Labor Market Institutions, Employment, and Wage Dynamics

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(PRELIMINARY AND INCOMPLETE)

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Abstract

In many European countries labor market regulations are pervasive. They take the form of wage floors (dependent, for instance, on a worker’s job history), hiring and firing restrictions, automatic promotions, and constraints to pay growth. What are the implications of these regulations for individual employment and wage dynamics and for the aggregate wage distribution? We answer this question by developing and estimating an equilibrium model of the Italian labor market using matched employer-employee data from the Work Histories Italian Panel (WHIP) merged with unique information on the constraints implied by national collective labor agreements (Contratto Collettivo Nazionale del Lavoro or CCNL). In the model ex-ante skill-heterogeneous workers and homogeneous firms match frictionlessly and are subject to the most salient regulations implied by CCNLs. The model can replicate, qualitatively and quantitatively, the main features of the dynamics of employment and wages: unemployment to employment and job-to-job transitions, wage growth (with tenure and experience), and downward wage rigidities. It can also largely explain the cross-sectional distribution of wages. Absent the labor market regulations we consider, the model would generate counterfactual predictions about the dynamics of wages and unemployment. Based on these results, we conclude that policy frictions offer an explanation for the dynamics of wages and employment observed in European labor markets that is naturally complementary to that provided by search frictions.

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1 Introduction

We consider a set of labor market regulations common in continental European countries (exogenous as well as endogenous minimum wage floors dependent on a worker’s job history, hiring and firing costs, and constraints on pay growth) and explore their effects on individual employment and wage dynamics and on the aggregate wage distribution. To this purpose, we develop and estimate an equilibrium model with heterogeneous workers and multi-job firms using Italian matched employer-employee data from the Work Histories Italian Panel (WHIP), which contain pay and between-firm as well as within-firm career information for a large sample of Italian workers employed at some point over the period 1994-2000. We merge to these data detailed information on the constraints implied by Italian national collective labor agreements, *Contratto Collettivo Nazionale del Lavoro* (CCNL) or National Collective Employment Contract, and analyze firm and worker behavior under these restrictions. Specifically, we model the following constraints of national employment contracts: (1) wage floors for each of the positions in the institutional job ladder of a firm; (2) dismissal/firing restrictions; (3) demotion restrictions; and (4) automatic promotions.

We show that, in the absence of frictions to labor market search, a model that explicitly incorporates these constraints can replicate salient features of the dynamics of job changes and of wage growth with tenure and experience, and largely explain the cross-sectional distribution of wages and of workers across employment and unemployment. In particular, even if firms are ex ante identical, the model generates a rich employment dynamics that would be absent without labor market restrictions.

When we allow for frictional labor market search, our estimates imply that the labor market policies in place in a number of European countries to a large extent account for the search frictions commonly estimated based on micro-level data. We show that interpreting search frictions as policy frictions has important implications for the impact of changes in the minimum wage and related policies on employment and wages.

This paper relates to three strands of literature. First, the literature on the effects on welfare and employment of minimum wages and other labor market regulations such as dismissal restrictions. Second, the literature on job assignment, workers’ careers within a firm, and firm wage policies. Third, the literature on real and nominal rigidities and their impact on real labor market outcomes such as job and wage dynamics.
We think of our unconstrained model without labor market restrictions as the full efficiency benchmark against which to compare the model that incorporates policy, and later search, constraints. The models developed in the literature to study the implications of a minimum wage are typically monopsonistic models and/or models with imperfections that lead to inefficiencies to arise even in the absence of government interventions. Those imperfections render the efficiency implications of a minimum wage a non obvious empirical question, that is, a minimum wage may be welfare improving. (See, for instance, Flinn (2006).) In our setting our focus will be to: (i) identify circumstances under which certain combinations of policies have an unambiguous efficiency and welfare impact, (ii) when their overall impact implies an equity-efficiency trade-off, assess the magnitude of the effect of these combinations of policies on labor market efficiency and welfare; and (iii) in either case, analyze and estimate the effect of the combination of various policies on job and wage mobility and life-cycle wage growth.

2 Employer-Employee and Labor Market Regulations Data

2.1 The Institutional Background

The core component of our data is an Italian matched employer-employee data, the so-called WHIP (Work Histories Italian Panel). In addition, we have constructed the time series of wage floors by industry, level in the job ladder, and seniority for the period 1980-2004 as implied by CCNLs. Here we start with an historical description of the recent evolution of the system of wage bargaining. Next, we describe the content of the sector-specific national contracts, the CCNLs. The components of the contractual wage and of the total pay are then discussed. We point out the provisions concerning the accumulation of seniority as relevant for wage floors. We review the basic provisions in terms of promotions and demotions. We conclude with an overview of the regulations pertaining to firing and unemployment.

