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Wage structure in Italian Manufacturing firms

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Wage structure in Italian Manufacturing Firms*

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Abstract

This paper jointly considers some pieces of evidence regarding peculiarities of industries' structure which are often separately addressed. Italian industrial sectors are known to be characterized by a high proportion of small enterprises that suffers from "constraints to growth". We look at the interplay of variables accounting for size, productivity and labor cost, and assess the relevance of labor force structure in determining the structure of cost for wage. We start by exploring the firm size-wage effect in Italian manufacturing sectors and investigate the extent to which such a trend is offset by a positive and counterbalancing relation linking together productivity and size. We investigate how size contributes to the wage differential within a firm on the earnings of distinct categories of employees. The empirical findings we present reveal that labor force structure matters in determining the wage cost structure of firms.

1 Introduction

This work makes use of microdata to empirically investigate the structure of the total cost for wage in Italian business firms. By means of non-parametric and parametric analysis we provide a unified framework to account for two phenomena emerging after an exploratory analysis, namely the positive relations linking together both wage and productivity to the size of the firm. In this respect the present paper provides some complementary features to other works on Italian data (Dosi and Grazzi, 2006; Bottazzi et al., 2007). We refer the interested reader to those works for an investigation of the properties of the size distributions of firms, their growth processes and productivity dynamics. Here, we focus on issues concerning differentials in the cost of labor and the relevance of organizational structure in affecting total cost for wage in a firm.

Literature on industry dynamics has received new impulse and enthusiasm from the growing availability of microdata which enable to recover a much more in-depth representation of the structure and dynamics characterizing different sectors.

Accurate microdata are of vital importance for empirical work aimed at recovering existing peculiarities in the organizational and productive structure of firms operating in different

*We thank Giovanni Dosi for many useful discussions and for his comments at various stages of this work and Federico Tamagni whose comments helped writing the final version. The statistical exercises which follow would not have been possible without the valuable help of the Italian Statistical Office (ISTAT) and in particular of Roberto Monducci and Andrea Mancini. The usual disclaimer apply.

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sectors as well as a broader understanding of the level of heterogeneity in a given sector. This relatively recent research strand has indeed revealed a much more dynamic and variegated picture than what conventionally expected.

Davis and Haltiwanger (1992, 1995) make use of a rich database, combining different sources of information, which enable for the matching of household and establishment data for the U.S. manufacturing, thus allowing to exploit the matching between person-level and establishment-level data, and being able to break down wage dispersion into between-plant and within-plant component. They find that mean wages are sharply higher at larger establishments, further, age dispersion falls with establishment size and size-class differences in wage dispersion often mask even sharper differences in the dispersion of wages generated by observable worker characteristics.

The literature on firm size-wage effect has extensively documented the evidence of a positive relation between employer size and wages. Starting as early as Moore (1911) scholars have been reporting the existence of such an increasing relationship. This regularity, though persistent over time and well documented for several countries, both at the firm and establishment level (Davis and Haltiwanger, 1991; Main and Reilly, 1993; Brunello and Colussi, 1998; Arai, 2003; Lallemand et al., 2005), is not completely understood.

Brown and Medoff (1989) present some thorough empirical results matching together the Current Population Survey (CPS), providing data for individuals, and various surveys containing data for establishments. They find that among the various assumptions attempting to explain the wage-size effect, the one to find sounder empirical support is the difference in workers' quality[1] among size classes, which accounts for roughly *one-half* of observed mean wage differentials[2]. Nevertheless, they also acknowledge that the analysis as such leaves the researcher uncomfortably unable to account for the part of the differential which is not explained by observable indicators of labor quality. Thus, the authors conclude that "the employer size-wage effect remains a fact in need of an empirically based theory (Brown and Medoff, 1989, p. 1057)." The empirical analysis we perform in Section 3 confirms the presence of such a residual effect of size on wage, and further investigation also reveals a different responsiveness of employees' wage to firm size according to the category (i.e. production/non-production worker) they belong to. The existence of such a puzzle has been for long a source of inspiration for many scholars on the subject to put forward new theories and reconsider old ones.

The results we present here confirm the existence of a significant and increasing relation between size of firms and unitary costs of labor. After a detailed presentation of the database (Section 2), we consider the relation between the cost of labor bore by a firm, its productivity and size (Section 3). With many respects this analysis parallels and complements that in Fagiolo and Luzzi (2006) and Bottazzi et al. (2006). There the authors consider how the interplay of size and financial soundness impacts firms' growth patterns. Here we assess the role of workforce composition in shaping the wage structure of firms, also evaluating for the possibility of relative cost advantages of smaller firms as compared to bigger ones.

Compared to the vast empirical literature focusing on the size-wage effects in different countries, there exists a limited number of similar attempts for Italy, most likely due to data scarcity. Lucifora (1993) and Brunello and Colussi (1998) are two of these exceptions. In particular Brunello and Colussi (1998) employ a Bank of Italy national survey on the income and wealth of Italian households (*Indagine sui bilanci delle famiglie italiane*) and find that

[1] Typical proxies of worker's quality are education, years of experience, etc.

[2] The issue of wage differentials, at length, has pervasively attracted interest of scholars dealing with various research topics in the domain of labor economics, see for instance the contribution of Zàbojnìk and Bernhardt (2001) and Hu (2003) respectively on corporate tournaments and compensation structure.

the observed raw differential of wage for small and big firms is almost entirely explained by differences in individual characteristics and by the endogenous allocation of workers to jobs.

The purpose - and the novelty - of the present work is to account for the existing firm size-wage gap, not in terms of worker characteristics but rather in terms of the outcome of these workers' differences in affecting the increased firm efficiency. Indeed we show in Section 3.2 that once accounted for labor productivity of firms, size plays a residual, yet significant, role in explaining the cost structure of companies. Being able to distinguish among different categories of employees we investigate whether wages of production and non-production workers display different sensitivities to firm size. Then, in Section 4 we assess the role of labor force structure of firms in accounting for the wage-size relation.

2 Description of the data

The research we present here draws upon the MICRO.1 databank developed by the Italian Statistical Office (ISTAT)[3]. MICRO.1 contains longitudinal data on a panel of several thousands of Italian firms with employment of 20 units or more and it covers the years 1989-97.

As reported in Bartelsman et al. (2004) the percentage of manufacturing firms with more than 20 employees is the 12% of the total population. However, these relative larger companies account for almost 70% in terms of employment. In the following, we focus our empirical analysis only on those firms operating in the manufacturing sectors, which referring to the ISIC classification, are those in the tabulation category D and include all firms in the range 15-37 (UNSD, 2002).

MICRO.1 contains the census of Italian firms bigger than 20 employees. There are though, for certain years, some non-respondents or firms appearing in the database only at the end of the period, as they reach the threshold criteria, or on the contrary exiting the database as they shrink. This makes MICRO.1 an unbalanced panel and some investigation revealed that, at least for the variables considered in this study, the degree of completeness of the database is around 65%. Nonetheless we believe that two following points largely endorse the validity of MICRO.1 for the nature of the analysis we are performing in this work. The census nature of MICRO.1 guarantee us against possible bias in the data collection process. We did not indeed detect any particular trend in non-respondents: firms not-responding for some years and then reappearing again, do not generally show particular changes in their structure, performance, etc. Finally, concerning the 20 employees threshold, the property of MICRO.1 to account for such a big share of employment, stands for the wide representativeness of the database of Italian firms operating in the different sectors of manufacturing industry.

As far as cross-country comparability is concerned, it is important to, at least, be aware of some country-specific characteristics. A first one pertains to the labor market regulations. In this work we are not interested at depth with this issue and refer the interested reader to Nickell (1997), Bertola and Ichino (1995) and ISTAT (2005), for a more comprehensive account on the matter and a closer focus on the Italian case. Then, as far as data collection is concerned, it is important to remind that most of U.S. studies consider the "plant" as the level of analysis, whether, on the contrary, in Europe, it is the "firm" to be the unit for data collection.

Firms in the database are classified according to their sector of principal activity following the ISIC classification. For our analysis we typically disaggregate each sector at the three

[3]The database has been made available to our team under the mandatory condition of censorship of any individual information.

