Disentangling employment and wage rigidity*

Luigi Guiso, Univ. di Sassari and Ente Einaudi
Luigi Pistaferri, Stanford University
Fabiano Schivardi, Bank of Italy

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PRELIMINARY

Abstract

A large body of literature has shown that both employment and wages respond to shocks to the firm. Previous empirical work has considered these two aspects separately. We construct a dynamic general equilibrium model of labor and wages adjustment where firms face firing costs (internal adjustment costs) and workers face mobility costs (external adjustment costs). The model shows that the two type of costs can be discriminated empirically only by jointly considering employment and wage changes. We construct a matched employer-employees dataset where, by considering the joint response of wages and employment, we are able to assess the nature of the frictions characterizing employment adjustment. Our results indicate that both types of costs are present, but that the internal component accounts for the bulk of adjustment costs.

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1 Introduction

The idea that labor markets deviate substantially from a walrasian competitive allocation mechanism has a long history in economics. Indeed, much of the macroeconomic debate on the business cycle originates from it. In keeping with this debate, over the last fifteen years an enormous amount of research has been devoted to the understanding of the labor market at the microeconomic level, reflecting on the elements that make the employment relationship *different* from other economic transactions. The modern analysis of the employment relationship puts the existence of frictions in the creation and destruction of employment at the very center of its research agenda.

Alongside theoretical developments, over the last decade the availability of data at the micro level has spurred an increasing number of studies on the costs of adjusting labor, documenting the existence of nonlinearities and of non-convex costs in the adjustment policies of individual units (see Hamermesh and Pfann (1996) for a survey). Following the theoretical literature on adjustment costs, that take a partial equilibrium approach at fixed wages (Bentolilla and Bertola 1990), this body of work maintains that, at the micro level, firms face an infinitely elastic labor supply curve, so that labor adjustments can be studied in isolation from wage adjustments.

On the other side, the literature on search and matching in the labor market (Mortensen and Pissarides 1999) has shown that, in the presence of search frictions, employment and wages are jointly determined at the level of the firm. In fact, a body of research in the labor literature has documented that wages too respond to firm level conditions. In particular, recent work based on matched employer-employees data has shown that shocks to the firm are partially transmitted to the compensation of its employees (Bronars and Famulari 2001, Guiso, Pistaferri and Schivardi 2003), in contrast to the hypothesis that workers' compensation is insulated from idiosyncratic changes in business conditions.

This paper argues that the joint consideration of labor and wages response to shocks can help to shed some light on the nature of the frictions that characterize the employment relation. In particular, our approach allows for the separate identification of adjustment costs internal to the firm, such as firing and hiring costs or those due to disruption in production, and external adjustment costs, i.e. those beard by the workers due to costly mobility across firms, such as for search, geographical relocation or the loss of firm or sector specific human capital. This is clearly an important distinction, because such costs have different implications for the functioning of the labor markets and for policy that aim at improving its functioning, particularly regarding the relative rigidity of wages and employment induced by institutional factors.

We adapt a general equilibrium model by Bertola (2004) with firing costs on the firm side, mobility costs on the workers' side and idiosyncratic shocks to labor demand. The model delivers patterns of adjustments that deviate from the frictionless paradigm in important ways. More importantly, it shows that both internal and external costs can generate the type of employment response to shocks that have been traditionally associated with the internal component only. This suggest that the interpretation of the results of the previous literature as evidence of internal adjustment costs might be unwarranted.

While stylized, the model is flexible enough to allow for the structural identification of the adjustment costs parameter, distinguishing between the two components of adjustment costs. The idea behind the empirical test is simple. If mobility costs are important, then an expanding firm will need to compensate new workers for the mobility cost they bear: stated differently, mobility costs imply an upward sloping supply for labor at the firm level. When a firm changes the level of employment, the workers compensation should also change in the same direction. We therefore supplement the employment adjustment equations previously used in the literature with a wage adjustment equation, which allows us to separately identify internal and external adjustment costs.

The empirical problem with this approach is that it can hardly be implemented with firm-level measures of wages, such as total wage bill divided by the labor force. This measure, in fact, is likely to be strongly influenced by changes in employment for reasons that have nothing to do with adjustment costs.[1] To overcome this problem, we rely on linked employer-employee longitudinal data with enough information to compute measures of shocks to the firm and correlate them to firm level employment and to determine the response of *individual compensations* after controlling for workers' characteristics. To obtain such information, we merge company-level data for a large sample of Italian firms with social security data available for a random sample of their employees for the 1982-1994 period, thus obtaining a matched dataset that allows for the joint estimation of wages and labor to idiosyncratic shocks.

We find that total adjustment costs are substantial. According to our estimates, which provide a lower bound for the cost, the per capita costs of changing employment are in the order of 5,000 euros. While not directly comparable, this is the same order of magnitude as Abowd and Kramarz (2003) for France, a country with a labor market similar to the Italian one. When estimating the role of external costs, we find them to be positive and statistically significant but economically modest, in the order of 110 euros, or little more than 2% of the overall adjustment costs. This result is robust to a number of extensions, such as accounting for heterogeneity in mobility costs across workers. This might be due to the fact that mobility in the Italian labor market is mostly local, so that workers can be

[1] For example, when hiring a firm might acquire high skilled people, thus paying them a higher wage. Moreover, given that the number of employees would appear at the denominator of a measure of average compensation, any measurement error due to the timing with which employment is recorded would induce a spurious correlation between employment and wages adjustment.

enticed by small wage differentials. In fact, we find that the wage premium paid to movers increases with the distance of the new job location with respect to the previous one.

Taken at face value, our results suggest that most of the costs of adjustment are internal to the firm. This implies that the assumption of fixed wages used by the previous literature, while in principle incorrect, mighty be empirically tenable, lending support to the interpretation of previous results as evidence of hiring and firing costs internal to the firm.

The empirical literature on the importance of adjustment costs in explaining firms' employment choices is growing. In terms of labor adjustment, our paper is close to those that account for the endogenous selection of the adjustment regime, such as Alonso-Borrego (1998) for Spain and Nilsen, Salvanes and Schiantarelli (2003) for Norway. On the wage side, Belzil (2000) estimates a wage equation with measures of job creation and destruction at the plant level, finding that they effect compensations. Another related approach is that of Buchinsky, Fougère, Kramarz and Tchernis (2003), who estimate a wage equation together with mobility and a participation equation. They are interested in obtaining an unbiased estimate of the return to seniority. As far as we know, we are the first to jointly use employment and wage data to identify the nature of adjustment costs.

Our work has potentially important policy implications. Indeed, the debate on labor market flexibility has been focused on internal costs of adjusting employment, particularly on employment protection legislation (EPL). However, given that external costs can induce responses that are indistinguishable from those imposed by EPL by looking at employment in isolation, policy prescriptions based on results form employment equations only might misplace emphasis on the type of adjustment costs.

The layout of the paper is as follows. Section 2 presents the institutional framework, while Section 3 introduces a simple general equilibrium model based on Bertola (2004).

Section 4 details the data and Section 5 discusses estimation issues. The results are reported in Section 6, along with sensitivity analysis. Section 7 concludes.

2 Institutional aspects

Following the literature on adjustment costs at the firm level, we do not directly measure costs of hiring and firing, but rather infer them from the observed responses of employment and wages to shocks. As other continental European countries, Italy features a fairly regulated labor market. We thus offer a brief sketch of its main institutional features.

According to Italian employment protection legislation (EPL), individual and collective dismissals of workers with open-end contracts are only allowed on a just cause basis. Workers can be fired for misbehavior (*giusta causa o giustificato motivo soggettivo*), or because of the firm's need to downsize or reorganize its activities (*giustificato motivo oggettivo*). Thus, it would not be possible to fire an employee with a long tenure and a high salary to replace her with a young worker paid the minimum contractual wage.

Workers can appeal in court against dismissal. Firing costs are nil when a dismissal is not contested or it is ruled to be fair, although firms may want to pay some form of compensation to the dismissed workers in order to avoid litigation (this is especially true in collective dismissals, when lump-sum payments are sometimes explicitly bargained with the unions). If the judge rules in favor of the worker, she is entitled to compensation that varies according to firm size. Firms with less than 16 employees must compensate unfairly dismissed workers with a severance payment that varies between 2.5 and 6 months of salary (*tutela obbligatoria*). Firms with more than 15 employees[2] have to compensate workers for

[2]More precisely, the rule refers to establishments with more than 15 employees, and to firms with more than 15 workers in the same municipality or with more than 60 employees in all establishments combined. The different provisions according to firm size are the subject of the hotly contested Art. 18 of the "*Statuto*

the loss of earnings from the date of the dismissal to the date of the ruling. Moreover, they are obliged to reinstate the worker, unless he or she opts for a further severance payment equal to 15 months worth of salary. Because of these differences, the costs of EPL have been traditionally thought to be substantially larger for firms above the 15 employees threshold. Recent studies that exploit the differential effects of EPL on the propensity to grow of firms just below the threshold have found significant but modest effects (Borgarello, Garibaldi and Pacelli 2003, Schivardi and Torrini 2004), an indirect evidence that the differential effects of EPL on small and large firms might be overstated.

