Wage Bargaining and Wage Posting Firms

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Abstract

This paper studies the coexistence of wage-posting and wage-bargaining firms. We embed two protocols in a common job-ladder model in which posting firms offer wage–tenure contracts and matching firms renegotiate against outside offers, and develop a maximum-likelihood classification procedure treating wage-setting regimes as latent. Using a German employer survey to benchmark the classification and Austrian matched employer–employee data for estimation, we obtain consistent evidence across settings. Bargaining firms account for about 23% in Austria and 24% in Germany; they occupy higher rungs of the ladder, exhibit greater within-firm wage dispersion, employ a more skill-intensive workforce, and concentrate in services. The model rationalizes wage cuts on job-to-job moves as transitions from posting to bargaining firms in exchange for future renegotiation-driven growth. Allowing posting firms to offer wage–tenure contracts is quantitatively essential: a no-growth specification inflates the implied share to 34% by misattributing deterministic wage growth to bargaining heterogeneity.

Keywords: Wage posting, Wage bargaining, Sequential auction, Random search, Wage dispersion
JEL codes: C78, E24, E25, J31, J41, M52

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1 Introduction

Building on the theoretical advancements that describe firms countering outside offers arising from on-the-job search (Postel-Vinay and Robin, 2002a,b), three key questions have emerged. First, how can firms engaging in such wage bargaining practices be distinguished empirically from traditional wage-posting firms, as described by Burdett and Mortensen (1998); Bontemps et al. (2000)? Second, what are the characteristics of wage-bargaining and wage-posting firms? Third, what are the implications of their coexistence for wage dynamics and worker mobility?

This paper addresses these questions by combining a tractable partial-equilibrium search model with a likelihood-based classification procedure, and by bringing together survey and administrative data. The model embeds two wage-setting protocols within a common job-ladder framework: a fraction of firms posts contracts ("P-firms"), and the remaining firms match outside offers from competing employers ("M-firms"). Following Burdett and Coles (2003) and Stevens (2004), we let P-firms offer wage–tenure contracts, so within-firm wage dispersion at P-firms reflects deterministic tenure growth common to all workers, whereas at M-firms it reflects renegotiation against heterogeneous outside-option histories. We work in partial equilibrium and take the cross-firm distribution of posted contracts as given, rather than rationalizing P-firm contract choice (Jolivet et al., 2006). The coexistence of the two protocols generates sharp directional implications for wages and worker mobility that discipline identification: $P \to P$ moves raise the observed wage; $P \to M$ moves can entail wage cuts because the matching firm matches the worker's continuation value rather than her current wage; $M \to P$ moves occur only when the destination's posted rank exceeds the M-firm's retention ceiling; and within-firm wage dispersion exceeds the deterministic-profile benchmark only at M-firms.

On the empirical side, we proceed in two complementary steps. First, we document motivating evidence using German micro data that directly measure wage setting at the vacancy. We use the IAB Job Vacancy Survey (JVS) linked to administrative worker histories, which allows us to (i) classify establishments based on whether pay was individually bargained at the most recent hire and whether the establishment is covered by a collective agreement, and (ii) connect those survey-based classifications to within-firm wage distributions and to the wage trajectories of workers who fill the surveyed vacancies. We document five facts: bargaining firms have higher raw wages and are more attractive employers (higher poaching ranks, lower exit ranks); they exhibit greater within-firm wage dispersion; they more frequently report ex-post upward compensation adjustments and negotiation over non-wage benefits; job-to-job movers switching from P- to M-firms are disproportionately likely to experience wage cuts conditional on firm wage rank; and the tenure gradient of separations is steeper at P-firms, consistent with backloaded wage–tenure contracts. Our findings are in line with prior empirical results from the literature (Brenčič, 2012; Brenzel et al., 2014; Caldwell and Harmon, 2019).

Second, we use Austrian matched employer–employee administrative data to estimate the model and recover firm types as latent variables, since administrative data do not directly record wage-setting institutions. We derive the likelihood of observed wages and job-to-job transitions conditional on firm type and embed it in a latent-class mixture model at the firm level. The procedure simultaneously fits the type-specific firm-rank distributions and the labor-market primitives and assigns each firm to a wage-setting regime through a classification-EM algorithm. The firm-type update combines a worker-level component (how well a firm's within-firm wage dispersion and its movers' wage changes align with the M- versus P-regime) with a firm-level component implied by the type distributions. To accommodate measurement error and potential misspecification, we relax the model's sharp restrictions through deviation terms that play a role similar to wage measurement error or unobserved mobility costs; their scale is selected by validation. Allowing posting firms to offer wage–tenure contracts is quantitatively essential: the main specification yields a bargaining share of 23%, compared with 34% under a no-growth specification that restricts P-firms to flat wages, because deterministic wage growth at P-firms generates within-firm dispersion that the no-growth specification otherwise attributes to bargaining heterogeneity. We further show that the resulting classification cannot be reproduced from firm-level observables alone, even by a saturated linear projection on within-firm wage and mobility moments, motivating the structural approach.

Our results deliver a consistent characterization of wage-setting regimes across the two countries and data sets. In Austria, we estimate that about 23% of firms are M-firms, close to the 24% share of bargaining firms in the German survey under our preferred definition; a post-estimation diagnostic that evaluates only the entry-wage term of the converged likelihood, the closest empirical analogue of the German survey question on whether the entry wage was bargained, delivers a similar share, independently corroborating the structural estimate. Differential analysis of both firm types can therefore be undertaken in administrative data without recourse to costly and size-restricted firm surveys. The estimated M-firms occupy higher rungs of the job ladder: they pay higher raw wages, exhibit greater within-firm wage dispersion, employ a more skilled workforce, and are concentrated in finance and other high-skill sectors, patterns consistent with prior revealed-preference evidence on firm rankings and with the German survey results. Mobility patterns also align with the model:

$P \to P$ moves are predominantly associated with wage gains, whereas $P \to M$ moves have a higher incidence of wage cuts followed by faster subsequent wage growth, consistent with the option-value channel emphasized in the model.

Beyond documenting a new set of facts, the paper contributes methodologically and substantively to several literatures. First, it contributes to work on wage posting and wage bargaining with on-the-job search (Burdett and Mortensen, 1998; Postel-Vinay and Robin, 2002a,b, 2004; Burdett and Coles, 2003; Stevens, 2004; Michelacci and Suarez, 2006; Jolivet et al., 2006; Flinn and Mullins, 2026; Doniger, 2023) by providing an empirical strategy to recover wage-setting regimes as latent firm types in administrative data, disciplined by model-implied likelihoods and validated against direct survey measures of bargaining. The closest paper is Flinn and Mullins (2026), who model and estimate a search environment in which firms choose between posting and bargaining at vacancy creation. We differ in three ways: we (i) classify individual firms in matched employer–employee data rather than treating demographic cells as segmented markets, (ii) allow wage–tenure contracts at posting firms rather than flat wages, and (iii) base classification on a model-implied likelihood combining within-firm wage dispersion with mobility-linked wage changes, validated against direct survey measures. Second, the paper speaks to the literature using linked data and surveys to characterize wage-setting practices and their consequences (Hall and Krueger, 2012; Brenzel et al., 2014; Brenčič, 2012; Caldwell and Harmon, 2019; Caldwell et al., 2026; Braun and Figueiredo, 2025; Barron et al., 2006; Doniger, 2021) by showing that mobility-related wage changes provide an additional, powerful dimension for distinguishing protocols. Third, it connects to recent work using likelihood-based clustering to recover latent firm structure (Bonhomme et al., 2019, 2023; Lentz et al., 2023), but targets differences in wage-setting institutions rather than differences in productivity or wage premia alone.

The remainder of the paper is organized as follows. Section 2 presents motivating evidence from German survey-linked micro data. Section 3 develops the model and derives the directional implications for within-firm wage dispersion and wage changes on mobility. Section 4 introduces the Austrian estimation data and develops the likelihood, the latent-type estimation, and the clustering algorithm. Section 5 reports the Austrian estimates and model fit, validates the recovered firm types through sign-restricted and out-of-sample tests, and compares the cross-sectional patterns of M- and P-firms with the German motivating evidence. Section 6 concludes.

2 Motivating Evidence

This section presents empirical evidence, using German microeconomic data, on the coexistence of two distinct wage-setting regimes: wage posting and wage bargaining.

2.1 Data Sets and Variables

We use the Job Vacancy Survey (JVS), together with firm and worker-level panel data from the Research Data Centre at the *Institut für Arbeitsmarkt- und Berufsforschung der Bundesagentur für Arbeit* (IAB). Earlier uses of the JVS include Brenzel et al. (2014) and Carrillo-Tudela et al. (2023); Online Appendix Section OA.2 gives a detailed description.

For the years 2011–2013 and 2016–2019, the JVS contains questions on wage and compensation bargaining at filled and unfilled vacancies. Two record linkages produce a survey-firm panel (workforce composition, worker flows, firm-level wage distributions) and a survey-worker panel (wages, tenure, mobility trajectories); the linkages use different identifiers and cannot be merged, so firm-level aggregates and individual worker histories are not observed for the same firm.

From the JVS we use four questions on filled vacancies: (1) whether wages were bargained at the vacancy; (2) whether the firm is covered by a sector-, firm-, or establishment-level collective bargaining agreement; (3) whether the firm paid more than expected; and (4) whether non-wage compensation was offered.[1] The survey-worker panel provides individual wages (total pay divided by days worked), worker characteristics (education, gender, age), and firm attributes (industry, location). The survey-firm panel provides worker inflows and outflows, from which we construct revealed-preference measures of firm quality: poaching rank (Bagger and Lentz, 2018) and exit rank (Morchio and Moser, 2024).

Classification. A firm is classified as a bargaining firm (M-firm) if it reports individual wage bargaining at the filled vacancy (question 1) and is not covered by a collective bargaining agreement (question 2). Each firm appears in a single survey wave, so the classification rests on a single response. This double criterion isolates firms where bilateral negotiation is the dominant wage-setting channel, excluding settings where pay is determined by a collectively agreed schedule.[2] We report robustness results using only question 1.

[1] Question (4) is available in all years except 2013.

[2] We deviate from Brenzel et al. (2014), who in some cases group CBA-covered firms with bargaining firms.

2.2 Firm Characteristics

We examine how bargaining firms differ from posting firms using the survey-firm panel. Table 1 reports weighted summary statistics by firm type. Under our preferred classification (questions 1 and 2), 24% of firms are classified as M-firms; when using only question 1, the share rises to 39%. The prevalence of individual bargaining has risen steadily, with the weighted share of M-firms increasing by roughly 10 percentage points between 2011 and 2019.[3]

Our 24% figure is related to but distinct from Caldwell et al. (2026), who use a separate HR-representative survey. Their broader definition, which includes selective bargaining and does not exclude collectively bargained firms, yields a higher prevalence (approximately 50%). When we use only question 1, 41% of bargaining firms are covered by a collective agreement (Online Appendix Table OA.2), comparable to the 35% in Caldwell et al. (2026). We exclude these firms because collective agreements constrain the scope for individual negotiation; Online Appendix Section OA.2 gives a detailed comparison.

Almost all firm characteristics differ significantly across types (Table 1); only the East/West share is insignificant. We highlight three patterns. First, M-firms offer higher average daily log wages (4.56 versus 4.49) and are more attractive to workers, as reflected in higher poaching ranks (0.55 versus 0.50) and lower exit ranks (0.36 versus 0.39). Second, M-firms exhibit wider within-firm wage dispersion, measured by the interquartile range of log wages (0.34 versus 0.31).[4] Third, M-firms more frequently report paying above initially intended wages to secure a hire (30% versus 10%) and more often bargain over non-wage compensation (52% versus 40%). In addition, M-firms are smaller on average (115 versus 402 employees), more concentrated in services (60% versus 52%), and employ a slightly lower share of women (42% versus 44%).

Despite these cross-sectional differences, predicting firm type from observables is difficult. The R^2 of a regression of M-firm status on firm characteristics is 0.42 under our preferred

[3] Online Appendix Table OA.3 reports year-by-year statistics. Consistent with Brenzel et al. (2014), approximately 37% of workers reported having negotiated their salary in 2011. Braun and Figueiredo (2025) report a comparable US share: in the Survey of Consumer Expectations approximately 70% of respondents report receiving take-it-or-leave-it offers, leaving $\sim$ 30% who bargain. Doniger (2023) reaches a comparable order of magnitude from a different angle: she calibrates a search model with posted-wage and sequential-auction contracts to US flow data and infers that roughly 42% of US firms set wages under a sequential-auction (renegotiation) protocol. Flinn and Mullins (2026) estimate a related model on the SCE and CPS across 36 demographic markets and find that the equilibrium share of bargaining firms ranges from about 5% to 35% across markets, with substantial cross-group variation.

[4] This pattern is consistent with Doniger (2021), who documents in the same German IAB universe that idiosyncratic (off-cycle) pay revisions, which resemble renegotiation events, are concentrated in industries where more firms report willingness to negotiate wages.

	All	P-Firms	M-Firms	Diff. $(M-P)$
Bargaining+	0.24	0.00	1.00	1.00
Bargaining	0.39	0.21	1	0.79
Size	334.06	401.88	115.76	-286.12
Age	40.59	40.67	40.33	-0.35
Wage	4.51	4.49	4.56	0.07
25 Percentile	4.30	4.29	4.34	0.05
75 Percentile	4.62	4.60	4.68	0.08
Poaching Rank	0.51	0.50	0.55	0.05
Exit Ranking	0.38	0.39	0.36	-0.03
Spread Wages	0.31	0.31	0.34	0.03
Services	0.54	0.52	0.60	0.09
East	0.19	0.19	0.19	0.01
Collective Agreement	0.57	0.74	0.00	-0.74
Pay More	0.15	0.10	0.30	0.20
Female Share	0.43	0.44	0.42	-0.02
Other Remuneration	0.43	0.40	0.52	0.11
Observations (firms)	59423	45001	14422	.
R^2 observables $\rightarrow$ bargaining	0.42	.	.	.
R^2 observables $\rightarrow$ bargaining without CA	0.09	.	.	.

Table 1: Summary Statistics

Note: The table contains summary statistics on wage-bargaining (M) and wage-posting (P) firms. Wage spread denotes the difference between the 75th and the 25th percentile of log wages. "Bargaining" refers to question 1, whereas "Bargaining+" refers to our preferred classification using both questions 1 and 2. All statistics are weighted using survey weights. 'Other Ren.' is one if there was negotiation also on other forms of remuneration. All differences between M- and P-firms are statistically significant at the 1% level, except Female Share and Age which are significant at the 0.1% level, and East is not statistically significant.

classification but only 0.09 when excluding collective-agreement status. This echoes the finding in Caldwell et al. (2026) that firm-level characteristics have limited predictive power for bargaining behavior. It also motivates the model-based classification in Section 4, which exploits wage and mobility dynamics rather than firm-level observables.

2.3 Worker Mobility

Wage Decreases and Worker Mobility If matching firms offer the option value of future wage growth through renegotiation, transitions from P- to M-firms may involve initial wage cuts even when the move is value-improving. Among job-to-job movers in our sample, 33% experience a wage decrease, in line with Sorkin (2018).

We estimate a linear probability model for a wage decline upon a job-to-job move, distinguishing across-type ($P2M$, $M2P$) from within-type ($M2M$, $P2P$) transitions. The omitted category is $M2P$.[5] The specification is

$$I\{\Delta w < 0\}_{i,t} = \alpha_{P2M} I\{P2M\} + \alpha_{\text{Firm-Type Stayer}} I\{\text{Firm-Type Stayer}\} + x_{i,t}\beta + \epsilon_{i,t}.$$

Table 2 reports the coefficients. $P2M$ transitions are more likely than within-type moves to involve a wage cut (column 1). The coefficient is robust to controls for firm quality via coworker average wages at origin and destination (column 2), demographics and origin/destination firm size (column 3), year fixed effects (column 4), and a logit specification (columns 5–6). Controlling for non-wage compensation at the destination (column 6) leaves the $P2M$ coefficient virtually unchanged, weighing against the compensating-amenities interpretation of wage cuts (Sorkin, 2018). Disaggregated results by transition type and a robustness check using only question 1 are in Online Appendix Tables OA.4 and OA.5.

	(1)	(2)	(3)	(4)	(5)	(6)
$P2M$	0.0544*	0.106*	0.106*	0.106*	0.510*	0.508*
	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MM/PP	0.0159	0.0480*	0.0537*	0.0531*	0.258*	0.257*
	(0.255)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	38848	38848	38848	38848	38848	38848
Controls		+Firm Q.	+Demo	+Year	Logit	+ Other Rem.

Table 2: Probability Wage Decrease Upon Mobility based on Mobility Type

Note: The table contains regression coefficients of the probability of wage decreases upon mobility on the type of mobility. We choose the $M2P$ mobility as our baseline contrast. Columns 1-4 present coefficients in a linear probability model whereas columns 5-6 show results for a logit model. "Demo" refers to demographics education, gender, age, firm location (east/west), occupation and firm size at origin and destination. "Other Ren" refers to the offer of other remunerations. Standard errors are clustered at the firm level. "Firm Q." denotes controls for firm quality as obtained for coworker average wages, excluding the mover. p-values in parentheses, $^{+}$ $p < 0.10$, * $p < 0.05$

Tenure and Worker Mobility If posting firms offer wage-tenure contracts, their quit rates should decline with tenure as the worker's continuation value rises. We test this by estimating a linear probability model for separation, with firm type, tenure, and their interaction as regressors (M-firms as the omitted category):

$$I\{Sep\}_{i,t} = \alpha_P I\{P\} + \alpha_\tau \tau_{i,t} + \alpha_{\tau \times P} \tau_{i,t} \times I\{P\} + x_{i,t}\beta + \eta_{i,t}$$

[5] $M2P$ is the most selective transition (a posting firm attracts a worker from a matching firm only when its full contract value exceeds the matching firm's retention capacity) and hence the transition least prone to wage cuts under either specification, making it the most informative benchmark for excess cuts on $P2M$. Disaggregated results by transition type are in Online Appendix Table OA.4.

Table 3 reports the results. P-firms have higher separation rates than M-firms across all specifications, consistent with their lower average position on the job ladder. The interaction $P \times$Tenure is negative and significant: the tenure gradient of separations is steeper at P-firms. Controlling for firm quality (column 2), the annual separation probability falls by about 0.5 percentage points per year of tenure at M-firms and by an additional 0.6 percentage points at P-firms. This pattern is consistent with wage-tenure contracts at posting firms and motivates allowing them in the main specification developed in Section 3.4. Results are robust to demographics and year fixed effects (columns 3–4), a logit specification (column 5), and the broader classification using only question 1 (Online Appendix Table OA.6).

Two further patterns, higher residual wage growth among M-firm stayers and larger within-firm residual wage variance at M-firms, are consistent with the classification and reported in Online Appendix Section OA.3.2. We return to whether wage cuts predict subsequent wage growth, the test of Sorkin (2018), in Section 5, using the Austrian panel and the model-based classification.

	(1)	(2)	(3)	(4)	(5)
P	0.0858*	0.0652*	0.0524*	0.0603*	0.316*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tenure	-0.00459*	-0.00459*	-0.00427*	-0.00411*	-0.0254*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
P × Tenure	-0.00708*	-0.00626*	-0.00519*	-0.00531*	-0.0297*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	597878	597878	597878	597878	597878
Controls		+Firm Q.	+Demo	+Year	Logit

Table 3: Probability Separation based on Firm Type

Note: The table contains regression coefficients of the probability of separation on tenure, interacted with firm type. We choose the M as our baseline contrast. Columns 1-4 present coefficients in a linear probability model whereas columns 5-6 show results for a logit model. "Demo" refers to demographics education, gender, age, firm location (east/west), occupation and firm size at origin and destination. "Firm Q." denotes controls for firm quality as obtained for coworker average wages, excluding the individual worker. p-values in parentheses, $^{+}$ $p < 0.10$, * $p < 0.05$

The patterns documented above are consistent with the coexistence of wage posting and offer matching firms. Our contribution is to show that the two regimes generate distinct mobility signatures, a dimension not explored in previous survey-based analyses (Brenčič, 2012; Brenzel et al., 2014; Hall and Krueger, 2012; Caldwell and Harmon, 2019; Caldwell et al., 2026). In the next sections, we formalize these implications in a model with wage posting and offer matching and impose them as soft restrictions in our Austrian estimation.

3 Theoretical Framework

This section develops a search-based classification framework with two wage-setting protocols: some firms post wage-tenure contracts, others match outside offers. The framework builds on sequential-auction models (Postel-Vinay and Robin, 2002b,a, 2004) and on the mixed-protocol environment of Flinn and Mullins (2026). As in Jolivet et al. (2006), posted contract values are taken as given, and the framework operates in partial equilibrium: it maps wage and mobility histories into latent firm types in matched employer–employee data without modeling the firm-side posting problem.

The central object is a *common rank* of jobs across protocols. For a matching firm, the rank is its productivity. For a posting-firm worker, the rank is the productivity of the smallest matching firm that could outbid the current contract; under flat posted contracts, the rank reduces to the posted wage. The common rank governs poaching, retention, firm size, and the likelihood. The remainder of this section develops the theoretical predictions of this environment, with derivations in Appendix A.