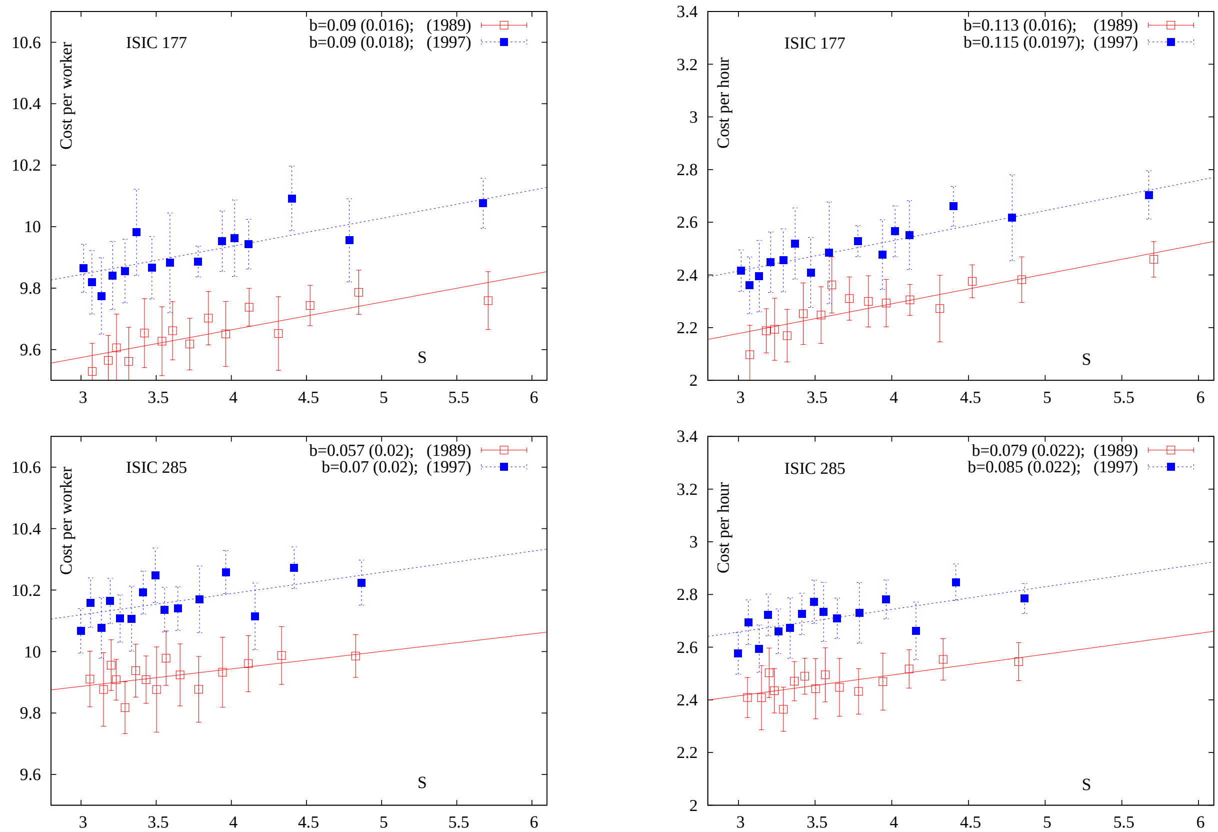

Figure 1: **(Left Side)** Relation between size (as number of employees employees) and cost of labor in 1989 and 1997. Variables are in logs. **(Right Side)** Cost of labor measured as average cost per hour of work (in thousands) in the same years.

digits level, unless explicitly stated. This is purported at considering firms which are, to a good extent, involved in the same production activity and at the same time this is meant to preserve a reasonable number of observations to perform econometric analysis.

MICRO.1 contains information appearing in firms' financial statement together with the additional variables contained in the annual census conducted by ISTAT. Thanks to the source of the data we have access to different measures of "cost of labor", in that we can sort out the wage paid to the worker from the total cost bore by firms[4]. MICRO.1 is a distinguishable resource for such empirical analysis as it also allows to distinguish the total number of employees between production and non-production workers and their wages[5].

Finally, in order to account for possible trends in the variables of interest we deflate our data on monetary variables making use of the sectoral index provided by ISTAT[6]. During the period under investigation 1989-1997, Italy underwent a monetary crisis that forced the Lira out of the monetary union; thus a procedure aimed at washing out inflation driven bias is badly needed to identify real trend in variables such as cost of labor or productivity. Finally

[4]Total cost per worker can indeed be split into *a)* salary paid to employee (comprising wage, overtime pay and bonus); *b)* corporate income taxation; *c)* retirement pay, the so-called *Trattamento Fine Rapporto*.

[5]The section on employment comprehends information on entrepreneurs, clearly with no data about cost of labor; non-production worker, comprising both managers and entry-level (respectively *dirigenti* and *impiegati*); production worker as blue-collars, assistants, apprentices and work from home arrangements (respectively *operai*, *commessi*, *apprendisti* and *lavoratori a domicilio*.

[6]Istat, the Italian statistical offices provides online many time series of the Italian economy at *http://con.istat.it/default.asp*

to ease the interpretation of results we also report all variables in euro, even though at the time these reports were filled in Lira currency[7].

3 Cost of Labor and Productivity in Italian Manufacturing Firms

The criteria we follow in the empirical analysis we present here is to move, incrementally, from bivariate and non-parametric analysis to functional models comprising more explanatory variables. In this bottom-up process we first identify some broad relations existing between variables and then we proceed to introduce some parametric specifications which allow for a more precise description of the identified effects. In the following we focus our analysis on firms active in the manufacturing sectors. We present plots and tables of most populated and representative sectors at the 3 Digit level of sectoral disaggregation.

3.1 An exploratory analysis

In this section we analyze the relation between total cost of labor, W, and size of the firm as proxied by number of employees, L. If the cost of labor does not depend on firm size, the labor total expenditure, W, grows proportionally with the number of employees L.

We start by considering the following scaling relation

$$W \sim L^{1+\beta} \tag{1}$$

If $\beta > 0$ then larger firms incur, in general, in increased labor costs, while if $\beta < 0$ the opposite happens. In order to capture these effects we fit a log-linear relation between the labor cost per employee $C = W/L$ and the number of employees L with the model

$$c_i(t) = \alpha + \beta l_i(t) + \epsilon_i(t) \tag{2}$$

where subscript t identifies the year of interest and lowercase symbols denote the logarithm of the original variables, that is $c = \log C$ and $l = \log L$. The choice of taking the log of variables is motivated by an improved representation of the data in the plot. Indeed, the width of the support of the distribution, as shown in Figure 1, would preclude to appreciate any relation between the variables with "raw" data.

Figure 1 exhibits plots for the sectors of knitting and crocheted articles (ISIC 177) and treatment and coating of metals (ISIC 285). Table 1 reports coefficients for all sectors in the analysis. In general, a positive relation appears between the labor cost per employee and size. Plots on the left of Figure 1 make use of yearly expenses per worker as a proxy for the wage rate, while those on the right employ of cost per hour. Both of plots display the same trend, thus revealing that the increasing relation between size and cost of labor is independent of the proxies of wage rate employed - at least those considered here. Due to the small magnitude of the standard errors of coefficients in Table 1 the relation is significant in all sectors and years considered but one, meaning that labor cost per employee is increasing more than proportionally in size.

Plots in Figure 1 as well as coefficients in Table 1 show that the relation between size and labor cost is stable over time, given the small change in coefficients between the beginning

[7] During the period under investigation the Italian currency with legal tender status was the Italian Lira whose exchange rate with the euro was fixed at 1 € per 1936.27 Lira.

SECTOR	ISIC Code	1989 α	1989 β	1989 $\overline{Lab. Cost}$	1997 α	1997 β	1997 $\overline{Lab. Cost}$
Production & processing of meat	151	**9.881** (0.067)	**0.050** (0.017)	24355 (5204)	**10.036** (0.069)	**0.053** (0.017)	28979 (6546)
Knitted & crocheted articles	177	**9.303** (0.065)	**0.090** (0.016)	16069 (3737)	**9.570** (0.070)	**0.091** (0.018)	20856 (4848)
Wearing apparel & accessories	182	**8.974** (0.050)	**0.151** (0.012)	15044 (4630)	**9.283** (0.046)	**0.142** (0.012)	19125 (6000)
Footwear	193	**9.299** (0.068)	**0.097** (0.017)	16450 (4164)	**9.652** (0.062)	**0.065** (0.016)	20362 (5193)
Articles of paper and paperboard	212	**9.720** (0.057)	**0.087** (0.014)	24118 (4923)	**9.748** (0.060)	**0.135** (0.015)	29956 (6989)
Printing and services related to printing	222	**9.760** (0.063)	**0.150** (0.016)	31691 (9146)	**9.756** (0.081)	**0.156** (0.021)	32811 (20975)
Plastic products	252	**9.683** (0.051)	**0.098** (0.013)	24187 (5711)	**9.803** (0.045)	**0.108** (0.011)	28340 (6356)
Articles of concrete, plaster & cement	266	**9.968** (0.079)	0.035 (0.020)	25160 (5834)	**9.865** (0.086)	**0.112** (0.023)	30111 (7101)
Metal products	281	**9.586** (0.071)	**0.114** (0.019)	22995 (5539)	**9.714** (0.072)	**0.140** (0.019)	28470 (6754)
Treatment & coating of metals; general mechanical engineering	285	**9.716** (0.089)	**0.057** (0.024)	20988 (4804)	**9.904** (0.076)	**0.069** (0.021)	26528 (6690)
Special purpose machinery	295	**9.991** (0.038)	**0.072** (0.009)	29798 (6297)	**10.081** (0.039)	**0.085** (0.009)	34436 (7865)
Furniture	361	**9.537** (0.042)	**0.113** (0.011)	21832 (4856)	**9.743** (0.040)	**0.088** (0.011)	24180 (5530)

Table 1: Relation between size (as number of employees) and labor cost per employee in 1989 and 1997. OLS estimates. Constant price log variables; standard errors in brackets; coefficients significant at the 0.05 level are in bold. See also Fig. 1, left panel. $\overline{Lab. Cost}$ is the average cost of labor for firms in every sector, in thousands of euro.

and the end of the period of analysis. Also note in Figure 1 that the fitted lines display an outward shift when comparing observation for 1989 and 1997. As the monetary variables in the analysis are already inflation-adjusted, such a shift represents the sectoral average increase in the cost of labor in real terms. Table 1 reports in the third column of each year of analysis the average cost of labor for all sectors. The assessment of such a trend, which goes far beyond the scope of the present work, might shed some light on the sources of Italian often claimed competitiveness loss in recent years (Malgarini and Piga, 2006).