In terms of wage setting, Italian industrial relations are based on multi-tier collective bargaining, with economy-wide, industry-wide and company-level agreements. The latter, as we illustrate below, provide sufficient room for wages potentially to respond to idiosyncratic shocks. Collective contracts signed by the three major trade unions (CGIL, CISL and UIL) have *erga omnes* validity, i.e., they apply to all workers covered by the agreement regardless of union membership. Economy-wide bargaining deals mainly with general employment regulations, such as safety and employment protection. The relevant tiers for wage formation are at the industry and company level. Agreements at the industry level were signed every three years during the period examined here, establishing the contractual minimums for the various job grades. Supplementary components of the compensation package are determined at the company level where the firm can decide on some components of the compensation unilaterally, and can also agree to company contract with the Unions, covering both wage and non-wage matters. Firm-level contracts are not obligatory and there is no standard rule governing their duration.

The relevance of the firm to wage determination has been evolving with industrial re-

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lations.[3] Our data cover the years from 1982 to 1994, when there was a fairly high degree of bargaining decentralization.[4] For this period, the wage bill can be decomposed into the following components:[5]

1. Contractual minimums (*minimi tabellari),* established at the industry level.

2. Cost-of-living allowance (*indennità di contingenza),* added to the contractual minimum according to the inflation rate.

3. Company-level wage increment (*superminimum)*, added to the contractual minimum on a permanent basis (in nominal terms). The increment has a firm-level and a worker-level component.

4. Production bonuses (*premi di produzione),* determined at the firm level. These are bonuses and other one-time payments, decided unilaterally by the firm without formal negotiations with the trade unions. They are not permanent.

5. Variable compensation (*retribuzione variabile),* determined by a firm-level contract. It can introduce a contingent component in the compensation package.

[3]Until the 1960s, company-level bargaining was not formally recognized. The economic boom encouraged the rise of company-level bargaining, at that time mainly focusing on wages and productivity and essentially autonomous *vis-à-vis* industry-wide agreements. The 1970s saw the greatest development of company-level agreements. Starting towards the end of that decade, the worsening economic crisis and the unions concern over unemployment led to a gradual reshaping of company-level bargaining. A major restructuring of the industrial relations system came in 1993, following devaluation and the severe recession that ensued. Given that our data cover only up to 1994, the 1993 agreement plays essentially no role and the industrial relations regime we have to consider is the relatively autonomous one in effect previously.

[4]Iversen (1998) constructs an index of centralization of wage bargaining which combines a measure of union concentration with a measure of the prevalent level of bargaining. The index covers 15 OECD countries from 1973 to 1995. He divides his sample into three groups: centralized (Norway, Sweden, Denmark, Austria, Finland), intermediately centralized (Netherlands, Germany, Belgium, Japan, Switzerland), and decentralized (Italy, UK, France, USA, Canada), ranked in order of degree of centralization. The index ranges from 0.071 (USA and Canada) to 0.538 (Norway), with Italy having a value of 0.179. For comparison, the UK has a value of 0.177, France of 0.121, and Switzerland of 0.25.

[5]See Erickson and Ichino (1995) for further details on wage formation in Italy for the period covered by our data.

The importance of firm-specific wage effects depends on the diffusion of company-level bargaining and on the magnitude of the firm-specific wage components. In terms of diffusion of firm-level contracts, the yearly report of CESOS, an association of trade unions, indicates that approximately half of Italian workers were involved in firm-level contract negotiations each year from 1984 to 1994.[6] The likelihood of firm-level contracts increases with firm size (Bellardi and Bordogna 1997). As we shall see, in our sample large firms are disproportionately represented, implying a greater importance of firm-level contracts than for the average firm.

A breakdown of the wage bill into its various components is not available for the economy as a whole. The dataset that most extensively used to address this issue uses wage formation data in the Metal products, Machinery and Equipment industry assembled by *Federmeccanica*, the association of employers for that sector. Though a partial view with respect to our analysis, that encompasses all the private sector, these data provide insights that are likely to extend to the economy as a whole because the patterns are induced by quite general institutional features (Rossi and Sestito 2000). Table 1 gives the breakdown of the average wage into the five components discussed above for 1984-1994 (approximately the same as our data, that cover the years 1982-1994). The industry-wide component of the wage declined from 84% in 1984 to 77% in 1994. This means that between one-sixth and one-quarter of the compensation was firm-specific, with quantitatively important scope for firms to influence the wages of their employees over and above industry-level bargaining.

[6] The 1994 Bank of Italy survey on manufacturing firms with at least 50 employees found that more than 92% of these workers were covered by a firm-level contract in addition to the industry-wide agreement and that 40% had been involved in a contractual round during the year (information on previous years is not available).

3 The Model

We adapt a model by Bertola (2004). The economy is comprised of a continuum of firms and workers. Workers solve the following problem over an infinite horizon:

$$\max_{m_{t+j}} E_t \sum_{j=0}^{\infty} \beta^j u(w_{t+j} - m_{t+j}c) \tag{1}$$

where $m = \{0, 1\}$ is the mobility decision, β the discount factor, w denotes the wage rate and c the job-to-job mobility cost.

Workers face uncertain wages. In each period, a worker can be employed in a "good" or a "bad" firm, which pay wages w_g and w_b respectively. As it will become clear below, in equilibrium the wage fluctuates with the firm productivity (or market demand), which follows a symmetric first order Markov process: $\Pr\{w' = w_i | w = w_i\} = p$, $i = g, b$. With probability $p \geq \frac{1}{2}$, the wage remains constant to its good (w_g) or bad value (w_b), with $w_g \geq w_b$. With probability $1 - p$, a good (bad) wage becomes bad (good). A worker employed in a bad firm can move instantaneously to a good one by paying a moving cost c. In a stationary environment, the value of working at a good or bad firm are as follows:

$$U_g = u(w_g) + \beta [pU_g + (1-p) U_b] \tag{2}$$

$$U_b = \max \{u(w_b) + \beta [(1-p) U_g + pU_b], u(w_g - c) + \beta [pU_g + (1-p) U_b]\} \tag{3}$$

The first expression shows that people that are in a good job draw utility from their wage $u(w_g)$, do not move, and get continuation utility equal to either U_g or U_b with probability p and $1 - p$, respectively. The second expression shows that the mobility decision is taken (and the cost c paid) when the second term in curly brackets (expected lifetime utility from moving) exceeds the first term (expected lifetime utility from staying). In an equilibrium featuring both mobility from bad to good jobs and nonzero employment in bad jobs, it must be that the workers at bad jobs are indifferent between moving or staying, which implies that the two terms in curly brackets are equal:

$$u(w_g) = u(w_b) + \theta \left[u(w_g) - u(w_g - c)\right] \tag{4}$$

where $\theta = 1 + \beta(1 - 2p)$. Given that $p \geq 1/2$ and $\beta < 1$, $0 < \theta < 1$. Equation 4 implicitly defines $\Delta w \equiv w_g - w_b$: wage differentials are determined by workers' mobility costs only, and are independent from the characteristics affecting firms' labor demand, such as firing costs and productivity shocks.[7]

To allow for analytical solutions, take the simple case of linear utility. Equation 4 rewrites:

$$w_g = w_b + \theta c \tag{5}$$

Thus with serially uncorrelated shocks ($p = \frac{1}{2}$), the firm must pay a wage premium that equals the moving cost: $w_g = w_b + c$, while with full persistence ($p = 1$) the firm only needs to pay the annuity value of the moving cost: $w_g = w_b + (1 - \beta)c$. Bertola (2004) formally shows that the wedge between wages implied by equation 5 constitutes a lower bound with respect to the more realistic case in which workers are risk averse.[8]

Firms also solve an infinite horizon problem:

$$\max_{l_{t+j}} E_t \sum_{j=0}^{\infty} \beta^j \left[F(l_{t+j}, \varepsilon_{t+j}) - w_{t+j} l_{t+j} + \mathbf{I}\left\{l_{t+j} - l_{t+j-1} < 0\right\} k\left(l_{t+j} - l_{t+j-1}\right)\right] \tag{6}$$

[7] We use the notation $\Delta x \equiv x_g - x_b$ throughout.

