Wage Dynamics and Insurance

Mario Macis*
University of Michigan
Ross School of Business
mmacis@umich.edu

October 2007

Abstract

In this paper, I analyze the influence of labor market conditions on wages by considering an insurance model of the employment relationship. The model allows for limited commitment on both sides of the labor contract, and has three main implications: First, wages can be correlated with both the best and the worst labor market conditions since the start of a worker's tenure. Second, a firm may be paying different wages to workers with the same outside option, if they were hired in different periods. Such wage differentials, however, should disappear if outside opportunities change substantially. Third, the sensitivity of current wages to upward or downward changes in outside options depends on the previous dynamics of wages. I test these predictions on a matched employer-employee panel of male workers from Northern Italy, using the unemployment rate as a proxy for outside options. A consistent and robust set of results supports the two-sided limited commitment labor contract model, while contrasting with alternative theories of wage determination, such as spot market models or continual rebargaining. The evidence suggests that long-term contracting based on insurance

*I have greatly benefited from the advice and suggestions of Michael Gibbs, Derek Neal, Canice Prendergast and Luigi Zingales. I am grateful to Alessandro Barbarino, Veronica Guerrieri, Luigi Guiso, Weerachart Kilenthong, Nicola Lacetera, Bentley MacLeod, Gabriel Madeira, Ronni Pavan, Fernanda Ruiz Nunez, Leena Rudanko, Jonathan Thomas and Sergio Urzua for useful comments. I also thank those who participated in the University of Chicago Applications of Economics Workshop and the Micro Lunch Workshop, Robert Hall and other participants of the SOLE meeting in Boston; Francis Kramarz and other participants of the CAED conference in Chicago, participants of the Eastern Economics Association meeting in Philadelphia, the Frontier Research in Economics Conference at the UTCC in Bangkok and of seminars at the Federal Reserve Board of Governors, Duke University, University of Illinois at Urbana-Champaign, the RAND Corporation and the University of Michigan for helpful comments. I am grateful to Riccardo Gatto from ISTAT for making his labor market time series data available to me. Financial support from the Esther and T.W. Schultz Endowment Dissertation Fellowship is gratefully acknowledged. All errors and omissions are my own responsibility.

considerations plays an important role in employment relationships, once the influence of market forces is taken into account.

1 Introduction

The influence of labor market conditions on wages is a central and highly debated issue in economics.[1] Two of the classes of models of wage determination most widely adopted in macroeconomics and labor economics literature, namely spot market models and continual Nash bargaining, predict current wages to be related only to current labor market conditions, short-run effects of temporary labor market shocks, and a proportional relationship between wage changes and changes in workers' outside options. Empirical studies, however, often reveal characteristics of wages that are at odds with these predictions (Malcomson, 1999).

Partly in response to the shortcomings of traditional models, a large body of theoretical literature emphasizes the importance of contracts in labor markets.[2] One of the main motives for firms and workers to engage in long term contracts is the allocation of aggregate risk. The idea that firms and workers "sign" implicit agreements that insulate wages from fluctuations in external conditions has a long tradition in economics and was first formalized in the models of Baily (1974), Gordon (1974) and Azariadis (1975). As emphasized by modern contract theory, the lack of enforceability of implicit arrangements when the parties have access to outside options is a significant obstacle to the viability of insurance employment contracts (Holmstrom, 1981). In spite of the abundance of theoretical work, the empirical evidence on the importance of implicit contracts in actual employment relationships is still relatively scarce. The few existing studies typically contrast the spot market model with implicit contract models with full commitment or one-sided limited commitment, assuming that employers can always commit.[3]

In this paper, I analyze the influence of labor market conditions on wages by considering an insurance model of the employment relationship where both the worker and the employer are free to take outside opportunities. I use the properties of the efficient wage contract produced by the model to develop a set of testable implications for the relationship between wages and outside opportunities at various points of workers' tenure. Even though the lack of commitment limits the role of employment contracts as insurance providers, it does not eliminate it. In fact, the model delivers predictions that contrast sharply not only with those of spot market models or those of models where wages are the outcome of continual

[1] Abraham and Haltiwanger (1995) offers a comprehensive review of the literature on wage movements over the business cycle.

[2] See Rosen (1985) and Malcomson (1999) for overviews of labor contract theory and empirics.

[3] Beaudry and DiNardo (1991) were the first to present microeconomic evidence suggesting that wage dynamics over the business cycle are more consistent with implicit contracts rather than spot market models. McDonald and Worswick (1999) and Grant (2003) replicated Beaudry and DiNardo's study using different data sources and sample periods. Bertrand (2004) examines the effect of increased import competition on implicit contracts. Beaudry and DiNardo (1995) consider a two-sided limited commitment model. Their focus, however, is on the behavior of hours worked.

rebargaining, but also with implicit contract models with more restrictive assumptions about commitment. A matched employer-employee dataset of male workers from Northern Italy allows me to test the model's empirical implications.[4]. As a proxy for external opportunities, I use the unemployment rate,[5] where a lower unemployment rate implies better outside options for workers.

To illustrate how market forces, under two-sided limited commitment, influence implicit contracts, I use a model originally developed by Thomas and Worrall (1988). In the model, risk-averse workers and risk-neutral employers can either trade at the spot market wage, in which case they fully bear the risk attached to economic fluctuations, or they can engage in long-term contracts. Because workers and employers can end the current relationship when better opportunities arise, the relationship continues only if contracts are self-enforcing, that is outside option constraints have to be satisfied at all times so that compliance to the contract remains in the self-interest of both parties. The efficient contract features a wage that is insensitive to changes in outside opportunities, unless these become "too attractive" for one of the parties. In particular, the wage is adjusted upwards when outside opportunities would otherwise prompt the worker to quit and downwards when outside opportunities would otherwise induce the employer to terminate the relationship. This solution balances the risk-averse workers' desire for a smooth earnings stream with the requirement that contracts be self-enforcing.

A first implication of the insurance model with two-sided limited commitment is that wages can be correlated with both the best and the worst labor market conditions since the start of a worker's tenure. This contrasts with models that predict that only current conditions matter for current wages as well as with implicit contract models that assume employer commitment. In fact, in models with employer commitment, real wages are downward rigid and depend only on the best conditions recorded since the start of the job (Harris and Holmstrom, 1982; Beaudry and DiNardo, 1991). I find that both the highest and the lowest unemployment rates experienced since the time of hiring have an independent effect on current wages, even after controlling for current and initial conditions. After performing a series of sensitivity checks, a consistent and robust set of results emerges across alternative labor market indicators, sample definitions, specifications and cohort restrictions. The fact that both the best and the worst labor market conditions since hiring have a significant impact on current wages is consistent with the insight from the theory that wages are

[4] I exclude firms operating in the South because of the dominant influence of centralized wage bargaining in this area of the country. This is the focus of Macis (2006).

[5] As did Beaudry and DiNardo (1991) and, more recently, Grant (2003), Bertrand (2004) and Oreopoulos et al. (2006). In my main analysis, I use regional unemployment rates. However, to check the robustness of the results, I implement the analysis using also the aggregate unemployment rate and the aggregate and regional employment to population ratios.

renegotiated (upward or downward) when either the worker's or the firm's outside option constraints become binding. I interpret this as evidence that commitment problems exist on both sides of the employment relationship. I also find current unemployment to be significantly correlated with current wages, even after controlling for past conditions. This finding provides further corroboration for the contractual framework with limited commitment on both sides of the employment relationship. In fact, with two-sided limited commitment, outside option constraints can become binding even at times when highest and lowest opportunities since hiring are unchanged. By contrast, with employer full commitment and worker full mobility, only the lowest unemployment rate observed since the time of hiring should be correlated with current wages.[6]

A second implication of the implicit contract model I consider is that a firm may pay different wages to workers with the same outside option, if they were hired in different periods; however, because of limited commitment, such wage differentials should disappear if outside opportunities change substantially. Consistent with this implication, I find that the unemployment rate at the time of hiring has an important effect on initial and subsequent wages, but this effect declines with tenure and disappears after four to six years on the job. Several recent studies document the existence of "cohort effects" in wages.[7] I contribute to this literature by considering explicitly an economic mechanism behind this phenomenon. In fact, I find that the impact of the initial unemployment rate virtually disappears if the unemployment rate changed substantially since the start of tenure. This confirms the theory's implication that larger changes in outside opportunities increase the likelihood that outside option constraints become binding, thus prompting wage renegotiation.

Finally, I use the efficient wage updating rule from the model to derive predictions for the relationship between year-to-year wage changes and changes in outside option values. A key implication of the insurance model with limited commitment is that contract wages should not respond to changes in outside opportunities that are "small" enough so that neither outside option constraint becomes binding. The notion of what constitutes a "small" change depends on how close to binding outside options constraints are, and this is typically difficult to determine in practice. Fortunately, the model provides guidance as to when outside

[6] Recognizing that enforcement problems might exist on both sides of labor contracts might rationalize the findings of the existing literature. Using data from the PSID and the CPS, Beaudry and DiNardo (1991) found that current wages depend on the best labor market conditions since hiring. Grant (2003) replicated Beaudry and DiNardo's study using six NLSY cohorts, concluding that both contemporaneous and best labor market conditions since hiring have a strong impact on current wages. As a matter of fact, even in Beaudry and DiNardo's original study, the coefficient on the current unemployment rate was statistically significant in some cases, in particular when worker fixed effects were included in the regression.

[7] See e.g. Baker et al. (1994), Kahn (2006) and Oreopoulos et al. (2006). Baker et al. use data on managers from one single firm, while Kahn and Oreopoulos et al. analyze cohorts of college graduates. In this paper, in contrast, I analyze data from a large number of firms and a more heterogeneous set of workers.

option constraints are binding. If the insurance model with two-sided limited commitment underlies the data, when the wage of a worker increases it is because the worker's constraint is binding, in which case the wage is made equal to the worker's outside option value. Similarly, a real wage decline indicates that the employer's constraint is binding, and the wage becomes equal to the employer's outside option value. Using this result from the model I am able to show that wages are predicted to respond asymmetrically to upward and downward year-to-year changes in outside option values, depending on the sign of the previous year's wage change. In my empirical analysis, I do find evidence of such asymmetries. For workers who experienced a wage raise in the previous period — an indication that their outside option constraint was binding — wages do not respond to "small" increases in the unemployment rate, while they significantly decline in response to "large" increases in unemployment. At the same time, consistent with the theory's predictions, wages are negatively correlated to both "small" and "large" declines in the unemployment rate.

These findings lend support to the insurance model of the employment relationship in a contractual environment where limited commitment exists on *both sides* of the labor contract. When I allow the results of the main regressions to vary across firms of different size, however, the evidence suggests that larger firms are better able to commit to implicit, long-term contracts with their workers compared to smaller firms. In fact, for workers employed at larger firms, a one-sided limited commitment implicit contract model (with worker full mobility and firm full commitment) seems to better describe the relationship between wages and outside opportunities. This is consistent with the notion that larger firms are better suited to provide their workers with wage insurance, e.g. because of their better access to capital markets.[8] It also provides validation to the assumption of employer commitment when analyzing data from large firms (e.g. Chiappori et al., 1999).

This study belongs to a strand of research that stresses the role of implicit and explicit contracts in labor markets. The relative scarcity of empirical studies in this area is partly due to the lack of adequate data,[9] and the fact that incorporating more realistic assumptions about enforceability of implicit contracts makes wage dynamics more complex compared to contractual environments with full commitment or one-sided limited commitment. My contribution to this literature is to derive a set of testable predictions from an implicit contract model with limited commitment on both the worker's and the employer's sides,

[8] This is also consistent with the observation that the role of unions is more important in larger firms, and the idea that unions might help mitigate enforcement problems (Riddell, 1981).

[9] The recent availability of matched worker-firm datasets allows researchers to use information on both sides of the employment relationship (Abowd and Kramarz, 1999). Guiso et al. (2005) use such a dataset to study the allocation of idiosyncratic risk within the firm. In my paper, instead, I study implicit contracts to protect workers' wages against aggregate shocks.

and to actually test them on a large and rich dataset. The results of my empirical analysis provide empirical support to this tradition of models, once the influence of market forces (outside options) is taken into account, and reinforce the importance of considering more realistic assumptions on contracts and commitment in the labor market. In addition to furthering our understanding of the nature of employment relationships, the study of wage formation and dynamics for new hires as well as existing workers can offer insights for building more realistic models of the labor market. In fact, wage determination turns out to be crucial for the empirical performance of important classes of equilibrium models.[10]

The paper is structured as follows: In Section 2, I present an insurance model of the employment relationship with two-sided limited commitment and derive empirically testable implications for the relationship between wages and outside opportunities. Section 3 describes the dataset used for the empirical analysis and the institutions that govern wage setting in Italy. In Section 4, I describe the empirical analysis and discuss the results. In Section 5, I present some remarks on the model's assumptions and contractual environment, and I consider alternative explanations for the patterns observed in the data. Section 6 concludes.

2 Theoretical Framework and Testable Implications

I describe a simple model of the employment relationship where the employer is risk-neutral and the worker is risk-averse and has no access to the intertemporal trade market. The model I consider was originally developed in Thomas and Worrall (1988). In contrast to earlier implicit contract models, this model does not assume that either party can commit to long term contracts. On the contrary, both the worker and the employer can renege on the existing contractual agreement to take better outside opportunities. Next, I illustrate how the properties of the efficient wage contract produce testable implications for the relationship between wages and outside opportunities.

[10] For instance, departures from the Walrasian paradigm of wage formation in favor of contractual arrangements have been found to improve the ability of real business cycles models to replicate the stylized facts of labor market variables (e.g. Boldrin and Horvath, 1995). More recently, a growing body of research (including Shimer, 2004 and 2005, Hall, 2005, Hall and Milgrom, 2006 and Rudanko, 2006) finds in the wage-setting mechanism the key for search and matching models to be able to replicate the extent of vacancies and unemployment fluctuations observed in the data.

2.1 Insurance Employment Contracts with Two-Sided Limited Commitment

2.1.1 Environment and Assumptions

In this model,[11] the analysis focuses on the interaction between two types of agents, workers and entrepreneurs, in a partial equilibrium setting. Agents are infinitely lived and discount future payoffs at the same rate $\beta \in (0,1)$. Time is discrete, and periods are denoted with $t = 0, 1, 2, ...$ Workers are risk averse, and are assumed to inelastically supply one unit of labor each period. Entrepreneurs are risk neutral and are assumed to possess some production technology so that if an entrepreneur employs a worker, the pair produces θ revenue units of output each period. The worker receives wage w and the entrepreneur is left with profit equal to $\theta - w$. Workers derive utility from consumption c according to the period utility function $u(c)$ – with $u'(c) > 0$ and $u''(c) < 0$ – and are assumed not to have access to capital markets, so they have to consume their entire income every period, i.e. $c = w$.

The source of uncertainty resides in the outside market. This is modeled as a spot market, with a finite set of possible states of nature, denoted $s_t \in \Phi \equiv \{\underline{s}, ..., \overline{s}\}$. States are i.i.d. and the probability of each state occurring is $p(s)$, with $\sum_{s=1}^{S} p(s) = 1$. Each period, the state of nature is identified by a spot market wage, denoted with $x(s)$, which is taken as given by the agents.

Agents can either trade in the spot market after observing the realization of s_t, or they can negotiate a long-term contract at date $t = 0$, which specifies payments at any date and state of nature. Information is complete and symmetric in that each agent has perfect knowledge of the state of nature.

2.1.2 Self-Enforcing Contracts

A key feature of the model is that precommitment is not assumed. On the contrary, the agents are free to renege on the contract to trade in the spot market, when doing so is in their best interest. However, an agent who reneges on an existing contract will have to trade in the spot market from then on. The expected present discounted value of the employer's current and future profits and the worker's future utility if they trade in the spot market

[11] See Thomas and Worrall (1988) for details and proofs.

from date t on, given history s^t, are denoted as $V_t^x(s^t)$ and $U_t^x(s^t)$ and defined as follows:

$$\begin{aligned} V_t^x(s^t) &= \theta - x(s_t) + \sum_s \sum_{\tau=t+1}^{\infty} \beta^{\tau-t} \left(\theta - x(s_\tau)\right) p_s \\ U_t^x(s^t) &= u\left(x(s_t)\right) + \sum_s \sum_{\tau=t+1}^{\infty} \beta^{\tau-t} u\left(x(s_\tau)\right) p_s \end{aligned}$$

On the spot market, where no insurance is available, workers' income depends on the state of the economy in each period and is hence potentially subject to great variability. An employment contract, on the other hand, provides insurance against such fluctuations. A contract, denoted with δ, signed at the beginning of an employment relationship, is defined as a contingent sequence of wage functions $\{w(s^t)\}_{t=1}^{\infty}$ where $w(s^t)$ is the wage paid after history $s^t \equiv \{s_0, s_1, s_2, s_3..., s_t\}$.