A quite straightforward consequence of the relation between size and labor cost described above is the significant degree of heterogeneity in the labor cost per employee born by firms in the same sectors. Let us consider consider again our illustrative sectors. Focusing on the relation in 1997, for firms in the knitted and crocheted sectors (top left of Figure 1) the plot shows that firms belonging to the bin of smallest size benefit of a labor cost per employee - in per capita terms - which is more than 25% smaller than firms in the bins populated by the biggest companies in the sector. This “spread” in the cost of labor might appear negligible at first, but one has to consider that most employment contracts in Italy are set according

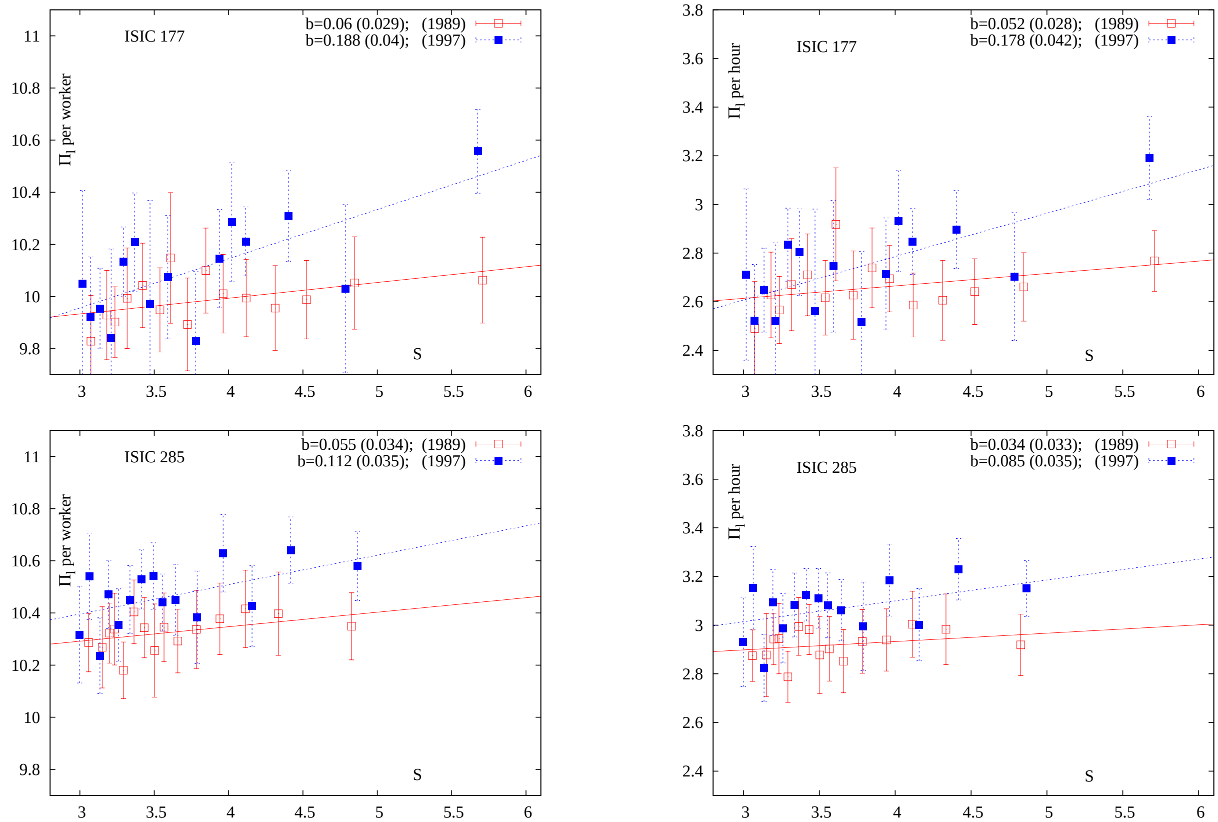

Figure 2: **(Left Side)** Relation between size (as number of employees) and labor productivity, Π_l, as value added per worker for years 1989 and 1997. Variables are in logs. **(Right Side)** Labor Productivity as value added per hour of work (in thousands) in the same years.

to nation-wide agreements in the various industrial sectors, once accounted for the flattening effects of such regulations on earnings, the wage spreads observed are substantial. In Section 3.2 and 4 we further investigate this relation and identify some of its sources. This "regularity" of firms facing rather different wage rates is well in tune with the evidence reported in Dosi and Grazzi (2006) and Bottazzi et al. (2007) on the heterogeneity in the mix of inputs and in the level of labor productivities of firms in the same sector; and as such contribute to lend empirical support to a picture of pervasive and persistent heterogeneities characterizing business firms.

As described at length in Section 1 the existence of a positive relation between size of the firm and wage is not a new one. Nonetheless, to provide a thourough account of those issues related to the scale of the activity also embracing, for instance, some measure of profitability (in this respect see also Prattern (1971)), it is necessary to control for the different level of labor productivity that can possibly characterize these firms.

To this respect, let us analyze the relation between the total value added produced by a firm, VA, and the number of its employees, L. If the productivity of labor does not depend on the size of the firms, we expect to find a proportional relation between these two variables. By the same token as before, we try to capture possible deviations from the proportionality assumptions by fitting a double log relation between labor productivity, $\Pi = VA/L$, and the number of employees, L

$$\pi_i(t) = \alpha + \beta l_i(t) + \epsilon_i(t) \tag{3}$$

SECTOR	ISIC Code	1989			1997		
		α	β	$\overline{Lab.\,Prod}$	α	β	$\overline{Lab.\,Prod}$
Production & processing of meat	151	**10.353**	0.033	38.746	**10.249**	**0.086**	44.777
		(0.132)	(0.033)	(15.126)	(0.160)	(0.039)	(19.500)
Knitted & crocheted articles	177	**9.752**	**0.060**	24.017	**9.390**	**0.189**	28.399
		(0.117)	(0.029)	(13.000)	(0.165)	(0.042)	(21.970)
Wearing apparel & accessories	182	**9.083**	**0.192**	21.648	**8.833**	**0.288**	24.071
		(0.079)	(0.020)	(14.351)	(0.091)	(0.024)	(18.899)
Footwear	193	**9.325**	**0.152**	21.649	**9.555**	**0.127**	25.300
		(0.090)	(0.023)	(8.891)	(0.140)	(0.037)	(11.242)
Articles of paper and paperboard	212	**10.264**	**0.072**	40.638	**10.124**	**0.152**	49.978
		(0.097)	(0.024)	(15.615)	(0.121)	(0.030)	(23.504)
Printing and services related to printing	222	**10.220**	**0.123**	46.251	**10.030**	**0.142**	42.637
		(0.083)	(0.021)	(16.938)	(0.134)	(0.035)	(19.383)
Plastic products	252	**0.323**	**0.057**	40.745	**10.026**	**0.155**	46.227
		(0.083)	(0.021)	(15.927)	(0.098)	(0.025)	(23.219)
Articles of concrete, plaster & cement	266	**10.599**	-0.011	41.474	**9.897**	**0.181**	42.711
		(0.137)	(0.035)	(16.867)	(0.157)	(0.041)	(17.396)
Metal products	281	**10.006**	**0.093**	33.619	**9.882**	**0.166**	39.350
		(0.108)	(0.028)	(12.776)	(0.138)	(0.037)	(18.581)
Treatment & coating of metals; general mechanical engineering	285	**10.125**	0.056	32.528	**10.049**	**0.113**	38.117
		(0.127)	(0.035)	(12.288)	(0.131)	(0.036)	(16.808)
Special purpose machinery	295	**10.514**	**0.035**	45.083	**10.318**	**0.100**	48.828
		(0.064)	(0.016)	(16.367)	(0.069)	(0.017)	(19.129)
Furniture	361	**9.698**	**0.156**	31.429	**9.736**	**0.160**	32.949
		(0.085)	(0.022)	(10.575)	(0.071)	(0.019)	(12.609)

Table 2: Relation between size (as number of employees) and labor productivity in 1989 and 1997. OLS estimates. Constant price log variables; standard errors in brackets; coefficients significant at the 0.05 level are in bold. See also Fig. 2, left panel. $\overline{Lab.\,Prod}$ is the average cost of labor for firms in every sector, in thousands of euro.

where $\pi = \log \Pi$. If $\beta = 0$, then the amount of value added produced per worker does not depend on the size of the firm. As shown by plots in Figure 2, this is not the case, and labor productivity does indeed depend on firm size through an increasing relation. Again, note that, as before, choosing per capita (left panel) or per hour (right panel) labor productivity does not affect the analysis. Statistical significance of coefficients in Table 2 supports the hypothesis that bigger firms enjoy higher levels of labor productivity.

Comparison of average labor productivity over time (third column of each year in Table 2) shows that such measure of efficiency is increasing in all but one sector (ISIC code 222).

Inspection of β coefficients in Table 1 and 2 one at a time does not allow to recover if one of the effects is overwhelming the other one, that is, it is not possible to answer the question if the increasing relation between size and productivity is sufficient to compensate a cost of labor which is also augmenting with the number of employees. It is then necessary to build a measure that provides a succinct picture of the relation between cost of labor and productivity at different levels of firm size.