3.1 Environment

Time is continuous. Workers and firms are risk neutral and discount the future at rate r. Workers can be unemployed or employed at one firm. Jobs are destroyed at rate δ. Unemployed workers meet firms at rate λ, employed workers meet firms at rate $\kappa\lambda$, and search is random.

Throughout, w denotes the log wage and all values (b, p, w_P, V_0, Ω, W_P) are interpreted in the same log-utility-equivalent units. Workers differ in an additive log worker-effect a_i that shifts every wage and the flow value of leisure by the same amount. Because a_i enters every continuation value additively, it cancels in every comparison and does not affect mobility decisions; in particular, workers do not sort on a_i. We work below in units net of a_i, so observed log wages decompose additively as $w_{ij} = a_i + w_{\text{model}}$, where w_{model} is the model-implied log wage. The empirical implementation removes a_i by an AKM worker fixed effect (Section 4.5).

A fraction ξ of firms are matching firms, denoted M, and a fraction $1-\xi$ are posting firms, denoted P. Matching firms are indexed by productivity p, with firm-weighted distribution Γ on $[\underline{p}, \overline{p}]$. Posting firms are indexed by a contract vector $x \in \mathcal{X}$, with firm-weighted distribution F. The contract pays a deterministic wage profile $w_P(\tau; x)$ as a function of tenure τ. The contract distribution F is treated as an empirical object to be estimated; we do not derive it from a firm-side optimal posting problem.

A matching firm can condition wages on the worker's outside option and can retain the worker against future offers up to the value implied by its productivity. A posting firm commits to its wage profile and does not renegotiate. The relevant object for a posted contract is therefore the contract value delivered to the worker, while the relevant object for a matching firm is the maximum value its productivity can support.

3.2 Posting-Firm Contracts

Posting firms commit to a deterministic wage profile that depends on the worker's tenure. We specify

$$w_P(\tau; x_j) = \theta_j + g_j \min\{\tau, \bar{\tau}\}, \qquad x_j = (\theta_j, g_j), \qquad g_j \geq 0, \tag{1}$$

where θ_j is the log entry wage, $g_j \geq 0$ is the within-firm log-wage growth slope, and $\bar{\tau}$ is a common tenure cap. The contract pays $w_P(\tau; x_j)$ until the worker separates and is not renegotiated against outside offers. The linear specification (1) is chosen for transparency; the framework only requires a bounded, weakly increasing profile $w_P(\tau; x)$, and the results below extend to any such specification. The baseline of Flinn and Mullins (2026), in which matching firms operate under worker bargaining weight equal to one, corresponds to the restriction $g_j = 0$ for all j; Section 3.7 records the resulting simplifications. The remainder of this section develops the model for the general profile (1).

3.3 Values and the Common Rank

We map posted contracts and matching-firm productivity into a common rank. Appendix A.1 contains derivations.

Unemployment. Let V_0 denote the value of unemployment. A meeting with a posting firm raises the worker's value only if the contract delivers more than V_0; a matching firm need only deliver the worker's outside option. Hence

$$rV_0 = b + \lambda(1 - \xi)P(V_0), \tag{2}$$

where b is the flow value of unemployment and $P(V)$ is the option value of an outside posting offer, defined below in (8).

Matching firms. Let $\Omega(p)$ denote the highest worker value a matching firm with productivity p can deliver while breaking even:

$$(r+\delta)\Omega(p) = p + \delta V_0 + \kappa\lambda(1-\xi)P(\Omega(p)). \tag{3}$$

The function Ω is strictly increasing.

Posting firms. The contract value $W_P(\tau;x)$ delivered by a wage profile $w_P(\cdot;x)$ to a worker with tenure τ solves the ODE

$$(r+\delta)W_P(\tau;x) = w_P(\tau;x) + \delta V_0 + \kappa\lambda(1-\xi)P(W_P(\tau;x)) + \frac{\partial W_P(\tau;x)}{\partial \tau}, \tag{4}$$

with terminal boundary $W_P(\bar{\tau};x) = \Omega(w_P(\bar{\tau};x))$, since the wage is flat from $\bar{\tau}$ onward.

The common rank. Generalising the rank construction of Postel-Vinay and Robin (2004) to wage–tenure contracts, define the *common rank* of a posting-firm worker as

$$\omega(\tau;x) \;\equiv\; \Omega^{-1}\big(W_P(\tau;x)\big). \tag{5}$$

By construction, an outside matching-firm offer with productivity p poaches the worker if and only if $\Omega(p) \geq W_P(\tau;x)$, that is, if and only if $p \geq \omega(\tau;x)$. Thus $\omega(\tau;x)$ is the lowest matching-firm productivity that can outbid the contract x at tenure τ, and the same scale ranks matching firms by $\omega = p$. We refer to ω as the *rank* throughout.

Rank distributions. Let $\mu_j \equiv \omega(0;x_j)$ denote the rank of posting firm j at tenure zero — the rank a new hire faces. The firm-weighted distribution of posting-firm entry ranks is

$$\Psi(y) = F\big\{x : \omega(0;x) \leq y\big\}. \tag{6}$$

For matching firms, $\omega = p$ and the firm-weighted distribution is Γ. The aggregate firm-weighted distribution of offer ranks is

$$K(y) = (1-\xi)\Psi(y) + \xi\Gamma(y), \qquad \overline{K}(y) = 1 - K(y). \tag{7}$$

The option value of an outside posting offer used above is

$$P(V) = \int \max\{W_P(0;x) - V, 0\}\, dF(x) = \int \max\{\Omega(p) - V, 0\}\, d\Psi(p), \tag{8}$$

expressed equivalently in terms of contracts or in terms of entry ranks.

3.4 The Rank ODE under Wage-Tenure Contracts

Under wage-tenure contracts, $\omega(\tau; x)$ depends non-trivially on tenure. The following lemma characterizes the rank as the solution to an ODE.

Lemma 1 (Rank ODE)**.** *For a posting-firm contract x and the rank $\omega(\tau; x) \equiv \Omega^{-1}\big(W_P(\tau; x)\big)$,*

$$\omega'(\tau; x) \;=\; h\big(\omega(\tau; x)\big)\big[\omega(\tau; x) - w_P(\tau; x)\big], \qquad h(y) \;\equiv\; r + \delta + \kappa\lambda(1-\xi)\overline{\Psi}(y), \tag{9}$$

with terminal condition $\omega(\bar{\tau}; x) = w_P(\bar{\tau}; x)$. The ODE is solved backwards from $\tau = \bar{\tau}$ to $\tau = 0$.

The proof sketch is given in Appendix A.2.

For the empirical specification (1), the terminal condition yields $\omega(\bar{\tau}; x_j) = \theta_j + g_j\bar{\tau}$, and the entry rank $\mu_j \equiv \omega(0; x_j)$ satisfies

$$\mu_j \in \big[\theta_j,\, \theta_j + g_j\bar{\tau}\big].$$

The lower bound is attained when $g_j = 0$; the upper bound is attained as $r + \delta \to \infty$. Note that the entry rank μ_j and the wage intercept θ_j are distinct objects: $\mu_j = \theta_j$ only in the flat-contract limit $g_j = 0$. Whenever $g_j > 0$, μ_j strictly exceeds θ_j because the contract delivers future raises whose option value is priced into the worker's current rank.

Fixed point of Ψ. The rank ODE depends on $\overline{\Psi}$ through h, and Ψ is itself defined from $\omega(0; \cdot)$ via equation (6). The equilibrium Ψ is therefore a fixed point.

Proposition 1 (Existence of Ψ)**.** *Let $\Lambda : \mathcal{P} \to \mathcal{P}$ map a candidate distribution $\phi \in \mathcal{P}$ to*

$$\Lambda[\phi](y) \;=\; F\big\{x : \omega[\phi](0; x) \le y\big\},$$

where $\omega[\phi](\tau; x)$ denotes the solution to the rank ODE of Lemma 1 with $\overline{\phi}$ in place of $\overline{\Psi}$ in h, and $\mathcal{P}$ is the space of CDFs on $\big[\min_x \theta(x), \max_x \theta(x) + g(x)\bar{\tau}\big]$. Then Λ admits at least one fixed point $\Psi = \Lambda[\Psi]$, with corresponding rank function $\omega = \omega[\Psi]$.

Appendix A.3 provides the proof sketch and the iterative scheme used to compute Ψ^* in finite firm samples.

3.5 Steady-State Allocation

The steady-state unemployment rate is

$$u = \frac{\delta}{\delta + \lambda}. \tag{10}$$

A worker with current rank y exits the current job at the hazard rate

$$q(y) = \delta + \kappa\lambda\overline{K}(y). \tag{11}$$

Let $H(y)$ denote the worker-weighted distribution of current ranks. The size of a posting firm with contract x_j is the integral of its tenure-survival profile,

$$s_P(x_j) = \frac{1}{N}\big[\delta + \kappa\lambda H(\mu_j)\big] \int_0^\infty \exp\Big(-\int_0^\tau q\big(\omega(s;x_j)\big)\,ds\Big)\,d\tau,$$

and the size of a matching firm with productivity p_j is

$$s_M(p_j) = \frac{1}{N}\frac{\delta + \kappa\lambda H(p_j)}{\delta + \kappa\lambda\overline{K}(p_j)}.$$

Retention is higher at higher-ranked firms because fewer outside offers dominate the current rank. With wage-tenure contracts, H has no closed form in terms of K because ω varies with tenure; H is determined jointly with the posting-firm stock densities through the fixed-point system derived in Appendix A.4.

3.6 Wages Within Matching Firms

At a matching firm, the flow wage equals the worker's last outside-option rank, less the option value of waiting for a better matching offer.

Lemma 2 (Matching-firm wage and inherited-rank distribution)**.** *A worker with current rank $t \le p$ employed by a matching firm with productivity p receives the flow wage*

$$T(t,p) \;=\; t - \int_t^p \frac{\kappa\lambda\xi\,\overline{\Gamma}(x)}{r + \delta + \kappa\lambda(1-\xi)\overline{\Psi}(x)}\,dx. \tag{12}$$

The stock distribution of inherited ranks within a matching firm of productivity p is

$$\mathcal{G}(t \mid p) \;=\; \frac{\delta + \kappa\lambda H(t)}{\delta + \kappa\lambda H(p)} \cdot \frac{\delta + \kappa\lambda\overline{K}(p)}{\delta + \kappa\lambda\overline{K}(t)}, \qquad t \in [\underline{w}, p], \tag{13}$$

with a mass point at $t = \underline{w}$.

Holding p fixed, T is increasing in t; holding t fixed, T is decreasing in p because the worker expects greater future gains from outside matching offers at a more productive firm. The within-firm wage distribution at a matching firm of productivity p is the distribution of $T(t, p)$ induced by $t \sim \mathcal{G}(\cdot \mid p)$. The proof sketch of Lemma 2 is given in Appendix A.5.

3.7 Implications and Scope

Implications for mobility. The common rank delivers two observable consequences for mobility at posting firms. First, exit hazards decline in tenure. At a posting firm with contract x_j, the worker's job-to-job hazard is $\kappa\lambda\overline{K}(\omega(\tau; x_j))$. Under wage-tenure contracts, $\omega(\tau; x_j)$ rises with tenure, so $\overline{K}(\omega(\tau; x_j))$ falls and job-to-job transitions are concentrated at low tenure. Under the baseline limit $g_j = 0$, $\omega(\tau; x_j) = \theta_j$ is tenure-invariant and the hazard is flat. Second, the common rank delivers sign restrictions on wage changes at job-to-job transitions. At a posting-to-posting move, the destination wage $\theta_{j'}$ exceeds the origin wage $w_P(\tau; x_j)$ because the destination's entry rank $\mu_{j'}$ exceeds the origin's current rank $\omega(\tau; x_j)$. At a matching-to-posting move, the destination posted wage similarly exceeds the pre-move wage. At a posting-to-matching move, the destination matches the worker's continuation value rather than the current wage, so the destination wage $T(\omega(\tau; x_j), p_{j'})$ is bounded above by $\omega(\tau; x_j)$. The implied wage change at a posting-to-matching move depends on the origin firm's growth slope: with $g_j = 0$, $\omega(\tau; x_j) = w_P(\tau; x_j)$ and the move is a weak wage cut; with $g_j > 0$, $\omega(\tau; x_j) > w_P(\tau; x_j)$, and the sign and magnitude of the wage change depend on g_j and origin tenure.

Objects used in identification, estimation, and classification. Five objects carry the empirical content of the framework. First, the wage profile $w_P(\tau; x_j) = \theta_j + g_j \min\{\tau, \bar{\tau}\}$ is the posting firm's contract. Second, the rank $\omega(\tau; x_j)$ maps the wage profile and tenure onto the common scale via (9). Third, the firm-weighted offer-rank distribution $K(y) = (1-\xi)\Psi(y) + \xi\Gamma(y)$ governs the option value of search. Fourth, the exit rate $q(y)$ and firm-size functions s_P, s_M link mobility and employment shares to the rank. Fifth, $T(t, p)$ and the inherited-rank distribution $\mathcal{G}(t \mid p)$ govern wages and within-firm dispersion at matching firms. The mobility implications discussed above—the tenure-declining exit hazard at posting firms and the wage-change sign restrictions at job-to-job transitions—enter both identification of the parameters and the EM classification of firms into the two protocols. Section 4 constructs the likelihood from these objects.

Baseline limit ($g_j = 0$). The framework nests the flat-posted-contract case as the parameter restriction $g_j = 0$ for all j, which is the mixed-protocol environment of Flinn and Mullins (2026) with worker bargaining weight at matching firms equal to one. The restriction has four substantive consequences relative to the main specification.

(i) Tenure-invariant rank and constant retention. With $g_j = 0$, the rank is tenure-invariant, $\omega(\tau; x_j) = \theta_j$. The exit hazard $q(\theta_j) = \delta + \kappa\lambda\overline{K}(\theta_j)$ is therefore constant within firm, and the size of a posting firm collapses to the closed form $s_P(\theta_j) = 1/[N\, q(\theta_j)]$.

(ii) Equilibrium fixed point. Ψ coincides with the firm-weighted distribution of posted wages Ψ; no fixed point as in Proposition 1 is required.

(iii) Closed-form steady state. H admits the closed form

$$H(y) = \frac{\delta K(y)}{\delta + \kappa\lambda\overline{K}(y)}, \tag{14}$$

and the matching-firm wage map and inherited-rank distribution reduce to $T(t, p)$ and $\mathcal{G}(t \mid p)$ of Postel-Vinay and Robin (2004).[6]

(iv) Within-firm dispersion at posting firms. The baseline implies no within-firm wage dispersion at posting firms (apart from measurement error): all workers at firm j receive θ_j. The main specification generates dispersion through $g_j\,\tau$.

(v) Wage changes at posting-to-matching moves. With $g_j = 0$, $\omega(\tau; x_j) = \theta_j$ and the wage change reduces to the standard markdown $\theta_j - T(\theta_j, p_{j'}) \leq 0$, independent of origin tenure. Under wage-tenure contracts, the wage change at posting-to-matching moves depends jointly on g_j and origin tenure.

We compare the baseline limit with the main specification empirically in Section 5.1.

Scope. The framework isolates the empirical content of wage-setting protocols under explicit assumptions: exogenous protocols, homogeneous workers, no non-wage amenities, and zero worker bargaining power at matching firms. These restrictions make wage and tenure histories informative about protocols, but they are not innocuous. In richer settings, wage cuts or low entry wages may also reflect amenities, unobserved productivity differences, or surplus sharing. The empirical exercise therefore uses wage and mobility moments jointly; it does not treat any single wage-change moment as definitive evidence of a protocol. For this reason, the framework should be viewed as a classification environment, not as a full model

[6] See Online Appendix Section OA.6 for the baseline expressions of H, firm sizes, T, and $\mathcal{G}$ with $g_j = 0$, together with the implied wage-change sign restrictions.

of optimal contract choice, welfare measurement, or protocol choice. Online Appendix OA.8 shows that the common-rank construction and Lemma 1 are preserved under positive worker bargaining power $\alpha \in [0, 1)$; only the matching-firm wage map (Lemma 2) and the magnitude of the $P \to M$ wage-cut signature are affected, and the qualitative classification structure goes through.

4 Identification and Estimation

4.1 Data

For estimation, we use the Arbeitsmarktdatenbank (AMDB), the Austrian universe of social-security-covered employment relationships from 2001–2018, produced by the Austrian Labor Market Service and the Federal Ministry for Social Affairs. A comparable version was used in Borovickova and Shimer (2017) and Holzheu and Nolden (2026). For each job we observe start and end dates and total annual earnings; we construct a daily average wage and keep each worker's highest-paying spell per year, following Kline et al. (2020). The data also include gender, age, date of firm establishment, location, sector of activity, an academic-degree indicator, and the population density of the workplace.[7]

The sample retains workers aged 25–60 at firms continuously in operation over 2001–2018 with at least 20 workers per year. We further follow Kline et al. (2020) in excluding unusual histories[8] and trim wages at the 2nd and 98th percentiles.

4.2 Observed Histories and Sampling Weights

For each worker i we observe a two-period history $(j_{i1}, w_{i1}, \tau_{i1}, j_{i2}, w_{i2}, D_i)$: the employer identifier or non-employment, the residualized wage, tenure at the employer, and an indicator for whether the worker changes employer state between the two periods. Firm types $z_j \in \{P, M\}$ are latent. The sample is conditioned on first-period employment, so worker i's period-1 employer is drawn from the steady-state stock of employed workers. Period-1 tenure is observed as $\tau_{i1} = \min(\tau_{i1}^{\text{true}}, \bar{\tau}_{\text{cap}})$, where $\bar{\tau}_{\text{cap}} = T - T_0$ is the gap from the panel start T_0 to the sample year T; tenures at the cap are right-truncated.

In data-side notation, the worker's origin retention rank is $y_{it} = \omega_{x_j}(\tau_{it})$ at a posting origin and $y_{it} = p_j$ at a matching origin; the offer rank at candidate destination j' is $r_{j'} = \mu_{j'}$ if

[7]Fewer than 5% of workers are flagged as holding an academic degree, suggesting incomplete register coverage; we use this variable with caution.

[8]Public-sector workers; workers with more than 10 jobs in a year, wages below 5 EUR per day, or wage changes exceeding 100%.

$z_{j'} = P$ and $r_{j'} = p_{j'}$ if $z_{j'} = M$. The aggregate offer-rank survivor $\overline{K}$ is defined in (7).

Sampling weights. The steady state of Section 3.5 implies that the probability of observing a period-1 worker at firm j is proportional to

$$s_j^P = \frac{1}{N}[\delta + \kappa\lambda H(\mu_j)] \sum_{s \geq 0} \mathcal{S}_j^d(s), \qquad s_j^M = \frac{1}{N} \frac{\delta + \kappa\lambda H(p_j)}{\delta + \kappa\lambda \overline{K}(p_j)}, \tag{15}$$

where H is the worker-weighted distribution of current retention ranks (Section 3.4) and $\mathcal{S}_j^d(0) = 1$, $\mathcal{S}_j^d(s+1) = \mathcal{S}_j^d(s)[1 - \delta - \kappa\lambda\overline{K}(\omega_{x_j}(s))]$ is the discrete-tenure survival kernel.[9]

4.3 Constructive Identification

Sharp restrictions on observables. If the model's restrictions held exactly, firm types and parameters could be recovered from the joint distribution of wages, firm size, and mobility. At a posting firm with contract $x_j = (\theta_j, g_j)$, the model implies that every worker earns the contract wage $w(\tau; x_j) = \theta_j + g_j \min\{\tau, \bar{\tau}\}$ at tenure τ; within-firm wage dispersion at P-firms is zero around this profile, and the cross-section of $\{x_j\}$ over P-classified firms is distributed f_X. At a matching firm with productivity p_j, workers with different inherited outside-option ranks $t \leq p_j$ earn $T(t, p_j)$ for $t \sim \mathcal{G}(\cdot \mid p_j)$; within-firm wage dispersion at M-firms is strictly positive, and the cross-section of p_j is distributed Γ. On the mobility side, a worker at origin rank y_{it} accepts an offer only when its rank $r_{j'}$ exceeds y_{it}: a $P \to P$ move requires the destination entry rank $\mu_{j'}$ to exceed the worker's current retention rank $\omega_{x_j}(\tau_{it})$; an $M \to P$ move requires $\mu_{j'} > p_j$; a $P \to M$ (resp. $M \to M$) move requires the destination productivity $p_{j'}$ to exceed $\omega_{x_j}(\tau_{it})$ (resp. p_j). Finally, the structural survival kernel $\mathcal{S}_j^d(\tau)$ ties the observed tenure distribution at firm j to its rank profile through the exit hazard $q(\omega_{x_j}(\tau))$. These observables, namely wage profiles by firm type and tenure, within-firm wage spread by firm type, the cross-firm wage distribution, the mobility transitions, and the tenure distribution, are the likelihood contributions formalized in Section 4.4.

