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ABSTRACT

Beneath the Surface: The Decline in Gender Injury Gap*

Despite its policy relevance there is little evidence on the joint evolution of gender differences in wages and workplace safety. Between 1994 and 2002 Italian micro-level data show a decline in both gaps, as well as an increased concentration of injuries among low-skilled female workers. The reduction in the gender wage gap is driven by sorting of workers across sectors and occupations, while the reduction in the gender injury gap and the increased concentration of injuries among low skilled female workers appears to be driven by changes in unobservables characteristics. Moreover, our findings indicate that in 2002 women became more vulnerable to non-employment spells, which seems to be followed by both wage reductions and increased workplace risk for the re-employed low-skilled female workers.

JEL Classification: J16, J28, J31

Keywords: gender gap, workplace injury, job amenities, wage differentials

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1 Introduction

The gender gap measures systematic differences in outcomes that men and women experience in the labor market. Several developed countries are witnessing a secular trend toward a reduced gender wage gap (see among others Blau, 1998, Blau and Kahn, 1997, O'Neill and Polachek, 1993), including Italy (Bono and Vuri, 2011). However, whereas wages are quite readily observed and quantified, other job amenities are not easily captured by labor force surveys or administrative data and remain unobserved to th resarcher, that is "beneath the surface" (see for an overview Altonji and Blank, 1999, Goldin, 1994). Workplace safety is one of the most important, yet understudied, job amenities. In 2009, over 2.8 million accidents involving more than three days lost occurred in the EU (Eurostat, 2012). During the same year, as a consequence of workplace accidents, 3.8 thousand workers died in the EU and about 4.5 thousand in the U.S. (Bureau of Labor Statistics, 2012).

The main contribution of this paper is to analyze jointly gender differences in wages *and* workplace safety. To this aim we employ matched employer-employee administrative data containing detailed information about wages and working histories in Italy over the period 1994-2002 and investigate how changes in human capital, job characteristics, and unobserved skills influence gender differences in pay and safety. A unique feature of this data set is the availability of individual-level information on the occurrence of workplace injuries, which allows simultaneous study of the distribution of wages and workplace injuries.

We document that there is a significant gender gap both in wages and in work-related safety. In 1994, wages for men were on average 20 percent higher than for women, and men experienced approximately three times as many work-related injuries as women. Both these gender gaps diminished over time. Between 1994 and 2002 the difference in wages between men and women decreased by 21 percent, while the difference in the probability of injury decreased by 37 percent. Such a convergence in the probability of injury results from a greater decline for men (-29 percent) than for women (-11 percent). However, only in the top two quartiles of the wage distribution did female workers experience a clear decline in injuries. In contrast, the lowest paid female workers bore most of the injury risk in 2002. As a result, at the end of the sample period injuries became clearly concentrated among low-paid female workers, whereas for male worker, this pattern was already present in 1994 and remained fairly stable over time.

To explain these distributional changes, we adopt the DiNardo et al. (1996) (hereafter DFL) decomposition in order to generate counterfactuals and to disentangle the changes in wages and injury distributions due to changes in unobservables from changes induced by variations in observable characteristics (or compositional changes, such as the switching of jobs across sectors and occupation). The observed changes in the (joint) distribution of wages and injuries could be explained by, for example, the transitioning of women from traditionally "female" professions (such as blue collar workers in the textile sector), usually concentrated in the middle of the wage distribution (Blau and Kahn, 2000), toward "male" professions at both the lowest and highest ends of the earnings distribution.

The analysis of the counterfactual scenarios indicates that the reduction in the gender wage gap appears to be driven by changes in the distribution of observed job and worker characteristics (such as industrial sectors, occupations, firm size, age, tenure, regions of birth, regions of work, part-time). However, this is not the case for the increased concentration of injuries among low-paid female workers. These changes are instead attributable to changes in unobservables, most likely related to changes in unobserved human capital and other skills (or their prices).

The result that more dangerous jobs are taken by lower-paid women is in line with the findings of Hamermesh (1999), who, based on industry-level injury data, shows that in spite of positive risk premia, more skilled and better paid workers often trade-off part of their earnings for workplace safety which is a normal good (thus creating a negative correlation between wages and injuries).

The available data does not allow us to pin down the exact mechanisms that drive the unexplained evolution of the gender gaps. For example, changes in educational attainment and skill biased technologial change may both play a role. However, our data can be used to investigate whether non-employment (presumably unemployment) spells simultaneously led to a reduction in wages and in workplace safety. This evidence provides an additional possible explanation for the increasing similarity of men and women in the labor market.

The paper is organized as follows. The next section describes the data and provides some descriptive statistics. Section 3 presents the methodological framework. Section 4 reports the empirical results, and Section 5 concludes.

2 The data

Data availability has been a long-standing issue in the literature on job amenities, and injury risk in particular, mainly because of the lack of individual level information on injuries. We overcome this issue by using administrative data on a 1 : 90 random sample of Italian workers, the Work Histories Italian Panel (WHIP), linked with administrative records from the Italian Workers' Compensation Authority (INAIL), covering the years 1994-2002 (Bena et al., 2012)[1]. Overall, the data set includes about 120,000 individual records for each of the 9 years in the sample. This dataset provides information on worker and job characteristics (age, sex, place of birth, type of occupation, sector, size of firm, number of weeks worked in a year, part-time job, earnings), the number of work-related injuries and their exact description, and the days of work lost due to such accidents. Moreover, the diagnosis and prognosis of the accidents are reported and certified by physicians. Hence, our data set provides an exceptionally rich source of information which we use to analyze the joint distribution of (deflated) weekly earnings and workplace injuries.

Despite this wealth of information there are three limitations in our data. First, precise estimation of injury risk is only available for employees in the non-agricultural private sector, as employees in other sectors are either not covered (public sector, agriculture and fishing), or the available information is inadequate to measure the exposure to injury risk (hours of work and days of work for self-employed workers are imprecisely measured).

Second, information on workplace injuries is currently available only for the 9-year

[1]The WHIP dataset includes working histories also for the 1985-1994 period.

period between 1994 and 2002. However, although relatively short, this period witnessed important economic and social changes and provides significant variability in wages, injury probabilities, and injury index.[2] Another reason why 9 years might not be such a short period when studying workplace injuries is that most injuries happen at the beginning of a job spell (see Table 1) and the Italian workforce changed significantly during the 1994-2002 period. Female labor force participation increased significantly, and new cohorts of workers entered the labor market. These changes were so pronounced that 42 percent of women and 35 percent of men working as employees in 2002 were still out of employment in 1994.

Third, like many administrative records that are used to compute social security benefits, our data set has no information on education, as education does not enter the benefit formula directly. Fortunately, the data does include information on whether the worker is a blue or a white collar, or whether he has managerial tasks, which tends to be highly correlated with education.