We present a complete overview of the institutional constraints for two reasons. On the one hand, wage floors besides the lowest minimum wage become most relevant in conjunction with restrictions on demotions, firing, and automatic promotions. On the other hand, the effects of the lowest minimum wage are influenced by the magnitude and conditionality of other policy instruments, like unemployment benefits.

Until 1993 two non-coordinated non-specialized wage bargaining levels (industry-wide and firm-wide) were in place in Italy, plus automatic price indexation (Scala Mobile). The July
1993 Income Policy Agreement (IPA) abolished the indexation clause and introduced a new bargaining system. The IPA was signed after a long period of high inflation; the automatic wage indexation clause generated a real wage rigidity hardly compatible with the severity of the Italian economic outlook at the beginning of the 1990s: high public finance imbalances and the resulting risk of failing to meet the requirements of the Maastricht Treaty. The IPA explicitly stated two objectives: curbing the inflationary pressure and making wages more responsive to local labor market conditions.

After 1993, in the novel hierarchy of specialized bargaining levels, the industry-wide national level (Contrattazione Collettiva Nazionale, hence forth CCN) is specifically devoted to defend the purchasing power of wages, now set according to the Government’s targeted rate of inflation. The regional (Contrattazione Sindacale Territoriale, henceforth CST) or firm (Contrattazione Integrativa Aziendale, henceforth CIA) level is instead devoted to the distribution of additional (topup) components, that is, wage components over and above the industry-wide contractual wage, and is now set according to firms’ performance and local conditions. The resulting decentralization changed substantially the nature of the top-up components. Moreover, as unions agreed on setting low inflation targets, wages set at the national level saw a new phase of moderation, which allowed for market-driven top-up components of pay to play a greater role.

The industry-wide national contracts regulate a worker’s rights. CCNLs are bargained by trade unions and employers’ organizations. The Italian government mediates the bargaining process and signs into law the agreed-upon contracts. A CCNL applies to all employers, irrespective of their membership in one of the employers’ organizations representing firms, and all workers, irrespective of a worker’s union membership status.

A CCNL is active for a period of 4 years. However, minimum wage provisions expire after 2 years. Delays (not uncommon) in the biannual renegotiations of the minimum wage provisions imply a “contractual vacation” allowance (henceforth IVC). IVC is a temporary component of pay related to the targeted inflation rate and paid to workers starting from the fourth month following the expiration of the CCNL.

1 The treaty formally instituted the European Union and led to the creation of the single European currency, the euro. The Maastricht requirements, also known as convergence criteria, are rules in terms of inflation rates, government finances, exchange rates, and long-term interest rates, set by the treaty for European Union member states to enter the third stage of European Economic and Monetary Union (EMU) and adopt the euro as their currency.

2 IVC equals 30% of the targeted inflation rate applied to the minimum wage and raises to 50% from the...
A CCNL establishes a common job-ladder for all firms belonging to the sector or sub-sector to which it pertains. We will refer to this job ladder as the institutional job ladder. The CCNL describes in details the tasks, complexity, specialization, and responsibility level pertaining to a worker assigned to each rung of the ladder. Some topics are not regulated within the CCNL. Instead, they are left to collective agreements signed at the firm level, CIA. Examples of such topics are firm-level performance pay components, workplace safety, and issues concerning job ladders (within what established in the CCNL).

### 2.2 Minimum Wage and Discretionary Pay Components

The contractual wage, as regulated by a CCNL, consists of the sum of several components defined on a per month basis. First, given the position or level of the worker in the institutional job ladder of the employing firm, and given his or her seniority, the CCNL establishes a wage floor (Minimo Tabellare). Whether a worker’s seniority accumulates with time at the firm or with time at a specific level within a firm varies across CCNLs and sectors.

Second, after IPA and until 2001, a time-invariant cost-of-living allowance was to be added to the wage floor to obtain the total base pay.\(^3\) The cost-of-living allowance is typically level-specific. After 2001, wage floors directly incorporate the cost-of-living allowance.

Finally, the total base pay may contain other allowances also set in the CCNL (that is, related to travel expenses, risky tasks, meals, and similar) and some sporadic topups. Topups are typically present in conjunction with a IVC or following the renewal of a CCNL when the realized inflation surpassed projected inflation. Most CCNLs establish that a worker is to be paid two months of pay in the month of June and December (tredecima and quattordicesima).\(^4\)

The wage earned by a worker may be above the contractual base pay due to three major components: (1) a firm-specific premium common to all or most workers employed at a firm (Premio Aziendale) and defined within the CIA (often level-specific); (2) a regional or local topup common to all workers employed at firms located in a given area (Terzo Elemento) and defined within the CST; (3) an individual-specific discretionay topup (Assegno ad personam, Assegno di merito, Premio Incentivante). The CCNL suggests the determinants of the firm-seventh month following the expiration of the CCNL.

