European Union and by international organizations (e.g. Eurostat (2017b)). At the same time, researchers have focused their attention on the reasons behind the persistence of the gap, looking mostly at the US (Blau and Kahn 2017). For Italy, some studies compare the Italian gender pay gap with other European countries (Arulampalam et al. 2007; Nicodemo 2009; Christofides et al. 2013), underling the role played by the low labour market participation (Olivetti and Petrongolo 2008); others link the gender pay gap to educational level (Addabbo and Favaro 2011; Mussida and Picchio 2014a) and to the field of study (Piazzalunga 2018); Del Bono and Vuri (2011) analyse how gender differences in job mobility affect the gender wage gap. Mussida and Picchio (2014b) compare the gender wage gap in

[1] Temporary reduction in working hours - whose income loss is partially compensated by government-financed income support - used to avoid involuntary dismissals.

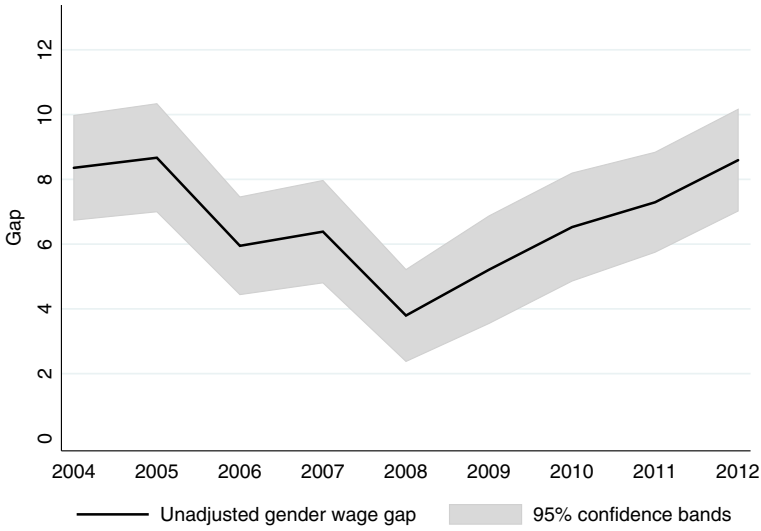

Fig. 1 Gender wage gap in Italy, 2004-12. *Note*: Gross wages per hour in 2008 real price. Source: EU-SILC, own calculations

Italy in the mid-1990s and in the mid-2000s. This study shows that over time the gender gap is pretty stable, but the underlying components change: while improvements in women's qualifications would have reduced the gap, the changes in returns increased it, in particular in the top part of the distribution. To the best of our knowledge, there are no studies about the GWG during the recession. However, the economic crisis could affect the GWG through different channels like structural changes of the labour market or austerity measures, and these channels need to be properly identified to support adequate policies.

To this effect, we study the gender earnings gap in Italy and its change during the 2008-12 economic crisis utilizing the European Union Statistics on Income and Living Conditions (EU-SILC). In particular, we explore the effect of the public sector wage freeze (described in Section 2) on the gender wage gap. Figure 1 shows that the unadjusted gender gap in hourly wages has been decreasing from 8.4% in 2004 to 3.8% in 2008. However, since 2008, the gender wage gap increased steadily, and in 2012 it exceeded the level of 2004 (8.6%).[2]

Our estimation strategy to analyse the GWG consists of two steps. First, we examine the evolution of the GWG during the 2004-2012 period (Section 4), decomposing the GWG into an explained and an unexplained component using the Oaxaca-Blinder methodology, and accounting for self-selection stemming from the low participation rate of Italian women into the labour market. In 2012, female participation rate was 53.4% compared to European Union (28 countries) average of 65.5% (Eurostat 2017a). We show that the GWG is unexplained by observed characteristics. A quantile decomposition analyses the gap along the wage distribution for the years 2008, 2010, and 2012. After 2010, the GWG increases particularly in the upper part of the wage distribution and this change comes mainly from the

[2]Estimations of the GWG from EU-SILC data are not exactly comparable with those provided by Eurostat (2017b), because the latter are based on the Structure of earnings survey (SES) methodology (see http://ec.europa.eu/eurostat/statistics-explained/index.php/Gender_pay_gap_statistics).

unexplained component that in 2012 has a U-shape, indicating the existence of a sticky floor and a glass ceiling. The higher GWG in the upper part of the distribution indicates that the increase in the GWG is driven by high-wage individuals, who probably are those employed in the public sector, where wages are higher.

Secondly, we run a counterfactual analysis to assess the effect of the 2010-11 wage freeze in the public sector (Section 5). We estimate what the GWG would have been if the wage freeze had not been implemented, keeping the public sector premium constant at the pre-policy level, and we compare such counterfactual wage gap with the real one. We find that the 2010-11 public sector wage freeze had a major role in the increase of the GWG. We also analyse some of the changes within the public sector looking particularly at education (Section 6). The main contribution of the paper is to show that the austerity measures and in particular the freeze in public sector wages has been one of the major causes of the increase of the GWG in Italy during the economic crisis. This is due to different aspects of the gender structure of the labour force. First, around 35% of employed women work in the public sector compared to 23% of men. Second, the GWG increased also within the public sector, because real wages decreased more for the public education sector where the large majority of employees are women (75%).

Our findings imply that public policies should be designed taking into account possible different effects by gender.

2 Austerity measures and the public sector wages

The economic crisis hit Italy and Europe at the end of 2008, and continued after 2011 with the sovereign debt crisis. Italy adopted different austerity measures in successive waves, many of them devoted to reducing public spending, affecting the public sector employment levels and wages (Bordogna 2013; Figari and Fiorio 2015).

From 2008, three main types of provisions were enforced (Bordogna and Neri 2012): cuts in the number of public employees through very tight replacement ratios; reform of the pension system (both for private and public employees); and measures to limit the wages of public employees.

As far as the reduction in public employees, for 2009 the replacement ratio was established at 10% of the number of retired persons in the previous year, and at 20% for the years 2010-2014. Temporary employment was also reduced.

The pension system was reformed in 2012: the retirement age for 'old-age pension'[3] for female public employees has been increased to 66; the standard pensionable age for all employees has been linked to changes in life expectancies with a first adjustment in 2013; the value of pensions has been reduced, shifting all the employees (private and public) from an earnings-related to a contributions-related system (for further details see Bordogna and Neri (2012)).

In this paper, we focus on the effects of the wage freeze in the public sector. Collective negotiations at national level were abolished by the decree law n.78/2010 of May 2010.[4] In addition, this law prevents individual wages to increase above the level of 2010, even if due

[3]That is, pension accessed on the basis of worker's age (instead that of the number of years of contribution - 'seniority pension').

[4]The government decree became law n.122 of 2010 and it was implemented since January 2011.

to promotions or seniority, with the partial exception of the component linked to merit or performance pay. These measures were later extended until the end of 2014.

Financial constraints introduced by the national government meant also, *de facto*, a freeze in wages negotiations at the local level. Rules were also adopted preventing any salary increase due to seniority or career promotion for non-contractualized personnel (such as prefects, university professors, police and armed forces, judges).

With the same law, the end-of-service allowance for all public employees was reduced significantly from January 2011. Other measures approved in 2010 include a sizeable cut in training expenditure (no more than 50% of the 2009 level). Detailed spending review procedures were also promoted under the Monti government, in charge over November 2011-April 2013.

Moreover, according to Bordogna and Neri (2012, p.15) 'most of these measures have been unilaterally adopted by the government, without previous negotiations with trade unions and without searching union consent; in some cases, explicitly against trade union protests'.

These measures substantially froze public wages at the level of 2010, without the possibility of recovering the losses at the end of the period, and also with effects on future pension payments. In addition, there were wage cuts for higher level salaries, by 5% for those with a yearly gross wage between 90,000 euro and 150,000 euro, and by 10% for the part exceeding 150,000 euro (Tronti 2011; Bordogna and Neri 2012).[5]

Among employees at public schools and universities, automatic seniority wage increases were cancelled (such increases were already abolished in the rest of the public sector at the end of the 90's).

Overall, these measures caused a decrease in the total pay bill of public employees from 11% of the GDP in 2009 (169 billion euro) to 10% in 2012 (160 billion euro). As a result of these measures, between 2010 and 2012 public sector real hourly wages decreased on average by 8.8%.[6] Women's hourly wages decreased by 11.3% from 2010 to 2012, while they decreased by 5.6% for men (see Fig. 2).