[8] Bertola (2004) shows that consumption falls upon moving: workers are trading off current consumption for expected future consumption. The expected reward must therefore be larger the more concave the utility function, because risk averse individuals suffer more from a given reduction in current consumption.

where F is output, l labor and ε a productivity shock that takes on two values ε_g and ε_b with the same Markov transition probabilities as wages: in fact, in equilibrium firms with high productivity pay w_g and firms with bad productivity pay w_b. Firms take state dependent wages w_g and w_b as given. They also pay a firing cost $k > 0$ for each unit of labor dismissed: $\mathbf{I}\{A\}$ is an indicator function taking on value 1 when A is true and zero otherwise (we omit hiring costs for simplicity).

The productivity shock is realized at the beginning of the period, before the employment decision is taken. Note that, given that in every period the share of firms in each state is constant, the model has no role for aggregate shocks, while it focuses on idiosyncratic shocks, i.e., on shocks that affect the single production units without altering aggregate outcomes. This aspect of the model will have a very strict counterpart in the empirical analysis, where the shocks will be defined at the level of the single firm, after filtering out aggregate shocks.

The program in (6) can be reformulated recursively as:

$$\begin{aligned} V\left(l_t, \varepsilon_i\right) &= \max_{l_{t+1}} \left[F\left(l_{t+1}, \varepsilon_i\right) - w_{t+1} l_{t+1} + \mathbf{I}\left\{l_{t+1} - l_t < 0\right\} k\left(l_{t+1} - l_t\right)\right] \\ &\quad + \beta\left[pV\left(l_{t+1}, \varepsilon_i\right) + (1-p) V\left(l_{t+1}, \varepsilon_{-i}\right)\right] \end{aligned} \tag{7}$$

where $i = \{g, b\}, -i = \{b, g\}$, and V is the asset value of the firm, e.g., the net present value of discounted profits given the current state. Since we have assumed that there are only two productivity shocks, in a stationary equilibrium there are also two employment levels, so that equation (7) can be rewritten for the four states (l_j, ε_i), $j = \{g, b\}$, $i = \{g, b\}$, from which the asset value on each state can be determined.

Firms decide both whether to adjust when hit by a shock and, in the case they do, by how much. We study these decisions sequentially, starting from the latter, i.e., assuming that adjustment is indeed optimal. To obtain the optimal level of employment, it is easier to work with the net present marginal value of employment. Define V_g as the marginal value of employment for a firm with a good shock and V_b with a bad one and $F_l(l, \varepsilon)$ as the marginal product of labor for productivity shock ε. The marginal asset values inherit the recursive representation of the total asset values and satisfy the recursive relationships:

$$V_g = F_l(l_g, \varepsilon_g) - w_g + \beta[pV_g + (1-p)V_b] \tag{8}$$

$$V_b = F_l(l_b, \varepsilon_b) - w_b + \beta[(1-p)V_g + pV_b] \tag{9}$$

At the optimum, the marginal value of a worker must equal to the marginal cost of hiring in the good state and of firing in the bad one: $V_b = -k, V_g = 0$. As discussed by Bertola (2004), these are both necessary and sufficient conditions for an optimum. Inserting these conditions in (8) and (9), we get

$$F_l(l_g, \varepsilon_g) - w_g - \beta(1-p)k = 0 \tag{10}$$

$$F_l(l_b, \varepsilon_b) - w_b + (1-\beta p)k = 0 \tag{11}$$

With firing costs, the marginal product of labor is above its marginal cost in the good state (the firm does not hire as much as she would without firing restrictions) and *vice versa*. To gain further insights, assume that the production function is quadratic, so that one can get analytical solutions:

$$F(l, \varepsilon) = \varepsilon l - \frac{\phi}{2} l^2. \tag{12}$$

Here ϕ indexes the rate of decay of MPL, i.e., the concavity of the production function.

Substituting in (10) and (11) and taking first differences, we obtain

$$\Delta l \equiv l_g - l_b = \phi^{-1}\left[\Delta\varepsilon - \theta(c+k)\right] \tag{13}$$

This equation determines labor response to shocks with firing and labor mobility costs. The size of the adjustment depends positively on the difference in the productivity level and the persistence of the shock p, and negatively on the firing and mobility costs. The effect of k and c are magnified by persistence, because firms are more willing to hire and workers more willing to move for more persistent shocks.

To fully characterize the solution, assume that the labor force is of mass 1 and firms are of total mass 2. Given the symmetric transition probability of shocks, in steady state half of them will be in state g and half in state b, so that total employment is $l = l_b + l_g$. To close the model, assume that wages adjust so that there is full employment at all times: $l_b + l_g = 1$. Equations (5), (10), (11) and the equilibrium condition $l_b = 1 - l_g$ determine equilibrium employment and wages:

$$w_g = \frac{\varepsilon_g + \varepsilon_b + \theta c + (1-\beta)k - \phi}{2} \tag{14}$$

$$w_b = \frac{\varepsilon_g + \varepsilon_b - \theta c + (1-\beta)k - \phi}{2} \tag{15}$$

$$l_g = \frac{\phi + \Delta\varepsilon - \theta(c+k)}{2\phi} \tag{16}$$

$$l_b = \frac{\phi - \Delta\varepsilon + \theta(c+k)}{2\phi} \tag{17}$$

The model so far has been characterized under the assumption that adjustment is optimal. However, the difference in the shocks (and therefore in marginal productivity in the two states) could be such as to make adjustment not worth, making inaction the preferred choice in any state. Given that in the empirical specification we must allow for shocks of any size, there will be cases in which the firm does not respond to small shocks. We can study the adjustment/inaction choice by considering the minimum size of the shock that makes adjustment optimal.

To determine the optimality of adjusting we need to consider the asset value of the firm under adjusting and under inaction. We first consider the optimality of hiring (i.e., moving from l_b to l_g as the shock goes from ε_b to ε_g). We tackle this problem using the total asset values determined by (7). By Bellman's optimality principle, we only need to check if deviating for one period delivers a higher payoff with respect to following the optimal policy. Consider a firm with initial employment l_b for which the shock switches from ε_b to ε_g. For adjustment to be optimal, it must be that

$$V(l_g, \varepsilon_g) \geq F(l_b, \varepsilon_g) - w_b l_b + \beta \left[pV(l_g, \varepsilon_g) + (1-p)V(l_b, \varepsilon_b) \right] \tag{18}$$

Given that the hiring cost is zero, the value of a firm hiring labor to the optimal point l_g is the value of a firm following the optimal plan in the state (l_g, ε_g), i.e., $V(l_b, \varepsilon_g) = V(l_g, \varepsilon_g)$; the right-hand-size represent the value of deviating from the optimal plan for just one period. After some algebra, we obtain that hiring is optimal if

$$\left[\varepsilon_g - \frac{\phi}{2} - \beta(1-p)k \right] (l_g - l_b) - (w_g l_g - w_b l_b) \geq 0 \tag{19}$$

Using the equilibrium values of employment and wages (14)-(17), we obtain:

$$(\Delta\varepsilon)^2 - \theta(c+2k)\Delta\varepsilon + \theta \left[\theta k(c+k) - \phi c \right] > 0 \tag{20}$$

The inequality in (20) shows that the optimality of adjusting only depends on the difference between the shocks $\Delta\varepsilon$, and not on the absolute levels ε_g and ε_b, which, in this model with a fixed labor supply and no unemployment, only determines the *level* of wages. Solving the equation and disregarding the smaller root, economically uninteresting, adjustment is optimal if the difference in productivity levels is larger than the following threshold:

$$\Delta\varepsilon^{*} = (\varepsilon_g - \varepsilon_b)^{*} = \frac{\theta(c+2k) + \sqrt{\theta c(\theta c + 4\phi)}}{2} \tag{21}$$

The threshold that determines the optimality of firing following a bad shock is:

$$-\Delta\varepsilon^{**} = (\varepsilon_b - \varepsilon_g)^{**} = -\frac{\theta(c+2k) + \sqrt{\theta c(\theta c - 4\phi)}}{2}$$

Both thresholds have the same implications for the adjustment decision: inaction is more likely the larger c and k, while more persistent shocks make adjustment more likely: $\frac{\partial \Delta\varepsilon^{*}}{\partial p} < 0, \frac{\partial \Delta\varepsilon^{*}}{\partial k} > 0, \frac{\partial \Delta\varepsilon^{*}}{\partial c} > 0$. Moreover, the cross partials indicate that the effects of frictions are reduced for more persistent shocks: $\frac{\partial^2 \Delta\varepsilon^{*}}{\partial p \partial c} < 0, \frac{\partial^2 \Delta\varepsilon^{*}}{\partial p \partial k} < 0$.