Let $V_t^\delta(s^t)$ denote the expected present discounted value of the employer's current and future profits under the current contract from t on, given history s^t, and let $U_t^\delta(s^t)$ be the expected present discounted value of the employee's utility. These can be written recursively as

$$\begin{aligned} V_t^\delta(s^t) &= \theta - w(s^t) + \sum_s \beta V_{t+1}^\delta(s^t, s) p_s \\ U_t^\delta(s^t) &= u(w(s^t)) + \sum_s \beta U_{t+1}^\delta\left(s^t, s\right) p_s \end{aligned}$$

Because this model does not assume precommitment, feasible contracts must be *self-enforcing*, meaning they must be such that neither agent has any incentive to renege under any circumstances. A self-enforcing contract is thus a contingent sequence of wage functions $\{w(s^t)\}_{t=1}^{\infty}$ such that, at any time t and after any history s^t, for both the worker and the employer, the short-term gain from reneging on the contract is no greater than the long-term gain from abiding by the contract, i.e.

$$V_{t+1}^\delta(s^t, s) \geq V_{t+1}^x(s^t, s), \text{ for all } s^t, \, s \text{ and t} \geq 0 \quad (1)$$

$$U_{t+1}^\delta(s^t, s) \geq U_{t+1}^x(s^t, s), \text{ for all } s^t, \, s \text{ and t} \geq 0 \quad (2)$$

The inequalities (1) and (2) are the employer's and the worker's *outside option constraints*, respectively. An alternative formulation expresses (1) and (2) in the following way

$$\begin{aligned} \widetilde{U}^\delta(s^t, s) &\equiv u(w(s^t, s)) - u(x(s_t)) + \sum_s \sum_{\tau=t+2}^{\infty} \beta^{\tau-t} \{u(w(s^\tau)) - u(x(s_\tau))\} p_s \geq 0 \\ \widetilde{V}^\delta(s^t, s) &\equiv x(s_t) - w(s^t, s) + \sum_s \sum_{\tau=t+2}^{\infty} \beta^{\tau-t} \left\{x(s_\tau) - w(s^\tau)\right\} p_s \geq 0 \end{aligned}$$

for all s^t and $t \geq 0$, and where $\widetilde{U}^{\delta}(s^t, s)$ and $\widetilde{V}^{\delta}(s^t, s)$ are the continuation values of contract δ for the worker and the employer, respectively. When $x(s)$, the spot market wage, is greater than the contract wage, there is a short-term incentive for the worker to renege on the contract, whereas when $x(s)$ is lower than the contract wage it is the firm that has an incentive to renege. The optimal contract must be such that the long-term benefits of abiding by it counterbalance the short-term incentives to renege.

2.1.3 Wage Dynamics under Self-Enforcing Contracts

In this setting, the efficient wage contracts can be characterized by using a Pareto frontier approach, as in Thomas and Worrall (1988) and Malcomson (1999). If $V_t^{\delta}(s^t)$ is the expected present discounted value of the employer's current and future profit under the current contract from t on, given history s^t, then the corresponding present discounted value of the worker's utility is equal to $u\left(w(s^t)\right) + \sum_s \beta U_{t+1}^{\delta}\left(V_{t+1}^{\delta}\left(s^t, s\right)\right) p_s$.

An efficient contract must maximize the worker's expected future utility for any given level of the employer's expected future profit at every date t. To this aim, $w(s^t)$ and V_{t+1}^{δ} are chosen so as to

$$\max_{w(s^t), V_{t+1}^{\delta}} u\left(w(s^t)\right) + \sum_s \beta U_{t+1}^{\delta}\left(V_{t+1}^{\delta}\left(s^t, s\right)\right) p_s \tag{3}$$

$$\text{s.t.} \quad V_t^{\delta}(s^t) = \theta - w(s^t) + \sum_s \beta V_{t+1}^{\delta}\left(s^t, s\right) p_s \tag{4}$$

and subject to the outside option constraints (1) and (2).

Let $\lambda_t(s^t)$, $\beta p_s \phi_{t+1}(s^t, s)$ and $\beta p_s \psi_{t+1}(s^t, s)$ denote the Lagrange multipliers on constraints (4), (1) and (2), respectively. Then, straightforward derivations deliver the following first-order conditions

$$u'[w_t^*(s^t)] - \lambda_t(s^t) = 0, \quad \text{for all } t \text{ and } s^t \tag{5}$$

$$U_{t+1}^{\delta\prime}(V_{t+1}^{\delta}(s^t, s))[1 + \phi_{t+1}(s^t, s)] + \psi_{t+1}(s^t, s) + \lambda_t(s^t) = 0, \quad \text{for all } t \text{ and } s^t \tag{6}$$

Plus the envelope condition

$$U_t^{\delta\prime}(V_t^{\delta}(s^t)) = -u'[w_t^*(s^t)], \quad \text{for all } t \text{ and } s^t \tag{7}$$

and the complementary slackness conditions on the inequality constraints:

$$\phi_{t+1}(s^t, s)\left\{U_{t+1}^{\delta}\left(V_{t+1}^{\delta}(s^t, s)\right) - U_{t+1}^{x}(s^t, s)\right\} = 0 \tag{8}$$

$$\psi_{t+1}(s^t, s)\left\{V^{\delta}_{t+1}(s^t, s) - V^{x}_{t+1}(s^t, s)\right\} = 0 \tag{9}$$

Using (5), (6) and (7) gives

$$u'[w^*_t(s^t)] = u'[w^*_{t+1}(s^t, s)][1 + \phi_{t+1}(s^t, s)] - \psi_{t+1}(s^t, s) \tag{10}$$

The main focus of this paper is wage dynamics. Equation (10) allows us to characterize how the wage at time $t+1$ relates to the wage paid at time t. based on (10), (8) and (9), the following cases are possible:

1. At time t+1, the employee's outside option constraint binds and the employer's outside option constraint does not bind. Because this means that $\phi_{t+1}(s^t, s) > 0$ and $\psi_{t+1}(s^t, s) = 0$, (10) implies that $u'[w^*_t(s^t)] > u'[w^*_{t+1}(s^t, s)]$ which in turn means that $w^*_{t+1}(s^t) > w^*_t(s^t, s)$. In this case, the wage needs to be raised to match the employee's outside option and prevent the employee from quitting.

2. The employer's outside option constraint binds and the employee's outside option constraint does not bind. Because this means that $\phi_{t+1}(s^t, s) = 0$ and $\psi_{t+1}(s^t, s) > 0$, (10) implies that $u'[w^*_t(s^t)] < u'[w^*_{t+1}(s^t, s)]$ which in turn means that $w^*_{t+1}(s^t) < w^*_t(s^t, s)$. In this case, the wage needs to be lowered to match the employer's outside option to prevent the firm to renege on the contract.

3. Neither outside option constraint binds. In this case, both $\phi_{t+1}(s^t, s)$ and $\psi_{t+1}(s^t, s)$ are equal to zero, and by (10) we have that $w^*_{t+1}(s^t) = w^*_t(s^t, s)$; that is, the wage at time t+1 is equal to the wage that was paid at time t.

Thomas and Worrall (1988) prove that, in this setting, for any history (s^{t-1}, s_t), the wage of an efficient contract at time t, $w^*(s^{t-1}, s)$ must be contained in a closed non-empty interval that depends on the contemporaneous realization of s: $[\underline{w}(s), \overline{w}(s)]$. $\underline{w}(s)$ is the lowest wage a worker is willing to accept, and $\overline{w}(s)$ is the highest wage the employer is willing to pay when the state of nature is s.[12]

The model delivers the following optimal updating rule for the contract wage paid to a worker at time t, for all $t > 0$

$$w_t = \min\left\{\max\left[w_{t-1}, \underline{w}(s_t)\right], \overline{w}(s_t)\right\}$$

or, more explicitly

[12]Note that if $w(s^{t-1}, s) = \underline{w}(s)$, the worker gets no gain from the contract from time t on, while if $w(s^{t-1}, s) = \overline{w}(s)$ it is the employer who does not get any gain. In fact, if $w(s^{t-1}, s) = \underline{w}(s)$, the worker's outside option constraint is binding, i.e. $\widetilde{U}^{\delta}(s^t, s) = 0$, whereas if $w(s^{t-1}, s) = \underline{w}(s)$ the employer's outside option constraint is binding, i.e. $\widetilde{V}^{\delta}(s^t, s) = 0$.

$$w_t = \begin{cases} \underline{w}(s_t) & \text{if } w_{t-1} < \underline{w}(s_t) \\ w_{t-1} & \text{if } \underline{w}(s_t) \leq w_{t-1} \leq \overline{w}(s_t) \\ \overline{w}(s_t) & \text{if } w_{t-1} > \overline{w}(s_t) \end{cases} \qquad \text{(Result 1)}$$

where s_t is the state of outside productivity at time t. In addition, it can be shown that the functions $\underline{w}$ and $\overline{w}$ that define, for each s, the region of admissible wages, are such that

$$\underline{w}(s{=}q) > \underline{w}(s{=}q') \text{ and } \overline{w}(s{=}q) > \overline{w}(s{=}q') \text{ for } q > q',\ q, q\prime \in \Phi \qquad \text{(Result 2)}$$

For any history (s^{t-1}, s_t), the updating rule for the contract wage between dates t and $t+1$ is very simple. As a consequence of workers' risk aversion, the wage is kept constant whenever possible, i.e. unless either outside option constraint becomes binding. If this occurs, the wage will be changed by the smallest amount necessary to satisfy with equality the binding outside option constraint. In particular, the wage is reduced to equal the top of the interval $[\underline{w}(s_t), \overline{w}(s_t)]$ if the current realization s_t makes $w(s^{t-1})$ higher than $\overline{w}(s_t)$ (i.e. when the employer's outside option constraint binds) or raised to equal the bottom of the interval $[\underline{w}(s_t), \overline{w}(s_t)]$ if the current realization s_t makes $w(s^{t-1})$ smaller than $\underline{w}(s_t)$ (i.e. when the worker's outside option constraint binds). This solution balances the risk-averse workers' desire for a smooth earnings stream with the requirement that contracts be self-enforcing. Figure 1 illustrates the wage dynamics under a hypothetical sequence of realizations of s_t.

The one-sided limited commitment cases can be seen as special cases of Result 1. Assuming employer commitment (Harris and Holmstrom, 1982; Beaudry and DiNardo, 1991) amounts to assuming that the employer's constraint never binds, so that

$$w_t = \max\{w_{t-1}, \underline{w}(s_t)\} \qquad \text{(Result 1-LCW)}$$

(where LCW stands for "limited commitment with worker mobility). Similarly, if we assume that the workers' outside option never binds, we get

$$w_t = \min\{w_{t-1}, \overline{w}(s_t)\} \qquad \text{(Result 1-LCE)}$$

(where LCE stands for "limited commitment with employer mobility). In the former case, the wage is downward rigid and is raised only when outside opportunities improve above their previously recorded maximum to prevent mobile workers from quitting in good times. In the latter case, the wage is upward rigid and is reduced only when outside opportunities worsen below their previously recorded minimum, to prevent the employer from replacing the current worker with someone hired in the spot market.

2.2 Empirical Implications of Insurance Employment Contracts with Limited Commitment

In this section, I derive a set of testable implications of the implicit contract model with two-sided limited commitment outlined earlier. I show that with two-sided limited commitment, (1) current wages can be correlated with both the best and the worst realizations of outside opportunities since the time of hiring; (2) a firm may be paying different wages to workers with the same outside option, if they were hired in different periods, but such wage differentials disappear if outside opportunities change substantially (3) the relationship between wage changes and changes in outside opportunities displays nonlinearities and asymmetries that depend on whether the worker's or the employer's outside option constraint was last binding.

2.2.1 The History of Outside Opportunities and Current Wages

Proposition 1 *With insurance employment contracts subject to two-sided limited commitment, current wages can be correlated with both the lowest and the highest realizations of outside opportunities since the time of hiring.*

Proof. See the Appendix. ■

The two-sided limited commitment feature of the model generates wage dynamics that are more complex compared to models with more restrictive assumptions about commitment. With full commitment, wages are set at the beginning of employment and are never changed. Assuming worker mobility and commitment on the part of the employer, as do Harris and Holmstrom (1982) or Beaudry and DiNardo (1991), one obtains the result that wages are revised only upwards, when outside opportunities improve above their historical maximum (Result 1-LCW). This implies that in a wage regression augmented with an indicator for current conditions, one for conditions prevailing at the start of tenure and one for the best conditions since the start of tenure, only the latter should be correlated with current wages. If one considers the inverse situation, i.e. a contractual environment where the worker's mobility is limited while the firm is unable or unwilling to commit to long-term contracts, we get that wages are only revised downwards, when outside opportunities deteriorate below their historical minimum (Result 1-LCE). Within such an environment, in a wage regression augmented with an indicator for current conditions, one for conditions prevailing at the start of tenure and one for the worst conditions since the start of tenure, only the latter should be correlated with current wages.

As seen in the previous section, however, with two-sided limited commitment, wage dynamics become less straightforward, and no single labor market indicator is sufficient to predict when wage renegotiation will occur. In contrast to the benchmark one-sided limited

commitment cases, there is not a single indicator of current or past conditions that is sufficient to predict current wages. However, *both the best and the worst* realizations of outside options since the date of hiring can contain information on whether wage renegotiation occurred. In particular, this implies that in a wage regression augmented with indicators for best and worst conditions recorded since hiring, both indicators can be correlated with current wages. This is because the event {change in best outside opportunities since hiring} is positively correlated with the event {worker's constraint is binding}$\Longleftrightarrow${worker's wage is raised}, and the event {change in worst outside opportunities since hiring} is positively correlated with the event {employer's constraint is binding}$\Longleftrightarrow${worker's wage is lowered}.

Additionally, with two-sided limited commitment, wages can also be correlated with current labor market conditions. The reason for this result is that outside option constraints can be binding even at times when the highest and lowest realizations of outside opportunities are unchanged. Clearly, the actual importance of indicators of present and past labor market conditions is purely an empirical issue. For example, in a labor market that does not fluctuate much, the influence of initial conditions should persist much longer compared to a labor market that exhibits larger fluctuations.

2.2.2 Cohort Effects, Tenure and Changes in Outside Opportunities

In the risk-sharing model with limited commitment, "cohort effects" in wages arise because otherwise identical workers are treated differently depending on the value of outside opportunities prevailing when they are hired. Because of limited commitment and the requirement for contracts to be self-enforcing, however, wages are renegotiated whenever such a time comes that either outside option constraint becomes binding. This implies that the persistence of cohort effects depends on the magnitude of changes in outside options since the date of job start.

Proposition 2 *When risk-sharing employment contracts are subject to limited commitment, the dependence of wages on the economic conditions prevailing at the time of hiring declines with tenure on the job.*

Proof. See the Appendix. ■

This proposition rests on the fact that the probability that outside opportunities change enough to trigger wage renegotiation increases with calendar time and, conversely, the probability that no constraint has yet been binding decreases with time.

Clearly, in the model it is not tenure *per se* that affects the persistence of cohort effects. In fact, cohort effects are predicted to disappear whenever changes in outside opportunities trigger a renegotiation of wages. Consider the simple example illustrated in Figure 2. In Figure 2, worker A is hired in period 1 and obtains wage w_A. In period 2, worker B is

hired, and the employer pays him wage w_B. Because outside opportunities improved in period 2 compared to period 1, the initial wage of worker B is higher than that of worker A. However, outside opportunities have not changed enough from period 1 to period 2 to trigger renegotiation of worker A's wage. In period 3, however, outside opportunities improved enough to prompt renegotiation of both workers' wages, so that in period 3 $w_A = w_B$ and the wage differential between A and B due to different conditions at the time of hiring (i.e. the "cohort effect") has disappeared.

Corollary 1 *For any pair of cohorts i and ii, hired in periods $t_0(ii) > t_0(i)$ and with productivity realizations $s_{t_0(i)}, s_{t_0(i)+1}, ..., s_{t_0(ii)}$ such that $w_{ii,t_0(ii)} - w_{i,t_0(ii)} > 0$, there exists threshold values $\chi(w_{ii,t_0(ii)})$ and $\chi(w_{i,t_0(ii)})$ such that if $s_{t_0(ii)+j} > \chi(w_{ii,t_0(ii)})$ or $s_{t_0(ii)+j} < \chi(w_{i,t_0(ii)})$ then $w_{ii,t_0(ii)+j} = w_{i,t_0(ii)+j}$.*

Proof. See the Appendix. ■

A change in outside opportunities that is "large enough" to trigger renegotiation of both workers' wages eliminates wage differentials related to different conditions prevailing in the dates the workers were hired.

Propositions 2 and Corollary, combined, suggest a further empirically testable prediction. Controlling for changes in outside opportunities, the effect of initial conditions on wages should not vary systematically with tenure.

2.2.3 Asymmetries in the Responsiveness of Wages to Changes in Outside Opportunities

The wage updating rule derived from the model of risk-sharing with two-sided limited commitment (Result 1) implies that the wage at time $t+1$ is unchanged from time t whenever changes in outside opportunities are "small enough" so that neither the worker's nor the employer's outside option constraint are binding. The rule dictates that the wage at time $t+1$ will change with respect to the wage at time t whenever either constraint becomes binding. In particular, when the worker's constraint is binding, the contract wage will be set equal to $\underline{w}(s_t)$, while if the employer's constraint binds, the wage will be equal to $\overline{w}(s_t)$. Consider a sample of N worker-employer pairs observed over periods $t-1$, t and $t+1$, and assume that the insurance model with two-sided limited commitment governs their interactions. Let $G_{1,t}$ denote the set of worker-employer pairs for whom the worker's outside option constraint was binding in period t, $G_{2,t}$ be the set of worker-employer pairs for whom neither outside option constraint was binding in period t and $G_{3,t}$ denote the set of worker-employer pairs for whom the employer's outside option constraint was binding in

period t. This implies that

$$\begin{aligned} w_{i,t} &= \underline{w}(s_t) > w_{i,t-1} \quad \text{if worker } i \in G_{1,t} \\ w_{i,t} &= w_{i,t-1} \quad \text{if worker } i \in G_{2,t} \\ w_{i,t} &= \overline{w}(s_t) < w_{i,t-1} \quad \text{if worker } i \in G_{3,t} \end{aligned}$$

that is, the wages of workers in $G_{1,t}$ have increased between period $t-1$ and period t, they have stayed constant for workers in $G_{2,t}$, and have decreased for workers in $G_{3,t}$. The model implies that $w_t = \underline{w}(s_t)$ for workers in $G_{1,t}$ and $w_t = \overline{w}(s_t)$ for workers in $G_{3,t}$.

