Is Inequality in Injury Rates Rising as Well? Evidence from Italy

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Abstract

Using individual level data from administrative records we study the evolution of injury rates between 1994 and 2003. The distribution of the probability of workplace injury in 2003 first order stochastically dominates that in 1994. This significant change in the distribution of risk is due to a general downward trend in workplace risk, particularly for workers most exposed to injuries. We also find that woman, who make up an increasing fraction of total workforce, are also increasingly subject to injuries, which reduces inequality in risk. Overall, though, a Blinder-Oaxaca decompositions shows that changes in individual characteristics are able to explain just a tiny fraction of these changes. Improved working conditions seem to be the driving force for the observed changes, which generate a significant reduction in injury inequality.

Keywords: Inequality, Injury, Amenities

1 Introduction

The return to workers' effort cannot be uniquely measured in terms of monetary earnings (Brown, 1980, Hamermesh, 1999). What distinguishes good jobs from bad jobs is not only the level of earnings, but also the danger of the task, its unpleasantness and its overall reputation. A low probability of injury or fatal accident is an important job amenity that not all workers can enjoy. While there is a longstanding debate on the evolution of the distribution of wages in the US (DiNardo et al., 1996, Katz and Murphy, 1992) and also in Italy (Brandolini et al., 2001, Manacorda, 2004, Manasse et al., 2004, OECD, 1996), there is little systematic evidence on the distribution of workplace risk and how this distribution has evolved over time (Leeth and Ruser, 2006). Measuring the evolution of the probability of risk provides an expanded view of the evolution of inequality in the labor market.

In this paper, we focus on the empirical distribution of workplace risk in Italy between 1994 and 2003. The distribution of workplace risk is the outcome of the market interaction between workers and firms. The distribution of risk can change over time for three main reasons. First, the characteristics of workers change over time. Between 1994 and 2003, for example, female labor force participation has significantly increased. This can directly affect the overall distribution of risk because of the different attitude of female workers to risk taking. It may also indirectly affect this distribution if female workers self select into relatively safe jobs.

Second, the distribution of workers across industries has changed over time. Reallocation of workers from the construction industry to the service industry, for example, may decrease the overall exposure of workers to workplace injuries. The evolution towards an economy based on services is likely to decrease the exposure to workplace injuries.

Third, the inherent risk of the tasks performed by workers evolves over time. Even within the same industry, technological progress may change the amount of risk faced by workers with given characteristics. Obviously, the impact of technological progress depends on firms' incentives to invest in risk-reducing technologies and on the additional incentives provided by government regulations. As a matter of fact, the initial year of our sample coincides with the introduction of a systematic new regulation about work safety ("Legge quadro sulla sicurezza del lavoro," L.626 1994).[1] In addition to regulatory changes, product market shocks affect the allocation of resources to the production of different goods and indirectly affect the risk to which workers with given characteristics are exposed.

What are the determinants of the evolution of workplace risk in Italy? We use individual level data from INPS administrative records to estimate the impact of workers' characteristics and their industry distribution on workplace risk. Estimating a logit model of the probability of injury, we find a significant downward trend in the average risk. We also find that the risk faced by female workers significantly increased relatively to males, although male workers still have a higher absolute probability of injury. Finally, the results show that the risk faced by trainees sharply increased in our sample. This may be due to the diffusion of flexible contracts, which particularly affected young workers.

Ideally we would like to observe the true individual probability of injury, since this is not observable, we use fitted values of the logit model. Figure 4 plots the cumulative distribution function of the probability of a workplace injury in 1994 and 2003. The CDF for 2003 first order stochastically dominates that for 1994. Moreover, there is a reduction in the number of workers exposed to the highest levels of risk, while the distribution of low risk workers remains largely unaffected. This implies a reduction in the overall inequality of the risk of injury. The difference between the two distributions in Figure 4 can be explained by changes in the individual characteristics of workers (e.g. sex, age, education), their allocation to different industries (e.g. services, construction) and by the change in the inherent risk to which workers of given characteristics are exposed. While

[1] Unfortunately, as for now, we do not have data prior to 1994.

the variability in the regressors capture the first two effects, changes in the marginal effects of those regressors explain the third.