To this end we are going to consider as a proxy for unit labor cost the ratio between total

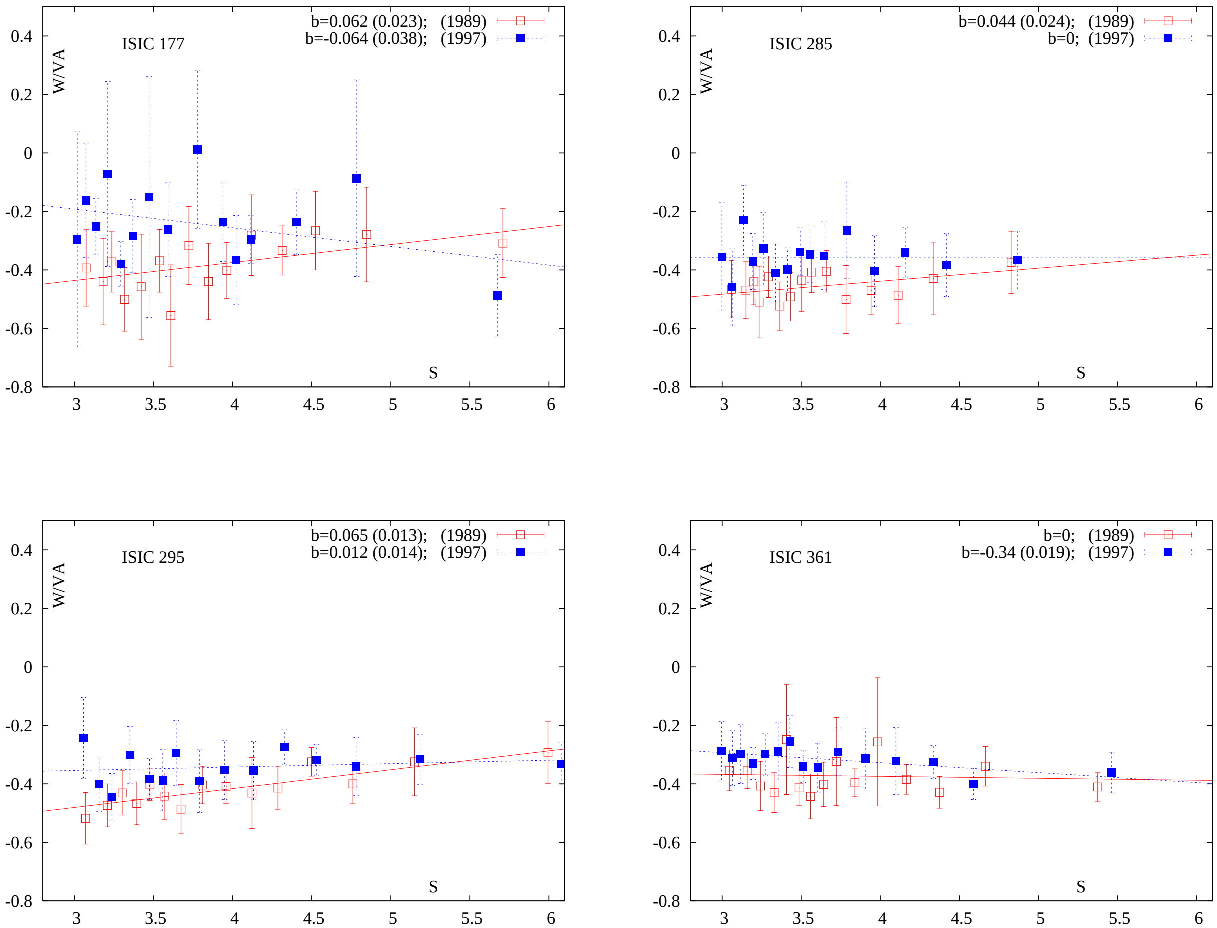

Figure 3: Relation between size (as number of employees) and unit labor cost (as cost per worker over labor productivity, c/Π_l) in four different ISIC 177, 285, 295 and 361. Variables are in log.

labor cost and value added (see also Kravis and Lipsey (1982)), $UC = W/VA$. Given the very likely occurrance of positive per capita value-added, unit labor cost takes values in the interval $(0, 1]$ (and when variables are in log, $(-\infty, 0]$). Quite obviously, a value of the ratio close to zero (one) suggests a very low (high) incidence of labor cost on value added, as such, unit labor cost also provides a first account of distributive shares.

We investigate the relation between unit labor cost, as defined above, and firm size, fitting the linear model

$$\frac{c_i(t)}{\pi_i(t)} = \alpha + \beta s_i(t) + \varepsilon_i(t) \tag{4}$$

Results for ISIC sectors 177, 285, 295 and 361 are displayed in Figure 3. Coefficients for all sectors are in Table 3. The plots do not display any clear relation between the variables of interests. On the contrary to previous tables, β parameters are only seldomly significant, and almost never for the latest period of investigation. The few coefficients one might comment upon are positive, suggesting that at first, bigger firms have to bear, on average, a higher unit cost of labor.

Then, pursuing to identify which of the two trends emerge as more influential we represent the relation among the variables of interest by means of a multivariate kernel regression (Bottazzi et al., 2006). This is a non-parametric technique which allows the representation

SECTOR	ISIC Code	1989			1997		
		α	β	$\overline{Unit\,Cost}$	α	β	$\overline{Unit\,Cost}$
Production & processing of meat	151	**-0.618**	0.041	0.707	**-0.367**	-0.007	0.865
		(0.111)	(0.027)	(0.771)	(0.133)	(0.032)	(2.089)
Knitted & crocheted articles	177	**-0.621**	**0.062**	0.721	0.000	-0.064	0.916
		(0.091)	(0.023)	(0.248)	(0.151)	(0.039)	(0.981)
Wearing apparel & accessories	182	**-0.242**	-0.018	0.761	**0.281**	**-0.115**	1.066
		(0.048)	(0.012)	(0.196)	(0.073)	(0.019)	(3.947)
Footwear	193	**-0.215**	-0.019	0.767	**-0.085**	-0.028	1.089
		(0.056)	(0.014)	(0.185)	(0.122)	(0.032)	(2.678)
Articles of paper and paperboard	212	**-0.685**	**0.042**	0.615	**-0.531**	0.011	0.676
		(0.077)	(0.019)	(0.151)	(0.105)	(0.026)	(0.559)
Printing and services related to printing	222	**-0.644**	**0.062**	0.685	**-0.416**	0.036	0.919
		(0.063)	(0.016)	(0.175)	(0.114)	(0.030)	(1.761)
Plastic products	252	**-0.788**	**0.069**	0.630	**-0.370**	-0.020	0.755
		(0.065)	(0.016)	(0.381)	(0.083)	(0.021)	(1.378)
Articles of concrete, plaster & cement	266	**-0.787**	**0.077**	0.670	-0.215	-0.033	0.774
		(0.102)	(0.026)	(0.758)	(0.123)	(0.032)	(0.533)
Metal products	281	**-0.619**	**0.059**	0.706	**-0.398**	0.022	0.819
		(0.083)	(0.022)	(0.342)	(0.121)	(0.033)	(1.026)
Treatment & coating of metals; general mechanical engineering	285	**-0.617**	0.045	0.653	**-0.357**	0.000	0.755
		(0.090)	(0.024)	(0.150)	(0.106)	(0.029)	(0.431)
Special purpose machinery	295	**-0.674**	**0.065**	0.702	**0.389**	0.012	0.762
		(0.054)	(0.013)	(0.444)	(0.060)	(0.014)	(0.408)
Furniture	361	**-0.347**	-0.007	1.183	**-0.191**	**-0.034**	0.773
		(0.081)	(0.021)	(10.864)	(0.060)	(0.016)	(0.372)

Table 3: Relation between size (as number of employees) and unit labor cost in 1989 and 1997. Constant price log variables; standard errors in brackets; coefficients significant at the 0.05 level are in bold. See also Fig. 3.

of relations among variables without imposing any *a priori* structure on the data themselves (see Pagan and Ullah (1999) and Härdle et al. (2004)). Here the interest is to estimate the conditional expectation of the logarithm of value added, va, given the size and the total cost of a firm, respectively, l and w.

$$E[va|(l,w)] = \int va\, f(va|l,w)\, dva = \frac{\int va\, f(va,l,w) dva}{f(l,w)} \tag{5}$$

where $f(va,l,w)$ is the joint probability density of having value added level va, size l and labor cost equal to w. Replacing $f(va,l,w)$ with the multivariate kernel density estimates $\hat{f}(va,l,w)$ a kernel estimation of the expected value added $\hat{E}(va|(l,w))$ can be defined