Proposition 3 *For workers in $G_{1,t}$, improvements in outside opportunities always lead to wage increases while deteriorations in outside opportunities lead to wage cuts only if the deterioration is "large enough". For workers in $G_{3,t}$, deteriorations in outside opportunities always lead to wage reductions while improvements in outside opportunities lead to wage increments only if the improvement is "large enough".*

Proof. *See the Appendix.* ■

Figure 3 offers a graphical illustration of Proposition 3. This proposition implies that if one looks at wage changes in a period immediately following a date when the worker's (the employer's) constraint was binding, there should be an asymmetry in the responsiveness of wages to improvement or deterioration of outside opportunities such that whenever outside opportunities improve (deteriorate), wages should be raised (lowered); whereas when outside opportunities deteriorate (improve), wages should be lowered (raised) only if the deterioration (improvement) is "substantial". Otherwise wages should remain unchanged.

These asymmetries are sharp implications of the insurance model with two-sided limited commitment and contrast with one-sided commitment hypotheses in that wages can respond to both upward or downward changes in outside options. These implications also contrast with the spot market model and with continual Nash bargaining (whereby each party receives a fixed share of the surplus), both of which imply a proportional relationship between changes in wages and changes in outside opportunities. The asymmetries implied by the insurance model also differ from those that would be implied by a "menu costs" model. With menu costs, the wage would be updated only in the presence of large changes in outside opportunities, whereas with the insurance model, as we have just seen, even small changes can trigger wage renegotiation.

3 Data and Institutional Setting

In this section, I outline the main features of the linked employer-employee dataset and explain the construction of the key variables used in the empirical analysis. Next, I describe the institutions that influence wage formation in Italy.

3.1 The Data

3.1.1 Description of the Data Sources

The data used in this paper come from tthe records of the Social Insurance Institute (INPS). The INPS dataset contains the complete work histories of a large sample of workers in the manufacturing sector. The INPS data provide information on annual gross earnings, the number of weeks worked, the occupational status (production worker, white collar, manager) and basic demographics on a yearly basis for the period 1981-1997. Because the individual-level data include an employer identifier, it is possible to follow each worker since he first joined a particular employer and control for worker and firm effects.

As did Beaudry and DiNardo (1991) and, more recently, Bertrand (2004) and Oreopoulos et al. (2006), I proxy outside opportunities to workers using the (annual average of quarterly) civilian unemployment rate. Unemployment data are from the Italian Statistics Institute (ISTAT) for the period 1993-1997 and from Gatto et al. (2001) and Gatto (2004) for the years 1982-1992. The Gatto series are the only unemployment series for the period before 1993 that are fully comparable with the new series developed by ISTAT starting in that year. As explained above, the INPS data go from 1982 to 1997, which gives me 16 year_of_job_start cohorts. Each cohort is observed for (1997 minus year_of_job_start plus 1) periods. Thus, ten year_of_job_start cohorts can be observed for a period of at least 5 years. Given the lower regional mobility of Italian workers compared to other economies such as the U.S., it can be argued that the relevant labor market is at the regional level. Therefore, in my main analysis I use regional unemployment rates. This also allows me to obtain more variation within the sample[13].

Figure 4A shows the time series of unemployment rates for males ages 15-64 at the regional level as well as the regional average, and Table 2, Panels A and B display summary statistics. In the period considered, Italy experienced two recessions in the early 1980s and 1990s. In the Centernorth as a whole, the unemployment rate varies between 3.5 percent and 5.3 percent over the business cycle, or about three standard deviations. Figure 4A also reveals a substantial degree of regional heterogeneity. During recessions, the unemployment rate increases by between one and four percentage points, depending on the region; in nearly all cases, such increases correspond to over two standard deviations.

[13] As I will explain below, I limit my analysis to workers and firms located in Italy's Centernorth. There are twelve regions in Italy's Centernorth, and this potentially provides 192 region-"year_of_job_start" cohorts (120 region-"year_of_job_start" cohorts observed for 5 years or more).

3.1.2 Sample Selection and Construction of the Key Variables

The analysis focuses on males working full-time in Central and Northern Italy. I exclude firms located in the South of Italy because of the dominant influence of centralized wage bargaining in this area of the country, documented in Macis (2006).[14] Firms located in Italy's Centernorth[15] represent over 80 percent of the original INPS dataset. The linked employer-employee nature of the INPS dataset allows me to unambiguously determine when a worker joins or leaves a firm, with the exception of the initial and final years, i.e. 1981 and 1997. I can therefore construct a precise measure of tenure for workers who entered any of the sampled firms after 1981. I eliminated the records with missing person or firm identifier and those corresponding to workers younger than 15 or older than 55 at the date of job start. In addition, I dropped outliers (first and last percentiles) in the weekly earnings distribution. The wage measure I use is the weekly total compensation, obtained by dividing the gross income earned by the number of weeks worked in each year. I deflated nominal values using the ISTAT-FOI (CPI) deflator.

In Table 1, I report summary statistics, for the whole selected sample, and by entry year cohort. The data consists of nearly 2 million person-year observations and includes information on over 400,000 workers. Each year, between 15,000 and 44,000 workers started a new employment relationship. For the total sample, average gross weekly earnings at 1997 constant prices are 446 euros, and the average age is 36.5 years. Over 64 percent of the observations are production workers.

3.2 Wage Determination in Italy

The total compensation of a typical Italian worker[16] is the sum of five main components, determined at the industry level, the company level and the individual level. The first is the contractual minimum (1), established at the industry level by collective agreements between unions and employers' associations. Within an industry, contractual minima vary according to the worker's qualification (production workers, white collars and managers), sub-qualification (several ranks, called "levels") and seniority, and they apply to every

[14] The "southern anomaly" is the subject of Macis (2007). In that paper, I show that wages in the South are *positively* correlated with the unemployment rate in this region. At the same time, wages in the South respond strongly to *Northern* labor market conditions. I argue that the centralized (i.e. nation-wide) nature of collective bargaining in Italy, combined with lower productivity of Southern workers, results in binding wage minima in this region so that (centrally bargained) wages determine unemployment.

[15] The Center and the North of Italy include 12 of the 20 Italian regions: Lombardia, Liguria, Piemonte, Valle d'Aosta, Trentino-Alto Adige, Veneto, Friuli-Venezia-Giulia, Emilia Romagna, Toscana, Marche, Umbria and Lazio. The South includes Abruzzi, Molise, Campania, Calabria, Puglia, Basilicata, Sicily and Sardinia.

[16] See Erickson and Ichino (1995) for a more detailed description of the institutional determinants of wage formation in Italy for the period 1981-1995.

worker in the industry, irrespective of actual union membership. The second component of the typical wage bill is the so-called "indexation" (2). This component is added to the contractual minimum every year based on the national inflation rate. The sum of components (1) and (2) is taken as an effective wage floor in company-level and individual-level negotiations. The three remaining components of the typical wage bill are determined at the company or the individual level. The "collective superminimum" (3) and the "individual superminimum" (4), set at the company and individual level, respectively, are added to the contractual minimum on a permanent basis, as a result of company-wide or individual bargaining. Finally, the individual compensation can include additional items, such as 13th month pay, and one-time bonuses (5).

While the focus of this paper is on individual employment relationships, it is important to establish that firms and workers are indeed able to negotiate a substantial portion of pay above and beyond industry minima. To check whether this is actually the case, I use the "index of contractual wages" (*numeri indice delle retribuzioni contrattuali*) provided every year since 1975 by the Italian Statistics Institute (ISTAT). As explained in ISTAT (2005), the index measures the yearly variation in the annual "contractual" compensation of a full-time, full-year worker based on national collective agreements and the law. The "contractual" compensation includes the wage minimum and the indexation, as well as other components of the compensation that are of general character (e.g. 13th or 14th months pay). As I mentioned above, contractual minima vary based on occupation, a worker's "level" within the occupation and the seniority on the job. ISTAT provides measures of contractual wages separately for production workers and white collar workers, and the measures provided are weighted averages of the various "levels". As for seniority, the measures provided by ISTAT are for workers with eight years of tenure. The base year is changed approximately every five years (in 1975, 1982, 1990, 1995 and 2000). Using these figures and the yearly rates of change, it is therefore possible to construct an annual series of contractual wages for Italian workers by industry. For each year, I normalize individual wages from the INPS dataset by the minimum wage prevailing in the industry, and kernel-estimate the distribution of these normalized wages. In Figure 5, I display the estimated kernel densities for production workers and white collar workers, separately. The plots reveal that a substantial fraction of workers earn a wage 25 percent, 50 percent or even 100 percent higher than the industry minimum. This is consistent with the Erikson and Ichino (1995) and Guiso et al. (2005) observation that the individual superminimum provides Italian firms and workers with an important source of wage dispersion.

4 Empirical Implementation

4.1 Testing Proposition 1: The Effect of the History of Outside Opportunities on Current Wages

Proposition 1 states that with two-sided limited commitment, both the best and the worst realizations of outside options since the date of hiring can contain information on whether wage renegotiation occurred. In particular, this implies that in a wage regression augmented with indicators for best and worst conditions recorded since hiring, both indicators can be correlated with current wages. I test Proposition 1 by estimating empirical wage functions of the following form

$$\begin{aligned} \ln w_{i,t_0(i)+t} &= \gamma_0 u_{r(i),t_0(i)} + \gamma_c u_{r(i),t_0(i)+t} + \gamma_{\min} u^{\min}_{r(i),t_0(i)+t} + \gamma_{\max} u^{\max}_{r(i),t_0(i)+t} \\ &\quad + X_{i,t_0(i)+t}\beta + v_{i,t_0(i)+t} \end{aligned} \tag{11}$$

where i denotes an individual, $r(i)$ is individual i's region of work, $t_0(i)$ is the date individual i joined his current employer, and t measures tenure with the current employer. $w_{i,t_0(i)+t}$ is individual i 's weekly real compensation in period $t_0(i)+t$. For my main results, I proxy outside opportunities to workers with the regional unemployment rate, where a lower unemployment rate implies better outside options. To check the robustness of the results, I also implement the analysis using the aggregate unemployment rate and the aggregate and regional[17] employment to population ratios. Standard errors are always clustered at the level of the year of job start-region cohort (or the year of job start cohort when aggregate measures are used) to allow for group level error terms.[18] Model (11) includes four unemployment rate statistics that parametrize the history of outside opportunities over the course of an individual's tenure with the current employer. $u_{r(i),t_0(i)}$ is the unemployment rate prevailing in individual i's region of work when individual i started working with his current employer, $u_{r(i),t_0(i)+t}$ is the contemporaneous unemployment rate, $u^{\min}_{r(i),t_0(i)+t}$ is the lowest unemployment rate recorded since individual i was hired up to time $t_0(i)+t$, $u^{\max}_{r(i),t_0(i)+t}$ is the highest unemployment rate recorded since individual i was hired up to time $t_0(i)+t$.

The main coefficients of interest are $\gamma_{\min}$ and $\gamma_{\max}$. Recall that under my identifying assumption, lower unemployment means better outside opportunities for workers. The implicit contract model with two-sided limited commitment implies $\gamma_{\min} < 0$ as well as $\gamma_{\max} < 0$. The spot market model, or continual Nash bargaining, imply $\gamma_{\min} = \gamma_{\max} = 0$. A one-sided limited commitment implicit contract model implies $\gamma_{\min} < 0$ and $\gamma_{\max} = 0$ if

[17] In the regional models, the regional unemployment and employment rates are adjusted for region and year fixed effects to make them independent of aggregate time series variation common across regions.

[18] See Moulton (1986) and Bertrand, Duflo and Mullainathan (2004).

the employee is mobile and the employer is able to commit, or $\gamma_{\min} = 0$ and $\gamma_{\max} < 0$ if the employee is able to commit (or if her mobility costs are very high). The coefficient on current unemployment, γ_c, is also of interest. γ_c should be irrelevant under the one-sided commitment hypothesis but could be relevant, together with $\gamma_{\min}$ and $\gamma_{\max}$, with two-sided limited commitment.

The control vector $X_{i,t_0(i)+t}$ includes time-invariant and time-changing observable individual and firm characteristics. In all specifications, the vector $X_{i,t_0(i)+t}$ includes a third-degree polynomial in age (taken as a proxy for labor market experience, a variable that is not available in the INPS dataset), four occupation indicators (production worker, white collar, manager, other; these indicators can be taken as proxies of education levels), twenty-nine industry indicators, indicator variables for apprentices, salespersons or other individuals working from home and for individuals working in a region different from their region of birth. Because the focus in this paper is on the effects of changing labor market conditions over time rather than across labor markets, I also include a full set of region of work indicators. This ensures that the estimates are within-region rather than between-regions effects. Because the key explanatory variables are by construction correlated with tenure on the job (see Figure 6A), it is crucial to appropriately control for any independent effect tenure might have on wages; failure to do so would bias the estimated coefficients on $u^{\min}_{r(i),t_0(i)+t}$ and $u^{\max}_{r(i),t_0(i)+t}$. To account for the effect of tenure on wages in the most general way, I include a full set of tenure indicators among the control variables in all my specifications.

Pooled OLS Results The first set of estimates, reported in Table 3, Panel A, are from a simple pooled OLS specification. Column (1) reports the results from a model that includes $u_{t_0(i)+t}$, $u_{t_0(i)}$ and $u^{\min}_{t_0(i),t}$, which would be the right variables to include if the "true" model underlying the data was an insurance model subject to one-sided limited commitment with worker mobility. The estimated coefficient on the initial unemployment rate is equal to zero, while those on current unemployment and lowest unemployment rate since hiring are equal to -0.013 and -0.017, respectively, and are both statistically significant at the one percent level. In Column (2) I report the results from a model including $u_{t_0(i)+t}$, $u_{t_0(i)}$ and $u^{\max}_{t_0(i),t}$ among the regressors, which would be appropriate if the "true" model was an implicit contract model with commitment on the part of the worker and employer mobility. When this specification is adopted, the estimated coefficient on current unemployment, γ_c, is equal to -0.022 and is statistically significant, while both γ_0 and $\gamma_{\max}$ are small and not statistically different from zero. Finally, the specification whose results are reported in Column (3) includes all four labor market tightness measures, which allows us to test the two-sided limited commitment model. When this specification is adopted, the coefficient on the initial unemployment rate is once again small in magnitude and not statistically significant, while current, lowest and highest unemployment appear to be all correlated with

current log wages. According to the OLS results, when the current unemployment rate is 1 percentage point higher, wages are 1 percent lower; when the lowest unemployment rate observed since the start of tenure is 1 percentage point lower, wages are 1.8 percent higher; and if the highest unemployment rate observed since the start of tenure is 1 percentage point higher, wages are 0.7 percent lower. Although these results suggest to some extent that an implicit contract model with limited commitment on both sides of the labor contract is consistent with the data, there are two important reasons why OLS estimates might be biased: unobserved worker heterogeneity and unobserved firm heterogeneity. I address this concern in the paragraph below.

Controlling for Worker And Employer Unobservable Heterogeneity If employers hire or dismiss workers of systematically different unobserved ability in different phases of the business cycle, an important omitted variable would be correlated with the history of outside opportunities, and OLS would deliver biased coefficients. Suppose, for instance, that firms hire workers of higher ability during downturns.[19] Then, there would be a positive correlation between the unemployment rate at the time of hiring and unobserved worker ability, which would impart an upward bias (toward zero) on the coefficient on $u_{t_0(i)}$. Further, because workers hired during downturns tend to have a greater $u^{\max}_{t_0(i),t}$, the coefficient on this variable would also be attenuated (biased toward zero) if unobservable worker ability is omitted from the regression. It is also possible that firms dismiss workers of systematically different ability in different phases of the business cycle. If, for instance, firms must spend resources to find good workers (search or screening costs), workers of greater ability would arguably be the last to leave the firm during downturns. Therefore, workers with longer tenure would be workers of higher unobservable ability. Now, because by construction $u^{\min}_{t_0(i),t}$ and $u^{\max}_{t_0(i),t}$ are strongly correlated with tenure (see Figure 6A), omitted ability would result in biased OLS estimates.

To address these concerns, I estimate model (11) including worker-specific fixed effects that are allowed to be correlated with the other regressors, including tenure and the labor market history parameters. Panel B of Table 3 reports the results of this set of regressions. In contrast with the OLS results, the coefficient on $u^{\max}_{t_0(i),t}$ is larger and statistically significant in both Columns (2) and (3). This result suggests that during downturns, firms indeed tend to hire workers with unobserved individual characteristics that are worth more in the market, so that the OLS estimates suffer downward bias. In Column (3), when all four labor market tightness indicators are included, both the coefficient on $u^{\min}_{t_0(i),t}$ and that on $u^{\max}_{t_0(i),t}$ are negative and statistically significant at the one percent level. The fact that both the best and the worst labor market conditions since hiring have a significant impact on

[19] See Heckman and Sedlacek (1985) and Solon, Barskey and Parker (1994).

current wages indicates that commitment problems exist on both sides of the employment relationship. The magnitudes of $\gamma_{\min}$ and $\gamma_{\max}$ are economically important, as they indicate that if the lowest (highest) unemployment rate since hiring is one percentage-point lower (higher), individual wages are 2.3 percent higher (1.7 percent lower). The coefficient on the current unemployment rate is large and statistically significant in Columns (1) and (2), i.e. when $u^{\max}_{t_0(i),t}$ and $u^{\min}_{t_0(i),t}$, respectively, are *omitted* from the regression. The magnitude and statistical significance of this coefficient, however, drop dramatically in Column (3), when both $u^{\min}_{t_0(i),t}$ and $u^{\max}_{t_0(i),t}$ are included in the regression: a 1 percentage point change in the unemployment rate is associated with a 0.4 percent change in wages.