\(^3\)A small component, which we do not distinguish from the cost-of-living allowance, is also added, the so-called Elemento Distinto della Retribuzione.

\(^4\)More precisely, in June of each year a worker receives his pay times two. In December of each year, he receives his pay plus the average of the monthly pay for the calendar year.
specific premium and lists the levels at which an individual specific topup may be granted. It does not constrain in any way their respective amounts.

An important distinction exists with reference to the individual-specific topup. First, the topup may or may not withstand wage increases. Specifically, unless stated otherwise in the employment contract, individual topups are reduced (until being eliminated) if the pay increases for other reasons.\footnote{This is the so called \textit{criterio di assorbibilità generale del superminimo} and a topup that is irreducible is referred to as \textit{contrattualizzato}. The two main topups are the \textit{Assegno di Merito}, which is irreducible, and the \textit{Assegno ad personam}, which is reduced unless stated otherwise.} Three typical examples of such situations are (1) when a worker is promoted to a higher level and the base pay at the destination level is higher than the base pay at the level of origin plus the topup; (2) when a worker’s seniority increases and the corresponding increase in base pay leads to a base pay not inclusive of the topup that is higher than the base pay plus topup in the pre-existing seniority class; (3) when, following the renewal of a CCNL, the base pay of the worker is increased.

In all the above cases, it is possible that the pay received by the worker remains unchanged, despite a promotion, an increase in seniority, and an improvement in base pay. On the other hand, if a topup is irreducible, it effectively becomes an additional component of non-discretionary pay because it applies to all future periods (as long as the employment relationship lasts) irrespective of the worker’s future performance. In fact, whether a topup (possibly granted as discretionary) remains discretionary is the second important distinction. The typical example of discretionary topups are bonus paid based on individual or branch performance during the previous year.

3 A Baseline Model Without Search Frictions

We consider a labor market in which ex ante identical firms compete for workers who differ in their skills or productivity level, $s$. A firm’s technology is linear in each worker’s output and output is linear in each worker’s skill. We assume that firms face hiring and dismissal costs, and are required to pay workers wages above a minimum that is time-varying and dependent on a worker’s job history. For simplicity, for the moment we assume that labor market search is frictionless and the jobs of all firms are identical, so we abstract from demotion and promotion restrictions. We denote by $\beta^f$ the discount factor of firms and by $\beta^w$ the discount factor of workers. Workers are finitely-lived, whereas firms are infinitely-lived. Given the substitutability of workers in production, for most of what follows we will consider the
component problem of firms competing for one worker at a time.

The state variables of the economy are a worker’s productivity level in the current period, \( s \), the worker’s age, \( t \in \{1, 2, \ldots, T\} \), the worker’s tenure status at the beginning of a period (or the end of last period, before the realization of the employment decision in the current period), \( j \in \{0, 1, 2, \ldots, T\} \), and the worker’s last paid wage, \( w^- \). If a worker just enters the labor market, then we assume \( w^- = 0 \). For the moment, we also assume that the one-period utility of an unemployed worker is zero. (In the current setup, this assumption is just a normalization.) Note that if \( j = 0 \), then the worker was unemployed in the last period.

After observing the state variables, firms simultaneously compete to hire unemployed and employed workers. We term prospective employers as poachers. To employ a worker, poachers need to pay a hiring cost, \( \phi \). We say that poachers are active if given the minimum wage a worker is entitled to and his skill, prospective firms are able to offer wages that allow them to at least break even.

When there are no poachers, an incumbent firm’s problem just consists in choosing whether to retain a worker or not. If the incumbent firm chooses to dismiss the worker, it has to pay a firing cost, \( \kappa \). When poachers are active, if the incumbent firm wishes to retain a worker, it has to at least match the expected present discounted value of wages that the poacher’s wage offer entails. If the incumbent firm makes an offer that induces the worker to leave, it needs to pay a different cost, \( \chi \), which we interpret as severance pay (here, defined as a dismissal cost upon a job-to-job transition). When a competing firm attempts to poach an employed worker, the state variable that such a firm faces at the beginning of a period is also \((s, t, j, w^-)\), and if such a firm successfully attracts the worker, the worker’s tenure in the end of this period is \( j = 1 \), i.e., the successful poaching firm counts the worker’s tenure status from the beginning..