In June 2015, the Italian Constitutional Court declared that the public sector wage freeze was not legitimate. The decision affected only future wage bargaining, and will not compensate public employees for previous losses (January 2011-June 2015).

3 Data and descriptive statistics

The analysis is based on the Italian sample of EU-SILC (European Union Statistics on Income and Living Conditions) for 2004-12.[7] In the full sample there are about

[5] In our data, 99.5% of men earn less than 90,000 euro per year, and only the 0.03% earn more than 150,000 euro. 99.9% of women earn less than 90,000 euro and none earn more than 150,000 euro. Hence, only a very small percentage of people in our sample is concerned by those cuts. Still, if anything, they should have reduced the gender wage gap, since more men than women have top wages.

[6] As a term of comparison, in the same period, real wages in the private sector decreased by 0.9%.

[7] One of the best dataset to conduct labour market analysis is the Italian Labour Force Survey (LFS), but it does not provide good information to evaluate wages: monthly wages in LFS are truncated from below at 250 euro and from above at 3,000 euro. To analyse the gender pay gap it is essential to have the whole distribution of wages and in particular the top ones.

Alternatively, Eurostat (2017b) uses the Structure of earnings (SES) survey. However, SES data are available only for (1995), 2002, 2006, 2010, thus the last wave available is before the wage freeze. Moreover, with data available only every four years, it is difficult to identify the entire trend. Finally, before 2010, NACE (Nomenclature statistique des activités économiques dans la Communauté européenne) sector O (Public administration and defence) was not included.

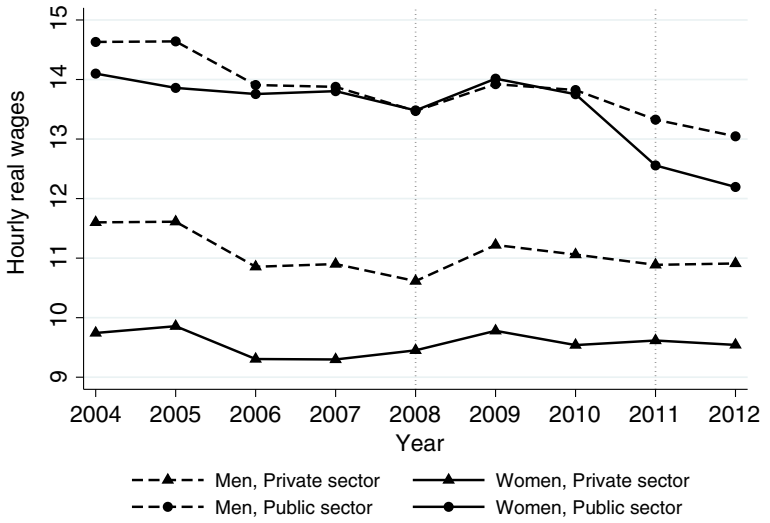

Fig. 2 Hourly wages: public and private sector, by gender, 2004-12. *Note*: Gross wages per hour in 2008 real price. The dotted vertical lines refer to the beginning of the economic crisis (2008) and to the implementation of the wage freeze (2011). Source: EU-SILC, own calculations

40,000–50,000 observations per year. We select 25–55 year old[8] employees, with Italian citizenship. The gender wage gap for foreigners is different from natives (see, for instance, Piazzalunga (2015) for an analysis of the gender wage gap among immigrants in Italy); moreover, non-Italian citizens cannot work in the public sector. We exclude individuals who are inactive, unemployed, retired, self-employed, or family workers. We also lose about 300 observations per year because the wage is missing. The final number of observations ranges between 14,429 (2004) and 9,778 (2012). Table A.1 in the Online Appendix[9] provides the detailed definitions of all dependent and control variables. Table B.1 summarizes the selection procedure[10] and descriptive statistics are shown in Tables B.2 and B.3.

When we take into account self-selection in participation, using the Heckman procedure (Heckman 1974), the sample is larger, including 25–55 year old employed, unemployed and non-employed people. We still exclude self-employed and employed people with no information about wages. The total number of observations ranges between 21,359 (2004) and 14,167 (2012).

The main dependent variable is the (log) hourly wage, which is the gross monthly wage divided by the number of hours usually worked per month - included normal overtime - and

[8]Using different age groups (e.g. 20-65) yields very similar results.

[9]Appendices are divided in A, B, C, D, and E. The first letter of each Table' or Figure's reference indicates in which Appendix it is included.

[10]As can be seen from Table B.1 the total number of observations decreased in the full sample available from EU-SILC (first columns), and thus also in the sample that we use. Thus, comparing the number of observations in each year in the analysis could be misleading.

it refers to the year of the survey. All wages are expressed in 2008 real prices.[11] Table A.2, which presents descriptive statistics on selected variables, shows that real wages per month and per hour decreased between 2004 and 2008 and then again between 2009 and 2012, due to the timing of collective bargaining and contracts and to price trends.[12] Hourly wages were stable between 2008 and 2012 in the private sector for both men and women and decreasing after 2010 in the public sector, more for women than for men (see Fig. 2 above).

Between 2008 and 2012, the distribution of wages for men did not change, while it changed for women, decreasing in the upper part of the distribution (Fig. B.1 in the Appendix). The decrease of female wages in the upper part of the distribution is driven by women employed in the public sector, affected by the wage freeze of 2011. Indeed, more women than men are employed in the public sector (respectively about 35% of employed women work in the public sector, compared to 23% of men). When we consider only people employed in the public sector, the cumulative distribution functions show that between 2008 and 2012 wages in the upper part of the distribution have been falling among both men and women, but the fall was larger for women (Fig. B.2).

Female employment has been quite stable between 2008 and 2012, while male employment decreased from 84% to 80% (Table A.2). Hours worked appear rather stable in the aggregated sample. This stability masks a decrease among men and women employed in the private sector, compensated by an increase for both men and women employed in the public sector.

The change in the composition of the labour force is one of the possible reasons suggested as a cause of the increase in the Italian gender wage gap (see, for instance, Bettio (2013)), because previously inactive women may enter into the labour market to compensate for the job loss of their partner (the so-called added worker effect). These women are likely to have low wages. The gender wage gap may also change due to composition effects if mainly low-paid men lost their job during the crisis. These changes could also lead to some concerns about our estimations, because the change of the GWG during the economic crisis would be driven by changes in the structure of the labour force.

During 2008-2012, the main differences in the average characteristics of working people are the increase in average age (and consequently in experience) and in the level of education (Table A.2). The same patterns are also evident in the total population aged 25–55, which means that they mainly reflect the ageing of the population and its increasing education level. However, workers are ageing faster than the general population. In the total population, individuals in 2012 are on average 1.5 years older than in 2004, while among employed people they are about 2 years older. Nonetheless, both in the total population and among employed people the trend has not changed since 2004. Hence, it seems that older people - both men and women - have been slightly more likely to be employed than younger ones in the past decade, both before and during the economic crisis. The same is true when looking at the private and public sector separately.

Another possible change could come from increase in emigration during the crisis. Nevertheless, Italians migrating abroad accounted only for 0.2% of the employed in 2008 and

[11] We chose 2008 because it is the middle year of the period under analysis (2004–2012) and also at the beginning of the economic crisis. Using a different base would not change the results, as it is just a change in the scale.

[12] Full tables with descriptive statistics by gender for employed and non working individuals (Heckman sample), for employed individuals (main sample), for employees in the private and in the public sector are reported in Appendix B.

increased to 0.3% in 2012 (Istat 2017a). These percentages are too small to affect the structural characteristics of the employed.

The above evidence suggests that, even though a (small) added worker effect took place (Bredtmann et al. 2017; Ghignoni and Verashchagina 2014) and more men than women lost their jobs (Table A.2), these changes have not affected the average characteristics of the stock of working individuals. Nevertheless, in the paper we also present results corrected for self-selection into the labour market.

4 Long-term changes in the gender wage gap

The main focus of the paper is to analyse the impact of the public sector wage freeze on the increase of the GWG presented in Section 5. However, as a first step it is important to describe the long-term changes of the GWG and its distribution. Therefore we apply the Oaxaca-Blinder decomposition of the gender wage gap to analyse changes in the explained component, based on observed characteristics, and in the unexplained residual component. Then, we apply a quantile decomposition to study the changes of the gender wage gap over the wage distribution.

4.1 Oaxaca-Blinder decomposition

We first estimate the following linear wage equation, separately for men (m) and women (f):

$$\ln W_g^t = \beta_g^t X_g^t + v_g^t = \delta_g^t Z_g^t + \gamma_g^t PUBLIC_g^t + e_g^t \tag{1}$$

where $t = 2004, 2005, ..., 2012$ and $g = \{m, f\}$.

