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WAGE DISPERSION AND EQUILIBRIUM SEARCH MODELS: SOME EVIDENCE FROM ITALY

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Wage Dispersion and Equilibrium Search Models: Some Evidence from Italy*

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Abstract

This paper provides a structural estimation of an equilibrium search model with on-the-job search and heterogeneity in firms' productivities using a sample of Italian workers. Allowing for productivity differentials among firms, the model is able to fit the wage distribution satisfactorily. Results indicate that arrival rates of offers for workers are higher when unemployed than when employed and firms exploit their monopsnony power when setting wages. As a result, workers earn far less than their marginal product. The paper also provides an estimate of the underlying distribution of productivity across firms. Geographical stratification reveals also interesting differences in transition parameters across workers.

Keywords: Equilibrium Search Models, Wage Dispersion, Search Frictions, Monopsony, Productivity Differentials.
JEL Classification: C33, C41, C61, D83, J31, J41, J64.

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1 Introduction

Wage regressions are probably one of the most widely estimated equations in labour economics. The identification of underlying theoretical parameters and the decomposition of observed wage variation represent two of the main areas of research in the field. However, results from reduced form approaches indicate that at most half of observed dispersion in wages can be "explained" by observable characteristics, and that the rest has to be imputed to measurement error or unobservable components. Search models explain observed variation in wages as resulting from productivity differentials and search frictions. The relative contribution of the two components is identified by structurally estimating the relevant parameters of equilibrium search models.

During recent years, some important theoretical contributions establish that wage dispersion is an equilibrium outcome even if workers and firms are homogeneous (Burdett and Mortensen, 1998). Moreover the obtained equilibrium distribution of wages comes in closed form solution allowing for an empirical estimation of such models. It is no surprise that these findings have been accompanied by a growing empirical literature dealing with the structural estimation of these equilibrium search models (see Van den Berg, 1999). Behind this research effort there are two main reasons. On the one hand, the partial equilibrium search models are not able to fully characterise equilibrium labour market outcomes (Rothschild, 1973); on the other hand, new available information on labour market histories of workers and firms adds considerable information to our understanding of labour market phenomena. Equilibrium search theory provides also a renewed framework for labour market policy analysis with an active role for firms as profit maximisers. This framework is also suitable for comparative statics exercises and test for some policy implications in an equilibrium environment that were not possible in previous search models (e.g., minimum wage). The second important

ingredient is the possibility of accessing until now unavailable information on labour market histories of workers and firms, and then structurally estimate the relevant parameters deriving from the theory.[1]

In an environment characterised by perfect information, the result of a wage posting game among homogeneous firms is the Bertrand outcome. The distribution of wages degenerates at the competitive equilibrium level. The introduction of some imperfections in this environment implies that the competitive outcome doesn't hold. The resulting distribution of wages degenerates at the monopsonistic level and the worker doesn't receive any surplus from the match (Diamond, 1971). Introducing search frictions, simply intended as time required for agents to obtain information, generates match specific rents that are shared between workers and firms. The perfectly competitive outcome (workers are paid their marginal product and enjoy all the surplus deriving from the match) and the monopsonistic result (workers do not get any fraction of the surplus and firms have complete monopoly power in offering wages) constitute the limiting cases in a framework that provides an alternative explanation to the (simple) marginal productivity theory of wages. In such an environment, search frictions give the employers some monopsony power, but this power is limited by competition with other employers over time. Firms can implement some *wage policies*, in the sense that they face a trade-off between posting high wages and attracting workers. With on-the-job-search, higher wages mean less profit per worker but more workers and less probability of quitting behaviour of "insiders"; firms fill vacancies more quickly and equalise profits with respect to low wage firms enjoying a greater labour force.

The possibility of a wage distribution as an equilibrium outcome comes in an elegant

[1] It is important to remember that although equilibrium search models can be estimated from workers' data only, the recent availability of so-called matched employer-employee data sets adds considerable amount of information to our previous knowledge. Firm data can be particularly useful for structural estimations of equilibrium search models.

closed form solution (Burdett and Mortensen, 1998; Mortensen, 1990).[2] However, the model in its basic form has the implication that both densities for the distribution of wages offered and the distribution of wages actually paid to employees (earnings distribution), are increasing and left skewed with the wages concentrated near the competitive equilibrium. This characteristic is clearly at odds with the form of the earnings distribution that we observe in reality that has a (log)normal shape with a very long right tail. As a consequence, the empirical implementation of equilibrium search models has mostly focused on fitting the right tail of the wage distribution.

The first attempts to structurally estimate the relevant parameters of the pure homogeneous Burdett and Mortensen (1998) model give unsatisfactory results, given they are not able to fit the wage distribution (see Van den Berg and Ridder, 1993a, 1993b; and Kiefer and Neumann,1993).[3] To fit the right tail of the distribution, it is essential to introduce some kind of heterogeneity across worker/firms' productivities or measurement error. Heterogeneity can be modelled along various dimensions.[4] Allowing productivity levels to vary across different segments of the labour market, as defined by occupation, education or age categories permits a reasonable fit to the data. Van den Berg and Ridder (1998) and Ridder and Van den Berg (1997) allow for this kind of *between-markets* observable heterogeneity. On the other hand, Bowlus et al. (1995, 2001), and Bontemps et al. (1999, 2000) estimate equilibrium search models assuming firms differ in their productivity level *within* the same market. The former approach allows for a discrete distribution of productivity types, whereas

[2] See also Butters (1977), Reinganum (1979), Burdett and Judd (1983), and Albrecht and Axell (1984) for different models of equilibrium wage dispersion.

[3] A previous version of my paper provides estimation of the structural parameters for the basic Burdett and Mortensen (1998) model. Results are available upon request.

[4] Eckstein and Wolpin (1990) are the first to estimate an equilibrium search model from panel data. Using Albrecht and Axell (1984) equilibrium model with ex-ante heterogeneity if workers' reservation wages, they find that worker heterogeneity is not very important in explaining observed wage dispersion.

the latter fits the data assuming a continuous distribution of productivities.[5]

This paper provides a structural estimation of the relevant parameters of the equilibrium search model allowing for a continuous distribution of productivity across firms.[6] First, I provide a non-parametric estimation of the distribution of earned wages; then I structurally estimate the frictional parameters of the equilibrium model using maximum likelihood techniques. Finally, conditional on previous steps, I can recover an estimate of the distribution of productivities across firms in the market and a measure of their monopsony power exerted when posting wages. The estimation method proves particularly effective to study the dynamics of wage mobility in a structural approach. To the best of my knowledge, this paper represents the first attempt of studying those dynamics in such a framework using Italian data. Given this, I compare my results with those found by Bontemps et al. (2000) for France.[7]

The main findings of the paper can be identified as follows. The arrival rate of employment of opportunities when unemployed is ten times higher than the one when employed. The low level of search while on-the-job negatively affects the speed at which workers climb the job ladder: Italian workers receive on average 0.5 acceptable offers per month. The estimated distribution of productivities in the economy indicates that this distribution is much more dispersed and polarised at very low and high levels than the corresponding wage distribution. Moreover, the mapping from productivity to wages indicates that high productivity firms offer proportionally higher wages. In general, firms are well able to exploit their monopsony power and appropriate most of the rents from the match. Stratification by observable worker characteristics also indicates interesting differences among groups. Finally, some interesting

[5] Bowlus et al. (2001) examine advantages and disadvantages of the two approaches.

[6] The estimation methodology is the "three" step method as proposed by Bontemps et al. (2000).