We distinguish three types of endogenous minimum wage, which capture the possibility of policy-mandated constraints on pay that lead to wage rigidity and differ by a worker’s employment status and tenure:

1. If \( j = 0 \) and a firm wants to hire a worker, then its wage offer must be at least equal to a certain proportion, \( \theta_0 \), of the worker’s last paid wage, \( w^- \). Hence, the wage floor in this case is \( \theta_0 w^- \).

2. If \( j \geq 1 \) and a poaching firm wants to hire a worker—from the point of view of this firm, the worker has tenure zero—then the poacher’s wage offer must be at least equal to a
different proportion, \( \theta_1 \), of the worker’s last paid wage, \( w^- \). Hence, the wage floor in
this case is \( \theta_1 w^- \).

3. If \( j \geq 1 \) and the incumbent firm wants to keep the worker—from the point of view of
this firm, the worker has positive tenure—then the incumbent firm’s wage offer must be
at least equal to a different proportion, \( \theta_2 \), of the worker’s last paid wage, \( w^- \). Hence,
the wage floor in this case is \( \theta_2 w^- \).

The three parameters \( \theta_0, \theta_1, \) and \( \theta_2 \) determine the degree of ‘stickiness’ of paid wages.

Besides the endogenous wage floor, we also assume firms face time-varying exogenous minimum
wage constraints, denoted by \( w_j \) for a worker at tenure \( j \), which reflect the time-varying wage
floors prescribed by CCNLs described in the previous section

### 3.1 Poachers

Consider the problem of poachers. There are infinitely many potential firms, so the present
value of profits for a poacher can only be zero or negative. If poachers make zero profit, the
wage they offer satisfies

\[
 s - w_p^t(s, j, w^-) - \phi + \beta E[V^{t+1}(s', 1, w_p^t(s, j, w^-)) | s] = 0,
\]

where \( \phi \) is the hiring cost and \( V^{t+1}(s, j, w^-) \) is the value function when poachers become
incumbent firms in the next period, which we discuss later. We use \( w_p^t(s, j, w^-) \) to denote
the wage offer that leads a poacher to make zero profits. Note that poachers also have to
respect the exogenous and the endogenous wage floors discussed above. Here, we distinguish
two cases:

1. Case 1: \( j = 0 \), the worker is unemployed in the last period. Poachers are active if

\[
 w_p^t(s, j, w^-) \geq \max\{w_1, \theta_0 w^-\};
\]

2. Case 2: \( j \geq 1 \), the worker is employed in the last period. Poachers are active if

\[
 w_p^t(s, j, w^-) \geq \max\{w_1, \theta_1 w^-\}.
\]
If $w_p^j(s, j, w^-) < \max\{w_1, \theta_0 w^-\}$ for the case $j = 0$ or $w_p^j(s, j, w^-) < \max\{w_1, \theta_1 w^-\}$ for the case $j \geq 1$, then to hire the worker a poacher incurs a negative profit, so there will be no poachers. We denote by $I_p^t(s, j, w^-)$ the indicator function for poachers, where $I_p^t(s, j, w^-) = 1$ denotes that there are active poachers.

Specifically, when $j = 0$, $I_p^t(s, 1, w^-) = 1$ if $\hat{w}_p^t(s, j, w^-) \geq \max\{w_1, \theta_0 w^-\}$. When $j \geq 1$, $I_p^t(s, j, w^-) = 1$ if $\hat{w}_p^t(s, j, w^-) \geq \max\{w_1, \theta_1 w^-\}$

### 3.2 Incumbent Firms

Consider an incumbent firm’s problem, that is, the problem of a firm competing for a worker it has employed in the previous period. The firm may fire the worker or let him leave to a different firm. We use $\Omega^t(s, j, w^-)$ to denote the value of the firm if it decides to retain the worker, which may not be optimal. Essentially, if there are no active poachers, the incumbent firm must decide whether to retain or dismiss the worker. If there are active poachers, the incumbent firm must decide whether to retain the worker or let the worker leave.

For $j \geq 1$ and $t \in \{1, \ldots, T\}$, we can rewrite the firm’s value function as

$$V^t(s, j, w^-) = I_p^t(s, j, w^-) \max \{\Omega^t(s, j, w^-), -\chi\}$$

$$+ [1 - I_p^t(s, j, w^-)] \max \{\Omega^t(s, j, w^-), -\kappa\}.$$  

Note that we assume here that if there are active poachers, a worker cannot be unemployed since any offer he receives is such that the prospect of employment is at least as attractive as that of unemployment.