The dependent variable is the log hourly wage (W_g^t), X_g^t is the vector of observable characteristics (age, age squared, experience, experience squared, region of residence, marital status, level of education, sector of employment (NACE), position, public sector, part-time job),[13] β_g^t are the coefficients to be estimated with OLS and v_g^t is a stochastic term. In the second part of (1), we isolate the coefficient associated with working in the public sector γ_g^t (i.e. 'public sector premium'), where $PUBLIC$ is a dummy equal 1 if the person works in the public sector, and Z_g^t are the remaining controls.

One issue that can arise is self-selection into the labour market. Indeed, it is widely recognized that the gender wage gap in Italy is also affected by the low participation of women in the labour market (Olivetti and Petrongolo 2008). Once that is taken into account, the gender wage gap is usually larger. Moreover, during the economic crisis the participation of women may change because of the added worker effect. We apply the Heckman-correction to account for self-selection into the labour market (Heckman 1974), including in the selection equation the number of children as an exclusion restriction (also controlling for age, region of residence, marital status, and level of education).

A similar issue should be considered with respect to the public sector (e.g. Depalo et al. (2015)). Employed individuals may select themselves into the private or the public sector, depending on unobserved characteristics or preferences. However, for the purpose of our analysis, we do not correct for self-selection into the two sectors: unfortunately, in our data

[13] We also controlled for the type of contract (i.e. temporary contracts) in an alternative specification, and the results do not change.

there is no useful information which may predict such a choice, and which does not affect wages.[14] For this reason, we should be cautious with the interpretation of the public sector premium in our results: in particular, it should not be read in causal terms. However, our interest is not in the causal interpretation of the public sector premium, but on its change, especially over the 2008-12 period. In order for our estimates to be reliable, we need to assume that self-selection in the public sector did not change over the 2008-12 period. This assumption is reliable with respect to the entrance into the public sector: hiring in the public sector was basically frozen during the economic crisis. On the other hand, a discussion is needed with respect to the exit from the public sector. It is unlikely that people simply resign, to stay at home or to go to the private sector (the private sector was also not hiring). Instead, it is possible that the incentive to retire changed over the period: to eliminate this risk, we focus on individuals aged 25-55, who cannot retire.

Another issue - which may affect the gender wage gap - is that the characteristics of people losing their job (and in particular men) may not be random. We have shown in the descriptive statistics (Section 3) that this last issue is not a problem because the average characteristics of the labour force did not change between 2008 and 2012.

To analyse the evolution of the gender wage gap during the economic crisis, we start applying the standard Oaxaca-Blinder decomposition (see Oaxaca (1973) and Blinder (1973)), which divides the wage gap into an explained component based on observed characteristics and an unexplained residual component.

The Oaxaca-Blinder is given by:

$$\begin{aligned} GWG^t &= \overline{\ln W}^t_m - \overline{\ln W}^t_f \\ &= (\overline{X}^t_m - \overline{X}^t_f)\hat{\beta}^t_m + \overline{X}^t_f(\hat{\beta}^t_m - \hat{\beta}^t_f) \end{aligned} \tag{2}$$

The first term refers to differences in characteristics (explained component), while the second term is the so-called unexplained component, due to differences in returns. We use the coefficients for males, $\hat{\beta}^t_m$, as benchmarks, to have results comparable with the Heckman-corrected ones and with the quantile decomposition.[15]

When we apply the Heckman-correction, we decompose the observed gender wage gap into an explained, an unexplained, and a selection component, following Neuman and Oaxaca (2003). The value of the selection component can be added to the gender gap to provide an estimate of the gender gap corrected for self-selection.

Table 1 shows the Oaxaca-Blinder decomposition of the gender wage gap for the period 2004-12.[16] The gap in Italy is quite small compared to other European countries (Eurostat 2017b), and observable characteristics indicate that there should be a gap in favour of women. The unexplained component decreases between 2004 and 2008 and increases from 2008 to 2009. After 2009, it is large and mostly stable (between 11% and 12%).

The explained component is negative: the difference in characteristics between men and women favours women, contributing to the reduction of the gender wage gap. It increases

[14] The most common variables used in the literature are if the parents worked in the public sector, which is not available in the data, or the number of children, which however we use already to explain participation.

[15] We also performed the decomposition using coefficients from the pooled regression (including both men and women in the sample, and a dummy for sex among the control variables) or $\hat{\beta}^t_f$ as the benchmark coefficients. Results are very similar (the unexplained component is usually larger in the last case) and are available from the authors upon request.

[16] All underlying wage equations are presented in Appendix C.

Table 1 Oaxaca-Blinder decomposition of the gender wage gap (GWG), 2004-12

Variable	2004	2005	2006	2007	2008	2009	2010	2011	2012
Men	2.41***	2.43***	2.37***	2.38***	2.35***	2.40***	2.38***	2.36***	2.35***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Women	2.33***	2.34***	2.30***	2.30***	2.30***	2.33***	2.31***	2.28***	2.27***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
GWG	**0.09*** **	**0.09*** **	**0.07*** **	**0.08*** **	**0.05*** **	**0.06*** **	**0.07*** **	**0.08*** **	**0.08*** **
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Standard Oaxaca-Blinder decomposition									
Expl.	−0.03***	−0.02***	−0.03***	−0.02***	−0.03***	−0.06***	−0.04***	−0.04***	−0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unexpl.	0.12***	0.11***	0.10***	0.09***	0.08***	0.12***	0.11***	0.12***	0.12***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Heckman corrected Oaxaca-Blinder decomposition									
Expl.	−0.03***	−0.02***	−0.03***	−0.02***	−0.03***	−0.06***	−0.04***	−0.04***	−0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unexpl.	0.13***	0.15***	0.13***	0.12***	0.09***	0.15***	0.14***	0.14***	0.12***
	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Selection	−0.02	−0.04	−0.02	−0.02*	−0.02	−0.03	−0.03*	−0.02	−0.00
	(0.02)	(0.03)	(0.02)	(0.01)	(0.03)	(0.03)	(0.02)	(0.02)	(0.04)
Men obs.	8,043	7,113	6,862	6,593	6,451	6,081	5,671	5,359	5,256
Women obs.	6,386	5,638	5,540	5,344	5,256	4,970	4,665	4,740	4,522

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Robust standard errors in parenthesis. Controlling for age, experience, region of residence, marital status, level of education, sector of employment (NACE), position, part-time job, public sector. Selection equation: controlling for age, region of residence, marital status, level of education, number of children aged 0-2, 3-5, 6-10, and 11-14. Log wages in 2008 real prices. Benchmark coefficients: Male coefficients, shown in Tables C.3 and C.5. Results with different benchmark coefficients are similar (the unexplained component is larger with female coefficients as benchmark). Available from the authors upon request. Source: EU-SILC, own calculations

in absolute terms between 2008 and 2009, counterbalancing the increase in the unexplained gap in this period. After 2009, the explained component decreases in absolute terms, contributing to the increase of the total gap. Since the explained gap is equal to the difference in characteristics multiplied by the benchmark coefficients, it may change also if the difference in characteristics remains stable, but the male coefficients change. This is what could have happened in Italy. Working in the public sector is associated with higher wages (see Tables C.2 and C.3) and more women than men are employed in the public sector. The difference in the percentage of men and women who are public sector employees remains stable, but the return decreases in 2011 and in 2012, reducing the explained gap.

The last part of Table 1 presents the results of the decomposition taking into account self-selection. As expected, taking into account self-selection increases the wage gap: working women in Italy are positively selected. The gap due to differences in characteristics is the same as in the standard Oaxaca-Blinder decomposition. On the other hand, the term due to differences in returns is larger, partially reduced by the explained component and partially by selection. The overall trend is very similar to the one in the previous decomposition.

Until now, we used hourly wages. An alternative is to use monthly wages, that take into account also working hours. Working hours increased in the public sector, both for men and for women in 2011 and 2012 (see Table A.2). This can be a consequence of austerity measures, which have introduced tight replacement ratios in terms of public employees, increasing the workload. Repeating the above analysis for monthly wages (Appendix D), we find that the gender gap in monthly wages is much higher (0.25 compared to 0.05 for hourly wages in 2008); the trend indicates that the overall gap decreases until 2009, and then it increases again. In the case of monthly wages, the explained component is much more relevant than in the hourly wages decomposition, because it includes different working schedule for men and women (part-time vs. full-time).