[7] Launov (2003) analyses labour market dynamics in an equilibrium search environment using Austrian data.

patterns in regional productivity differentials are recognised.

The rest of the paper is organised as follows: in section two I present the theoretical equilibrium search model with productivity dispersion across firms. Then, in section three I describe the data and the selection of the sample. The estimation method and results are also provided. In the last section, I conclude and discuss some further research issues.

2 The Equilibrium Search Model

Here I provide a complete description of the Burdett and Mortensen (1998) equilibrium search model. The model is also extended along the lines proposed by Bontemps et al. (2000). In the original version with homogeneous workers and firms, the economy is composed by a large number of firms whose measure is normalised to 1; m is the large number of workers in the economy. It is assumed that the worker can be in one of the two states, employed or unemployed, and u is the number of unemployed. Workers are assumed to search both when employed and unemployed. In both cases the probability of receiving an offer is distributed according to a standard Poisson process where λ_0 is the arrival rate of job offers while unemployed and λ_1 when employed. R is the reservation wage when unemployed, while the wage earned w is the reservation wage when employed. When unemployed a worker has utility flow given by b, this is assumed equal among workers and can be interpreted as the value of leisure or the level of unemployment benefit per period. When employed, workers earn their wage w and p is the flow revenue generated per employed worker, a firm earns $p - w$ when the job is filled. There is no endogenous job destruction deriving from productivity shocks, but δ is the exogenous probability that a job is destroyed at every moment in time. Define $k_0 = \lambda_0/\delta$ and $k_1 = \lambda_1/\delta$. $F(w)$ is the distribution of wages offered to workers and $G(w)$ is the distribution of wages actually paid to employed workers. The latter is the earnings distribution. First analyse the behaviour of workers. They adopt a strategy of search that

has the reservation wage property, the latter (with zero discounting) is given by

$$R - b = [k_0 - k_1] \int_R^\infty \frac{1 - F(x)}{1 + k_1[1 - F(x)]} dx. \tag{1}$$

The reservation wage of unemployed workers is given by the value of leisure plus the expected gain from search while employed. For unemployed workers, it is optimal to accept any wage above the reservation wage. Given the difference $k_0 - k_1$, the expected gains from search are determined by the probability of getting an offer higher than the actual wage, discounted by the probability that the job is terminated (both for exogenous destruction or because of a better opportunity). Employed workers adopt a reservation strategy as well and will accept any wage strictly greater than w.

The equation of motion of unemployment in this economy is given by the difference between the flow in and the flow out of the stock. In steady state

$$\delta(m - u) = \lambda_0[1 - F(R)]u.$$

Since $F(R)$ is equal to zero because no worker will accept a wage below the reservation wage, further manipulations give the equilibrium unemployment rate

$$\frac{u}{m} = \frac{\delta}{\delta + \lambda_0}. \tag{2}$$

This expression is increasing in δ and decreasing in λ_0.

Let $G(w)(m - u)$ be the number of employed receiving a wage no greater than w; the evolution of this stock over time is given by

$$\frac{dG(w)(m - u)}{dt} = \lambda_0 F(w)u - [\delta + \lambda_1(1 - F(w))]G(w)(m - u),$$

where the first part of the right hand side refers to the flow of workers that are unemployed and receive an acceptable offer above their reservation wage (and below w), and the second is the sum of workers previously holding a job that has been destroyed and those who find a

better opportunity and quit the old job. The flows in and out of this group should be equal in a steady state, so that the distribution of wages currently paid reads as

$$G(w) = \frac{F(w)}{1 + k_1[1 - F(w)]}. \tag{3}$$

The fraction of workers receiving a wage less or equal to w is given by the fraction of firms offering that particular wage (or less), divided by the probability that the job is either destroyed or the worker quits. Equation (3) represents the structural relationship between the distribution of wages actually paid to employed workers and the distribution of wages offered, as imposed by the steady state condition.

Let $l(w|R, F)$ be the measure of workers per firm earning a wage w given R and F. That specifies the steady state number of workers available to a firm offering a particular wage conditional on the wage offered by other firms, represented by F, and the workers' reservation wage R. This measure can be written as

$$l(w|R, F) = \frac{g(w)}{f(w)}(m - u), \tag{4}$$

where $g(w)$ and $f(w)$ are the densities of the corresponding distributions. This expression is increasing in w and continuous on the support of the distribution F. In what follows it is also useful to recall again the structural relationships between the earnings and offer distribution. This is given by the following expression

$$f(w) = \frac{1 + k_1}{[1 + k_1 G(w)]^2} g(w). \tag{5}$$

Using 5, substitute again in the expression for $l(w)$.[8] The latter can be rewritten as

$$l(w|R, F) = \frac{[1 + k_1 G(w)]^2}{1 + k_1}(m - u). \tag{6}$$

[8] The expression $1 - F(w)$ for the offer distribution is given by

$$1 - F(w) = \frac{1 - G(w)}{1 + k_1 G(w)}.$$

This is the number of workers available to work at the firm offering that particular wage w.[9] Let's now look at the firm's productivity. First the case with homogeneous firms is analysed, the model is then extended to allow for heterogeneity in firms' productivities.

Homogeneous Firms. Firms post wages to maximise their steady state profit flow, given R and F. p is the common flow revenue generated by an employed worker, with $b < p < \infty$. When a worker and a firm meet they do not bargain over the wage but divide the surplus deriving form their match getting $w - b$ and $p - w$ respectively. Notice that the wage has been previously fixed by the firm to maximise the steady state flow of profits. Firms solve the following problem

$$\pi(w|R, F) = \max_{w}(p - w)l(w|R, F). \tag{7}$$

An equilibrium is defined as follows

Definition 2 (Burdett and Mortensen, 1998) *An equilibrium solution to the search and wage posting game is a triple $\{R, F, \pi\}$ such that R satisfies the reservation wage equation, π satisfies the firm maximisation problem and F is such that: $(p - w)l(w|R, F) = \pi$ for all w in support of F, $(p - w)l(w|R, F) \leq \pi$ otherwise.*

Burdett and Mortensen (1998) demonstrate that the equilibrium solution exists, is unique and the wage offer distribution is continuous and not degenerate with support $[R, \overline{w}]$.[10] Any employer offering a wage less than R in equilibrium would have no employee indeed. On the other hand any employer offering a wage $\underline{w} \geq R$ will have a positive workforce and profits.