Identification of equilibrium objects. The empirical distribution of contract vectors $\{x_j\}$ at P-classified firms identifies f_X; the entry-rank map $\mu(x) = \omega_x(0; \Psi)$ then induces $\Psi(y) = F_X\{x : \mu(x) \leq y\}$ as the fixed point in Proposition 1. The cross-section of p_j at M-classified firms identifies Γ, and the matching-firm wage map T is determined by theory once Ψ is in hand. The worker-weighted current-rank distribution H is jointly identified from (i) the cross-section of posting-firm workers across contracts x_j and tenures τ, and (ii) the cross-section

[9] When $g_j \equiv 0$, $\mu_j = \theta_j$, $\omega_{x_j}(\tau) = \theta_j$, $\mathcal{S}_j^d(s) = (1 - q(\theta_j))^s$ sums to $1/q(\theta_j)$, and the steady-state identity $\delta + \kappa\lambda H(\theta_j) = \delta(\delta + \kappa\lambda)/q(\theta_j)$ collapses s_j^P to the flat-contract weight $s_j^{BL} = \delta(\delta + \kappa\lambda)/[N\, q(\theta_j)^2]$.

of matching-firm employment shares. Given the classification, the type share ξ is identified from the share of M-classified firms; the unemployment flows (λ, δ) from $u = \delta/(\delta + \lambda)$ and the job-finding rate; and the structural retention rate κ from the rank-exit relationship $q(y) = \delta + \kappa\lambda\overline{K}(y)$, with $\overline{K}$ constructed from (Ψ, Γ) at the current classification.

From exact restrictions to estimation. Posting firms in the data may exhibit residual dispersion around the contract profile, matching-firm wages are observed with noise, and some job-to-job moves violate the strict rank ordering. The likelihood below introduces three relaxation parameters $(\sigma_P, \sigma_M, \sigma_\omega)$ that soften the sharp restrictions: ϕ_{σ_P} widens the wage density at P-firms around the contract profile $w(\tau; x_j)$; ϕ_{σ_M} widens the wage density at M-firms around the matching-firm wage map T; and Φ_ω smooths the strict acceptance condition $r_{j'} > y_{it}$ into a graded threshold. As $(\sigma_P, \sigma_M, \sigma_\omega) \to 0$ the likelihood collapses to the sharp restrictions above. We calibrate the three by validation likelihood (Section 4.5) and treat them as hyperparameters rather than as primitives of measurement error or mobility cost; the estimated values summarize how much each sharp restriction must be relaxed for the likelihood to be coherent with the data.

4.4 Likelihood and Classification EM

The complete-data likelihood combines the sampling objects of Section 4.2 with type-specific wage densities. Each firm $j = 1, \ldots, N$ has latent type z_j with marginal probabilities $(1 - \xi, \xi)$; conditional on type, the posting-firm contract x_j is drawn from f_X and the matching-firm productivity p_j from γ, giving the firm-level contribution

$$\log \mathcal{L}_F(z, x, p) = \sum_j \Big\{ \mathbf{1}\{z_j = P\} \log[(1 - \xi) f_X(x_j)] + \mathbf{1}\{z_j = M\} \log[\xi \gamma(p_j)] \Big\}.$$

Worker contributions are evaluated conditional on the firm-level vector and we suppress this dependence below. Throughout, we use the smoothed finite-firm offer tail $\overline{K}^{\Phi}_N(y) = N^{-1} \sum_{j'} \Phi_\omega(r_{j'} - y)$ and exit rate $q^{\Phi}_N(y) = \delta + \kappa\lambda\overline{K}^{\Phi}_N(y)$; these absorb mobility transitions that violate the strict rank ordering through the kernel Φ_ω. Collect the structural parameter vector as

$$\Pi = (\Gamma, \xi, \lambda, \delta, \kappa),$$

and let $\sigma = (\sigma_P, \sigma_M, \sigma_\omega)$ denote the smoothing hyperparameters introduced in Section 4.3, fixed by validation. The parametric form of Γ and the identification of each element of Π are specified in Section 4.5.

Initial worker contribution. Posting-firm incumbents are observed at known tenure τ_{i1}. The period-1 wage density is the contract wage at that tenure plus Gaussian noise, weighted by the structural survival to τ_{i1}:

$$\mathcal{L}_{i1}^{P} = \frac{1}{N}\big[\delta + \kappa\lambda H(\mu_j)\big]\, \mathcal{S}_j^{d}(\tau_{i1})\, \phi_{\sigma_P}(w_{i1} - w(\tau_{i1}; x_j))\,, \tag{16}$$

where $w(\tau; x_j) = \theta_j + g_j \min\{\tau, \bar{\tau}\}$. At a matching firm, the wage is $T(t, p_j)$ for an inherited rank $t \le p_j$ drawn from $\mathcal{G}(\cdot \mid p_j)$ (Section 3.6); the inherited-rank-integrated wage density is

$$f_j^M(w) = p_0(p_j)\phi_{\sigma_M}(w - T(\underline{w}, p_j)) + \int_{\underline{w}}^{p_j} \phi_{\sigma_M}(w - T(t, p_j))\, g(t \mid p_j)\, \mathrm{d}t, \tag{17}$$

with mass point $p_0(p_j)$ at $\underline{w}$ and continuous density $g(t \mid p_j)$. The matching-firm wage anchor does not vary with tenure, so the tenure-conditional factor reduces to the geometric survival $(1 - q(p_j))^{\tau_{i1}}$:

$$\mathcal{L}_{i1}^{M} = \frac{1}{N}\big[\delta + \kappa\lambda H(p_j)\big]\, (1 - q(p_j))^{\tau_{i1}}\, f_j^M(w_{i1}). \tag{18}$$

For workers whose observed tenure equals the panel cap $\bar{\tau}_{\text{cap}}$, the structural tenure is right-truncated and the contribution integrates the joint density over $\tau \ge \bar{\tau}_{\text{cap}}$; the explicit truncated forms are given in Appendix B.2.

Transitions from a posting firm. Suppose worker i is employed at posting firm j at date t, so $z_j = P$; the origin retention rank is $y_{it} = \omega_{x_j}(\tau_{it})$. A transition to non-employment contributes

$$\mathcal{L}(j_{i,t+1} = U \mid j_{it} = j, z_j = P) = \delta.$$

A $P \to P$ move to posting firm j' contributes

$$\mathcal{L}(j \to j', w_{i,t+1} \mid z_j = P, z_{j'} = P) = \frac{\kappa\lambda}{N}\Phi_\omega(\mu_{j'} - \omega_{x_j}(\tau_{it}))\, \phi_{\sigma_P}(w_{i,t+1} - \theta_{j'}),$$

where the destination wage is the starting wage $\theta_{j'} = w(0; x_{j'})$ since entry tenure is zero. A $P \to M$ move to matching firm j' contributes

$$\mathcal{L}(j \to j', w_{i,t+1} \mid z_j = P, z_{j'} = M) = \frac{\kappa\lambda}{N}\Phi_\omega(p_{j'} - \omega_{x_j}(\tau_{it}))\, \phi_{\sigma_M}\big(w_{i,t+1} - T(\omega_{x_j}(\tau_{it}), p_{j'})\big)\,;$$

the mover enters the matching wage map at the current retention rank $\omega_{x_j}(\tau_{it})$, not at the entry rank μ_j. A posting-firm stayer contributes only the probability of staying:

$$\mathcal{L}(j_{i,t+1} = j \mid j_{it} = j, z_j = P) = 1 - q_N^{\Phi}(\omega_{x_j}(\tau_{it})).$$

Transitions from a matching firm. Suppose worker i is employed at matching firm j at date t, so $z_j = M$; the origin retention rank is $y_{it} = p_j$. A transition to non-employment contributes

$$\mathcal{L}(j_{i,t+1} = U \mid j_{it} = j, z_j = M) = \delta.$$

An $M \to P$ move to posting firm j' contributes

$$\mathcal{L}(j \to j', w_{i,t+1} \mid z_j = M, z_{j'} = P) = \frac{\kappa\lambda}{N}\Phi_\omega(\mu_{j'} - p_j)\, \phi_{\sigma_P}(w_{i,t+1} - \theta_{j'}).$$

An $M \to M$ move to matching firm j' contributes

$$\mathcal{L}(j \to j', w_{i,t+1} \mid z_j = M, z_{j'} = M) = \frac{\kappa\lambda}{N}\Phi_\omega(p_{j'} - p_j)\, \phi_{\sigma_M}(w_{i,t+1} - T(p_j, p_{j'}))\,.$$

A matching-firm stayer contributes only the probability of staying:

$$\mathcal{L}(j_{i,t+1} = j \mid j_{it} = j, z_j = M) = 1 - q_N^\Phi(p_j).$$

Observed likelihood and CEM. With $\mathcal{L}_i$ collecting worker i's initial and transition contributions, the observed likelihood $\sum_{z\in\{P,M\}^N} \mathcal{L}_F(z, x, p) \prod_i \mathcal{L}_i$ is infeasible to evaluate directly because job-to-job transitions involve firm pairs whose types are both latent. We use a classification EM algorithm (Celeux and Govaert, 1992; Lentz et al., 2023), a variant of the EM algorithm of Dempster et al. (1977) in which the latent types are reassigned by hard classification rather than weighted by posterior probabilities. In the C-step, holding all other firm types fixed, firm j is reassigned to the type yielding the higher complete-data contribution; sweeps are repeated until no assignment changes. In the M-step, the structural parameter vector Π is updated. Within the CEM, each likelihood evaluation requires updating the deterministic allocation: given a candidate classification, we estimate f_X from P-classified firms, solve the fixed point for Ψ, construct K, and solve the worker-rank fixed point for H; these objects are recomputed after every C-step sweep and M-step update.

4.5 Empirical Implementation

Parametrization. The matching-firm productivity distribution is Kumaraswamy on $[\underline{p}, \overline{p}]$: $(p - \underline{p})/(\overline{p} - \underline{p}) \sim \text{Kum}(a_M, b_M)$ with $\mathcal{F}(x \mid a, b) = 1 - (1 - x^a)^b$. The posting-firm contract vector is $x_j = (\hat{\theta}_j, \hat{g}_j)$ from the joint AKM described in the wage-concept paragraph below, with profile $w(\tau; x_j) = \hat{\theta}_j + \hat{g}_j \min\{\tau, \bar{\tau}\}$ and $\bar{\tau}$ fixed before estimation at $\bar{\tau} = 14$ years, the right-truncation point of observed tenure in the panel, beyond which within-firm wage growth cannot be identified. Conditional on the current classification, the contract density f_X is fit parametrically from $(\hat{\theta}_j, \hat{g}_j)$ at P-classified firms as a joint density with Kumaraswamy marginals coupled by a Gaussian copula whose correlation is calibrated from the Spearman rank correlation between $\hat{\theta}_j$ and $\hat{g}_j$.[10] The induced rank distribution Ψ and the worker-rank distribution H are recovered from the fixed-point system of Section 3.4. Under this parametrization, the structural parameter vector Π of Section 4.4 reads

$$\Pi = (a_M, b_M, \xi, \lambda, \delta, \kappa),$$

with (λ, δ) calibrated from unemployment flows and κ identified by the per-firm OLS condition stated in step (b) below. The smoothing hyperparameters $(\sigma_P, \sigma_M, \sigma_\omega)$ are fixed by validation in step (a).

Identification scheme: iterated profile. The structural parameter κ and the smoothing hyperparameters $(\sigma_P, \sigma_M, \sigma_\omega)$ interact through the equilibrium objects (Ψ, H, K). We identify them by a nested iteration of two profile steps, starting from a calibrated initial $\kappa_0 = 0.20$ inherited from the flat-contract case $g_j \equiv 0$:[11]

(a) *σ-step*: for fixed κ, run the CEM at every triple $(\sigma_P, \sigma_M, \sigma_\omega)$ on a grid. Each grid point yields a firm classification and parameter estimates on an estimation subsample; the average log-likelihood is evaluated on a held-out validation subsample (worker spells split between subsamples, stratified by firm). The validation-LL-best triple is $\hat{\sigma}(\kappa)$.

(b) *κ-step*: for fixed $\hat{\sigma}$, sweep a grid of κ values, recomputing the CEM and equilibrium objects at each. At every grid κ, compute the per-firm OLS slope of the empirical job-to-job hazard $\widehat{\mathrm{qr}}_j$ on $\overline{K}(y_j)$, where y_j is the firm-mean of $\omega_{x_j}(\tau)$ at P-firms and p_j at M-firms. The per-firm-OLS fixed point $\hat{\kappa}$ solves $\kappa_{\mathrm{pf}}(\hat{\kappa}; \hat{\sigma}) = \hat{\kappa}$; we find it by linear interpolation of $\kappa_{\mathrm{pf}}(\kappa; \hat{\sigma}) - \kappa$ across the grid.

(c) *Iteration check*: rerun (a) at $\kappa = \hat{\kappa}$ over a local sub-grid centred on the previous $\hat{\sigma}$. If $\hat{\sigma}(\hat{\kappa})$ coincides with the previous $\hat{\sigma}$ (to grid resolution) and $\kappa_{\mathrm{pf}}(\hat{\kappa}; \hat{\sigma}(\hat{\kappa})) = \hat{\kappa}$ (to interpolation tolerance), iteration converges. Otherwise, return to (b) at the new $\hat{\sigma}$ and continue. In our data, convergence is reached in two outer iterations.

[10] When the marginal density ψ is needed for numerical integration, figures, or moment comparisons, we use a smoothed grid density associated with the induced values $\{\mu_j\}$; this is not a likelihood primitive.

[11] In the flat-contract case $(g_j \equiv 0)$, κ is identified at every CEM iteration by a firm-level OLS regression of the empirical job-to-job hazard on $\overline{K}(\theta_j)$ given the current classification. Under wage-tenure contracts, $\overline{K}$ depends on the rank distribution Ψ, which depends on the classification and on κ through the equilibrium fixed point; the same moment becomes the self-consistency condition $\kappa_{\mathrm{pf}}(\hat{\kappa}; \hat{\sigma}) = \hat{\kappa}$ identified through the iterated scheme.

Preconditioning. Two firm-level inputs to the CEM are precomputed once on the full 2001–2018 panel and held fixed across iterations: the contract vector $x_j = (\theta_j, g_j)$ from the AKM regression, and the matching productivity proxy p_j (both described next). Both are computed for every firm in the sample, regardless of eventual classification; the CEM uses x_j when firm j is classified P and p_j when it is classified M.

Wage concept and sample. Per the worker-effect convention of Section 3.1, observed log wages decompose as $\log w_{ij} = a_i + w_{\text{model}}$, and the model speaks to the log wage net of a_i. We therefore estimate on residualized real log daily wages obtained from an AKM regression with firm-tenure slopes,

$$y_{ijt}^{\text{raw}} = \alpha_i + \theta_j + g_j\,\tau_{ijt} + \delta_{\text{age}} + \delta_{\text{year}} + \varepsilon_{ijt}, \qquad g_j \geq 0,$$

where the non-negativity constraint on firm-tenure slopes is enforced by active-set iteration. The estimated worker effects, age and year fixed effects, and firm-tenure slopes deliver the residual $y_{ijt} = y_{ijt}^{\text{raw}} - \hat{\alpha}_i - \hat{\delta}_{\text{age}} - \hat{\delta}_{\text{year}}$, the firm wage-level estimates $\hat{\theta}_j$, and the firm wage-growth slopes $\hat{g}_j$. The likelihood uses the residual y_{ijt} together with the contract vector $x_j = (\hat{\theta}_j, \hat{g}_j)$.[12] The likelihood is estimated on two-period worker histories from 2015 and 2016; firm-level rank and profile objects use all worker spells observed at firm j over 2001–2018, which reduces noise in small firm-year samples. The estimation sample contains approximately 4,700 firms and 620,000 workers. We pool male and female workers to maintain comparability with the German survey evidence and report a male-only specification and a re-estimation on 2010 worker histories as sensitivity checks.

Matching-firm productivity. The matching-firm productivity p_j is measured by the 98th percentile of within-firm residualized log wages y_{ijt} over the 2001–2018 observation window, which proxies the upper bound of feasible wages from the matching protocol; the 95th percentile is reported as a sensitivity check.

Hyperparameter grid bounds. The σ-grid in step (a) of the identification scheme is anchored by two reference scales of posting-firm wage noise computed on the residualized panel. The tighter scale, $\hat{\sigma}_P^{\ell} = \text{median}_j\{s_j^{\Delta}/\sqrt{2}\} = 0.066$, uses the cross-firm median of stayer wage-change standard deviations and removes any common firm-level wage-tenure profile through differencing. The conservative scale, $\hat{\sigma}_P^{u} = \text{median}_j\{s_j^{w}\} = 0.171$, uses the cross-firm median

[12] For the flat-contract specification ($g_j \equiv 0$) we set $\theta_j = \hat{\theta}_j + \hat{g}_j\,\overline{\tau}_j$, where $\overline{\tau}_j$ is the within-firm mean of tenure, so the scalar rank summarizes the firm-mean residual wage.

of within-firm wage standard deviations. The grid is

$$\sigma_P \in [0.066, 0.171], \qquad \sigma_M \in [0.066, 0.171], \qquad \sigma_\omega \in [0.066, 0.266],$$

with σ_M bounded by $\hat{\sigma}_P^u$ (an explicit upper-bound choice that lets the matching-firm noise parameter absorb up to the median cross-firm wage dispersion) and σ_ω bounded by the standard deviation of the rank gap among job-to-job movers. Online Appendix Section OA.4 gives the definitions and reports within-firm dispersion diagnostics that motivate the wage-tenure profile and the matching-firm class.

5 Results

5.1 Estimates and Model Fit

Parameter Estimates. Online Appendix Table OA.9 reports the parameter estimates on the residualized Austrian panel. The estimated share of M-firms is 23.2%, close to the 24% share of bargaining firms in the German survey under our preferred definition. The estimated job-displacement rate is $\delta = 0.021$, and the job-finding rate from unemployment is $\lambda = 0.338$. Both estimates lie within the ranges typically used in the search literature. The on-the-job search efficiency κ is identified from the per-firm OLS condition described in Section 4.5: at the joint (σ, κ) fixed point it equals 0.175, compared with $\kappa = 0.20$ in the no-growth specification estimated on the same residualized panel. The wage-noise parameters are $\sigma_P = 0.141$ and $\sigma_M = 0.171$, and the mobility-acceptance smoothing parameter is $\sigma_\omega = 0.266$. For scale, the empirical standard deviation of first-period residualized wages is 0.20, and the empirical standard deviation of $\theta_{i2} - \theta_{i1}$ among movers is 0.24. Online Appendix Table OA.10 reports the average log likelihood over the hyperparameter grid. The likelihood is maximized at the triple $(\sigma_P, \sigma_M, \sigma_\omega) = (0.141, 0.171, 0.266)$, with average log likelihood -11.194.

The σ_P-coordinate of the maximizer lies in the interior of the data-implied grid and the profile likelihood declines on either side; ξ stays within ± 5 percentage points across neighboring grid points (Online Appendix Table OA.10).

Model Fit. We first assess the fit of the estimated firm-rank distributions. The rank object is type-specific. For M-firms, the rank is the firm productivity p_j. For P-firms, the rank is the entry-equivalent flat wage $\mu_j \equiv \omega_j(0)$, the scalar that summarizes the posted contract (θ_j, g_j) for mobility decisions. The M-firm rank distribution $\Gamma(p)$ is fit as a Kumaraswamy density on the cross-firm distribution of p_j. The P-firm rank distribution $\Psi(\mu)$ is the equilibrium distribution of entry-equivalent wages $\mu_j = \omega_j(0)$ across posting firms, obtained as the fixed point of the rank ODE in Lemma 1; for plotting we summarize the converged $\{\mu_j\}$ by a Kumaraswamy density (the likelihood and fixed-point system use the empirical $\{\mu_j\}$ directly). The joint density of P-firm contracts, $f_X(\theta, g)$, is fit separately as a two-dimensional Gaussian kernel density estimator over P-classified firms, with the empirical scatter reported in Online Appendix Figure OA.2.

Figure 1 overlays the empirical rank histograms on the fitted densities. The fitted densities closely track the empirical distributions on both supports. Online Appendix Table OA.11 reports the corresponding first and second moments, with close fit of empirical data and predicted moments.