We describe the counterfactual scenario in which the population of workers observed in 1994 is exposed to the same inherent risk faced by workers in 2003. In practice, we use the marginal effects estimated with the 2003 data to construct the risk of injuries for the 1994 population. Figure 4 shows that the changes in estimated marginal effects explain a substantial fraction of the difference in risk distributions between 1994 and 2003. In particular, they can account for the significant decrease in the number of workers exposed to the highest risk levels.

2 Data

We use administrative records on wages and injuries, at the individual level. The "Work Histories Italian Panel" (WHIP) contains individual work histories and is based on a 1:90 sample drawn from INPS (the Italian National Institute of Social Security) administrative archives.[2] Since the original data contain more than 1.5 million observations we use a 10 percent sample for each year. The linked employer-employee section of WHIP refers to all dependent workers, and excludes those employed in the agricultural and in the public sector. Summary statistics are provided in the empirical section.

Data on injuries come from the Italian National Institute for the Insurance against Occupational Accidents and Diseases (INAIL), the Italian workers compensation system. Only injuries occurred to employees in the private non agricultural sector, as recorded and classified by INAIL have been used. We exclude injuries happened while commuting, since they are not consistently recorded during the period.

[2] WHIP is developed by Laboratorio Revelli, Centre for Employment Studies. See http://www.laboratoriorevelli.it/whip

3 Empirical analysis

As a starting point we model the probability of injury p using the logit model. The neat feature of the logit model is that the log-odds of injury are linear with respect to the regressors, while keeping the estimated probabilities $\widehat{p}$ bounded between 0 and 1,

$$\log \frac{\widehat{p}_{it}}{1-\widehat{p}_{it}} = \widehat{\alpha}_t + \widehat{\beta}_t' x_{it} \text{ for } t = 1994, ..., 2003 \quad (1)$$

We run separate regressions for each year, and in order to compare the evolution of $\widehat{\beta}$ over time we are implicitly assuming that the variance of the error term is constant over time.[3] We replicated all our results using a linear probability model and the conclusions were qualitatively identical.

Beside providing a synthetic way to gauge how injuries have evolved over time, the evolution of the β coefficients tells us something about the evolution of inequality. By definition, if all βs were equal to zero there would be no inequality in (predicted) injury rates. The evolution of the (estimated) probability of injury can be decomposed into changes that are due to changing Xs, like for example the increased female labor force participation, or the increased use of flexible, and part-time labor market contracts, and changes that are due to changing βs, that can be defined as changes in workplace amenity (not unlike a Oaxca decomposition).

Table 1 reports the summary statistics of the socioeconomic factors included in our Xs. The most significant changes that have to be borne in mind are the increased female/male labor force participation, the decrease in the fraction of white collar workers, and the increased use of official training, and of flexible working contracts. Average age is always close to 36 years.

The regional distribution does not vary much over time (Table 2), with 25 percent of

[3]This is due to the identification of up to a scale parameter of limited dependent variable models like probits and logits.

the sample working in the North-east, 7 percent on the two Islands, 15 percent in the South, and the remaining fraction in the North-west and in the Center. The distribution over industries instead has been subject to important trends toward the credit sector, grown from 10 to 16 percent, the retail sector, grown from 17 to 21 percent, with most of drop concentrated in the public and private service sector (the excluded category in Table 3.

Table 4 presents the evolution of the set of marginal effects related to socioeconomic factors, our first results. Female workers, who compromise a growing fraction of the total workforce, are also increasingly subject to greater risk of getting injured, and only part of this increase is offset by the overall reduction in riskiness as measured by the intercept. Women's log-odds in 1994 were 84 percent lower than men's, while the difference was only 60 percent in 2003. Trainees, on the other hand, seem to subject to safer tasks now, than they did 10 years ago. A trend that might be related to their growing number. White collar workers seem to be more subject to injuries, and so are full time workers, compared to part-time workers. No clear trends are visible from either the regional, or the industry variables, with the exception of the construction sector that shows a (noisy) reduction in the probability of injury.