Heterogeneous Firms. Assume now that firms are heterogeneous with respect to their labour productivity parameter p. Let $\Gamma(p)$ denote the (continuous) distribution of productivity with support $[\underline{p}, \overline{p}]$. Under this assumption, the optimal strategy for the firm is to

[9] Again, the relationship can be expressed as

$$l(w|R, F) = \frac{1 + k_1}{[1 + k_1(1 - F(w))]^2}(m - u).$$

[10] First they rule out non continuous wage offer distributions, i.e. no mass points can exist in the offer distribution. Any wage above it would give a greater profit without losing applicants. Offering a wage equal to a mass point cannot be profit maximising for firms.

post a wage in the set of profit maximising wages. Let the function $w = K(p)$ denotes the mapping from the support of the productivity distribution to the support of the wage offer distribution.[11] Notice that given continuity of this function, the mapping from productivity to offered wages determines a continuous distribution for $F(w)$. Firms maximise (7) with respect to w. From the first order condition it is then possible to determine the firm value of the productivity parameter

$$p = w + \frac{1 + k_1 G(w)}{2k_1 g(w)}. \tag{8}$$

Bontemps et al. (2000) also derive a closed form solution for the density of the productivity of firms that are active in the market equilibrium. This can be written as

$$\gamma(p) = \frac{2k_1 (1 + k_1) g(w)^3}{3k_1 g(w)^2 [1 + k_1 G(w)]^2 - g'(w) [1 + k_1 G(w)]^3}. \tag{9}$$

Finally, the wage offer $w = K(p)$ of a firm with productivity p is equal to

$$w = K(p) = p - [1 + k_1 \overline{\Gamma}(p)]^2 \int_{\underline{w}}^{p} \frac{dx}{[1 + k_1 \overline{\Gamma}(x)]^2}. \tag{10}$$

This is the central equation of the model (Bontemps et al., 2000). In this economy an equilibrium is defined as follows

Definition 3 (Bontemps et al., 2000) *A market equilibrium is a triple* $(R, F(w), K_p)$ *such that*

1. *The distribution of wage offers in the economy is*

$$F(w) = \int F(w|p) d\Gamma(p)$$

   where $\Gamma(p)$ *is the distribution of firms active in the market.*

2. R *is the worker's best strategy to firms' behaviour and satisfies*

$$R - b = [k_0 - k_1] \int_R^{\infty} \frac{1 - F(x)}{1 + k_1 [1 - F(x)]} dx.$$

[11] This function is continuous and monotone. See Bontemps et al. (2000) for proofs regarding uniqueness and existence of the function.

3. $K_p = \arg\max_w \{\pi(p,w) | R \leq w \leq p\}$ *is a set of profit maximising wages of type p firms with* $\pi(p,w)$ *defined in (7) and* K_p *defined in (10).*

For the homogeneous case, Burdett and Mortensen (1998) show that as long as $\underline{w} = R$ and $\lambda_1 > 0$, then the unique candidate for F for any p is

$$F(w|p) = \left[\frac{(1+k_1)}{k_1}\right]\left[1 - \left(\frac{p-w}{p-R}\right)^{1/2}\right] \ \forall \ w \in [R, \overline{w}]. \tag{11}$$

Notice that in the standard basic Burdett and Mortensen (1998) model, the monopsonistic solution is avoided allowing the employed workers to compare at every moment in time the wage earned and the new job offer arrivals. Extreme solutions can be obtained as limiting cases: If $k_1 \to 0 \Rightarrow \overline{w} \to R \Rightarrow R \to b$, and the Diamond solution is obtained; on the other hand if $k_1 \to \infty \Rightarrow G(w) \to p$, this is the case when frictions vanish; finally as $k_0 \to \infty$ as well, then the competitive equilibrium results (the offer arrive instantaneously). This completes the description of the theoretical models, in the next section I discuss the empirical implementation of the model and present the estimation strategy.

3 Empirical Analysis

The closed form solution obtained by Burdett and Mortensen (1998) for the equilibrium distribution of wages allows an empirical estimation of the model using data on both workers and firms. Nonetheless, the model in its basic form has the implication that densities for both the distribution of wage offers F and that of the wages paid G are increasing and left skewed with the wages concentrated near the competitive equilibrium p. This characteristic is clearly at odds with the form of the distribution that we observe in reality that has a (log)normal shape with a very long right tail.

In the case of perfect homogeneity among workers and firms, the relevant parameters to be estimated are: b, the workers' common value of non market time; p, the firms' common

value of productivity; the two ratios k_0 and k_1 (or λ_0 and λ_1 alternatively); and the job separation (or destruction) rate δ. If b is unobserved then, R is the fifth parameter.[12] To get a satisfactory fit of the wage distribution is necessary to introduce some heterogeneity among firms. When firms are assumed to differ with respect to their productivity parameter, it is also possible to get an estimate of this distribution using estimated transition parameters and information from the distribution of wages paid to workers actually employed. Before discussing the estimation method, in the next subsection, I briefly present the data.

3.1 Data

In this study, I use a matched employer-employee data base from Italian Administrative Archives representative of the population of employed workers in the private non-farm sector. The source of information is the National Social Security Institute (INPS).[13] Data from Isfol-Inps data base contain all the relevant information I need to estimate an equilibrium search model.[14] The main difficulty with this data set is related to the definition of the status of a worker and his/her classification. While the position while employed is illuminating about the actual position in the labour market, on the other hand, if the worker exits the market, it is impossible to know if the subsequent period of absence from the records is due to unemployment, work in the public sector, self-employment or retirement. This relevant problem is also related to the impossibility of knowing exactly if the worker has been laid off or the end of the job has been determined by a voluntary separation.[15]

To estimate the relevant parameters of the equilibrium search model I use a sub-sample

[12] If a minimum wage is binding in the labour market, then the lower bound of the distribution is automatically determined. Van den Berg (1999) discusses the issue.

[13] See, among others, Casavola et al. (1999) and Contini (2002) for an accurate description of the dataset and extensive applications.

[14] Other important studies have used a source of information almost identical to mine. In particular, Postel-Vinay and Robin (2002) estimate their equilibrium model using the French Administrative DADS panel.

[15] See Brugiavini and Brunello (1998) for discussions about this problem.

Table 1: Descriptive Statistics (see Appendix)

of workers observed during a the period 1985-1996. I look at the current status of all workers in the sample in February 1991. Then, I observe elapsed and residual duration in the state (employment or unemployment), the wage actually earned or accepted when exiting unemployment and, for those employed, the next transition to another job or unemployment (or censoring). In Table 1 in the Appendix I report descriptive statistics for the sample used in the estimation. I restrict my attention to male workers. Apprentices are excluded as are part time workers. Finally I trim the lowest 1% and highest 99% tails of the overall wage distribution.[16]

3.2 The Likelihood Function and Estimation Method

In what follows I sketch out the procedure used to estimate the model as proposed by Bontemps et al. (2000) on French data. The model allows for two states in the market: employment and unemployment. A binary variable indicates the state of the agent in February 1991, where employed workers take 0 and unemployed 1. Define elapsed and residual durations. Let t_{ib} and t_{if} denote these durations with $i = 0, 1$. Define left and right censored observations for those spells in progress in January 1985 and December 1996. Let d_{ib} and d_{if} denote those indicators. For each worker in the sample I then observe paid or accepted wages. Let w_0 and w_1 denote these variables. Finally, for those employed at the date selected, I can determine the outcome of their first transition, given the duration is not right censored. The model allows for two destinations upon exiting from previous employment:

[16] Following Contini (2002), yearly wages are deflated with the CPI at 1996 prices. Then, to make them comparable across workers with different number of days worked during the year, the following adjustment is adopted: realwage=(yearly wage/days paid)*26 where 26 is the average number of days worked during the month.

job to unemployment and direct job-to-job transition.[17]

The likelihood is obtained by multiplication of the individual contributions. Below, the derivation of the likelihood of each observation is provided.