Another potentially important source of bias is given by firm heterogeneity in hiring practices over the business cycle. Although the pooled OLS and worker fixed effects specifications included industry effects, unobserved firm-specific characteristics could also be systematically correlated with hiring practices in different phases of the business cycle. If some firms hire systematically more (or less) able workers during different phases of the business cycle, omitted firm unobservables would lead to bias in the estimated coefficients of interest. As a first step towards analyzing the importance of firm heterogeneity, in Panel C of Table 3, I report the results from estimation of model (11) with firm fixed effects, but without worker effects. The results do not differ much from the OLS specification, which seems to indicate that Italian firms do not have significantly different hiring policies over the business cycle. Next, I specify the error term as follows

$$v_{i,t_0(i)+t} = \mu_i + \zeta_{j(i,t_0(i)+t)} + e_{i,t_0(i)+t} \tag{12}$$

where μ_i is an individual-specific effect, $j(i, t_0(i) + t)$ denotes the employer worker i is paired with at time $t_0(i)+t$, and $\zeta_{j(i,t_0(i)+t)}$ is a fixed effect attached to such employer. The matched employer-employee nature of the INPS dataset allows me to account for individual- and employer-specific fixed effects simultaneously. To do so, I implement the projection method developed by Abowd, Creecy and Kramarz (2002).[20] The results of this estimation are reported in Table 3, Panel D. The point estimates displayed in Panel D do not differ substantially from those from Panel B, where the specification included worker fixed effects only.[21]

Sensitivity Analysis In Table 4, I report the results of a series of robustness checks, including different cohort and sample restrictions, and allowing for a dynamic effect of current and initial unemployment rate on current wages. In Column (1) the sample includes

[20] The estimates are carried out in Stata using the routine developed by Amine Ouazad.

[21] Table 3, Panel D does not report standard errors because their computation would require inverting a matrix of dimensionality equal to the number of workers plus the number of firms plus that of the other covariates.

only workers who work full-year, i.e. at least 45 weeks in all years. In Column (2), I report results obtained when excluding workers with multiple employers over the sample period. In Column (3), the sample is restricted to firms that are consistently present in the dataset, thus eliminating potential bias coming from firm entry/exit (e.g. because of bankruptcy; unfortunately, I do not have information on the reasons why a firm exits the dataset), and workers continuously observed between the date of job start and 1997. These restrictions are meant to select workers with long-term attachment to firms, for which implicit contracts should apply best. To check whether the results are influenced by a few cohorts observed only for a short period of time or for a longer period, Column (4) excludes the first four and the last four cohorts from the sample.[22] In all cases, worker fixed effects are included.[23] The results appear to be very robust across sample definitions and cohort restrictions. In the specification displayed in Column (5), I account for the possibility that $u^{\min}_{t_0(i),t}$ and $u^{\max}_{t_0(i),t}$ are capturing, at least in part, a dynamic effect of current unemployment on the wage-tenure profile. If the wages of workers with longer tenure are stickier, both upward and downward, compared to workers with shorter tenure, the wage-tenure profile would be flatter during booms and steeper during recessions[24]. To allow for the possibility of different wage responsiveness to current conditions at different tenure levels, I include interactions of current unemployment with the tenure dummies ($\phi^c_t u_{t_0(i)+t}$). Column (5) reveals that $\gamma_{\min}$ is somewhat smaller, but still strongly statistically significant, as a result of this check, while $\gamma_{\max}$ does not appear to be affected. Finally, to explore the possibility that $u^{\min}_{t_0(i),t}$ and $u^{\max}_{t_0(i),t}$ are picking up a persistent effect of initial conditions over workers' tenure, I include interactions of the unemployment rate at job start with the tenure dummies ($\phi^0_t u_{t_0(i)}$). As can be seen in Column (6), the results are robust to this further check as well.

Next, I examine whether the results are robust to the use of alternative measures of the state of the labor market, and I report the results in Table 5. In particular, I estimate model (11) using the aggregate unemployment rate for the entire Centernorth (Table 5, Panel A), regional employment rates (Table 5, Panel B) and the aggregate employment rate for the Centernorth (Table 5, Panel C). The employment rate is calculated as the ratio of total employment over the population ages 16-64. On average, in Italy's Centernorth, the employment rate varies between 70 and 76 percent over the business cycle (see Table 2). In reading the coefficients from Table 5, Panels B and C, we have to keep in mind that now their sign is expected to be positive, as a greater employment rate proxies for better outside opportunities to workers. In addition, the highest employment rate since hiring now records the best outside opportunities while the lowest employment rate since hiring records

[22] Excluding either the first four or the last four cohorts, separately, does not alter the results.

[23] I have also run the same specification checks including both worker and firm fixed effects, and the coefficients were basically unchanged.

[24] As noted by Grant (2003).

the worst. Reported in Table 5, Panels A, B and C are the baseline results as well as the same robustness checks from the previous analysis. The coefficients on $u^{\min}_{t_0(i),t}$ and $u^{\max}_{t_0(i),t}$ ($e^{\min}_{t_0(i),t}$ and $e^{\max}_{t_0(i),t}$ when the employment rate is used), are in most cases significant at the 5 percent level or better, and in all cases statistically significant at the ten percent level. The magnitude of $\gamma_{\min}$ and $\gamma_{\max}$ estimated when using aggregate unemployment (Table 5, Panel A) is similar to what was obtained using regional unemployment rates, while the impact of current unemployment appears to be stronger. When regional employment rates are used (Panel B), the estimated coefficients on $e^{\min}_{t_0(i),t}$ and $e^{\max}_{t_0(i),t}$ imply that if the highest (lowest) employment rate since hiring is one percentage-point higher (lower), individual wages are between 0.6 and 2.7 percent higher (between 0.7 and 1.1 percent lower), depending on the specification considered.

Overall, a consistent and robust set of results seems to emerge across labor market indicators, sample definitions, specifications and cohort restrictions. Current wages are strongly correlated with both the best and the worst labor market conditions recorded since the start of tenure. I interpret this as evidence that limited commitment characterizes both sides of the employment relationship.

In almost all specifications, current labor market conditions are also found to have a statistically significant influence on current wages. This finding is inconsistent with the assumption of one-sided limited commitment with worker mobility. This result, and the recognition that not only workers but also employers might not be able to fully commit to implicit wage contracts, can rationalize the findings of the existing literature. In their influential study, Beaudry and DiNardo (1991) found that current wages depend on the best labor market conditions since hiring, and interpreted their result as evidence that an implicit contract model with worker mobility describes the behavior of wages over the business cycle better than the spot market model. Grant (2003) replicated Beaudry and DiNardo's study using six NLSY cohorts, concluding that both contemporaneous and best labor market conditions since hiring have a strong impact on current wages. As a matter of fact, even in Beaudry and DiNardo's original study, the coefficient on the current unemployment rate was statistically significant in some cases, especially when worker fixed effects were included in the regression. These authors did not entertain the possibility that commitment problems might exist on the side of employers as well.[25] As discussed earlier, when employers are able

[25] Beaudry and DiNardo (1995) consider a two-sided limited commitment model. Their focus, however, is on the behavior of hours worked. Grant (2003) provides the results of a regression where instead of the minimum unemployment rate since hiring he includes the maximum. He calls this a "foil" regression, and asserts that introducing the maximum unemployment rate since hiring would not be justified by any realistic economic model. Grant finds that the coefficient on the maximum is not statistically significant. The reason of the difference between his result and those presented in this paper might be that workers in the United States are much more mobile across employers compared to Italian workers, which might require firms to increase wages when outside opportunities of workers improve and force them not to lower wages when

to commit, the only labor market indicator that should be correlated with current wages is the minimum unemployment rate, so that once the minimum is controlled for, the current unemployment rate should not influence current wages. By contrast, the fact that current wages respond to changes in current unemployment even after controlling for past labor market conditions is perfectly consistent with a contractual environment with two-sided limited commitment. As discussed in Section 2, with two-sided limited commitment neither $u^{\min}_{t_0(i),t}$ nor $u^{\max}_{t_0(i),t}$ are sufficient statistics for predicting current wages. In fact, outside option constraints can become binding even at times when highest and lowest opportunities since hiring are unchanged. Hence, current unemployment could be correlated with current wages even after controlling for $u^{\min}_{t_0(i),t}$ and $u^{\max}_{t_0(i),t}$.

Results by Firm Size In Table 6, I allow the coefficients on $u_{t_0(i)}$, $u_{t_0(i)+t}$, $u^{\min}_{t_0(i),t}$ and $u^{\max}_{t_0(i),t}$ to vary by firm size. I divide the sample into four quartiles, based on firm revenues. The median firm in the bottom quartile has annual revenues of about 1.4 million euros and employs 82 workers, while that in the top quartile has 26 million euros revenues and 638 workers. Larger firms are typically thought to be better able to create internal labor markets that shield workers from adverse external shocks, perhaps due to their better access to credit. Consistent with this notion, Table 6 reveals that for workers employed in the top half of the firm size distribution, the coefficient on the current unemployment rate and that on the highest unemployment rate observed since the time of hiring are both small and not statistically significant at conventional levels. For these firms, the only labor market indicator that appears to be significant is the minimum unemployment rate since the start of the job. In other words, for workers employed at larger firms, a one-sided limited commitment implicit contract model (with worker full mobility and firm full commitment) seems to better describe the relationship between wages and outside opportunities: wages are shielded from negative shocks but they are raised if outside options improve above their historical best since the date of hiring. This result provides validation to the assumption of employer commitment when analyzing data from large firms (e.g. Chiappori et al., 1999).

4.2 Testing Proposition 2: Cohort Effects, Tenure and Changes in Outside Opportunities

As explained in the theoretical section, contractual models of the employment relationship based on insurance considerations give rise to wage differentials across entry cohorts related to differences in outside opportunities at the time of hiring. However, because of limited commitment and the requirement for wage contracts to be self-enforcing, such wage

outside opportunities deteriorate. The same explanation has been offered by Abowd, Kramarz and Roux (2006) for the finding that the returns to tenure in France are much lower compared to the United States.

differentials disappear as soon as some outside option constraint becomes binding.

Panel B of Figure 4 displays average entry-level wages, the average wage of existing workers and the average unemployment rate for the years 1982-1997, and Panel C shows average wage-tenure profiles for the year-of-job start cohorts in the dataset. Three things emerge from the pictures. First, differences in starting wages across year-of-entry cohorts often lead to differences in average entry cohort wages. Second, such differences in some cases persist for several years, while in other cases they are relatively short-lived. Third, the negative correlation between starting wage and initial unemployment rate is stronger than that between unemployment and the wage of existing workers, which suggests that the "cohort effects" are indeed related with the conditions in the labor market at the time of hiring.

According to Proposition 2 and its Corollary, the cohort effects should (a) decline with tenure, and (b) be less persistent when outside opportunities changed more substantially since the date of hiring. To test the Corollary, it is necessary to devise an appropriate measure of change in outside opportunities since hiring. Based on the theory, the initial contract wage is updated whenever either outside option (the worker's or the employer's) constraint becomes binding. The yearly absolute change in u_t, i.e. $|u_t - u_{t-1}|$, is obviously not an appropriate measure, since within the model under consideration even a small change in outside options from one year to the next could trigger wage renegotiation. Also, the absolute difference between current and initial outside opportunities, $|u_t - u_{t_0}|$, is not an adequate measure, because even though $|u_t - u_{t_0}|$ might be small in a given period t, a significant change might have occurred in the past (i.e. between periods $t_0 + 1$ and $t - 1$) that triggered wage renegotiation. Instead, I propose using the greatest absolute difference between the current unemployment rate and the unemployment rate prevailing at the time of hiring recorded between time $t_0(i)$ and time $t_0(i) + t$, a measure that I will denote with $MAXDIFF_{t_0(i),t}$:

$$MAXDIFF_{t_0,t} \equiv \max_{t_0(i) \leq j \leq t_0(i)+t} \left| u_j - u_{t_0(i)} \right|$$

To test Proposition 2 and its Corollary, I exploit cyclical variation in unemployment rates at the regional level and estimate wage equations of the following form:

$$\ln w_{i,t_0(i)+t} = \alpha + \sum_{t=0,...} \phi_t u_{t_0(i)} + X_{i,t_0(i)+t}\beta + v_{i,t_0(i)+t} \tag{13}$$

$$\ln w_{i,t_0(i)+t} = \alpha + \lambda u_{t_0(i)} + \sum_{MAXDIFF_{t_0,t}} \lambda_{MAXDIFF_{t_0,t}} u_{t_0(i)} + X_{i,t_0(i)+t}\beta + v_{i,t_0(i)+t} \tag{14}$$

where w_{i,t_0+t} is the real weekly compensation of individual i in period $t_0(i) + t$. Outside opportunities at the time of hiring are proxied with $u_{t_0(i)}$, the unemployment rate prevailing

at date $t_0(i)$ in individual i's region of work. In Equation (13), the coefficients ϕ_t on the interaction of tenure dummies with the unemployment rate at the time of hiring are the objects of interest. In Equation (14), the effects of interest are given by $\lambda_{MAXDIFF_{t_0,t}}$, the coefficients on the interaction of $MAXDIFF$ brackets dummies with the unemployment rate at the time of hiring. Panel C of Table 2 displays summary statistics on $MAXDIFF$. The vector $X_{i,t_0(i)+t}$ includes a third-degree polynomial in age (taken as a proxy for labor market experience, a variable that is not available in the INPS dataset), a full set of tenure dummies, four occupation indicators (production worker, white collar, manager, other), fixed effects for region of work, twenty-nine industry indicators, indicator variables for apprentices, salespersons or individuals working from home, and for individuals working in a region different from their region of birth. I adjust the regional unemployment rates for region and year fixed effects to make them independent of aggregate trends, and I cluster the standard errors at the level of year_of_job_start-region cells to allow for group-level error terms.

Panel A of Table 7 reports the coefficients from a pooled OLS specification of equations (13) and (14), while the model estimated in Panel B includes individual fixed effects, to control for permanent unobservable differences in earnings capabilities of individuals hired in different years. All specifications include unrestricted tenure effects, so that the $u_{t_0(i)}$ coefficients measure changes in tenure profiles in earnings that result from variation in unemployment rates at the time of hiring. In a similar way, the $\lambda_{MAXDIFF_{t_0,t}}$ coefficients are meant to capture whether the influence of outside option values at the time of hiring on subsequent wages depends on the extent to which outside options have changed since the time of hiring.

Column (1) of both Panel A and Panel B report the coefficient estimates of ϕ_t from Equation (13). The results confirm Proposition 2, as they indicate a strong initial effect of the unemployment rate at the time of hiring that persists but fades after 4-6 years on the job. Column (3) of both Panels A and B report the coefficient estimates of $\lambda_{MAXDIFF_{t_0,t}}$ from Equation (15). The results are in line with Proposition 2. There is a strong effect of the unemployment rate at the time of hiring, i.e. for $MAXDIFF = 0$, and this effect drops to zero only when $MAXDIFF$ is greater than 1.25 in the fixed effects specification of Panel B, or greater than 1.75 in the OLS specification of Panel A. The change in outside options required to eliminate cohort effects is substantial. In fact, in a low unemployment economy such as that of Northern Italy, a one percentage point change in the unemployment rate represents 1.6 standard deviations of aggregate unemployment and between 0.65 and 2.3 standard deviations of regional unemployment (see Table 2, Panels A and B).

Columns (2) and (4) report results from estimation of an equation that includes both interactions of $u_{t_0(i)}$ with tenure dummies and with $MAXDIFF$ brackets dummies. The

interpretation of the coefficients is now slightly different from before. For example, the coefficient ϕ_1 (column 2, second row) is now measuring the effect of the initial unemployment rate on earnings of individuals with one year of tenure, at $MAXDIFF = 0$, i.e. when no change in outside opportunities has occurred since the time of hiring. Strikingly, in Column (2), the estimates of ϕ_t are now roughly constant over tenure, and always statistically significant. The interpretation of this result is that when changes in outside opportunities since the time of hiring have been taken into account, the effect of the initial unemployment rate does not vary systematically with tenure. When individual fixed effects are included (Column 2, Panel B), the estimated effect of initial unemployment seems to decline with tenure, but it remains always sizable and statistically significant. Overall, both the OLS and the fixed effects estimates seem to suggest that if $MAXDIFF = 0$, i.e. if outside opportunities do not change, the effect of outside options at the time of hiring persists over the course of tenure.

Sensitivity Analysis In Figure 7, I report the results of a series of robustness checks, all of which confirm that cohort effects become small when larger changes in outside opportunities occur between the time of job start and the current date. I plot OLS and 2-way fixed effects estimates of $\lambda_{MAXDIFF_{t_0,t}}$ for (a) full year workers, (b) workers without multiple employers in the period considered, (c) workers with at least 3 years ex-post tenure. The results confirm that cohort effects (i.e. wage differentials due to workers being hired at different times and under different labor market conditions) do exist, but their persistence is inversely related to the magnitude of changes in outside opportunities since hiring. Note that in some cases the estimated impact of the initial unemployment rate does not fall to zero even when very large changes in the unemployment rate have occurred since the time of job start. This seems to be the case for workers with a high degree of attachment to their job (e.g. those who stay with an employer for at least 3 years). This suggests that although implicit contract considerations and outside options' changes seem to play a role in explaining cohort effects, other mechanisms might also be at work that generate persistent effects of initial conditions[26].