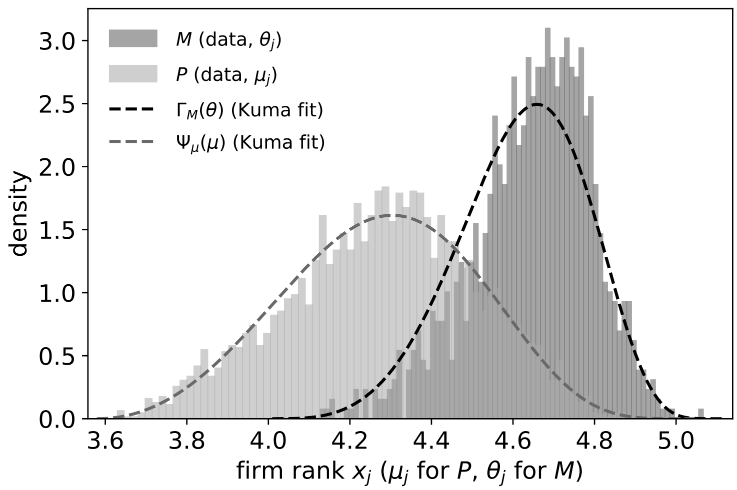
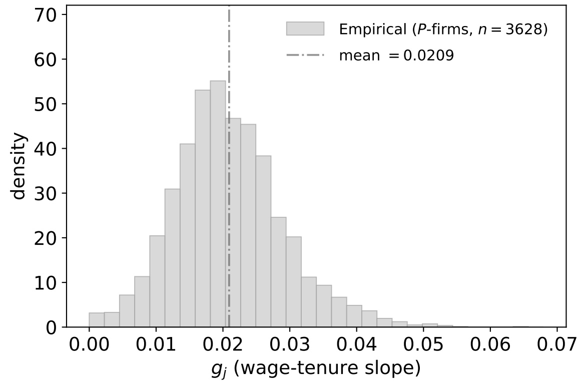


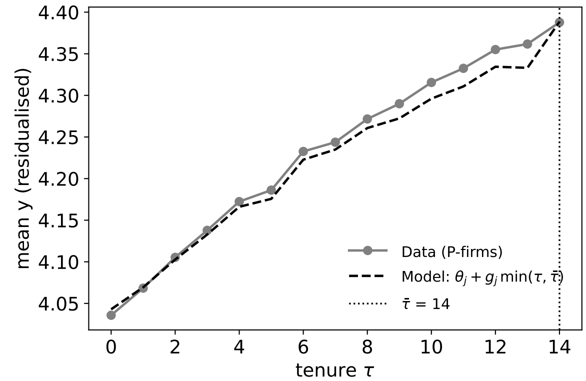
Figure 1: Estimated firm-rank distributions by firm type.

Note: Histograms plot the firm-level rank x_j for P- and M-firms; dashed lines plot the fitted Kumaraswamy densities. The rank is $\mu_j \equiv \omega_j(0)$ for P-firms and p_j for M-firms, both expressed on the residualized log-wage scale. The fitted densities are $\Psi(\mu)$ for P-firms and $\Gamma(p)$ for M-firms. The sample contains 3,628 P-firms and 1,099 M-firms in the Austrian 2015 panel.

Figure 2 summarizes the estimated P-firm wage-tenure profile. The left panel plots the marginal distribution of the firm-level slope g_j across P-firms: right-skewed on $[0, 0.056]$ with cross-firm mean 0.021 and a small mass near $g_j = 0$ (0.2% of P-firms posting a flat profile). The Pearson correlation between θ_j and g_j among P-firms is -0.13, consistent with the wage-tenure-contract logic of Burdett and Coles (2003): firms with lower starting wages compensate via steeper wage-tenure growth to retain workers. The right panel compares the empirical mean wage profile $\mathbb{E}[w_i \mid P, \tau]$ with the model-implied profile $w_j(\tau) = \theta_j + g_j \min\{\tau, \bar{\tau}\}$ ($\bar{\tau} = 14$): the gap is below 0.03 log points at all tenure years in the 2015 cross-section.



(a) Distribution of g_j across P-firms



(b) Wage-tenure profile, P-firms

Figure 2: P-firm wage-tenure slope and resulting wage profile.

Note: Left panel: histogram of estimated firm wage-tenure slopes $\hat{g}_j$ across P-firms, computed from the joint AKM on the 2001–2018 residualized panel and shown for the P-classified firms in the 2015 estimation sample; the vertical dot-dashed line marks the cross-firm mean, 0.021; the spike at $g_j = 0$ comprises 0.2% of P-firms; the y-axis is capped at the 95th percentile of bin densities so the spike does not compress the rest of the distribution. Right panel: solid line plots empirical mean residualized wages by tenure at P-firms in the 2015 cross-section (the EM estimation year); the dashed line plots the model-implied profile $\theta_j + g_j \min\{\tau, \bar{\tau}\}$ averaged across the same rows; the vertical dotted line marks $\bar{\tau} = 14$.

Stayer wage changes are more peaked and fatter-tailed than the Gaussian shock implies, so the likelihood-selected (σ_P, σ_M) overstates the dispersion of Δw for stayers while fitting mobility and initial wages well; Online Appendix Figure OA.3 reports the comparison.

Summary statistics by firm type. Table 4 reports cross-sectional summary statistics by firm type at the converged classification. The wage block reports mean raw daily log wages, mean AKM-residualized wages, within-firm wage variance, and the cross-firm variance of firm mean wages. The structural block reports the model-implied exit rate $qr(y_j) = \delta + \lambda\kappa K(y_j)$ at the firm's unified rank y_j, where $y_j = \mu_j$ for P-firms, $y_j = p_j$ for M-firms, and $K(y) = (1 - \xi)\Psi(y) + \xi\Gamma(y)$.

M-firms pay higher wages: the raw daily log-wage gap is 0.092 log points (4.300 vs. 4.208), and the AKM-residualized gap is 0.099. Within-firm wage variance is larger at M-firms (0.201 vs. 0.169), consistent with heterogeneous renegotiated contracts at matching firms; the cross-firm variance of firm mean wages is slightly larger among P-firms, reflecting the wider support of the P-firm rank distribution. The model-implied exit rate is lower at M-firms (0.031 vs. 0.056), placing them on higher rungs of the structural job ladder.

	P-firms	M-firms	$M - P$
Wages			
$E[w_{\text{raw}}]$ raw daily log wage	4.208	4.300	+0.092
$E[w]$ (AKM-residualised)	4.195	4.294	+0.099
$Var[w]$ within	0.169	0.201	+0.032
$Var_j[w]$ across	0.044	0.033	−0.011
Firm rank from the structural model			
$E[qr(y)]$ exit rate	0.056	0.031	−0.025
Worker characteristics			
E[age]	41.73	41.22	−0.51
Academic share	0.023	0.050	+0.027
Female share	0.298	0.439	+0.141
Firm characteristics			
Avg firm size, $E[N]$	109.9	161.2	+51.3
Density	439.6	571.9	+132.3
Firm age	43.07	41.18	−1.90

Table 4: Summary statistics by firm type.

Note: The table reports cross-sectional summary statistics by firm type under the hard classification. The sample contains 3,628 P-firms and 1,099 M-firms. $E[w]$ is the mean residualized wage. $\text{Var}[w]$ is the average within-firm wage variance, and $\text{Var}_j[w]$ is the cross-firm variance of firm mean wages. $E[qr(y)]$ is the model-implied exit rate evaluated at the unified rank y_j. $E[N]$ is average yearly firm size.

5.2 Validating the Classification

Sign-restricted predictions. The model implies five sign-restricted predictions on observable moments. The estimated classification satisfies all five.

(i) Within-firm wage dispersion. Average within-firm log-wage variance is 0.201 at M-firms and 0.169 at P-firms (Table 4), consistent with heterogeneous renegotiated wages at matching firms and the posted, tenure-aware profile at posting firms.

(ii) Wage cuts on $P \to M$ moves. The probability of a wage cut on a $P \to M$ move is −0.019 unconditionally and remains essentially zero (−0.007, insignificant) under a rich observables baseline that conditions on origin and destination firm wage quality, log firm size, and worker demographics; it flips to +0.054 once we additionally control for origin and destination wage-tenure slopes g_j, significant at the 1% level (Online Appendix Table OA.12). Workers leaving high-g_j P-firms are on rising wage profiles, which mechanically raises the unconditional cut probability; conditioning on g_j isolates the cut net of this level effect. The sign flip requires the structural slope control, not just rich observables, and matches the German evidence in Section 2.

(iii) Tenure-separation gradient. At M-firms the annual separation probability falls by 0.45 pp/yr of tenure; at P-firms the gradient is steeper by an additional 0.12 pp/yr, significant at the 1% level and stable across the firm-quality, demographic, and year-fixed-effect controls (Online Appendix Table OA.14). This matches the structural prediction that at P-firms the exit hazard $q(\omega_j(\tau))$ falls as the retention rank $\omega_j(\tau) = \theta_j + g_j \min(\tau, \bar{\tau})$ rises with tenure, while at M-firms $q(p_j)$ is tenure-invariant. The Austrian magnitude is meaningfully smaller than the German (-0.6 pp/yr) because the main specification absorbs the wage-growth component of firm heterogeneity into the explicit slope g_j rather than into the tenure-separation gradient. Re-running the same regression with the no-growth classification confirms this interpretation: the additional P-side gradient rises from -0.12 pp/yr under the main classification to -0.15 pp/yr under the flat-wage specification, where the wage-growth component of firm heterogeneity is not absorbed into g_j and instead reappears in the gradient (Online Appendix Table OA.15).

(iv) Initial- and mover-density fit. The model-implied densities of period-1 wages and of $P \to P$ and $M \to P$ mover wages closely track the empirical histograms at the estimated σ (Online Appendix Figure OA.7).

(v) Stayer wage growth at M-firms. M-firm stayers exhibit a wage drift of +2.5 pp/yr versus +2.1 pp/yr at P-firms, pooled across the full 2001–2018 panel (Online Appendix Table OA.18); the M-P gap of +0.4 pp/yr is larger at low tenure. The same direction holds in raw wages. The sign matches the renegotiation channel at matching firms and reproduces the German pattern that bargaining-firm stayers exhibit higher residual wage growth (Section 2), providing an additional out-of-sample check on the classification. Doniger (2021) documents the same direction in German IAB data using idiosyncratic (off-cycle) pay revisions as a direct measure of renegotiation events: such revisions are larger, more dispersed, and concentrated in firms that report willingness to negotiate.

We conclude that within-firm wage variance alone is therefore an incomplete classifier. Relative to a within-firm-variance initial classifier, the CEM reassigns 35.4% of observations and 32.6% of firms; 77.2% of firm-level reassignments go from M to P. Reassignment is concentrated among firms with noisier wage signals, including smaller firms. The log-likelihood differences entering the CEM firm-type update show that the worker-side likelihood carries the bulk of the classification information (interquartile range $[-14.6, 2.7]$ for d_j^{workers} vs. $[-5.2, -4.0]$ for d_j^{firm}; Online Appendix Figures OA.4 and OA.5).

At the converged CEM classification, the implied firm-type posterior is concentrated near the boundaries. Let $\pi_j^M \equiv \Lambda(d_j^{\text{workers}} + d_j^{\text{firm}})$ denote the firm-level posterior evaluated at the converged firm-type assignment, where $\Lambda(\cdot)$ is the logistic function. We find that 72.5% of firms have $\pi_j^M < 0.1$, 20.4% have $\pi_j^M > 0.9$, and only 2.7% lie in the intermediate interval $(0.3, 0.7)$. Borderline firms under the converged classification are rare.

The role of wage growth in firm classification. To isolate how the wage-tenure slope changes the classification compared to a setting with $g_j = 0$, we re-estimate the no-growth specification on the same residualized panel. At its LL-best hyperparameters $(\sigma_P, \sigma_M, \sigma_\omega) = (0.171, 0.091, 0.266)$, the no-growth specification yields $\xi = 33.7\%$, about 45% larger than the main-specification estimate of 23.2%. Of the 4,522 firms common to the two classifications, 851 are M under the no-growth specification but P under the main specification; only 403 are classified the other way around.[13]

Table OA.16 characterizes these 851 firms. On wage levels and firm size they resemble consistent-M firms, but their wage-tenure slope is M-like ($g_j = 0.025$ vs. 0.027 for consistent-M) while their within-firm wage variance (0.036) is materially below the consistent-M value (0.047). The no-growth specification reads the elevated within-firm dispersion as bargaining heterogeneity; the main specification absorbs the tenure-driven component into g_j, leaving residual dispersion too tight to be plausibly M-generated. This mechanism brings the Austrian estimate close to the German survey benchmark.

Predictability from firm observables. A natural concern is that our classification is reproducible from firm characteristics alone, in which case the structural likelihood would be doing no additional work. Consistent with Caldwell et al. (2026)'s finding for the German setting, in the Austrian data standard firm characteristics (industry, size, density, firm age, worker composition, and the firm's raw mean log wage) explain at most $R^2 = 0.24$ (AUC 0.83) of the EM-classified M-firm indicator (Panel A of Table 5), far short of the 92.9% of firms placed in $\pi_j^M < 0.1$ or $\pi_j^M > 0.9$ by the structural posterior.

Adding behavioral firm features lifts R^2 but only modestly. The strongest single block is the within-firm wage-distribution shape (SD, IQR, $P90-P10$ gap, and excess kurtosis: $R^2 = 0.337$); stacking all five behavioral blocks reaches $R^2 = 0.379$ (Panels B–C). At firm-level scale, M-firms can be described as having a wider, fatter-tailed within-firm wage distribution at given tenure and somewhat more dispersed wage growth across stayers. Pushing the LPM to the worker level (Panel D, 754,350 observations) yields no improvement on the saturated firm-level specification ($R^2 = 0.286$). The remaining gap to the structural posterior reflects shape information no linear projection can encode. The structural likelihood multiplies a

[13] 674 firms are M under both specifications and 2,594 are P under both. The two classifications are largely but not perfectly nested.

per-worker likelihood ratio between two non-nested densities (the P-firm Gaussian around the posted profile, the M-firm bimodal density from renegotiation) across all observations at the firm, whereas an LPM captures only the linear projection of the wage onto the regressors. Our structural approach therefore aligns with Caldwell et al. (2026)'s reduced-form evidence.

Specification	N obs	R^2	Adj. R^2	F	AUC
Panel A: Firm-level, standard firm characteristics (nested)					
Industry fixed effects	4,727	0.111	0.109	83.8	0.647
+ log size, density, firm age	3,739	0.141	0.139	61.3	0.707
+ worker composition	3,739	0.188	0.186	72.0	0.756
+ raw mean wage	3,739	0.218	0.215	79.9	0.786
Panel B: Firm-level, one behavioural block on top of the full Panel-A baseline					
All firm chars. + within-firm wage moments	3,739	0.286	0.282	87.5	0.837
All firm chars. + posted starting wage θ_j	3,739	0.219	0.216	74.6	0.786
All firm chars. + wage-tenure slope g_j	3,739	0.222	0.219	75.7	0.793
All firm chars. + wage-growth dispersion	3,739	0.239	0.236	77.9	0.809
All firm chars. + exit and mobility moments	3,679	0.230	0.227	60.8	0.794
Panel C: Firm-level, all behavioural blocks stacked					
All firm chars. + all behavioural features	3,679	0.349	0.344	75.3	0.878
Panel D: Worker-level (one observation per worker–firm–period)					
All firm chars. + own y, tenure, profile residual	754,350	0.284	0.284	16,662	0.817

Table 5: Predictability of M-firm status from observable firm characteristics.

Note: Linear probability models of the EM-classified M-firm indicator on the indicated regressor blocks. Panels A–C are fit at the firm level; Panel D at the worker level. Panel A nests industry fixed effects, log yearly firm size, local population density, firm age, share female and share with an academic degree, and the firm's raw mean log wage. Each Panel-B row adds one behavioral block on top of the full Panel-A baseline; Panel C stacks all five blocks. The blocks are: within-firm wage moments (SD, IQR, $P90-P10$ gap, excess kurtosis of residualized wages); posted starting wage θ_j; wage-tenure slope g_j; wage-growth dispersion (SD and IQR of stayer Δw); and exit and mobility moments (EU and EE exit rates, hire-from-non-employment share, wage-cut-at-entry share, wage-gain-at-exit share). Panel D adds the worker's own y_{it}, τ_{it}, and the residual to the firm's posted profile; the sample is a random one-million-row subset of the worker-level panel. Reduced firm-level samples reflect firms missing covariates. AUC is computed against the EM label.

Wage cuts and subsequent growth. The model implies that some workers accept wage cuts when moving from P- to M-firms because the new firm offers future wage growth through renegotiation. This prediction contrasts with Sorkin (2018), who finds that US workers experiencing wage cuts upon mobility are not subsequently compensated by higher wage growth. We implement the same test in the Austrian data: regress subsequent residualized wage growth (over $\tau = 2$ and $\tau = 3$ horizons, conditional on the worker remaining at the destination through the horizon) on an indicator for a wage cut at the move, both pooled and decomposed by mover cell.

	$M \to P$	Pooled	Within type	$P \to M$
$\tau = 2$, no controls	0.018	0.031	0.034	0.035
$\tau = 2$, with controls	0.025	0.036	0.038	0.039
$\tau = 3$, no controls	0.020	0.035	0.037	0.041
$\tau = 3$, with controls	0.029	0.041	0.042	0.045

Table 6: Wage cuts and subsequent wage growth.

Note: The table reports OLS coefficients on $1\{\Delta w_{\text{move}} < 0\}$. The dependent variable is subsequent residualized wage growth from the first year at the destination firm to year $1 + \tau$, conditional on remaining at the destination through $1 + \tau$. Standard errors are clustered at the worker level; all reported coefficients have $p < 0.001$. "Pooled" uses all job-to-job movers. The other columns report estimates by mover cell. Specifications with controls add age, female, academic, log origin firm size, and log destination firm size. Online Appendix Table OA.17 reports the full set of specifications, including the original wage measure.

Table 6 reports the results. The pooled coefficient is positive (0.031 to 0.041 across specifications), so wage-cut movers in Austria experience higher subsequent growth than wage-gain movers. The effect is heterogeneous across mover cells: in every specification the coefficient is largest on $P \to M$ moves and smallest on $M \to P$ moves, with a cross-type gap of 1.4 to 2.1 log points (significant in the interaction specifications reported in Online Appendix Table OA.17). The positive within-type coefficient implies that the level of the coefficient alone is not uniquely diagnostic; the cross-type difference is the option-value signature predicted by the model.

Variance decomposition of mover wages. A model-free test of the renegotiation channel asks whether origin rank matters more at M-destinations than at P-destinations. We estimate the two-sided firm-fixed-effects regression $y_{i,t+1} = \alpha + \psi^O_{j(i)} + \psi^D_{j'(i)} + \varepsilon_{i,t+1}$ jointly on the largest connected component of the bipartite J2J-mover graph; per-cell rows project the global (ψ^O, ψ^D) onto each mover subsample and decompose $\text{Var}(\psi^O + \psi^D \mid S)$, since re-estimating the fixed effects within a single cell is infeasible under the connected-set requirement. Di Addario et al. (2023) run a similar two-sided firm-fixed-effects exercise on Italian Veneto administrative data and report small aggregate origin shares. We replicate the small aggregate and show that a small overall origin contribution is consistent with the presence of bargaining firms in the sample rather than evidence against it: under the main classification the aggregate masks a sign-restricted type contrast that lines up with the renegotiation channel.

Table 7 reports the result. Under the main classification, the origin share rises from 13% at P-destinations to 22% at M-destinations, with the $P \to M$ atom contributing 19%. This matches the model's prediction that origin rank transfers into the M-firm wage through renegotiation, without imposing the structural rank construction. The no-growth classification produces the reverse pattern (21% at P-destinations, 13% at M-destinations), so the main classification is the only one that recovers the model-implied sign of the origin contrast — even though aggregate decompositions across all movers are nearly identical.

	Wage growth			*Flat wage*		
	Dest.	Origin	Cov.	Dest.	Origin	Cov.
All movers	0.592	0.147	0.261	0.597	0.151	0.252
P-destination	0.617	0.130	0.253	0.589	0.208	0.203
$P \to P$	0.630	0.118	0.252	0.688	0.152	0.160
$M \to P$	0.601	0.161	0.238	0.456	0.278	0.266
M-destination	0.532	0.216	0.252	0.601	0.134	0.265
$P \to M$	0.559	0.187	0.254	0.764	0.074	0.162
$M \to M$	0.529	0.241	0.230	0.523	0.154	0.324

Table 7: Variance decomposition of mover wages: two-sided firm fixed effects.

Note: Origin and destination firm fixed effects $(\psi_j^O, \psi_{j'}^D)$ are estimated jointly by OLS on next-period mover wages y_{t+1} over the largest connected bipartite component of the J2J mover graph. Each row decomposes $\text{Var}(\psi^O + \psi^D \mid S)$ for the indicated mover subsample S into shares attributed to the destination FE, the origin FE, and the covariance term; the three shares sum to one. The overall $R^2 = \text{Var}(\psi^O + \psi^D)/\text{Var}(y_{t+1})$ governs how much of the wage variance the fixed effects span. "All movers" uses the global regression; per-cell rows project the global fixed effects onto the cell and decompose the projected fitted-value variance, since the connected-set requirement is not satisfied within any single cell. Sample sizes: 190,394 J2J movers under the main classification (4,667 origin firms, 4,686 destination firms, overall $R^2 = 0.633$); 176,964 under the no-growth classification (4,464 origin firms, 4,484 destination firms, $R^2 = 0.613$). Per-cell composition differs because the two classifications assign different sets of firms to the P- and M-types.