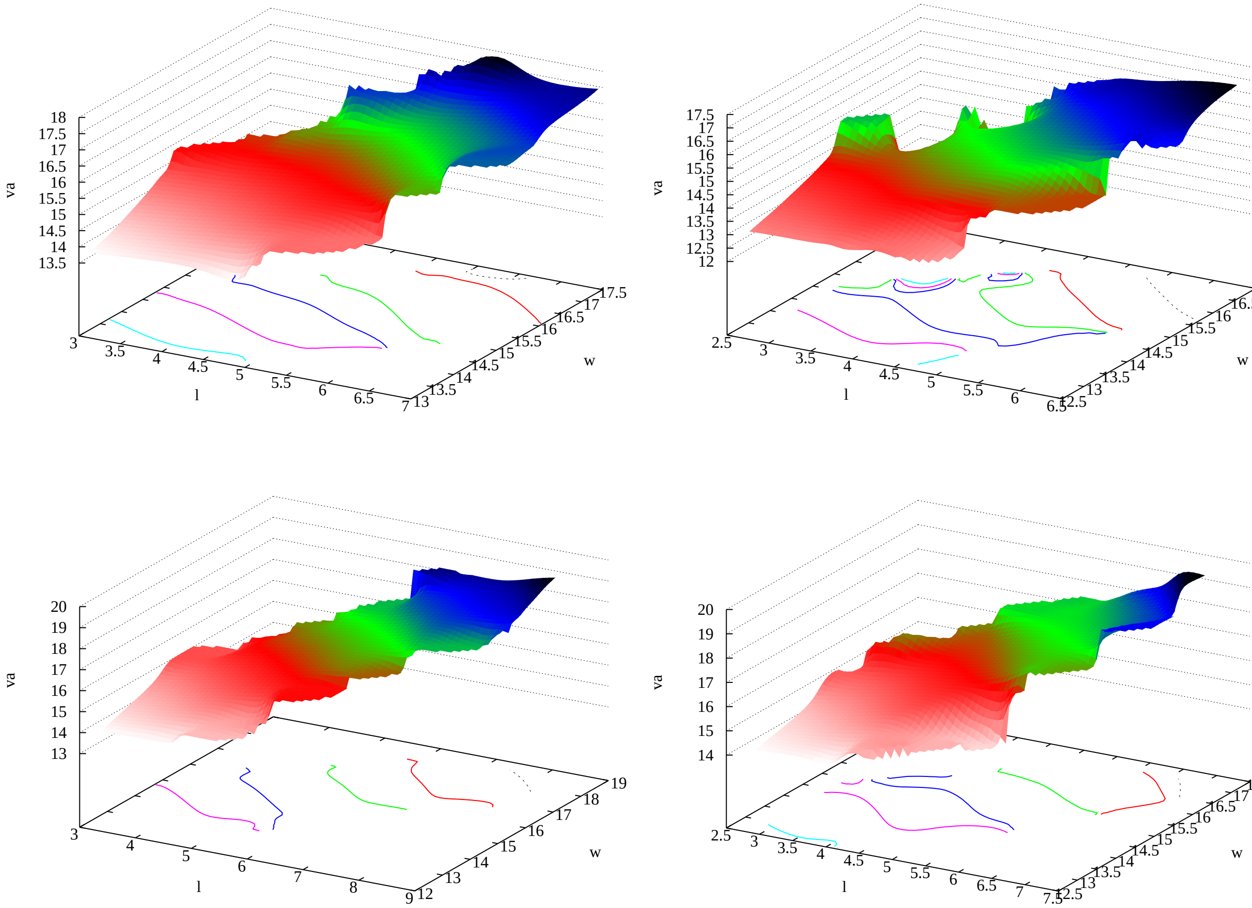

Figure 4: Kernel estimate of the conditional expectation of value added $\hat{E}(va|(l,w))$ in 1997 in 4 different sectors, starting top-left and moving clockwise, ISIC 17, 28, 29 and 36. The estimation is computed in 50 points.

(Silverman, 1986)

$$\hat{E}[va|(l,w)] = \frac{\sum_{i=1}^{N} va_i \; K\left(\frac{l-l_i}{h_l}, \frac{w-wi}{h_w}\right)}{\sum_{i=1}^{N} K\left(\frac{l-l_i}{h_l}, \frac{w-w_i}{h_w}\right)} \tag{6}$$

The resulting conditional expectation functions $\hat{E}(va|(l,w))$ for four sectors are shown in Fig. 4. To each combination of (log) size l and (log of) cost w, on x and y axis corresponds the relative level of (log) value added va, on the z axis. Using the kernel estimation technique, smooth surfaces have been obtained from the discrete sets of observations. As a reference, the location of the observed amount of inputs (l,w) has been reported on the basis of plots. The use of logarithmic scales allows us to represent firms of very different dimensions on the same plot so that the identification of possible patterns becomes possible.

Plots in Fig. 4 are realized with data aggregated at the 2 Digit sectoral level in order to account for the data requirement of non-parametric analysis in terms of number of observations.

Some features of Fig. 4 are more explicit, whereas others deserve more accurate comments. First of all, as might be expected after the bivariate analysis, the plots corroborate the hypothesis that cost of labor is, on average, increasing both in size and productivity[8]. Again, as the analysis in Bottazzi et al. (2006) revealed for the relation between the mix of inputs and output, the non-parametric analysis enables to better appreciate the substantial diversity, both in terms of efficiency and labor force structure, of the firms which are involved in the same production activity and competing in the same sector. In this respect, Fig. 4 confirms, additionally to an already well-documented heterogeneity in firms' size (Bottazzi et al., 2007), the width of the support of the distribution of labor productivity and how it impacts on the cost of labor.

Further, cost of labor appears to be slightly more sensible to variation in productivity than size. Then, since the relation among variables does not display any clear non-linearity, we proceed to fit a parametric linear multivariate model which allows to explicitly account for and estimate the residual effects of size, once we have elicited the cross-correlation between labor cost and productivity.

3.2 A multivariate parametric approach

The previous paragraph suggested that the scale of the activity itself does affect both cost of labor and productivity. We now address this issue in a multivariate linear framework which allows to assess the effects of size and cost on value added. The specification of the model chosen at this stage, will enable us to enrich the analysis later on, see Section 4, introducing how different structures of labor force matters in shaping the firm wage-size relation. In the following we start fitting the model

$$\ln(W_i) = \alpha_1 + \alpha_2 \ln(L_i) + \alpha_3 \ln(VA_i) + \varepsilon_i \tag{7}$$

We rearrange terms in equation (7), divide by total number of employees, L, and express the left-hand side in terms of unitary cost of labor, $C_i = W_i/L_i$, to get results in a more straightforward form to interpret

$$\ln(\frac{W_i}{L_i}) = \alpha_1 + (\alpha_2 + \alpha_3 - 1)\ln(L_i) + \alpha_3 \ln(\Pi_i) + \varepsilon_i, \tag{8}$$

where α_3 and $\phi = (\alpha_2 + \alpha_3 - 1)$ are labor cost elasticity to productivity and the residual effect of size, respectively. Since the residuals of OLS estimation clearly display a Laplacian shape, rather than a Gaussian one, we employ minimum absolute deviation (MAD) as a robust estimation technique (Huber, 1981; Press et al., 1992). Results of regressions both for OLS and MAD for year 1993 are reported, sector by sector, in Table 4. Coefficients accounting for the impact of productivity on labor cost, captured by α_3, confirm the positive relation which also emerged in the non-parametric analysis of Figure 4. All coefficients are positive and statistically significant; again the heterogeneities in the magnitude of parameters well account for existing differences between sectors. At the same time, all α_3 display an increasing trend over time, reflecting a higher responsiveness of unitary cost for labor to employer productivity. Even more interesting in the setting of equation 8 is that it allows to evaluate, by means of parameter ϕ, for the residual effect of size on labor cost once accounted for the relation with productivity. Coefficients ϕ is positive and significant for all sectors in the analysis and irrespectively of the econometric technique employed, meaning that, net of productivity effect, cost is increasing in size. To repeat, although we do not condition here

[8]The trend appears somewhat more noisy at the extreme of the distribution of labor productivity, *y axis*. This is due to the smaller number of observations in those areas.

SECTOR	ISIC Code	OLS			MAD		
		α_1	ϕ	α_3	α_1	ϕ	α_3
Production & processing of meat	151	**2.434**	**0.0707**	**0.25**	**2.26**	**0.073**	**0.29**
		(0.105)	(0.012)	(0.024)	(0.079)	(0.009)	(0.018)
Knitted & crocheted articles	177	**1.77**	**0.0897**	**0.335**	**1.07**	**0.083**	**0.426**
		(0.068)	(0.012)	(0.017)	(0.048)	(0.008)	(0.018)
Wearing apparel & accessories	182	**1.274**	**0.069**	**0.485**	**1.074**	**0.058**	**0.559**
		(0.034)	(0.007)	(0.009)	(0.024)	(0.005)	(0.006)
Footwear	193	**1.29**	**0.073**	**0.477**	**0.956**	**0.033**	**0.614**
		(0.058)	(0.011)	(0.015)	(0.039)	(0.007)	(0.009)
Articles of paper and paperboard	212	**1.72**	**0.088**	**0.395**	**1.645**	**0.09**	**0.415**
		(0.097)	(0.012)	(0.023)	(0.075)	(0.009)	(0.017)
Printing and services related to printing	222	**1.38**	**0.083**	**0.509**	**1.39**	**0.083**	**0.506**
		(0.09)	(0.013)	(0.023)	(0.07)	(0.009)	(0.017)
Plastic products	252	**2.19**	**0.131**	**0.245**	**2.08**	**0.117**	**0.287**
		(0.065)	(0.01)	(0.014)	(0.046)	(0.007)	(0.01)
Articles of concrete, plaster & cement	266	**2.14**	**0.12**	**0.277**	**1.823**	**0.079**	**0.391**
		(0.099)	(0.016)	(0.019)	(0.073)	(0.018)	(0.014)
Metal products	281	**1.45**	**0.107**	**0.459**	**1.335**	**0.084**	**0.509**
		(0.082)	(0.012)	(0.019)	(0.063)	(0.009)	(0.0147)
Treatment & coating of metals; general mechanical engineering	285	**1.904**	**0.069**	**0.381**	**1.484**	**0.081**	**0.478**
		(0.082)	(0.015)	(0.0168)	(0.061)	(0.011)	(0.012)
Special purpose machinery	295	**2.25**	**0.072**	**0.321**	**2.03**	**0.069**	**0.378**
		(0.067)	(0.007)	(0.015)	(0.048)	(0.005)	(0.011)
Furniture	361	**2.348**	**0.104**	**0.214**	**2.056**	**0.085**	**0.305**
		(0.052)	(0.009)	(0.012)	(0.0381)	(0.0067)	(0.009)

Table 4: Minimum absolute deviation (MAD) estimates for cost of labor as a linear function of size and productivity, for 1993. Estimated coefficient of equation 8. ϕ is the labor cost elasticity to productivity, α_3 is the residual effect of size on labor cost. Constant price log variables. Standard errors in brackets; coefficients significant at the 0.05 level are in bold.

on employer characteristics, we do control for the relation between productivity and labor cost, that is exactly the supposed effects of heterogenous skills in the workforce. Thus, the evidence emerging from Table 4 is that of some relative advantage of smaller firms over bigger ones in terms of average cost of labor. This regularity has to be jointly considered with the already well known trouble caused by limited access to credit of smaller firms to provide a more comprehensive understanding of the so-called "constraints to growth" phenomenon affecting Italian firms. For germane discussions on financial fragility that employ different database on Italian firms, see Fagiolo and Luzzi (2006) and Bottazzi et al. (2006).

