

WAGE DYNAMICS AND INSURANCE

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Abstract

In this paper, I analyze the influence of macroeconomic conditions on wages by considering an insurance model of the employment relationship. Unlike previous empirical studies, I allow for limited commitment on the side of both the worker and the employer. I derive a set of empirical predictions implied by the model and test them on a matched employer-employee panel of male workers from Northern Italy. The model implies, first, that wages should 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; however, such wage differentials should disappear if outside opportunities change substantially. Third, the sensitivity of current wages to upward or downward changes in outside options depends on the sign of the wage change in the previous period. A consistent and robust set of results supports the two-sided limited commitment labor contract model. By contrast, other widely used models of wage determination, such as spot market models or continual surplus splitting rules, do not appear to be consistent with the data.

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1 Introduction

The question of how wages are influenced by labor market conditions is a central issue in economics, characterized by conflicting theoretical hypotheses and not conclusive empirical evidence.¹ In this paper, I study the influence of macroeconomic conditions on real wages by considering an insurance model of the employment relationship. Unlike previous empirical studies, I allow for a contractual environment where both the worker and the employer are free to take outside opportunities when it is in their best interest.

Understanding the impact of outside conditions on individual and aggregate wages is relevant for at least two reasons. Labor earnings represent the main source of income for the vast majority of individuals and households in developing as well as modern economies, and therefore labor market fluctuations can have substantial consequences in terms of welfare. From a more theoretical perspective, wage determination turns out to be crucial for the empirical performance of equilibrium models of the labor market.² Thus, understanding the process that underlies wage formation and dynamics for new hires and existing workers can offer insights for building more realistic models of the labor market.

I begin by deriving a set of testable implications of the theory for the relationship between wages and outside opportunities at various points of workers' tenure. The predictions are obtained directly from the properties of the efficient wage contract produced by the model. Even though the lack of commitment limits the role of employment contracts as insurance providers, it does not eliminate it. I show that the model delivers predictions that contrast sharply not only with those of spot market models, but also with implicit contract models with more restrictive assumptions about commitment. Next, I conduct empirical tests of these predictions. To this aim, I use a matched employer-employee panel of workers from Northern Italy.³ The dataset includes the entire workforce of a large sample of manufacturing firms observed over the period 1982-1997. My empirical analysis delivers a consistent and robust set of results that support the two-sided limited commitment labor contract model.

In the model, originally developed by Thomas and Worrall (1998), agents can either trade at the spot market wage, in which case they fully bear the risk attached to economic

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

²For example, departures from the Walrasian paradigm of wage formation in favor of contractual arrangements have been shown to improve the ability of real business cycles models to replicate the stylized facts of labor market variables (Boldrin and Horvath, 1995). More recently, a growing body of research, including Hall (2005), Hall and Milgrom (2006) and Rudanko (2006), tries and address the critique of Shimer (2005) that the Mortensen-Pissarides model does not satisfactorily explain the extent of labor market fluctuations, precisely by embedding alternative mechanisms of wage formation into the Mortensen-Pissarides framework.

³I exclude firms operating in the South because of the dominant influence of centralized wage bargaining in this area of the country, documented in Macis (2006).

fluctuations, or they can engage in long-term contracts. If both workers and employers can end the current relationship when better opportunities arise, the relationship continues only if contracts are self-enforcing. In other words, 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 contract wage will therefore be 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 (i.e. when the worker's outside option constraint binds), and downwards when outside opportunities would otherwise prompt the employer to terminate the relationship (i.e. when the employer'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.

First of all, I show that wages should 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, such as spot market models or continual surplus-splitting rules. This feature is also inconsistent with implicit contract models that assume employer commitment. In such models, real wages are downward rigid and only the best conditions recorded since the start of the job are correlated with current wages (Harris and Holmstrom, 1982; Beaudry and DiNardo, 1991). Proxying external opportunities to workers with the unemployment rate⁴, I find that the highest and lowest unemployment rates experienced since the time of hiring have an independent effect on current wages, even after controlling for current and initial conditions and for worker and firm observable and unobservable characteristics. 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 real wages are renegotiated when either the worker's or the firm's outside option constraints become binding. This is evidence that enforcement 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. This feature is not consistent with the assumption of one-sided limited commitment, frequently

⁴As did Beaudry and DiNardo (1991) and, more recently, Grant (2003) and Bertrand (2004). For 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.

made in the existing research.⁵

A second implication of the implicit contract model is that a firm may pay different wages to workers with the same outside option, if they were hired in different periods. However, such wage differentials should disappear if outside opportunities change substantially. Consistent with the theory, I find that initial conditions have an important effect on wages, but this effect declines with tenure. This confirms the results of the existing studies of cohort effects in wages. I improve on the existing literature by considering explicitly an economic mechanism behind this phenomenon. In fact, I find that the impact of the initial unemployment rate 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.⁶

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 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

⁵This result might rationalize the findings of the existing literature. Using data from the Panel Study of Income Dynamics 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. In fact, even in Beaudry and DiNardo's original study, the coefficient on the current unemployment rate is statistically significant in some cases, especially when worker fixed effects are included in the regression. Thus, the existing empirical evidence does not provide strong support to one-sided limited commitment models. In fact, with firms full commitment and worker full mobility, only the lowest unemployment rate observed since the time of hiring should influence current wages.

⁶Alternative explanations have been proposed for the presence of "cohort effects" in wage data. In Gibbons and Waldman (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 start of jobs. Their model, however, makes no direct prediction about the relationship between cohort effects and tenure or between cohort effects and changes in outside opportunities.

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.

My findings lend support to the insurance model of the employment relationship in a contractual environment where enforcement problems exist on both sides of the labor contract. By contrast, these findings are at odds with other models of wage determination, such as the spot market model or continual renegotiation of wages according to some surplus-splitting rule (e.g. Nash bargaining). These two alternative models of wage formation most widely adopted in macroeconomics as well as labor economics literature 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.

This study belongs to a strand of research that stresses the importance of implicit and explicit contracts in labor markets.⁷ The allocation of aggregate risk between the employer and the worker is an important motivation behind the desire for firms and workers to engage in long term contracts. This is a view with a long tradition in economics, first formalized in the models of Baily (1974), Gordon (1974) and Azariadis (1975). In these early models, risk neutral entrepreneurs and risk averse workers have an incentive to enter in long-term "implicit contracts" that insulate wages from fluctuations in the outside labor market thereby improving the welfare of both parties. 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.⁸ Thomas and Worrall (1988) show that even though enforcement problems limit the role of employers as insurance providers, it does not eliminate it. In spite of the abundance of theoretical work, however, the empirical evidence on the importance of contracts in actual employment relationships is still scarce. This is partly due to the lack of adequate data 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 therefore to derive a set of testable predictions, and to actually test them on a large and rich dataset. The results of my empirical analysis provide empirical support to this tradition

⁷See Rosen (1985) and Malcomson (1999) for an overview of labor contract theory and empirics.

⁸As noted by Holmstrom (1981), the assumption that the parties will never renege on the contract can be seen as the major weakness of the earliest theoretical contributions in this area.

of models, and therefore reinforce the importance of considering more realistic assumptions on contracts and commitment in the labor market.

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 present the empirical analysis and discuss the results. Section 5 concludes.

2 Theoretical Framework and Testable Implications

I begin by describing a 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.⁹ Next, I use the properties of the efficient wage contract produced by the model to derive a set of testable implication for the relationship between wages and outside opportunities.

2.1 Insurance Employment Contracts with Two-Sided Limited Commitment

2.1.1 Environment and Assumptions

In this model,¹⁰ 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 $t = 0, 1, 2, \dots$. 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 one revenue unit of output each period. The worker receives wage w and the entrepreneur is

⁹The assumption that a worker can commit to the terms of a labor contract without ever leaving his or 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; Holmstrom, 1983; 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, excluding the possibility of wage reductions might be harmful in terms of incentives provisions within the firm when effort is unobservable.

¹⁰The reader is referred to Thomas and Worrall (1988) for details and proofs.

left with profit equal to $1 - w$. 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,¹¹ 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 $s_t \in \Phi \equiv \{1, \dots, S\}$. 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

¹¹The assumption of risk averse workers and risk neutral employers is common in the implicit contracts literature. Although the extreme assumption of risk neutrality for employers is not essential for the implications of the model to carry through, employers and workers must have different degrees of risk aversion, with workers being more risk averse than employers. Several arguments have been advanced in the literature to support this assumption, including the Knightian argument that 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 important when workers cannot smooth consumption privately because they have limited access to credit markets. Although this assumption is rather extreme, it is not a bad approximation of reality when it comes to Italy. As documented by Casolaro, Gambacorta and Guiso (2005), the Italian household loan market is much smaller compared to those of other countries at a comparable stage of economic development. In 1990, total household debt in Italy amounted to 29 percent of disposable income, about one third of 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 (Appendix Table 1).

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:

$$V_t^x(s^t) = 1 - x(s_t) + \sum_s \sum_{\tau=t+1}^{\infty} \beta^{\tau-t} (1 - x(s_\tau)) p_s$$

$$U_t^x(s^t) = u(x(s_t)) + \sum_s \sum_{\tau=t+1}^{\infty} \beta^{\tau-t} u(x(s_\tau)) p_s$$

On the spot market, where no insurance is available, workers' income depends on the state of the economy in each period and is hence 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 $s^t \equiv \{s_0, s_1, s_2, s_3, \dots, s_t\}$.

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

$$V_t^\delta(s^t) = 1 - w(s^t) + \sum_s \beta V_{t+1}^\delta(s^t, s) p_s$$

$$U_t^\delta(s^t) = u(w(s^t)) + \sum_s \beta U_{t+1}^\delta(s^t, s) p_s$$

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 sticking to 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, convenient formulation expresses (1) and (2) in the following way

$$\tilde{U}^\delta(s^t, s) \equiv u(w(s^t, s)) - u(x(s_t)) + \sum_s \sum_{\tau=t+2}^{\infty} \beta^{\tau-t} \{u(w(s^\tau)) - u(x(s_\tau))\} p_s \geq 0$$

$$\tilde{V}^\delta(s^t, s) \equiv x(s_t) - w(s^t, s) + \sum_s \sum_{\tau=t+2}^{\infty} \beta^{\tau-t} \{x(s_\tau) - w(s^\tau)\} p_s \geq 0$$

for all s^t and $t \geq 0$, and where $\tilde{U}^\delta(s^t, s)$ and $\tilde{V}^\delta(s^t, s)$ 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 must 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 $u(w(s^t)) + \sum_s \beta U_{t+1}^\delta(V_{t+1}^\delta(s^t, s)) p_s$.