Tables 2 and 3 describe the evolution of our main controls, while the rest of this section focuses on the two main outcomes of interest, namely wages and injuries. Table 2 shows participation rates in the first and last years of the sample. There are several changes in labor force participation across sectors. The most evident are the 3 percentage point increase for males and the almost 6 percentage point increase for females in the

[2] In 1992, a severe recession forced the Italian government to devalue the lira (the currency lost almost 40 percent of its value with respect to the German Mark) and to abandon the European Exchange Rate Mechanism. The old political parties disappeared in the midst of widespread corruption charges against their leaders, and a government of technocrats was formed. New parties and new leaders entered the new political scene, called "2nd Republic," in 1996. Despite these changes, economic growth saw an unprecedented low, with average yearly growth rates close to 1.5 percent.

financial intermediation sector.[3] Most of these workers seem to come from traditional sectors like vehicle manufacturing for men (-1 percentage point) and the textile industry for women(-6 percentage points). [4]

Table 3 shows that there were no major changes between 1994-2002 in the proportion of white and blue collar employees or in the geographical location of jobs. Both men and women experienced a substantial increase in part-time jobs. The participation rate of male workers in large firms declined over time, whereas the female participation rate increased. The last two columns show that the gender differences in age has been declining, mainly due to the increase in the age of retirement for women.[5]

Table 4 describes the distribution of our first main variable of interest, the log weekly wages, in 1994 and 2002 (the 2002 "prime" year represents a counterfactual year that we will discuss later). Wages include overtime payments and are deflated to constant 1995 values. They are computed as the log of weekly earnings (annual earnings divided by the number of weeks worked per year). Overall, wages have been stagnant in the middle and increasing at the tails of the wage distribution, thus displaying a polarization for both male and female workers. The changes at the top and bottom of female wage distribution are more pronounced than the corresponding variations for males. Women in the top percentiles of the distribution underwent the largest increase in wages, although women

[3] Given that temporary help agencies (agencies that rent out workers on a non-permanent basis to firms) are recorded as financial intermediaries, part or even most of this increase might be attributed to these agencies.

[4] Changes in the textile industry generate the largest convergence between male and female workers across sectors. In fact, this industry almost exclusively employs women and has been constantly declining since the 1990s. An analysis of participation rates in the manufacturing sectors reveals that increased foreign competition explains part of the decline. Results are available upon request.

[5] Although retiring much later than in the past, women are increasingly employed in part-time jobs, so their tenure in office is decreasing in comparison to men.

in all quantiles faced some improvements. This was not the case for men. Adjusting for inflation, men between the 10th and the 75th percentile received lower wages in 2002 than 9 years earlier. The Gini index and the Theil index show that the relatively more stagnant evolution of wages in the middle of the wage distribution has led to increasing inequality.

Regarding our second main variable of interest, workplace injuries, we use two slightly different measures. To account for differences in exposure to workplace risk the weekly probability of injury is computed by dividing the likelihood that a worker is injured at least once during the year by the number of days worked during that year.[6] We also compute an injury index, defined as the annual number of days lost due to an injury divided by the number of weeks worked during the year. This index depends not only on the occurrence of an injury but also on its severity. To facilitate interpretation of the results, we report the probability of injury and the injury index on a yearly basis, i.e., the probability of injury in a year and the number of days lost per year.

Figure 1 and Table 5 show the evolution of injuries over time and also by wage quartile. The overall risk of injury for male workers dropped from 8.7 percent in 1994 to 6.2 percent in 2002. The corresponding decline among female workers was considerably smaller, from 2.8 percent to 2.5 percent. A similar picture emerges from the injury index, which fell from 2.8 to 1.8 for men and from 0.9 to 0.7 for women. Despite the noise, Figure 1 shows that the injury index is decreasing for the lowest quartile in the males' distribution and

[6] The proportion of workers experiencing more than one injury within any given year is negligible (0.2 percent). The number of weeks worked is adjusted to account for part-time in order to provide an accurate measure of exposure to workplace injury risk.

the highest quartile in the females' distribution. Table 6 describes the changes in the average gender wage and injury gaps. The gender wage gap decreased from 0.201 to 0.158 (-21 percent) and the gender gap in the probability to get injured has decreased from 0.059 to 0.037 (-37 percent). The gap in the injury index also declined during the same period (from 1.878 to 1.165, a 38 percent reduction). The next section introduces a semi-parametric strategy for testing whether the evolution of observable characteristics can explain these patterns in wages and injuries.

3 Methodological framework

Given the well-known heterogeneity in risk across sectors, the pattern in injury risk and wages may simply be a result of changes in the participation rates across sectors (as documented earlier in Table 2).

More generally, changes over time in the distribution of injuries and wages and their joint distribution can be ascribed to changes in several observable characteristics of the workers (age, tenure, part-time work, industrial sector, occupation, region of work, region of birth), or unobservable factors, such as the price of skills, the workers' attitudes towards risk and the assignment of hazardous tasks and wages among workers with the same characteristics and within a specific occupation. Hence, the observed changes in the gender gaps can also be decomposed into these two components. To do so, we estimate the counterfactual densities (indicated by a prime ') of wages and injuries that would have been observed at the end of the sample period (2002) had the observed characteristics been distributed as they were at the beginning of the period (1994).

The difference in the statistics based on the counterfactual and the observed density in 1994 represents the impact of changes in unobservable factors, but also changes in workers' attitudes towards risk and changes in the assignment of tasks within a specific type of occupation. The difference between the observed density in 2002 and the counterfactual one (denoted by 2002') indicates the impact of changes in observable characteristics. This reveals how changes in wages and injuries are driven by variations in labor force participation and by the sorting decisions of workers into different types of activities. We adopt the reweighting approach of DiNardo et al. (1996) to compute the counterfactual density and to create counterfactual population measures of a single outcome variable (i.e. wages or injury indexes, *separately*) or counterfactual measures based on the joint distribution of wages and workplace injuries. As noted by DiNardo (2002), when creating the counterfactual scenario with *all* covariates being distributed as in 1994, the reweighting procedure is a function of the propensity score and two constants.[7]

Thus, the sample weights can be estimated using Bayes's rule as follows:

$$\hat{\Phi}_x(2002, 1994) = \frac{\hat{Pr}(t_x = 1994|x)\hat{Pr}_{2002}}{\hat{Pr}(t_x = 2002|x)\hat{Pr}_{1994}}, \tag{1}$$

where $\hat{Pr}(t_x = 1994|x)$ and $\hat{Pr}(t_x = 2002|x)$ are the probabilities for an observation

[7] We have also created counterfactual scenarios by redistributing only a subset of covariates as in 1994 and changing the order in the sequential decomposition as in DFL. In all these specifications the differences between the actual and counterfactual 2002 distributions were mainly driven by changes in the distribution of sectors and occupations. Since the inclusion of other covariates did not affect our results, we only report the specification in which all observations are reweighted to replicate the distribution of covariates in 1994.

to belong to 1994 or 2002, conditional on the covariates x; $\hat{Pr}_{1994}$ and $\hat{Pr}_{2002}$ are the unconditional probabilities for an observation to belong to 1994 or 2002, respectively.

This procedure can easily be extended to compute statistics based on the joint distribution of two outcomes of interest, namely wages and injury indexes.[8] We can thus compute the counterfactual joint distributions of wages and injury probabilities and the related statistics such as concentration curves (O'Donnell et al., 2008) and concentration indexes (Wagstaff et al., 1991 and Kakwani et al., 1997), which are discussed later in Section 4.3. The weights from equation 1 can be used to construct these counterfactuals, as both measures can be computed using sampling weights (O'Donnell et al., 2008).