Init-only diagnostic: an entry-bargaining benchmark. The German Bargaining+ survey question, "was the wage bargained at hire?", is most closely compared with the entry term of the converged likelihood. After the CEM converges, we evaluate a diagnostic that uses only this term of the converged likelihood: at each worker–firm–year row we form $g^{\text{init}} = \text{init}_M/(\text{init}_M + \text{init}_P)$ under a uniform prior, average within firm across worker-years, and label a firm "entry-M" if its mean posterior exceeds 0.5. The exercise is not a re-classification of firms; the CEM classification is fixed at convergence. It is a partial-likelihood diagnostic that asks what the entry term alone would imply at the estimated model. Although narrower than our structural definition, the entry-bargaining benchmark should track ξ since entry-bargained firms typically renegotiate elsewhere in the spell.

Table 8 reports the entry-M share for the main and no-growth specifications in two windows: all worker–firm–years and tenure ≤ 1, the analogue of the survey question. Averaged across all worker–firm–years, the main specification yields an entry-M share of 21.4%, matching qualitatively its structural ξ of 23.2% and the German Bargaining+ benchmark of $\sim 24\%$. The no-growth specification gives 28.3%, above the survey benchmark but below its own structural ξ of 33.7%. Restricting to tenure ≤ 1 shifts the two specifications in opposite directions: the main-specification share falls to 18.9% (at very short tenure, P-firm wages cluster tightly around θ_j before $g_j\tau$ has accumulated, so init_P is sharp and the posterior leans toward P), while the no-growth share rises to 30.8%. Either window preserves the relative ranking and confirms that the model aligns the Austrian and German shares most closely.

	Full ξ	Init-only, share of firms entry-M	
		Tenure ≤ 1	All obs.
Wage growth	23.2%	18.9%	21.4%
Flat wage (no-growth)	33.7%	31.2%	28.3%
German Bargaining+ benchmark	—	$\sim 24\%$	

Table 8: Entry-M share at the converged CEM: init-only diagnostic.

Note: "Full ξ" is the structural M-firm share from the LL-best estimate. "Init-only" columns report the share of firms labeled entry-M when the firm-level posterior is constructed from the entry-wage term of the converged likelihood alone, under a uniform prior; the structural CEM classification is unchanged. "Tenure ≤ 1" restricts to worker-firm-year observations with tenure 0 or 1; "All obs." uses every worker-firm-year. Both columns aggregate per-row posteriors to a firm-level mean and threshold at 0.5. The $\sim 24\%$ benchmark is the German Bargaining+ survey share of firms reporting the entry wage was bargained.

Sensitivity. In addition to the contract-space comparison discussed above (the no-growth specification yields $\xi = 33.7\%$), we re-estimate the model along three further dimensions, holding the EM procedure and the residualized panel construction fixed. *(i) Cross-section.* On the 2010 panel instead of the headline 2015 panel, the estimated bargaining share is $\xi = 17.7\%$, around six percentage points below the headline. Measured ξ thus rises over time, in parallel with the German evidence in Section 2 that the weighted M-firm share rose roughly 10 percentage points between 2011 and 2019. The Austrian increase may also partially reflect the March 2011 amendment to the Equal Treatment Act, which requires job advertisements to state the minimum wage and the firm's willingness to overpay (Frimmel et al., 2022).[14] *(ii) Sample composition.* Restricting to male workers yields $\xi = 17.2\%$; the likelihood-maximizing σ_ω collapses to the lower bound of the σ-grid (0.066) and κ rises to 0.29, indicating that male movers' choices track the theoretical job ladder more closely than the average mover.[15] *(iii) M-firm productivity proxy.* Lowering the within-firm wage percentile used to construct $\theta_{\max}$ from the 98th to the 95th yields $\xi = 17.5\%$, holding σ and κ essentially unchanged at the headline values. Full parameter estimates and tuning

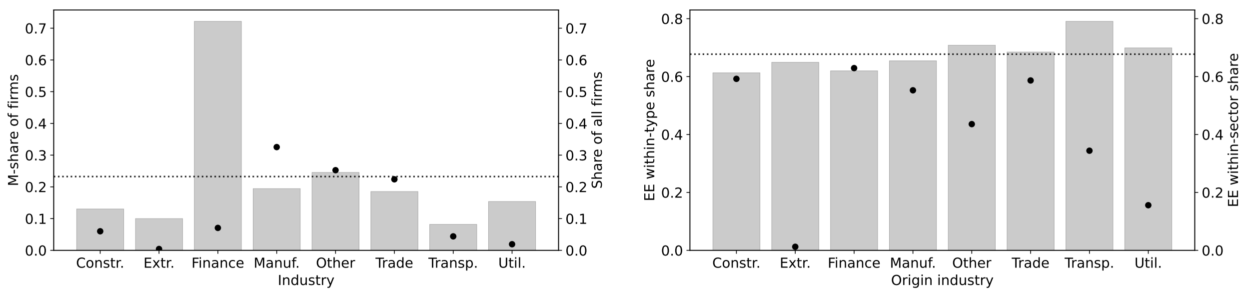
[14] We refrain from using earlier sample years as this increases the incidence of tenure truncation in our sample.

[15] We hold the σ-grid bounds at the full-panel values for cross-sample comparability; only σ_M would change materially under a male-only re-derivation (male data-derived upper 0.145 vs. full-panel 0.171, where σ_M pins).

parameters for each specification are reported in Online Appendix Table OA.9.

5.3 Cross-Country Correspondence and Firm Characteristics

Having shown that the classification satisfies the sign restrictions and out-of-sample diagnostics in Section 5.2, we turn to describing the firms it assigns to each type and to comparing the resulting cross-sectional patterns with the German motivating evidence.



(a) M-share by broad sector

(b) Within-type and within-sector mobility, by origin sector

Figure 3: Firm-type composition and worker mobility by sector.

Note: Left panel: bars on the left axis plot the share of M-firms in each one-digit sector; the dotted line marks the economy-wide M-firm share, $\xi = 0.232$; black dots on the right axis plot each sector's share of all firms. Right panel: bars on the left axis plot the share of job-to-job movers from each origin sector who move to a firm of the same type; the dotted line marks the sample average, 0.68; black dots on the right axis plot the share of movers who remain in the same one-digit sector.

Worker and firm characteristics. Workers at M-firms are slightly younger on average (41.2 vs. 41.7 years), more skill intensive (academic share 5.0% vs. 2.3%),[16] and concentrated in denser areas. M-firms also employ a higher share of female workers (44% vs. 30% at the firm level).[17] M-firms are also larger on average (161.2 vs. 109.9 workers per year). Figure 3 reports firm-type composition and mobility by broad sector. Transportation, Extraction, Construction, and Utilities have M-firm shares between 8% and 15%. Finance is the outlier in Austria: 72% of finance firms are classified as M-firms, well above any other sector. This is consistent with the broader pattern documented in Brenzel et al. (2014) that bargaining is more prevalent in knowledge- and service-intensive sectors than in public administration or basic services, and with US survey evidence that knowledge workers are substantially more likely to bargain over pay than other workers (Hall and Krueger, 2012). Outside Finance, the

[16] The Austrian academic category is narrower than the corresponding German qualification codes; the within-sample ratio is more comparable than the level.

[17] The AT female-share differential is opposite to the DE pattern (M slightly lower than P), reflecting differences in the firm populations covered by the two data sources: note that the AT administrative universe over-represents male-dominated sectors like construction and transport among P-firms.

M-firm share is below 25% in each broad sector. The bottom panel shows that within-type mobility averages 68% across sectors, only modestly above the random-matching benchmark $1 - 2\xi(1-\xi) = 64\%$ at the estimated $\xi = 0.232$ (the factor of two reflects the two cross-type transitions, $P \to M$ and $M \to P$), so job-to-job movers frequently cross firm types.

	Germany (P-firms vs. M-firms)	Austria (P-firms vs. M-firms)	Match
Panel A. Cross-sectional firm characteristics			
M-firm share, ξ	24%	23.2%	✓
Raw wage premium at M-firms	0.07 log points	0.09 log points	✓
Within-firm wage dispersion	IQR: 0.31 vs. 0.34	IQR: 0.189 vs. 0.214	✓
Academic-worker share	Higher at M-firms	2.3% vs. 5.0%	✓
Average worker age	40.7 vs. 40.3 years	41.7 vs. 41.2 years	✓
Firm size	402 vs. 115 workers	109.9 vs. 161.2 workers	×
Sectoral composition	Elevated in services	Finance share: 72%	✓
Structural job-ladder rank	Lower exit rank at M-firms	$E[q_r(y)] = 0.056$ vs. 0.031	✓
Panel B. Worker mobility and wages			
Wage-cut coefficient on $P \to M$ moves (main spec, with g_j controls)	—	0.054**	—
Wage-cut coefficient on $P \to M$ moves (no-growth spec)	0.106*	−0.029**	×
Tenure–separation gradient (additional decline at P vs. M)	−0.6 pp/yr	−0.12 pp/yr	✓
Stayer wage growth ($M - P$)	+0.5 pp/yr (w/ controls)	+0.4 pp/yr (+2.5 vs. +2.1)	✓

Table 9: Correspondence with the German evidence.

Note: The table compares qualitative directions and selected quantitative anchors between the German motivating evidence in Section 2 and the Austrian estimates. ✓ denotes the same direction in both samples; × denotes a different direction or a substantially different magnitude. In Panel A, the first number refers to M firms.

Correspondence with the German evidence. Table 9 summarizes how the Austrian estimates compare with the German motivating evidence. The main cross-sectional patterns align closely: the M-firm share is similar, M-firms pay higher raw wages, within-firm wage dispersion is higher at M-firms, M-firms are more skill intensive, more prevalent in services and Finance, and higher on the structural job ladder. Firm size is the one cross-sectional dimension where the two samples disagree: M-firms are larger than P-firms in Austria, while they are smaller in Germany. This is consistent with Doniger (2023) who also finds M-firms to be larger than P-firms in her US calibration. The tenure-separation evidence also lines up once wage-tenure slopes are accounted for. The gradient at P-firms is steeper than at M-firms in both samples, qualitatively confirming the wage-tenure-contract prediction, although the additional P-side decline is much smaller in Austria (-0.12 percentage points per year of tenure) than in Germany (-0.6 percentage points per year), because the main specification absorbs the wage-growth component of firm heterogeneity into the explicit slope g_j.

6 Conclusion

We develop and estimate a framework in which wage-posting (P-firms) and wage-bargaining (M-firms) coexist within a common job-ladder environment, and we propose a likelihood-based classification procedure that treats firms' wage-setting regimes as latent. Allowing posting firms to offer wage–tenure contracts is essential to the classification: the main specification yields a bargaining share of 23%, compared with 34% under a no-growth specification, with the difference accounted for by deterministic wage growth at P-firms that the no-growth specification otherwise attributes to bargaining heterogeneity.

The estimates align with survey evidence on wage setting at hire across two independent settings. Bargaining firms account for 23% of firms in Austria and 24% in Germany, occupy higher rungs of the job ladder, exhibit greater within-firm wage dispersion, employ a more skilled workforce, and are concentrated in finance and other high-skill sectors. Mobility patterns are consistent with the model: $P \to P$ moves predominantly raise wages, whereas $P \to M$ moves are disproportionately associated with wage cuts that are followed by faster subsequent wage growth, consistent with the option-value channel of renegotiation at matching firms.

Methodologically, a likelihood-based estimator can recover the two wage-setting regimes in a way that is consistent with theory and validated against external survey benchmarks. Analyses distinguishing firm types are therefore feasible even when survey data are unavailable or limited in scope. The resulting classification cannot be reproduced from firm-level observables alone, even by saturated linear projections on within-firm wage and mobility moments; the joint use of the structural functional form across all worker observations at a firm is what pins down regime identity.

Our analysis emphasizes firms and their wage-setting regimes, treating the regime composition as given. Several extensions appear promising. First, a natural next step is to provide an equilibrium foundation for the coexistence of the two protocols. In the current framework, the share of P- versus M-firms is exogenous; embedding the model in general equilibrium with endogenous vacancy posting would allow firms' choices between wage bargaining and wage posting to be rationalized as equilibrium outcomes, and would let the regime composition respond to labor-market conditions and policy. Second, incorporating vacancy data into the estimation and classification could help discipline the model's implications for recruiting behavior.

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Appendix

A Additional Derivations for the Theoretical Framework

A.1 Values and the Common Ranking

This appendix derives the value equations and the common ranking used in Section 3.3. As in the main text, the distribution F of posted contract values is taken as an input to the classification model rather than derived from a firm-side optimal posting problem.

Let $P(W)$ denote the expected gain from drawing a posted contract whose value exceeds W:

$$P(W) = \mathbb{E}_{W' \sim F} \max\{W' - W, 0\} = \int_{\underline{W}}^{\overline{W}} \max\{W' - W, 0\}\, dF(W') = \int_{W}^{\overline{W}} \overline{F}(W')\, dW'.$$

This expression is understood with the appropriate truncation when W lies outside the support of F. It implies $P'(W) = -\overline{F}(W)$. The value of unemployment satisfies

$$rV_0 = b + \lambda(1-\xi)P(V_0).$$

A posting firm that promises worker value W pays a flow wage $w_P(W)$ satisfying

$$(r+\delta)W = w_P(W) + \delta V_0 + \kappa\lambda(1-\xi)P(W), \tag{19}$$

so $w_P(W) = (r+\delta)W - \delta V_0 - \kappa\lambda(1-\xi)P(W)$ and

$$w_P'(W) = r + \delta + \kappa\lambda(1-\xi)\overline{F}(W) > 0.$$

A matching firm with productivity p can deliver at most the value $\Omega(p)$ while breaking even, where

$$(r+\delta)\Omega(p) = p + \delta V_0 + \kappa\lambda(1-\xi)P(\Omega(p)). \tag{20}$$

Differentiating gives

$$\Omega'(p) = \frac{1}{r + \delta + \kappa\lambda(1-\xi)\overline{F}(\Omega(p))} > 0.$$

Inverting equation (20) gives

$$\Omega^{-1}(W) = (r+\delta)W - \delta V_0 - \kappa\lambda(1-\xi)P(W) = w_P(W).$$

Thus a posted contract promising W and a matching firm with productivity $p = \Omega^{-1}(W)$ deliver the same maximum worker value. For a worker with current value W at a matching firm with productivity p, integration by parts gives the expected gain from meetings with other matching firms,

$$M(W,p) = \int_{\Omega^{-1}(W)}^{p} \overline{\Gamma}(p')\, d\Omega(p'),$$

with the lower bound truncated when $\Omega^{-1}(W) < \underline{p}$. The wage $w_M(W,p)$ paid by the matching firm solves

$$(r+\delta)W = w_M(W,p) + \delta V_0 + \kappa\lambda(1-\xi)P(W) + \kappa\lambda\xi M(W,p). \tag{21}$$

Combining equations (19) and (21) yields

$$w_M(W,p) = w_P(W) - \kappa\lambda\xi \int_{\Omega^{-1}(W)}^{p} \overline{\Gamma}(p')\, d\Omega(p').$$

Define the common rank by $t = w_P(W) = \Omega^{-1}(W)$, and let $\Psi(t) = F(\Omega(t))$ denote the firm-weighted distribution of posting-firm ranks. Then $\overline{F}(\Omega(t)) = \overline{\Psi}(t)$. Using this common-rank notation, we obtain $w_M(W,p) = T(t,p)$, where

$$\begin{aligned} T(t,p) &= t - \kappa\lambda\xi \int_t^p \overline{\Gamma}(x)\Omega'(x)\, dx \\ &= t - \int_t^p \frac{\lambda\kappa\xi\overline{\Gamma}(x)}{r+\delta+\kappa\lambda(1-\xi)\overline{\Psi}(x)}\, dx. \end{aligned}$$

A.2 Derivation of the Equivalent Flat Wage ODE

Proof sketch of Lemma 1. Consider a worker at a posting firm with contract vector x at tenure τ. Her wage is $w(\tau; x)$. In the main empirical specification, $x = (\theta, g)$ and

$$w(\tau; x) = \theta + g \min\{\tau, \bar{\tau}\},$$

where θ is the scalar starting wage, g is the slope before the plateau, and the common $\bar{\tau}$ is fixed before estimation from the observed tenure distribution. For a candidate distribution Ψ of posting-firm equivalent flat wages, let $P_\mu(W)$ denote the option value from drawing a posted contract with value above W. The worker's value $W_x(\tau)$ satisfies

$$(r+\delta)W_x(\tau) = w(\tau; x) + W_x'(\tau) + \delta V_0 + \kappa\lambda(1-\xi)P_\mu(W_x(\tau)). \tag{22}$$

For a candidate distribution Ψ of posting-firm equivalent flat wages, let $\Omega_\mu(w)$ denote the flat-contract value associated with rank w under that distribution. Define the equivalent flat wage $\omega_x(\tau)$ by $W_x(\tau) = \Omega_\mu(\omega_x(\tau))$. The function $\Omega_\mu(w)$ satisfies

$$(r+\delta)\,\Omega_\mu(w) = w + \delta V_0 + \kappa\lambda(1-\xi)P_\mu(\Omega_\mu(w)). \tag{23}$$

Substituting $W_x(\tau) = \Omega_\mu(\omega_x(\tau))$ into (22):

$$(r+\delta)\,\Omega_\mu(\omega_x) = w(\tau;x) + \Omega'_\mu(\omega_x)\,\omega'_x(\tau) + \delta V_0 + \kappa\lambda(1-\xi)\,P_\mu\big(\Omega_\mu(\omega_x)\big). \tag{24}$$

Evaluating (23) at $w = \omega_x(\tau)$ gives

$$(r+\delta)\,\Omega_\mu(\omega_x) = \omega_x + \delta V_0 + \kappa\lambda(1-\xi)\,P_\mu\big(\Omega_\mu(\omega_x)\big).$$

Subtracting this from (24), the terms δV_0 and $\kappa\lambda(1-\xi)P_\mu(\Omega_\mu(\omega_x))$ cancel exactly, leaving

$$\omega_x(\tau) = w(\tau;x) + \Omega'_\mu(\omega_x(\tau))\,\omega'_x(\tau). \tag{25}$$

Differentiating the flat-contract equation with respect to w gives

$$(r+\delta)\Omega'_\mu(w) = 1 - \kappa\lambda(1-\xi)\overline{\Psi}(w)\Omega'_\mu(w),$$

so

$$\Omega'_\mu(w) = \frac{1}{h(w)}, \qquad h(w) = r + \delta + \kappa\lambda(1-\xi)\overline{\Psi}(w).$$

Substituting $\Omega'_\mu(\omega_x) = 1/h(\omega_x)$ into (25) and rearranging gives the general contract-vector form

$$\omega'_x(\tau) = h(\omega_x(\tau))[\omega_x(\tau) - w(\tau;x)]. \tag{26}$$

For $\tau < \bar{\tau}$, this becomes

$$\omega'(\tau) = h(\omega(\tau))[\omega(\tau) - \theta - g\tau].$$

For a given candidate distribution Ψ, this ODE is exactly equivalent to the Bellman equation (22). The change of variable $W_x = \Omega_\mu(\omega_x)$ absorbs the option-value term into the flat-contract value mapping associated with Ψ.

Boundary condition and numerical solution. With the common terminal plateau, the ODE (26) is solved backward on $[0, \bar{\tau}]$ from the exact terminal condition

$$\omega_x(\bar{\tau}) = \theta + g\bar{\tau}.$$

For $\tau \geq \bar{\tau}$, the solution is $\omega_x(\tau) = \theta + g\bar{\tau}$. The solution is integrated backward to $\tau = 0$, yielding the initial equivalent flat wage $\mu(x) = \omega_x(0)$.

A.3 Computation of the Equilibrium Allocation

Proof sketch of Proposition 1. The map Λ sends a candidate distribution Ψ to the distribution of entry ranks induced by $X \sim F$ via the rank ODE of Lemma 1. Because the ODE depends on Ψ only through its bounded survivor $\overline{\Psi}$, its solution $\omega(0; x; \Psi)$ varies continuously with Ψ for each contract x. Integrating against F preserves continuity, so Λ is a continuous self-map of the compact, convex set of CDFs on the rank support. Schauder's fixed-point theorem then delivers at least one $\Psi^* = \Lambda\Psi^*$. In practice, the nested iteration we use to compute Ψ^* (Online Appendix OA.7) converges to the same limit from any starting point we have tried.