Also note that this "size-effect" varies a lot from sector to sector, suggesting the existence of "sectoral specificities" that drive the way firms organize their production activity in different sectors.

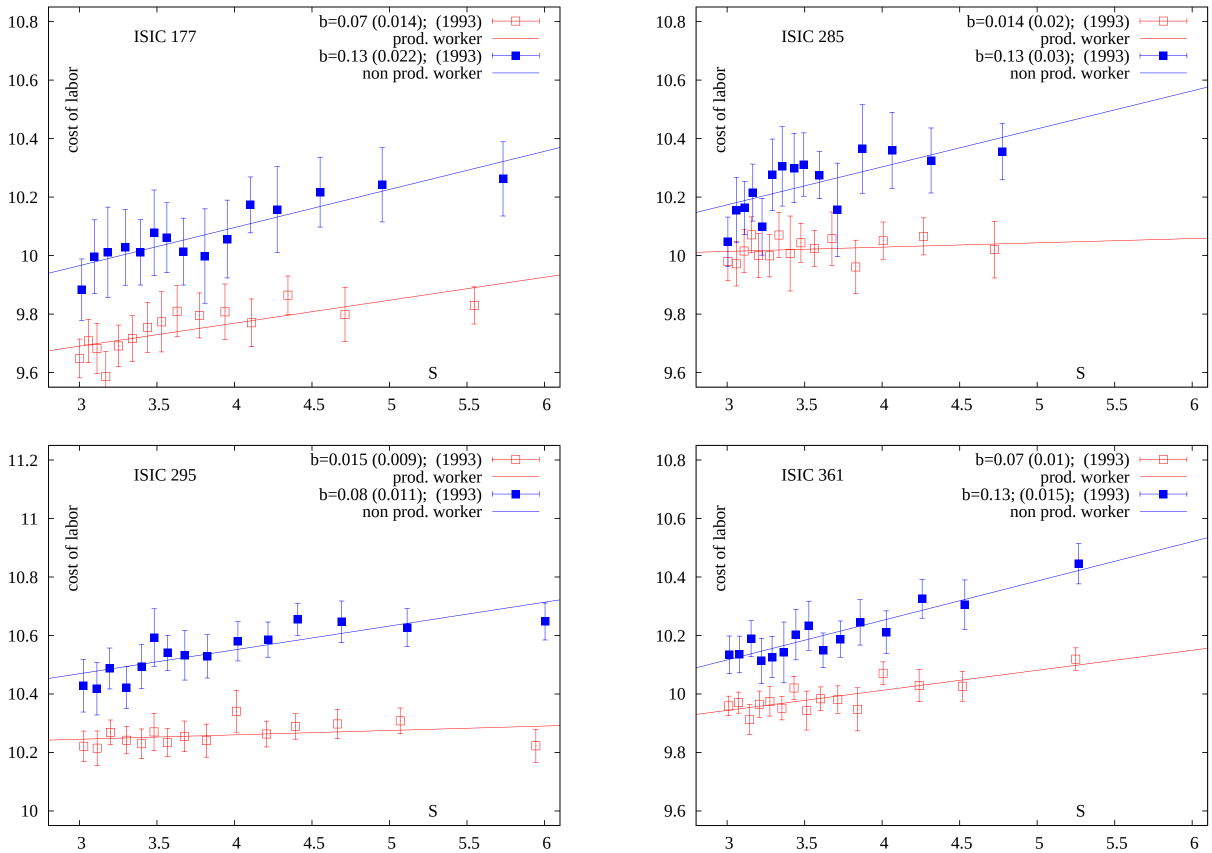

Figure 5: Relation between size (as number of employees) and cost of labor, respectively for production and non-production workers, year 1993. Variables are in logs.

4 The relevance of labor force structure

Thus far, both the non-parametric analysis and the linear parametric specification we chose, pointed at an intertwined contribution of productivity and size in determining the cost structure of a firm. In particular, the previous section showed that even after accounting for productivity, labor cost is still increasing with size.

With respect to the database employed, this result represents a common regularity to all sectors of investigation, with the expected inter-sectoral differences. As such this evidence deserves some comments and clarification. First, in the analysis we present here we do not control for different production inputs, as for instance, different capital productivities, thus we are not making any statement on generic measures of productivity, i.e. TFP, or on the relation between productivity and size, for these and other issues, see Bottazzi et al. (2006). Then the possibility remains that bigger size, in terms of number of employees, is compensated by a more than proportional increase in market shares. However, as shown in Bottazzi et al. (2007), this objection would not hold since market share and employment are proportionally related.

This suggests us that a more promising direction of investigation might be to explicitly take into account differences in organizational structures of firms operating in the same productive sector but of heterogenous size, the rationale being that different dimensions bear consequences in terms of employment structure, i.e. a firms twice as big as another one, will hardly be the simple "duplication" of the smaller one. In the following we shall tackle this issue by analysing the diverse composition of employment at the firm level in terms of white and blue collars[9].

In this respect one has two main - and partly competing - theories addressing the issue of workforce composition in relation to wage and productivity differentials between employees belonging to distinct groups, i.e. production and non-production workers. On the one side one might conjecture that wage differentials is the proportionate monetary compensation to different contribution to firm's output as in the hierarchical (or "tournament") model of pay distribution (Lazear and Rosen, 1981).[10]

Alternatively, one might favor a more comprehensive interpretation which would also encompass, beyond individual workers' differences, also labor force structure as a relevant factor in explaining wage differentials among firms, as for instance, in hierarchical theories of the firm (Simon, 1957).[11]

We account for such a possibility running two different regressions for white and blue collars' wages and their responsiveness to firm size. A preliminary evidence of a different impact of size on the earnings of blue *versus* white collars is provided by Figure 5 and Table 5, which displays the estimated coefficients of the simple linear model

$$c_{j,i} = \alpha_j + \beta_j l_i + \varepsilon_i, \qquad j = W,\ B \tag{9}$$

where $c_{W,i}$ and $c_{B,i}$ denote the logarithm of unitary labor cost of firm i for white and blue collar workers, respectively. Coefficients in Table 5 and the plots in Figure 5 both show that, irrespectively of firm size, white collars earn more than blue collars; this trend is accounted for by the difference in the estimated intercept for production/non-production workers[12]. This regularity *per se* is not a surprising one, for it might be well expected that white collars are on average paid more than blue collars. What is more pertaining to the present analysis is the differences in the values of the β coefficients for the two groups. This difference supports the conjecture that, on average, white collars' wage is also more responsive to size than blue collars' salary. Though we are not conditioning on individual's characteristics, this result shows that two different degrees of wage responsiveness to size matter in determining the wage structure of the firm. This result, together with the residual effect of size on total cost of labor reported in Table 4, call for a further investigation of the issue of labor force structure.

We proceed to consider the scaling relation of costs for different categories of workers by fitting the following expression

$$c_{B,i} = \alpha_B + \beta_B l_{B,i} + \gamma_W l_{W,i} + \varepsilon_i, \tag{10}$$

where l_B and l_W are respectively the logarithm of the number of blue and white collars. The coefficient β_B captures the effect of an increase in size for that category of employees,

[9]Our database enables us to distinguish between production workers (comprising factory workers, apprentices and work-from-home arrangements) and non-production workers (including employees ranging from entry-level administrative positions to executive). In the following we will use production workers/blue collars, on one side, and non-production workers/white collars, on the other, as synonyms.

[10]This explanation is grounded in neoclassical economics and efficiency wage theory and it argues that a relatively dispersed pay structure will attract talented employees and motivate high individual performances as a consequence of the substantial rewards on offer (Beaumont and Harris, 2003). But similar arguments could also lead to opposite effects as greater pay dispersion will impact negatively on individual and organizational performance (Akerlof and Yellen, 1990).

[11]In his seminal work (Simon, 1957, p. 33) also consider the role of the number of layers, which makes up the labor force structure, in affecting the total cost for labor of firms (see also Calvo and Wellisz (1979) and Van der Meer and Wielers (1998)).

[12]Magnitude of the difference might look negligible, but one has to bear in mind that variables are in log.