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

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

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

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

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

$$U_{t+1}^{\delta'}(V_{t+1}^\delta(s^t, s)) [1 + \phi_{t+1}(s^t, s)] + \psi_{t+1}(s^t, s) + \lambda_t(s^t) = 0, \quad \text{for all } t \text{ and } s^t \quad (6)$$

Plus the envelope condition

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

and the complementary slackness conditions on the inequality constraints:

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

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

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

$$u'[w_t^*(s^t)] = u'[w_{t+1}^*(s^t, s)][1 + \phi_{t+1}(s^t, s)] - \psi_{t+1}(s^t, s) \quad (10)$$

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) show that 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 . 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.¹²

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

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

or, more explicitly

¹²In fact, if $w(s^{t-1}, s) = \underline{w}(s)$, the worker's outside option constraint is binding, i.e. $\tilde{U}^\delta(s^t, s) = 0$, whereas if $w(s^{t-1}, s) = \overline{w}(s)$ the employer's outside option constraint is binding, i.e. $\tilde{V}^\delta(s^t, s) = 0$.

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

where s_t is the state of outside productivity at time t , $s^{t-1} = \{s_0, s_1, \dots, s_{t-1}\}$, $\underline{w}(s_t)$ is the minimum acceptable wage for the worker if state s_t occurs, $\bar{w}(s_t)$ is the highest wage the employer is willing to pay if state s_t occurs. In addition, it can be shown that the functions \underline{w} and \bar{w} that define, for each s , the region of admissible wages, are such that

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

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 $[\underline{w}(s_t), \bar{w}(s_t)]$ if the current realization s_t makes $w(s^{t-1})$ higher than $\bar{w}(s_t)$ (i.e. when the employer's outside option constraint binds) or raised to equal the bottom of the interval $[\underline{w}(s_t), \bar{w}(s_t)]$ 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

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

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

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

(where LCE stands for "limited commitment with employer mobility"). In the former case, the wage is downward rigid and is increased 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 are correlated with both the best and the worst realizations of outside opportunities since the time of hiring; (2) cohort effects in wages arise from the model, and their persistence is inversely related with the magnitude of changes in outside opportunities since the time of hiring; (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 are positively correlated to (a) initial, (b) current, (c) highest and (d) lowest 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 on the side of both the worker and the employer, 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 is predicted to 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).

As shown 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. Appendix 1 shows that in a wage regression augmented with indicators for (a) the current state of the labor market, (b) initial conditions, (c) best and (d) worst conditions recorded since hiring, both best and worst realizations of outside opportunities since the time of hiring are correlated with current

wages. This is because the event {best outside opportunities since hiring} is positively correlated with the event {worker's constraint is binding} \iff {worker's wage is raised}, and the event {worst outside opportunities since hiring} is positively correlated with the event {employer's constraint is binding} \iff {worker's wage is lowered}.

Additionally, with two-sided limited commitment, wages are 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 (for an illustration, see the wage change between periods 9 and 10 in Figure 1). Clearly, the actual importance of the four labor market indicators is purely an empirical issue. For example, as will be examined in detail in the empirical Section, in a labor market that does not fluctuate much, the influence of initial conditions persists 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. However, because of limited commitment and the requirement for contracts to be self-enforcing, wages are renegotiated whenever such a time comes that either outside option constraint becomes binding. This implies that "cohort effects" exist but their persistence over time depends on the magnitude of changes in outside options since the time of job start. 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. This example motivates the following Proposition:

Proposition 2 *For any pair of cohorts i and ii , hired in periods $t_0(ii) > t_0(i)$ and with productivity realizations $s_{t_0(i)}, s_{t_0(i)+1}, \dots, s_{t_0(ii)}$ such that $w_{ii,t_0(ii)} - w_{i,t_0(ii)} > 0$, there exists some threshold value $\chi(s_{t_0(ii)})$ such that if $s_{t_0(ii)+j} > \chi(s_{t_0(ii)})$, then $w_{ii,t_0(ii)+j} = w_{i,t_0(ii)+j}$.*

Proof. See the Appendix. ■

This Proposition simply states that changes in outside options "large enough" to trigger wage renegotiation will dissipate any wage differential purely due to workers having been hired under different economic circumstances. In the empirical Section, the task will be

to examine whether cohort effects in wages are less persistent when the changes in outside options since hiring are larger. The theoretical reason behind this test is that with greater changes in outside options it is more likely that some outside option constraint becomes binding. The following Corollary describes an important implication of Proposition 2:

Corollary 1 *When risk-sharing employment contracts are subject to limited commitment, the dependence of wage payments on the economic conditions prevailing at the time of hiring declines with tenure.*

Proof. See the Appendix. ■

The intuition behind Corollary 1 is that the likelihood that outside opportunities change enough to trigger wage renegotiation increases with calendar time. Propositions 2 and Corollary suggest an additional empirically testable prediction. 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. Hence, 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 $\bar{w}(s_t)$. 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

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

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 $w_t = \bar{w}(s_t)$ for workers in $G_{3,t}$. The following Proposition concerns the relationship between changes in outside opportunities in the subsequent period and wage changes:

Proposition 3 *For workers in $G_{1,t}$, improvements in outside opportunities from period t to $t + 1$ 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 from period t to $t+1$ 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 4. Proposition 4 implies that if one looks at wage changes in a period immediately following a date when the worker's (resp. the employer's) constraint was binding, there is an asymmetry in the responsiveness of wages to improvement or deterioration of outside opportunities such that whenever outside opportunities improve (resp. deteriorate), wages should be raised (resp. lowered); whereas when outside opportunities deteriorate (resp. improve), wages should be lowered (resp. raised) only if the deterioration is "substantial".

These asymmetries are sharp implications of the insurance model with two-sided limited commitment and contrast with the spot market model and with continual Nash bargaining (whereby each party receives a fixed share of the surplus), both of which would 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 two administrative sources, one for workers and one for firms. The workers' data are from the records of the Social Insurance Institute (INPS), and the firm-level data are from the Company Accounts Data Services (CADS), an institution established in 1980 jointly by the Bank of Italy, the Italian Banking Association and a pool of major banks with the purpose of collecting information on borrowers. The INPS dataset contains the complete work histories of all workers who ever transited in any of the 1,400 firms included in the Bank of Italy's survey of manufacturing firms with at least 50 employees. 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, these data can be matched with the CADS dataset. The CADS data span the period 1982-1996, and contain a rich set of variables on roughly 40,000 firms per year,¹³ including the sector of economic activity (at the 4-digit level), its location and detailed balance sheet information. The structure of the INPS dataset is such that once a worker has joined one of the Bank of Italy's sample firms, he or she is kept in the dataset even when he leaves that firm. Therefore, not only job stayers but also switchers can be followed over time. The INPS data are of administrative origin and are considered to be very reliable (see Guiso et al., 2005). The CAD data are used by the banks in the consortium to assess the financial soundness of companies, and make decisions related to credit lines and loans. For this reason, the data are subject to extensive quality checks.

As did Beaudry and DiNardo (1991) and Bertrand (2004), I proxy outside opportunities to workers using the annual average of quarterly civilian unemployment rates. 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-CAD 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 low 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 sample¹⁴.

¹³The CAD dataset has been used, among others, by Guiso et al. (2005) and Guiso and Schivardi (2006).

¹⁴As explained below, I limit my analysis to workers and firms located in Italy's Centernorth. There

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.

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).¹⁵ Firms located in Italy's Centernorth¹⁶ represent over 80 percent of the original INPS-CADS 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 selected sample, overall and by entry cohort. The data consists of over 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

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).

¹⁵The "southern anomaly" is the subject of Macis (2006). 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 rather than viceversa.

¹⁶The 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.

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 worker¹⁷ 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 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 four 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, typically as a result of company-wide or individual bargaining. Finally, the individual compensation can include one-time bonuses called "production premia" (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 is meant to measure the yearly variation in the annual 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

¹⁷See Erickson and Ichino (1995) for a more detailed description of the institutional determinants of wage formation in Italy for the period 1981-1995.

change, it is therefore possible to construct an annual series of contractual wages for Italian workers by industry. Of course, it is difficult to assess how binding a minimum wage is without observing the whole wage distribution before and after the minimum has been imposed. However, even looking at the distribution of wages of individuals currently employed can be informative. For each year, I normalize individual wages from the INPS-CAD dataset by the minimum wage prevailing in the industry, and kernel-estimate the distribution of these normalized wages. In Figure 5,¹⁸ I display the estimated kernel densities for production workers and white collar workers, separately. The plots reveal that the industry-level minimum wage is not binding. No spike at 1 can be detected in the distribution of normalized wages. In fact, 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

I test Proposition 1 by estimating empirical wage functions of the following form

$$\ln w_{i,t_0(i)+t} = \gamma_c u_{r(i),t_0(i)} + \gamma_0 u_{r(i),t_0(i)+t} + \gamma_{\min} u_{r(i),t_0(i)+t}^{\min} + \gamma_{\max} u_{r(i),t_0(i)+t}^{\max} + X_{i,t_0(i)+t} \beta + v_{i,t_0(i)+t} \quad (11)$$

where i denotes an individual, $t_0(i)$ 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. However, to check the robustness of the results, I also implement the analysis using the aggregate unemployment rate and the aggregate and regional¹⁹ 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.²⁰ 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

¹⁸Note that because the minimum contractual wage measure constructed by ISTAT is actually an average of wage minima that are heterogeneous across workers (by occupation, level and seniority), it is possible to observe individuals who earn less than the "minimum".

¹⁹In 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.

²⁰See Moulton (1986) and Bertrand, Duflo and Mullainathan (2004).

the unemployment rate prevailing in individual i 's region of work, $r(i)$, when individual i started working with his current employer (or in the Centernorth as a whole when aggregate measures is used), $u_{r(i),t_0(i)+t}$ is the contemporaneous unemployment rate, $u_{r(i),t_0(i)+t}^{\min}$ is the lowest unemployment rate recorded since individual i was hired up to time $t_0(i) + t$, $u_{r(i),t_0(i)+t}^{\max}$ is the highest unemployment rate recorded since individual i was hired up to time $t_0(i) + t$.

The main coefficients of interest are γ_{\min} and γ_{\max} . As demonstrated in the proof to Proposition 1 (see the Appendix), 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 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 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 constant, 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 the independent effects of tenure on wages; failure to do so would bias the estimated coefficients on $u_{r(i),t_0(i)+t}^{\min}$ and $u_{r(i),t_0(i)+t}^{\max}$. To account for the effect of tenure on wages in the most general way, I include a full set of tenure indicators among the right-hand side 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 $u_{t_0(i),t}^{\min}$, 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. In fact, if one assumes a contractual environment where the employer is able to commit to the contract, wages are adjusted upward whenever outside options are at the historical maximum level since the start of the current job, therefore current wages should only be correlated with the lowest unemployment rate since hiring

(Harris and Holmstrom, 1982 or Beaudry and DiNardo, 1991). The estimated coefficient on $u_{t_0(i)}$ is equal to zero, while those on $u_{t_0(i)+t}$ and $u_{t_0(i),t}^{\min}$ are both negative and statistically significant. In Column (2) I report the results from a model including $u_{t_0(i)+t}$, $u_{t_0(i)}$ and $u_{t_0(i),t}^{\max}$ 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 still negative and strongly statistically significant, while both γ_0 and γ_{\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. When this specification is adopted, the coefficient on the initial unemployment rate is once again small in magnitude and not statistically significant, while $u_{t_0(i)+t}$, $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$ appear to be all correlated with current log wages. However, the estimated coefficient on $u_{t_0(i),t}^{\max}$ is somewhat smaller and much less precisely estimated compared to that on $u_{t_0(i),t}^{\min}$.