If there are poachers, that is, $I_p^t(s, j, w^-) = 1$, and the incumbent firm wants to keep hiring the worker, then the incumbent firm needs to offer a counter wage $w_c$ that makes the worker prefer to stay at the incumbent firm than to leave it,

$$w_c + \beta^w E\left\{U^{t+1}[s', j + 1, w_c] \mid s\right\} \geq w_p^t(s, j, w^-) + \beta^w E\left\{U^{t+1}[s', 2, w_p^t(s, j, w^-)] \mid s\right\},$$  \hspace{1cm} (1)

where $U^t(s, j, w^-)$ is the value function of workers that we specify later. We denote the set of wages that satisfy (1) as $W^t_c(s, j, w^-)$. The value of the firm if it chooses to retain the worker is given by

$$\Omega^t(s, j, w^-) = \max_w \{s - w + \beta^f E[V^{t+1}(s', j + 1, w) \mid s]\},$$  \hspace{1cm} (2)
subject to
\[ w \geq \max\{w_{j+1}, \theta_2 w^-\} \text{ and } w \in \mathcal{W}_c(s, j, w^-). \]

If there are poachers, that is, \( I'_p(s, j, w^-) = 0 \), then the value of the firm if it chooses to hire the worker is given by
\[ \Omega'(s, j, w^-) = \max_w \left\{ s - w + \beta E [V^{t+1}(s', j + 1, w) | s] \right\}, \tag{3} \]
subject to
\[ w \geq \max\{w_{j+1}, \theta_2 w^-\}. \]

Let \( I'_i(s, j, w^-) \) be an indicator function that denotes whether the incumbent firm wishes to retain the worker. If the firm retains the worker, we use \( w'_i(s, j, w^-) \) to denote the incumbent firm’s wage offer, which solves the firms problem (2) or (3) depending on whether there are active poachers.

For \( j = 0 \), an incumbent firm’s problem reduces to the poachers’ problem. For \( t = T + 1 \), we have \( V^{T+1}(s, j, w^-) = 0 \).

### 3.3 Workers

At the start of a period, the state variable for a worker is \((s, t, j, w^-)\). From the discussion in the previous subsection, we use \( w'_i(s, j, w^-) \), to denote the actual wage received by a worker and \( J'(s, j, w^-) \) to denote the worker’s tenure status in the next period. Then,

\[
w'_i(s, j, w^-) = \begin{cases} 
    w'_i(s, j, w^-), & \text{if } I'_p(s, j, w^-) = 1 \text{ and } I'_i(s, j, w^-) = 1 \\
    w'_p(s, j, w^-), & \text{if } I'_p(s, j, w^-) = 1 \text{ and } I'_i(s, j, w^-) = 0 \\
    w'_i(s, j, w^-), & \text{if } I'_p(s, j, w^-) = 0 \text{ and } I'_i(s, j, w^-) = 1 \\
    \emptyset, & \text{if } I'_p(s, j, w^-) = 0 \text{ and } I'_i(s, j, w^-) = 0
\end{cases}
\]

and

\[
J'(s, j, w^-) = \begin{cases} 
    j + 1, & \text{if } I'_p(s, j, w^-) = 1 \text{ and } I'_i(s, j, w^-) = 1 \\
    1, & \text{if } I'_p(s, j, w^-) = 1 \text{ and } I'_i(s, j, w^-) = 0 \\
    j + 1, & \text{if } I'_p(s, j, w^-) = 0 \text{ and } I'_i(s, j, w^-) = 1 \\
    0, & \text{if } I'_p(s, j, w^-) = 0 \text{ and } I'_i(s, j, w^-) = 0
\end{cases}
\]
The value function for a worker is

\[ U^t(s, j, w^-) = \begin{cases} 
  w^t_f(s, j, w^-) \\
  + \beta w^t \mathbb{E} \left\{ U^{t+1} \left[ s', J^t(s, j, w^-), w^t_f(s, j, w^-) \right] | s \right\}, & \text{if } J^t(s, j, w^-) \geq 1 \\
  w^t_f(s, j, w^-) \\
  + \beta w^t \mathbb{E} \left\{ U^{t+1} \left[ s', J^t(s, j, w^-), w^- \right] | s \right\}, & \text{if } J^t(s, j, w^-) = 0 
\end{cases} \]

Recall that we assume that if a worker is unemployed, then \( w^- \) is the last wage received by the worker.

3.4 Example: Equilibrium in the Last Period

To see how the model works, consider the last period, where \( V^{T+1}(s, j, w^-) = U^{T+1}(s, j, w^-) = 0 \). The state variable for the incumbent firm is \( (s, T, j, w^-) \). Here we discuss the case where \( j \geq 1 \). The case in which \( j = 0 \) works analogously.