In order to have a clearer picture about how and why injury rates have evolved over time, notice that using the Blinder-Oaxaca decomposition (without the residuals, given that we use predicted values),

$$\log \frac{\widehat{p}_{it}}{1-\widehat{p}_{it}} - \log \frac{\widehat{p}_{i,t-1}}{1-\widehat{p}_{i,t-1}} = \widehat{\alpha}_t - \widehat{\alpha}_{t-1} + \widehat{\beta}_t' x_{it} - \widehat{\beta}_{t-1}' x_{i,t-1} \tag{2}$$

$$= \Delta\widehat{\alpha}_t + \Delta\widehat{\beta}_t' x_{i,t-1} + \widehat{\beta}_{t-1}' \Delta x_{i,t} \tag{3}$$

$$= \Delta\widehat{\alpha}_t + \Delta\widehat{\beta}_{t-1}' x_{i,t} + \widehat{\beta}_t' \Delta x_{i,t-1} \tag{4}$$

Using this decomposition we can, for example, ask ourself how the probability of injury of a given worker i ($\Delta x = 0$), evolves over time due to the changing workplace amenities.

This is what we show in Table 7. The Table reports the mean, the median, and the 90 percentile of three predicted probabilities of injury: (i) the standard one $\widehat{p_t} = x'\widehat{\beta}_t$, (ii) the one obtained using the 1994 coefficients $\widehat{p}_{t,94} = x'\widehat{\beta}_{94}$, and (iii) the one obtained using the 2003 coefficients $\widehat{p}_{t,03} = x'\widehat{\beta}_{03}$.

The most striking result is the reduction in injury rates, from 3.3 percent to 2.4 percent (27 percent drop), a reduction that can almost entirely be accounted by changing workplace amenities (changing βs). Only 3 percent $(1 - 0.032/0.033)$ can be attributed to changing Xs.

As for counterfactuals, had 1994 workers been subject to 2003 workplace conditions, their injury rate would have been 2.5 percent and not 3.3 percent (first row). The median changes show similar results, though for the 90 percentile changes are more pronounced. Injury rates for the 10 percent most risky jobs have dropped from 7.6 percent to 5.5 percent. Figure 4 plots the cumulative distribution function of $\widehat{p_t}$ (light grey line), of $\widehat{\widehat{p}}_{t,94}$ (grey line), and of $\widehat{p}_{t,03}$ (dark grey line). At low probabilities of injury no improvements are visible over time, while the largest horizontal distance between injury rates at 1994 conditions and 2003 conditions happens at the high end of the distribution. Changing Xs instead, explain a small part of the total reduction in injury rates between the 60th and the 80th percentile. The shape of the CDF tells us something about the inequality of injury rates as well. Since more workers risk less today than they did 10 years ago, while small risks have changed little over time, it is not surprising that the Gini index of injury rates, as well as other measures of inequality, have dropped over time (the Gini index has dropped from 0.474 to 0.449), and again mostly because of changing work amenities.

4 Conclusions

Despite the growing attention to the growing wage inequality, little is known about how other job characteristics have evolved over time. Hamermesh (1999) shows that in the US earnings inequality has understated inequality in the returns to work, because increasing wage differentials are associated with increasing inequality in injury rates. Our approach is slightly different. We do not condition on earnings, which are likely to be simultaneously determined with the probability of injury, but rather try to understand how the distribution of injury rates has evolved over time. Nevertheless, inequality in injury rates has decreased over the last 10 years, dampening the documented increase in earnings inequality.

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Table 1: Summary statistics of socioeconomic factors (mean) by year.

Year	Female	Age	Trainees	White col.	Fraction of the year worked
1994	0.380	36.204	0.013	0.391	0.728
1995	0.383	35.952	0.015	0.399	0.720
1996	0.387	36.317	0.014	0.385	0.711
1997	0.390	36.126	0.016	0.387	0.715
1998	0.387	36.346	0.027	0.367	0.709
1999	0.384	35.852	0.033	0.350	0.676
2000	0.380	35.938	0.041	0.345	0.635
2001	0.393	35.861	0.045	0.345	0.628
2002	0.394	36.141	0.047	0.346	0.623
2003	0.403	36.363	0.047	0.347	0.624

Table 2: Summary statistics of the area of residence (mean) by year.