Controlling for Worker And Employer Unobservable Heterogeneity Although the results displayed in Table 3, Panel A suggest to some extent that an implicit contract model with limited commitment on both sides of the labor contract describes the data better than alternative models, there are two important reasons why OLS estimates might be biased: unobserved worker heterogeneity and unobserved firm 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.²¹ 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 (in absolute value) $u_{t_0(i),t}^{\max}$, 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 $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$ are strongly correlated with tenure (see Figure 6A), omitted ability would result in biased OLS estimates.

To address this concern, I estimate model (11) including a worker-specific fixed effects that is allowed to be correlated with the other regressors, including tenure and the labor

²¹See Heckman and Sedlacek (1985) and Solon, Barsky and Parker (1994).

market history parameters. Panel B of Table 3 reports the results of this set of regressions. In striking contrast with the OLS results, the coefficient on $u_{t_0(i),t}^{\max}$ 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 $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$ 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 current wages indicates that enforcement problems exist on both sides of the employment relationship. The magnitudes of γ_{\min} and γ_{\max} are economically important, as they indicate that if the lowest (resp. highest) unemployment rate since hiring is one percentage-point lower, individual wages are between 2.3 (resp. 1.7) percent higher. The coefficient on the current unemployment rate is large and statistically significant in Columns (1) and (2), i.e. when $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$, respectively, are omitted from the regression. The magnitude and statistical significance of this coefficient, however, drop dramatically in Column (3), when both $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$ are included in the regression.

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 firms do not have significantly different hiring policies over the business cycle. Next, I specify the error term as follows

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

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-CAD dataset allows me to account for individual- and employer-specific fixed effects simultaneously. To do so, I implement the projection method developed by Abowd, Creedy and Kramarz (2002).²² 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

²²The estimates are carried out in Stata using the routine developed by Amine Ouazad.

fixed effects only.

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 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 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). 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.²³ In all cases, worker fixed effects are included.²⁴ The results appear to be robust across sample definitions and cohort restrictions. In the specification displayed in Column (5), I account for the possibility that $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$ 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 recessions²⁵. 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 ($\sum_t \phi_t^c u_{t_0(i)+t}$). Column (5) reveals that γ_{\min} is somewhat smaller, but still strongly statistically significant, as a result of this check, while γ_{\max} does not appear to be affected. Finally, to explore the possibility that $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$ 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 ($\sum_t \phi_t^0 u_{t_0(i)}$). As can be seen in Column (6), the results are robust to this further check.

In Table 5, I examine whether the results are robust to the use of alternative measures of the state of the labor market. In particular, I estimate model (11) using the aggregate unemployment rate for the entire Centernorth (Panel A), regional employment rates (Panel B) and the aggregate employment rate for the Centernorth. The employment rate is calculated as the ratio of total employment over the population ages 16-64. As can be seen from Figure 7, the employment to population ratio in Italy's Centernorth is procyclical, and its negative correlation with the unemployment rate is strong. On average in Italy's Centernorth, the employment rate varies between 56 and 59 percent over the business cycle.

²³Excluding either the first four or the last four cohorts, separately, does not alter the results.

²⁴I have also run the same specification checks including both worker and firm fixed effects, and the coefficients were basically unchanged.

²⁵As noted by Grant (2003).

In reading the coefficients from Table 5, Panels B and C, one has 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 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 $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$ ($e_{t_0(i),t}^{\min}$ and $e_{t_0(i),t}^{\max}$ when the employment rate is used), are in all cases statistically significant at the ten percent level, at least. The magnitude of γ_{\min} and γ_{\max} estimated when using aggregate unemployment (Table 5, Panel A) is similar to what was obtained using regional unemployment rates. When regional employment rates are used (Panel B), the estimated coefficients on $e_{t_0(i),t}^{\min}$ and $e_{t_0(i),t}^{\max}$ imply that if the highest (resp. lowest) employment rate since hiring is one percentage-point higher, individual wages are between 0.6 and 2.7 (resp. between 0.7 and 1.1) percent higher, depending on the specification adopted.

Overall, a consistent and robust set of results emerges 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.

In almost all specifications, current labor market conditions are 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. As discussed earlier, with such a contractual environment, the only labor market indicator correlated with current wages should be 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 consistent with Proposition 1 and the contractual environment with two-sided limited commitment. As discussed in Section 2, with two-sided limited commitment neither $u_{t_0(i),t}^{\min}$ nor $u_{t_0(i),t}^{\max}$ 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 $u_{t_0(i),t}^{\min}$ and $u_{t_0(i),t}^{\max}$. This result might rationalize the findings of the existing literature. 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 significant impact on current wages. Even in Beaudry and DiNardo (1991) the coefficient on the current unemployment rate is statistically significant in some cases, especially when worker fixed effects are included in the regression. These authors did not entertain the possibility that enforcement problems exist

on the side of employer as well.²⁶

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

Panel B of Figure 4 displays average wage-tenure profiles of the year-of-job start cohorts in the dataset, together with their entry wage at tenure zero (i.e. in the year they joined the current employer), the average wage of existing workers (i.e. workers with tenure greater or equal to one year) and the aggregate unemployment rate. Three things emerge from the picture. 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, there exists a strong negative correlation between starting wage and initial unemployment rate (much stronger than that between unemployment and the wage of existing workers), which suggests that the "cohort effects" are indeed related with the condition of the labor market at the time of hiring. Proposition 2 implies that the persistence of cohort effects depends on the extent to which outside opportunities change since the date of hiring. To test Proposition 2, it is necessary to devise an appropriate measure of change in outside opportunities since the time of 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 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 value of the 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, a significant change might have occurred in

²⁶Beaudry and DiNardo (1995) consider a two-sided limited commitment model. Their focus, however, is on the joint behavior of hours and wages. 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 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 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.

the past 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 $MAXDIFF_{t_0(i),t}$:

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

According to the Corollary to Proposition 2, one indirect implication of this feature is that the influence of outside opportunities at entry should decline with tenure, because year after year the likelihood that either outside option constraint becomes binding increases.

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

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

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

where w_{i,t_0+i} 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 object 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. As done above, I adjusted the regional unemployment rates for region and year fixed effects to make them independent of aggregate trends, and I cluster standard errors at the level of the "year_of_job_start"-region cohort to allow for group level error terms.

Table 6 displays the results of the estimation of regional models (14) and (15). Tenure dummies were generated after computing tenure as "current_year" minus "year_of_job_start". $MAXDIFF$ dummies were constructed for the following $MAXDIFF$ ranges: $\{[0]; (0, 0.5]; (0.5, 1]; (1, 1.5]; (1.5, 2]; (2, 2.5]; (2.5, 3]; (3, \dots)\}$.

Panel A of Table 6 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. As discussed earlier, unobserved worker heterogeneity could be a source of bias for the OLS estimates if workers of systematically different unobserved ability are hired in different phases of the business cycle. All specifications include unrestricted tenure effects (with tenure rounded to the nearest year) so that the $u_{t_0(i)}$ coefficients measure changes in tenure profiles in earnings that result from variation in outside opportunities, proxied with 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 3, as they suggest a strong initial effect of the unemployment rate at the time of hiring that persists but fades after three to five years of tenure. 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 the prediction of Proposition 2. There is a strong effect of the unemployment rate at the time of hiring, i.e. with $MAXDIFF = 0$, an effect that drops to zero when $MAXDIFF$ is greater than 1 in the fixed effects specification of Panel B, or greater than 1.5 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. While the estimates of $\lambda_{MAXDIFF_{t_0,t}}$ reported in Column (4) of both Panels A and B do not differ much from those reported in Column (3), 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. In fact, the estimates reported in Column (2) 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 8, 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. In Figure 8-A, I plot the estimates of $\lambda_{MAXDIFF_{t_0,t}}$ for (a) full year workers, (b) workers without multiple employers in the period considered, (c) a balanced panel of firms and workers and (d) the 1986-1992 cohorts only. In Figure 8-B, I report the coefficients from regressions where controls for both worker and firm effects have been included. In addition, I define an alternative set of *MAXDIFF* ranges: $\{[0]; (0, 0.4]; (0.4, 0.8]; (0.8, 1.2]; (1.2, 1.6]; (1.6, 2]; (2, 2.4]; (2.4, 2.8]; (2.8, 3.2]; (3.2, \dots)\}$. These 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. However, it can be seen from Figure 8 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 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.

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

Proposition 3 asserts that if one looks at wage changes in a period immediately following one when the worker's (resp. the employer's) constraint was binding, wages should be raised (lowered) whenever outside opportunities improve (deteriorate), whereas when outside opportunities deteriorate (improve), wages should be lowered (raised) only if the deterioration 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 year effects and 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 9 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 on $\Delta u_{i,t}$ 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 7. Consider the results for workers for whom $\Delta w_{-1} > 0$ (first row in Table 7). 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 2 percent when the unemployment rate increases by more than 0.6 percentage points. 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 0.6 percentage points, and by about 3 percent when the decline in the unemployment rate is larger than 0.6 percentage points. The second row of Table 7 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 significantly 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 much smaller compared to the coefficient for "large" declines, but they both fail to attain conventional levels of statistical significance.

4.4 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 (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 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 Malcomson setting would generate the same wage dynamics as the insurance model. As a test to empirically distinguish this alternative explanation from the insurance story, consider the following. Risk averse workers are willing to accept a lower average wage in exchange for income stability. The desire for insurance is stronger where the volatility of outside opportunities is greater. Therefore, if the 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 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 8, 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 unemployment volatility 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.

5 Conclusions

I have considered a model of wage insurance in the employment relationship with enforcement problems 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 I presented indicates that wages are related to outside opportunities in a way consistent with the implications of 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.