A.4 Steady-State Stock Distributions

This appendix derives the steady-state allocation used in the main specification, taking the posting-firm contracts $x \in \mathcal{X}$ as given. Posting-firm contracts are $x = (\theta, g)$ and $w(\tau; x) = \theta + g \min\{\tau, \bar{\tau}\}$, with common $\bar{\tau}$ fixed before estimation. Let F_X be the firm-weighted distribution of posting-firm contracts, with density f_X. For each contract x, let $\omega_x(\tau)$ be the equivalent flat wage at tenure τ, and let $\mu(x) = \omega_x(0)$. The induced distribution of posting-firm offer ranks is

$$\Psi(y) = F_X\{x : \mu(x) \leq y\}.$$

The firm-weighted offer-rank distribution is

$$K(y) = (1 - \xi)\Psi(y) + \xi\Gamma(y), \qquad \overline{K}(y) = 1 - K(y).$$

A worker with current retention rank y exits the current job at rate

$$q(y) = \delta + \kappa\lambda\overline{K}(y).$$

Unlike the baseline, there is no scalar cumulative flow equation in rank space: posting-firm workers move through current ranks as tenure evolves. The corresponding flow balance is therefore written on the state space (x, τ). Let $m_P(x, \tau)$ denote the stock density of employed workers at posting contracts x and tenure τ. A worker at contract x and tenure τ has current retention rank $\omega_x(\tau)$, so m_P satisfies the age equation

$$\frac{\partial m_P(x,\tau)}{\partial \tau} = -q(\omega_x(\tau)) m_P(x,\tau). \tag{27}$$

The entry boundary condition is

$$m_P(x, 0) = (1-\xi) f_X(x) \left[\lambda u + \kappa\lambda(1-u) H(\mu(x))\right].$$

Using $\lambda u = \delta(1-u)$, this becomes

$$m_P(x, 0) = (1-\xi) f_X(x)(1-u) \left[\delta + \kappa\lambda H(\mu(x))\right].$$

Solving (27) gives

$$m_P(x,\tau) = (1-\xi) f_X(x)(1-u) \left[\delta + \kappa\lambda H(\mu(x))\right] \exp\left(-\int_0^\tau q(\omega_x(s))\, ds\right). \tag{28}$$

For a finite firm j with contract x_j, this continuum expression corresponds to

$$n_j^P(\tau) = I_j^P \mathcal{S}_j(\tau), \qquad \mathcal{S}_j(\tau) = \exp\left(-\int_0^\tau q(\omega_j(s))\, ds\right),$$

where $\omega_j(\tau) \equiv \omega_{x_j}(\tau)$ and

$$I_j^P = \frac{1-u}{N}\left[\delta + \kappa\lambda H(\mu_j)\right], \qquad \mu_j = \mu(x_j).$$

The corresponding firm size is

$$\ell_j^P = I_j^P \int_0^\infty \mathcal{S}_j(\tau)\, d\tau.$$

Matching firms have constant current retention rank. For a matching firm with productivity p_j,

$$q_j^M = q(p_j) = \delta + \kappa\lambda \overline{K}(p_j),$$

and

$$I_j^M = \frac{\lambda u}{N} + \frac{\kappa\lambda(1-u)}{N} H(p_j) = \frac{1-u}{N}\left[\delta + \kappa\lambda H(p_j)\right].$$

Since the exit rate is constant within the firm,

$$\ell_j^M = \frac{I_j^M}{q_j^M} = \frac{1-u}{N}\frac{\delta + \kappa\lambda H(p_j)}{\delta + \kappa\lambda \overline{K}(p_j)}.$$

The worker-weighted distribution of current retention ranks is determined by the resulting stocks:

$$H(y) = \frac{1}{1-u}\left[\int_{\mathcal{X}}\int_0^\infty \mathbf{1}\{\omega_x(\tau) \le y\} m_P(x,\tau)\, d\tau\, dx + \int \mathbf{1}\{p \le y\} m_M(p)\, dp\right], \tag{29}$$

where the matching-firm stock density is

$$m_M(p) = \xi\gamma(p)(1-u)\frac{\delta + \kappa\lambda H(p)}{\delta + \kappa\lambda \overline{K}(p)}.$$

Equations (28)–(29), together with the fixed point for Ψ, determine H, firm sizes, and tenure stocks.

A.5 Matching-Firm Wages and Inherited-Rank Distribution

Proof sketch of Lemma 2. Let $t \le p$ denote the inherited outside-option rank of a worker employed by a matching firm with productivity p. The posting-firm distribution entering worker continuation values is Ψ. The matching-firm wage is

$$T(t,p) = t - \kappa\lambda\xi\int_t^p \overline{\Gamma}(x)\Omega'_\mu(x)\, dx.$$

Since

$$\Omega'_\mu(x) = \frac{1}{r + \delta + \kappa\lambda(1-\xi)\overline{\Psi}(x)},$$

we obtain

$$T(t,p) = t - \int_t^p \frac{\kappa\lambda\xi\overline{\Gamma}(x)}{r + \delta + \kappa\lambda(1-\xi)\overline{\Psi}(x)}\, dx.$$

Thus a worker moving from posting firm j at tenure τ to matching firm j' is paid $T(\omega_j(\tau), p_{j'})$.

We next derive the stock distribution of inherited ranks inside a matching firm. Let $\mathcal{G}(t \mid p)$ be the share of workers at a matching firm with productivity p whose inherited rank is weakly below t, for $t \le p$. The inflow into this set consists of unemployed workers and employed workers with current retention rank weakly below t. It is therefore proportional to

$$\lambda u + \kappa\lambda(1-u)H(t) = (1-u)\left[\delta + \kappa\lambda H(t)\right].$$

Workers leave this set through job destruction or through an outside offer with rank above t, which occurs at rate

$$q(t) = \delta + \kappa\lambda\overline{K}(t).$$

Hence the stock of workers at a matching firm p with inherited rank weakly below t is proportional to

$$\frac{\delta + \kappa\lambda H(t)}{\delta + \kappa\lambda\overline{K}(t)}.$$

At $t = p$, this set is the entire stock of the matching firm. Dividing the expression at t by the expression at p gives

$$\mathcal{G}(t \mid p) = \frac{\delta + \kappa\lambda H(t)}{\delta + \kappa\lambda H(p)} \frac{\delta + \kappa\lambda\overline{K}(p)}{\delta + \kappa\lambda\overline{K}(t)}, \qquad t \leq p. \tag{30}$$

There is a mass point at the lower bound $\underline{w}$, corresponding to workers hired from unemployment. On the continuous part, write $g(t \mid p) = \partial\mathcal{G}(t \mid p)/\partial t$. The wage distribution inside a matching firm with productivity p is the distribution of $T(t, p)$ induced by $t \sim \mathcal{G}(\cdot \mid p)$.

B Likelihood Specification

B.1 Cross-Sectional Wage Densities for the Diagnostic Figures

We use the notation of Section 3.4 (μ_j, $\omega_j(\tau)$, H, Ψ, $\overline{K}$, T). The discrete-tenure survival kernel is $\mathcal{S}_j^d(0) = 1$, $\mathcal{S}_j^d(s+1) = \mathcal{S}_j^d(s)[1 - q(\omega_j(s))]$, $q(y) = \delta + \kappa\lambda\overline{K}(y)$.

The diagnostic figures plot model-implied cross-sectional wage densities against empirical histograms pooled over all worker–firm–year rows. Each plotted density is the per-row tenure-conditional initial-stock term (16) or (18) integrated over τ under the model's steady-state tenure distribution at firm j: $\mathcal{S}_j^d(\tau)$ at P-firms, geometric $(1 - q(p_j))^\tau$ at M-firms. The estimation uses the per-row terms (with the right-truncation correction below); marginalising τ puts the model overlay on the same cross-sectional scale as the histogram.

For P-firms,

$$f_{P,1}(w) \propto \sum_{j \in P} N_j[\delta + \kappa\lambda H(\mu_j)] \sum_{s \geq 0} \mathcal{S}_j^d(s)\, \phi_{\sigma_P}\big(w - \theta_j - g_j \min\{s, \bar{\tau}\}\big), \tag{31}$$

where N_j is firm j's panel-row count. For M-firms, integrating (18) against the geometric pmf $q(p_j)(1-q(p_j))^\tau$ collapses the prefactor $[\delta + \kappa\lambda H(p_j)]/q(p_j)$, leaving

$$f_{M,1}(w) \propto \sum_{j\in M} N_j \Bigg[\frac{\delta + \kappa\lambda H(\underline{w})}{q(\underline{w})}\, \phi_{\sigma_M}\big(w - T(\underline{w}, p_j)\big) \\ + \int_{\underline{w}}^{p_j} \phi_{\sigma_M}\big(w - T(t, p_j)\big) \frac{\kappa\lambda}{q(t)} \left[h(t) + k(t) \frac{\delta + \kappa\lambda H(t)}{q(t)} \right] dt \Bigg], \tag{32}$$

with $h(y) = H'(y)$ and $k(y) = (1-\xi)\psi(y) + \xi\gamma(y)$. The integral is evaluated by trapezoidal quadrature on $t \in [\underline{w}, \max_j p_j]$, enforcing $\mathbf{1}\{t \le p_j\}$ per firm. For $P \to P$ and $M \to P$ moves,

$$f_{X\to P}(w_2) \propto \sum_{i\in\mathcal{M}_{XP}} \sum_{j'\in P} N_{j'} \Phi_\omega\big(\mu_{j'} - r_i^X\big) \phi_{\sigma_P}\big(w_2 - \theta_{j'}\big), \qquad r_i^P = \omega_{j(i)}(\tau_i), \;\; r_i^M = p_{j(i)}, \tag{33}$$

so the only structural difference between the two cells is the origin rank (P-origins evolve with tenure; M-origins are firm-level). Destinations j' range over P-firms weighted by $N_{j'}$, mimicking the integral against the empirical contract distribution.

B.2 Right-Truncation Correction for Initial-Stock Terms

Period-1 tenure is observed as $\tau_{i1} = \min(\tau_{i1}^{\text{true}}, \bar{\tau}_{\text{cap}})$ with $\bar{\tau}_{\text{cap}} = T - T_0$. For $\tau_{i1} = \bar{\tau}_{\text{cap}}$ the latent $\tau_{i1}^{\text{true}} \ge \bar{\tau}_{\text{cap}}$ is integrated over the right tail: in (16) the contract plateau makes the wage anchor constant for $\tau \ge \bar{\tau}$, so $\mathcal{S}_j^d(\tau_{i1})$ is replaced by $\sum_{s\ge\bar{\tau}_{\text{cap}}} \mathcal{S}_j^d(s)$ (summed to a horizon $\bar{s}$ plus a geometric remainder at $q(\omega_j(\bar{s}))$); in (18), $\sum_{k\ge\bar{\tau}_{\text{cap}}} q(p_j)(1-q(p_j))^k = (1-q(p_j))^{\bar{\tau}_{\text{cap}}}$ replaces the geometric tenure distribution, so $(1-q(p_j))^{\tau_{i1}}$ becomes $(1-q(p_j))^{\bar{\tau}_{\text{cap}}}$ in the per-row truncated form.

Online Appendix to:

Wage Bargaining and Wage Posting Firms

Kerstin Holzheu   Jean-Marc Robin

June 10, 2026

Contents

OA.1 Notation

Online Appendix Table OA.1: Notation

Object	Notation	Definition or property	Ref.
Firm protocol and share	$z_j \in \{P, M\}$, ξ	P posts contracts; M matches outside offers; ξ is the share of M firms.	Sec. 3.1
Search and separations	λ, $\kappa\lambda$, δ	Offer rates when unemployed and employed; exogenous destruction rate.	Sec. 3.1
Discount rate and unemployment	r, b, V_0	Discount rate; flow value of unemployment; present value of unemployment.	(2)
Worker effect	a_i	Multiplicative worker productivity; identified by an AKM worker fixed effect.	Sec. 3.1
Contract vector	$x_j = (\theta_j, g_j)$	Log entry wage and within-firm log-wage growth slope, $g_j \geq 0$.	(1)
Tenure and plateau	τ, $\bar{\tau}$	Worker tenure on the current job; common terminal plateau.	(1)
Wage profile	$w(\tau; x_j)$	$\theta_j + g_j \min\{\tau, \bar{\tau}\}$.	(1)
Contract distribution	F_X, f_X	Firm-weighted distribution and density of posting contracts.	Sec. 3.2
Retention rank	$\omega_{x_j}(\tau)$	Equivalent flat-wage rank at tenure τ, $\Omega^{-1}(W_P(\tau; x_j))$.	(9)
Entry rank	$\mu_j = \omega_{x_j}(0)$	Rank a new hire faces at posting firm j.	(6)
Entry-rank distribution	$\Psi(y)$	Induced distribution $F_X\{x : \omega_x(0) \leq y\}$.	(6)
Productivity and distribution	p_j, Γ, γ	Productivity at M firm j; firm-weighted distribution and density.	Sec. 3.1
Maximal value	$\Omega(p)$	Highest worker value an M firm with productivity p can deliver.	(3)
Inherited rank	t	Outside-option rank that pins down the M-firm wage, $t \leq p_j$.	Sec. 3.6
Matching wage map	$T(t, p)$	Wage at an M firm of productivity p for a worker with inherited rank t.	App. A.5
Within-M inherited ranks	$\mathcal{G}(t \mid p)$	Distribution of inherited ranks inside an M firm.	App. A.5
Current rank (worker)	y_{it}	$y = \omega_{x_j}(\tau)$ at a P firm and $y = p_j$ at an M firm.	Sec. 4.2
Offer rank (destination)	$r_{j'}$	$r_{j'} = \mu_{j'}$ if $z_{j'} = P$; $r_{j'} = p_{j'}$ if $z_{j'} = M$.	Sec. 4.2
Aggregate offer-rank distribution	$K(y)$, $\overline{K}(y)$	$(1-\xi)\Psi(y) + \xi\Gamma(y)$; survivor $\overline{K} = 1 - K$.	(7)
Option value	$P(W)$	Expected gain from drawing a posted contract above value W.	(8)
Worker current-rank distribution	$H(y)$	Worker-weighted distribution of retention ranks.	Sec. 3.5
Exit rate	$q(y)$	$\delta + \kappa\lambda\overline{K}(y)$.	(14)
Stock densities and firm size	$m_P(x, \tau)$, $m_M(p)$, ℓ_j^P, ℓ_j^M	Worker stock densities and firm sizes at posting (across (x, τ)) and matching firms.	App. A.4
Unemployment share	u	Steady-state unemployment rate, $u = \delta/(\delta + \lambda)$.	Sec. 3.1
Smoothing parameters	σ_P, σ_M, σ_ω	Wage-density and acceptance-kernel smoothing scales.	Sec. 4.3
Smoothed finite-firm offer mass	$\overline{K}_N^\Phi$, q_N^Φ	Finite-firm smoothed analogues of $\overline{K}$ and q.	Sec. 4.4
Structural parameter vector	Π	$(\Gamma, \xi, \lambda, \delta, \kappa, \sigma_P, \sigma_M, \sigma_\omega)$; parametric form in Section 4.5.	Sec. 4.4

Flat-contract restriction $g_j \equiv 0$. Under this restriction, the contract collapses to a scalar rank θ_j: $\mu_j = \theta_j$, $\omega_{x_j}(\tau) \equiv \theta_j$, and $w(\tau; x_j) = \theta_j$. The remaining symbols are unchanged.

OA.2 German Data Sources

Our empirical motivation draws on four data sources from the IAB Research Data Centre. The IABSE-ADIAB links administrative employment records to the Job Vacancy Survey (JVS), enabling analysis of individual labor market trajectories alongside survey responses on bargaining. The BHP (Establishment History Panel) provides firm-level data on employment dynamics, employee counts, industry, and location. The JVS itself captures establishment-level data on filled and unfilled vacancies, including employer-reported information on wage bargaining, hiring difficulties, and recruitment channels. At the time of analysis, the IABSE-ADIAB could not be merged to the BHP, so firm-level aggregates and individual worker histories cannot be observed for the same establishment.

Classification based on a single response. The bargaining variable (question 1, variable `zf175`) is collected only in the main (fourth-quarter) survey wave. The survey draws a new stratified sample each year, so repeated observations of the same establishment are rare and the data are effectively a repeated cross-section for this variable. Each firm's classification therefore rests on a single binary survey response, and the issue of firms lying close to a 50% threshold does not arise: alternative tie-breaking conventions ($\geq$ 50% vs. $>$ 50%) are not consequential for the measure.

Comparison Caldwell et al. (2026) Our survey-based evidence draws on the IAB Job Vacancy Survey (JVS), which differs from the recent firm survey introduced by Caldwell et al. (2026) in several respects. The JVS is a large, representative quarterly establishment survey conducted by the IAB since 1989, covering thousands of establishments across all sectors and size classes with design and nonresponse weighting. The bargaining question in the JVS is asked at the vacancy level: whether pay was individually bargained for the most recent hire. This vacancy-level measurement maps naturally onto the sequential-auction framework of Postel-Vinay and Robin (2002a), in which the wage-setting protocol governs the terms of a specific match. By contrast, Caldwell et al. (2026) survey 772 firms through the ifo Institute, over-sampling larger establishments, and elicit whether the firm differentiates pay between equally productive workers in the same position. Their definition is intentionally broader, encompassing both negotiation and the tailoring of initial offers, and is elicited separately for four employee groups. An advantage of their data is that firm-level responses can be linked directly to worker administrative records for consenting firms. The JVS can also be linked to worker histories via the record-linkage procedure of Lochner (2019), which we employ here. On the other hand, the JVS provides a substantially larger and more representative sample and has been available with the bargaining question since at least Brenzel et al.

(2014), predating the Caldwell et al. survey by nearly a decade. Regarding the treatment of collective bargaining agreements, Caldwell et al. (2026) report that 35% of firms employing sophisticated bargaining strategies are covered by a CBA. We find a similar share in the JVS: 41% (weighted) and 34% (unweighted) of M-firms in our sample (using question 1) feature CBAs, confirming that CBA coverage does not preclude individual negotiation (cf. Table OA.2). Our preferred classification therefore excludes CBA-covered establishments from the M-type category, and we show robustness to alternative definitions that relax this restriction.

	Unweighted	Weighted
M-firms with collective agreement	0.34	0.41

Online Appendix Table OA.2: Share of M-firms with collective agreement

Note: The table shows the average share of firms with collective agreement classified as bargaining firms using question 1 only.

OA.3 Supplementary German Evidence

OA.3.1 Summary Statistics and Mobility Regressions

	2011	2012	2013	2016	2017	2018	2019
Female Share	0.42	0.42	0.44	0.45	0.45	0.43	0.43
Size	316.09	380.96	298.38	442.60	261.69	354.20	283.51
Age	39.96	39.93	39.98	40.73	40.97	41.23	41.22
Spread Wages	0.34	0.32	0.31	0.32	0.31	0.31	0.30
Wage	4.42	4.45	4.45	4.52	4.53	4.57	4.60
25 Percentile	4.20	4.24	4.25	4.31	4.33	4.37	4.40
75 Percentile	4.54	4.56	4.56	4.62	4.64	4.68	4.71
Poachingrank	0.51	0.51	0.52	0.51	0.51	0.52	0.52
Exitranking	0.41	0.40	0.40	0.39	0.38	0.37	0.35
Manufacturing	0.15	0.15	0.13	0.13	0.15	0.16	0.13
Services	0.55	0.52	0.55	0.53	0.53	0.53	0.54
East	0.18	0.19	0.19	0.18	0.20	0.19	0.20
Coll.Agreem.	0.58	0.56	0.63	0.58	0.57	0.53	0.54
Pay More	0.11	0.11	0.14	0.13	0.15	0.19	0.19
Bargaining	0.37	0.35	0.40	0.42	0.45	0.48	0.47
Bargaining +	0.19	0.19	0.21	0.22	0.25	0.29	0.30
# Firms	8987	8167	8710	7232	8968	8792	8567

Online Appendix Table OA.3: Summary Statistics

Note: The table contains summary statistics across time. Wage spread denotes the difference between the 75th and the 25th percentile of log wages. ”Bargaining” refers to question 1, whereas ”Bargaining+” refers to our preferred classification using both questions 1 and 2. All statistics are weighted using survey weights.

	(1)	(2)	(3)	(4)	(5)	(6)
$P2M$	0.0544*	0.106*	0.106*	0.106*	0.510*	0.508*
	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MM	0.0620	0.0720	0.0773	0.0770	0.364$^+$	0.363$^+$
	(0.232)	(0.148)	(0.113)	(0.115)	(0.094)	(0.095)
PP	0.0158	0.0480*	0.0536*	0.0530*	0.257*	0.257*
	(0.260)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	38806	38806	38806	38806	38806	38806
Controls		+Firm Q.	+Demo	+Year	Logit	+ Other Rem.

Online Appendix Table OA.4: Probability Wage Decrease Upon Mobility based on Mobility Type

Note: The table contains regression coefficients of the probability of wage decreases upon mobility on the type of mobility. We choose the $M2P$ mobility as our baseline contrast. Columns 1-4 present coefficients in a linear probability model whereas columns 5-6 show results for a logit model. ”Demo” refers to demographics education, gender, age, firm location (east/west) and occupation. ”Other Rem.” refers to the offer of other remunerations. p-values in parentheses, $^+$ $p < 0.10$, * $p < 0.05$

	(1)	(2)	(3)	(4)	(5)	(6)
$P2M$	-0.00706	0.0404*	0.0445*	0.0438*	0.213*	0.210*
	(0.637)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)
MM/PP	-0.0196^{+}	0.00997	0.0139	0.0131	0.0661	0.0655
	(0.095)	(0.381)	(0.215)	(0.243)	(0.204)	(0.209)
Observations	38790	38790	38790	38790	38790	38790
Controls		+Firm Q.	+Demo	+Year	Logit	+ Other Rem.