Consider first the scenario in which there are active poachers, that is, \( I^T_p(s, j, w^-) = 1 \), which requires

\[ w^T_p(s, j, w^-) = s - \phi \geq \max \{ w_1, \theta_1 w^- \} \tag{4} \]

Note that to make zero profit for poachers in the last period, the wage rate simply equals the difference between the productivity and the hiring cost. For the incumbent firm, we need to consider the following cases:

1. If \( w^T_p(s, j, w^-) \geq \max \{ w_{j+1}, \theta_2 w^- \} \), that is, the poacher can make an offer that satisfies the incumbent firm’s minimum wage constraint. In this case, the incumbent firm will retain the worker. To see why, note that the incumbent firm’s best wage offer is

\[ w^T_I(s, j, w^-) = \max \{ w^T_p(s, j, w^-), w_{j+1}, \theta_2 w^- \} = w^T_p(s, j, w^-), \]

and the value for the firm by retaining the worker is

\[ \Omega^T(s, j, w^-) = s - w^T_p(s, j, w^-) = s - (s - \phi) = \phi > 0. \]

Therefore the firm always retains the worker given the assumption of this case, that is, Equation (4) and \( w^T_p(s, j, w^-) = s - \phi \geq \max \{ w_{j+1}, \theta_2 w^- \} \). Combining the two
restrictions leads to
\[ s \geq \phi + \max\{w_1, w_{j+1}, \theta_1 w^-, \theta_2 w^-\}. \]

2. If \( w_p^T(s,j,w^-) < \max\{w_T, \theta_2 w^-\} \), then the incumbent firm may or may not want to retain the worker. If the incumbent retains the worker, its wage offer is
\[ w_I^T(s,j,w^-) = \max\{w_{j+1}, \theta_2 w^-\}. \]

(a) Case 1: the incumbent firm wants to retain the worker, that is,
\[ \Omega^T(s,j,w^-) = s - \max\{w_{j+1}, \theta_2 w^-\} \geq -\chi. \]

The assumptions of this case are \( \tilde{w}_p^T(s,j,w^-) = s - \phi < \max\{w_{j+1}, \theta_2 w^-\} \) and \( s - \max\{w_{j+1}, \theta_2 w^-\} \geq -\chi \), together with (4). Combining these restrictions, we obtain
\[ \phi + \max\{w_{j+1}, \theta_2 w^-\} > s \geq \max\{\phi + \max\{w_1, \theta_1 w^-\}, -\chi + \max\{w_{j+1}, \theta_2 w^-\}\}; \]

(b) Case 2: the incumbent firm does not want to retain the worker, that is,
\[ \Omega^T(s,j,w^-) = s - \max\{w_{j+1}, \theta_2 w^-\} < -\chi. \]

The assumptions of this case are \( w_p^T(s,j,w^-) = s - \phi < \max\{w_{j+1}, \theta_2 w^-\} \) and \( s - \max\{w_{j+1}, \theta_2 w^-\} < -\chi \), together with (4). Combining these restrictions, we obtain
\[ \min\{\phi + \max\{w_{j+1}, \theta_2 w^-\}, -\chi + \max\{w_{j+1}, \theta_2 w^-\}\} > s \geq \phi + \max\{w_1, \theta_1 w^-\}, \]
which reduces to
\[ -\chi + \max\{w_{j+1}, \theta_2 w^-\} > s \geq \phi + \max\{w_1, \theta_1 w^-\}. \]

Consider now the case in which there are no active poachers, that is,
\[ w_p^T(s,j,w^-) = s - \phi < \max\{w_1, \theta_1 w^-\}. \] (5)

For the incumbent firm, we need to consider the following two cases:
1. The firm wants to retain the worker, that is,

\[ \Omega^T(s, j, w^-) = s - \max\{w_{j+1}, \theta_2 w^-\} \geq -\kappa. \]

\[ w^T_f(s, j, w^-) = \max\{w_{j+1}, \theta_2 w^-\}. \]

The assumptions of this case are (5) and \( s - \max\{w_T, \theta_2 w^-\} \geq -\kappa \), which, combined, lead to

\[ \phi + \max \{w_1, \theta_1 w^-\} > s \geq -\kappa + \max\{w_{j+1}, \theta_2 w^-\}; \]

2. The firm wants to fire the worker. Note that this is the only case that produces a transition from employment to unemployment. In this case,

\[ \Omega^T(s, j, w^-) = s - \max\{w_{j+1}, \theta_2 w^-\} < -\kappa. \]

The assumptions of this case are (5) and \( s - \max\{w_{j+1}, \theta_2 w^-\} < -\kappa \), which, combined, lead to

\[ s < \min\{\phi + \max\{w_1, \theta_1 w^-\}, -\kappa + \max\{w_{j+1}, \theta_2 w^-\}\}. \]

4 Representative Simulations

Here we consider the case in which firms and workers are fully forward looking and discount the feature at the same rate. Since the model is a yearly one, we set firms’ and workers’ discount factor at 0.95. We assume for the moment that individuals live for ten periods \( (T = 10) \) and their skill level \( s \) is discrete. We use Tauchen (1986)’s method to approximate the process for \( s \) as an AR(1) process with persistence parameters equal to 0.85. The exogenous wage floor is set as

\[ w_j = 0.18 + 0.13(j - 1). \]

The details of the model parametrization are contained in Table 1.