First, I showed that with two-sided limited commitment, current wages should be correlated with both the best and the worst labor market conditions since the start of the job. Proxying external opportunities to workers with the local unemployment rate, I found that the highest and lowest unemployment rates since the start of the job have an independent effect on current wages, after controlling for the current unemployment rate, the unemployment rate prevailing at the time the job started and fully accounting for unobservable worker and firm heterogeneity. The estimates indicate that when the unemployment rate falls by one percentage point below its historical minimum, real wages rise by 2 percent. When the unemployment rate increases by one percentage point above its historical maximum, real wages suffer a 1.5 percent reduction. This is evidence that enforcement 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 outside opportunities since the start of the job. My results indicate that initial conditions do have an important effect on wages, but this effect weakens when changes in the unemployment rate since the start of tenure occur and virtually disappears if the changes are substantial. Workers starting their job during a bust earn wages 5-6 percent lower compared to workers starting during a boom. A substantial fraction of such wage differentials persists 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.

Finally, I have 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 how close to binding outside option constraints are. In my empirical analysis, I found 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 in unemployment. At the same time, for this group of workers, wages are negatively correlated to declines in the unemployment rate of any magnitude.

These findings lend support to the insurance model of the employment relationship where both the worker and the employer are free to take outside opportunities when doing so is in their best interest. On the other hand, alternative models of wage determination widely used in the literature such as the spot market model and Nash bargaining with continual surplus-splitting do not appear to be consistent with the data.

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6 Appendix

6.1 Proof of Proposition 1

[to be completed] Suppose that a longitudinal dataset is available including wage data on M workers entering the labor market in one of $t = 0, \dots, T$ calendar years. The data include, for each date t , information on wages, w_t , and the realizations of productivity $s_t \in \Phi = \{1, 2, \dots, S\}$ where s_t are independent and identically distributed. Suppose we run the following regression:

$$w_t = \alpha + \gamma_0 s_0 + \gamma_c s_t + \gamma_{\min} \left[\min \{s_j\}_{j=0}^t \right] + \gamma_{\max} \left[\max \{s_j\}_{j=0}^t \right] + \varepsilon_t \quad (\text{A1})$$

where ε_t is a random disturbance such that $E(\varepsilon_t | s_0, \dots, s_t) = 0$. Because the s_t , for $t = 0, 1, \dots, T$ are i.i.d., the regressors in (A1) are independent. To prove Proposition 1, I need to show that when wages w_t are determined according to Result 1, we have that $\text{plim } \hat{\gamma}_{\min} > 0$ and $\text{plim } \hat{\gamma}_{\max} > 0$. For convenience, I report Result 1 and Result 2 below:

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

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

It is helpful to begin by considering the one-sided limited commitment benchmark cases. Assume that the process according to which wages are determined follows the updating rule

implied by the version of the Thomas and Worrall (1988) model where the worker is free to terminate the employment relationship while the employer is committed to the contract. Recall that in this case, the wage is downward rigid, and it is given by

$$w_t = \max [w_0, \max\{\underline{w}(s_j)\}_{j=1}^t] \quad (\text{Result 1-LCW})$$

. To simplify the notation, assume that $w(s_0) = \underline{w}(s_0)$. Therefore, we can write $w_t = \max\{\underline{w}(s_j)\}_{j=0}^t = \underline{w}(\max\{s_j\}_{j=0}^t)$, where the last equality follows from Result 2. Two immediate implications are that, controlling for $\max\{s_j\}_{j=0}^t$, initial conditions (s_0), current conditions (s_t) and worst conditions since hiring ($\min\{s_j\}_{j=0}^t$) should be uncorrelated with current wages. Thus, $\text{plim} \widehat{\gamma}_0^{lcw} = 0$, $\text{plim} \widehat{\gamma}_c^{lcw} = 0$, and $\text{plim} \widehat{\gamma}_{\min}^{lcw} = 0$, where the superscript *lcw* stands for "limited commitment with worker mobility". As for $\text{plim} \widehat{\gamma}_{\max}^{lcw}$, we have

$$p \lim \widehat{\gamma}_{\max}^{lcw} = \frac{\text{cov} [w_t, \max\{s_j\}_{j=0}^t]}{\text{var} [\max\{s_j\}_{j=0}^t]} = \frac{\text{cov} [\underline{w}(\max\{s_j\}_{j=0}^t), \max\{s_j\}_{j=0}^t]}{\text{var} [\max\{s_j\}_{j=0}^t]} > 0$$

where the positive sign is a consequence of Result 2.

Let us now consider the one-sided limited commitment case with employer mobility and worker commitment, say because he or she has very high mobility costs. The wage updating rule is now given by:

$$w_t = \min [w_0, \min\{\overline{w}(s_j)\}_{j=1}^t] \quad (\text{Result 1-LCE})$$

Again, to simplify the notation, assume that $w(s_0) = \overline{w}(s_0)$. In this case, wages are upward rigid and $w_t = \min\{\overline{w}(s_j)\}_{j=0}^t = \overline{w}(\min\{s_j\}_{j=0}^t)$. Two immediate implications of this being the true model are that, controlling for $\min\{s_j\}_{j=0}^t$, initial conditions (s_0), current conditions (s_t) and the best realization of s since hiring ($\max\{s_j\}_{j=0}^t$) should be uncorrelated with current wages. Thus, $\text{plim} \widehat{\gamma}_0^{lce} = 0$, $\text{plim} \widehat{\gamma}_1^{lce} = 0$, and $\text{plim} \widehat{\gamma}_{\max}^{lce} = 0$, where the superscript *lce* stands for "limited commitment with employer mobility".

As for $\text{plim} \widehat{\gamma}_{\min}^{lce}$, we have:

$$p \lim \widehat{\gamma}_{\min}^{lce} = \frac{\text{cov} [w_t, \min\{s_j\}_{j=0}^t]}{\text{var} [\min\{s_j\}_{j=0}^t]} = \frac{\text{cov} [\overline{w}(\min\{s_j\}_{j=0}^t), \min\{s_j\}_{j=0}^t]}{\text{var} [\min\{s_j\}_{j=0}^t]} > 0$$

where the positive sign is a consequence of Result 2.

Now, consider the model with two-sided limited commitment. I will show that $\text{plim} \widehat{\gamma}_{\max}^{lc2}$ and $\text{plim} \widehat{\gamma}_{\min}^{lc2}$ (where *lc2* stands for "two-sided limited commitment") are *both* positive.

Let us consider $\text{plim} \widehat{\gamma}_{\max}^{lc2}$. The wage at time t , according to Result 1, is given by $w_t = \min(\max\{w_{t-1}, \underline{w}(s_t)\}, \overline{w}(s_t))$. The plim of the estimated coefficient on $\max\{s_j\}_{j=0}^t$ is therefore given by

$$\text{plim} \widehat{\gamma}_{\max}^{lc2} = \frac{\text{cov} \left[w_t, \max\{s_j\}_{j=0}^t \right]}{\text{var} \left[\max\{s_j\}_{j=0}^t \right]}$$

The covariance term in the numerator of the expression for $\widehat{\delta}_t^{LC}$ can be written as:

$$\begin{aligned} & \text{cov} \left(w_t, \max\{s_{t-j}\}_{j=0}^t \right) = \\ & = \text{cov} \left(w_t, \max\{s_{t-j}\}_{j=0}^t \mid I_t = 1 \right) * \Pr(I_t = 1) \\ & + \text{cov} \left(w_t, \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2 \right) * \Pr(I_t = 2) \\ & + \text{cov} \left(w_t, \max\{s_{t-j}\}_{j=0}^t \mid I_t = 3 \right) * \Pr(I_t = 3) \end{aligned}$$

where

$$I_t = \begin{cases} 1 & \text{if, as of time } t, \text{ the latest binding constraint was the firm's} \\ 2 & \text{if, as of time } t, \text{ the latest binding constraint was the worker's} \\ 3 & \text{if, as of time } t, \text{ no constraint was ever binding since time } 0 \end{cases}$$

Denoting with $t-i$ (for $i = 0, 1, \dots, t-1$) the date when the latest constraint was binding, the probabilities of these events are given by the following expressions:

$I_t = 1$ if, as of time t , the latest binding constraint was the firm's. If this happened at time $t-i$, it must be that no constraint was ever binding since then and up to time t . Hence,

$$\Pr(I_t = 1) = \sum_{i=0}^{t-1} \left\{ \Pr[\overline{w}(s_{t-i}) < w_{t-i-1}] \prod_{j=1}^i \Pr[\underline{w}(s_{t-i+j}) \leq w_{t-i-1+j} \leq \overline{w}(s_{t-i+j})] \right\}$$

$I_t = 2$ if, as of time t , the latest binding constraint was the worker's. If this happened at time $t-i$, it must be that no constraint was ever binding since then and up to time t . Hence,

$$\Pr(I_t = 2) = \sum_{i=0}^{t-1} \left\{ \Pr[w_{t-i-1} < \underline{w}(s_{t-i})] \prod_{j=1}^i \Pr[\underline{w}(s_{t-i+j}) \leq w_{t-i-1+j} \leq \overline{w}(s_{t-i+j})] \right\}$$

$I_t = 3$ if no constraint was ever binding from time 0 to time t . Hence,

$$\Pr(I_t = 3) = \prod_{q=1}^t \Pr[\underline{w}(s_{t-q+1}) \leq w_{t-q} \leq \bar{w}(s_{t-q+1})]$$

Now, if $I_t = 1$, i.e. if the firm constraint was binding at time $t - i$ and no constraint was ever binding after then, it must be that $w_{t-i+j} = \bar{w}(s_{t-i})$. Therefore, we can write

$$\text{cov}\left(w_t, \max\{s_{t-j}\}_{j=0}^t \mid I_t = 1\right) = \text{cov}\left(\bar{w}(s_{t-i}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 1\right)$$

It must also be true that the productivity realizations observed from time $t - i$ to time t must have all been greater or equal compared to that at time $t - i$, i.e. $s_{t-i} \leq \min\{s_{t-i+j}\}_{j=1}^i$, for if they were not, then the latest binding constraint would have occurred at a date later than $t - i$. We also know that at $t - i$, when the firm's constraint was binding, the productivity realization must have been lower compared to that at $t - i - 1$, i.e. $s_{t-i} < s_{t-i-1}$. Therefore, we know with certainty that $s_{t-i} \neq \max\{s_{t-j}\}_{j=0}^t$ and we have that

$$\text{cov}\left(\bar{w}(s_{t-i}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 1\right) = 0$$

So, conditional on the latest binding constraint having been the firm's, the covariance between $\max\{s_{t-j}\}_{j=0}^t$ and the current wage w_t is equal to zero.