The main predictions of the simple model above can be illustrated using Figure 1. In a frictionless world, in which both $k = 0$ and $c = 0$, firms face an infinite elastic labor supply at the prevailing wage $\widetilde{w}$: from (4), $\Delta w = 0$, so that wages do not respond to the idiosyncratic firm conditions. Moreover, there is no lumpiness in the employment response to shocks: labor always moves as to keep the marginal product of labor (MPL) equal to the wage rate. In terms of Figure 1, the wage is fixed at $\widetilde{w}$ and employment fluctuates between $\widetilde{l}_g$ and $\widetilde{l}_b$; from (13), the frictionless response of employment to shocks is:

$$\Delta\widetilde{l} = \phi^{-1}\Delta\varepsilon. \tag{22}$$

The introduction of frictions has several implications. First, the response of employment becomes lumpy: firms only adjust when the shocks are sufficiently large. In Figure 1, for movements of the MPL within the $[w_b, w_g]$ range, employment does not respond. By substituting (21) in the frictionless employment equation (22), we obtain the smallest change in the frictionless employment at which adjustment occurs even with frictions, $\Delta\widetilde{l}^*$:

$$\Delta\widetilde{l}^* = \phi^{-1}\Delta\varepsilon^* = \gamma^H \tag{23}$$

In terms of Figure 1, the firm adjusts employment in the presence of frictions only when the frictionless employment moves above $\widetilde{l}_g$ or below $\widetilde{l}_b$. One important implication of (23) is that *any* type of friction induces lumpiness: in fact, $\Delta\widetilde{l}^* \neq 0$ if either $c \neq 0$ or $k \neq 0$. This implies that lumpy adjustments will signal the presence of frictions, but cannot be used to determine their nature. This is in contrast with most of the literature on employment adjustment at the level of the firm, where lumpy behavior is usually taken as signaling adjustment costs at the level of the firm only (Hamermesh and Pfann 1996). Note that for firms that reduce employment, the downward threshold is $\Delta\widetilde{l}^{**} = -\phi^{-1}\Delta\varepsilon^{**} = \gamma^L$.

The second implication relates to wage changes. Given that firms need to compensate workers from the moving costs they bear upon changing employer, wage changes only occur together with employment changes. Moreover, the wage response to the shocks is due to the cost of moving: if firing costs were the only friction in the market, then we should observe no wage response at the firm level. In terms of the figure, the broken wage schedule only holds with $c \neq 0$. In particular, one can write $\Delta w = \theta c$ for workers employed in firms that adjust employment upward, and $\Delta w = -\theta c$ for firms that adjust downward.

The third implication relates to employment changes. With respect to a frictionless world, frictions not only induce lumpy adjustments, but also dampen employment changes when they take place, as can be seen by expressing actual adjustment in deviation from the frictionless counterpart:

$$\Delta l = \Delta\widetilde{l} - \psi \tag{24}$$

where $\psi = \phi^{-1}\theta(c+k)$. Writing $\psi = \Lambda_c + \Lambda_k$, one can define Λ_c as the external adjustment cost and Λ_k as the internal adjustment costs. The main objective of the empirical analysis is the separate identification of these two cost elements.change in employment with respect to the frictionless case is reduced by $(\widetilde{l}_g - l_g^{cf})$ in the case of hiring and by $(l_b^{cf} - \widetilde{l}_b)$ in that of firing. Note again that the effect of moving and firing costs is identical, reinforcing the statement that they cannot be disentangled by considering employment changes only. For firms that reduce employment, $\Delta l = \Delta\widetilde{l} + \psi$ symmetrically.

4 Data

We rely on two administrative data sets, one for firms and one for workers. Data for firms are obtained from *Centrale dei Bilanci* (Company Accounts Data Service, or CAD for brevity), while those for workers are supplied by *Istituto Nazionale della Previdenza Sociale* (National Institute for Social Security, or INPS). Since for each worker we can identify the firm he/she works for, we combine the two data sets and use them in a matched employer-employee framework. There is a burgeoning empirical literature on the use of matched employer-employee data sets (see Hamermesh (1999) for an account).

The CAD data span from 1982 to 1994, a period that comprises two complete business cycles. It contains detailed information on a large number of balance sheet items together with a full description of firm characteristics (location, year of foundation, sector of operation, ownership structure), plus other variables of economic interest usually not included in balance sheets, such as employment and flow of funds. Balance sheets are collected for approximately 30,000 firms per year by *Centrale dei Bilanci*, an organization established in the early 1980s jointly by the Bank of Italy, the Italian Banking Association, and a pool of leading banks to gather and share information on borrowers. Since the banks rely heavily on it in granting and pricing loans to firms, the data are subject to extensive quality controls by a pool of professionals, ensuring that measurement error should be negligible.

INPS provides us with data for the entire *population* of workers registered with the social security system whose birthday falls on one of two randomly chosen days of the year. Data are available on a continuous basis from 1974 to 1994. We use the data after 1981 for consistency with the timing of the CAD data. The INPS lacks information on self-employment and on public employment (public firms are also absent in the CAD). The INPS data set derives from forms filled out by the employer that are roughly comparable to those collected by the Internal Revenue Service in the US.[9] Misreporting is prosecuted.

Given that the INPS data set includes a fiscal identifier for the employer which is also present in the CAD data set, linking the employer's records to the employees is relatively straightforward. As in other countries where social security data are available, the Italian INPS data contain some detailed information on worker compensation but information on demographics is scant.

Table 2 reports various descriptive statistics for the firms (Panel A) and workers (Panel B) present in our sample. We report separate statistics for the whole sample and for the sample obtained after matching firm and worker information. From an initial sample of 177,654 firm/year observations, we end up with 116,686, corresponding to 16,037 firms. We exclude firms with intermittent participation (40,225 observations) and those with missing values on the variables used in the empirical analysis (20,620 observations) or extreme

[9] While the US administrative data are usually provided on a grouped basis, INPS has truly individual records. Moreover, in the US earnings records are censored at the top of the tax bracket, while the Italian data set is not subject to top-coding.

employment changes (123 observations). Since the panel is unbalanced, the firms in this sample appear from a minimum of one to a maximum of 13 years.

The whole sample ranges from very small firms to firms with almost 180,000 employees, with an average of 204 and a median of 60. As expected, most of the firms are in the North (75 percent). As for the distribution by industry, manufacturing firms account for about 75 percent of the final sample. Construction firms account for about 15 percent. The remaining 10 percent is scattered in the service and retail sectors. The matched sample includes larger firms, but the distribution by region and industry is similar to that in the whole sample.

Panel B reports sample characteristics for the workers in the 1982-1994 INPS sample. We start with an initial sample of 267,539 worker/year observations (including multiple observations per year for the same worker due to multiple jobs, intra-firm position change, and inter-firm mobility) and end up with 162,184. Sample selection is made with the explicit aim of retaining workers with stable employment and tenure patterns. First we exclude those younger than 18 or older than 65 (2,652 observations), circumventing the problem of modeling human capital accumulation and retirement decisions. To avoid dealing with wage changes that are due to job termination (quits or layoffs) or unstable employment patterns, we exclude workers with part-time employment and those with multiple jobs (81,117 observations). For similar reasons, we drop individuals who worked for less than 12 months (43,750 observations). Moreover, we keep only individuals with non-zero recorded earnings in all years (105 observations lost). Finally, we eliminate those with missing values on the variables used in the empirical analysis (8,627 observations). Since these selections − particularly those that exclude firm-movers − can potentially affect our results, we account for sample selection bias (see Section 4.3).

Our measure of earnings covers remuneration for regular and overtime pay plus non-wage compensation. We deflate earnings using the CPI (1991 prices). For workers with intermittent participation we treat two strings of successive observations separated-in-time as if they pertained to two different individuals.

Workers in the whole sample are on average 39 years old in 1991; production workers account for 62 percent of the sample, 37 percent are clericals, and about 2 percent managers. Males are 73 percent of our sample and those living in the South 14 percent. Finally, net earnings in 1991 are roughly 17,000 euro on average. In the matched sample individual characteristics are fairly similar to the ones in the whole sample.