ISIC	Prod. Workers		Non Prod. Workers		ISIC	Prod. Workers		Non Prod. Workers	
	α	β	α	β		α	β	α	β
151	**10.124**	0.043	**10.043**	**0.120**	252	**9.852**	**0.090**	**9.853**	**0.186**
	(0.051)	(0.013)	(0.077)	(0.019)		(0.044)	(0.011)	(0.063)	(0.016)
177	**9.533**	**0.079**	**9.653**	**0.130**	266	**10.108**	**0.046**	**10.007**	**0.143**
	(0.055)	(0.015)	(0.088)	(0.022)		(0.076)	(0.020)	(0.087)	(0.023)
182	**9.262**	**0.112**	**9.412**	**0.171**	281	**9.915**	**0.073**	**9.797**	**0.160**
	(0.041)	(0.011)	(0.068)	(0.017)		(0.064)	(0.017)	(0.084)	(0.023)
193	**9.534**	**0.081**	**9.414**	**0.190**	285	**10.038**	0.015	**9.852**	**0.130**
	(0.059)	(0.016)	(0.084)	(0.022)		(0.075)	(0.021)	(0.108)	(0.030)
212	**9.912**	**0.079**	**9.897**	**0.161**	295	**10.351**	0.015	**10.376**	**0.082**
	(0.057)	(0.014)	(0.079)	(0.020)		(0.034)	(0.008)	(0.047)	(0.012)
222	**10.106**	**0.111**	**10.091**	**0.180**	361	**9.869**	**0.069**	**9.842**	**0.135**
	(0.061)	(0.016)	(0.076)	(0.020)		(0.038)	(0.010)	(0.058)	(0.015)

Table 5: Relation between size (as number of employees) and cost of production and non-production workers in 1993. OLS estimates. Constant price log variables; standard errors in brackets; coefficients significant at the 0.05 level are in bold. See also Equation 9 and Fig. 5.

whether γ_W controls for the residual effect due to the number of non-production workers. We perform the same analysis also with respect to unitary cost of white collar, c_W, fitting the model

$$c_{W,i} = \alpha_W + \beta_W l_{W,i} + \gamma_B l_{B,i} + \varepsilon_i. \tag{11}$$

Table 6 reports the estimated coefficients and standard errors; again due to non-normality of the residuals we report MAD estimates. Comparison of the estimates for the unitary costs of labor for production and non-production workers reveals that white collars' wage is positively related to an increase in employment in the other category, as shown by the positive γ_B coefficients in the last column of Table 6. On the contrary, this is not the case for production workers as can be inferred given the lack of significantly positive γ_W coefficients reported in the third column of Table 6. This evidence confirms and qualifies the results of Figure 5 which displays a higher responsiveness of non-production worker's wage to firm size. Evidence from Table 6 shows, indeed, that the earnings of white collars depend not only on a general measure of firm size (as the total number of employer in Figure 5), but also, more specifically, on the number of production workers.

Such regularity further supports the hypothesis of the relevance of labor force structure in shaping the cost of labor bore by firms. We then proceed to verify if the data display any scaling relation between the number of workers of various categories. To account for possible non-linear trend we fit the relation

$$L_W = \alpha + \gamma L_B^{\beta} + \varepsilon_i, \tag{12}$$

where L_W and L_B are respectively the number of white and blue collars. Estimated coefficients of OLS regression are reported in Table 7. Different values of the scaling parameter β in different sectors point at some specificity in the structure of labor force. The coefficients ranging from 0.5 to 1.5 stand for different degrees of responsiveness of labor force structure to an increase in the number of production worker.

SECTOR	ISIC Code	Production workers α_B	β_B	γ_W	Non Prod. Workers α_W	β_W	γ_B
Production & processing of meat	151	**3.757**	**0.061**	-0.024	**3.514**	**0.110**	**0.035**
		(0.038)	(0.012)	(0.015)	(0.059)	(0.022)	(0.019)
Knitted & crocheted articles	177	**3.485**	**0.077**	**-0.049**	**3.374**	**0.038**	**0.122**
		(0.035)	(0.008)	(0.011)	(0.056)	(0.017)	(0.012)
Wearing apparel & accessories	182	**3.489**	**0.117**	**-0.088**	**3.527**	**-0.047**	**0.166**
		(0.030)	(0.005)	(0.009)	(0.044)	(0.013)	(0.008)
Footwear	193	**3.733**	**0.160**	**-0.149**	**3.456**	-0.010	**0.155**
		(0.043)	(0.010)	(0.014)	(0.068)	(0.022)	(0.015)
Articles of paper and paperboard	212	**3.632**	**0.103**	**-0.038**	**3.683**	-0.003	**0.150**
		(0.039)	(0.011)	(0.015)	(0.060)	(0.023)	(0.017)
Printing and services related to printing	222	**3.617**	**0.063**	0.006	**3.535**	**0.085**	**0.090**
		(0.039)	(0.010)	(0.014)	(0.051)	(0.018)	(0.013)
Plastic products	252	**3.623**	**0.104**	**-0.044**	**3.545**	**0.093**	**0.075**
		(0.028)	(0.007)	(0.010)	(0.046)	(0.016)	(0.011)
Articles of concrete, plaster & cement	266	**3.746**	**0.070**	**-0.059**	**3.665**	0.021	**0.103**
		(0.052)	(0.013)	(0.018)	(0.060)	(0.021)	(0.015)
Metal products	281	**3.764**	**0.101**	**-0.079**	**3.618**	0.007	**0.125**
		(0.040)	(0.009)	(0.014)	(0.057)	(0.019)	(0.013)
Treatment & coating of metals; general mechanical engineering	285	**3.856**	**0.109**	**-0.094**	**3.711**	-0.013	**0.147**
		(0.045)	(0.009)	(0.015)	(0.070)	(0.024)	(0.015)
Special purpose machinery	295	**3.880**	**0.064**	**-0.064**	**3.983**	**-0.029**	**0.087**
		(0.018)	(0.005)	(0.006)	(0.028)	(0.010)	(0.007)
Furniture	361	**3.572**	**0.084**	**-0.042**	**3.494**	**0.033**	**0.092**
		(0.024)	(0.006)	(0.009)	(0.039)	(0.014)	(0.009)

Table 6: Scaling of unitary cost to different categories of workers. Coefficients of equation 10 and 11 are estimated with MAD. Standard errors in brackets; coefficients significant at the 0.05 level are in bold.

To get a more straightforward, visual representation of this relation we thus plot in Figure 6 the following (log-linear) relation:

$$l_W = \alpha + \beta l_B + \varepsilon_i, \tag{13}$$

where again, low-case letters denote logarithms. Figure 6 displays the relation between the (log of) number of white and the (log of) blue collars and, as a guide for the eye, the linear fit and a non-parametric kernel regression. The plots show the existence of non-linearities in the relation between variables, in particular, the linear fit well describes the relationship for bins around the sector average number of blue collars, but this is not the case for observations at the extreme, both in the bottom left and upper right region of plots. All sectors in Figure 6 display an "U" relation, meaning that, taking as a reference the linear fit, small and big firms employ more non-production workers than average-sized firms. Given the properties of our database, discussed at length in Section 2, and more in general of Italian industrial organization it is not possible to put too much emphasis on the implication for smaller firms, incidentally also note that for special purpose machinery (ISIC 295) the number of non-production worker at the smallest bin exceeds the number of production ones. It can indeed be the case that for smaller

ISIC	α	γ	β	ISIC	α	γ	β
151	0.790	0.151	**1.035**	252	0.194	**0.167**	**1.104**
	(1.258)	(0.038)	(0.034)		(0.520)	(0.023)	(0.023)
177	**1.587**	**0.054**	**1.152**	266	**1.625**	0.079	**1.255**
	(0.753)	(0.025)	(0.076)		(0.636)	(0.018)	(0.041)
182	1.940	**0.008**	**1.523**	281	2.941	**0.021**	**1.479**
	(0.478)	(0.001)	(0.020)		(0.319)	(0.003)	(0.020)
193	**-4.873**	**1.220**	**0.551**	285	1.826	0.032	**1.363**
	(1.003)	(0.284)	(0.034)		(0.373)	(0.011)	(0.069)
212	**3.667**	**0.017**	**1.477**	295	0.523	**0.328**	**1.076**
	(0.447)	(0.002)	(0.018)		(1.030)	(0.044)	(0.021)
222	0.521	**0.155**	**1.113**	361	**-1.015**	**0.270**	**0.997**
	(0.365)	(0.008)	(0.006)		(0.489)	(0.038)	(0.025)

Table 7: Relation between number of white and blue collars, see Equation 12. Standard errors in brackets; coefficients significant at the 0.05 level are in bold.

firms, positions, roles and duties are not so much sharply distinguished between categories of workers and that promotions are likely to be accorded to workers as a sort "loyalty reward" with employees keeping very much their previous tasks, so that we can observe this "weird" distribution of non-production as compared to production workers. On the contrary, when bigger firms are concerned, this sort of disclaimer does not apply, consequently, we can infer that beyond a certain - sector specific - threshold, the number of non-production workers grows more than proportionally in the number of blue collars.

5 Conclusions

In this paper we have shown the existence of a firm size-wage gap also for Italian manufacturing firms (c.f. Figure 1 and Table 4). This appears as a robust regularity as it holds over time and across all sectors under investigation. Further and more compelling for the analysis, this relation remains true even when explicitly accounting for the various levels of labor productivity that characterize different firms.