If $I_t = 2$, i.e. if the worker's constraint was binding at time $t - i$ and no constraint was ever binding after then, it must be that $w_{t-i+j} = \underline{w}(s_{t-i})$. Therefore, we can write

$$\text{cov}\left(w_t, \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2\right) = \text{cov}\left(\underline{w}(s_{t-i}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2\right)$$

If the worker's constraint was the latest to bind, we know that the realizations of productivity observed from time $t - i$ to time t must have all been lower or equal compared to that at time $t - i$, i.e. $s_{t-i} \geq \max\{s_{t-i+j}\}_{j=1}^i$. We also know that at $t - i$, when the worker's constraint was binding, the productivity realization must have been greater compared to that at $t - i - 1$, i.e. $s_{t-i} > s_{t-i-1}$. This implies that s_{t-i} represents the best realization of productivity between period $t - i - 1$ and period t , i.e. $s_{t-i} = \max\{s_{t-j}\}_{j=0}^{i+1}$. This means that

$$\text{cov}\left(\underline{w}(s_{t-i}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2\right) = \text{cov}\left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2\right)$$

The last expression can be further decomposed as follows:

$$\begin{aligned}
& cov \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2 \right) \\
= & cov \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2, \underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}) = \max\{s_{t-j}\}_{j=0}^t \right) \\
& * \Pr \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}) = \max\{s_{t-j}\}_{j=0}^t \right) \\
& + \underbrace{cov \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2, \underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}) \neq \max\{s_{t-j}\}_{j=0}^t \right)}_{=0 \text{ by i.i.d.}} \\
& * \Pr \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}) \neq \max\{s_{t-j}\}_{j=0}^t \right) \\
= & cov \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2, \underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}) = \max\{s_{t-j}\}_{j=0}^t \right) \\
& * \Pr \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^{i+1}) = \max\{s_{t-j}\}_{j=0}^t \right) \\
= & cov \left(\underline{w}(\max\{s_{t-j}\}_{j=0}^t), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 2 \right) * \Pr \left(\max\{s_{t-j}\}_{j=0}^{i+1} = \max\{s_{t-j}\}_{j=0}^t \right)
\end{aligned}$$

Finally, if $I_t = 3$, i.e. if no constraint was ever binding between time 0 and time t , we must have that $w_t = w_0 \in [\underline{w}(s_0), \bar{w}(s_0)]$. Therefore, we can write

$$\begin{aligned}
& cov \left(w_t, \max\{s_{t-j}\}_{j=0}^t \mid I_t = 3 \right) \\
& = cov \left(w_0(s_0), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 3 \right) \\
= & cov \left(w_0(s_0), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 3, s_0 = \max\{s_{t-j}\}_{j=0}^t \right) * \Pr \left(s_0 = \max\{s_{t-j}\}_{j=0}^t \right) \\
& + cov \left(w_0(s_0), \max\{s_{t-j}\}_{j=0}^t \mid I_t = 3, s_0 \neq \max\{s_{t-j}\}_{j=0}^t \right) * \Pr \left(s_0 \neq \max\{s_{t-j}\}_{j=0}^t \right) \\
& = cov \left(w_0(\max\{s_{t-j}\}_{j=0}^t), \max\{s_{t-j}\}_{j=0}^t \right) * \Pr \left(s_0 = \max\{s_{t-j}\}_{j=0}^t \right) \\
& \quad + \underbrace{cov \left(w_0(s_0), \max\{s_{t-j}\}_{j=1}^t \right)}_{=0 \text{ by i.i.d.}} * \Pr \left(s_0 \neq \max\{s_{t-j}\}_{j=0}^t \right) \\
= & cov \left(w_0(\max\{s_{t-j}\}_{j=0}^t), \max\{s_{t-j}\}_{j=0}^t \right) * \Pr \left(s_0 = \max\{s_{t-j}\}_{j=0}^t \right)
\end{aligned}$$

Therefore, we end up with

$$\begin{aligned}
\text{plim} \widehat{\gamma}_{\max}^{lc2} &= \frac{\text{cov} \left[w_t, \max \{s_{t-j}\}_{j=0}^t \right]}{\text{var} \left[\max \{s_{t-j}\}_{j=0}^t \right]} \\
&= \frac{\text{cov} \left[\underline{w}(\max \{s_{t-j}\}_{j=0}^t), \max \{s_{t-j}\}_{j=0}^t \right]}{\underbrace{\text{var} \left[\max \{s_{t-j}\}_{j=0}^t \right]}_{= \text{plim} \widehat{\gamma}_{\max}^{lcw}}} \\
&\quad * \Pr \left\{ (I_t = 2) \cap \left(\max \{s_{t-j}\}_{j=0}^{i+1} = \max \{s_{t-j}\}_{j=0}^t \right) \right\} \\
&\quad + \frac{\text{cov} \left[w_0(\max \{s_{t-j}\}_{j=0}^t), \max \{s_{t-j}\}_{j=0}^t \right]}{\text{var} \left[\max \{s_{t-j}\}_{j=0}^t \right]} \\
&\quad * \Pr \left\{ (I_t = 3) \cap \left(s_0 = \max \{s_{t-j}\}_{j=0}^t \right) \right\}
\end{aligned} \tag{A2}$$

All the terms in (A2) are positive. This proves that $\text{plim} \widehat{\gamma}_{\max}^{lc2} > 0$. The expression for this plim is given by the expression obtained in the one-sided limited commitment case with worker mobility ($\text{plim} \widehat{\gamma}_{\max}^{lcw}$) and the probability that the $\max \{s_j\}_{j=0}^t$ was actually associated with the worker's constraint being binding (plus some term that depends on the initial conditions, the probability that $s_0 = \max \{s_j\}_{j=0}^t$ and that no constraint was ever binding after period zero).

Analogous reasoning leads to the conclusion that $\text{plim} \widehat{\gamma}_{\min}^{lc2} > 0$, so that both the highest and the lowest realizations of st since the time of hiring influence current wages under an insurance model with two-sided limited commitment.

6.2 Proof of Proposition 2

Consider two identical workers, denoted i and ii , hired by the same employer in periods $t_0(i)$ and $t_0(ii)$, with $t_0(ii) > t_0(i)$. Define the "cohort effect" as the non-zero difference between the worker's wages at any date $t \geq t_0(ii)$, i.e. $w_{i,t} - w_{ii,t}$, where $w_{i,t}$ and $w_{ii,t}$ are determined according to Result 1. Suppose that a cohort effect does exist, i.e. that at the time worker ii is hired we have that $w_{ii,t_0(ii)} - w_{i,t_0(ii)} \neq 0$ and suppose that it is the case that $w_{ii,t_0(ii)} > w_{i,t_0(ii)}$. For the cohort effect to vanish at time $t_0(ii) + 1$, it must be that some outside option constraint (the worker's or the employer's) binds for both workers. For the case where $s_{t_0(ii)+1} > s_{t_0(ii)}$, Result (2) implies that there is some $\chi(s_{t_0(ii)}) \in \Phi$ such that if $s_{t_0(ii)+1} \geq \chi(s_{t_0(ii)})$, then $w_{ii,t_0(ii)} < \underline{w}(\chi(s_{t_0(ii)}))$ and $w_{ii,t_0(ii)+1} = \underline{w}(\chi(s_{t_0(ii)}))$. Because we started with $w_{ii,t_0(ii)} > w_{i,t_0(ii)}$, $s_{t_0(ii)+1} \geq \chi(s_{t_0(ii)})$ also implies $w_{i,t_0(ii)+1} = w_{ii,t_0(ii)+1} = \underline{w}(\chi(s_{t_0(ii)}))$, and the cohort effect disappears. With $s_{t_0(ii)} < s_{t_0(ii)+1} < \chi(s_{t_0(ii)})$, either both worker's wages are unchanged, or only worker i 's wage would change, so that a "cohort

effect" would still be present. The same logic can be applied to the case where $s_{t_0(ii)+1} < s_{t_0(ii)}$.

6.3 Proof of Corollary 1

The proof is simply based on the fact that the probability that outside opportunities change enough to trigger wage renegotiation increases with calendar time. Let t_0 be the date the employment relationship begins, and let $w_{t_0} = w_0(s_{t_0})$ be the initial wage where $w_0(\cdot)$ is an increasing function of s . If the shocks s_t are *i.i.d.*, the contract wage in subsequent periods loses its dependence on s_{t_0} as soon as some outside option constraint becomes binding. Conversely, $w_{t_0+k} = w_{t_0}(s_{t_0})$ if no constraint was ever binding between times t_0 and $t_0 + k$, where k represents tenure on the job.

Define $\Omega(s^{t_0+k})$ as the set of states of the world (subset of Φ) such that, after history s^{t_0+k} , neither constraint is binding at time s_{t_0+k+1} .

$$\Omega(s^{t_0+k}) = \{s' \in \Phi \text{ s.t. if } s_{t_0+k+1} = s', \text{ then } \underline{w}(s') \leq w(s^{t_0+k}) \leq \bar{w}(s')\}$$

The probability that after k periods, neither the worker's outside option constraint nor the employer's have ever been binding is equal to

$$\Pr \{[s_{t_0+1} \in \Omega(s^{t_0})] \cap [s_{t_0+2} \in \Omega(s^{t_0+1})] \cap \dots \cap [s_{t_0+k} \in \Omega(s^{t_0+k-1})]\}$$

For $k = 0$, and for any $s_{t_0} = s$, we can write $w_0(s^{t_0}) = w_0(s_{t_0}) = w_0(s)$, and

$$\Omega(s^{t_0}) = \{s' \in \Phi \text{ s.t. if } s_{t_0+1} = s', \text{ then } \underline{w}(s') \leq w_0(s) \leq \bar{w}(s')\}$$

so that the set $\Omega(s^{t_0})$ depends only on s , the realization of s_{t_0} . Now, if $s_{t_0+1} \in \Omega(s^{t_0})$, then $w(s^{t_0+1}) = w(s_{t_0}) = w(s)$, and

$$\Omega(s^{t_0+1}) = \{s' \in \Sigma \text{ s.t. if } s_{t_0+2} = s', \text{ then } \underline{w}(s_{t_0+2}) \leq w(s) \leq \bar{w}(s_{t_0+2})\}$$

which again depends only on s , so that conditional on $s_{t_0+1} \in \Omega(s^{t_0})$, the set $\Omega(s^{t_0+1})$ is identical to $\Omega(s^{t_0})$. It follows that

$$\begin{aligned} & \Pr \{[s_{t_0+1} \in \Omega(s^{t_0})] \cap [s_{t_0+2} \in \Omega(s^{t_0+1})] \cap \dots \cap [s_{t_0+k} \in \Omega(s^{t_0+k-1})]\} \\ &= \left\{ \Pr [s_{t_0+k} \in \Omega(s^{t_0+k})] \right\}^k \end{aligned}$$

and this probability is decreasing in k because $\Pr [s_{t_0+k} \in \Omega(s^{t_0+k})] \leq 1$.