5 Identification

The simple GE model has only two productivity states. This is of course an untenable assumption when bringing the model to the data. We generalize this structure by allowing the shock (and the consequent labor adjustment) to take any value. Equation (22) indicates a linear relation between shocks and frictionless labor changes that we maintain:

$$\Delta\widetilde{l} = \phi^{-1}\Delta\varepsilon + e$$

where we include the random term e to capture unobserved heterogeneity. Since hiring and firing costs might be different, we allow for a non-symmetric response of positive and negative adjustments. Our theory suggests the deterministic adjustment thresholds:

$$\begin{aligned}
\gamma^H &= \phi^{-1}\Delta\varepsilon^* = \phi^{-1}\frac{\theta(c+2k)+\sqrt{\theta c(\theta c+4\phi)}}{2} \\
\gamma^L &= \phi^{-1}\Delta\varepsilon^{**} = -\phi^{-1}\frac{\theta(c+2k)+\sqrt{\theta c(\theta c-4\phi)}}{2}
\end{aligned}$$

Since there may be some randomness in the thresholds also due to unobserved firm characteristics, we write them as

$$
\begin{aligned}
\Gamma_L &= \gamma_L + \eta \\
\Gamma_H &= \gamma_H + \eta
\end{aligned}
$$

Labor adjustment can thus be written as:

$$
\Delta l = \begin{cases} \Delta\widetilde{l} + \psi_L & \text{if } \Delta\widetilde{l} < \Gamma_L \\ 0 & \text{if } \Gamma_L \leq \Delta\widetilde{l} \leq \Gamma_H \\ \Delta\widetilde{l} - \psi_H & \text{if } \Delta\widetilde{l} > \Gamma_H \end{cases}
$$

Under symmetry, $\psi_L = \psi_H$.

We estimates our structural parameters using a multi-step strategy. First, we estimate the parameters that affect the probability of adjusting using observations on all firms. Then, we estimate the size of adjustment using only the observations on the firms that adjust. Finally, we estimate the wage equation. The parameters we estimate at these three stages are non-linear combinations of the structural parameters; the latter are over-identified from these restrictions and therefore we can test the overidentifying restrictions. We use optimal minimum distance to map reduced form parameters onto structural parameters.

The three regimes (hire, fire, do nothing) are defined by the dummies:

$$
\begin{aligned}
s^+ &= \mathbf{1}\left\{\Delta\widetilde{l}_t > \Gamma_H\right\} = \mathbf{1}\left\{e_t - \eta_t > \gamma_H - \phi^{-1}\Delta\varepsilon_t\right\} \\
s^- &= \mathbf{1}\left\{\Delta\widetilde{l} < \Gamma_t^L\right\} = \mathbf{1}\left\{e_t - \eta_t < \gamma_L - \phi^{-1}\Delta\varepsilon_t\right\}
\end{aligned}
$$

$$1 - s^{+} - s^{-} \quad = \quad \mathbf{1}\left\{\Gamma_t^L \leq \Delta\widetilde{l} \leq \Gamma_t^H\right\} = \mathbf{1}\left\{\gamma_L - \phi^{-1}\Delta\varepsilon_t \leq e_t - \eta_t \leq \gamma_H - \phi^{-1}\Delta\varepsilon_t\right\}$$

and so the likelihood function for the regime a firm happen to be in is:

$$\begin{aligned} L &= \prod_{s^-=1} \Phi\left(\frac{\gamma_L - \phi^{-1}\Delta\varepsilon_t}{\sigma_{e-\eta}}\right) \prod_{s^+=1}\left[1 - \Phi\left(\frac{\gamma_H - \phi^{-1}\Delta\varepsilon_t}{\sigma_{e-\eta}}\right)\right] \\ &\quad \prod_{1-s^+-s^-=1}\left[\Phi\left(\frac{\gamma_H - \phi^{-1}\Delta\varepsilon_t}{\sigma_{e-\eta}}\right) - \Phi\left(\frac{\gamma_L - \phi^{-1}\Delta\varepsilon_t}{\sigma_{e-\eta}}\right)\right] \\ &= \prod_{s^-=1} \Phi_L \prod_{s^+=1} (1 - \Phi_H) \prod_{1-s^+-s^-=1} (\Phi_H - \Phi_L) \end{aligned}$$

with $\sigma_{e-\eta} = \left(\sigma_e^2 + \sigma_\eta^2 - 2\sigma_{e\eta}\right)^{1/2}$ being the scale factor.[10]

Using the law of iterated expectations and the fact that average adjustment for firms that do not adjust is zero, one can write the equation for the size of adjustment conditioning on adjusting as:

$$\begin{aligned} E\left(\Delta l \left| \text{adjust}\right.\right) &= -\psi_H \frac{1-\Phi_H}{1-\Phi_H+\Phi_L} + \psi_L \frac{\Phi_L}{1-\Phi_H+\Phi_L} + \phi^{-1}\Delta\varepsilon \\ &\quad + E\left(e\left|s^+=1\right.\right)\frac{1-\Phi_H}{1-\Phi_H+\Phi_L} + E\left(e\left|s^-=1\right.\right)\frac{\Phi_L}{1-\Phi_H+\Phi_L} \end{aligned} \tag{25}$$

Note now that if e is $e \sim N\left(0, \sigma_e^2\right)$ one can use the properties of the truncated normal

[10] We could write a likelihood function that estimates jointly the parameters of the decision to adjust and those of the size of the adjustment. This would increases the efficiency of the estimates. However, we prefer the two-step strategy because of computational ease (the likelihood function in the general case fails to converge); and computation of standard errors is done by the block bootstrap.

distribution to derive

$$E\left(e\left|s^{+}=1\right.\right) = E\left(e\left|e-\eta>\gamma_H-\phi^{-1}\Delta\varepsilon\right.\right)=\rho_{e,e-\eta}\sigma_e\frac{\phi_H}{1-\Phi_H} \quad (26)$$

$$E\left(e\left|s^{-}=1\right.\right) = E\left(e\left|e-\eta<\gamma_L-\phi^{-1}\Delta\varepsilon\right.\right)=-\rho_{e,e-\eta}\sigma_e\frac{\phi_L}{\Phi_L} \quad (27)$$

where $\rho_{e,e-\eta}$ is the coefficient of correlation between e and $e-\eta$. Replacing (26) and (27) into (25) yields:

$$\begin{aligned} E\left(\Delta l\left|\text{adjust}\right.\right) &= -\psi_H\frac{1-\Phi_H}{1-\Phi_H+\Phi_L}+\psi_L\frac{\Phi_L}{1-\Phi_H+\Phi_L}+\phi^{-1}\Delta\varepsilon+\rho_{e,e-\eta}\sigma_e\frac{\phi_H-\phi_L}{1-\Phi_H+\Phi_L} \\ &= -\psi\frac{1-\Phi_H-\Phi_L}{1-\Phi_H+\Phi_L}+\phi^{-1}\Delta\varepsilon+\rho_{e,e-\eta}\sigma_e\frac{\phi_H-\phi_L}{1-\Phi_H+\Phi_L} \quad (28) \end{aligned}$$

The last equality uses the symmetry condition ($\psi_L=\psi_H$). This regression can be run on the sample of firms that adjust.

Finally, the wage equation can be written as:

$$\Delta w_{ijt}=\begin{cases} \theta c+X_{ijt}\beta+\omega_{ijt} & \text{if } s_{jt}^{+}=1 \\ X_{ijt}\beta+\omega_{ijt} & \text{if } 1-s_{jt}^{+}-s_{jt}^{-}=1 \\ -\theta c+X_{ijt}\beta+\omega_{ijt} & \text{if } s_{jt}^{-}=1 \end{cases}$$

or

$$\Delta w_{ijt}=X_{ijt}\beta+\theta c\left(s_{jt}^{+}-s_{jt}^{-}\right)+\omega_{ijt} \quad (29)$$

which shows that a regression of Δw_{ijt} onto $\left(s_{jt}^{+}-s_{jt}^{-}\right)$ identifies θc.

The identification procedure thus entails the following steps:

1. Obtain a measure of idiosyncratic shocks to the marginal product of labor.

2. Estimate an ordered probit of negative, zero and positive adjustments using the shock and possibly other covariates as explanatory variables; recover the functionals of the normal distribution in (28).

3. Regress employment adjustment of firms that adjust on the shock and on the functions of the normal obtained at step 2.

4. Estimate the wage change, including an indicator for adjustment $\left(s_{jt}^{+} - s_{jt}^{-}\right)$.

It is clear that if one uses the theoretical restrictions imposed on γ_H and γ_L, the thresholds of the adjustment decision, the model is over-identified with two overidentifying restrictions (note that we can separately identify θc and θk, but θ cannot be identified. Given that $\theta = 1 + \beta(1 - 2p) \leq 1$, our estimates will provide lower bounds for the true costs of adjustments). In what follows we use optimal minimum distance on the reduced form estimates to recover estimates of the structural parameters. We use the block bootstrap-generated covariance matrix (based on 200 replications) as the weighting matrix. We do not use the theoretical restriction on γ_L because it depends on a square root term that is not defined for some values of the parameters, and so we have one overidentifying restriction.