4.3 Testing Proposition 3: Asymmetries in the Responsiveness of Wages to Changes in Outside Opportunities

Proposition 3 suggests that if one looks at wage changes in a period immediately following one when the worker's (the employer's) constraint was binding, wages should be raised

[26] A growing body of empirical studies – including Baker et al. (1994), Kahn (2006) and Oreopoulos et al. (2006) – documents the presence and persistence of cohort effects in wages. Besides implicit contracts, cohort effects in wages can arise, for instance, in models of job assignment such as Prendergast (1993) or Gibbons and Waldman (1999 and 2003).

(lowered) whenever outside opportunities improve (deteriorate), whereas when outside opportunities deteriorate (improve), wages should be lowered (raised) only if the deterioration (improvement) is "large". To test this Proposition, one needs to (a) identify periods when the worker's or the employer's outside options constraints were binding and (b) define a "small" and a "large" change in outside opportunities.

To test Proposition 3, I need to restrict the sample to include workers with a tenure of at least 3 years. I obtain residual wage changes after regressing the "raw" yearly wage changes onto a set of worker-level and firm-level variables, including a cubic in age, a full set of tenure effects, an indicator variable for individuals working in a region different from their region of birth, an indicator variable for salespersons or individuals working from home, four broad occupation variables (production worker, white collar, manager, other), twenty-nine industry indicators, twelve region indicators and the change in the logarithm of firm revenues. Let Δw denote yearly wage residual changes so that $\Delta w = w_{i,t} - w_{i,t-1}$ and $\Delta w_{-1} = w_{i,t-1} - w_{i,t-2}$, and let $\Delta u = u_{i,t} - u_{i,t-1}$ denote the yearly change in the unemployment rate (which I use as a proxy for changes in outside opportunities). Guided by the model, I take the sign of Δw_{-1} as an indicator of whether the worker's constraint, the employer's constraint or no constraint was binding in period $t-1$. As for yearly changes in the unemployment rate, I classify them as "large" when greater or equal to 0.6 percentage points, or about one standard deviation of the average unemployment rate in the Centernorth (see Table 2, Panel A). Figure 8 shows the distribution of residual wage changes, while Panel C of Table 2 shows descriptive statistics for the positive, negative and absolute changes in the local unemployment rate in the sample.

Next, I regress Δw (residual wage changes) on $\Delta u_{i,t}$ (unemployment rate changes) and a set of interactions of this variable with dummies for the sign of Δw_{-1}, for whether Δu is positive, "large", etc., and report the regression results in Table 8. Consider the results for workers for whom $\Delta w_{-1} > 0$ (first row in Table 8). Recall that I am taking $\Delta w_{-1} > 0$ as an indication that the worker's outside option constraint was binding in the previous period. For these workers, as predicted by Proposition 3, wages do not seem to respond significantly to "small" increases in the unemployment rate, while they significantly decline in response to "large" increases in unemployment. On average, wages are cut by about 3 percent when the unemployment rate increases by more than one standard deviation. At the same time, the theory also predicts that for these workers the wage should be raised following both small and large declines in the unemployment rate (i.e. after any improvement in outside opportunities). The estimated coefficients seem to suggest that, indeed, wages are negatively correlated to both "small" and "large" declines in the unemployment rate. On average, wages increase by just over 1 percent when the unemployment rate declines by less than one standard deviation, and by about 2 percent when the decline in the unemployment

rate is larger than one standard deviation. The second row of Table 8 displays the results for individuals whose real wage declined in the previous period ($\Delta w_{-1} < 0$). The results for this group of people are mixed. Contrary to the model's prediction, wages for these workers do not seem to respond to "small" increases in the unemployment rate. As for the responsiveness of wages to declines in the unemployment rate, the coefficient for "small" changes is smaller compared to the coefficient for "large" declines, but they both fail to attain conventional levels of statistical significance.

5 Discussion

In this section, I present some remarks on the model's assumptions and contractual environment, and I consider alternative explanations for the patterns observed in the data.

5.1 Remarks on Assumptions and Environment

Two-Sided Limited Commitment The assumption that a worker can commit to the terms of a labor contract without ever leaving her current employer is typically ruled out in the employment contracts literature on the basis that involuntary servitude is illegal in modern economies (Harris and Holmstrom, 1982; Beaudry and DiNardo, 1991). At the same time, there are reasons to believe that assuming commitment on the part of the employer is also often not realistic. Such reasons include the high cost of enforcing implicit contracts (Thomas and Worrall, 1988). In addition, even though in this paper I am focusing on insurance considerations and the obstacles to full insurance contracts generated by outside opportunities, incentive problems remain in the background. Excluding a threat of termination might be harmful in terms of incentives provision within the firm when effort is unobservable.

Preferences and Access to Credit Markets The assumption of risk averse workers and risk neutral employers is common in the implicit contracts literature. Several arguments have been advanced in the literature to support this assumption, including the Knightian argument by which entrepreneurs are the "confident and venturesome" willing to assume the risk while insuring the "doubtful and timid" (Knight, 1921: pp 269-70). Another argument is that entrepreneurs have better access to capital markets. Clearly, the role of employers as insurance providers is potentially more important when workers cannot smooth consumption privately. Although the assumption that workers cannot save or borrow is rather extreme, Beaudry and Pages (2001) argue that it is not unreasonable when analyzing business cycle

issues.[27] In the Italian case, in particular, the assumption that workers have limited access to credit is not a bad approximation of reality. In fact, Casolaro, Gambacorta and Guiso (2005) document that the Italian household loan market is much smaller compared to those of other countries at a comparable stage of economic development[28]. As reported in Appendix Table 1, in 1990, total household debt in Italy amounted to 29 percent of disposable income, about one third the figure recorded in France or the United States, and consumer credit represented just 1.3 percent of GDP, against a 6.6 percent average in the Euro area.

Fixed hours of work In the model I described, working hours are not a margin of choice and workers supply a given amount of work inelastically. Assuming that workers' utility is separable in consumption and leisure, one could produce a version of the model that would deliver a result identical to Result 1, only for earnings instead of wages[29]. However, the assumption of fixed work hours is not unjustified in the Italian context. In fact, working hours in Italy are often mandated by collective agreements. The INPS dataset does not contain information on hours worked. The only dataset that provides individual-level data on hours worked per week is the Bank of Italy Survey of Household Income and Wealth (SHIW). In this dataset, the variable "weekly hours worked" is available from 1987 to 2002. In Appendix Table 2, I present results from a regression of (the natural logarithm of) weekly hours worked on the current unemployment rate, controlling for age, education indicators, region indicators and a linear time trend for a sample of full-year, full-time males ages 16-54 working in the manufacturing sector[30]. The regression results show that total hours worked per week are acyclical, i.e. they do not display any systematic variation over the business cycle. This result provides validation for the hypothesis adopted in the theoretical framework that individuals supply a fixed amount of work hours.

Partial vs. General Equilibrium The model I have considered in this paper is a partial equilibrium one, where the productivity of existing matches is non-random and uncertainty resides in workers' outside options, which are exogenously formed in some external spot market. I have concentrated on this simple model only to provide a tractable

[27] Beaudry and Pages (2001) find that the volatility of labor income and personal consumption expenditures are similar in the United States.

[28] Casolaro, Gambacorta and Guiso (2005) show evidence indicating that the Italian household loan market is small not because demand for loans is limited, but because of a limited supply of credit, in turn caused by the inadequacies of formal and informal loan contract enforcement and the tight regulation of the Italian banking sector.

[29] As done in Sigouin (2004).

[30] In the regression, sample weights are used and the standard errors are robust to arbitrary forms of heteroschedasticity and clustered by year.

illustration of how commitment problems affect the relationship between histories of outside options and current wages. However, the basic framework originally developed by Thomas and Worrall (1988) can be readily embedded into equilibrium models of the labor market, where outside options arise endogenously. For example, Sigouin (2004) incorporates two-sided limited commitment into a model economy with matching frictions. In his model, the labor productivity of matches depends on an aggregate stochastic component, and the terms of ongoing contracts are affected by those of newly formed contracts in order to prevent the parties from reneging. More recently, Rudanko (2006) introduced risk averse workers and limited commitment into a Mortensen-Pissarides model of the labor market. In her paper, too, outside opportunities are endogenous, and the incentives to renege arise because different contracts are offered every period depending on the state of aggregate productivity. Thus, the value offered by the new contracts affects the terms of existing contracts. The behavior of earnings in Sigouin (2004) and Rudanko (2006) is governed by the same rule described in this paper under Result 1:[31] labor earnings in period t are equal to earnings in period $t-1$ as long as the level of earnings in period $t-1$ falls within the range of admissible earnings associated with period t's realization of aggregate productivity; otherwise, earnings are set equal to the lower or the upper bound of the interval of admissible wages, depending on whether the worker's or the employer's constraint is binding.

It is important to note that the crucial identifying assumption that underlies my empirical work is that the proxy I use for workers' outside options, the unemployment rate, does not affect the efficiency of matches. In other words, changes in the unemployment rate shift the outside alternative up or down, but do not make it efficient to fire or to quit. This identifying assumption is important irrespective of partial vs. general equilibrium considerations.

5.2 Alternative Explanations

A natural question to ask at this point is whether other models would also produce the same empirical implications of the insurance implicit contract theory.

Together with long-term contracting, alternative explanations exist for labor market shocks at the time of hiring to have lasting effects on wages. In models of job assignment, such as Prendergast (1993) or Gibbons and Waldman (1999 and 2003), cohort effects arise in the presence of "task-specific" human capital if firms' initial assignment of workers to different tasks depends on the state of the economy at the time of job start. However, in contrast to the implicit contract story, these models make no direct prediction on the relationship between cohort effects and changes in outside options. In this paper, I have found evidence that the persistence of cohort effects is inversely related to the magnitude

[31] See equations (16) and (17) in Sigouin (2004), p. 354; and Proposition 2.6 in Rudanko (2006), p. 10.

of changes in labor market conditions, consistent with implicit contracts.

Insurance considerations are not the only reason for workers and firms to engage in long-term contracting. The provision of incentives and holdup problems are two other major motives for contracts to emerge in employment relationship (Malcomson, 1999). The holdup problems that arise because of incomplete contracting in bilateral relationships in which unverifiable investments must be made are the focus of MacLeod and Malcomson (1993). These authors ask what are the contracts that would guarantee that the investor receives the full marginal return, thus generating efficient investment. In particular, in Section 7 of their paper, MacLeod and Malcomson consider a multiperiod model with general investment and a cost of switching partner. They show that in this setting, efficient investment is induced by a fixed-price contract that is renegotiated only when either party would otherwise dissolve the relationship to take an outside option. In an employment relationship where the employer is the investor and the payment is the wage, the MacLeod and Malcomsom setting would generate the same wage dynamics as the insurance model I have considered in this paper.

As a way to empirically test the importance of insurance considerations in employment relationships, I propose the following. An intrinsic feature of insurance contracts is that risk averse workers are willing to accept a lower average wage in exchange for income stability, where the desire for insurance is stronger in more uncertain environments. Therefore, if an insurance motive is indeed present, workers should be willing to give up a larger fraction of expected wages where outside opportunities are subject to greater variability. I proxy the volatility of outside options with the standard deviation (or the coefficient of variation) of the regional quarterly unemployment rate over the period 1980-2000. To test the prediction, I examine the relationship between the unemployment rate volatility and the initial wage workers receive at the start of the employment relationship. In Table 9, I report the results of a regression of initial wages on unemployment rate volatility. Controls include age, occupation, industry, region and year effects. The estimated coefficient on the standard deviation of unemployment is negative and statistically significant at the 1 percent level. Its magnitude indicates that workers' wage is 5 percent lower in regions where the unemployment rate is more volatile by one standard deviation. The outcome of this test suggests that insurance considerations indeed play a role in the Italian labor market. In fact, this prediction follows purely from insurance considerations and it would not be implied by hold-up models or models with risk-neutral agents.

6 Conclusions

I have considered a model of wage insurance in the employment relationship with limited commitment on both sides of the labor contract. After deriving a set of testable implications

for the relationship between outside opportunities and individual real wages, I conducted empirical tests using a large, matched employer-employee panel of workers from Northern Italy observed over the period 1982-1997. The evidence indicates that wages are related to outside opportunities, proxyed with the unemployment rate, in a way consistent with the model and the contractual environment. A consistent and robust set of results emerged across alternative labor market indicators, sample definitions, specifications and cohort restrictions.

I found that current wages respond to both the highest and lowest unemployment rates since the start of the job, after controlling for the current unemployment rate, the unemployment rate prevailing at the time the job started, and accounting for unobservable worker and firm heterogeneity. The estimates indicate that, on average, when the unemployment rate falls by one percentage point below its historical minimum, real wages rise by about 2 percent. When the unemployment rate increases by one percentage point above its historical maximum, real wages suffer a reduction of about 1.5 percent. This finding is consistent with the insight from the theory that wages are renegotiated when either the worker's or the firm's outside option constraints become binding. I interpret this as evidence that commitment problems exist on both sides of the employment relationship.

Next, I examined cohort effects in wages and their persistence in the face of changes in the unemployment rate since the start of the job. Workers starting their job during a bust earn wages 5-6 percent lower compared to workers starting during a boom. Such wage differentials persist in subsequent years even in the presence of changes in the unemployment rate as large as two standard deviations. When changes in the unemployment rate since the time of hiring are larger, however, cohort effects vanish. This is consistent with the theory's implication that larger changes in outside opportunities increase the likelihood that some outside option constraint becomes binding, thus prompting wage renegotiation.

I have also shown that under the implicit contract hypothesis with two-sided limited commitment, wages should respond asymmetrically to year-to-year changes in outside opportunities depending on the previous dynamics of wages. In my empirical analysis, I found some evidence of such asymmetries. For workers who experienced a wage raise in the previous period – an indication that their outside option constraint was binding – wages do not respond to increases in the unemployment rate below one standard deviation, while they significantly decline in response to greater increases. At the same time, for this group of workers, wages respond to both small and large declines in the unemployment rate.

My findings lend support to the insurance model of the employment relationship in a contractual environment where limited commitment exists on both sides of the labor contract, and contrast with other models of wage determination such as spot market models or continual Nash bargaining. In fact, these alternative mechanisms of wage formation

predict current wages to be related only to current labor market conditions, short-run effects of temporary labor market shocks, and a proportional relationship between wage changes and changes in workers' outside options.

When I allow the results of the main regressions to vary across firms of different size, the evidence suggests that larger firms are better able to commit to implicit, long-term contracts with their workers compared to smaller firms. This suggests that considerable heterogeneity might exist in the forms of implicit agreements between workers and firms. Uncovering and explaining such heterogeneity, presumably related to firms' financial structure and workers' access to credit, is a task for future research.

References

[1] Abowd, J. and Kramarz, F. (1999), "The Analysis of Labor Markets using Matched Employer-Employee Data", Handbook of Labor Economics, O. Ashenfelter et D. Card eds., Ch. 26, Volume 3B, North-Holland, 2629-2710.

[2] Abowd, J., Creecy, R.H. and Kramarz, F. (2002), "Computing Person and Firm Effects Using Linked Longitudinal Employer-Employee Data", mimeo, Cornell University.

[3] Abowd, J., Kramarz, F. and Roux, S. (2006), "Wages, Mobility and Firm Performance: Advantages and Insights from Using Matched Worker-Firm Data", *Economic Journal*.

[4] Abraham K.G. and Haltiwanger J.C. (1995), "Real Wages and the Business Cycle", *Journal of Economic Literature*, XXXIII, 1215-1264.

[5] Azariadis, C. (1975), "Implicit Contracts and Underemployment Equilibria", *Journal of Political Economy*, 6, 1183-1202.

[6] Baily, M.N. (1974) "Wages and Employment under Uncertain Demand", *Review of Economic Studies*, 125, 37-50.

[7] Baker, G., Gibbs, M. and Holmstrom, B (1994), "The Wage Policy of a Firm", *Quarterly Journal of Economics*, 109 (4), 921-955.

[8] Beaudry, P. and DiNardo, J. (1991), "The Effect of Implicit Contracts on the Movement of Wages over the Business Cycle: Evidence from Micro Data", *Journal of Political Economy,* 99 (4), 665-688.

[9] Beaudry, P. and DiNardo, J. (1995), "Is the Behavior of Hours Worked Consistent with Implicit Contract Theory?", *Quarterly Journal of Economics*, 110, 3, 743-68.

[10] Bertrand, M. (2004), "From the Invisible Handshake to the Invisible Hand? How Import Competition Changes the Employment Relationship", *Journal of Labor Economics*, vol. 22, no. 4, 723-765.

[11] Bertrand, M., Duflo, E. and Mullainathan, S. (2004), "How Much Should We Trust Differences-in-Differences Estimates?", *Quarterly Journal of Economics*, 119 (1), 249-75.

[12] Bils, M. J. (1985), "Real Wages over the Business Cycle: Evidence from Panel Data", *Journal of Political Economy*, 93 (4), 666-689.

[13] Boldrin, M. and Horvath, M. (1995), "Labor Contracts and Business Cycles", *Journal of Political Economy*, 103 (5), 972-1004.

[14] Casolaro, L., Gambacorta, L. and Guiso, L. (2005), "Regulation, Formal and Informal Enforcement and the Development of the Household Loan Market: Lessons from Italy", Banca d'Italia *Temi di Discussione* N. 560.