4 Evidence of gender differences

4.1 The magnitude of the gender *wage* gap

We can now turn to the description of Table 4. A comparison of the actual 2002 wage distribution and its counterfactual with covariates distributed as in 1994 reveals that the (observed) compositional effect (changes in age, tenure, part-time work, industrial sector, occupation, region of work, region of birth) has penalized male workers in every quantile of the wage distribution. Changes in unobserved factors alone would have led to much higher wages than those observed in 2002, especially at the tails of the distribution. Despite the increased polarization at the two extremes of the distribution, changes in

[8]The function $g(.)$ used in the construction of the population measure (see Biewen, 2001, equation 1) can be specified as a function of both wages w and injury index inj and by replacing the conditional density function $f(y|t_y = 2002)$ with the conditional joint density function $f(w, inj|t_y = 2002)$.

unobserved factors alone would have led to a more homogenous wage distribution than the one observed in 2002, especially in the central part, as indicated by Gini and Theil indices.

Female workers experienced an average wage increase of 2.5 percent between 1994 and 2002. The wages of women in the 90th and 95th percentiles rose by much more: 5 and 9 percent respectively. The changes in the distribution of unobservables would have led, in the counterfactual 2002 distribution, to a larger increase in wages below the median.

Variations in the distribution of the observed covariates have partly limited this growth. Despite improvement in female wages due to unobservables, sectors and occupations where females were more likely to be employed and get better paid, may have been forced out of the market by internationalization and global competition. Conversely, the wage increase in the upper part of the distribution can be explained by both changes in unobserved and observed characteristics.

Figures 2 to 4 provide a more complete picture of the different impact of observables and unobservables on the 2002 wage distribution for male and female workers. Figure 2 shows that observables reduced wages of male workers at each percentile, and that changes in wages were positive only at the lowest and at the highest percentiles. Women also experienced a polarization in wages and larger increases in particular in the upper tail of the wage distribution but, unlike men, increases occurred across the whole spectrum. Changes in observable characteristics partially explain the rise among high-skilled women and the lower rise among low-skilled ones. Figure 3 describes the difference in percentiles of the wage distribution between men and women. The gender gap is more pronounced at the lowest and the highest wage percentiles, with changes in observables explaining most of the almost parallel downward shift in the gap. Figure 4 shows that, apart from the extremes, this shift is almost uniform; however, the most skilled women experienced the largest reduction in the gap, while the least skilled women actually experienced an increase in the wage gap.

Overall, the actual and counterfactual values of the Gini and Theil indices in Table 4 indicate that these variations in the wage distribution of women have led to a greater inequality as a result of almost equal impacts of both compositional effects and changes in unobserved characteristics. In addition Table 6 provides exact figures for the evolution of the gender wage gap. The unconditional average gender wage gap was 20 percent in 1994 and approximately 4 percentage points lower in 2002 (a 20 percent reduction). The gender gap narrowed substantially in the upper part of the wage distribution, where the gap was considerably larger. At the 95th (5th) percentile, it fell from 36 to 30 (17 to 15) percent. On average, the decline in the gender wage gap was mainly determined by changes in observed characteristics (2002 vs. 2002'). This reduction is mainly attributable to changes in the distribution of all covariates that have penalized more male than female workers.

4.2 The magnitude of the gender *injury* gap

Table 5 shows a 29 percent reduction in injury risk for male workers and an 11 percent reduction for females. The counterfactual results suggest that unobservables drive these changes. Similarly, Table 6 shows that gender differences in the probability of injury and the severity of the accidents fell mainly because of unobserved variables. Changes in the composition of jobs, occupations and sectors have counteracted the effects of unobserved variables only to a very limited degree.

Figure 5 suggests that the same is true regarding the severity of injuries. Figure 6 makes this even more explicit by showing the differences between the male and female distribution of days lost due to workplace injuries. Finally, Figure 7 reports the difference-in-difference between 2002 and 1994, and the male and female distribution of days lost due to injury. As can be seen from this figure, the narrowing of the injury gap is clearly driven by changes in injuries that lead to short term absences from work.

4.3 Gender wage and injury gap together

After describing the marginal distribution of wages and injuries, together with their actual and counterfactual evolution, we now describe their joint distribution. The purpose of this joint analysis is to investigate whether the observed gain in female wage distribution and consequent reduction in gender differences truly reflects improvements in working conditions and career advancement along the entire wage distributions, and whether these can be interpreted as the consequence of (observed) changes in workers' and job characteristics or variations in (unobserved) human capital and in the price of skills.

Figure 1 shows the evolution of the average injury index within each wage quartile for male and female workers. The pattern described in the figure reveals the increased concentration of injuries among low wage female workers. To determine whether these patterns are driven by changes in observable characteristics, in Table 7 the probability of injury is computed for male and female workers by wage quartile in 1994, 2002 and in the 2002 counterfactual scenario. The risk of injury declined for male workers in all quartiles, with the biggest difference in the first quartile (-37 percent). The probability of injury among female workers slightly increased for the first quartile, but remained stable for the second and considerably decreased for the 3rd and 4th quartiles. Observable characteristics explain little about the evolution of male injuries across all quartiles, but sometimes predict even larger changes in injury risks for women.

The corresponding evolution of the injury index (taking severity into account) is shown in Table 8. The 30 percent decline in injury probability in the first quartile of the male wage distribution is accompanied by a 42 percent decline in the injury index. This indicates that the severity of injuries decreased considerably in the lowest part of the male wage distribution. For female workers, there is almost no change in injury probability in the first wage quartile, while there is a 16 percent increase in the mean injury index, indicating again that the severity of injuries is driving the changes.

The severity of workplace injuries decreased for men and women in the upper part of the wage distribution. The 20 and 43 percent decrease in the probability of injury among women in the 3rd and 4th wage quartiles was accompanied by a reduction in the mean injury index of about 61 and 40 percent, respectively. It appears that when fixing the distribution of covariates as in 1994, male and female workers in 2002 would have experienced fewer and less serious injuries in every quartile. In contrast, the compositional change between 1994 and 2002 in the distribution of covariates seems to have only slightly increased the number of workers subject to injury risk.

The last three columns of Table 7 and 8 describe the gender gap in workplace injuries by wage quartile. For the injury probabilities, the gap is always positive and, except for the 4th quartile, decreasing over time. The gender gap tends to be larger among low skilled workers. Similarly, the gender gap in the severity of injuries is generally positive, decreasing over time, and larger for low skilled workers. In 1994, women in the 4th wage quartile had a larger injury index then men, but the gap is not statistically significant and had shrunk to zero by 2002. The gender gap in the injury index decreased significantly (from 5.2 to 2.4) for workers in the 1st quartile of the wage distribution. The 2002 counterfactual values are very close to the 2002 observed ones, suggesting that observables are not the main driving force of these changes.