Unemployed Workers. The probability of drawing an unemployed worker is $u/m = 1/(1+k_0)$. The distribution of elapsed and residual unemployment durations is assumed to be exponential. The exit rate from unemployment is λ_0, and the likelihood is

$$\frac{\lambda_0^{2-d_{0b}-d_{0f}}}{(1+k_0)} \exp\left[-\lambda_0(t_{0b}+t_{0f})\right] f(w_0)^{1-d_{0f}}. \tag{12}$$

Employed Workers. The probability of sampling an employed individual is $1-u/m = k_0/(1+k_0)$. The job duration, given w_1, is exponentially distributed with parameter δ, while the employment relationship has exponential duration with parameter $\delta + \lambda_1\overline{F}(w_1)$.[18] The likelihood reads as

$$\frac{k_0}{(1+k_0)} g(w) \left[\delta+\lambda_1\overline{F}(w_1)\right]^{1-d_{1b}} \exp\left\{-\left[\delta+\lambda_1\overline{F}(w_1)\right](t_{1b}+t_{1f})\right\} \left\{\delta^v \left[\lambda_1\overline{F}(w_1)\right]^{1-v}\right\}^{1-d_{1f}}, \tag{13}$$

where v is equal to one if the employment relationship terminates into unemployment.

The model is fully characterised by the five unknowns parameters Γ, λ_0, λ_1, δ, and R. The frictional parameters are identified from the duration data, the productivity distribution is identified from the empirical distribution of wages observed and R is identified as the lowest wage observed in the sample.[19]

The nonparametric estimation procedure can be outlined as follows.

[17] Following Contini (2002) and Postel-Vinay and Robin (2002) I arbitrarily define as job-to-job transitions those moves with an intervening period of unemployment less or equal to one month.

[18] Where $\overline{F}(w_1) = 1 - F(w)$.

[19] See Kiefer and Neumann (1993).

1. First I estimate $G(w)$ and $g(w)$ using a nonparametric procedure. I use a standard Gaussian kernel estimator for the density and the empirical cumulative distribution for $G(w)$. Let $\widehat{G}$ and $\widehat{g}$ denote such estimates. Conditional on k_1, consistent estimates of $\overline{F}$ and f are

$$\widehat{\overline{F}}(w) = \frac{1 - \widehat{G}(w)}{1 + k_1 \widehat{G}(w)} \tag{14}$$

and

$$\widehat{f}(w) = \frac{1 + k_1}{\left[1 + k_1 \widehat{G}(w)\right]^2} \widehat{g}(w) \tag{15}$$

2. Replace $\overline{F}$ and f in the likelihood function by the preceding expressions, and maximize the likelihood with respect to k_0, k_1, and δ.

3. Estimate $p = K^{-1}(w)$ and $\gamma(p)$ using the equations below

$$\begin{aligned} p &= w + \frac{1 + k_1 G(w)}{2 k_1 g(w)}, \\ \gamma(p) &= \frac{2k_1 \left(1 + k_1\right) g(w)^3}{3k_1 g(w)^2 \left[1 + k_1 G(w)\right]^2 - g'(w) \left[1 + k_1 G(w)\right]^3}, \end{aligned}$$

where p represents a firm-specific constant value of productivity, $\gamma(p)$ denotes the density of the productivity distribution and $g'(w)$ is obtained by differentiation of the earnings density.

It is important to recognise that the procedure can be decomposed in two separate parts. The first two steps basically analyse only worker behaviour and do not look at the firms, while the third exploits information recovered from previous steps to get the distribution of productivity. The latter is obtained without assuming any parametric form.

3.3 Results

It is a well known fact that standard wage regression are able to explain at most 50% of wage variation across individuals. The remaining variation in wages is imputed to standard

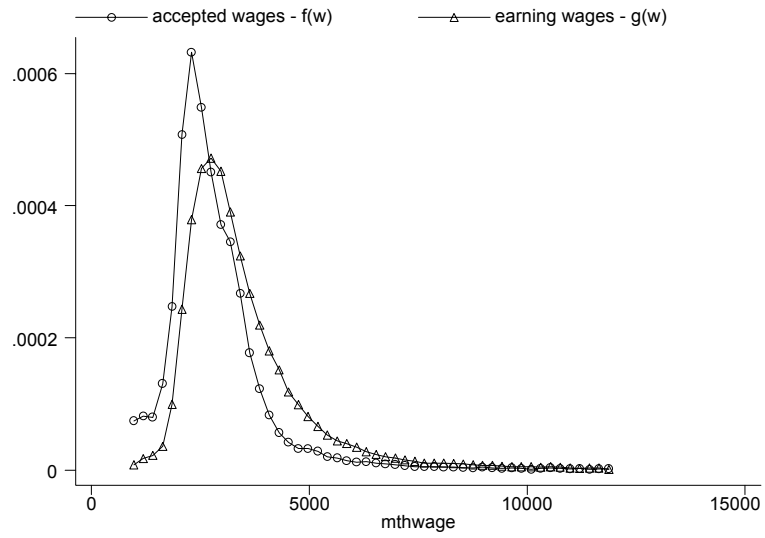

Figure 1: Kernel Density Estimates of Earnings and Offer Wages

measurement error and other unobservable factors. Equilibrium search models try to decompose wage variation in two main components, variation due to differences in productivity across firms and variation due to search frictions. Moreover, equilibrium search models make specific predictions about the shape of earnings and accepted wages. In the theoretical section this relationship has been characterised in a steady state equilibrium. In general, the expected empirical relationship is that of first order stochastic dominance of the earnings distribution on the wage offer. In Figure 1 this prediction is explicitly tested using standard kernel estimations of the two densities. The earnings distribution is shifted to the right, indicating that higher wages are more likely to be earned for those employed in February 1991. The distribution of accepted wages after unemployment is instead more concentrated at lower wages.

In Table 2 estimation results for transition parameters are presented. The first interesting result is that of an arrival rate of acceptable wage offers when employed much lower than the one when unemployed; λ_1's estimate for the all sample is almost ten times larger than λ_0. According to these results, the estimated average duration of unemployment is equal to 23

Table 2: Transition Parameters

	δ	λ_0	λ_1	k_1
All Sample	0.0128	0.0431	0.0064	0.5039
	[0.0127, 0.0128]	[0.0427, 0.0436]	[0.0063, 0.0068]	[0.4925, 0.5218]
Blue Collars	0.0139	0.0421	0.0053	0.383
	[0.0138, 0.0140]	[0.0415, 0.0427]	[0.0051, 0.0055]	[0.3742, 0.3920]
White Collars	0.0109	0.0466	0.0103	0.9472
	[0.0107, 0.0111]	[0.0450, 0.0484]	[0.0097, 0.0108]	[0.8802, 0.9953]
Managers	0.0122	0.0786	0.0655	5.3561
	[0.0115, 0.0132]	[0.0630, 0.1070]	[0.0408, 0.1373]	[3.3168, 10.892]
15-25	0.0251	0.0350	0.0079	0.3154
	[0.0247, 0.0254]	[0.0339, 0.0359]	[0.0073, 0.0085]	[0.2926, 0.3429]
26-40	0.0126	0.0475	0.0060	0.4762
	[0.0124, 0.0128]	[0.0465, 0.0483]	[0.0057, 0.0063]	[0.4525, 0.5114]
41-50	0.0098	0.0709	0.0040	0.4111
	[0.0097, 0.0099]	[0.0677, 0.0737]	[0.0039, 0.0042]	[0.4005, 0.4288]

Time period is month. 5% and 95% percentiles of the bootstrap distribution in square brackets.

months. On the other hand, the average duration of an employment relationship terminated by the worker with a quit is equal to 156 months. This indicates that on-the-job search activity is very low and that job search reveals much more profitable when unemployed. On the other hand, the job destruction rate is estimated close to 0.012, with an average duration of the job of 83 months. Finally, $k_1 = \lambda_1/\delta$ gives a measure of the speed at which workers climb the wage ladder. It can be also interpreted as the average number of offers received in the time interval. Assuming an equal opportunity of receiving better offers during the year, the average number of offers if equal to six for a random worker in this sample.