[15] Chiappori, P.A., Salanie', B. and Valentin, J. (1999), "Early Starters versus Late Beginners", *Journal of Political Economy*, 107(4), 731-760.

[16] Davis, S.J. and Haltiwanger, J. (1999), "Gross job flows," Handbook of Labor Economics, in: O. Ashenfelter & D. Card (ed.), Handbook of Labor Economics, Edition 1, Volume 3, Chapter 41, 2711-2805.

[17] Erickson, C.L. and Ichino, A. (1995), "Wage Differentials in Italy: Market Forces, Institutions and Inflation", in Freeman R.B. and Katz, L.F. Eds., "Differences and Changes in Wage Structures", NBER Comparative Labor Market Series.

[18] Gatto R., Gennari P., Massarelli N. (2001), "La ricostruzione e il riallineamento delle serie storiche delle forze di lavoro 1984-1992", in "Occupazione e Disoccupazione in Italia: Misura e Analisi dei Comportamenti" Conference Proceedings, MURST (January 15/16, 2001)

[19] Gatto Riccardo (2004), "Sulla Ricostruzione delle Serie dei Principali Indicatori del Mercato del Lavoro", Doctoral Thesis, Dipartimento Scienze Economiche, Roma.

[20] Gibbons, R. and Waldman, M. (1999), "A Theory of Wage and Promotion Dynamics inside Firms"Robert Gibbons, *Quarterly Journal of Economics*, Vol. 114, No. 4, pp. 1321-1358.

[21] Gibbons, R. and Waldman, M. (2003), "Enriching a Theory of Wage and Promotion Dynamics Inside Firms", MIT Sloan Working Paper No. 4324-03.

[22] Gordon, D.F. (1974), "A Neo-Classical Theory of Keynesian Unemployment", *Economic Inquiry* 12 (4), 431-459.

[23] Grant, D. (2003), "The Effect of Implicit Contracts on the Movement of Wages over the Business Cycle: Evidence from the National Longitudinal Surveys", *Industrial and Labor Relations Review*, 56, 393-408.

[24] Guiso, L., Pistaferri, L. and Schivardi, F. (2005), "Insurance Within the Firm", *Journal of Political Economy*, Vol. 113, 1054-87

[25] Guiso, L. and Schivardi, F. (2006), "Spillovers in Industrial Districts", *Economic Journal*, forthcoming.

[26] Hall, R. E. (2005), "Employment Fluctuations with Equilibrium Wage Stickiness", *American Economic Review,* 95(1), 50-65.

[27] Hall, R. E. and Milgrom, P. R. (2006), "The Limited Influence of Unemployment on the Wage Bargain", Unpublished Manuscript, Stanford University.

[28] Harris, M. and Holmstrom, B. (1982), "A Theory of Wage Dynamics", Review of Economic Studies, 49, 315-333.

[29] Heckman, J.J. and Sedlacek, G. (1985), "Heterogeneity, Aggregation, and Market Wage Functions: An Empirical Model of Self-selection in the Labor Market", *Journal of Political Economy*, University of Chicago Press, vol. 93(6), 1077-1125.

[30] Holmstrom, B. (1981), "Contractual Models of the Labor Market", *American Economic Review*, 71, 308-313.

[31] Holmstrom, B. (1983), "Equilibrium Long term Labor Contracts", Quarterly Journal of Economics 98 (2), 23-54.

[32] ISTAT (2005), "Le Retribuzioni Contrattuali Annue di Competenza", *Informazioni,* 15.

[33] Kahn, L. (2006), "The Long-Term Labor Market Consequences of Graduating College in a Bad Economy", Unpublished Manuscript, Harvard University.

[34] Knight, F. H. (1921), "Risk, Uncertainty and Profit", New York: Houghton Miffin.

[35] MacLeod, W.B. and Malcomson, J.M. (1993), Investments, Holdup and the Form of Market Contracts", *American Economic Review*, 83, 811-37.

[36] Macis, M. (2001), "Il mercato del lavoro e la giurisprudenza in materia di licenziamenti (Italia, 1989-1998)", *Diritto delle Relazioni Industriali*, N. 2.

[37] Macis, M. (2006), "Employment and Welfare Consequences of Compressing the Wage Structure", Unpublished Manuscript, University of Chicago.

[38] Malcomson, J.M. (1999), "Individual Employment Contracts", in Handbook of Labor Economics, Volume 3B, 2291-2370.

[39] McDonald, J.T. and Warswick, C. (1999), "Wages, Implicit Contracts, and the Business Cycle: Evidence from Canadian Micro Data", *Journal of Political Economy*, Vol. 107, No. 4, 685-709.

[40] Moulton, B.R. (1986), "Random Group Effects and the Precision of Regression Estimates", *Journal of Econometrics*, 32, 385-397.

[41] Oreopoulos, P., von Wachter, T. and Heisz, A., "The Short- and Long-Term Career Effects of Graduating in a Recession: Hysteresis and Heterogeneity in the Market of College Graduates", Unpublished Manuscript, University of Toronto.

[42] Prendergast, C. (1993), "The Role of Promotion in Human Capital Acquisition", *Quarterly Journal of Economics*, 108 (2), 523-534

[43] Riddell, W.C. (1981), Bargaining under Uncertainty", *American Economic Review*, 71, 579-90.

[44] Rosen, S. (1985), "Implicit Contracts: A Survey", Journal of Economic Literature, 23, 1144-75.

[45] Rudanko, L (2006), "Labor Market Dynamics under Long Term Wage Contracting and Incomplete Markets", Unpublished Manuscript, University of Chicago.

[46] Shimer, R. (2004), "The Consequences of Rigid Wages in Search Models", *Journal of the European Economic Association Papers and Proceedings.*

[47] Shimer, R. (2005), "The Cyclical Behavior of Equilibrium Unemployment and Vacancies", *American Economic Review*, 95(1), 24-49.

[48] Sigouin, C. (2004), "Self-Enforcing Employment Contracts and Business Cycles Fluctuations", *Journal of Monetary Economics*: 51, 339-373.

[49] Solon, G. R., Barsky and Parker, J.A. (1994), "Measuring the Cyclicality of Real Wages: How Important is Composition Bias?", *Quarterly Journal of Economics*, 109 (1), 1-26.

[50] Shimer, R. (2005): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, pp. 25-49.

[51] Thomas, J. and Worrall, T. (1988), "Self-Enforcing Wage Contracts", *Review of Economic Studies*, LV, 541-554.

7 Appendix [under revision]

Tables and Figures

FIGURE 1
Wage Dynamics under Two-Sided Limited Commitment

The Figure illustrates the wage dynamics implied by the insurance model of the employment relationship with two-sided limited commitment. The contract wage is unchanged from the previous period as long as it lies within the wage bounds associated with the current period's realization of productivity.

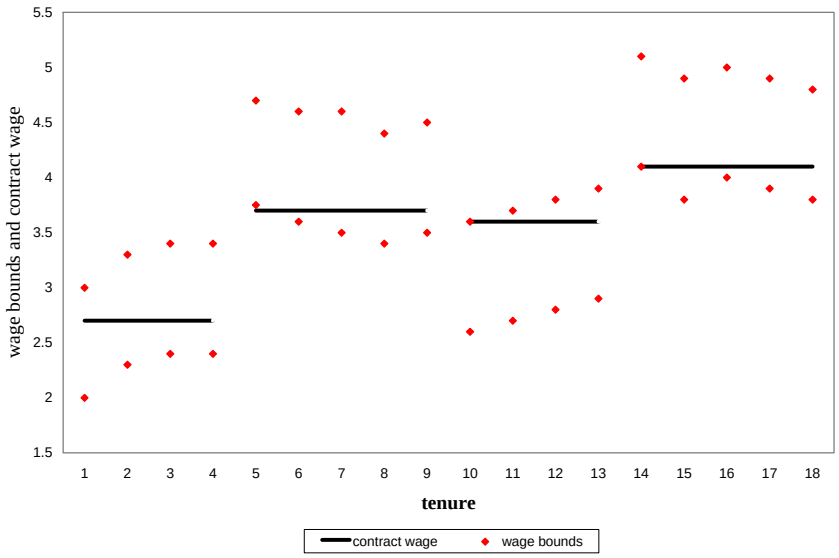


FIGURE 2
Cohort Effects and Changes in Outside Options

The Figure illustrates the temporary nature of cohort effects implied by the insurance model of the employment relationship with two-sided limited commitment. An employer may pay different wages to workers with the same outside options if they were hired at different times, i.e. under different economic conditions; however, if outside opportunities change sufficiently to make the outside option constraints of both workers binding, such wage differential disappears.

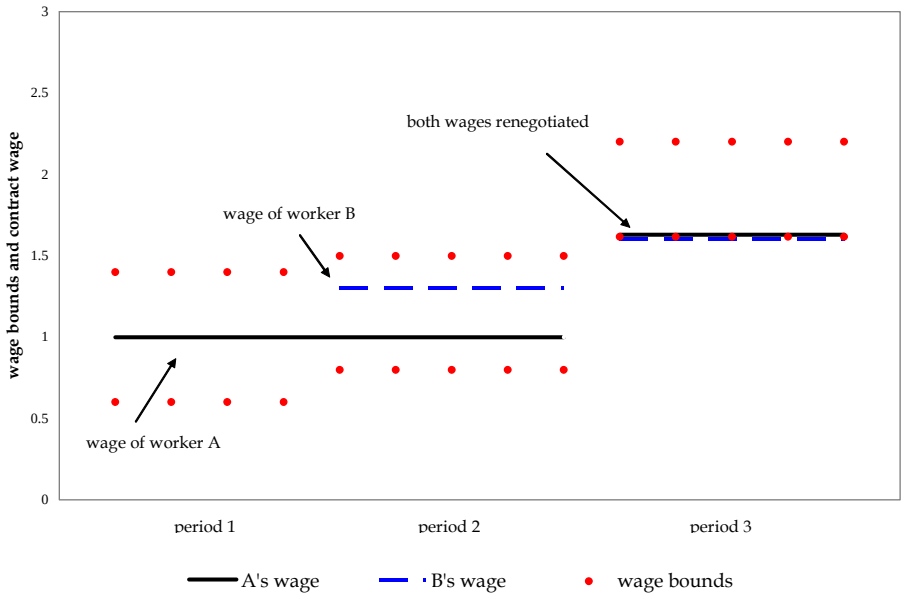
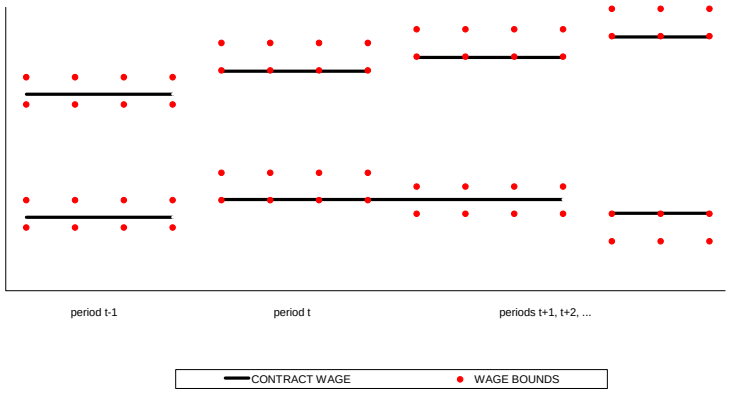
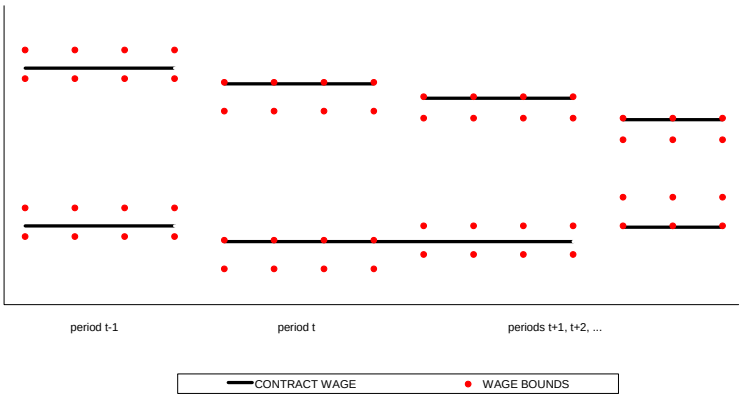


FIGURE 3
Asymmetric Response of Wages to Changes in Outside Opportunities

This Figure illustrates the non-linear and asymmetric responsiveness of the contract wage to upward and downward changes in outside opportunities. In Panel 3A, the worker's outside option constraint is binding in period t, and the wage is made equal to the worker's outside option value (the lower bound of the interval of admissible wages). Then, in period $t+1$, the contract wage is raised whenever outside opportunities improve, while it is lowered only if the deterioration of outside opportunities is "substantial", for otherwise the wage remains unchanged. In Panel 3B, I illustrate the case when the employer's outside option constraint is binding in period t.



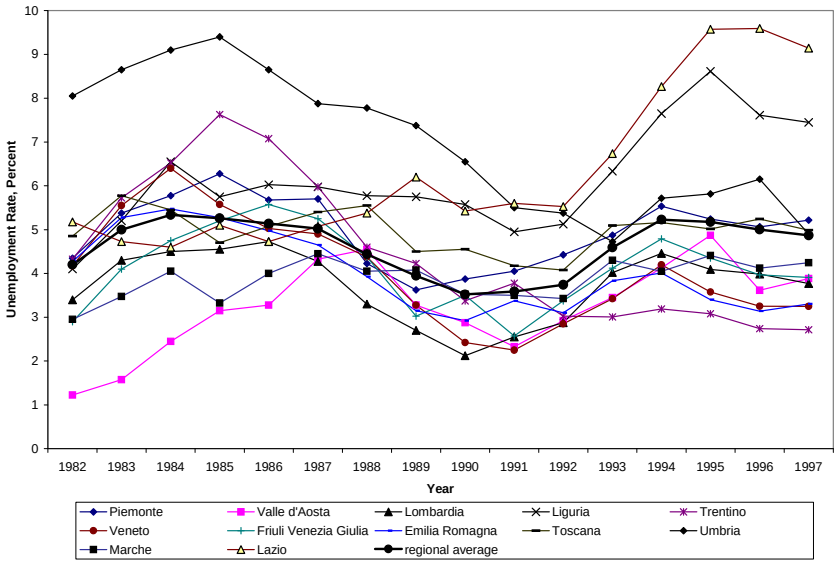
Panel 3A: Worker's Outside Option Constraint Binding in Period t-1



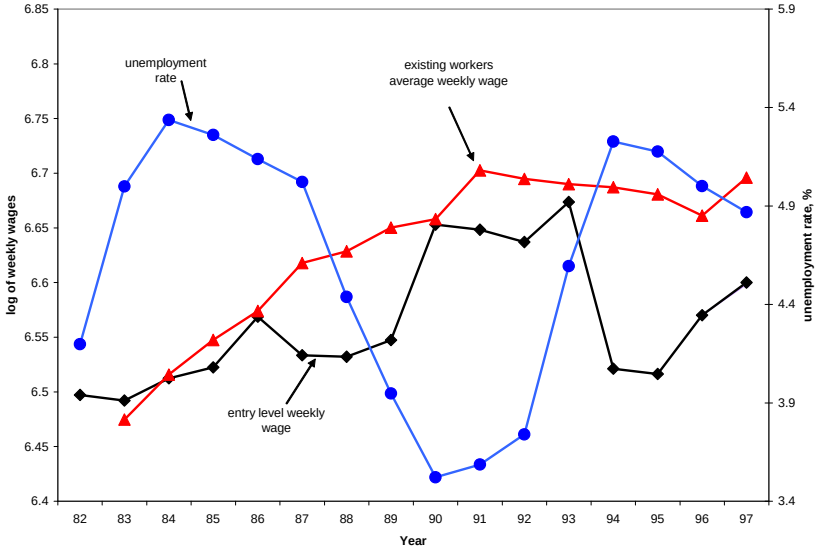
Panel 3B: Employer's Outside Option Constraint Binding in Period t-1

FIGURE 4

4A: Unemployment Rates for Males Ages 15-64, Italy's Centernorth and Regions, 1982-1997



4B: Entry Wages, Existing Workers' Wages and the Unemployment Rate



4C: Wage-Tenure Profiles by Year of Job Start

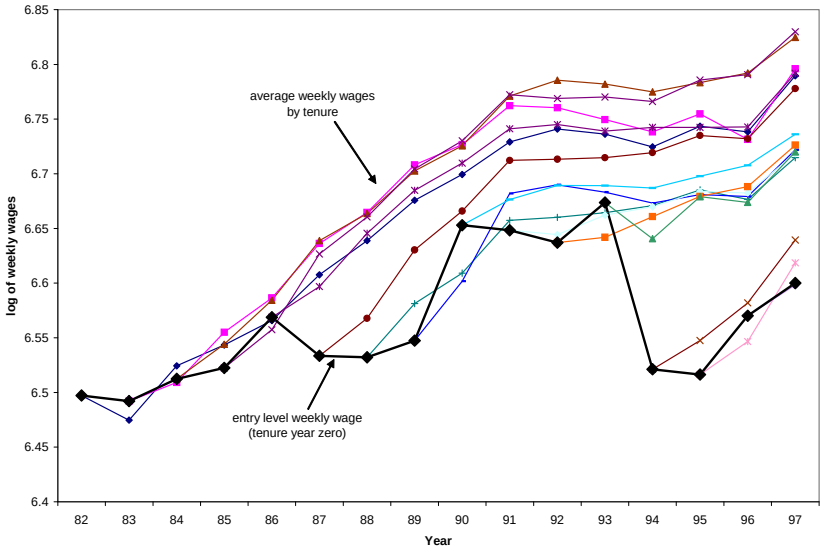
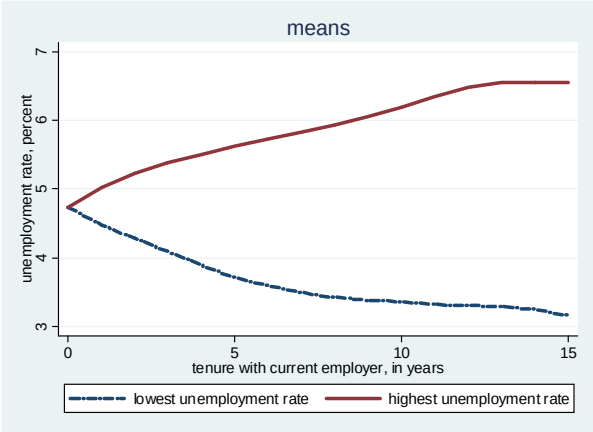


FIGURE 5
Ratio of Individual Earnings to Industry Minimum

Let $W_{i,k}$ denote the earnings of worker i in industry k, and $W_{min,k}$ the minimum wage prevailing in industry k. I formed the ratio of wage to minimum as $R_i = \frac{W_{i,k}}{W_{min,k}}$. Let $f(R)$ denote the density function of the random variable R. The figures plot the Kernel estimate of $f(R)$ for production workers and white collars.