6 Results

6.1 Employment adjustment

We start by documenting the lumpiness of employment adjustment. Figure 2 plots the distribution of employment changes pooling all years together, excluding for readability the first and last percentile of the distribution (approximately + and -100). The first thing to note is that the amount of adjustment is fairly modest: about 95% of the observations lie between -28 and $+25$. The median employment change is exactly zero (the mean is similar), and about 17% of the firms in our sample do not change their employment from one year to the next; 40% adjust downward, and 42% adjust upward. Not surprisingly, this indicates that lumpiness is an important component of the employment choice.

The model predicts that firms will respond to changes in the marginal product of labor. Given that we do not have a direct measure of it, we follow the previous literature on q-models of adjustment (Abel and Eberly 1994) and use an average measure, defined as value added (in thousand of 1991 euros) at time t divided by employment at time $t-1$, $y_t = \frac{VA_t}{l_{t-1}}$. To obtain a measure of idiosyncratic shocks, we first regress y_t on a full set of firm fixed effects, year dummies, industry dummies, and area dummies. We then take the residual of this regression as our measure of idiosyncratic shocks. Given that we estimate the model in levels, so that the results might be very sensitive to the presence of outliers, we exclude the first and last percentile of the resulting shock distribution.[11] We also exclude firms whose employment increases more than 20-folds and those that have negative growth greater than 90% in absolute value and an initial size of more than 100. These selections are meant to exclude events beyond our interests, such as acquisitions, mergers, breaking-ups, or just measurement error.

We then run an ordered probit for the choice of employment change regime (positive, zero, or negative change in employment). Table 3 reports the results for the regression with the shock as sole regress or. We find that the effect of the shock is positive and statistically significant, as expected; the two adjustment thresholds are also precisely estimated. Note that such estimate are identified up to scale, so that their size cannot be interpreted directly.

[11] The distribution is in fact characterized by extreme values. The median value of the shock is -249 euros, the first and the extreme percentiles are -37,000 and 42,000 euros.

One potential problem with this specification is that it does not take into account the fact that, as documented for example at length by (Schivardi and Torrini 2004), the probability of inaction decreases with firm size. Column 2 repeats the same regression including the lagged value of firm size. The parameter of interests are unaffected. Size is significant and has a negative coefficient, meaning that large firms are more likely to adjust employment downward.[12] We have also tried different specifications, always finding that results are robust.

Using the estimates of the order probit, we construct the variables included int the size of adjustment equation (28). Our first specification allows for asymmetry and thus has two dampening parameters ψ_H and ψ_L. We cannot reject the hypothesis of symmetry (p-value 67 percent) and so we impose it to improve efficiency. We find that the shock has a positive and significant impact on the size of adjustment. More importantly, the estimate of ψ is negative and statistically significant, which implies that adjusting labor is costly. Again, the structural parameters cannot be red directly from these estimates. We therefore differ the discussion of the magnitude of the estimates after the estimation of the full model.

6.2 Wage adjustment

To disentangle the external and internal components of total adjustment costs, we now turn to the wage equation. We construct wages as the sum of annual normal compensation and fringe benefits. We include in the wage growth regression a variable, $\left(s_{jt}^{+} - s_{jt}^{-}\right)$ which equals -1 if the firm is reducing employment and 1 if it is expanding it. As shown in equation 29, the coefficient on this variable is crucial for the identification of the extent of

[12] As always with order probits, the effect on the middle region, i.e. inaction, cannot be directly red from the coefficient. By computing the changes in the distribution implied by the estimate we find that inaction probability decreases with size, as expected.

external costs, θc.

In Table 5 we report the results of the wage growth equation. As for the employment equation, we exclude the first and last percentile of wage changes. We include the usual regressors of wage equations suggested by the literature, i.e. age, tenure, area, sector, year, location and job title dummies. The variable of interest is the employment policy of the firm at which the worker is currently attached. The first specification enters s_{jt}^{-} and s_{jt}^{+} as separate regressors. The results, reported in column 1, show that wages are more sensitive to employment increases than decreases (0.14 vs. -0.09 respectively). This suggests that -as one might expect- real wages are more flexible upward than downward. We cannot reject the null that the two coefficients are statistically the same at 5% (p-value of 6.2%); for semplicity, we impose symmetry in the rest of the analysis. All other regressors are in line with expectations: wage growth decreases with age and tenure (reflecting concavity of the wage *level* functions with respect to such variables), even at a modest rate: an additional year of age implies that wages increase by approximately 7 euros less per year. The wage of male workers increases on average by 200 euros more that than of females, and blue and white collar are characterized by lower wage growth than managers (the excluded category). Wages also grow less in the South (not reported). Given that these estimates are very stable throughout all specifications, we will not comment them any more in what follows.

In column 2 we enter $\left(s_{jt}^{+} - s_{jt}^{-}\right)$ directly, and find that adjustment entails external costs: the estimate is positive and statistically significant, with a t-statistic of 7. In absolute terms, the value is rather modest: it implies that expanding firms pay a yearly premium of 116 euros to their workers. Note that this is an estimate of θc, not of the mobility cost c only. Given that $\theta < 1$, it represents a lower bound for the cost of adjusting, a point to which we will come back later.

Notwithstanding the lower bound argument, the value of moving costs estimated in our wage equation seems surprisingly low. The conventional wisdom is that the Italian labor market is characterized by a low willingness of workers to move in the face of better job opportunities (Faini, Galli and Rossi 1996). In fact, high unemployment rate in the South (18% in 2002) has persisted in the face of basically full employment in the rest of the country (4.7%), particularly in the North-East, where firms are often said to face labor shortage. Even in our data we find that only 3% of observations relate to moving workers, a rather small number.[13] This conventional wisdom evidently contrasts with the implications of our estimates, and begs the question of whether we are underestimating moving costs.

A first possibility is that moving costs are heterogeneous across workers. If this were the case, then a relatively small share of mobile workers could equilibrate the labor market even with small wage differentials and even if moving costs were high for the majority of the population. This suggests that movers are a self-selected sample. We control for self-selection bias in a standard manner by estimating a probit for job mobility. To this purpose we use both continuing workers and movers. For individuals with multiple concurrent jobs, we keep only the wages on the *main* job (defined on the basis of the number of months worked). Our mobility probit ($M_{it} = \{0, 1\}$) includes the same variables of the wage growth equation (age, gender, job, industry, region, and year dummies, and $s_{jt}^{+} - s_{jt}^{-}$; both the latter and industry at time t refer to the firm one was working for at time $t-1$), plus a set of exclusion restrictions: the shock faced by the firm one was working on at time $t-1$ and lagged tenure (which proxies for the loss of firm-specific capital for those who leave).[14] The mobility results, reported in Table 6, are in accordance with our expectations. People with long tenure are less likely to leave their current firm. People that were working in

[13]This is partially due to the features of our data. Recall that we can follow the individual only if he moves to another private firm. We lose the worker if he moves to public employment, self-employment, or retirement.

[14]Our workers' data go back to 1973, so we can construct tenure accurately up to that year.

firms that are hit by a negative shock are more likely to leave. The exclusion restrictions are individually and jointly significant (a χ_2^2 statistic of 71). We also find that high-skilled, young, male workers are more likely to move. Mobility is lower in the South and has tended to be higher in recent years. Can sample selection then be responsible for the low moving cots we estimate? In columns (3) and (4) we repeat the regression of the second column but enter the Mills ratio $\frac{\phi\left(x\widehat{\beta}\right)}{1-\Phi\left(x\widehat{\beta}\right)}$ where $\widehat{\beta}$ comes from the mobility probit. The results are basically unchanged: mobility costs are exactly the same and the Mills ratio is statistically insignificant. This indicates that heterogeneity is unlikely to account for the small estimate of moving costs.

A crucial assumption of the model is that the wage is the same for all workers in a firm, so that, when hiring, the firm increases wages by the same amount to both the continuing and the newly hired workers. This might be an extreme assumption: even if within the firm wages tend to be fairly similar for workers in the same position, a firm could attract new workers by proposing them a promotion with respect to their current position, thus without reviewing upward the whole wage structure. This possibility can be analyzed by including a mobility dummy in the wage equation. We therefore construct a dummy that is equal to 1 in the first year of employment in the new firm, and add it to the basic regression. Results, reported in column (4) of Table 5, show that movers do get an additional wage premium, equal to approximately to 50% more that the basic estimates of θc (.177 vs. 116). The result holds true also when the mobility dummy and $(s^+ - s^-)$ are entered jointly (column 5). This suggests that the assumption of perfect correlation of wages within the firm might be too strong; however, the estimates of the wage premium of movers remains still rather limited.