We simulate the model and generate the aggregate wage distribution, the employment rate, the patterns of transition from employment to unemployment, from unemployment to employment, and of job-to-job transitions, and in this latter case the associated wage changes, as well as the wage-age and wage-tenure profiles implied by this parameterization. Under this parametrization, the model produces an aggregate wage distribution that is positively skewed
Table 1: Parameters of the Baseline Economy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor, $\beta^f$</td>
<td>0.95</td>
</tr>
<tr>
<td>Discount factor, $\beta^w$</td>
<td>0.95</td>
</tr>
<tr>
<td>Firing cost, $\kappa$</td>
<td>0.30</td>
</tr>
<tr>
<td>Hiring cost, $\phi$</td>
<td>0.20</td>
</tr>
<tr>
<td>Separation cost, $\chi$</td>
<td>0.00</td>
</tr>
<tr>
<td>Wage stickiness, $\theta_0$</td>
<td>0.50</td>
</tr>
<tr>
<td>Wage stickiness, $\theta_1$</td>
<td>0.50</td>
</tr>
<tr>
<td>Wage stickiness, $\theta_2$</td>
<td>1.00</td>
</tr>
<tr>
<td>Persistence of skill process, $\rho$</td>
<td>0.85</td>
</tr>
<tr>
<td>Standard deviation of skill process, $\sigma$</td>
<td>0.30</td>
</tr>
</tbody>
</table>

(Figures 1 and 2) as observed in the data, an age-profile of the probability of employment that leads to an employment rate of about 80% as observed in the data (Figure 3) and that is consistent with an approximately constant probability of job-to-job transitions with age (Figure 4). Even if wage changes upon a job-to-job transition can be positive or negative (Figure 5), on average wages increase (but eventually decrease) with age and tenure in a firm (Figure 6), as also observed in the data.

Overall, these results suggest that our baseline model already successfully captures many relevant features of the dynamics of employment and wages. In the next sections we will consider a richer version of the model in which firms consist of multiple jobs, wage floors are dependent on the job history of a worker, and multiple constraints from CCNLs, including automatic promotions and restrictions on pay growth, affect individual and aggregate outcomes.
4.1 Wage Distribution

Figure 1: Aggregate Wage Distribution

Figure 2: Wage Distribution Conditional on Age

$t = 1$

$t = 2$

$t = 3$

$t = 4$

$t = 5$

$t = 6$
4.2 Dynamics of Employment

Figure 3: Wage Distribution Conditional on Age

Figure 4: Age Profile of Employment Rate
4.3 Wage Growth Due to Job-to-Job Transition

Figure 6: Wage Growth Rate Conditional on Changing Employer
4.4 Individual Wage Profiles

5 Conclusion

In this paper we consider a set of labor market regulations common in continental European countries (exogenous as well as endogenous minimum wage floors dependent on a worker’s job history, hiring and firing costs, and constraints on pay growth) and explore their effects on individual employment and wage dynamics and on the aggregate wage distribution. We find that these policy constraints play an important role in explaining individual and aggregate outcomes and have a significant impact on the effect of changes in minimum wages and related policies on employment and wages.

A Appendix

A.1 Solution Algorithm

We use backward induction to solve for a representative incumbent firm’s value function, \( V^t(s, j, w^-) \), a representative worker’s value function, \( U^t(s, j, w^-) \), policy functions for poachers, \( w_p^t(s, j, w^-) \), and \( I_p^t(s, j, w^-) \), policy functions for incumbent firms, \( w_f^t(s, j, w^-) \), \( w_I^t(s, j, w^-) \), and \( I_I^t(s, j, w^-) \), and policy function for workers, \( w_f^t(s, j, w^-) \) and \( I^t(s, j, w^-) \), from period 1 through period \( T + 1 \).