Given the focus of the paper and the different structure of public and private wages, we also present the results of the Oaxaca-Blinder decomposition for the two sectors separately (Table 2).[17] The gender wage gap is much larger in the private sector (12–16%); in the public sector, for most years it is zero. In both cases, it is entirely due to the unexplained component. The increase of the gap between 2008 and 2009 is due to the private sector, while between 2010 and 2011 there is a substantial increase in the public sector, from 0 to 5.8%. This jump suggests that austerity measures, introduced in 2010 and effective since 2011, played a major role. Sections 5 and 6 analyse these changes in detail.

4.2 Quantile decomposition

We then apply a quantile decomposition to analyse the changes of the gender pay gap at different points of the wage distribution, following the methodology proposed by Chernozhukov et al. (2013).

In order to extend the Oaxaca-Blinder procedures to the entire wage distribution, one needs to know the entire male, female, and counterfactual unconditional distribution of wages $F_W(w)$, for each quantile τ.

$F_{W\langle m|m\rangle}$ represents the actual distribution of wages W for men (unconditional), and $F_{W\langle f|f\rangle}$ for women. $F_{W_g|X_g}(w|x)$ is the conditional distribution of wages given the individual characteristics X_g, and $F_{X_g}(x)$ represents the distribution of characteristics, with $g = \{m, f\}$ (male and female respectively).

The counterfactual distribution of interests $F_{W\langle m|f\rangle}$ is the unconditional distribution of wages for women if they had faced the wage structure of men:[18]

$$F_{W\langle m|f\rangle}(w) = \int_{x_f} F_{W_m|X_m}(w|x) dF_{X_f}(x) \tag{3}$$

The above distribution is not observed: it is constructed by integrating the conditional distribution of wages for men ($F_{W_m|X_m}(w|x)$) with respect to the distribution of characteristics for women ($F_{X_f}(x)$).

[17] In this case, the estimated wage equations do not include any correction for self-selection from non-employment into work. We could estimate the wage equations for public and private including the inverse Mill's ratio estimated on the full sample of employed and not employed individuals (see Tables C.4 and C.5). However this procedure would not really take into consideration the self-selection from non-employment into public or private sector, because the first step of the Heckman procedure that estimates the lambda would be the same.

[18] The non-discriminatory coefficients for the quantile decomposition à la Chernozhukov et al. (2013) are male coefficients; the counterfactual distribution shown in (3) corresponds to the counterfactual $X_f\beta_m$ in the standard Oaxaca-Blinder decomposition, where male coefficients are used as benchmark.

Table 2 Oaxaca-Blinder decomposition of the gender wage gap, public and private sectors, 2004-12

Variable	2004	2005	2006	2007	2008	2009	2010	2011	2012
Public sector									
Men	2.59***	2.61***	2.56***	2.55***	2.53***	2.56***	2.56***	2.52***	2.50***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Women	2.57***	2.56***	2.55***	2.55***	2.53***	2.57***	2.55***	2.47***	2.45***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
GWG	**0.02***	**0.05*****	**0.01**	**–0.00**	**–0.00**	**–0.01**	**0.00**	**0.05*****	**0.05*****
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Explained	− 0.02	− 0.03**	− 0.04***	− 0.04***	− 0.04***	− 0.07***	− 0.05***	− 0.02	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Unexplained	0.04***	0.07***	0.05***	0.03*	0.03**	0.06***	0.05***	0.07***	0.05***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Men obs.	1,945	1,747	1,703	1,616	1,480	1,420	1,269	1,206	1,134
Women obs.	2,287	2,011	2,012	1,885	1,814	1,707	1,524	1,589	1,452
Private sector									
Men	2.35***	2.37***	2.31***	2.32***	2.30***	2.35***	2.33***	2.31***	2.31***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Women	2.19***	2.21***	2.16***	2.16***	2.18***	2.21***	2.19***	2.19***	2.18***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
GWG	**0.16*****	**0.15*****	**0.15*****	**0.16*****	**0.12*****	**0.14*****	**0.14*****	**0.12*****	**0.13*****
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Explained	0.00	0.01	− 0.00	0.02*	− 0.00	− 0.01	− 0.01	− 0.02	− 0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unexplained	0.16***	0.14***	0.15***	0.14***	0.12***	0.15***	0.15***	0.14***	0.15***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Men obs.	6,098	5,366	5,159	4,977	4,971	4,661	4,402	4,153	4,122
Women obs.	4,099	3,627	3,528	3,459	3,442	3,263	3,141	3,151	3,070

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Robust standard errors in parenthesis. Controlling for age, experience, region of residence, marital status, level of education, sector of employment (NACE), position, part-time job, public sector. Log wages in 2008 real prices. Benchmark coefficients: Male coefficients, shown in Table C.8 (public sector) and Table C.11 (private sector). Results with different benchmark coefficients are similar (the unexplained component is larger with female coefficients as benchmark). Available from the authors upon request. Source: EU-SILC, own calculations

Different approaches have been proposed to estimate the counterfactual distribution. We follow Chernozhukov et al. (2013), who estimate the conditional distribution of the outcome variable $F_{W|X}$ using a quantile regression[19] (Koenker and Bassett 1978): $Q_{W|X}(\tau) = X\beta_\tau$, where $Q_{W|X}(\tau) = F^{-1}_{W|X}(\tau)$ is the τ^{th} quantile of W conditionally on X.[20]

[19] Alternatively, Chernozhukov et al. (2013) suggest to use distribution regression methods.

[20] Similarly, the (unconditional) quantile function is defined as the inverse of the distribution function: $Q_\tau(W) = F^{-1}_W(\tau)$.

β_τ is estimated by minimizing the following expression:

$$\hat{\beta}_\tau = \underset{\beta}{\operatorname{argmin}} \left(\frac{1}{N} \sum_{i=1}^{N} (w_i - x_i\beta)(\tau - \mathbf{1}(w_i \leq x_i\beta)) \right) \tag{4}$$

where N is the total number of observations in the sample, and $\mathbf{1}(\cdot)$ is the indicator function. The covariate distribution is estimated with the empirical distribution function. The estimator for the unconditional counterfactual distribution is obtained by the plug-in-rule, integrating the estimator for conditional distribution function (estimated with quantile regression) with respect to an estimator of the covariate distribution function (estimated with the empirical distribution function). Once the counterfactual distribution has been obtained, counterfactual quantiles can be calculated by inverting the estimated distribution function.

Then, the overall difference in wages can be decomposed similarly to the traditional Oaxaca-Blinder decomposition as follows:

$$F_{Y\langle m|m\rangle} - F_{Y\langle f|f\rangle} = [F_{Y\langle m|m\rangle} - F_{Y\langle m|f\rangle}] + [F_{Y\langle m|f\rangle} - F_{Y\langle f|f\rangle}] \tag{5}$$

The first term is the difference due to the wage structure (or differences in returns) and the second term is the difference due to characteristics.

Figure 3 shows the results of the quantile decomposition. It reveals some additional features of the gender wage gap in Italy and its evolution during the crisis. In 2008, the total GWG is decreasing along the wage distribution (from 13% to 0.7%).[21] The unexplained component accounts for more than 100%, and it is larger at the bottom of the distribution, indicating the existence of a sticky floor (Christofides et al. 2013). Both the total gender wage gap and the unexplained component widen in 2010, but their patterns along the wage distribution remain the same as in 2008. Thus, the growth of the GWG between 2008 and 2010 concerns all the working population, even though it is slightly larger for the middle and the top of the wage distribution.

In 2012, instead, the gender wage gap has a U-shape, and it is larger at the bottom (13.5%) and at the top of the wage distribution (11.6%). The total gap changes between 2010 and 2012 in the upper part of the wage distribution, in particular for individuals above the 60th percentile. At the top of the wage distribution, the total gap increases from 0.7% in 2008, to 4.2% in 2010 and to 11.6% in 2012. Looking at the differences between the explained and unexplained component in these three years, we note that change in the total gap comes mainly from changes in the unexplained component. In fact, in 2012, the unexplained component also increases in the upper part of the wage distribution, and has a U-shape, indicating the existence of both a sticky floor and a glass ceiling, but while the sticky floor is already present in 2008 and 2010, the glass ceiling emerges in 2012. Hence, the increase of the gender gap for high-income individuals is partially driven by changes in the wage structure. The shape of the explained component is constant between 2008, 2010 and 2012. There a is a small decrease in absolute value between 2010 and 2012. This is due to changes in the characteristics of the labour force, like for instance an higher increase in male education than in female education.