6.4 Proof of Proposition 3

Consider a worker in $G_{1,t}$ between periods t and $t + 1$. Let $s_t = s$, and $s_{t+1} = s'$. Consider first the case of $s' > s$. In this case, $w_{t+1} > w_t$ because $w_t = \underline{w}(s)$ and $w_{t+1} = \underline{w}(s') > \underline{w}(s)$, where the inequality follows from Result 2. Next, consider the case of $s' < s$. For each $s \in \Phi$, Result (2) implies that there is some $\chi(s) \in \Phi$ such that $w_{t+1} = w_t$ if $\chi(s) < s' < s$ and $w_{t+1} < w_t$ if $s' \leq \chi(s)$. Therefore, for workers in $G_{1,t}$, improvements in outside opportunities always lead to wage increases while deteriorations in outside opportunities lead to a wage reduction only if the deterioration is "large enough" i.e. if $|s' - s| \geq |\chi(s) - s|$. A similar argument leads to the conclusion that 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" i.e. if $|s' - s| \geq |\zeta(s) - s|$, where $\zeta(s) \in \Phi$ is such that $w_{t+1} = w_t$ if $s < s' < \zeta(s)$ and $w_{t+1} > w_t$ if $s' \geq \zeta(s)$.

FIGURE 1
Wage Dynamics

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.

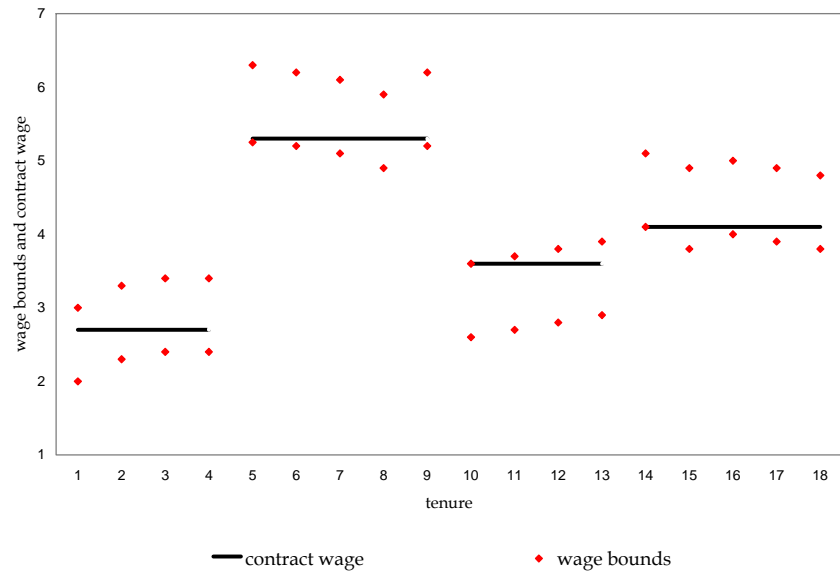


FIGURE 2
Cohort Effects

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 opportunities if they were hired at different times, i.e. under different economic conditions; however, with limited commitment, if outside opportunities change sufficiently to make the outside option constraints of both workers binding, the effect of initial conditions evaporates.

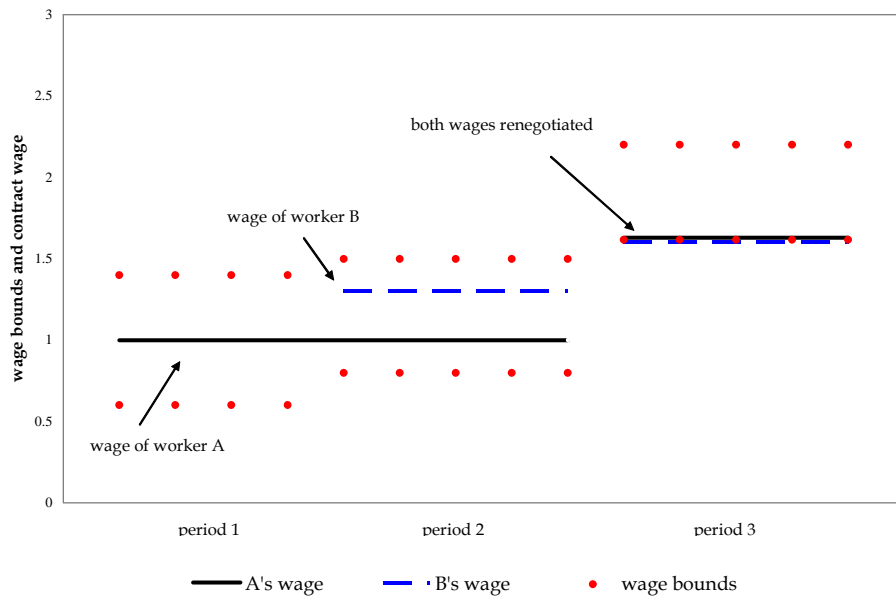
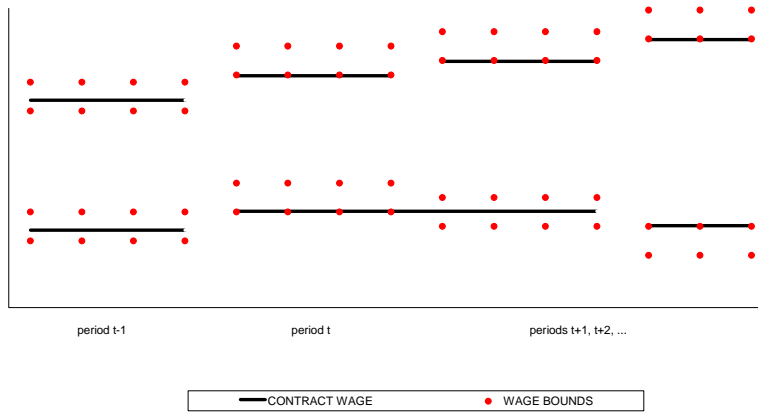
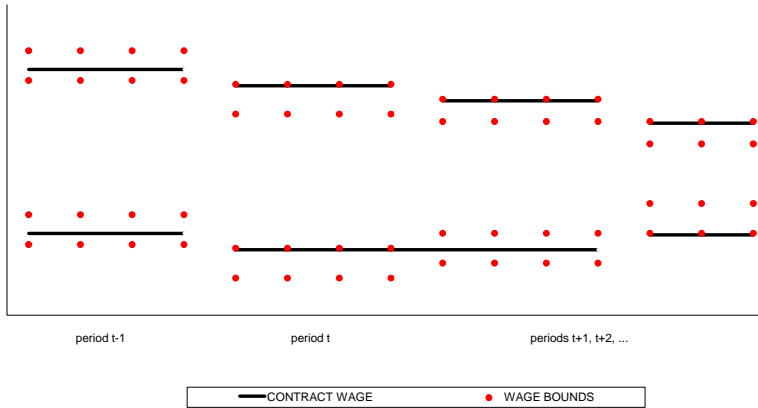


FIGURE 3
Asymmetric Response of Wages to Changes in Outside Opportunities

This Figure illustrates the asymmetric responsiveness of the contract wage to upward and downward, small and large 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. 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 should remain unchanged. In Panel 3B, I illustrate the case when the employer's outside option constraint is binding in period t .



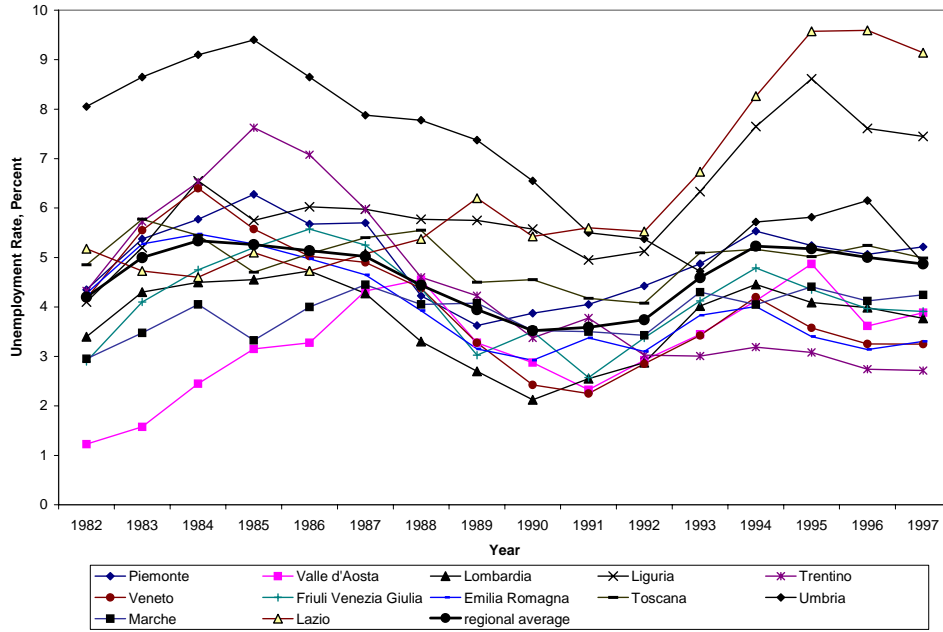
Panel 3A: Worker's Outside Option Constraint Binding in Period $t-1$



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

FIGURE 4

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



Panel 4B: Entry Level and Existing Workers Weekly Wages,
and Tenure Profiles by Year of Job Start, 1982-1997

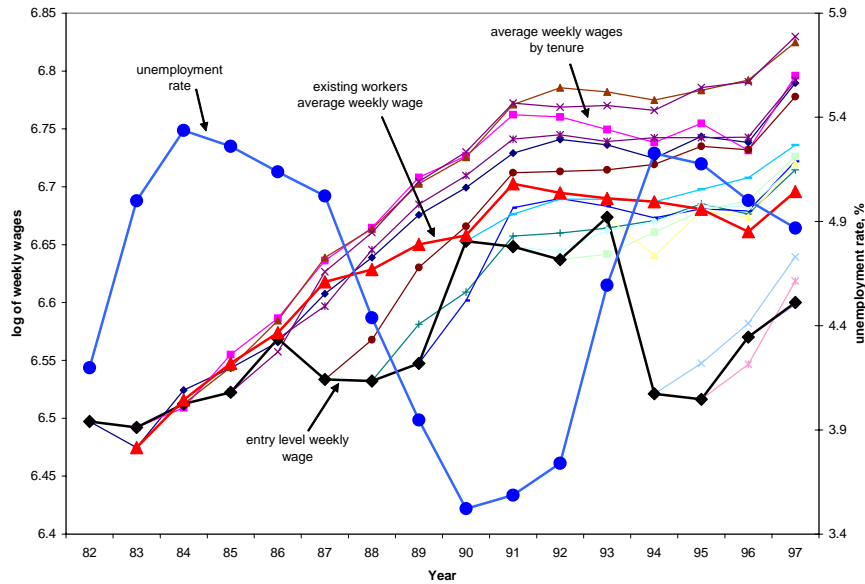


FIGURE 5
Ratio of Individual Earnings to Industry Minimum

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 figure plots the Kernel estimate of $f(R)$.