As predicted by the theory, transition parameters provide a measure of the importance of search frictions in the labour market. However, workers differ according to some observable and unobservable characteristics that affect their labour market outcomes. Stratification of the sample according to worker characteristics gives some indication of the difference in the degree of search frictions that workers face when looking for a job. Results in Table 2 indicate interesting differences among different occupations and age groups. As expected managers rank very high in the probability of getting outside offers, their estimated arrival rate of

offers is equal to 0.06 per month with an average number of offers per month greater than five. On the other hand, job destruction rates are almost constant across different groups with a somewhat higher rate for blue collars. Stratification by different age groups provides expected results with higher job destruction rate for young workers and higher probability of moves for them. Results in the last column of the Table also confirm well known findings about the concave relationship between wage and experience in the labour market, with an increasing profile in early stages of the career and with a flattening in late stages.

Transition parameters illustrate interesting results about the degree of search frictions in the labour market and fully characterise the distribution of wages in equilibrium search models. However, as previously discussed, the model in its pure form is not able to fit the wage distribution and some form of heterogeneity if firms' productivities is necessary to get satisfactory results. The estimation method allows also to recover an estimate of the productivity parameter for each firm and consequently look at the characteristics of the productivity distribution in the economy. In Figure 2 the estimated productivity distribution is reported using a standard kernel method.[20] The graph indicates that most of the firms are concentrated in the lower and higher percentiles of the distribution and that the density in the very long tail of the distribution tends to zero, as predicted by the model and as found when approximating the distribution by some parametric family (e.g., the Pareto family is often used). It should be noted here that the productivity distribution is much more dispersed and concentrated at extreme values than the wage distributions. I will return to these issues in more detail when discussing the stratification by regional area of work of firms.

Figure 3 looks at the estimated mapping between productivity and offered wages. The estimated wage offer function K indicates that the relationship is increasing at all levels of

[20] To ease exposition, it should be noted that the plot has excluded the 1% lowest and 99% highest observations.

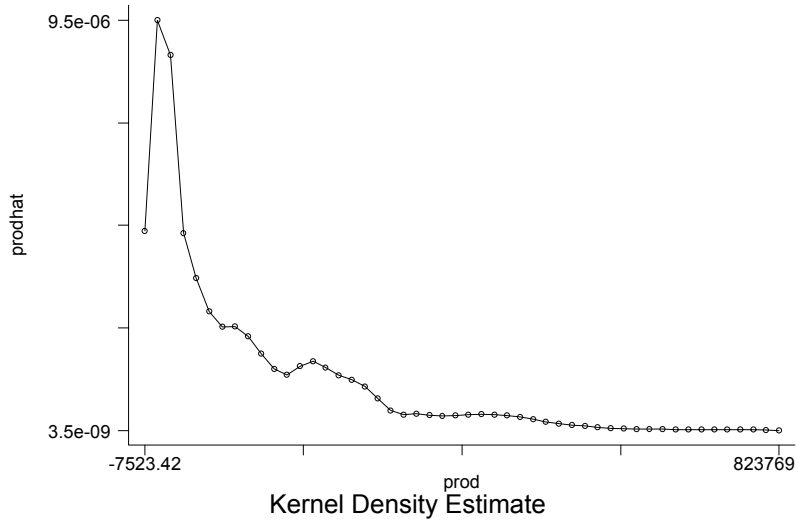

Figure 2: Kernel Density Estimates of Estimated Distribution of Productivity

productivity but is characterised by an inflection point at median productivity levels. The relationship appears somewhat concave at lower levels to become convex at higher levels of productivity.

The above results should then be analysed looking at the monopsony power index (Figure 4). The latter is defined as $MPI = [p - K(p)]/p$ and gives a direct measure of the degree of exploitation of labour market frictions by firms when setting wages. The index varies between 0 and 1 with higher values indicating a lot of monopsony power from firms in setting wages. This condition can be theoretically identified as one of very low mobility and almost no search while on-the-job. The index gives also a measure of the proportion of the rents that accrue to workers when starting an employment relationship, or how far are workers from being paid their marginal product p. Figure 4 indicates that firms are able to extract almost all the surplus from their workers. The relationship is concave with an asymptotic tendency toward one for high productivity firms. This results can be easily interpreted in the theoretical framework proposed in this paper. Given very low level of on-the-job search and a few opportunities to move to better-paying wages, firms are able to extract all the surplus

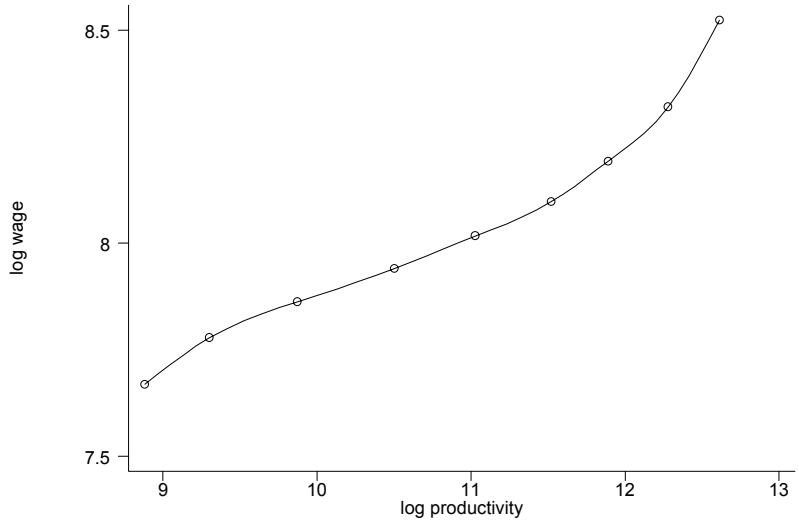

Figure 3: Mapping from Productivity to Wages, Percentiles - Log Scale

from their workers paying them wages just above their value of leisure. However, the pattern is somewhat different for low productivity and high productivity firms. The mapping from productivity to wages in Figure 3 indicates that high productivity firms offer *proportionally* higher wages compared to those paid by firms in the lower part of the distribution. Higher productivity and higher offered wages have opposite effect on the monopsony index; in this case it seems that, at least for high productivity firms, paying higher wages doesn't harm their capacity of getting most of the rents deriving from the match.

Previous results indicate that the degree of search frictions in Italian labour market is considerable. Workers face difficulties in climbing the job ladder and firms are able to exploit the monopsnony power that accrues to them because of the presence of information problem in the market. However, estimates of transition parameters indicate that segmentation of the labour market by observable characteristics of workers can help us to identify those groups that are more severely damaged in this context. Results found for different age groups and for different occupation categories confirm previous expectations. However, monopsony power of firms and low mobility can also be amplified by a low level of geographical mobility