The increase of the GWG for high-income individuals may suggest that it concerns mainly women working in the public sector. Indeed, public sector wages are higher than private ones, particularly for women.

[21] In line with what has been found in the 1995-2001 period by Arulampalam et al. (2007) and in 2007 by Christofides et al. (2013).

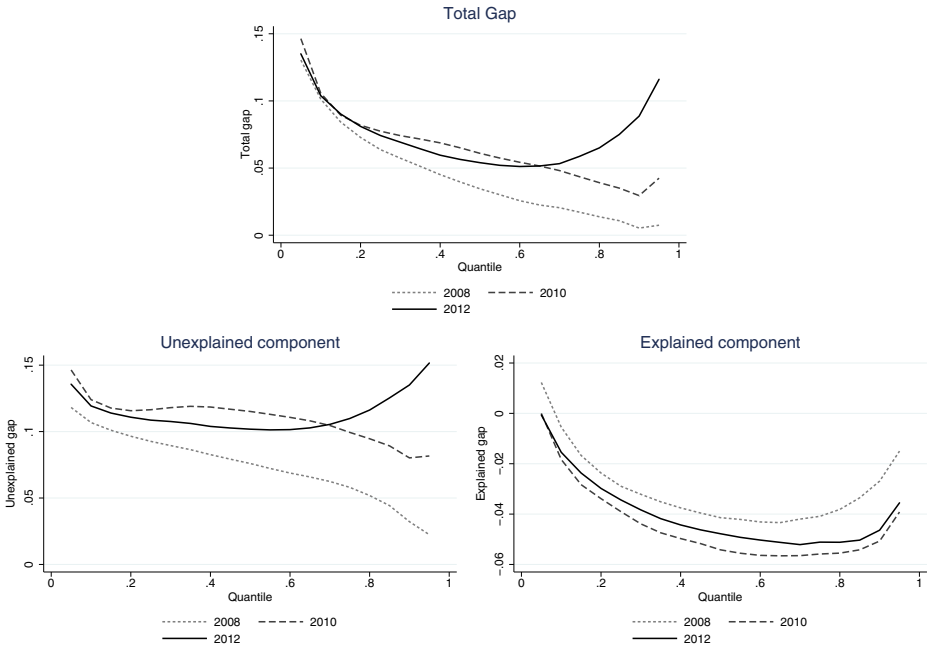

Fig. 3 Quantile decomposition, 2008, 2010, and 2012. *Note*: Log wages in 2008 real price. Source: EU-SILC, own calculations

5 Impact of the wage freeze

This section explores the impact of the wage freeze in the public sector on the gender wage gap. In the following, we argue that the 2011-12 increase of the GWG is a consequence of the wage freeze in the public sector.

Figure 2 above (see Section 2) shows that hourly wages in the public sector are higher than in the private sector and that public sector wages decreased after 2010. Looking at the estimates of the wage equations,[22] *ceteris paribus*, working in the public sector is associated with higher wages: in 2010 wages in the public sector were 15% higher than in the private sector. In particular for women, until 2010, the public sector premium was about 20%, while for men it was slightly less than 10%. Figure 4 summarizes these parameters for the pooled sample of men and women, and for men and women separately.

The public sector premium decreased from 0.15 in 2010 to 0.11 in 2011 (statistically significant drop) and to 0.09 in 2012.[23] For women, the coefficient associated with working in the public sector decreased from 0.21 to 0.14 (statistically different at 1%) between 2010 and 2011, and for men from 0.09 to 0.07 (not significant). These estimates are robust to the correction for participation into the labour market (Tables C.4 and C.5 show the Heckman-corrected results for women and men separately).

[22] See Tables C.1, C.2 and C.3 in the Appendix.

[23] Since the wage freeze continued, one might expect the coefficient to fall also in the subsequent years.

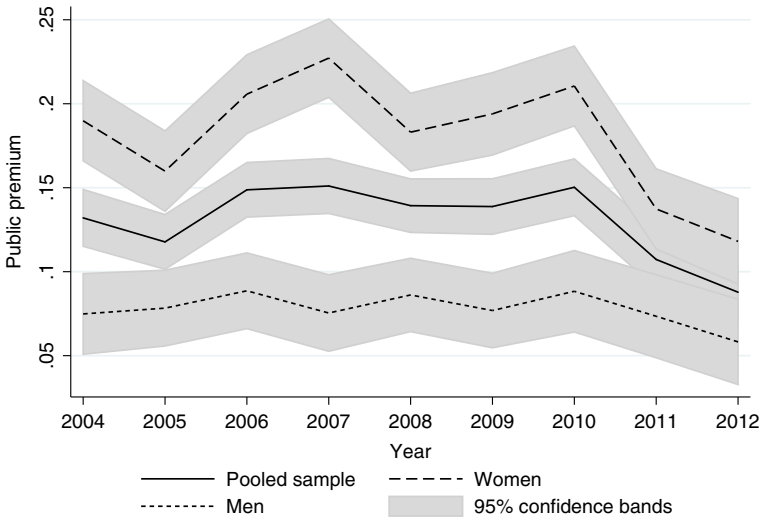

Fig. 4 Public sector premium, 2004-12. *Note*: Parameters of public sector dummy in the wage equations. See Tables C.1, C.2, and C.3 in the Appendix. Source: EU-SILC, own calculations

We cannot give a causal interpretation of the coefficient associated with being a woman in the pooled regression, or of those associated with the public sector variable, because of the self-selection of men and women into the public or private sector and because we cannot exclude omitted variable bias. However, they indicate that the increase in the gender wage gap was partially driven by the wage freeze. Indeed, being a woman is associated with a reduction in wages of about 11-12%, stable after 2009. On the other hand, there is an important reduction of the premium for working in the public sector in 2011, mainly for women.

Having observed the discontinuity in the public sector premium, we now turn to analyse if and how it affected the gender wage gap. As described in Section 2 above, the law was approved in 2010 and was implemented in January 2011: thus, we compare 2009 (pre-policy period) and 2011 (post-policy period).

We use the same sample described above, except for the age group. Instead of using a sample of people 25–55 years old, in both period we select people born between 1954 and 1984, thus 25–55 years old in 2009 and 27–57 years old in 2011. In this way, not only we reduce the risk of different propensity to retire (see Section 4.1), but we focus on a sample drawn from exactly the same population.

We first apply an extension of the Oaxaca-Blinder decomposition, which accounts for changes over time. This methodology estimates how much of the change in the gender wage gap is due to changes in individual characteristics of employed men and women, and how much can be imputed to changes in the wage structures. Details about the methodology and results are presented in Appendix E. For both men and women, the decrease in real wages between 2009 and 2011 is entirely due to changes in the wage structures. This is not surprising, considering the descriptive statistics previously shown; indeed, it would take some time to change the average characteristics of the stock of working people. As a consequence, the increase in the gender wage gap of about 1% (from 6.3 to 7.5%) can be entirely attributed to

the changes in the wage structures of both men and women. Taking into account selection yields very similar results, also in the Appendix.

The 'extended' decomposition divides the change in the gap between 2009 and 2011 in changes in the individual characteristics and changes in the returns. However, it does not provide information about the effect of the wage freeze itself. In order to evaluate the direct impact of the wage freeze, we estimate the counterfactual wages for men and female as if the wage freeze had never happened.

The gender wage gap at time t is:

$$\begin{aligned} GWG_{t,\gamma_t} &= \overline{\ln W}^t_m - \overline{\ln W}^t_f \\ &= (\widehat{\delta}^t_m \bar{Z}^t_m + \widehat{\gamma}^t_m PU\bar{B}LIC^t_m) - (\widehat{\delta}^t_f \bar{Z}^t_f + \widehat{\gamma}^t_f PU\bar{B}LIC^t_f) \end{aligned} \tag{6}$$

Again, we focus only on $t \in \{2009, 2011\}$.