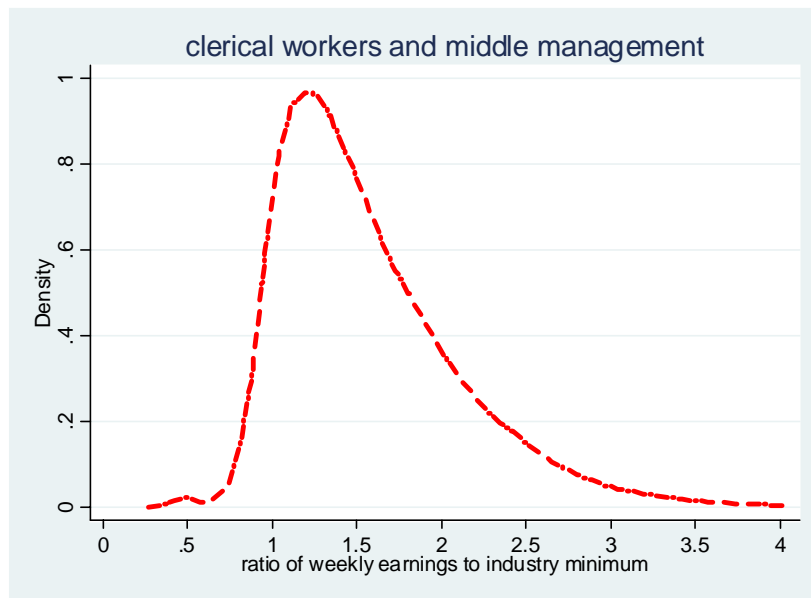
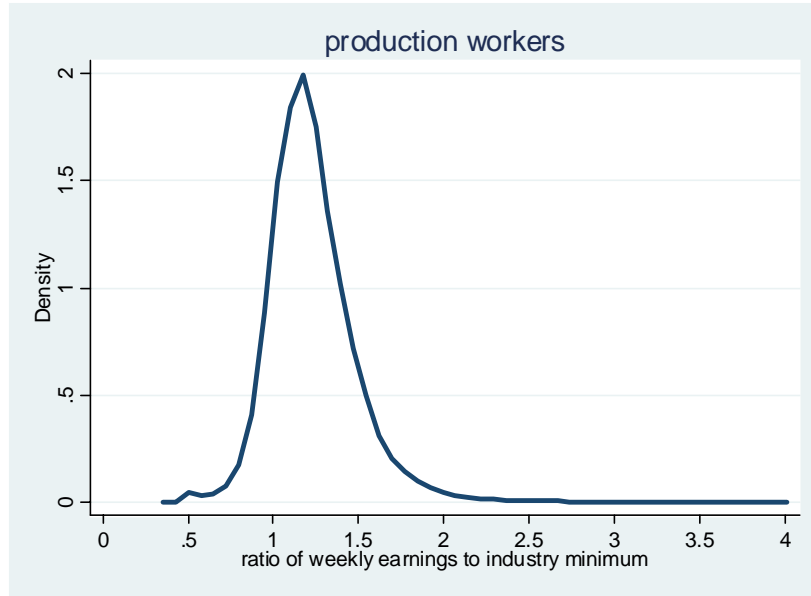
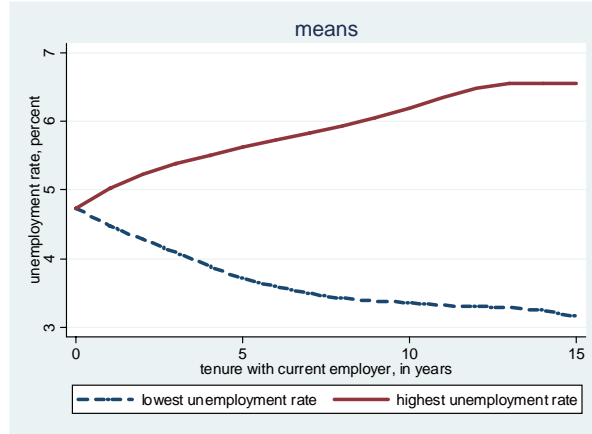


FIGURE 6

Panel 6A: Mean Lowest and Highest Unemployment Tenure Profiles



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

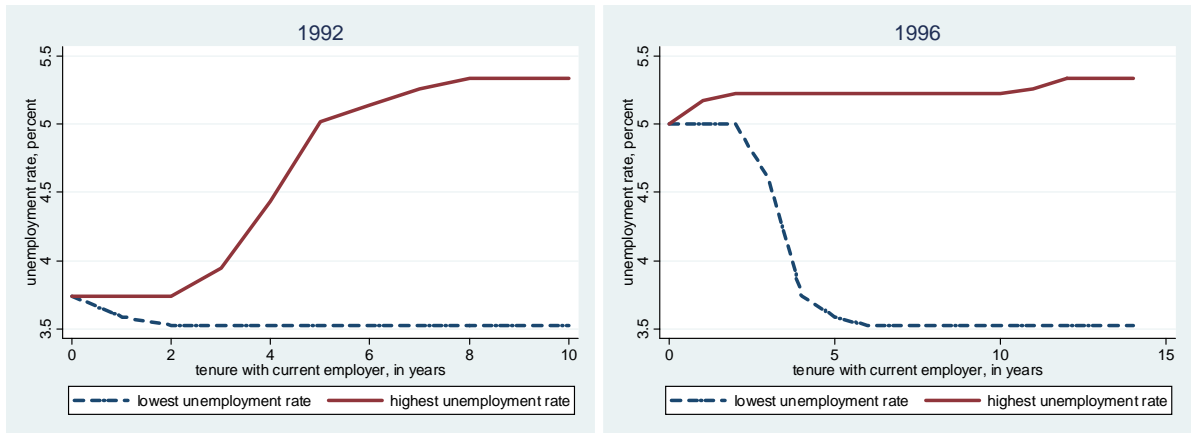


FIGURE 7
Alternative Labor Market Tightness Indicators
in Italy's CenterNorth

Unemployment Rate and Employment to Population (15-65) Ratio, 1982-1997

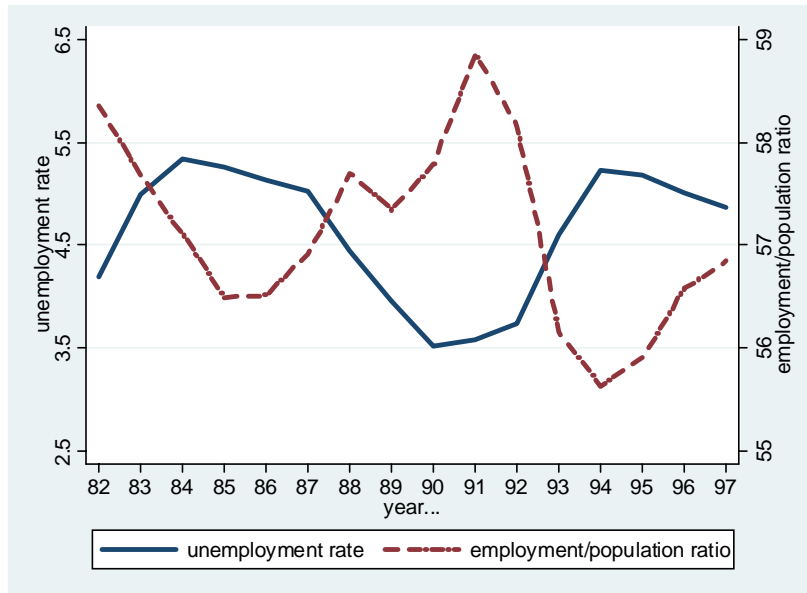
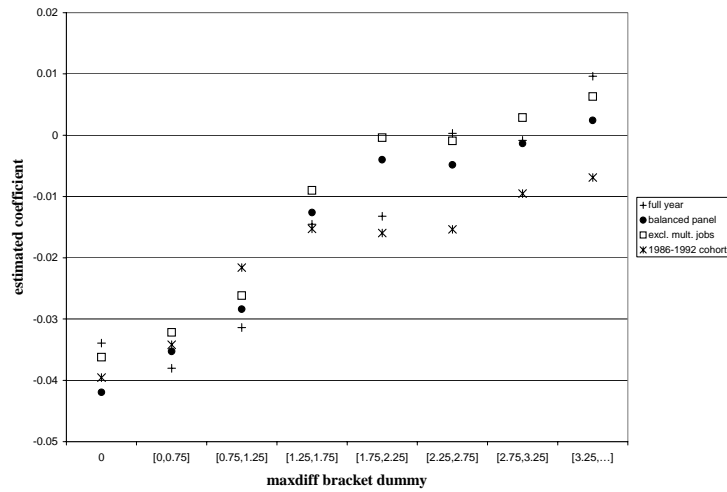


FIGURE 8
Effect of Initial Unemployment Rate on Wages
Sensitivity Analysis Results

This Figure reports coefficients from a log wage regression on the unemployment rate prevailing at the time of hiring interacted with maxgap brackets dummies. The variable MAXDIFF, defined in the text and in the Notes to Table 6, is a measure of the change in the unemployment rate since the time of hiring (proxying changes in outside opportunities to workers). See the Notes to Table 6 for additional details on variables description and controls.

Panel 8A: Controlling for Worker Fixed Effects



Panel 8B: Controlling for Worker and Firm Fixed Effects

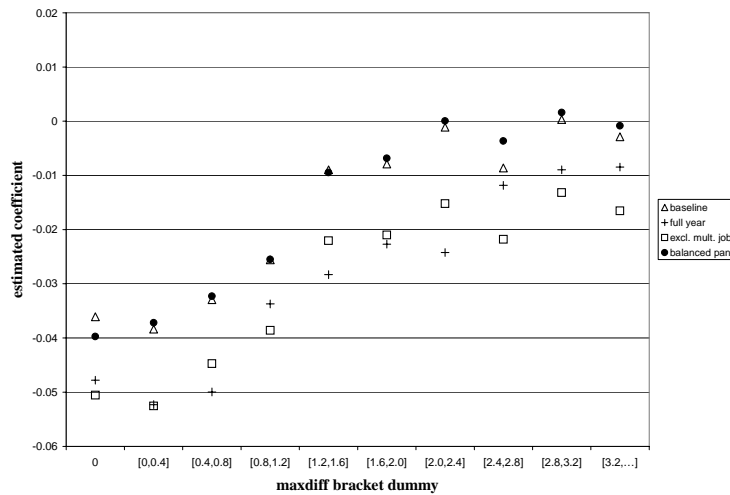


FIGURE 9
Distribution of Residual log Wage Changes

The figure displays the distribution of residual log wage changes, trimmed at 1st and 99th percentiles.