Our results are well in tune with the findings in Brown and Medoff (1989) where individual worker skills leave unexplained *one-half* of the wage differentials. This suggests that such wage gap cannot be satisfactorily accounted for only by recurring to the conjecture of proportionate monetary compensation to different worker's contribution to firm's output. To this end a complementary and promising approach is to explicitly call into play the different categories of workers, i.e. production and non production, and their impact on the structure of labor force in shaping the overall wage arrangement of firms. In this respect we find that non-production workers' wage is more responsive to increase in size, whether the salary of production worker is almost flat to raise in dimension. Clearly, this is in addition to a quite straightforward difference in the average earnings of the two categories. Further, the analysis of scaling relation between the number of white and blue collars displays the existence of non-linearities. In particular, the "U" relation (Figure 6), which is common to all sectors, reveals that a higher than proportionate number of non-production workers is employed in bigger firms. Such

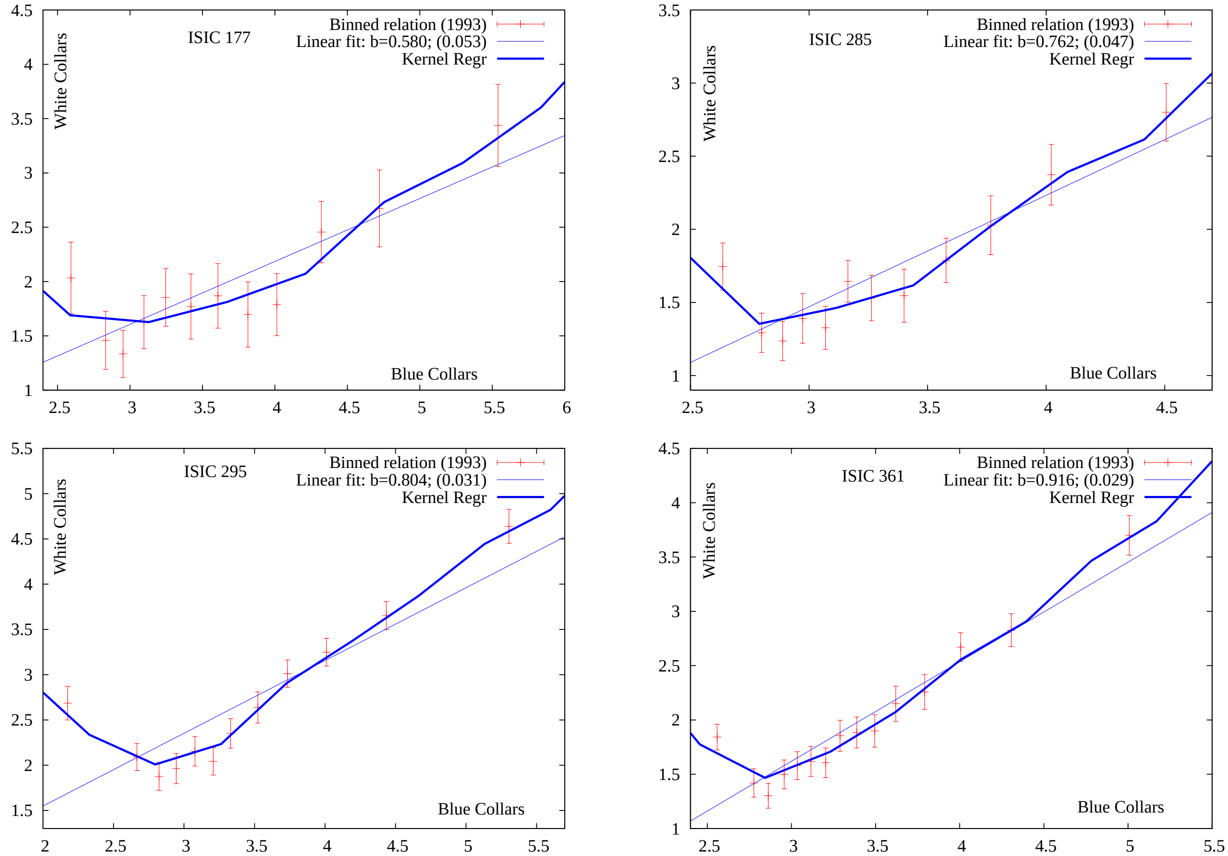

Figure 6: Relation between number of white and blue collars in 4 sectors at 3 Digits for year 1993. Linear fit (standard errors in brackets) and non-parametric kernel regression.

organizational arrangement, joint with the higher responsiveness of white collars' wage to firm size, offers some complementary interpretations of troubles affecting the growth processes of Italian firms. In particular, it lends support to a "hierarchical theory" of the firm in that, given different average rewards for the various categories of workers, a different setting of the labor force bears consequences on the total cost for labor. At the same time, the "U" relation in Figure 6 highlights some interesting features for the "replication and scale" perspective, see also (Dosi and Grazzi, 2006, pp. 180-190).

Concluding, as far as labor regulation, on one side, and corporate practice, on the other, are concerned the present work offers some compelling evidence and some - far from being resolving - policy interpretation of the results. Our findings stand for the necessity to complement the "constraints to growth" analysis with a joint assessment of cost of labor and labor force structure together with better known sources of distress, as for instance, limited access to credit for smaller/ younger firms.

References

Akerlof, G. A. and J. L. Yellen (1990, May). The fair wage-effort hypothesis and unemployment. *The Quarterly Journal of Economics 105*(2), 255–83.

Arai, M. (2003, July). Wages, profits, and capital intensity: Evidence from matched worker-firm data. *Journal of Labor Economics 21*(3), 593–618.

Bartelsman, E. J., J. Haltiwanger, and S. Scarpetta (2004, Oct). Microeconomic evidence of creative destruction in industrial and developing countries. Working Paper 04-114/3, Tinbergen Institute.

Beaumont, P. B. and R. I. D. Harris (2003). Internal wage structure and organizational performance. *British Journal of Industrial Relations 41*(1), 53–70.

Bertola, G. and A. Ichino (1995). Crossing the river: A comparative perspective on Italian employment dynamics. *Economic Policy 21*, 359–420.

Bottazzi, G., E. Cefis, G. Dosi, and A. Secchi (2007). Invariances and diversities in the evolution of italian manufacturing industry. *Small Business Economics*. forthcoming.

Bottazzi, G., M. Grazzi, and A. Secchi (2006). Characterizing the production process: A disaggregated analysis of italian manufacturing firms. In M. Malgarini and G. Piga (Eds.), *Capital Accumulation, Productivity and Growth*, Central issues in contemporary economic theory and policy 7. Palgrave Macmillan, New York.

Bottazzi, G., A. Secchi, and F. Tamagni (2006). Financial fragility and growth dynamics of italian business firms. Lem working paper, 2006/7, S. Anna School of Advanced Studies.

Brown, C. and J. Medoff (1989). The employer size-wage effect. *The Journal of Political Economy 97*(5), 1027–1059.

Brunello, G. and A. Colussi (1998). The employer size-wage effect: evidence from Italy. *Labor Economics 5*, 217–230.

Calvo, G. and S. Wellisz (1979). Hierarchy, ability and income distribution. *Journal of Political Economy 87*(5), 991–1010.

Davis, S. J. and J. Haltiwanger (1991). Wage dispersion between and within U.S. manufacturing plants: 1963-86. *Brookings Paper on Economic Activity, Microeconomics 1991*, 115–200.

Davis, S. J. and J. Haltiwanger (1992). Gross job creation, gross job destruction, and employment reallocation. *Quarterly Journal of Economics 107*, 819–863.

Davis, S. J. and J. Haltiwanger (1995, December). Employer size and the wage structure in U.S. manufacturing. NBER working papers, National Bureau of Economic Research, Inc.

Dosi, G. and M. Grazzi (2006). Technologies as problem-solving procedures and technologies as input–output relations: some perspectives on the theory of production. *Industrial and Corporate Change 15*(1), 173–202.

Fagiolo, G. and A. Luzzi (2006). Do liquidity constraints matter in explaining firm size and growth? some evidence from the italian manufacturing industry. *Industrial and Corporate Change 15*(1), 173–202.

Härdle, W., M. Müller, S. Sperlich, and A. Werwatz (2004). *Nonparametric and Semiparametric Models*. Springer Series in Statistics.

Hu, L. (2003). The hiring decisions and compensation structures of large firms. *Industrial and Labor Relations Review 56*, 663–681.

Huber, P. J. (1981). *Robust Statistics*. New York : Wiley.

ISTAT (2005). *Rapporto Annuale 2004*. Istituto Nazionele di Statistica.

Kravis, I. B. and R. E. Lipsey (1982). The location of overseas production and production for export by U.S. multinational firms. *Journal of International Economics 12*, 201–223.

Lallemand, T., R. Plasman, and F. Rycx (2005, April). The establishment-size wage premium: Evidence from european countries. IZA Discussion Papers 1569, Institute for the Study of Labor (IZA).

Lazear, E. P. and S. Rosen (1981, October). Rank-order tournaments as optimum labor contracts. *Journal of Political Economy 89*(5), 841–64.

Lucifora, C. (1993). Inter-industry and occupational wage differentials in Italy. *Applied Economics 25*, 1113–1124.

Main, B. G. M. and B. Reilly (1993). The employer size-wage gap: Evidence from britain. *Economica 60*, 125–142.

Malgarini, M. and G. Piga (Eds.) (2006). *Capital Accumulation, Productivity and Growth*. Palgrave Macmillan, New York.

Moore, H. L. (1911). *Laws of Wages: An essay in statistical economics*. History of Economic Thought Books. McMaster University Archive for the History of Economic Thought.

Nickell, S. (1997, Summer). Unemployment and labor market rigidities: Europe versus North America. *The Journal of Economic Perspectives 11*(3), 55–74.

Pagan, A. and A. Ullah (1999). *Nonparametric Econometrics*. Cambridge University Press.

Prattern, C. F. (1971). *Economies of Scale in Manufacturing Industry*. Cambridge University Press.

Press, W. H., B. P. Flannery, S. A. Teukolsky, and W. T. Vetterling (1992). *Numerical Recipes in C : The Art of Scientific Computing* (2^{nd} ed.). Cambridge University Press.

Silverman, B. W. (1986). *Density Estimation for Statistics and Data Analysis*. Chapman & Hall/CRC.

Simon, H. A. (1957). The compensation of executives. *Sociometry 20*(1), 32–35.

UNSD (2002). *International Standard Industrial Classification of All Economic Activities, Revision 3.1, (ISIC Rev. 3.1)*. UNSD - Economic Statistics and Classifications Section.

Van der Meer, P. and R. Wielers (1998). Hierarchy, wages and firm size. *Acta Sociologica 41*(2), 163–172.

Zàbojnìk, J. and D. Bernhardt (2001). Corporate tournaments, human capital acquisition, and the firm size-wage relation. *Review of Economics Studies 68*, 693–716.