We set \( V^{T+1}(s, j, w^-) = 0 \) and \( U^{T+1}(s, j, w^-) = 0 \). Then, we loop over the state variables \((s, t, j, w^-)\). At each grid point for each of the state variables, we proceed according to the
following steps. For each state \((s, t, j, w^-)\), we determine the wage offer \(w_p^t(s, j, w^-)\) that leads poachers to make zero profit, that is,

\[
s - w_p^t(s, j, w^-) - \phi + \beta^t \mathbb{E} \left[ V^{t+1}(s', 1, w_p^t(s, j, w^-)) \mid s \right] = 0.
\]

Note that \(w_p^t(s, j, w^-)\) is actually independent of \(w^-\).

1. When \(j = 0\), that is, the worker was unemployed in the last period and is currently waiting to be employed, we distinguish two cases:

   (a) If \(w_p^t(s, j, w^-)\) is less than the minimum wage required,

   \[
w_p^t(s, j, w^-) < \max\{w_1, \theta_0 w^-\},
   \]

   then \(I_p^t(s, j, w^-) = 0\) and the worker will not be hired.

   (b) If \(w_p^t(s, j, w^-)\) is larger than the minimum wage required,

   \[
   \tilde{w}_p^t(s, j, w^-) \geq \max\{w_1, \theta_0 w^-\},
   \]

   then \(I_p^t(s, j, w^-) = 1\) and the worker is employed.

2. When \(j \geq 1\), the worker is employed, so there is an incumbent firm. We distinguish the following cases:

   (a) If \(w_p^t(s, j, w^-)\) is less than the minimum wage required, that is,

   \[
w_p^t(s, j, w^-) < \max\{w_1, \theta_1 w^-\},
   \]

   then, \(I_p^t(s, j, w^-) = 0\) and there is no active poaching firm. If the incumbent firm retains the worker, then its wage offer \(w_p^t(s, j, w^-)\) solves the problem

   \[
   \Omega^t(s, j, w^-) = \max_w \left\{ s - w + \beta^t \mathbb{E} \left[ V^{t+1}(s', j + 1, w) \mid s \right] \right\},
   \]

   subject to

   \[
w \geq \max\{w_{j+1}, \theta_2 w^-\}.
   \]

   i. If \(\Omega^t(s, j, w^-) \geq -\kappa\), then \(I_p^t(s, j, w^-) = 1\) and the incumbent firm retains the worker, so

   \[
   V^t(s, j, w^-) = \Omega^t(s, j, w^-)
   \]

   ii. If \(\Omega^t(s, j, w^-) < -\kappa\), then \(I_p^t(s, j, w^-) = 0\) and the incumbent firm dismisses the worker, so

   \[
   V^t(s, j, w^-) = -\kappa
   \]
(b) If $w_p^f(s,j,w^-)$ is larger than the minimum wage required, that is,  
$$w_p^f(s,j,w^-) \geq \max\{w_1, \theta_1 w^-\},$$
then $T_p^f(s,j,w^-) = 1$ and poaching firms are active. 
If the incumbent firm retains the worker, then its wage offer $w^f(s,j,w^-)$ has to be larger than the institutional minimum wage and lead to a present value of wages at least as attractive as that implied by the wage offer of poaching firms. Hence, $w^f(s,j,w^-)$ solves 
$$\Omega^f(s,j,w^-) = \max_w \left\{ s - w + \beta \mathbb{E} \left[ V^{t+1}(s',j+1,w) \mid s \right] \right\},$$
subject to 
$$w \geq \max\{w_{j+1}, \theta_2 w^-\} \text{ and } w \in W_c^f(s,j,w^-),$$
where $W_c^f(s,j,w^-)$ contains the set of wages $w_c$ that yield a present value of utility for the worker at least as high as the present value of utility yielded by a poacher’s offer, that is, 
$$w_c + \beta \mathbb{E} \left\{ U^{t+1}(s',j+1,w_c) \mid s \right\} \geq w_p^f(s,j,w^-) + \beta \mathbb{E} \left\{ U^{t+1}(s',1,w_p^f(s,j,w^-)) \mid s \right\}.$$  
Now, two cases are possible: 

i. If $\Omega^f(s,j,w^-) \geq -\chi$, then $T_p^f(s,j,w^-) = 1$ and the incumbent firm retains the worker, with 
$$V^f(s,j,w^-) = \Omega^f(s,j,w^-)$$

ii. If $\Omega^f(s,j,w^-) < -\chi$, then $T_p^f(s,j,w^-) = 0$ and the incumbent firm will separate from the worker, with 
$$V^f(s,j,w^-) = -\chi$$

The value function for the worker, $U^f(s,j,w^-)$, the actual wage received by the worker, $w^f(s,j,w^-)$, and the worker’s tenure status in the next period, $J^f(s,j,w^-)$, are specified as in Section 3.3.

References