Online Appendix Table OA.5: Probability Wage Decrease Upon Mobility based on Mobility Type

Note: The table contains regression coefficients of the probability of wage decreases upon mobility on the type of mobility. We choose the $M2P$ mobility as our baseline contrast. Columns 1-4 present coefficients in a linear probability model whereas columns 5-6 show results for a logit model. "Demo" refers to demographics education, gender, age, firm location (east/west) and occupation. "Other Rem." refers to the offer of other remunerations. In this table, we define bargaining firms using question 1 only. p-values in parentheses, $^{+}$ $p < 0.10$, * $p < 0.05$

	(1) Mover	(2) Mover	(3) Mover	(4) Mover	(5) Mover
P	0.0915*	0.0695*	0.0606*	0.0669*	0.340*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tenure	-0.00689*	-0.00670*	-0.00628*	-0.00617*	-0.0422*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
P × Tenure	-0.00480*	-0.00420*	-0.00322*	-0.00329*	-0.0124*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.016)
Observations	597908	597908	597908	597908	597908
Controls		+Firm Q.	+Demo	+Year	Logit

Online Appendix Table OA.6: Probability Separation based on Firm Type

Note: The table contains regression coefficients of the probability of separation on tenure, interacted with firm type. We choose the M as our baseline contrast. Columns 1-4 present coefficients in a linear probability model whereas columns 5-6 show results for a logit model. "Demo" refers to demographics education, gender, age, firm location (east/west), occupation and firm size at origin and destination. "Firm Q." denotes controls for firm quality as obtained for coworker average wages, excluding the individual worker. In this table, we define bargaining firms using question 1 only. p-values in parentheses, $^{+}$ $p < 0.10$, * $p < 0.05$

OA.3.2 Further Indications for Wage Posting/Wage Bargaining

	(1)	(2)
M-firm	-0.00538*	0.00535*
	(0.017)	(0.021)
Controls		Yes
Observations	813838	813838

Online Appendix Table OA.7: Wage Growth of Job Stayers

Note: The table contains regression coefficients of stayer wage growth on firm type and control variables (in column 2) for education, gender, age, firm location (east/west), occupation and year. p-values in parentheses,$^{+}$ $p < 0.10$, * $p < 0.05$

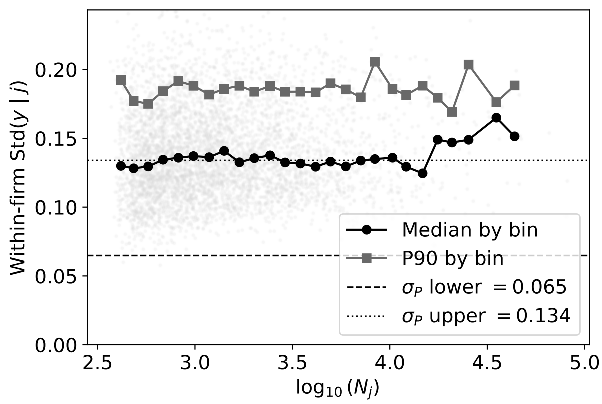
	N	Mean firm-level SD Res. Wages
P-firm	171182	0.2884
M-firm	9136	0.3030

Online Appendix Table OA.8: Standard Deviation Residual Wages

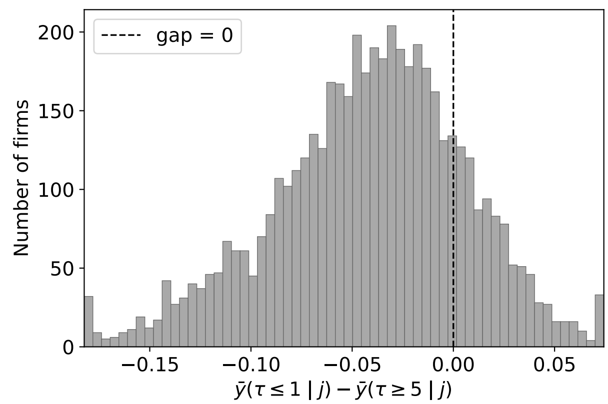
Note: The table contains the standard deviation of residual wages by firm type.

OA.4 Within-firm Dispersion Diagnostics

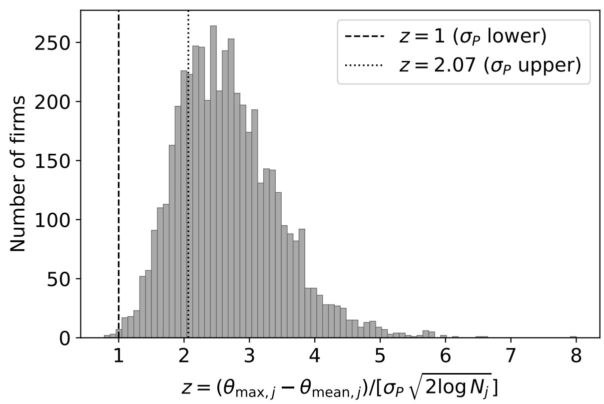
Figure OA.1 reports four within-firm-dispersion diagnostics that motivate the wage-tenure profile and the matching-firm class. The reference scales $\hat{\sigma}_P^{\ell} = 0.066$ and $\hat{\sigma}_P^{u} = 0.171$ are defined in Section 4.5; the formulas underlying each panel are given in the figure caption. Panels (a) and (b) show that flat posting is too restrictive: within-firm wage dispersion is large relative to the lower noise scale, and new hires and incumbents earn systematically different wages within the same firm. Panels (c) and (d) sharpen the test by standardising the peak-to-mean wage gap and the within-firm dispersion of individual wage-tenure slopes against Gaussian-noise benchmarks; both exceed the conservative upper-scale threshold for a non-trivial set of firms. Because a posting firm assigns all its workers the same firm-level slope, excess slope dispersion is direct evidence of within-firm contract heterogeneity — the empirical signature of matching-firm renegotiation.



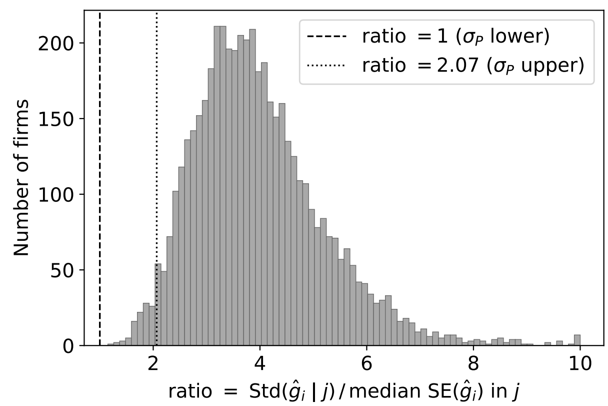
(a) Within-firm wage dispersion by firm size



(b) New-hire vs. incumbent wage gap



(c) Standardized peak-to-mean wage gap



(d) Within-firm dispersion of wage-tenure slopes

Online Appendix Figure OA.1: Pre-estimation evidence on within-firm wage heterogeneity.

Notes: Dashed reference lines use the lower wage-noise scale, $\hat{\sigma}_P^\ell = 0.066$; dotted reference lines use the conservative upper scale, $\hat{\sigma}_P^u = 0.171$. Panel (a) plots within-firm log-wage standard deviations against $\log_{10} N_j$, with median and 90th percentile by firm-size bin. Panel (b) plots mean new-hire wages (tenure ≤ 1) minus mean incumbent wages (tenure ≥ 5) within the same firm. Panel (c) reports the standardised peak-to-mean wage gap $z_j = (\theta_{\max,j} - \theta_{\text{mean},j})/[\hat{\sigma}_P^\ell \sqrt{2 \log N_j}]$; values above one exceed the expected maximum gap under $\hat{\sigma}_P^\ell$-Gaussian noise, and the dotted line equals $\hat{\sigma}_P^u / \hat{\sigma}_P^\ell$ (conservative analogue of the unit threshold). Panel (d) reports the within-firm standard deviation of individual wage-tenure slopes $\hat{\beta}_{ij}^{(s)}$ across worker-firm spells s, divided by the median per-spell standard error implied by $\hat{\sigma}_P^\ell$.

OA.5 Further Results

This appendix collects supplementary material for the main specification of Section 5.1. Section OA.5.1 reports the headline parameter estimates and the sensitivity to hyperparameters and to alternative sample or specification choices. Section OA.5.2 reports firm-distribution and classification diagnostics, the mobility regressions backing validation moments (ii) and (iii), and the characterisation of firms reclassified across specifications. Section OA.5.3 reports the full wage-cut-and-subsequent-growth exercise and the stayer wage-growth table.

The mathematical details of the likelihood comparisons underlying the diagnostic plots are reported in the paper Appendix B.1.

OA.5.1 Parameter Estimates and Hyperparameter Choice

Table OA.9 reports the estimates from the main specification on the full Austrian sample together with the no-growth comparison estimated on the same residualized panel.

	ξ	δ	λ	κ	σ_P	σ_M	σ_ω
Wage growth, full sample	0.232	0.021	0.338	[0.17]	0.141	0.171	0.266
Wage growth, men only	0.172	0.016	0.262	[0.29]	0.141	0.171	0.066
Wage growth, sample year 2010	0.177	0.026	0.429	[0.15]	0.155	0.125	0.266
Wage growth, p95 $\theta_{\max}$	0.175	0.021	0.338	[0.18]	0.141	0.171	0.266
Flat wage, residualized panel	0.337	0.021	0.333	0.20	0.171	0.091	0.266

Online Appendix Table OA.9: Parameter estimates and sensitivity specifications.

Note: The table reports the headline estimates on the 2015 Austrian residualised panel together with sensitivity specifications: a no-growth comparison on the same panel, a re-estimation on the 2010 cross-section, a male-only sample, and an alternative M-firm productivity proxy at the 95th percentile. The residualised panel removes worker fixed effects and worker-specific tenure slopes from wages. The hyperparameter grid covers $(\sigma_P, \sigma_M, \sigma_\omega)$. In the main specification, κ is identified from the per-firm OLS fixed point and reported in square brackets; in the no-growth specification, κ is estimated jointly with $(\sigma_P, \sigma_M, \sigma_\omega)$. The job-finding rate λ is calibrated from unemployment-to-employment flows, and the on-the-job offer rate is $\kappa\lambda$. Each row reports the parameter estimates at the validation-log-likelihood-best $(\sigma_P, \sigma_M, \sigma_\omega)$-triple within that specification's own grid.

Table OA.10 reports the profile of the average log likelihood over σ_P, evaluated at the maximizing $(\sigma_M, \sigma_\omega)$ pair for each row. The likelihood is maximized at $\sigma_P = 0.141$ in the interior of the data-implied grid and declines on either side.

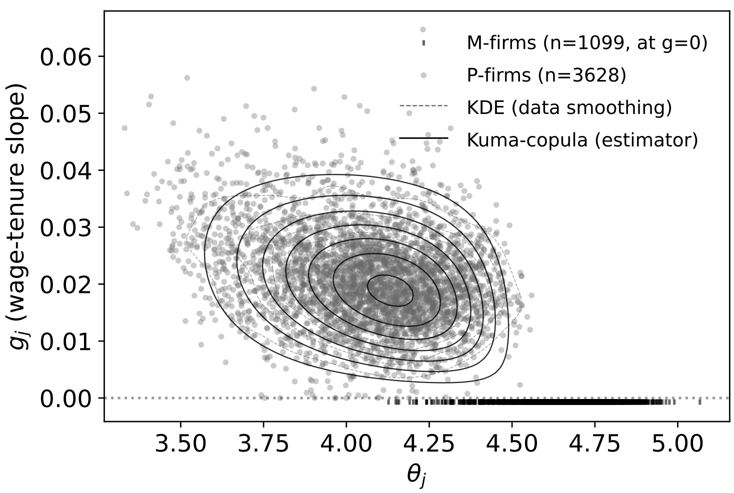
σ_P	Average log likelihood	ξ
0.066	−11.685	0.515
0.080	−11.541	0.431
0.097	−11.425	0.356
0.117	−11.316	0.279
0.141	−11.194	0.145
0.171	−11.294	0.231

Online Appendix Table OA.10: Hyperparameter grid over σ_P.

Note: The table reports the average log likelihood and the estimated M-firm share at the maximizing $(\sigma_M, \sigma_\omega)$ pair for each value of σ_P. The maximizing pair at the headline $\sigma_P = 0.141$ is $(\sigma_M, \sigma_\omega) = (0.171, 0.266)$.

OA.5.2 Firm Distributions and Classification Diagnostics

Figure OA.2 reports the joint distribution of the intercept θ_j and wage-tenure slope g_j among firms classified as P-firms. The solid black contours show the fitted Kumaraswamy-marginal Gaussian-copula joint density used as the firm-side prior f_X in the likelihood. The dashed gray contours are a two-dimensional Gaussian kernel-density smoothing of the empirical scatter, included only for comparison so the parametric fit can be visually assessed against the data. Both overlays are drawn at the same shared density levels, so a Kuma-copula contour at the same level as a KDE contour traces out the level set of equal density under each estimator. Firms classified as M-firms are shown on the $g = 0$ axis because the main specification imposes flat profiles at M-firms.



Online Appendix Figure OA.2: Estimated joint density of P-firm contracts.

Note: The figure plots (θ_j, g_j) for firms classified as P-firms. Solid black contours: fitted Kumaraswamy-marginal Gaussian-copula joint density, used as the firm-side prior f_X in the likelihood. Dashed gray contours: two-dimensional Gaussian kernel-density smoothing of the scatter, included for comparison only and not used in the estimation. Both overlays share the same density-level scale. The Kuma-copula contours close at $g = 0$ because the fitted g-marginal has its mode on the lower boundary. Firms classified as M-firms are plotted on the $g = 0$ axis. The Pearson correlation between θ_j and g_j among P-firms is -0.13.

Table OA.11 compares empirical and fitted moments of the type-specific firm rank. For P-firms the rank is the equivalent flat-wage entry value μ_j. For M-firms the rank is the firm wage θ_j. The fitted Kumaraswamy distributions match the empirical mean and variance for both firm types.

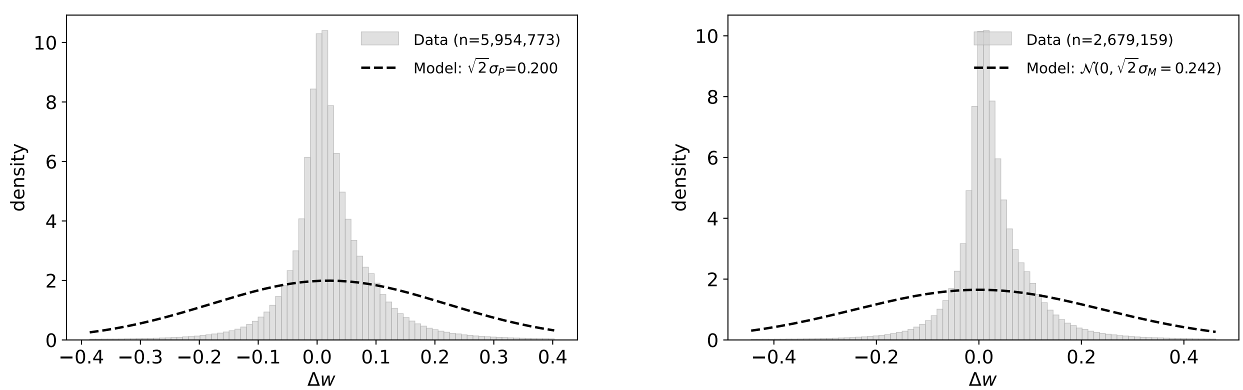
Stayer wage changes. A remaining source of mismatch is visible in stayer wage changes. Figure OA.3 compares the empirical distribution of Δw for stayers with the Gaussian distribution implied by $\sqrt{2}\sigma_P$ at P-firms and $\sqrt{2}\sigma_M$ at M-firms. The empirical distributions

	P-firms (rank $= \mu_j$)		M-firms (rank $= \theta_j$)	
	$E[x]$	Var$[x]$	$E[x]$	Var$[x]$
Empirical	4.279	0.054	4.648	0.021
Fitted	4.279	0.053	4.622	0.024

Online Appendix Table OA.11: Empirical and fitted moments of the firm-rank distributions.

Note: Empirical moments are computed at the firm level. For P-firms the rank is $\mu_j = \omega_j(0)$, with $n_P =$ 3,628. For M-firms the rank is θ_j, with $n_M =$ 1,099. The fitted moments are evaluated analytically from the fitted Kumaraswamy densities on the supports $[3.58, 5.05]$ for P-firms and $[4.01, 5.12]$ for M-firms.

are more peaked and have substantially thicker tails than the Gaussian benchmark: empirical kurtosis is about 17.2 at P-firms and 18.0 at M-firms, compared with 3 for a Gaussian distribution. The empirical standard deviations are also smaller than the model-implied Gaussian widths: 0.097 versus 0.200 at P-firms and 0.105 versus 0.242 at M-firms. Thus the likelihood-selected (σ_P, σ_M) improves the fit of mobility and initial wage components but overstates the dispersion of stayer wage changes under the Gaussian shock specification.



(a) P-firm stayers

(b) M-firm stayers

Online Appendix Figure OA.3: Stayer wage-change distributions by firm type.

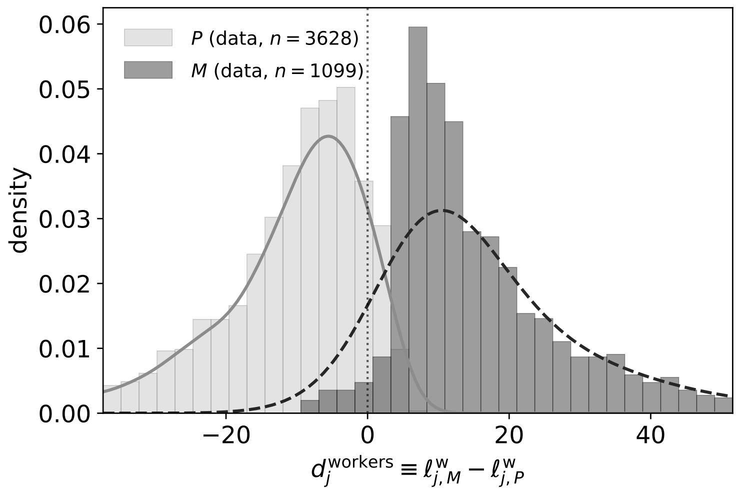
Note: Histograms plot empirical densities of stayer wage changes Δw; dashed lines plot the model-implied Gaussian densities. The model-implied standard deviations are $\sqrt{2}\sigma_P = 0.200$ in the left panel and $\sqrt{2}\sigma_M =$ 0.242 in the right panel.

Figures OA.4 and OA.5 show the two log-likelihood differences that enter the classification step. Define

$$d_j^{\text{workers}} = \ell_{j,M}^{\text{workers}} - \ell_{j,P}^{\text{workers}}, \qquad d_j^{\text{firm}} = \ell_{j,M}^{\text{firm}} - \ell_{j,P}^{\text{firm}}.$$

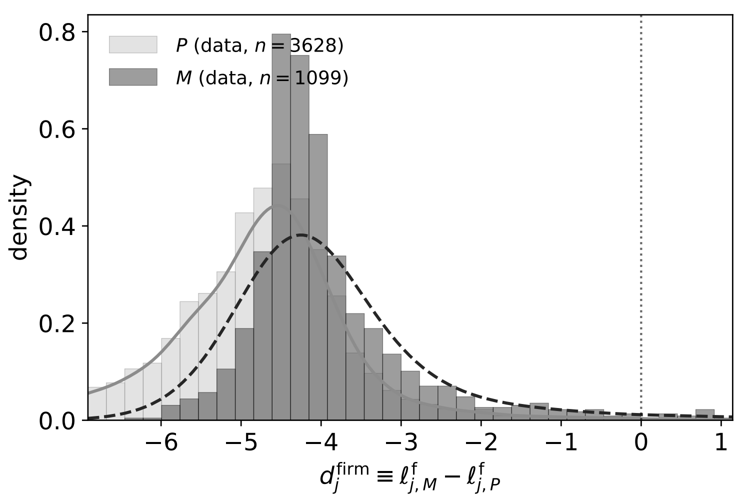
Positive values indicate stronger support for the M-firm specification. The worker-side density is substantially more dispersed than the firm-side density, which is why the worker likelihood carries most of the classification information.

Figure OA.6 reports the posterior probability of the M-firm type. Let $\pi_j^M = \Lambda(d_j^{\text{workers}} + d_j^{\text{firm}})$,



Online Appendix Figure OA.4: Worker-side log-likelihood difference by firm classification.

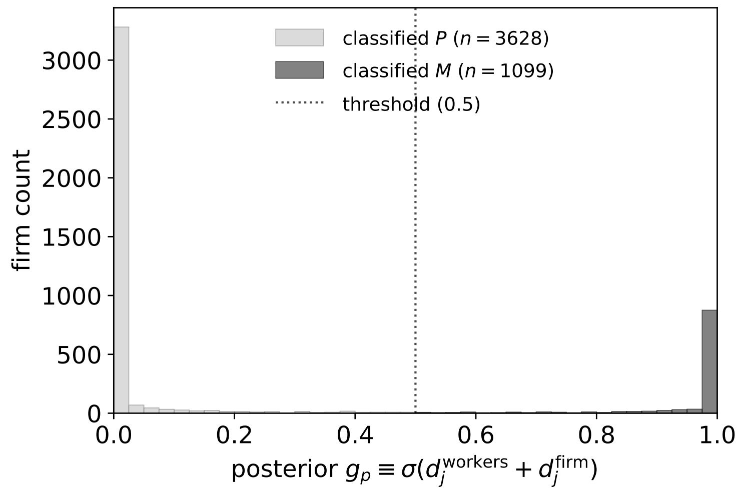
Note: The figure plots kernel density estimates of d_j^{workers} separately for firms classified as P and M. The vertical dotted line marks zero, the point at which the worker likelihood is indifferent between the two type assignments. The x-axis is restricted to the 5th–95th percentile range.