Year	North East	Islands	South
1994	0.246	0.074	0.151
1995	0.257	0.071	0.145
1996	0.249	0.071	0.148
1997	0.251	0.071	0.149
1998	0.253	0.065	0.143
1999	0.255	0.069	0.143
2000	0.253	0.068	0.141
2001	0.248	0.066	0.150
2002	0.244	0.070	0.150
2003	0.236	0.070	0.156

Table 3: Summary statistics of socioeconomic factors (mean) by year.

Year	Energy	Mining	Metal	Textile	Construction	Retail	Communication	Credit
1994	0.016	0.052	0.158	0.172	0.093	0.169	0.050	0.096
1995	0.014	0.051	0.164	0.170	0.088	0.171	0.051	0.099
1996	0.014	0.048	0.165	0.174	0.080	0.170	0.052	0.101
1997	0.013	0.053	0.158	0.176	0.082	0.170	0.056	0.100
1998	0.014	0.054	0.171	0.173	0.085	0.174	0.055	0.105
1999	0.011	0.052	0.176	0.170	0.090	0.185	0.060	0.122
2000	0.011	0.048	0.167	0.163	0.088	0.194	0.061	0.138
2001	0.006	0.046	0.169	0.161	0.089	0.200	0.052	0.148
2002	0.009	0.046	0.160	0.150	0.097	0.201	0.052	0.147
2003	0.011	0.043	0.146	0.147	0.096	0.205	0.053	0.156

Table 4: Marginal effects of socioeconomic factors on the injury log-odds.

Year	Intercept	Female	Age	Trainees	White col.	Fraction of the year worked
1994	-3.36	-0.839	-0.008	-0.017	-1.648	0.944
1995	-3.49	-0.907	-0.006	-0.073	-1.645	0.857
1996	-3.35	-0.801	-0.010	-0.130	-1.626	0.998
1997	-3.34	-0.827	-0.012	-0.409	-1.509	0.922
1998	-3.33	-0.765	-0.013	-0.184	-1.558	0.935
1999	-3.29	-0.716	-0.011	-0.446	-1.525	0.858
2000	-3.63	-0.677	-0.015	-0.367	-1.486	1.263
2001	-3.58	-0.614	-0.013	-0.549	-1.563	1.226
2002	-3.71	-0.668	-0.011	-0.532	-1.524	1.218
2003	-3.92	-0.600	-0.010	-0.380	-1.420	1.201

Table 5: Marginal effects of the region of residence (wrt. to the Center, and the North-West) on the injury log-odds.

Year	North east	South	Islands
1994	0.178	-0.189	-0.381
1995	0.171	-0.121	-0.283
1996	0.186	-0.197	-0.262
1997	0.230	-0.175	-0.301
1998	0.220	-0.115	-0.351
1999	0.232	-0.211	-0.260
2000	0.173	-0.228	-0.347
2001	0.236	-0.169	-0.197
2002	0.276	-0.193	-0.324
2003	0.155	-0.182	-0.292

Table 6: Marginal effects of industries (wrt. to the service sector) on the injury log-odds.

Year	Energy	Mining	Metal	Textile	Construction	Retail	Communication	Credit
1994	-0.235	0.411	0.235	0.039	0.541	-0.125	0.241	0.010
1995	-0.253	0.477	0.406	0.139	0.431	0.110	0.076	-0.074
1996	-0.033	0.387	0.240	-0.045	0.369	-0.164	-0.055	-0.064
1997	-0.038	0.319	0.302	0.049	0.424	-0.136	0.131	0.006
1998	0.013	0.410	0.328	0.047	0.415	-0.050	0.179	0.025
1999	-0.350	0.381	0.292	0.069	0.341	-0.021	0.136	-0.028
2000	-0.134	0.607	0.360	0.157	0.473	0.074	0.385	0.229
2001	0.065	0.375	0.199	-0.061	0.376	-0.037	0.209	0.061
2002	-0.192	0.429	0.167	-0.030	0.260	-0.130	0.109	0.021
2003	-0.210	0.544	0.368	0.122	0.499	0.050	0.329	0.169