FIGURE 6

6A: Mean Lowest and Highest Unemployment: Tenure Profiles



6B: Lowest and Highest Unemployment Rates: Tenure Profiles during Boom and Recession

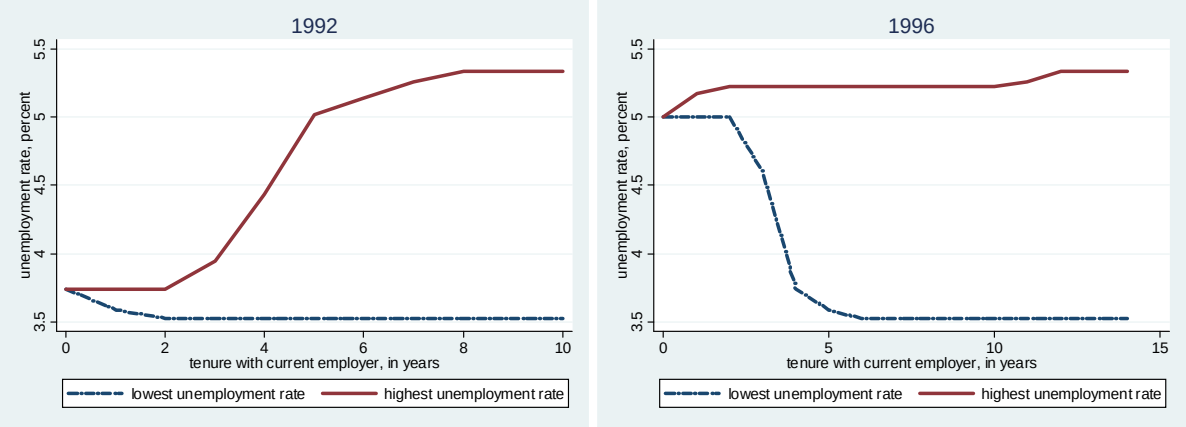


FIGURE 7
Effect of Initial Unemployment Rate on Wages
Sensitivity Analysis Results

This Figure reports coefficients from a log wage regression on the unemployment rate prevailing at the time of hiring interacted with MAXDIFF brackets dummies. The variable MAXDIFF, defined in the text and in the Notes to Table 7, is a measure of the change in the unemployment rate since the time of hiring (proxying changes in outside opportunities to workers). "Full-year" includes individuals who worked no less than 45 weeks in any given year; "excl. mult. jobs" indicates that workers with multiple employers over the sample period have been excluded; "tenure>3" indicates that the sample is restricted to workers with at least 3 years of ex-post tenure. "OLS" indicates least squares regressions, and "2FE" indicates regressions with both worker and firm fixed effects. See the Notes to Table 7 for details on variables description and controls.

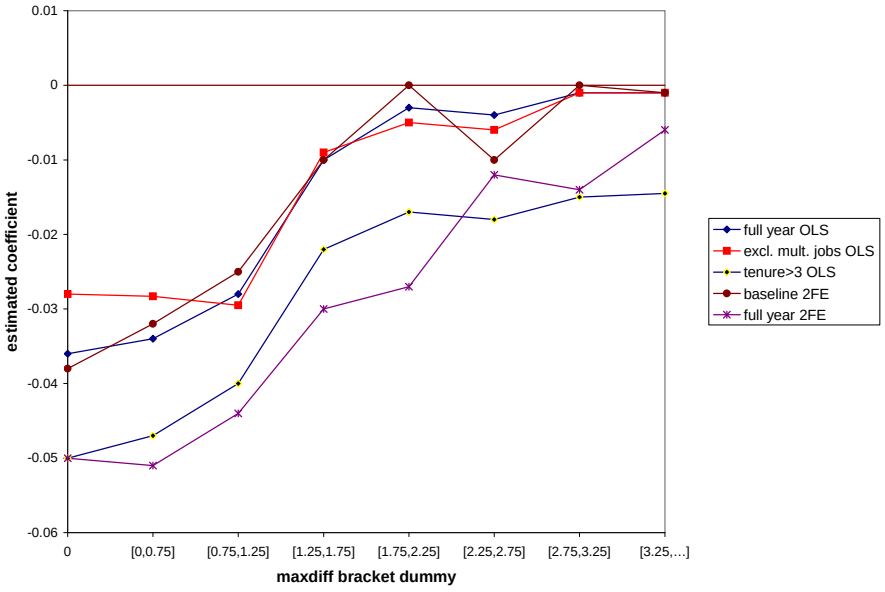


FIGURE 8
Distribution of Residual log Wage Changes

The figure displays the distribution of residual log wage changes, trimmed at 1st and 99th percentiles. Residuals were obtained from regressing yearly changes in log wages on a full set of tenure fixed effects, a third-degree polynomial in age, occupation fixed effects (production worker, clerical, manager, other), twelve region fixed effects, twenty-nine industry fixed effects, an indicator variable for individuals working in a region different from their region of birth, an indicator for apprentices and one for salespersons or individuals working from home.

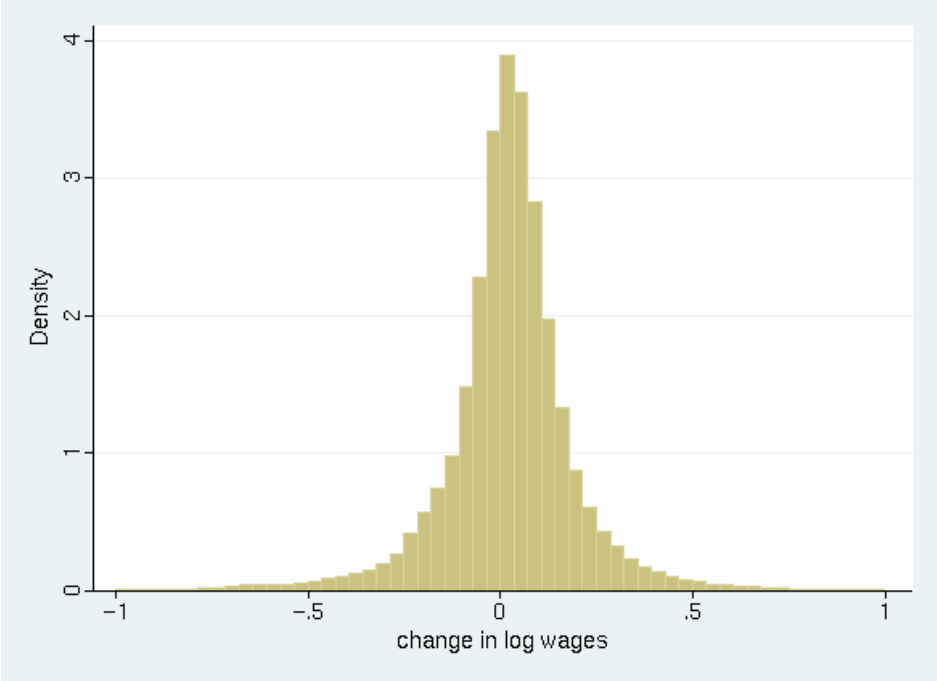


TABLE 1
INPS Dataset Summary Statistics

This Table reports summary statistics for the INPS panel of workers employed in firms located in Central and Northern Italy. The sample includes males who were between the ages of 15 and 55 in the year of job start and who always worked full-time. (1) The variable "wage" is gross weekly earnings, obtained dividing annual gross earnings by the number of weeks worked. Monetary values, expressed in thousand Euros, have been deflated using the ISTAT-FOI consumer price index. (2) This column reports the average and standard deviation of completed tenure (in years) for each cohort of workers in the sample. Cohorts are defined by year of job start.

Panel A: whole sample

person-	% production	age		wage(1)		tenure	
year obs.	workers	mean	std	mean	std	mean	std
1,979,660	64.33	36.5	9.9	446	317	3.79	3.06

Panel B: by "year of job start" cohort

year of	cohort	entry wage		tenure(2)	
job start	size	mean	std	mean	std
1982	15,915	365.7	203.5	7.93	5.23
1983	17,774	365.2	180.8	7.86	4.69
1984	19,825	378.6	219.0	7.66	4.62
1985	16,207	386.4	251.0	7.02	4.45
1986	28,970	405.0	244.8	6.14	3.95
1987	31,068	387.9	237.1	5.04	3.69
1988	37,129	387.9	225.7	5.51	3.37
1989	39,208	397.7	244.8	5.26	2.93
1990	39,482	456.6	314.6	4.51	2.60
1991	44,574	448.9	305.8	4.70	2.26
1992	26,219	453.5	355.4	4.03	1.90
1993	21,455	472.1	358.5	3.55	1.37
1994	27,137	400.8	320.2	2.79	1.12
1995	36,635	388.4	254.1	2.26	0.77
1996	25,588	431.8	337.8	1.40	0.45

TABLE 2
Male Unemployment and Employment Rates Summary Statistics

Labor market data are from the Italian Statistics Institute (ISTAT) for the period 1993-1997 and from Gatto et al. (2001) and Gatto (2004) for the years 1982-1992. The Gatto series are the only labor market series for the period before 1993 that are fully comparable with the new series developed by ISTAT starting in that year.

The variables in Panel C are defined as follows: du is the year-to-year change in the unemployment rate, and $|du|$ is its absolute value; $DIFF$ is the absolute value of the difference between the current unemployment rate and the unemployment rate at the start of tenure, i.e. $DIFF = |u_j - u_{t_0}|$; $MAXDIFF$ is the greatest $DIFF$ recorded between time t_0 and time $t_0 + t$, i.e.$MAXDIFF = \max_{t_0 \le j \le t_0 + t} |u_j - u_{t_0}|$, where t_0 is the date of hiring and t is tenure with the present employer.

Panel A: Male Unemployment and Employment Rates

	Average	Standard Deviation	Minimum	Maximum
Unemployment Rates, %				
Aggregate (Centernorth)	4.62	0.63	3.52	5.33
Regional	4.73	1.17	1.23	9.59
Regional Adjusted	0	1.33	-3.37	3.87
Employment to Population Ratio, %				
Aggregate (Centernorth)	72.6	1.62	70.02	75.58
Regional	69.1	1.91	64.98	83.65

Panel B: Male Regional Unemployment and Employment Rates, Detailed Statistics

	Sample Size		Unemployment Rate		Employment Rate	
	Workers	Fraction	Average	Standard Deviation	Average	Standard Deviation
Piemonte	60,675	14.20	4.96	0.78	71.46	1.61
Valle d'Aosta	4,072	0.95	3.24	1.02	74.14	3.95
Lombardia	178,319	41.74	3.72	0.81	73.78	2.15
Liguria	11,219	2.63	6.15	1.18	76.37	1.71
Trentino	2,869	0.67	4.44	1.64	67.84	1.28
Veneto	27,857	6.52	4.03	1.20	73.99	1.02
Friuli Venezia Giulia	20,011	4.68	4.11	0.88	68.25	1.05
Emilia Romagna	52,771	12.35	4.00	0.88	73.56	1.19
Toscana	24,738	5.79	4.96	0.48	69.60	1.42
Umbria	5,144	1.20	6.98	1.56	68.33	2.11
Marche	11,939	2.79	3.87	0.44	70.64	2.81
Lazio	27,572	6.45	6.30	1.80	66.00	2.61

Panel C: Unemployment Rate Changes, DIFF and MAXDIFF

	Regional Unemployment				
	du>0	du<0	|du|	DIFF	MAX DIFF
min	0.017	-1.475	0.004	0.004	0.004
1%	0.017	-1.475	0.017	0.025	0.050
5%	0.050	-0.975	0.070	0.081	0.179
10%	0.152	-0.875	0.103	0.164	0.275
25%	0.199	-0.599	0.216	0.349	0.575
50%	0.425	-0.369	0.375	0.750	1.167
75%	0.667	-0.216	0.600	1.400	1.908
90%	1.146	-0.103	0.975	1.908	2.350
95%	1.146	-0.075	1.146	2.175	2.600
99%	1.316	-0.004	1.475	3.373	3.414
max	1.531	-0.004	1.531	4.990	4.990
mean	0.492	-0.428	0.459	0.937	1.255
st.dev.	0.352	0.304	0.330	0.735	0.819

TABLE 3
Effect of Current, Initial, Lowest and Highest Unemployment Rates since Hiring on Current Wages

The sample includes full-time employed males who joined their current employer between 1982 and 1997 and who were no younger than 15 and no older than 55 when they started their current job. The dependent variable is the logarithm of weekly earnings, expressed in 1997 Italian Liras. All regressions include a third-degree polynomial in age, a full set of tenure fixed effects, occupation fixed effects, twelve region fixed effects, twenty-nine industry fixed effects, an indicator variable for individuals working in a region different from their region of birth, an indicator for apprentices and one for salespersons or individuals working from home. All regressions reported in Panel B also include worker fixed effects, those in Panel C include employer fixed effects, and those in Panel C include both worker effects and employer effects. The regional unemployment rates have been demeaned. Standard errors (reported in parentheses) are robust to arbitrary forms of heteroschedasticity and are corrected to allow for group effects within year of job start-region cells.

Panel A: Pooled OLS

	(1)	(2)	(3)
current unemployment rate	−0.013 (0.003)***	−0.022 (0.002)***	−0.010 (0.002)***
unemployment rate at tenure start	−0.000 (0.002)	−0.003 (0.004)	0.004 (0.004)
lowest unemployment rate since tenure start	−0.017 (0.004)***		−0.018 (0.004)***
highest unemployment rate since tenure start		−0.004 (0.005)	−0.007 (0.004)*
Unemployment Rate	regional	regional	regional
Observations	1,979,660	1,979,660	1,979,660
Number of Clusters	180	180	180
R-Squared	0.55	0.55	0.55

Panel B: Worker Fixed Effects

	(1)	(2)	(3)
current unemployment rate	−0.010 (0.002)***	−0.018 (0.002)***	−0.004 (0.002)*
unemployment rate at tenure start	−0.001 (0.005)	0.004 (0.007)	0.007 (0.008)
lowest unemployment rate since tenure start	−0.021 (0.003)***		−0.023 (0.003)***
highest unemployment rate since tenure start		−0.013 (0.006)**	−0.017 (0.006)***
Unemployment Rate	regional	regional	regional
Observations	1,979,660	1,979,660	1,979,660
Number of Clusters	180	180	180
R-Squared (overall)	0.28	0.28	0.28

TABLE 3 - continued from previous page

Panel C: Firm Fixed Effects

	(1)	(2)	(3)
current unemployment rate	−0.014 (0.002)***	−0.021 (0.002)***	−0.008 (0.002)***
unemployment rate at tenure start	−0.002 (0.002)	0.001 (0.002)	0.005 (0.003)*
lowest unemployment rate since tenure start	−0.015 (0.003)***		−0.019 (0.003)***
highest unemployment rate since tenure start		−0.004 (0.004)	−0.006 (0.003)*
Unemployment Rate	regional	regional	regional
Observations	1,979,660	1,979,660	1,979,660
Number of Clusters	180	180	180
R-Squared (overall)	0.60	0.60	0.60

Panel D: Worker and Firm Fixed Effects

	(1)	(2)	(3)
current unemployment rate	−0.013	−0.019	−0.008
unemployment rate at tenure start	−0.008	−0.002	−0.004
lowest unemployment rate since tenure start	−0.017		−0.019
highest unemployment rate since tenure start		−0.013	−0.015
Unemployment Rate	regional	regional	regional
Observations	1,979,660	1,979,660	1,979,660

TABLE 4
Effect of Current and Past Labor Market Conditions on Current Wages
Sensitivity Analysis I: Different Samples and Cohorts

The sample includes full-time employed males who joined their current employer between 1982 and 1997 and who were no younger than 15 and no older than 55 when they started their job. The dependent variable is the logarithm of weekly earnings, expressed in 1997 Italian Liras. All regressions include a third-degree polynomial in age, a full set of tenure fixed effects, occupation fixed effects (production worker, clerical, manager, other), twelve region fixed effects, twenty-nine industry fixed effects, an indicator variable for individuals working in a region different from their region of birth, an indicator for apprentices and one for salespersons or individuals working from home. All regressions include worker fixed effects. In Column (1) the sample includes only workers who work full-year, i.e. at least 45 weeks in all years. In Column (2), I exclude workers with multiple employers over the sample period. In Column (3), the sample is restricted to firms present in the dataset for the entire period 1982-1997 and workers continuously observed between the date of job start and 1997. u_cInt indicates that interactions of tenure dummies with the current unemployment rate are included in the regression. U_0Int indicates that interactions of tenure dummies with the initial unemployment rate are included in the regression. The regional unemployment rates have been adjusted for region and year fixed effects. Standard errors (reported in parentheses) are robust to arbitrary forms of heteroschedasticity and are corrected to allow for group effects within year of job start when aggregate measures are used as regressors or year of job start -region cells when regional measures are used.