Quartile-specific measures of injury risk neglect intra-quartile differences in injury risk. A more comprehensive measure of inequality in the distribution is provided by the concentration curve (Wagstaff et al., 1991 and Kakwani et al., 1997), which describes the proportion of injuries that are attributable to the cumulative percentage of the sample ranked by wage. If wages and the probability of injury were uncorrelated, the concentration curve would correspond to the 45-degree line. If, instead, low wage earners bear more risk of injury, the concentration curve will fall above the 45-degree line.[9]

Figure 8 presents the concentration curves of injury probability by wage level for men

[9] A quantitative measure of the distribution of the injury risk y over income levels is provided by the concentration index that represents the area between the concentration curve and the 45° line. For a sample of n individuals, this index is

$$C = \frac{2}{n\mu} \sum_{i=1}^{n} y_i R_i - 1 \qquad (2)$$

where μ is the mean injury index and R_i is the fractional rank of the *i-th* individual in the income distribution.

and women in panel (a) and (b) respectively. The position of the concentration curves of men relative to the 45° line shows a permanent concentration of hazardous tasks among low paid male workers, and a marginal reduction in concentration between 1994 and 2002. This decrease in concentration cannot be explained by observable factors. Table 9 attests that such changes are statistically significant and that the counterfactual scenario in 2002 is identical to the actual one.

The opposite is true for women. Wages and the probability of injury are uncorrelated in 1994. However, by 2002, the concentration curve resembles that of men, indicating a substantial shift in the probability of injury towards lower paid female workers, but again, changes cannot be attributed to observable factors. It is worth noting that the increase in the concentration of injuries starts approximately after the fifth percentile, that is after the portion of the wage distribution that benefited most from the increase shown in Figure 2. This result thus confirms with micro data the findings by Hamermesh (1999) indicating that unobserved shocks leading to an increase in wages, in particular in the upper tail of the distribution also lead non-pecuniary job amenities to a similar shift. The *cfactual* line represents the counterfactual concentration curve that would have occurred in 2002 if all observed attributes were distributed as in 1994. The increase in the concentration of injury risk among low wage female workers seems to be mainly driven by changes in unobservable attributes (see also Table 9). This could be driven by an increased unobserved heterogeneity between high skilled and low skilled women, that may have disproportionately increased wages and workplace safety at the top of the wage distribution. Similarly, a decrease in the relative price of low skills may have induced low skilled women to bear the risk associated with more hazardous tasks.

4.4 The effect on non-employment spells

We have established in the previous section that, with the exception of those in the upper part of the wage distribution, women faced a moderate increase in wages and a substantial increase in workplace risk. In this section we exploit the panel structure of the dataset to determine whether shocks in the career of workers (considered as part of the unobserved characteristics in the reweighting procedure) might have contributed to these results. In Italy, as in other European countries characterized by wage compression, most of labor career shocks are absorbed by unemployment spells (Hijzen et al., 2010). Hence, non-employment spells provide information on the occurrence of changes in foreign competition, technological shocks (the ICT revolution) and other changes in the return to specific skills.

We constructed a dummy variable indicating whether a worker in the preceding four years remained non-employed for at least three months following a period of employment.[10] We then use this dummy to explain the probability of injury. The first four columns of Table 10 report the average marginal effect controlling for industrial sector, age, tenure, region of birth, region of work, part-time, firm size and occupation dummies. The results indicate that female workers in 2002 who had experienced a period of non-employment exhibit a 26 % increase in the probability of an injury. The same effect is

[10]The non-employment status includes those individuals that are not observed in the panel of working histories. Most of these are likely to be unemployed, though they might also have *temporarily* switched to the public sector, to the agricultural sector, or become self-employed.

not significantly different from zero for women in 1994 whereas it is approximately stable around 15% for male workers.

Table 10 also reports the estimated impact of non-employment spells on the logarithm of wages. Consistently with the previous findings, non-employment has no effect for female workers in 1994 but it implies a 2 % wage reduction in 2002. For male workers the negative effect of non-employed increases from a 2% wage loss in 1994 to approximately a 5% reduction in 2002.

In 2002 female workers passing through non-employment face lower wages and lower workplace safety. About 10 years before they would have faced fewer negative consequences. This is consistent with an overall assimilation of male and female workers.[11] Considering that the majority of non-employment spells are concentrated in the lower part of the wage distribution, the magnitude of this effect can explain the increased concentration of risk among low-paid female workers.

5 Concluding Remarks

Using a unique dataset, we study the narrowing of the gender gap in wages and workplace injury risk in Italy between 1994 and 2002. This decrease in gender differences is associated with rising inequality within the female wage distribution and an increased concentration of injuries among low-skilled female workers. While the reduction in the gender wage gap is largely explained by changes in the observed characteristics of work-

[11]In a set of non reported regressions we have found no evidence that exit rates from the labor market have led to the increased concentration of injuries for low skilled female workers.

ers and jobs, the increased concentration of injuries for female workers is largely due to changes in unobservable attributes. Female workers located in the upper part of the wage distribution have benefited most from the increase in wages and the decrease in injuries. Wage gains were less evident for women above the 10th percentile and in the central part of the wage distribution, who have also been penalized by the largest increase in workplace risk.

Our findings indicate that an analysis based only on wage differential would overstate the improvement for low paid female workers and understate the gain for high skilled female workers (Hamermesh, 1999). Unobserved changes in the 1994-2002 period in education and skills in new cohort of females (Black and Chinhui, 2000, Blau and Kahn, 2000), changes related to skilled biased technological change (Autor et al., 2003, Bacolod and Blum, 2010) or due to increased globalisation (Blinder, 2009) could have heavily influenced human capital and contributed to increase inequality in terms of pecuniary and non-pecuniary job attributes. Workers in the lower and central part of the wage distribution and in particular women in traditionally female sectors have probably experienced a depreciation in the value of their skills.

Other phenomena not directly related to human capital could explain the role of unobservables in shaping wage distribution and concentration of injuries. First, changes in (unobserved) risk preferences or preferences for overtime (possibly related to the well-documented decrease in fertility rate in Italy) and part-time work may have affected the allocation of hazardous tasks within jobs. Second, the falling of institutional and social barriers and the changes in attitudes towards work-related risk within a specific occupation might explain part of the wage increases in the lowest part of the distribution for females. Weichselbaumer and Winter-Ebmer (2007) show that the elimination of government regulations prohibiting women from working in unpleasant jobs or tasks requiring physical strength has lowered the gender wage gap.

Our analysis of working histories reveals that women in 2002 have been heavily affected by non-employment spells, which lead to a reduction in wages and an increase in the probability of an injury. These changes are unlikely to be related to variations in preferences or to the changes in institutional and social barriers. Hence, our findings suggest that the increased equality between men and women might be driven by the increased vulnerability of women to non-employment spells. This mechanism may also play a relevant role in other European countries characterized by rigid institutional settings and wage compression. In these countries, labor market shocks are not entirely reflected in changes in wages and are likely to be absorbed by other non-pecuniary job attributes.