Table 7: Estimated probability of injury, and its decomposition

	Mean			Median			90 th percentile		
	p	p 94	p 03	p	p 94	p 03	p	p 94	p 03
1994	0.033	0.033	0.025	0.024	0.024	0.019	0.076	0.076	0.056
1995	0.031	0.032	0.025	0.022	0.023	0.018	0.074	0.075	0.056
1996	0.031	0.033	0.025	0.023	0.024	0.019	0.070	0.074	0.056
1997	0.030	0.033	0.025	0.022	0.024	0.018	0.068	0.077	0.057
1998	0.031	0.034	0.026	0.024	0.025	0.019	0.070	0.076	0.057
1999	0.032	0.034	0.026	0.025	0.025	0.019	0.068	0.077	0.057
2000	0.028	0.033	0.024	0.021	0.025	0.018	0.066	0.075	0.056
2001	0.028	0.032	0.024	0.020	0.024	0.018	0.063	0.074	0.055
2002	0.025	0.032	0.024	0.018	0.024	0.018	0.057	0.074	0.055
2003	0.024	0.032	0.024	0.017	0.023	0.017	0.055	0.074	0.055

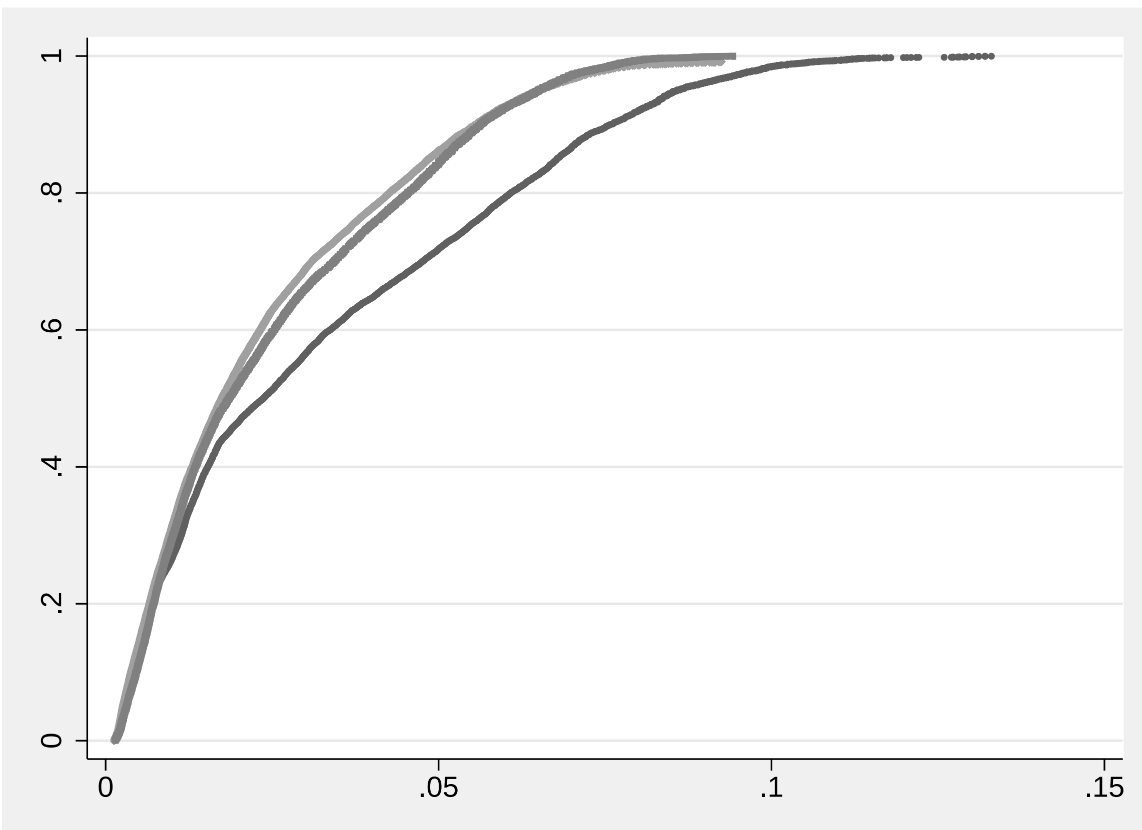

Figure 1: CDF of probability of injury. In order of darkness (or left to right): CDF 2003, CDF 1994 with 2003 coefficients, CDF 1994.