	(1) FullYear (45 wks)	(2) Excluding Mult. Jobs	(3) Balanced Panel	(4) Cohorts 1986-1992	(5) u_cInt	(6) u_0Int
current unemployment rate	−0.003 (0.002)	−0.004 (0.002)*	−0.005 (0.002)**	−0.000 (0.002)	.	−0.006 (0.003)**
unemployment rate at tenure start	−0.004 (0.009)	.	.	0.003 (0.011)	0.014 (0.008)*	.
lowest unemployment rate since tenure start	−0.022 (0.004)***	−0.021 (0.004)***	−0.025 (0.003)***	−0.024 (0.004)***	−0.016 (0.003)***	−0.017 (0.004)***
highest unemployment rate since tenure start	−0.015 (0.005)**	−0.018 (0.006)***	−0.016 (0.006)***	−0.018 (0.007)***	−0.018 (0.005)***	−0.016 (0.007)**
Worker Fixed Effects	yes	yes	yes	yes	yes	yes
Unemployment Rate	regional	regional	regional	regional	regional	regional
Observations	333,716	1,850,801	1,631,006	1,696,300	1,979,660	1,979,660
Number of Clusters	177	180	180	77	180	180
R-Squared	0.39	0.26	0.27	0.17	0.28	0.29

TABLE 5
Effect of Current and Past Labor Market Conditions on Current Wages
Sensitivity Analysis II: Alternative Labor Market Tightness Indicators

The sample includes full-time employed males who joined their current employer between 1982 and 1997 and who were no younger than 15 and no older than 55 when they started their job. The dependent variable is the logarithm of weekly earnings, expressed in 1997 Italian Liras. All regressions include a third-degree polynomial in age, a full set of tenure fixed effects, occupation fixed effects (production worker, clerical, manager, other), twelve region fixed effects, twenty-nine industry fixed effects, an indicator variable for individuals working in a region different from their region of birth, an indicator for apprentices and one for salespersons or individuals working from home. All regressions include worker fixed effects. Standard errors (reported in parentheses) are robust to arbitrary forms of heteroschedasticity and clustered by year of job start when aggregate unemployment is used as a regressor, and by year of job start-region when regional unemployment is used. In Column (1) the sample includes only workers who work full-year, i.e. at least 45 weeks. In Column (2), I report results that exclude workers with multiple employers over the sample period. In Column (3), the sample is restricted to firms present in the dataset for the entire period 1982-1997 and workers and workers continuously observed between the date of job start and 1997. u_cInt indicates that interactions of tenure dummies with the current unemployment rate are included in the regression.

Panel A: Aggregate Unemployment Rate

	(1) Baseline	(2) FullYear (45 wks)	(3) Excluding Mult. Jobs	(4) Balanced Panel	(5) Cohorts 1986-1992	(6) u_cInt
current unempl. rate	−0.005 (0.003)*	−0.015 (0.005)**	−0.024 (0.005)***	−0.024 (0.005)***	−0.013 (0.003)***	.
unempl. rate at tenure start	0.007 (0.008)	0.015 (0.011)	.	.	−0.001 (0.017)	0.002 (0.008)
lowest unempl. rate since tenure start	−0.022 (0.011)**	−0.017 (0.008)**	−0.019 (0.009)**	−0.017 (0.009)*	−0.021 (0.011)*	−0.017 (0.009)*
highest unempl. rate since tenure start	−0.019 (0.010)*	−0.022 (0.008)**	−0.012 (0.005)**	−0.013 (0.006)**	−0.023 (0.009)**	−0.020 (0.007)***
Worker Fixed Effects	yes	yes	yes	yes	yes	yes
Unemployment Rate	aggregate	aggregate	aggregate	aggregate	aggregate	aggregate
Observations	1,979,660	333,716	1,744,210	1,468,370	1,200,062	1,998,134
R Squared	0.28	0.40	0.28	0.28	0.26	0.29
Clusters	15	15	15	15	7	180

TABLE 5 - continued from previous page

Panel B: Regional Employment to Population Ratio

	(1) Baseline	(2) FullYear (45 wks)	(3) Excluding Mult. Jobs	(4) Balanced Panel	(5) Cohorts 1986-1992	(6) u_cInt
current E/P ratio	0.009 (0.002)***	0.004 (0.003)*	0.007 (0.002)***	0.007 (0.002)***	0.004 (0.002)***	.
E/P ratio at tenure start	−0.005 (0.004)	−0.009 (0.007)	.	.	0.005 (0.010)	−0.003 (0.004)
lowest E/P ratio since tenure start	0.009 (0.004)**	0.011 (0.003)***	0.009 (0.004)**	0.010 (0.004)***	0.006 (0.003)*	0.007 (0.004)**
highest E/P ratio since tenure start	0.008 (0.005)*	0.017 (0.005)***	0.009 (0.005)*	0.008 (0.005)*	0.027 (0.005)***	0.006 (0.004)*
Worker Fixed Effects	yes	yes	yes	yes	yes	yes
E/P Ratio	regional	regional	regional	regional	regional	regional
Observations	1,979,660	333,716	1,744,210	1,468,370	1,200,062	1,979,660
R Squared	0.28	0.39	0.27	0.29	0.23	0.28
Clusters	180	177	156	156	77	180

Panel C: Aggregate Employment to Population Ratio

	(1) Baseline	(2) FullYear (45 wks)	(3) Excluding Mult. Jobs	(4) Balanced Panel	(5) Cohorts 1986-1992	(6) u_cInt
current E/P ratio	0.007 (0.002)***	0.004 (0.002)	0.006 (0.002)**	0.006 (0.002)**	0.003 (0.003)	.
E/P ratio at tenure start	−0.006 (0.008)	−0.010 (0.007)	.	.	0.008 (0.007)	0.005 (0.007)
lowest E/P ratio since tenure start	0.019 (0.005)***	0.017 (0.006)***	0.019 (0.006)***	0.021 (0.007)***	0.014 (0.007)*	0.028 (0.007)***
highest E/P ratio since tenure start	0.015 (0.008)*	0.018 (0.008)**	0.017 (0.009)*	0.016 (0.009)*	0.030 (0.007)***	0.016 (0.008)*
Worker Fixed Effects	yes	yes	yes	yes	yes	yes
E/P Ratio	aggregate	aggregate	aggregate	aggregate	aggregate	aggregate
Observations	1,979,660	330,512	1,744,210	1,468,370	1,696,300	1,979,660
R Squared	0.28	0.39	0.30	0.30	0.23	0.28
Clusters	15	15	15	15	7	180

TABLE 6
Effect of Current and Past Unemployment on Wages by Firm Size

The sample includes full-time employed males who joined their current employer between 1982 and 1997 and who were no younger than 15 and no older than 55 when they started their current job. The dependent variable is the logarithm of weekly earnings, expressed in 1997 Italian Liras. All regressions include a third-degree polynomial in age, a full set of tenure fixed effects, occupation fixed effects (production worker, clerical, manager, other), twelve region fixed effects, twenty-nine industry fixed effects, an indicator variable for individuals working in a region different from their region of birth, an indicator for apprentices, one for salespersons or individuals working from home, and individual fixed effects. Standard errors (reported in parentheses) are robust to arbitrary forms of heteroschedasticity and clustered by year of job start-region (clustering by year of job start-firm delivers similar results).

	Firm Size Quartile (Revenues)			
	Bottom Quartile	Second Quartile	Third Quartile	Top Quartile
current unemployment rate	−0.008 (0.005)*	−0.014 (0.007)**	−0.008 (0.006)	−0.006 (0.004)
unemployment rate at tenure start	−0.002 (0.008)	0.003 (0.008)	−0.014 (0.008)	−0.004 (0.007)
lowest unemployment rate since tenure start	−0.025 (0.006)***	−0.030 (0.007)***	−0.029 (0.007)***	−0.038 (0.007)***
highest unemployment rate since tenure start	−0.021 (0.008)**	−0.026 (0.008)***	−0.007 (0.009)	−0.011 (0.008)
Number of Firms	221	200	250	267
Median Firm Employment	82	141	263	638
Median Firm Revenues (1,000 Euros)	1,444	3,582	7,931	26,494
Unemployment Rate	regional			
R-Squared	0.29			

TABLE 7
Cohort Effects, Tenure and Changes in Outside Opportunities

The sample includes full-time employed males who joined their current employer between 1982 and 1997 and who were no younger than 15 and no older than 55 when they started their job. The dependent variable is the logarithm of weekly earnings, expressed in 1997 Italian Liras. u_{t_0} is the unemployment rate prevailing at the date of hiring. MAXDIFF is the greatest absolute difference between the current unemployment rate and the unemployment rate at the start of tenure recorded between time t_0 and time t_0+t, i.e. MAXDIFF $= \max_{t_0 \leq j \leq t_0+t} |u_j - u_{t_0}|$, where t_0 is the date of hiring and t is tenure with the present employer. The Table reports the coefficients on the interaction of u_{t_0} (the unemployment rate at tenure start) with tenure dummies and of u_{t_0} with MAXDIFF brackets dummies. Tenure has been computed as year-"year_of_job_start". All regressions include a third-degree polynomial in age, a full set of tenure dummies, occupation fixed effects (production worker, clerical, manager, other), twelve region fixed effects, twenty-nine industry fixed effects, an indicator variable for individuals working in a region different from their region of birth, an indicator for apprentices and one for salespersons or individuals working from home. The regional unemployment rates have been demeaned. Standard errors (reported in parentheses) are robust to arbitrary forms of heteroschedasticity and clustered by by "year_of_job_start"-region.

Panel A: Pooled OLS

	u_{t_0}*tenure			u_{t_0}*MAXDIFF	
Tenure	(1)	(2)	MAXDIFF	(3)	(4)
0	−0.036 (0.009)***	−0.035 (0.009)***	0	−0.029 (0.005)***	−0.035 (0.009)***
1	−0.026 (0.003)***	−0.025 (0.004)***	(0, 0.75]	−0.029 (0.003)***	−0.040 (0.009)***
2	−0.025 (0.003)***	−0.022 (0.005)***	(0.75 ,1.25]	−0.030 (0.005)***	−0.041 (0.010)***
3	−0.018 (0.003)***	−0.023 (0.006)***	(1.25 ,1.75]	−0.009 (0.004)**	−0.020 (0.008)**
4	−0.012 (0.003)***	−0.026 (0.006)***	(1.75 ,2.25]	−0.005 (0.011)	−0.015 (0.015)
5	−0.006 (0.003)*	−0.025 (0.006)***	(2.25 ,2.75]	−0.008 (0.007)	−0.018 (0.011)
6	−0.002 (0.003)	−0.025 (0.008)***	(2.75 ,3.25]	−0.014 (0.006)**	0.006 (0.011)
7	0.001 (0.003)	−0.025 (0.008)***	(3.25, ..]	−0.003 (0.004)	−0.010 (0.010)
8	0.004 (0.003)	−0.024 (0.008)***			
9	0.004 (0.004)	−0.028 (0.008)***			
10	0.003 (0.005)	−0.034 (0.008)***			
Includes u_{t_0}*tenure	yes	yes		no	yes
Includes u_{t_0}*MAXDIFF	no	yes		yes	yes
Unemployment Rate	regional	regional		regional	regional
Observations	1,979,660	1,979,660		1,979,660	1,979,660
Number of Clusters	180	180		180	180
R-Squared	0.54	0.55		0.55	0.55

TABLE 7 - continued from previous page

Panel B: Worker Fixed Effects

	U_0*Tenure			U_0*MAXDIFF	
Tenure	(1)	(2)	MAXDIFF	(3)	(4)
0	−0.036 (0.011)***	−0.037 (0.011)***	0	−0.028 (0.006)***	−0.037 (0.011)***
1	−0.022 (0.004)***	−0.025 (0.004)***	(0, 0.75]	−0.028 (0.004)***	−0.043 (0.012)***
2	−0.022 (0.004)***	−0.027 (0.005)***	(0.75 ,1.25]	−0.022 (0.005)***	−0.039 (0.014)***
3	−0.015 (0.004)***	−0.026 (0.004)***	(1.25 ,1.75]	−0.005 (0.005)	−0.025 (0.013)**
4	−0.005 (0.004)	−0.024 (0.005)***	(1.75 ,2.25]	0.001 (0.009)	−0.019 (0.016)
5	−0.003 (0.004)	−0.019 (0.005)***	(2.25 ,2.75]	0.001 (0.009)	−0.020 (0.016)
6	0.007 (0.004)*	−0.018 (0.006)***	(2.75 ,3.25]	0.006 (0.005)	−0.015 (0.015)
7	0.011 (0.005)**	−0.015 (0.006)***	(3.25, ..]	0.008 (0.006)	−0.013 (0.015)
8	0.013 (0.005)**	−0.016 (0.007)**			
9	0.012 (0.006)*	−0.018 (0.008)**			
10	0.008 (0.007)	−0.025 (0.009)***			
Includes U_0*Tenure	yes	yes		no	yes
includes U_0*MAXDIFF	no	yes		yes	yes
Unemployment Rate	regional	regional		regional	regional
Observations	1,979,660	1,979,660		1,979,660	1,979,660
Number of Clusters	180	180		180	180
R-Squared	0.20	0.20		0.20	0.20

TABLE 8
Asymmetric Response of Wage Changes to Unemployment Changes

The dependent variable is the residual wage change obtained from regressing raw yearly wage changes on individual fixed effects, a cubic in age, a set of tenure dummies, an indicator variable for individuals working in a region different from their region of birth, an indicator variable for salespersons or individuals working from home, four broad occupation variables (production worker, clerical, manager, other), twenty-nine industry indicators and twelve region indicators. The explanatory variables include Δu, i.e. the yearly change in the local unemployment rate, and a set of interactions with dummy variables for the sign of Δw_{-1}, for whether Δu was positive, "large", and so on. A change in the unemployment rate is defined as "large" if it is greater or equal to 0.6 percentage points (about one standard deviation of the average unemployment rate in the twelve regions). The "balanced firms" sample includes only workers at firms that are in the dataset for the entire period 1982-1997. The (robust) standard errors are clustered by year-region cell.

Balanced Firms Sample

	$\Delta u > 0$		$\Delta u < 0$	
	Δu "small"	Δu "large"	Δu "small"	Δu "large"
$\Delta w_{-1}>0$	0.002	−0.029	−0.011	−0.017
	(0.008)	(0.009)***	(0.005)**	(0.008)**
predicted	**=0**	**<0**	**<0**	**<0**
$\Delta w_{-1}<0$	−0.002	−0.029	−0.008	−0.018
	(0.006)	(0.008)***	(0.011)	(0.017)
predicted	**<0**	**<0**	**=0**	**<0**
Unemployment Rate	regional			
Observations	1,096,302			
Number of Clusters	165			

TABLE 9
Unemployment Volatility and Initial Wage

The dependent variable is the log of initial real weekly wage. Unemployment rate volatility is measured as the standard deviation (or the coefficient of variation) of the regional quarterly unemployment rate over the period 1980-2000. Controls include age, occupation, industry, region and year effects. Standard errors are clustered by region.

Dep. Var. : log of entry wage			
	standard deviation of unemployment rate		ln (coefficient of variation of unemployment rate)
	(1)	(2)	(3)
coefficient (standard error)	−0.051 (0.008)***	−0.050 (0.004)***	−0.068 (0.010)***
control for unemployment	no	yes	no
Observations	400,842	400,842	400,842
Number of Clusters	12	12	12
R-Squared (overall)	0.52	0.52	0.52

APPENDIX TABLE 1
International Comparison of Household Indebtedness

The data reported in this Table are from Casolaro, Gambacorta and Guiso (2005), Table 1.

	Italy	France	Germany	UK	USA
Total Indebtedness as a % of disposable income					
1990	29.1	88.3	70	115.7	87.3
1997	33.8	64.9	107.6	105	97.6

	Italy	France	Germany	EURO area
Loans from Banks as a % of GDP (1990)	16.2	32.5	63.1	39.9
- house purchase	5.2	20.3	37.3	23.9
- consumer credit	1.3	6.7	10.9	6.6

APPENDIX TABLE 2
Cyclicality of Weekly Working Hours

Data are from the Bank of Italy SHIW dataset. The sample includes full-year, full-time males ages 16-54 working in the manufacturing sector, years 1987-2002. The dependent variable in the regression is the logarithm of weekly hours worked. Controls include age, education indicators, region indicators and a linear time trend. The standard error is robust to arbitrary forms of heteroschedasticity and clustered by year. Sample weights are used. Not clustering results in a standard error equal to 0.0022. Not using sample weights delivers a coefficient equal to 0.0029 with standard error 0.0034. Not clustering or using weights gives a 0.0029 coefficient with a 0.0019 standard error.

OLS coefficient of regression of ln(yearly work hours) on the unemployment rate

Coefficient	Stand.Err.	R-Squared	N.Obs.
0.0021	0.0044	0.0171	9,788