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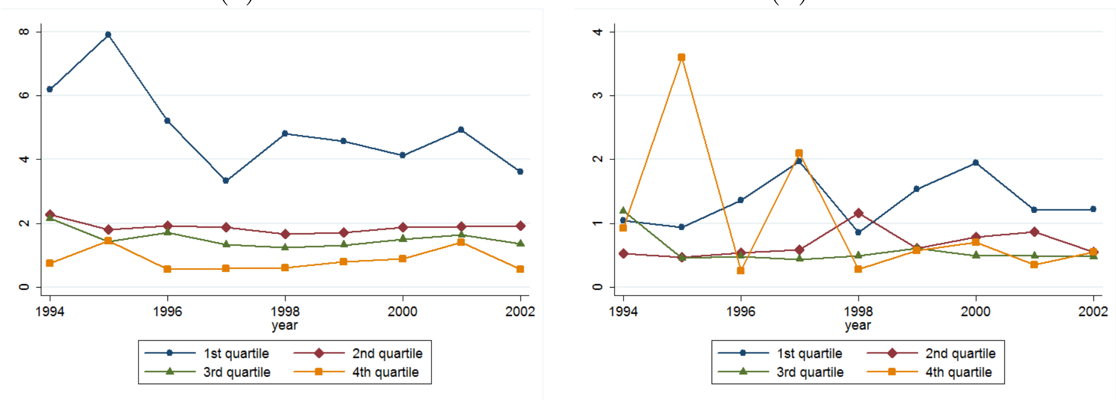
Figure 1: The average injury index by wage quartile.

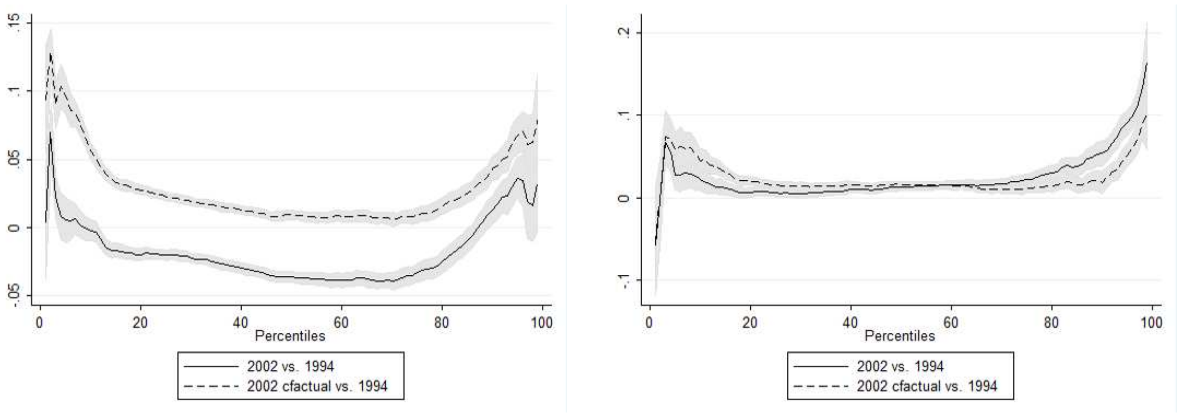
(a) Men (b) Women



The series represent the evolution of the average injury index within each wage quartile for male and female workers.

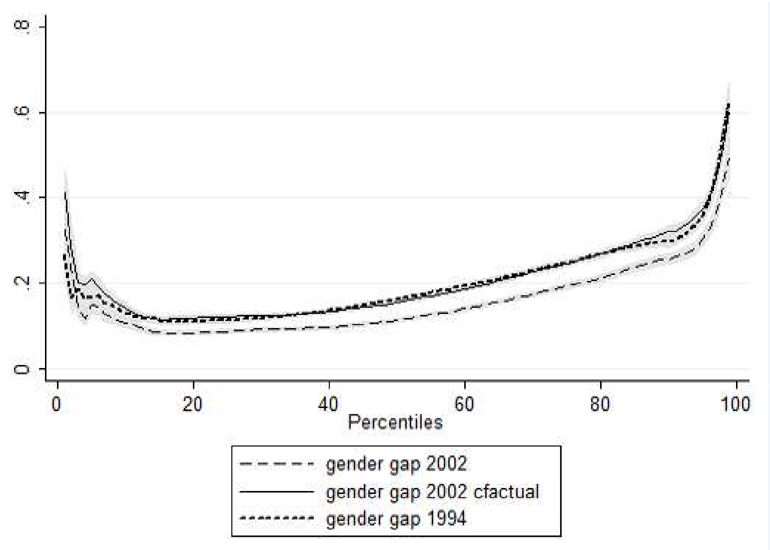
Figure 2: Differences in the percentiles of the log wage distribution for male and female workers.

Men Women



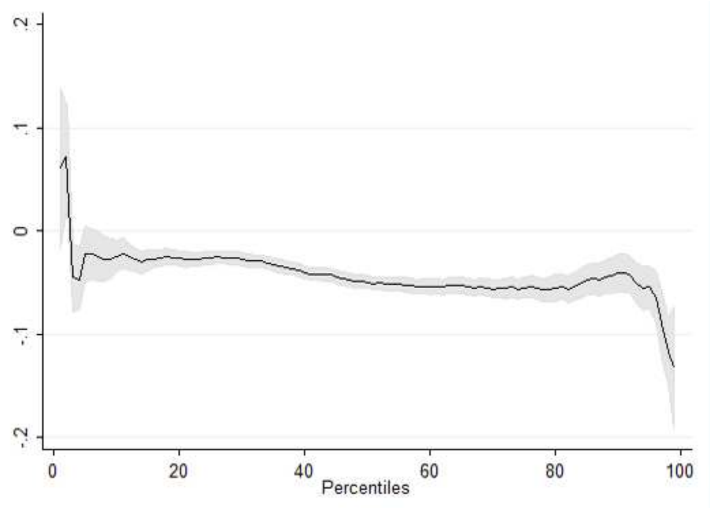
Note: The solid line shows the difference between the percentiles of the 2002 log wage distribution and the percentiles of the 1994 log wage distribution. The dotted line shows the difference between the percentiles of the 2002 counterfactual log wage distribution (computed assuming the same distribution of observable characteristics as in 1994) and the percentiles of the 1994 log wage distribution. Grey areas represent 95 percent confidence intervals.

Figure 3: Gender gap in log wage distribution for male and female workers.



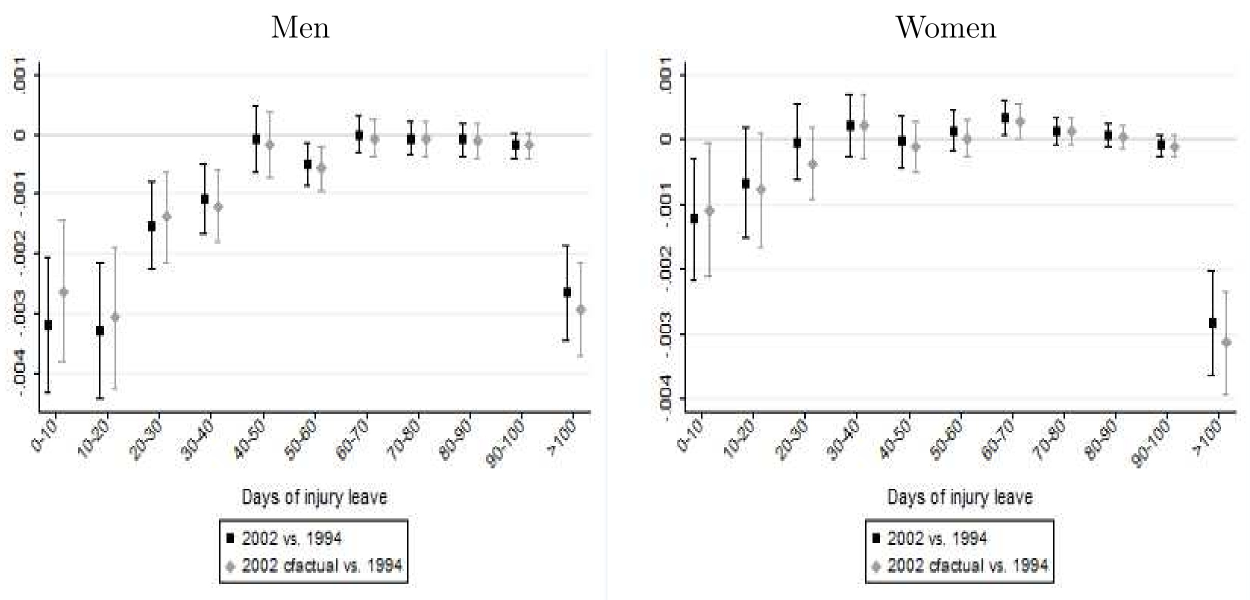
Note: The dotted line shows the gender gap at every percentile of the 1994 wage distribution. Similarly, the dashed line represents the gender gap in 2002 and the solid line the gender gap in the 2002 counterfactual distribution. Grey areas represent 95 percent confidence intervals.