We can estimate two counterfactual gender wage gaps. The first one is the counterfactual gender wage gap in 2009, as if the public premium was the one of 2011, i.e. nothing else changed, only the return for working in the public sector:

$$\begin{aligned} GWG_{09,\gamma_{11}} &= \overline{\ln W}^{09}_m - \overline{\ln W}^{09}_f \\ &= (\widehat{\delta}^{09}_m \bar{Z}^{09}_m + \widehat{\gamma}^{11}_m PU\bar{B}LIC^{09}_m) - (\widehat{\delta}^{09}_f \bar{Z}^{09}_f + \widehat{\gamma}^{11}_f PU\bar{B}LIC^{09}_f) \end{aligned} \tag{7}$$

$GWG_{09,\gamma_{11}}$ can be interpreted as the gender wage gap that we would have observed with the distribution of characteristics Z of 2009, return to characteristics of 2009 (wage structure), distribution of people into the public and private sector of 2009, and public premium $\widehat{\gamma}_g$ of 2011.[24] We interpret the public premium of 2011 as a consequence of the wage freeze in the public sector, since nothing else, which could have affected it, changed between 2009 and 2011.

The second counterfactual is the gender wage gap in 2011, if the public premium was the one of 2009:

$$\begin{aligned} GWG_{11,\gamma_{09}} &= \overline{\ln W}^{11}_m - \overline{\ln W}^{11}_f \\ &= (\widehat{\delta}^{11}_m \bar{Z}^{11}_m + \widehat{\gamma}^{09}_m PU\bar{B}LIC^{11}_m) - (\widehat{\delta}^{11}_f \bar{Z}^{11}_f + \widehat{\gamma}^{09}_f PU\bar{B}LIC^{11}_f) \end{aligned} \tag{8}$$

$GWG_{11,\gamma_{09}}$ is the counterfactual gender wage gap that we would have observed with the distribution of characteristics Z of 2011, return to characteristics of 2011 (wage structure), distribution of people into the public and private sector of 2011, and public premium $\widehat{\gamma}_g$ of 2009 (i.e. in the absence of the wage freeze).

Given these counterfactuals, we can decompose the change in the gender wage gap between 2009 and 2011 in a 'policy effect' and 'other effects'. The 'policy effect' denotes the part of the gender wage gap due to changes in the public sector premium (the wage freeze in public sector). Considering the first counterfactual gender wage gap, the 'policy effect' corresponds to the difference between the actual gender wage gap in 2009 ((6) for 2009) and the counterfactual gender wage gap, where only the public premium has changed (7). 'Other effects' refer to the change in the gender wage gap due to everything else, i.e. changes in the characteristics and in the coefficients, except the public sector premium. Using the first counterfactual, it corresponds to the difference between actual gender wage gap in 2011 ((6) for 2011) and the counterfactual gender wage gap (7).

[24] Estimated separately for men and women.

Hence, considering the first counterfactual (from (7)), the decomposition is the following:

$$\begin{aligned}\Delta GWG &= GWG_{11,\gamma_{11}} - GWG_{09,\gamma_{09}} && \text{(total change)}\\ &= (GWG_{11,\gamma_{11}} - GWG_{09,\gamma_{11}}) && \text{(other effects (1))}\\ &\quad +(GWG_{09,\gamma_{11}} - GWG_{09,\gamma_{09}}) && \text{(policy effect (1))}\end{aligned} \tag{9}$$

In the following decomposition we employ the second counterfactual (from (8)):

$$\begin{aligned}\Delta GWG &= (GWG_{11,\gamma_{11}} - GWG_{11,\gamma_{09}}) && \text{(policy effects (2))}\\ &\quad +(GWG_{11,\gamma_{09}} - GWG_{09,\gamma_{09}}) && \text{(other effects (2))}\end{aligned} \tag{10}$$

Finally, since there is no reason to prefer one decomposition against the other one, we calculate the Shapley decomposition suggested by Shorrocks (2013), and estimate the average policy effect (P) and the average effect imputed to other changes (O):

$$\begin{aligned}P &= \frac{1}{2}(GWG_{09,\gamma_{11}} - GWG_{09,\gamma_{09}}) + \frac{1}{2}(GWG_{11,\gamma_{11}} - GWG_{11,\gamma_{09}})\\ O &= \frac{1}{2}(GWG_{11,\gamma_{11}} - GWG_{09,\gamma_{11}}) + \frac{1}{2}(GWG_{11,\gamma_{09}} - GWG_{09,\gamma_{09}})\end{aligned} \tag{11}$$

This analysis is also replicated taking into account selection. In this case, $GWG_{09,\gamma_{09}}$ and $GWG_{11,\gamma_{11}}$ represent the gender wage gaps estimated for 2009 and in 2011 using the predicted wages with Heckman-corrections. Similarly, the corrected coefficients are used to estimate the counterfactual wage gaps in (7) and (8).

Table 3 and 4 show, respectively, the counterfactual simulation - which allows us to isolate the impact of the wage freeze - and the related decomposition into 'policy effect' and 'other effects'.

Table 3 presents the actual wage gaps in 2009 (6.3%) and in 2011 (7.5%), and the estimates of two counterfactuals, constructed as discussed above. $GWG_{09,\gamma_{11}}$ is the gender wage gap that we would have observed in 2009 if the coefficient associated for working in the public sector was the same of 2011: $GWG_{09,\gamma_{11}}$ is estimated to be 8.4% (Table 3), larger and significantly different (at 1%) from $GWG_{09,\gamma_{09}}$, the actual gender wage gap in 2009. Since we keep constant the individual characteristics, the rest of the wage structure, and the proportion of people working in the public sector, the difference of 2% among the two wage gaps is entirely due to the wage freeze (Table 4).

The second counterfactual, $GWG_{11,\gamma_{09}}$, represents the gender wage gap that we would have measured in 2011 with the public sector premium of 2009, everything else equal to 2011 values. It is estimated at 5.4%, significantly smaller than the actual gender wage gap in 2011.

Hence, even though the change between 2009 and 2011 is small, it is completely due to the changes in the return to the public sector - which we can interpret as the consequence of the wage freeze introduced by the government, partially compensated by other changes (Table 4). Moreover, an increase of 1 percentage point on a gender wage gap of about 6-8% is considerable, in particular when bearing in mind that the increase continued in 2012.

Table 3 Actual and counterfactual gender wage gaps, 2009 and 2011

				Heckman-corr.	
Gender Wage Gaps	Obs.	Mean	S.E.	Mean	S.E.
$GWG_{09,\gamma_{09}}$	11,051	0.06^{***}	(0.01)	0.09^{***}	(0.00)
$GWG_{11,\gamma_{11}}$	10,347	0.08^{***}	(0.01)	0.10^{***}	(0.00)
Counterfactual Gender Wage Gaps					
$GWG_{09,\gamma_{11}}$	11,051	0.08^{***}	(0.01)†	0.11^{***}	(0.00)††
$GWG_{11,\gamma_{09}}$	10,347	0.05^{***}	(0.01)†	0.08^{***}	(0.01)††

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$;

†sig. different ($p < 0.05$) from the correspondent actual GWG ($GWG_{09,\gamma_{11}}$ vs. $GWG_{09,\gamma_{09}}$; $GWG_{11,\gamma_{09}}$ vs. $GWG_{11,\gamma_{11}}$);

†† sig. different ($p < 0.01$) from the correspondent actual GWG ($GWG_{09,\gamma_{11}}$ vs. $GWG_{09,\gamma_{09}}$; $GWG_{11,\gamma_{09}}$ vs. $GWG_{11,\gamma_{11}}$).

Robust standard errors in parenthesis; for Heckman GWG and the counterfacutal GWG bootstrapped standard errors in parenthesis. The sums may not result to the corresponding total due to rounding. Source: EU-SILC, own calculations

Taking into account the Heckman-correction yields the same results. The last two columns of Table 3 present the gender wage gaps predicted using the Heckman-corrected coefficients. As expected, they are larger than the observed ones, and they increase from 2009 (9%) to 2011 (10%). The Heckman-corrected counterfactual $GWG_{09,\gamma_{11}}$ (11%) is significantly larger than the gender wage gap in 2009, while $GWG_{11,\gamma_{09}}$ (8%) is significantly smaller than the gender wage gap in 2011. The differences due to the policy and to 'other changes' are the same as above (Table 4).

When we estimate the counterfactuals, we make use of the public sector premium in 2009 and in 2011 to isolate the impact of the wage freeze on the gender wage gap. This relies on the assumption that between 2009 and 2011 nothing else changed, which could affect the public sector premium. It seems a realistic assumption since there was no other policy change. The stock of working people was similar in the two periods. The pension reform introduced in the same period mentioned in Section 2 was approved in December 2011 and was effective since January 2012, thus it cannot affect our estimates. Hence, we can consider that the counterfactual analysis isolates the impact of the wage freeze on the gender wage gap.