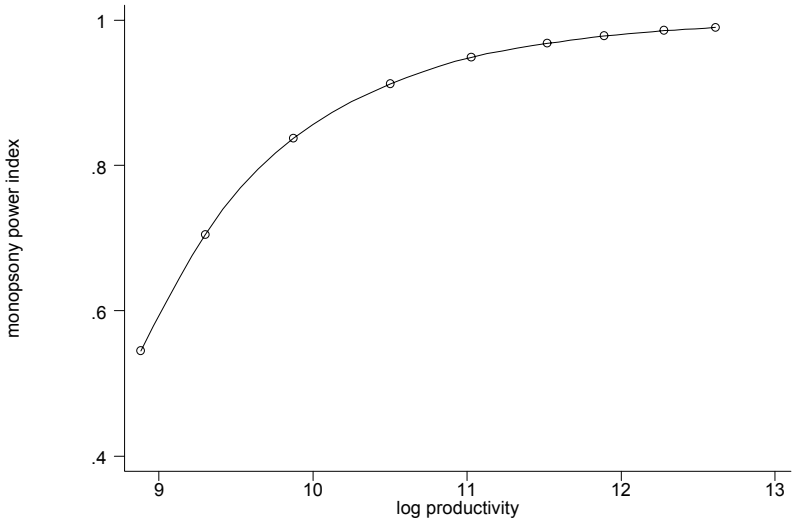

Figure 4: Monopsony Power versus Log Productivity

of workers across different areas. In what follows, I try to shed some light on this issue separately looking at four macro-regions. This exercise could also prove useful when looking at productivity differentials in regional contexts.[21]

Figure 6 in the Appendix provides kernel estimates of earnings and offered wages for different areas. The striking result is that the predicted stochastic dominance relationship between the earnings and offer distribution is not confirmed for the South: accepted and earning wages seem to collapse to the same distribution. A visual inspection indicates that it is the distribution of accepted wages after unemployment that collapses towards the earnings distribution. This could indicate that workers in the South are more likely to get higher wages upon exiting unemployment.[22] Table 3 provides estimation results for arrival rates across different regions. As expected, results show some variability. Estimated parameters

[21] See Contini (2002) for the problem of comparability between reported working days for firms in the North and the South of Italy.

[22] It is hazardous to draw conclusion about this point. However, on the supply side, this effect can reflect more picky workers in the South with higher possibilities of work in the black market and relatively higher reservation wages; on the demand side the effect can be explained along the lines proposed by Contini (2002); firms in the South fire temporarily their workers allowing them to work under regular conditions only a part of the year and hiring them again at previous wages.

Table 3: Transition Parameters by Regions

	δ	λ_0	λ_1	k_1
North-west	0.0116	0.0477	0.0068	0.5907
	[0.0115, 0.0117]	[0.0463, 0.0488]	[0.0065, 0.0071]	[0.5597, 0.6179]
North-east	0.0122	0.0468	0.0073	0.6031
	[0.0120, 0.0124]	[0.0452, 0.0483]	[0.0070, 0.0077]	[0.5751, 0.6335]
Centre	0.0120	0.0416	0.0063	0.5236
	[0.0118, 0.0122]	[0.0401, 0.0426]	[0.0060, 0.0068]	[0.5012, 0.5676]
South	0.0159	0.0386	0.0047	0.2995
	[0.0156, 0.0161]	[0.0377, 0.0395]	[0.0044, 0.0052]	[0.2800, 0.3292]

Time period is month. 5% and 95% percentiles of the bootstrap distribution in square brackets.

for the South indicate slightly higher job destruction rate (0.0159 against 0.0116 for the North-west). The arrival rate of acceptable offers is everywhere higher in other parts of the Country with the highest value for the North-East. Above estimates are then summarised in the k_1 parameter with a value for the South that is almost half of the one estimated for the North.

After estimating separately for each macro-region the density of earning wages and the transition parameters, in Table 4 some properties of the estimated productivity distribution are reported.[23] Estimated values for productivity are very high given the low value of the frictional parameters. It seems not particularly worth looking at absolute values, while it is more interesting to look at some qualitative results. Some differences in the distribution of the productivity across firms for different areas emerge when looking at standard descriptive indicators for the distribution. First, the ratio between the 90th and 10th percentile indicates that productivity dispersion is higher in the North-east of Italy. Although the distribution is clearly right skewed, the degree of asymmetry is lower with respect to the one found for other parts of the Country. On the contrary, in the South the distribution of productivity is characterised by a strong concentration of firms in the lower deciles with a very high peak

[23] See also Figure 6 in the Appendix for a visual inspection of these issues.

Table 4: Estimated Productivity Distribution

	min	p10	median	p90	p90/p10	mean	skewness	kurtosis
North-west	2879	6908	55832	228627	33.09	102583	5.02	42.48
North-east	2838	6709	60838	362155	53.98	128684	2.79	15.97
Centre	3337	7299	49202	279558	38.30	121301	4.44	31.88
South	3135	7049	59767	293722	41.66	124696	5.56	53.70

Monetary values are expressed in 000s of Italian Lira.

in the productivity distribution.[24] The mapping from productivity to wages and the value of the monopsony power index do not indicate interesting differences across different areas (Figures 7-8).

4 Concluding Remarks

This paper provides an extensive empirical analysis of an equilibrium search model with heterogeneity in firms' productivities. The model is able to exploit the double source of wage variation as advocated by equilibrium search models: on-the-job search and productivity differentials across firms. The latter is necessary to get a good fit of the wage distribution. In particular, an exogenous continuous distribution of firms' productivity is assumed to exist. The model is structurally estimated using a "three steps" procedure as recently proposed by Bontemps et al. (2000). First, the earnings distribution is estimated non-parametrically; then these estimates are used to recover frictional parameters using maximum likelihood methods. Conditional on the previous steps, in the third stage, an estimate of the productivity distribution is provided.

Results indicate that search frictions are important in the process of determination of wages and that Italian firms are able to extract from their workers most of the rents upon formation of a match. Wages are increasing (and convex) function of productivity levels. High

[24] Average productivity in the South is estimated to be higher than in other parts of the Country. Higher capital/labour ratios can constitute an explanation for this fact. However the model doesn't have capital and the interpretation of this result is left for future research.

productivity firms are able to offer higher wages but still enjoy most of the match-specific rents. This result calls for interesting extensions of the model along the lines proposed by Acemoglu and Shimer (2000). Introducing (endogenous) capital as production factor can further help in explaining the source of wage dispersion before drawing policy conclusion from this analysis.

This paper contributes to the new emerging literature dealing with the structural estimation of equilibrium search models. To the best of my knowledge, it represents the first attempt to analyse the Italian labour market in such a framework. As a consequence, my results can be only compared to those obtained for other countries. In particular, the results presented in this study carry some resemblance with those obtained by Bontemps et al. (2000) for France. In both countries firms are well able to exploit their monopsony power when the degree of estimated upward wage/labour mobility is very low. As a consequence high productivity firms can offer high wages and still make big profits. Stratification by sector of activity as proposed by Bontemps et al. (2000) can prove useful to distinguish more clearly those firms. Providing further evidence on these issues is my future research agenda.