Figure 4: Difference between the gender gap in 2002 and 1994.



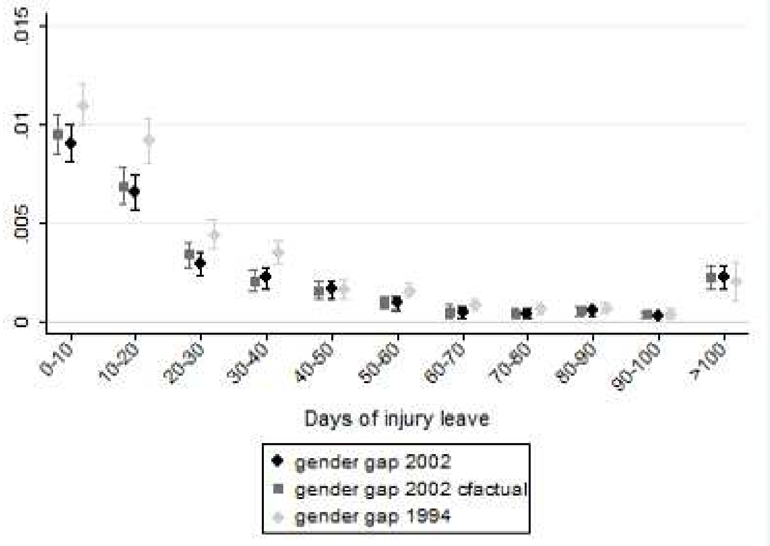
Note: The solid line represents the difference between the two gender gaps, computed in 2002 and 1994. The grey area represents 95 percent confidence intervals.

Figure 5: Changes in the distribution of days lost due to workplace injury by gender



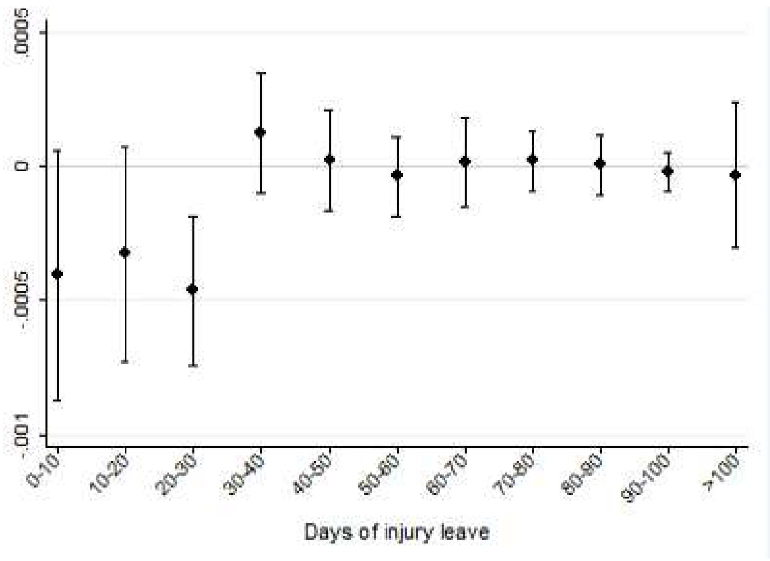
Note: The black squares represent the difference of frequencies between the distribution of days lost due to workplace injury in 2002 and in 1994. The grey circles represent the difference of frequencies between the counterfactual distributions of days lost due to workplace injury in 2002 (computed assuming the same distribution of observable characteristics as in 1994) and the distribution in 1994. The capped spikes represent 95 percent confidence intervals.

Figure 6: The gender gap in the frequency of days lost due to workplace injury.



Note: The black circles represent the gender gap in the frequency of days lost due to workplace injury in 2002. The grey squares represent the gender gap in 2002 counterfactual distribution. The light diamonds represent the gender gap in 1994. The capped spikes represent 95 percent confidence intervals.

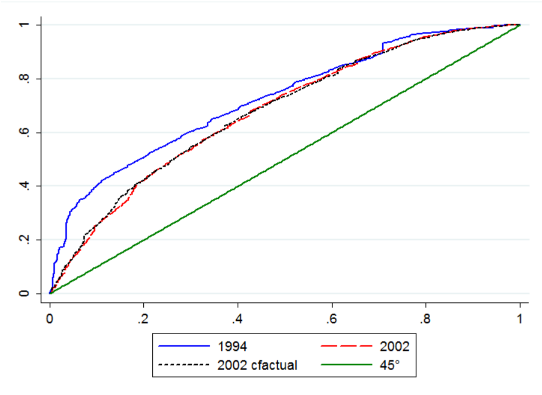
Figure 7: Change in the gender gap in the frequency of days lost due to workplace injury between 1994 and 2002 .



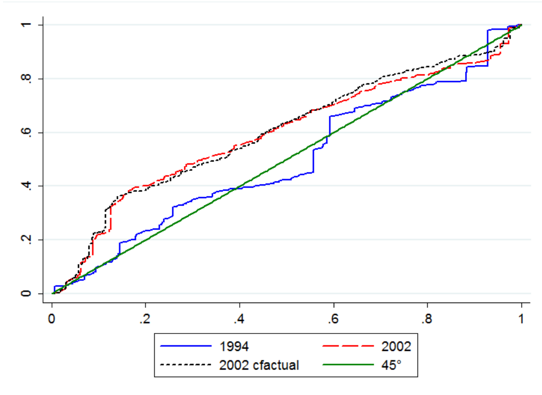
Note: The black circles represent the difference between the gender gap in the frequency of days lost due to injury in 2002 and in 1994. The capped spikes represent 95 percent confidence intervals.

Figure 8: Concentration curves for men and women in 1994 and 2002.

(a) Men



(b) Women



The concentration curves describe the proportion of injuries that are attributable to the cumulative percentage of the sample ranked by wage. The curve denoted by 2002 cfactual represents the counterfactual concentration curve for 2002, assuming the same distribution of observable characteristics as in 1994. The values of concentration index, i.e. the area between the concentration curve and the 45 °C line are reported in Table 9.