On the other hand, we cannot claim that in the absence of such a policy everything else would have been as it is in 2011. The wage freeze was justified as a way to reduce public spending and improve the conditions of Italian economy. One could claim that the government could have taken other measures instead of the wage freeze. Plausibly, that would have caused other changes in employment and in the wage structure - no matter if the policy would have been in the direction of cutting public spending (as the wage freeze) or in the opposite direction. We follow here a partial equilibrium approach, as it is usually the case with decomposition and counterfactual methodologies, thus we cannot derive general equilibrium considerations (Fortin et al. 2011).

The above counterfactual analysis focuses on the changes between 2009 and 2011, because the wage freeze was introduced in May 2010, and implemented since January 2011. Using 2009 as a pre-policy period anticipate both the discussion and the implementation of

Table 4 Decomposing the change in the gender wage gap, 2009-11

				Heckman-corr.	
Total change	$GWG_{11,\gamma_{11}}$ - $GWG_{09,\gamma_{09}}$	0.01	(0.01)	0.01	(0.01)
Diff. due to the policy (1)	$GWG_{09,\gamma_{11}}$ - $GWG_{09,\gamma_{09}}$	0.02^{***}	(0.01)	0.02^{***}	(0.00)
Diff. due to the policy (2)	$GWG_{11,\gamma_{11}}$ - $GWG_{11,\gamma_{09}}$	0.02^{***}	(0.01)	0.02^{***}	(0.00)
Diff. due to other changes (1)	$GWG_{11,\gamma_{11}}$ - $GWG_{09,\gamma_{11}}$	-0.01	(0.01)	-0.01^{**}	(0.01)
Diff. due to other changes (2)	$GWG_{11,\gamma_{09}}$ - $GWG_{09,\gamma_{09}}$	-0.01^{*}	(0.01)	-0.01^{*}	(0.01)
Shorrocks-Shapley decomposition					
Av. diff. due to the policy		0.02^{***}	(0.00)	0.02^{***}	(0.00)
Av. diff. due to other changes		-0.01	(0.01)	-0.01^{**}	(0.01)

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Bootstrapped standard errors in parenthesis. The sums may not result to the corresponding total due to rounding. Source: EU-SILC, own calculations

the law.[25] However, changes in the wage gap took place already since 2008 (Table 1). As a robustness check, we replicate the estimates of Tables 3 and 4 using the 2007-2009 average (instead of year 2009 only) as pre-policy period. Previous results are confirmed (see Tables B.10 and B.11).

As we did in Section 4 for the decomposition of wages, the counterfactual analysis is also reworked using monthly wages, instead of hourly wages. Results are presented in Appendix D (Tables D.3 and D.4). The difference with respect to hourly wages is that the increase of the gap is partly due to the policy and partly due to other changes. In this case, the policy accounts for about 50% of the increase, while in hourly wages the policy accounts for more than 100% of the increase. One major difference between these two estimations is that the decrease of the public sector premium between 2009 and 2011 in monthly wages[26] is less strong than in hourly wages. In fact, monthly wages also take into account the increase of working hours between 2009 and 2011, that compensates part of the loss due to the wage freeze. For this reason, our preferred specification is the one with hourly wages.

6 Within public sector

In the previous section, we have shown that the gender wage gap increased due to the public sector wage freeze. This increase could be due to the large proportion of women employed in the public sector. If that was the only mechanism in place, we would expect a stable gender wage gap *within* the public sector. But we know from Table 2 in Section 4.1 that the gender wage gap increased between 2009 and 2012 only within the public sector. Thus, as a final contribution, we analyse changes within the public sector.

[25] The law was passed as one of the first measures to tackle the European sovereign debt crisis. This crisis was triggered in October 2009 by the Greek declaration that debt and deficit levels had been undercounted by the previous governments, and hit Italy at the beginning of 2010.

[26] Monthly wage equations available from the author upon request.

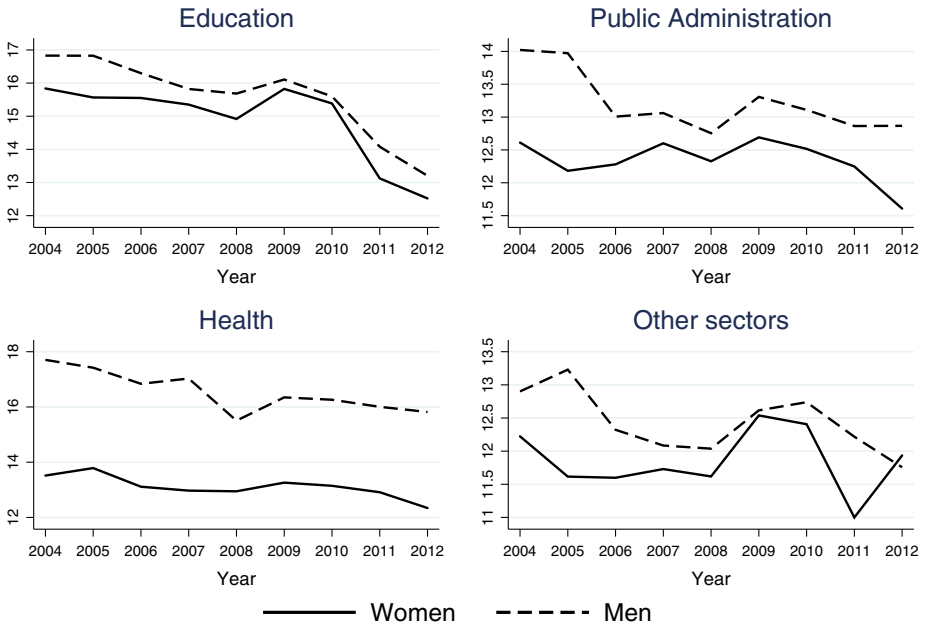

Fig. 5 Wages in the public sector, by gender and sub-sector of employment, 2004-12. *Note*: Gross wages per hour in 2008 real price. 'Other sectors' is a residual group and it includes heterogeneous categories by gender. Source: EU-SILC, own calculations

In the following, we consider the different distribution of men and women in the sub-sectors of the public sector (for instance, more than 75% of employees in education are women, Table B.12) and we investigate if this gap emerged as a consequence of sub-sector-specific policy implementation (see Section 2). We divide the public sector in the following sub-sectors: Public administration and Defence, Education, Health and social work, and Other sectors. Looking at the trend in wages in the different public sub-sectors, we note that in the education sector average hourly wages decreased more than in other sub-sectors (see Fig. 5). In addition, female wages decreased more than male ones in Education: wages decreased by 14.7% in 2011 for women and by 9.7% for men (see Table B.12). Female wages decreased more than male ones also in Public Administration and in Health.

In order to control for other covariates, we estimate three wage equations for men, women, and the pooled sample employed in the public sector. In addition to the usual covariates (age, education, region, marital status, experience, position, and part-time), we control for the public sub-sectors (see wage equations in Appendix C).

Before 2010, working in the (public) education sector had a positive impact on wages compared to other public sub-sectors, especially for women.[27] However, the premium dropped from 8% in 2010 to 0% in 2011 and 2012. The decrease is particularly remarkable for women, for whom the coefficient associated with working in education dropped from 10% in 2010 to 1% in 2011. For men, this coefficient decreased from 0% in 2010 to -4% in 2011.

[27] The omitted sector is Health and social work.

Therefore, we can conclude that the abolition of the automatic seniority wage increases in the public education sector (due to the 2010-11 law) contributed to the increase of the gender wage gap within the public sector.

7 Conclusions

The Italian gender pay gap increased from 3.8 to 8.6% between 2008 and 2012, despite being much lower than the European average, and despite some studies showing that the Great Recession in Italy had a less negative impact on women than on men.

In this paper we show that this increase is a consequence of the wage freeze in the public sector, introduced as an austerity measure during the economic crisis. The application of a counterfactual analysis to hourly wages shows that more than 100% of the GWG growth between 2009 and 2011 is due to the wage freeze in the public sector: it reduced the public sector premium and had a disproportionate impact on women. This is not only due to the large proportion of women working in the public sector, but also to the larger wage drop in the public education sector, where about 75% of the employees are women.

Another important result of the paper is that the Italian gender wage gap is unexplained by observed characteristics, when using the Oaxaca-Blinder decomposition on EU-SILC data. In order to understand the changes in the distribution of the GWG before and after the crisis, the paper also includes a quantile decomposition. Results of this analysis imply that there are two different trends before and after 2010. Between 2008 and 2010, the gender pay gap increased along the entire quantile distribution both in the explained and unexplained components. After 2010, the gender wage gap increased largely among people in the upper part of the wage distribution.