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Appendix: Figures and Tables

Figure 5: Kernel Density Estimates of Earned and Offered Wages

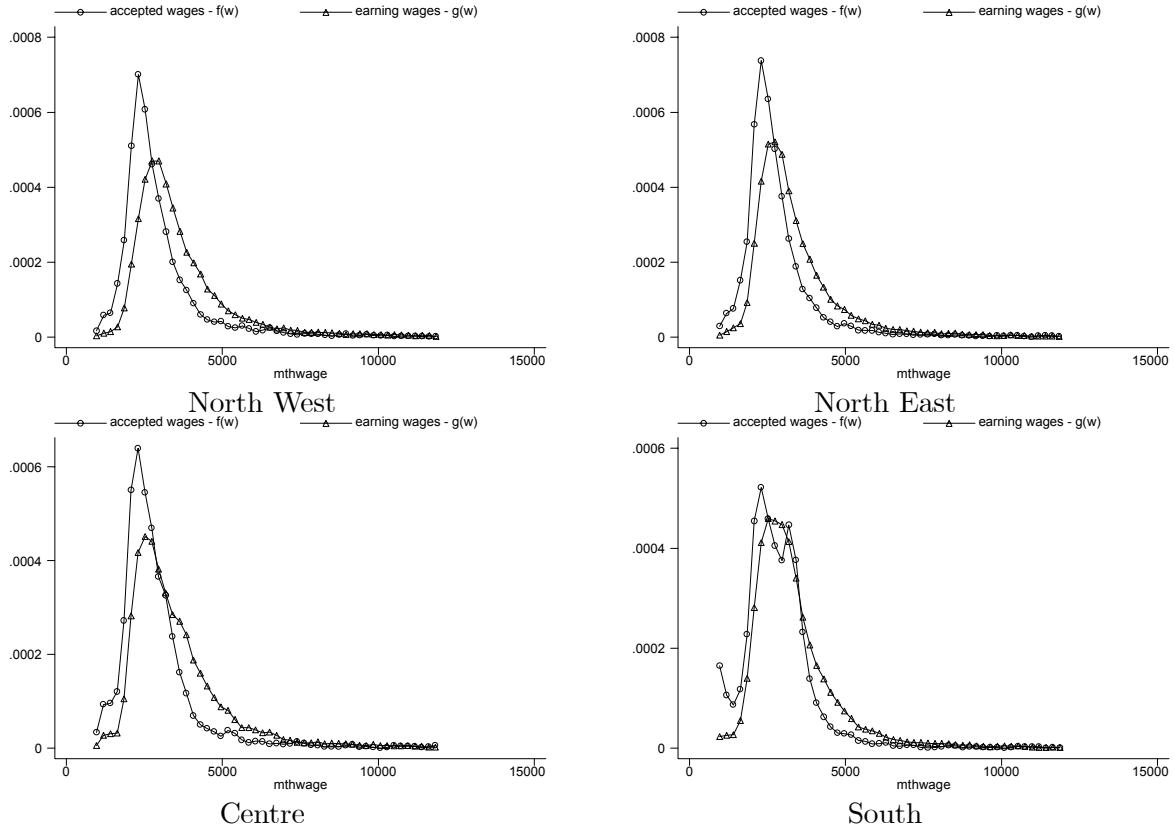
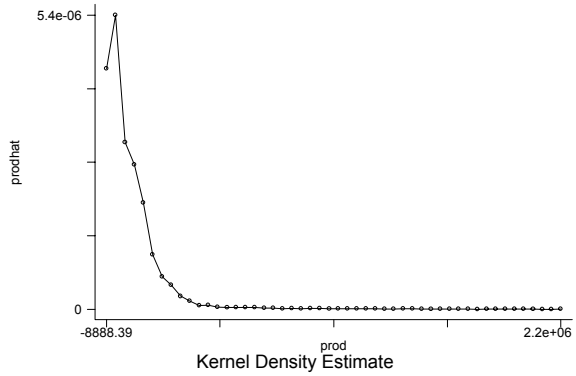
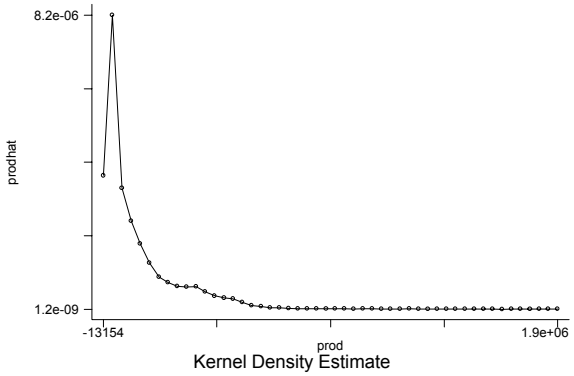


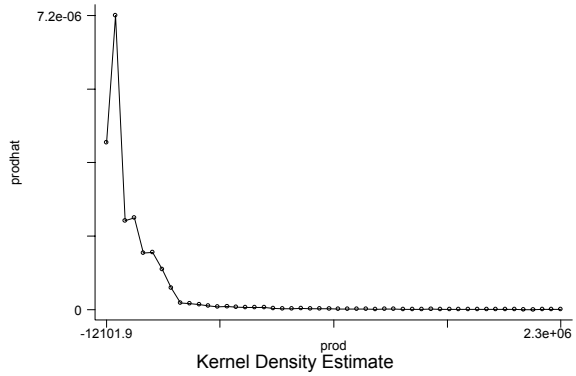
Figure 6: Kernel Density Estimates of Productivity Distribution



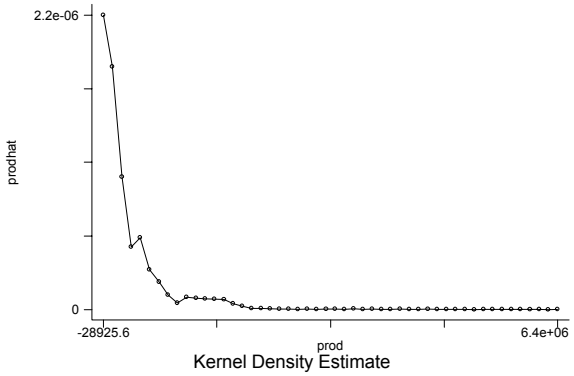
North West



North East

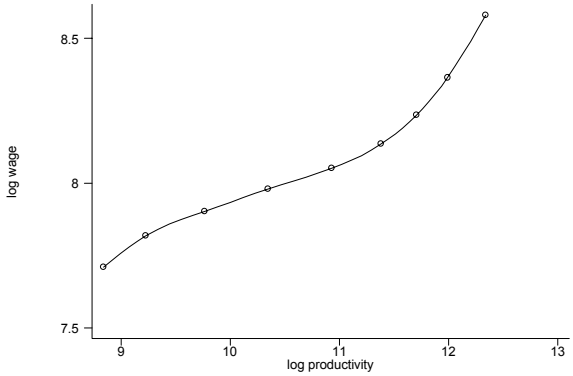


Centre



South

Figure 7: Mapping From Productivity to Wages



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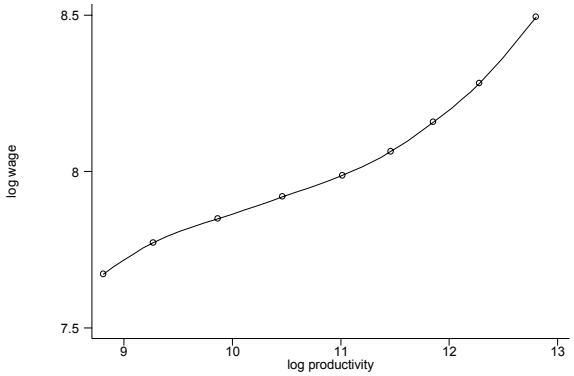