Table 1: Descriptive statistics on the probability of injury and the number of working days lost due to injury by age and tenure.

	Males		Females	
	injury probability	injury index	injury probability	injury index
16 $\leq$age $<$ 30	.092	2.250	.029	.623
30 $\leq$age $<$ 40	.069	1.898	.022	.678
40 $\leq$age $<$ 50	.059	2.081	.026	.809
50 $\leq$age $<$ 65	.062	2.992	.034	1.811
tenure $\leq$ 1 year	.110	3.549	.043	1.367
1 $<$ tenure $<$ 2 years	.079	2.465	.026	.654
2 $<$ tenure $<$ 3 years	.069	2.022	.022	.556
3 $<$ tenure $<$ 4 years	.070	2.231	.032	1.138
4 $<$ tenure $<$ 5 years	.067	1.748	.024	.590
tenure $\geq$ 5 years	.054	1.699	.016	.499

Note: The injury probability is the estimated probability of injury within a year. The injury index is the estimated yearly number of working days lost due to injury.

Table 2: Composition of the sample by industry.

Sector	Men		Women		Men-Women	
	1994	2002	1994	2002	1994	2002
CA: Extraction of fuel minerals	0.08	0.05	0.01	0.01	0.07***[0.02]	0.04***[0.01]
CB:Extraction of non-fuel minerals	0.41	0.37	0.07	0.06	0.34***[0.04]	0.32***[0.03]
DA:Food industries	3.74	3.15	4.53	4.01	-0.79***[0.13]	-0.86***[0.11]
DB:Textile industries	3.01	2.50	15.67	9.95	-12.66***[0.16]	-7.45***[0.13]
DC:Hide and leather industries	1.47	1.30	3.54	2.51	-2.07***[0.09]	-1.21***[0.08]
DD:Wood industry	1.75	1.54	0.69	0.63	1.06***[0.08]	0.90***[0.06]
DE:Paper, printing and publishing	2.52	2.14	2.03	1.70	0.49***[0.10]	0.44***[0.08]
DF:Coke manufacturing and refineries	0.27	0.26	0.12	0.08	0.15***[0.03]	0.18***[0.03]
DG:Chemical product manufacturing	2.72	2.15	1.95	1.70	0.77***[0.10]	0.46***[0.08]
DH:Rubber and plastics	2.14	2.11	1.78	1.59	0.35***[0.09]	0.52***[0.08]
DI:Processing of non-metallic minerals	3.10	2.56	1.40	1.17	1.69***[0.10]	1.40***[0.08]
DJ:Metal and metallic products	10.88	10.63	4.70	4.60	6.19***[0.19]	6.03***[0.16]
DK:Manufacturing and repair of machinery	4.88	5.16	2.08	2.34	2.81***[0.13]	2.82***[0.12]
DL:Manufacturing of electrical machinery	5.24	5.09	5.21	5.32	0.04[0.15]	-0.23*[0.13]
DM:Vehicle manufacturing	3.63	2.61	1.23	1.00	2.41***[0.11]	1.61***[0.08]
DN:Other manufacturing industries	2.42	2.20	2.59	2.16	-0.17*[0.10]	0.03[0.09]
E:Electrical energy, gas and water	2.06	1.36	0.60	0.48	1.46***[0.08]	0.88***[0.06]
F:Construction	15.01	15.88	1.81	1.90	13.20***[0.20]	13.99***[0.18]
G:Commerce	12.31	13.31	20.09	21.94	-7.78***[0.23]	-8.63***[0.21]
H:Hotels and restaurants	4.18	5.17	8.63	10.54	-4.46***[0.15]	-5.37***[0.15]
I:Transport and communications	7.85	7.93	2.35	2.92	5.50***[0.16]	5.01***[0.14]
J:Financial intermediation	8.27	11.28	15.90	21.16	-7.63***[0.20]	-9.89***[0.20]
K:Business services	1.04	1.23	2.01	2.22	-0.97***[0.08]	-0.99***[0.07]

Note: The table reports the proportion of workers in each industry and the difference between men and women. Bootstrapped standard errors in square brackets (200 replications). *** 1 % significant. ** 5% significant, * 1% significant.

Table 3: Descriptive statistics on worker and job characteristics.

	Men		Women		Men - Women	
	1994	2002	1994	2002	1994	2002
Avg. age	36.54	36.75	33.16	34.94	3.39***[0.07]	1.82***[0.06]
Avg. months of tenure	62.36	68.63	55.46	60.92	6.90***[0.30]	7.71***[0.42]
% apprentice	4.64%	5.58%	4.58%	6.79%	0.06 [0.10]	-1.21***[0.10]
% blue-collar	67.03 %	67.62%	49.07%	46.10%	17.96***[0.31]	21.52***[0.28]
% white-collar	26.74 %	25.47%	46.17%	46.84%	-19.43***[3.02]	-21.37***[2.68]
% manager	1.60%	1.33%	0.18%	0.26%	1.14***[0.07]	1.07***[0.06]
% part-time	2.10%	5.08%	17.88%	27.74%	-15.78***[0.16]	-22.66***[0.19]
% jobs in the North	57.12%	56.41%	65.86%	63.43%	-8.74***[0.32]	-7.02***[0.29]
% jobs in the Center	19.01%	19.14%	19.82%	20.33%	-0.81***[0.26]	-1.19***[0.23]
% jobs in the South and Islands	23.87%	24.45%	14.32%	16.24%	9.55***[0.26]	8.21***[0.24]
% firm size $0-9$	26.62%	28.24%	33.46%	31.54%	-6.84***[0.30]	-3.30***[0.27]
% firm size $10-19$	12.88%	13.48%	14.60%	13.19%	-1.72*** [0.22]	0.29 [0.20]
% firm size $20-199$	28.42%	29.81%	28.43%	27.41%	-0.00 [0.29]	2.40***[0.26]
% firm size $200-999$	13.14%	12.93%	10.72%	12.48%	2.42***[0.22]	0.45** [0.19]
% firm size ≥ 1000	17.91%	15.23%	11.77%	15.16%	6.14***[2.39]	0.06 [0.21]
n.obs	72,891	84,408	34,267	45,005		

Note: Bootstrapped standard errors in square brackets (200 replications). *** 1 % significant. ** 5% significant, * 1% significant.

Table 4: Weekly wages in 1994 and 2002.