To sum up, the increase in the GWG during the economic crisis was mainly due to there being a large share of women in the public education sector, in which hourly wages changed the most. In particular, changes occurred in the upper part of the hourly wage distribution (above the 60th percentile), indicating the emerging of a glass ceiling after 2010, in addition to the sticky floor.

Economic policies regarding public sector pay freezes and cuts in the service sector, implemented during this crisis, have serious gender side effects, that have often been disregarded. Similar policies have been introduced also in other European countries (Estonia, Greece,[28] Hungary, Ireland, Latvia, Lithuania, Portugal, Czech Republic, Romania, Spain) (EPSU 2012) and it would be interesting to estimate the effects of these policies, comparing short term policies (e.g. wage cuts for one year) with medium term ones (e.g. wage freeze for several years).

Acknowledgments We are grateful to Karina Doorley for very useful suggestions. We also want to thank Leif Andreassen, Paolo Brunori, Marina Della Giusta, Alessio Fusco, Ronald Oaxaca, Raul Ramos, Enrico Rettore, Mariacristina Rossi, Eva Sierminska, Steinar Strøm, Philippe Van Kerm for helpful discussions and comments, as well as seminar participants at the University of Cambridge, LISER, FBK-IRVAPP, University of Modena, University of Torino, and conference participants at 2014 EALE, 2015 AIEL, 2016 ISTAT. The article has also benefited from useful comments by one editor of the journal, the associate editor, and the anonymous referees. We thank Collegio Carlo Alberto for financial and technical support. Part of this research was conducted while Daniela Piazzalunga was visiting LISER, and she would like to acknowledge their hospitality.

[28] Christopoulou and Monastiriotis (2016) analyse the changes in the wage structure in the public and private sector in Greece during the economic crisis, and show that despite the austerity measures public wages were less affected than private ones.

References

Addabbo, T., Favaro, D.: Gender wage differentials by education in Italy. Appl. Econ. **43**(29), 4589–4605 (2011)

Arulampalam, W., Booth, A.L., Bryan, M.L.: Is there a glass ceiling over Europe? Exploring the gender pay gap across the wage distribution. Ind. Labor Relat. Rev. **60**(2), 163–186 (2007)

Banca d'Italia: The labour market. In: Annual Report for 2011, pp. 67–78. Banca d'Italia (2012)

Banca d'Italia: The labour market. In: Annual Report for 2012, pp. 73–81. Banca d'Italia (2013)

Bettio, F.: Perché in Italia si riapre il gender pay gap. InGenere, 30 May (2013)

Bettio, F., Corsi, M., D'Ippoliti, C., Lyberaki, A., Lodovici, M.S., Verashchagina, A.: The impact of the economic crisis on the situation of women and men and on gender equality policies. Synthesis report, European Commission (2013)

Blau, F.D., Kahn, L.M.: The gender wage gap: Extent, trends, and explanations. J. Econ. Lit. **55**(3), 789–865 (2017)

Blinder, A.S.: Wage Discrimination: Reduced Form and Structural Estimates. J. Hum. Resour. **8**(4), 436–455 (1973)

Bordogna, L.: Employment relations and union action in the Italian public services: Is there a case of distortion of democracy? Comparative Labor Law & Policy Journal **34**(2), 507–530 (2013)

Bordogna, L., Neri, S.: Social dialogue and the public services in the aftermath of the economic crisis: strengthening partnership in an era of austerity in Italy. National report VP/2011/001, European Commission project, Industrial Relations and Social Dialogue (2012)

Brandolini, A., D'Amuri, F., Faiella, I.: Country case study-Italy. In: Jenkins, S.P., Brandolini, A., Micklewright, J., Nolan, B. (eds.) The Great Recession and the Distribution of Household Income, pp. 130–152. Oxford University Press, Oxford (2013)

Bredtmann, J., Otten, S., Rulff, C.: Husband's unemployment and wife's labor supply. The Added Worker Effect across Europe, ILR Review. https://doi.org/10.1177/0019793917739617 (2017)

Chernozhukov, V., Fernández-Val, I., Melly, B.: Inference on Counterfactual Distributions. Econometrica **81**(6), 2205–2268 (2013)

Christofides, L.N., Polycarpou, A., Vrachimis, K.: Gender wage gaps, 'sticky floors' and 'glass ceilings' in Europe. Labour Econ. **21**, 86–102 (2013)

Christopoulou, R., Monastiriotis, V.: Public-private wage duality during the greek crisis. Oxf. Econ. Pap. **68**(1), 174–196 (2016)

Del Bono, E., Vuri, D.: Job mobility and the gender wage gap in Italy. Labour Econ. **18**(1), 130–142 (2011)

Depalo, D., Giordano, R., Papapetrou, E.: Public-private wage differentials in euro-area countries: evidence from quantile decomposition analysis. Empir. Econ. **49**(3), 985–1015 (2015)

EPSU: The wrong target one year on: pay cuts in the public sector in the European Union. Technical report, Labour Research Department (2012)

Eurostat: Activity rates by sex, age and citizenship. Accessed at http://ec.europa.eu/eurostat/web/products-datasets/product?code=lfsa_argan (December 2017) (2017a)

Eurostat: Sustainable development indicators: social inclusion. Gender pay gap in unadjusted form. Accessed at http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tsdsc340&plugin=1 (December 2017) (2017b)

Figari, F., Fiorio, C.V.: Fiscal Consolidation Policies in the Context of Italy's Two Recessions. Fisc. Stud. **36**(4), 499–526 (2015)

Fortin, N., Lemieux, T., Firpo, S.: Decomposition methods in economics. In: Ashenfelter, O., Card, D. (eds.) Handbook of Labor Economics 4A, pp. 1–102. Elsevier, North Holland (2011)

Ghignoni, E., Verashchagina, A.: Can the crisis be an opportunity for women? In malo. In: M. A., Sciulli, D. (eds.) Disadvantaged Workers, AIEL Series in Labour Econ, pp. 257–276. Springer International Publishing, Cham (2014)

Heckman, J.: Shadow prices, market wages, and labor supply. Econometrica **42**(4), 679–694 (1974)

Istat: Migrations. Accessed at `dati.istat.it` (December 2017) (2017a)

Istat: Unemployment rate. Accessed at `dati.istat.it` (December 2017) (2017b)

Koenker, R., Bassett, G.J.: Regression quantiles. Econometrica **46**(1), 33–50 (1978)

Mussida, C., Picchio, M.: The gender wage gap by education in Italy. J. Econ. Inequal. **12**(1), 117–147 (2014a)

Mussida, C., Picchio, M.: The trend over time of the gender wage gap in Italy. Empir. Econ. **46**(3), 1081–1110 (2014b)

Neuman, S., Oaxaca, R.L.: Gender versus ethnic wage differentials among professionals: Evidence from Israel. Annales d'Économie et de Statistique **71/72**, 267–292 (2003)

Nicodemo, C.: Gender pay gap and quantile regression in European families. IZA Discussion Paper 3978 (2009)
Oaxaca, R.: Male-female wage differentials in urban labor markets. Int. Econ. Rev. **14**(3), 693–709 (1973)
Olivetti, C., Petrongolo, B.: Unequal pay or unequal employment? A cross-country analysis of gender gaps. J. Labor Econ. **26**(4), 621–654 (2008)
Piazzalunga, D.: Is there a double-negative effect? Gender and ethnic wage differentials in Italy. LABOUR: Review of Labour Economics and Industrial Relations **29**(3), 243–269 (2015)
Piazzalunga, D.: The gender wage gap among college graduates in Italy. Italian Econ. J. **4**(1), 33–90 (2018)
Shorrocks, A.F.: Decomposition procedures for distributional analysis: a unified framework based on the Shapley value. J. Econ. Inequal. **11**(1), 99–126 (2013)
Sierminska, E., Takhtamanova, Y.: Job flows, demographics, and the Great Recession. In: Immervoll, H., Peichl, A., Tatsiramos, K. (eds.) Who loses in the downturn? Economic crisis, employment and income distribution (Research in Labor Economics, volume 32), pp. 115–154. Emerald Publishing Limited (2011)
Tronti, L.: Regulating wages and collective bargaining in the public sector. Technical report, Presidenza del Consiglio dei Ministri, Dipartimento della Funzione Pubblica (2011)
Villa, P., Smith, M.: Gender equality, employment policies and the crisis in EU member states. Synthesis report, European Commission (2010)