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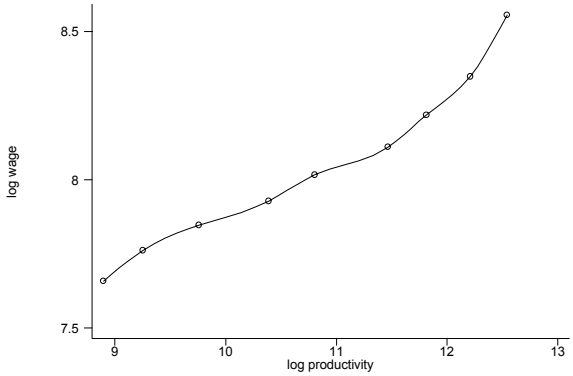
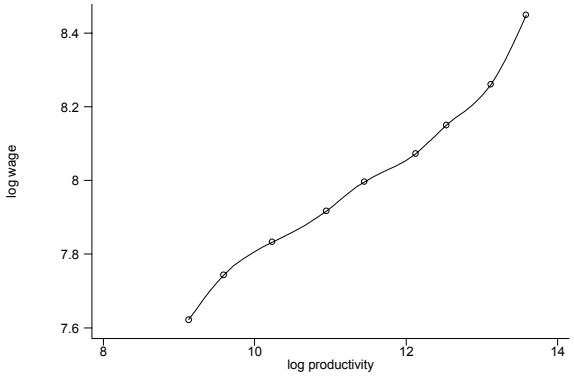
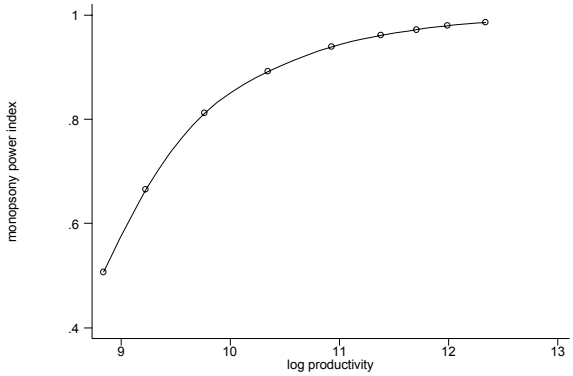


Centre



South

Figure 8: Monopsony Power Index vs Productivity



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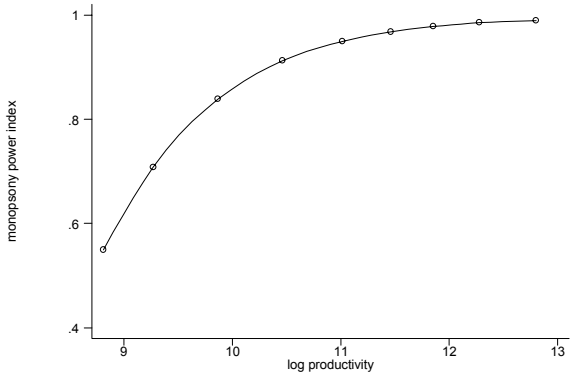

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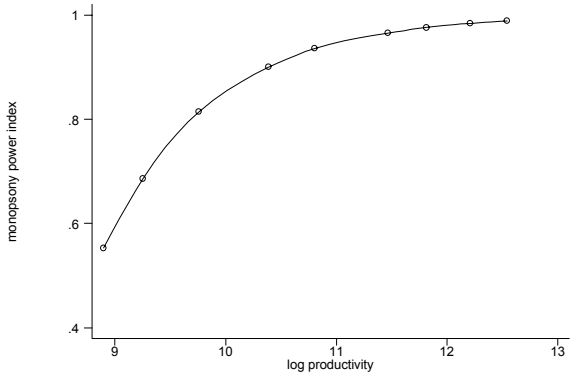

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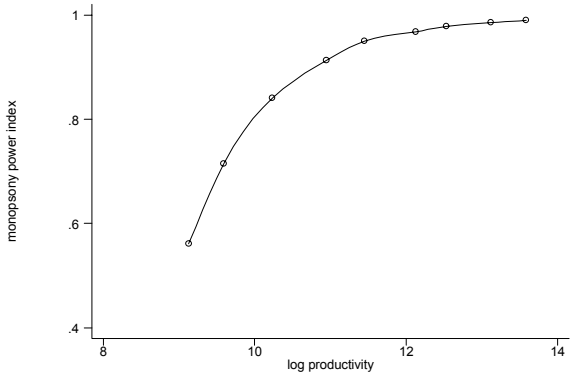

South

Table 1: Descriptive Statistics

	All Sample	Blue Collars	White Collars	Managers	15-25	26-40	41-50	North-west	North-east	Centre	South
Number of Workers	60,506	41,223	18,819	464	12,904	31,042	16,523	20,307	13,351	11,281	15,557
Unemployed	16.48%	19.37%	10.40%	5.60%	34.10%	14.41%	6.42%	12.57%	15.40%	15.49%	23.22%
Employed	83.52%	80.63%	89.60%	94.40%	65.90%	85.59%	93.58%	87.43%	84.60%	84.51%	76.78%
Age: mean (std dev)	33.75 (8.75)	32.94 (8.91)	35.32 (8.11)	41.69 (5.97)	22.51 (2.07)	32.34 (4.31)	45.20 (2.80)	33.85 (8.89)	33.16 (8.81)	34.62 (8.64)	33.93 (8.57)
Unemployed											
left censored	36%	34%	44%	23%	43%	31%	23%	37%	32%	38%	36%
right censored	15%	15%	13%	15%	14%	16%	14%	12%	12%	17%	17%
Duration (not censored)											
mean (std dev)	24.37 (21.42)	24.18 (25.30)	25.30 (21.96)	24.41 (21.22)	23.44 (20.57)	25.19 (22.15)	24.22 (21.25)	23.96 (22.03)	23.11 (22.01)	24.79 (21.43)	25.24 (20.58)
Employed											
Transitions $e \longrightarrow u$	13%	13%	12%	12%	15%	14%	10%	15%	15%	13%	9%
Transitions $e \longrightarrow u$	87%	87%	88%	88%	85%	86%	90%	85%	85%	87%	91%
left censored	25%	23%	27%	28%	1%	24%	40%	25%	27%	25%	21%
right censored	41%	39%	46%	43%	29%	43%	45%	45%	41%	43%	36%
Duration (not censored)											
mean (std dev) - total	47.10 (32.01)	44.40 (31.46)	53.03 (32.41)	62.33 (31.16)	35.01 (25.44)	47.75 (31.55)	58.82 (34.72)	48.73 (31.74)	46.91 (31.00)	50.24 (33.59)	43.03 (31.64)
if transition $e \longrightarrow e$	25.67 (20.18)	24.39 (19.37)	28.55 (20.90)	34.75 (20.40)	37.62 (25.98)	26.75 (20.69)	30.68 (23.13)	26.73 (19.91)	24.15 (19.73)	28.69 (21.63)	22.38 (19.17)
if transition $e \longrightarrow u$	50.44 (32.22)	47.55 (31.80)	56.78 (32.23)	65.63 (30.62)	26.09 (15.07)	51.14 (31.69)	61.99 (34.36)	52.79 (31.85)	51.01 (30.88)	53.67 (33.88)	45.14 (31.90)
Wage Distribution											
minimum	974	975	974	1166	978	974	977	983	975	975	974
p10	2139	2068	2455	6407	1972	2176	2426	2229	2147	2116	2040
median	3032	2807	3856	9017	2527	3053	3542	3136	2944	3028	2969
p90	5030	3974	6477	11164	3480	4913	6083	5323	4886	5193	4667
p90/p10	2.35	1.92	2.63	1.74	1.76	2.25	2.50	2.38	2.27	2.45	2.28
mean (std dev)	3386 (1440)	2941 (891)	4227 (1726)	8749 (2059)	2468 (762)	3372 (1341)	3992 (1723)	3547 (1518)	3311 (1389)	3423 (1503)	3212 (1302)

Durations are expressed in months. Monetary values are in 000s of Italian Lira.