Another possibility is that, contrary to the US, the labor market is very segmented geographically, so that mobility is mostly local. If this where the case, even small wage differentials might be sufficient to induce short-range mobility.[15] To check for this possibility, we first determine the range of mobility of workers by using the location of the firm they work in. Table 7 reports summary statistics of mobility in our dataset, compiled by using the location of the firms (location is not reported in the workers' archive). Approximately 1/3 of movers do not change municipality, and more than 50% remain in the same local labor market, defined as the local labor system.[16] Of all movers, less than 20% change macro area (defined as Nort-West, North-East, Center, South, and Islands). Table 7, Panel B reports flows across macro-areas. Workers flows are mostly from South to North: around 85% of movers do not change macro area if working in the North, while only 56% do so when working in the South. These numbers are in line with previous analysis of mobility in Italy.

To check if short-distance mobility is accounting for the low level of moving costs, we estimate the model including measures of distance between firms for workers that move. We compute distances between municipalities from the geodetic coordinates of each of them. The distribution of the distance between firm for workers that move confirms the fact that mobility is mostly local: the median distance is 9 kilometers and the average one is 77,4. We then include this distance measure in the wage equation. Results, reported in column (6), indicate that wage changes are positively related to distance. The estimate of the distance coefficient is .0016, implying that each additional kilometer requires a wage differential of

[15]Indeed, there is widespread evidence that Italian workers are not very mobile. For example, the labor force survey of the national institute of statistics contains the question asked to job seekers "In which location would you be willing to work?" Using the 1995 survey, Faini et al. (1996) calculate that 40% of respondents is willing to accept a job only in the municipality of residence, 38% in a municipality that can be reached daily, and only 22% anywhere.

[16]Local labor system are groups of municipalities characterized by a self-contained labor market, as determined by the National Institute for Statistics, (NIS) on the basis of the degree of working-day commuting by the resident population. Using 1991 Census data, the NIS procedure identified 784 LLSs covering the whole national territory

1,6 euros. The average "mobility premium implied by this estimate is 1.6*77.4=124, which is very much in line with our basic estimates of 116 euros. This analysis would therefore indicate that the prevalence of short-range mobility is an important factor in determining the low estimates of mobility costs.

6.3 Joint estimates

Table 8 uses optimal minimum distance on the reduced form parameters to back up the structural parameters. The weighting matrix of OMD is obtained from the block bootstrap. The coefficients are all very precisely estimated, even if the test of overidentifying restrictions is borderline and signals that the model can be improved. The estimate of ϕ (the curvature of the production function) is about 1.2. Firms adjust upward if the change in frictionless employment is above 5, and downward if frictionless employment goes down by 7 or more. The estimates of $\theta(c+k)$ are 5,277 euro. This is a lower bound for total adjustment costs. While we have no direct measure of θ, some inference can be drawn for illustrative purposes. Assume that $\beta = .96$. Recalling that $y = 1 - \beta(2p-1)$ and that $p \geq 1/2$, we obtain that $0.04 \leq \theta \leq 1$, so that $5,277 \leq (c+k) \leq 131,925$. The method advocated by Tauchen and Hussey (1991) can be used to construct the state space and the transition probability matrix. We find that for our measure of shock, $p = 0.5007$, a low level of persistence.[17] If we use this estimate of p, we obtain $(c+k) = 5,284$, about one-third of average wages in our sample. Previous studies have also find significant costs of adjusting employment. For example, using direct measures the costs of termination from survey data for France in 1992, Abowd and Kramarz (2003) find values in the range of 17,000 and 40,000 euros.

[17]This happens for two reasons: (a) our value added regressions include firm fixed effects, which sweep out much of the persistence, and (b) our dependent variable is the value added-lagged employment ratio, which reduce some of the non-stationarity of the data.

Differently from their study, our measure also incorporates any indirect cost of adjusting, such as that coming from productive disruption; moreover, it represents the sum of both the internal and the external adjustment cost.

While we can only provide a lower bound for the absolute level of total adjustment costs, the relative contribution of internal and external costs is identified from the ratio of the estimate of θc and $\theta(c+k)$. Our results imply that the latter clearly dominates, accounting for around 97% of total costs. Taken face value, therefore, these results imply that the amount of deviation from the frictionless paradigm attributable to mobility costs is rather modest. This implies that the assumption of fixed wages used by the literature studying non convexities in labor adjustments, while in principle incorrect, mighty be empirically tenable, lending support to the interpretation of previous results as evidence of hiring and firing costs internal to the firm.

7 Conclusions

This paper has used matched employer-employee data to shed light on the nature of the frictions characterizing the labor market. We find that both internal and external adjustment costs contribute to deviations from the frictionless paradigm. However, the bulk of adjustment costs is accounted for by the internal component.

In terms of policy, our results confirm a view of the Italian labor market as fairly mobile locally, but very segmented geographically. This conclusion is in line with previous analysis of the Italian labor market. It implies that policy should reduce mobility costs that entail the geographical relocation of workers, calling into questions housing policy and social services to supplement the loss of extended family ties.

In terms of future work, it will be important to generalize the model to allow for a mobility cost that depends on distance between jobs. At the same time, it would be interesting to apply this methodology to a country where mobility is more widespread, such as the US, and check if the results are substantially different in such an environment.

Table 1
Wage bill decomposition for the Machinery industry, 1984-94

Each entry represents the percentage contribution to the wage determination. The first column is the contractual minimum, the second the indexation component, the third the sum of the two, which constitutes the industry-wide component of the wage. The remaining columns represent the firm level components: the superminimum is the wage premium above the contractual minimum, the production premiums are bonuses and other one-time payments, the variable compensation is determined by firm-level contracts, the last column in the sum of the firm level components. The data source is *Federmeccanica (* the association of employers for the Metal products, Machinery and Equipment sector).

Year	Contr. Min. [1]	Indexation [2]	*Industry Share* [1]+[2]	Supermin. [4]	Production premium [5]	Variable component [6]	*Firm share* [4]+[5]+[6]
1984	32.4	51.9	*84.3*	13.0	2.7	0.0	*15.7*
1985	32.1	51.2	*83.3*	14.2	2.5	0.0	*16.7*
1986	30.1	51.3	*81.4*	15.5	3.1	0.0	*18.6*
1987	31.2	50.0	*81.2*	15.8	3.0	0.0	*18.8*
1988	30.4	47.5	*77.9*	17.3	3.1	1.7	*22.1*
1989	29.5	47.8	*77.3*	16.8	3.4	2.5	*22.7*
1990	28.1	48.3	*76.4*	17.9	3.3	2.4	*23.6*
1991	30.3	48.0	*78.3*	16.6	3.0	2.1	*21.7*
1992	31.0	46.8	*77.8*	17.2	3.0	2.0	*22.2*
1993	32.7	45.2	*77.9*	17.3	3.0	1.8	*22.1*
1994	32.5	44.6	*77.1*	18.2	2.9	1.8	*22.9*

Table 2
Firms' and workers' characteristics

Panel A reports summary statistics for the firms in our data set. Panel B shows descriptive statistics for the sample of workers. All statistics refer to 1991. The matched firm sample includes firms that area matched at least once with a worker in the workers' data set.

Panel A: Firm characteristics

	Mean		Stand. dev.	
	Whole sample	Matched sample	Whole sample	Matched sample
Value added (thousand euros)	8712	15485	127028	116589
Number of employees	203	370	2355	2642
South	0.0884	0.0892	0.2839	0.2851
Center	0.1627	0.1672	0.3691	0.3731
North	0.7489	0.7436	0.4337	0.4367
Manufacturing	0.7750	0.7964	0.4176	0.4027
Construction	0.1549	0.1317	0.3619	0.3382
Retail	0.0253	0.0278	0.1571	0.1644
Services	0.0447	0.0441	0.2067	0.2052

Panel B: Workers' characteristics

	Mean		Stand. dev.	
	Whole sample	Matched sample	Whole sample	Matched sample
Earnings (thousand euros)	16.94	17.25	9.39	9.02
Age	38.93	39.15	10.43	10.40
Male	0.7284	0.7423	0.4448	0.4374
Productions	0.6164	0.6188	0.4863	0.4857
Clericals	0.3662	0.3655	0.4818	0.4816
Managers	0.0173	0.0157	0.1305	0.1242
South	0.1427	0.1244	0.3498	0.3301
Center	0.1880	0.1859	0.3907	0.3890
North	0.6693	0.6897	0.4705	0.4626

Table 3
Employment Adjustment: Ordered probit estimates

Dependent variable: a discrete variable taking the value -1 for negative employment changes, 0 for no changes and 1 for positive changes. Firm shock is the residual of a regression of value added per worker on firm fixed effects, and year, sector, and regional dummies

	(1)	(2)
Lower threshold	−0.2631	−0.2683
	(0.0056)	(0.0042)
Higher threshold	0.2011	0.1962
	(0.0060)	(0.0041)
Firm shock	0.0351	0.0351
	(0.0007)	(0.0004)
Lagged size/100		−0.0028
		(0.0003)
# observations	98,635	98,635

Table 4
Employment Adjustment: size of the adjustment

The dependent variable is employment change from one year to the next. The regression only include adjusting firms. See Table 3 for the definition of the firm shock. The other two variables are functionals of the normal p.d.f. and c.d.f. obtained from the estimates of the ordered probit of Table 3, column 1.