	Men			Women		
	1994	2002	2002'	1994	2002	2002'
Mean log deflated weekly earnings	5.771 [.002]	5.753 [.002]	5.800 [.002]	5.570 [.002]	5.595 [.002]	5.593 [.002]
5th percentile	5.053 [.006]	5.059 [.006]	5.150 [.005]	4.883 [.007]	4.911 [.007]	4.941 [.008]
10th percentile	5.280 [.003]	5.278 [.003]	5.336 [.002]	5.150 [.006]	5.173 [.004]	5.195 [.006]
25th percentile	5.507 [.001]	5.487 [.001]	5.529 [.001]	5.394 [.002]	5.400 [.002]	5.409 [.002]
50th percentile	5.727 [.002]	5.690 [.001]	5.736 [.002]	5.564 [.002]	5.578 [.001]	5.580 [.002]
75th percentile	6.016 [.002]	5.983 [.003]	6.025 [.002]	5.768 [.002]	5.790 [.003]	5.780 [.003]
90th percentile	6.336 [.003]	6.349 [.004]	6.380 [.004]	6.039 [.005]	6.093 [.006]	6.058 [.006]
95th percentile	6.572 [.005]	6.609 [.005]	6.640 [.007]	6.215 [.007]	6.306 [.006]	6.267 [.007]
Gini index	0.281 [.002]	0.287 [.002]	0.283 [.002]	0.216 [.002]	0.249 [.005]	0.233 [.004]
Theil index	0.174 [.004]	0.182 [.005]	0.175 [.004]	0.098 [.004]	0.188 [.020]	0.158[.015]

Note: The columns denoted by 2002' report counterfactual values for 2002, assuming the same distribution of observable characteristics as in 1994. Bootstrap standard errors in square brackets (200 replications).

Table 5: The probability of injury and the number of working days lost due to injury in 1994 and 2002..

	Men			Women		
	1994	2002	2002'	1994	2002	2002'
Injury probability	0.087	0.062	0.058	0.028	0.025	0.021
	[0.003]	[0.002]	[0.001]	[0.003]	[0.002]	[0.002]
Injury index	2.810	1.865	1.751	0.932	0.700	0.540
	[0.237]	[0.078]	[0.075]	[0.167]	[0.086]	[0.054]

Note: The table reports the mean probability of injury and the mean number of days lost due to injury within a year. The columns denoted by 2002' report counterfactual values for 2002, assuming the same distribution of observable characteristics as in 1994. Bootstrap standard errors in square brackets (200 replications).

Table 6: The gender wage and injury gap.

	Men-Women 1994	Men-Women 2002	Men-Women 2002'
Mean log deflated	0.201	0.158	0.207
weekly earnings	[0.003]	[0.003]	[0.003]
5th percentile	0.170	0.148	0.209
	[0.009]	[0.009]	[0.008]
10th percentile	0.130	0.105	0.141
	[0.006]	[0.004]	[0.005]
25th percentile	0.113	0.087	0.120
	[0.002]	[0.002]	[0.002]
50th percentile	0.163	0.112	0.156
	[0.002]	[0.002]	[0.002]
75th percentile	0.248	0.193	0.245
	[0.003]	[0.003]	[0.003]
90th percentile	0.297	0.256	0.322
	[0.006]	[0.006]	[0.007]
95th percentile	0.357	0.303	0.373
	[0.008]	[0.007]	[0.009]
Injury probability	0.059	0.037	0.037
	[0.004]	[0.002]	[0.002]
Injury index	1.878	1.165	1.211
	[0.305]	[0.139]	[0.106]

Note: The injury probability is the estimated probability of injury within a year. The injury index is the estimated yearly number of days lost due to injury. The column denoted by 2002' reports counterfactual values for 2002, assuming the same distribution of observable characteristics as in 1994. Bootstrap standard errors in square brackets (200 replications).

Table 7: The average injury probability by wage quartile.

	(a) Men			(b) Women			(c) Men-Women		
Wage quartile	1994	2002	2002'	1994	2002	2002'	1994	2002	2002'
1st quartile	0.150	0.094	0.088	0.039	0.040	0.035	0.111	0.053	0.053
	[0.009]	[0.004]	[0.003]	[0.006]	[0.007]	[0.008]	[0.011]	[0.009]	[0.009]
2nd quartile	0.096	0.072	0.068	0.025	0.025	0.020	0.072	0.048	0.048
	[0.004]	[0.003]	[0.003]	[0.005]	[0.003]	[0.002]	[0.005]	[0.004]	[0.003]
3rd quartile	0.078	0.057	0.054	0.030	0.024	0.020	0.048	0.033	0.034
	[0.004]	[0.002]	[0.002]	[0.004]	[0.002]	[0.002]	[0.006]	[0.003]	[0.003]
4th quartile	0.023	0.024	0.023	0.021	0.012	0.011	0.003	0.012	0.012
	[0.003]	[0.002]	[0.003]	[0.007]	[0.002]	[0.001]	[0.008]	[0.003]	[0.003]

Note: The injury probability is the estimated probability of injury within a year. The columns denoted by 2002' report counterfactual values for 2002, assuming the same distribution of observable characteristics as in 1994. Bootstrap standard errors in square brackets (200 replications).

Table 8: The average injury index by wage quartile.

	(a) Men			(b) Women			(c) Men-Women		
Wage quartile	1994	2002	2002'	1994	2002	2002'	1994	2002	2002'
1st quartile	6.262	3.613	3.359	1.051	1.222	0.909	5.221	2.391	2.450
	[0.809]	[0.251]	[0.235]	[0.210]	[0.265]	[0.192]	[0.871]	[0.467]	[0.360]
2nd quartile	2.283	1.934	1.778	0.529	0.549	0.470	1.755	1.386	1.308
	[0.181]	[0.155]	[0.139]	[0.143]	[0.067]	[0.069]	[0.218]	[0.170]	[0.158]
3rd quartile	2.153	1.360	1.346	1.226	0.475	0.400	0.928	0.885	0.947
	[0.429]	[0.129]	[0.139]	[0.408]	[0.065]	[0.043]	[0.603]	[0.124]	[0.137]
4th quartile	0.550	0.551	0.519	0.922	0.554	0.381	-0.372	-0.003	0.138
	[0.101]	[0.061]	[0.065]	[0.487]	[0.200]	[0.114]	[0.552]	[0.226]	[0.135]

Note: The injury index is the estimated yearly number of days lost due to injury for each worker. The columns denoted by 2002' report counterfactual values for 2002, assuming the same distribution of observable characteristics as in 1994. Bootstrapped standard errors in square brackets (200 replications).

Table 9: Statistics on the joint distribution of log wages and injuries.

	(a) Men			(b) Women			(c) Men-Women		
	1994	2002	2002'	1994	2002	2002'	1994	2002	2002'
Concentration index	-0.447***	-0.353***	-0.355***	0.008	-0.185*	-0.201**	-0.456***	-0.168	0.154*
(Inj. Index, log wages)	[0.049]	[0.022]	[0.024]	[0.124]	[0.109]	[0.081]	[0.132]	[0.113]	[0.088]

Note: The table reports the concentration index of the injury index and log weekly earnings. Bootstrap standard errors in square brackets (200 replications).
*** 1 % significant. ** 5% significant, * 1% significant.

Table 10: The effect of non-employment spells on injuries and wages

	Probability of injury Average marginal effects, probit				Log-wages OLS, coefficients			
	Men		Women		Men		Women	
	1994	2002	1994	2002	1994	2002	1994	2002
non-employment	.006***	.006***	-.002	.003**	-.021***	-.047***	-.005	-.021***
	(.002)	(.002)	(.002)	(.001)	(.004)	(.003)	(.005)	(.004)
semi-elasticity	.144***	.167***	-.013	.264**				
	(.051)	(.043)	(.148)	(.106)				

Note: Robust standard errors in parenthesis. Probit and OLS regressions include as additional controls dummies for industrial sectors, age, tenure, regions of birth, regions of work, part-time, firm size and occupations.