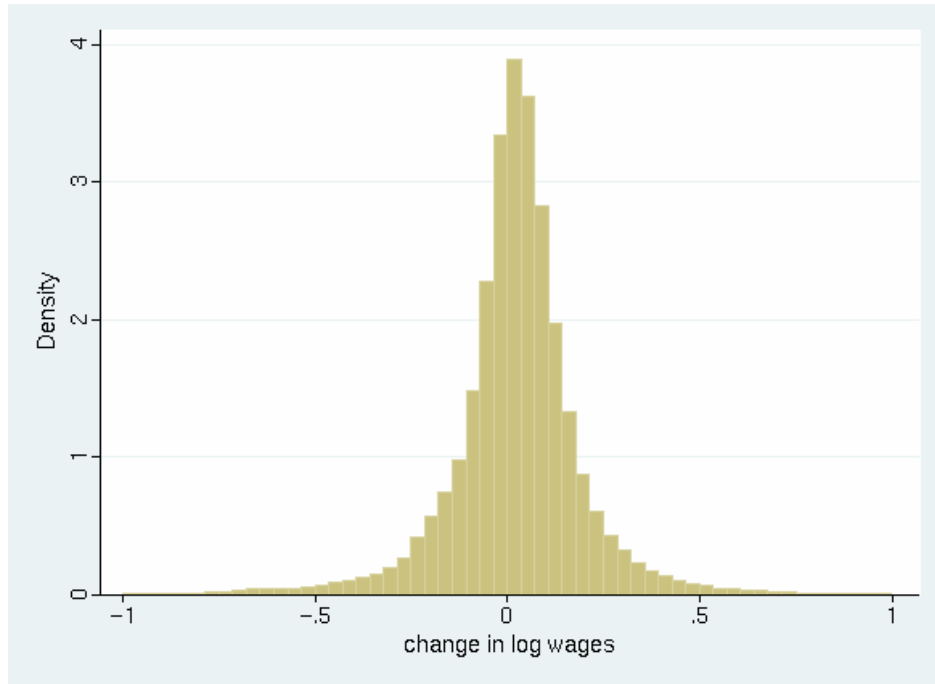


TABLE 1
INPS-CAD Dataset Summary Statistics

This table reports summary statistics for the INPS-CAD 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- year obs.	% production workers	age		wage ⁽¹⁾		tenure	
		mean	std	mean	std	mean	std
2,388,393	64.33	36.5	9.9	446	317	3.79	3.06

Panel B: by entry cohort

year of job start	cohort size	entry wage		tenure ⁽²⁾	
		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
Unemployment Rates Summary Statistics

The variables in Panel C are defined as follows. du is the year-to-year change in the unemployment rate, $|du|$ 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. $MAXDIFF = \max_{t_0 \leq j \leq t_0+t} |u_j - u_{t_0}|$, where t_0 is the date of hiring and t is tenure with the present employer. 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.

Panel A: Unemployment Rate, Employment Rate

	Standard			
	Average	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)	57.13	0.92	55.63	58.86
Regional	57.03	1.39	47.41	64.38

Panel B: Regional Unemployment and Employment Rates, Details

	Sample Size		Unemployment Rate		Employment Rate	
	Workers	Fraction	Average	Standard Deviation	Average	Standard Deviation
Piemonte	60,675	14.20	4.96	0.78	58.09	1.65
Valle d'Aosta	4,072	0.95	3.24	1.02	58.09	1.65
Lombardia	178,319	41.74	3.72	0.81	58.23	1.05
Liguria	11,219	2.63	6.15	1.18	60.75	1.76
Trentino	2,869	0.67	4.44	1.64	57.57	1.20
Veneto	27,857	6.52	4.03	1.20	55.16	1.17
Friuli Venezia Giulia	20,011	4.68	4.11	0.88	51.85	1.79
Emilia Romagna	52,771	12.35	4.00	0.88	61.97	0.82
Toscana	24,738	5.79	4.96	0.48	56.76	0.93
Umbria	5,144	1.20	6.98	1.56	54.86	1.05
Marche	11,939	2.79	3.87	0.44	60.49	2.32
Lazio	27,572	6.45	6.30	1.80	51.71	1.57

Panel C: Unemployment Rate Changes,
DIF and MAXDIF

	Regional Unemployment				
	du>0	du<0	du	DIF	MAX DIF
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 and Past Labor Market Conditions 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 (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 reported in Panel B also include worker fixed effects, while regressions whose results are reported 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 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.

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	1,998,134	1,998,134	1,998,134
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	1,998,134	1,998,134	1,998,134
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 Observations	regional 1,998,134	regional 1,998,134	regional 1,998,134
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 Observations	regional 1,998,134	regional 1,998,134	regional 1,998,134

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 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. UcInt indicates that interactions of tenure dummies with the current unemployment rate are included in the regression. U0Int 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 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.

	(1)	(2)	(3)	(4)	(5)	(6)
	FullYear (45 wks)	Excluding Mult. Jobs	Balanced Panel	Cohorts 1986-1992	UcInt	U0Int
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	1,998,134	1,998,134
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 eriod 1982-1997 and workers and workers continuously observed between the date of job start and 1997. UcInt indicates that interactions of tenure dummies with the current unemployment rate are included in the regression.

Panel A: Aggregate Unemployment Rate

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	FullYear (45 wks)	Excluding Mult. Jobs	Balanced Panel	Cohorts 1986-1992	UcInt
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	1,998,134	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)	(2)	(3)	(4)	(5)	(6)
	Baseline	FullYear (45 wks)	Excluding Mult. Jobs	Balanced Panel	Cohorts 1986-1992	UcInt
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	1,998,134	333,716	1,744,210	1,468,370	1,200,062	1,998,134
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)	(2)	(3)	(4)	(5)	(6)
	Baseline	FullYear (45 wks)	Excluding Mult. Jobs	Balanced Panel	Cohorts 1986-1992	UcInt
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	1,998,134	330,512	1,744,210	1,468,370	1,696,300	1,998,134
R Squared	0.28	0.39	0.30	0.30	0.23	0.28
Clusters	15	15	15	15	7	180

TABLE 6
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_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. $\text{MAXDIFF} = \max_{t_0 \leq j \leq t_0+t} |u_j - u_{t_0}|$, 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_0 (the unemployment rate at tenure start) with tenure dummies and of U_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 "year_of_job_start"-region.

Panel A: Pooled OLS

Tenure	U ₀ *Tenure		MAXDIFF	U ₀ *MAXDIFF	
	(1)	(2)		(3)	(4)
0	-0.035 (0.009)***	-0.036 (0.009)***	0	-0.030 (0.004)***	-0.036 (0.009)***
1	-0.026 (0.003)***	-0.028 (0.004)***	(0, 0.5]	-0.026 (0.003)***	-0.032 (0.009)***
2	-0.025 (0.003)***	-0.029 (0.004)***	(0.5 ,1]	-0.030 (0.005)***	-0.036 (0.010)***
3	-0.018 (0.003)***	-0.029 (0.005)***	(1 ,1.5]	-0.009 (0.004)**	-0.015 (0.008)*
4	-0.012 (0.003)***	-0.032 (0.005)***	(1.5 ,2]	-0.005 (0.011)	-0.009 (0.014)
5	-0.006 (0.003)*	-0.031 (0.005)***	(2 ,2.5]	-0.007 (0.007)	-0.012 (0.010)
6	-0.002 (0.002)*	-0.031 (0.006)***	(2.5 ,3]	-0.013 (0.006)**	0.012 (0.010)
7	-0.001 (0.003)	-0.031 (0.007)***	(3, ..]	-0.002 (0.005)	-0.004 (0.009)
8	-0.004 (0.003)	-0.031 (0.007)***			
9	-0.004 (0.004)	-0.034 (0.007)***			
10	-0.004 (0.005)	-0.040 (0.008)***			
Includes U ₀ *Tenure	yes	yes		no	yes
Includes U ₀ *MAXDIFF	no	yes		yes	yes
Unemployment Rate	regional	regional		regional	regional
Observations	1,998,134	1,998,134		1,998,134	1,998,134
Number of Clusters	180	180		180	180
R-Squared	0.54	0.54		0.54	0.54

TABLE 6 - continued from previous page

Panel B: Worker Fixed Effects

Tenure	U ₀ *Tenure		MAXDIFF	U ₀ *MAXDIFF	
	(1)	(2)		(3)	(4)
0	-0.035 (0.012)***	-0.035 (0.011)***	0	-0.029 (0.005)***	-0.035 (0.011)***
1	-0.022 (0.004)***	-0.025 (0.004)***	(0, 0.5]	-0.025 (0.004)***	-0.034 (0.011)***
2	-0.022 (0.004)***	-0.027 (0.005)***	(0.5 ,1]	-0.021 (0.003)***	-0.031 (0.012)***
3	-0.015 (0.004)***	-0.026 (0.004)***	(1 ,1.5]	-0.004 (0.005)	-0.017 (0.011)
4	-0.005 (0.004)	-0.024 (0.005)***	(1.5 ,2]	0.002 (0.009)	-0.011 (0.014)
5	-0.003 (0.004)	-0.019 (0.005)***	(2 ,2.5]	0.001 (0.009)	-0.012 (0.014)
6	0.007 (0.004)*	-0.018 (0.006)***	(2.5 ,3]	0.006 (0.005)	0.006 (0.013)
7	0.011 (0.005)**	-0.015 (0.006)***	(3, ..]	0.009 (0.006)	-0.005 (0.013)
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	1,998,134	1,998,134		1,998,134	1,998,134
Number of Clusters	180	180		180	180
R-Squared	0.20	0.20		0.20	0.20

TABLE 7
Asymmetric Response of Wage Changes to Unemployment Changes

The dependent variable is the residual wage change obtained from regressing raw yearly wage changes on year 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", etc... 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 regressions also include worker fixed effects to account for individual unobserved heterogeneity in residual wage growth. 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 (0.008)	-0.017 (0.008)**	-0.011 (0.005)**	-0.029 (0.009)***
predicted	=0	<0	<0	<0
$\Delta w_{-1} < 0$	-0.008 (0.011)	-0.018 (0.017)	-0.002 (0.006)	-0.029 (0.008)***
predicted	<0	<0	=0	<0
Unemployment Rate	regional			
Observations	1,096,302			
Number of Clusters	165			

TABLE 8
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 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. The specifications in Columns (3) and (4) also control for worker random effects.

	(1)	(2)	(3)	(4)
standard deviation of unemployment rate	-0.051 (0.008)***	-0.050 (0.004)***	-0.051 (0.009)***	-0.051 (0.008)***
control for unemployment rate	no	yes	no	yes
Observations	400,842	400,842	400,842	400,842
Number of Regions	12	12	12	12
Worker Random Effects	no	no	yes	yes
R-Squared (overall)	0.52	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	