Firm shock	3.0823 (0.9521)
$\frac{\phi_H - \phi_L}{1-\Phi_H+\Phi_L}$	332.0489 (167.2659)
$\frac{1-\Phi_H-\Phi_L}{1-\Phi_H+\Phi_L}$ (Estimate of $-\psi$)	-133.4295 (62.0443)
# observations	81,361

Table 5
Wage adjustment

Dependent variable: yearly wage change (in 000s euros). For stayers, the change is computed as the difference in the wage from year to year; for movers, it is the change in the annualized wage following the job move. All regressions include sector (1 digit), year and location (3 macro-areas) dummies. s^+ is a dummy equal to 1 if the firm the worker is employed at has increased its workforce in the current year; s^- is one if it has decreased it. Mill's ratio is computed from a mobility probit (see next table). Move is a dummy equal to one if the observation relates to a job change. Distance is the kilometers between the two municipalities where a the firms between which a worker moves are located, and zero form non moving workers.

	(1)	(2)	(3)	(4)	(5)	(6)
s^+	0.1578					
	(0.025)					
s^-	−0.0745					
	(0.026)					
$\theta c_{(s^+ - s^-)}$		0.1158	0.1164		0.1164	
		(0.0114)	(0.0117)		(0.0117)	
Mill's ratio			−0.0979			
			(0.1992)			
Move dummy				0.1776	0.1523	
				(0.0876)	(0.0874)	
Distance						0.0016
						(0.0007)
Age	−0.0067	−0.0067	−0.0076	−0.0073	−0.0068	−0.0073
	(0.0008)	(0.0008)	(0.0026)	(0.0008)	(0.0008)	(0.0008)
Tenure	−0.0012	−0.0012	−0.0011	−0.0011	−0.0011	−0.0012
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Male	0.2004	0.2010	0.2121	0.1993	0.2000	0.1990
	(0.0135)	(0.0135)	(0.0304)	(0.0136)	(0.0135)	(0.0136)
Blue collar	−1.8264	−1.8268	−1.8798	−1.8390	−1.8276	−1.8369
	(0.1034)	(0.1035)	(0.1215)	(0.1040)	(0.1034)	(0.1040)
White collar	−1.4138	−1.4129	−1.4496	−1.4253	−1.4147	−1.4230
	(0.1035)	(0.1035)	(0.1147)	(0.1040)	(0.1034)	(0.1041)
R^2	0.044	0.044	0.049	0.042	0.044	0.042
N. obs.	102,073	102,073	94,100	102,073	94,100	102,073

Table 6
Mobility equation

Dependent variable: a dummy equal to 1 for job changes. The regression also includes region dummies, year dummies, and industry dummies. The variable "firm shock" is equal to ε_{jt} for workers that do not move, and ε_{j-1t} for those who move. The variable "new firm shock" is ε_{jt} for those who move and zero for those who do not. The variables "Firm $(s^+ - s^-)$" and "New firm $(s^+ - s^-)$" are defined analogously.

Probit estimates

Firm shock	−0.0023 (0.0016)
New firm shock	0.0127 (0.0041)
Firm $(s^+ - s^-)$	−0.0124 (0.0151)
New firm $(s^+ - s^-)$	0.9829 (0.0401)
Lagged tenure	−0.0006 (0.0004)
Age	−0.0222 (0.0015)
Male	0.2599 (0.0348)
Blue collar	−0.3737 (0.09191)
White collar	−0.12152 (0.0927)
Pseudo R^2	0.1342
N. obs.	96,402

Table 7
Workers' geographical mobility

The first panel reports the share of workers that move within a given geographical unit. LLS are local labor systems (see footnote 16); Macro-areas are the ones reported in the second panel of the table. The second panel reports a matrix of mobility flows across macro areas.

Panel A: Share of mobility within:

Municipality	LLS	Province	Region	Macro-Area
.33	.54	.63	.74	.81

Panel B: Mobility Across Macro Areas

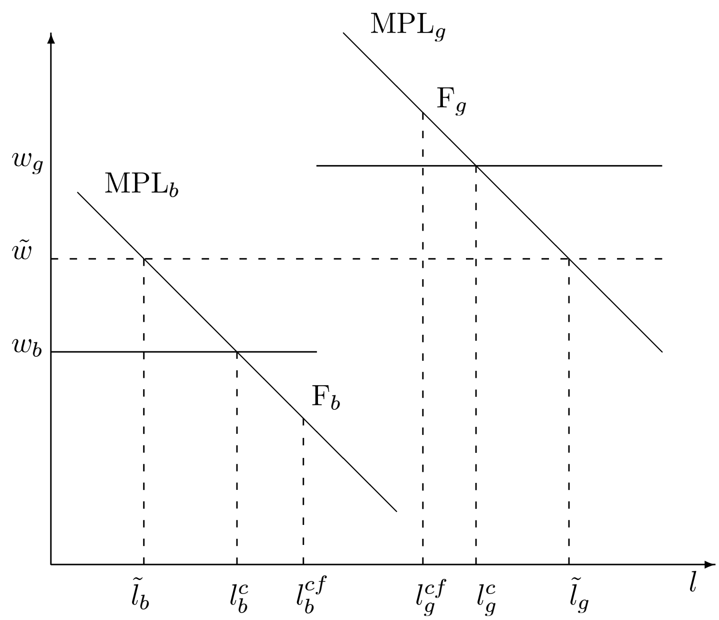
				To		
	N-W	N-E	Center	South	Islands	N. Obs.
From						
N-W	0.86	0.07	0.04	0.02	0.01	3627
N-E	0.11	0.84	0.03	0.01	0.01	2276
Center	0.18	0.06	0.68	0.07	0.01	1030
South	0.21	0.07	0.13	0.56	0.03	382
Islands	0.16	0.13	0.07	0.03	0.62	259

Table 8
Optimal Minimum Distance results

Estimates obtained by solving the over-identified system by optimum minimum distance. The weighting matrix is obtained from the block bootstrap based on 200 replications.

	Structural estimates
γ_H	5.3593 (0.1666)
γ_L	-7.0089 (0.1616)
$\sigma_{e-\eta}$	26.6435 (8.0671)
ϕ	1.0702 (0.3278)
θc	0.1156 (0.0066)
θk	5.1610 (0.1912)
OID test	4.1209 (1 d.f.; p-value 4.24%)

Figure 1: Equilibrium with no frictions, moving costs and firing costs



Note: $\tilde{w}$ is the wage that would prevail in a frictionless labor market, l^* is employment in the frictionless case, l^c with moving costs, l^{cf} with both firing and moving costs.

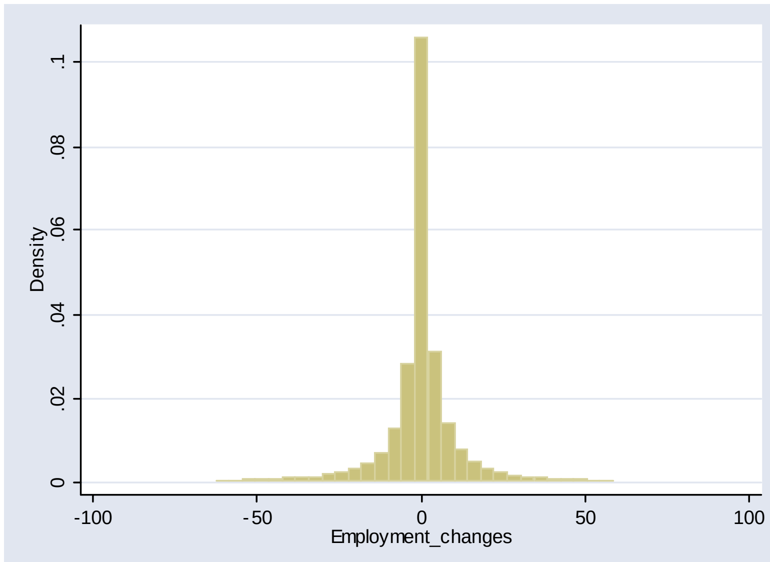


Figure 2: Histogram of employment changes

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