Online Appendix Figure OA.5: Firm-side log-likelihood difference by firm classification.

Note: The figure plots kernel density estimates of d_j^{firm} separately for firms classified as P and M. The interquartile range of d_j^{firm} is $[-7.4, -4.7]$, compared with $[-70.6, 2.3]$ for d_j^{workers}.

where $\Lambda(\cdot)$ is the logistic function. The posterior distribution is concentrated near zero and one: 75% of firms have $\pi_j^M < 0.1$, 22% have $\pi_j^M > 0.9$, and 1.6% lie in the interval $(0.3, 0.7)$.



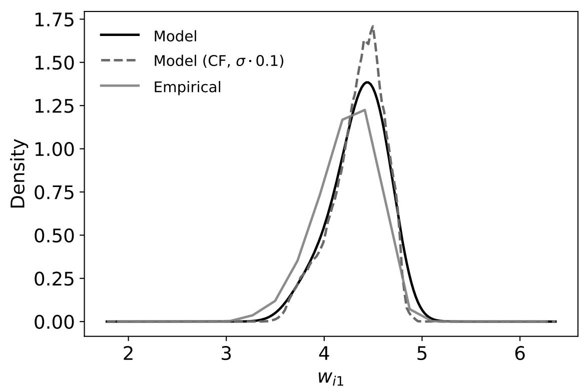
Online Appendix Figure OA.6: Posterior probability of the M-firm type.

Note: The figure plots the firm-level posterior probability $\pi_j^M = \Lambda(d_j^{\text{workers}} + d_j^{\text{firm}})$. Light-gray bars are firms classified as P; dark-gray bars are firms classified as M. The vertical dotted line marks the 0.5 classification threshold.

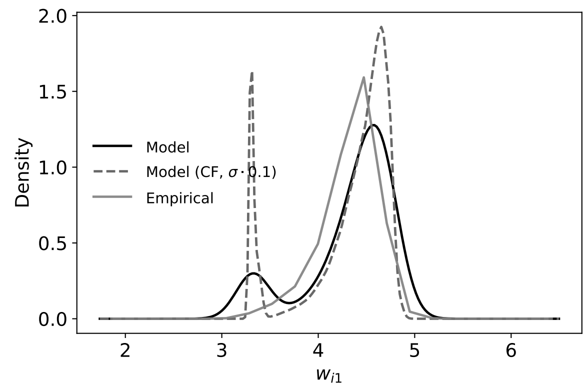
Per-component model-fit overlays (validation moment (iv) of Section 5.1). Figure OA.7 reports model-implied densities for the four likelihood components against their empirical counterparts and a counterfactual in which the noise parameters $(\sigma_P, \sigma_M, \sigma_\omega)$ are set to one-tenth of their estimated values. Figures OA.7a and OA.7b report the initial components, and Figures OA.7c and OA.7d report two dynamic components: $P \to P$ moves at P-firms and $M \to P$ moves at M-firms. The model fits the P-firm initial density and the $M \to P$ dynamic component well. For the M-firm initial density, the model fits the upper mode well.[18]

Mobility regressions backing the validation moments (ii) and (iii) of Section 5.1. The tables below report the linear probability models referenced inline in the main-text Classification paragraph. Tables OA.12 and OA.13 report the probability of a wage decrease upon mobility (validation moment (ii)) under the main and no-growth classifications respectively. Tables OA.14 and OA.15 report the separation-tenure gradient by firm type (validation moment (iii)) under the same two classifications.

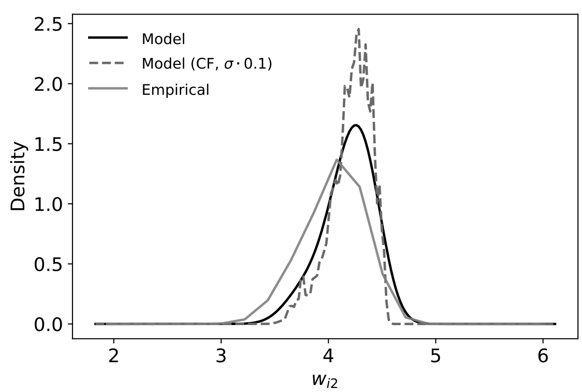
[18]The theoretical M-firm initial wage distribution has a mass point at the lower bound $p_0(\theta)$. The offset of the counterfactual mover densities is driven by the mobility term $\Phi_\omega(\theta' - \theta)$: when σ_ω is small, it approximates $\mathbf{1}\{\theta' > \theta\}$ and tilts accepted moves toward higher θ', shifting the distribution of w_2 to the right.



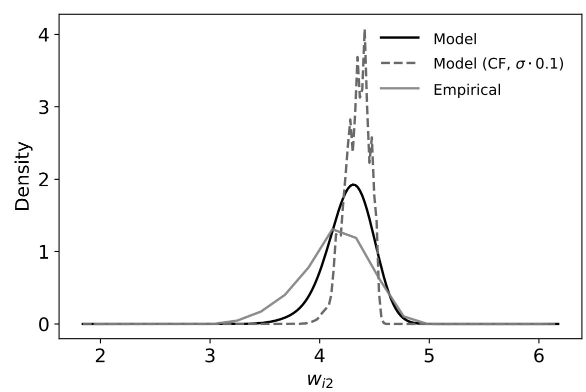
(a) Initial likelihood: P-firms



(b) Initial likelihood: M-firms



(c) Dynamic likelihood: $P \to P$



(d) Dynamic likelihood: $M \to P$

Online Appendix Figure OA.7: Workers' wage distributions in periods 1 and 2 by firm type.

Note: The figure plots the model-implied likelihood component, the empirical counterpart, and a counterfactual with the noise parameters set to one-tenth of their estimated values. The empirical counterpart is a binned wage histogram matched to the model density grid. The upper panels report the initial contribution; the lower panels report the dynamic contribution. The likelihood components are defined in equations (31), (32), and (33) above.

	(1)	(2)	(3)	(4)	(5)	(6)
$P2M$	-0.070^{*}	-0.019^{*}	-0.007	0.054^{*}	0.053^{*}	0.240^{*}
	(0.000)	(0.019)	(0.393)	(0.001)	(0.001)	(0.001)
MM/PP	-0.036^{*}	-0.012^{+}	-0.008	0.009	0.008	0.039
	(0.000)	(0.067)	(0.165)	(0.399)	(0.439)	(0.388)
Observations	190406	190406	190406	190406	190406	190406
Controls		+Firm Q.	+Demo+Size	$+g_j$	+Year FE	Logit

Online Appendix Table OA.12: Probability of a wage decrease upon mobility — main classification.

Note: Coefficients from linear probability models (columns 1–5) and a logit model (column 6) of $1\{\Delta w < 0\}$ on a $P \to M$ indicator, a within-type-mover indicator ($M \to M$ or $P \to P$), and additional controls. The omitted category is $M \to P$ mobility. "Firm Q." denotes the leave-one-out coworker average wage at origin and destination. "Size" denotes log firm size at origin and destination. "g_j" denotes the estimated wage-tenure slope at origin and destination. "Demo" denotes worker age, sex, and an academic-degree indicator. Standard errors are clustered at the firm level; p-values are in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$. The sample contains 190,406 job-to-job movers in the Austrian 2015 panel.

	(1)	(2)	(3)	(4)	(5)	(6)
$P2M$	-0.137^{*}	-0.029^{*}	-0.017^{*}	0.050^{*}	0.049^{*}	0.222^{*}
	(0.000)	(0.000)	(0.027)	(0.003)	(0.004)	(0.003)
MM/PP	-0.073^{*}	-0.028^{*}	-0.022^{*}	0.011	0.010	0.048
	(0.000)	(0.000)	(0.000)	(0.304)	(0.354)	(0.287)
Observations	176976	176976	176976	176976	176976	176976
Controls		+Firm Q.	+Demo+Size	$+g_j$	+Year FE	Logit

Online Appendix Table OA.13: Probability of a wage decrease upon mobility — no-growth classification.

Note: Same regression specification as Table OA.12, but the P/M indicators use the no-growth (flat-wage, $g_j \equiv 0$) classification rather than the main classification. Without the structural g_j control (column 4 of the main-classification table is unavailable here because the no-growth specification imposes $g_j = 0$), the sign flip on the $P \to M$ coefficient does not appear: this is consistent with the main-text interpretation that the structural slope control is what reveals the wage-cut signature on $P \to M$ moves.

	(1)	(2)	(3)	(4)	(5)
P	0.009*	0.004	0.006^{+}	0.004	0.074
	(0.007)	(0.166)	(0.069)	(0.147)	(0.145)
Tenure	−0.005*	−0.005*	−0.003*	−0.004*	−0.124*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$P\times$ Tenure	−0.001*	−0.001*	−0.001*	−0.001*	−0.039*
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Observations	9,094,208	9,094,208	9,094,208	9,094,208	9,094,208
Controls		+Firm Q.	+Demo	+Year FE	Logit

Online Appendix Table OA.14: Separation rate, tenure, and firm type — main classification.

Note: Coefficients from linear probability models (columns 1–4) and a logit model (column 5) of the separation indicator $\mathbf{1}\{\text{Sep}\}_{i,t}$ on a P-firm indicator, tenure (in years), and their interaction. The omitted category is M-firms. "Firm Q." denotes the leave-one-out coworker average wage at the firm. "Demo." denotes worker age, sex, and an academic-degree indicator. Standard errors clustered at the firm level; p-values in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$. The sample contains 9,094,208 worker-year observations from the Austrian 2015 panel — the same residualized panel used to estimate the main specification, which spans 2001–2018 with the 2015 cross-section as the EM training year.

	(1)	(2)	(3)	(4)	(5)
P	0.009*	0.002	0.004	0.004	0.112*
	(0.009)	(0.432)	(0.183)	(0.157)	(0.023)
Tenure	−0.005*	−0.005*	−0.003*	−0.004*	−0.122*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$P\times$ Tenure	−0.001*	−0.001*	−0.001*	−0.001*	−0.051*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Observations	8,716,923	8,716,923	8,716,923	8,716,923	8,716,923
Controls		+Firm Q.	+Demo	+Year FE	Logit

Online Appendix Table OA.15: Separation rate, tenure, and firm type — no-growth classification.

Note: Same regression specification as Table OA.14, but the P-firm indicator uses the no-growth (flat-wage, $g_j \equiv 0$) classification rather than the main classification. Under the no-growth specification, the wage-growth component of firm heterogeneity is not absorbed into g_j, so any residual within-firm wage drift at P-firms must instead load on the tenure-separation gradient; comparing the $P\times$Tenure coefficient across the two tables tests this prediction.

Characterization of the 851 **no-growth-only** M **firms (Section 5.1).** Table OA.16 reports cell means for the cross-tabulation of the main and no-growth classifications. The headline numbers are quoted inline in the main-text discussion.

	Both P	Both M	No-growth-only M	Δ vs. Both M
N firms	2,594	674	851	
Wages				
$E[w_{\text{raw}}]$ raw daily log wage	4.180	4.350	4.343	−0.007
$E[w]$ (AKM-residualised)	4.165	4.346	4.338	−0.007
$Var[w]$ within	0.027	0.047	0.036	−0.011
$Var_j[w]$ across	0.022	0.034	0.067	+0.033
Firm-level structural objects				
θ_j (M-side firm wage)	4.467	4.709	4.656	−0.053
μ_j (P-side entry-equiv. wage)	4.238	4.441	4.462	+0.021
g_j wage-tenure slope	0.019	0.027	0.025	−0.002
$E[qr(y)]$ exit rate	0.059	0.028	0.042	+0.014
Worker characteristics				
E[age]	41.91	40.81	40.99	+0.18
Academic share	0.014	0.066	0.051	−0.015
Female share	0.270	0.468	0.345	−0.124
Firm characteristics				
Avg yearly firm size, $E[N]$	91.3	168.0	171.3	+3.3
Density (pop./km^2)	374	724	675	−49
Firm age	43.32	40.50	43.36	+2.85
Finance share	0.013	0.328	0.071	−0.257

Online Appendix Table OA.16: Firm characteristics by classification cell.

Note: Cells are defined by the cross-tabulation of firm classifications under the main specification and the no-growth specification estimated on the same residualized panel. The table is computed over the 4,522 firms common to both classifications, of which 403 are classified as M under the main specification and P under the no-growth specification and are omitted from the table to focus on the no-growth overclassification. The last column reports the average in the no-growth-only M cell minus the average in the consistent-M cell. Variable definitions are as in Table 4.

OA.5.3 Additional Wage-Growth and Variance-Decomposition Results

Table OA.17 reports the full wage-cut and subsequent-growth exercise summarized in Table 6. The table includes both wage measures, both horizons, both control sets, and the mover-cell decomposition. The residualized wage is denoted y, and the original log daily wage is denoted y_{orig}.

Stayer wage growth at M- and P-firms. Table OA.18 reports the cross-year wage change of stayers (same firm in two consecutive years) by firm type, pooled across the full 2001–2018 panel. Panel A reports the average; Panel B disaggregates by worker tenure; Panel C disaggregates the M-firm sample by quartile of the firm's structural rank $\theta_{\max}$. The P-firm mean stayer drift of +2.03 pp/yr (residualized) is close to the cross-firm mean of the AKM firm-tenure slope $\bar{g}_j = 2.2\%$/yr, consistent with the AKM specification. M-firm stayer drift

			$\beta_{\text{cut-mover}}$			
Wage measure	τ	Controls	$M2P$	Pooled	Stayer	$P2M$
y_{orig}	2	no	0.017	0.030	0.032	0.034
y_{orig}	2	yes	0.025	0.036	0.038	0.039
y_{orig}	3	no	0.017	0.033	0.035	0.038
y_{orig}	3	yes	0.028	0.041	0.043	0.045
y	2	no	0.018	0.031	0.034	0.035
y	2	yes	0.025	0.036	0.038	0.039
y	3	no	0.020	0.035	0.037	0.041
y	3	yes	0.029	0.041	0.042	0.045

Online Appendix Table OA.17: Wage cuts and subsequent wage growth: full results.

Note: The table reports OLS coefficients on $1\{\Delta w_{\text{move}} < 0\}$. The dependent variable is wage growth from the worker's first observation at the destination firm to year $1 + \tau$, conditional on the worker remaining at the destination through $1 + \tau$. Standard errors are clustered at the worker level; all reported coefficients have $p < 0.001$. "Pooled" uses all job-to-job movers without firm-type decomposition. Specifications with controls add age, female, academic, log origin firm size, and log destination firm size.

exceeds P-firm stayer drift in 15 of 17 years; the gap is concentrated at low tenure and rises with the firm's rank quartile.

	P-firms		M-firms	
	raw Δy	resid. Δy	raw Δy	resid. Δy
Panel A. Pooled across all stayer-pairs (2001–2018)				
All stayers	2.09	2.03	2.50	2.43
Panel B. By worker tenure (residualized Δy only)				
Tenure 0	—	5.21	—	6.25
Tenure 1	—	2.37	—	3.13
Tenure 2–3	—	1.53	—	2.04
Tenure 4–7	—	1.47	—	1.77
Tenure 8–14	—	0.88	—	0.94
Tenure 15+	—	0.86	—	0.75
Panel C. M-firm stayers by rank quartile of $\theta_{\max}$				
$Q1$ (lowest rank, $\bar{\theta}_{\max} = 4.82$)			2.34	2.29
$Q2$ ($\bar{\theta}_{\max} = 5.01$)			2.40	2.34
$Q3$ ($\bar{\theta}_{\max} = 5.14$)			2.44	2.38
$Q4$ (highest rank, $\bar{\theta}_{\max} = 5.36$)			2.82	2.73

Online Appendix Table OA.18: Stayer wage growth by firm type: pooled 2001–2018 panel.

Note: The table reports the average cross-year wage change Δy for workers who remain at the same firm in two consecutive years ("stayer-pairs"), pooled across all years 2001–2018 in the residualized Austrian panel. All entries are in percent per year. "Raw" is the change in the original log daily wage; "residualized" is the change in the AKM residual y (worker, age, year fixed effects removed; firm fixed effects and the firm-tenure slope $g_j \cdot \tau$ retained). Firm type (P vs M) is taken from the converged main classification at the LL-best (σ, κ). Panel B reports residualized Δy only because raw and residualized differ by less than 0.1 pp/yr across cells. Panel C splits the M-firm stayer-pairs into quartiles of the firm's structural productivity proxy $\theta_{\max}$ (the bias-corrected 98th percentile of within-firm residualized wages over 2001–2018). The pooled stayer-pair sample sizes are 5,954,773 at P-firms and 2,679,159 at M-firms.

OA.6 Baseline-Model Derivations

This appendix collects derivations specific to the flat-posted-contract limit ($g_j = 0$) of the framework: the steady-state stock distribution and firm sizes, and the wage-change sign restrictions. The body references these results in the baseline-limit paragraph of Section 3.7. The wage-growth versions of these objects are derived in Appendices A.4 and A.5 of the main paper appendix.

OA.6.1 Steady-State Distributions under Flat Posted Contracts

This subsection derives the baseline steady-state allocation under flat posted contracts. Let n be the mass of workers employed at posting firms, let $G(W)$ be the distribution of contract values among those workers, let m be the mass of workers employed at matching firms, let $L(p)$ be the distribution of productivities among those workers, and let u be the mass of unemployed workers. The unemployment flow equation is

$$\lambda u = \delta(n+m).$$

For posting jobs, the type-specific flow equation is

$$\begin{aligned} &nG(W)\left[\delta+\kappa\lambda(1-\xi)\overline{F}(W)\right]+n\kappa\lambda\xi\int_{\underline{W}}^{W}\overline{\Gamma}(\Omega^{-1}(W'))\,dG(W') \\ &\qquad = u\lambda(1-\xi)F(W)+m\kappa\lambda(1-\xi)\int_{\underline{p}}^{\Omega^{-1}(W)}\left[F(W)-F(\Omega(p))\right]dL(p). \end{aligned} \tag{OA.1}$$

For matching jobs, the corresponding flow equation is

$$\begin{aligned} &mL(p)\left[\delta+\kappa\lambda\xi\overline{\Gamma}(p)\right]+m\kappa\lambda(1-\xi)\int_{\underline{p}}^{p}\overline{F}(\Omega(p'))\,dL(p') \\ &\qquad = u\lambda\xi\Gamma(p)+n\kappa\lambda\xi\int_{\underline{W}}^{\Omega(p)}\left[\Gamma(p)-\Gamma(\Omega^{-1}(W))\right]dG(W). \end{aligned} \tag{OA.2}$$

Setting $W=\Omega(p)$ and adding equations (OA.1) and (OA.2) gives

$$\left[mL(p)+nG(\Omega(p))\right]\left[\delta+\kappa\lambda(1-\xi)\overline{F}(\Omega(p))+\kappa\lambda\xi\overline{\Gamma}(p)\right]=u\lambda\left[(1-\xi)F(\Omega(p))+\xi\Gamma(p)\right]. \tag{OA.3}$$

Let $\Psi(\theta)=F(\Omega(\theta))$ and $K(\theta)=(1-\xi)\Psi(\theta)+\xi\Gamma(\theta)$. Using $u\lambda=\delta(n+m)$, equation (OA.3) implies the conditional distribution of employed workers across ranks,

$$H(\theta)=\frac{m}{m+n}L(\theta)+\frac{n}{m+n}G(\Omega(\theta))=\frac{\delta K(\theta)}{\delta+\kappa\lambda\overline{K}(\theta)}. \tag{OA.4}$$

If K has density k, differentiation gives

$$h(\theta)=\frac{\delta(\delta+\kappa\lambda)}{[\delta+\kappa\lambda\overline{K}(\theta)]^2}k(\theta).$$

The type-specific densities are

$$\frac{m}{m+n}L'(p)=\frac{\delta(\delta+\kappa\lambda)}{[\delta+\kappa\lambda\overline{K}(p)]^2}\xi\Gamma'(p),$$

and

$$\frac{n}{m+n}(G\circ\Omega)'(w)=\frac{\delta(\delta+\kappa\lambda)}{[\delta+\kappa\lambda\overline{K}(w)]^2}(1-\xi)(F\circ\Omega)'(w).$$

Let N denote the total number of active firms. The size of a posting firm with posted rank θ is

$$\ell_P(\theta) = \frac{n(G \circ \Omega)'(\theta)}{N(1-\xi)(F \circ \Omega)'(\theta)} = \frac{n+m}{N} \frac{\delta(\delta + \kappa\lambda)}{[\delta + \kappa\lambda\overline{K}(\theta)]^2},$$

and the size of a matching firm with rank θ is

$$\ell_M(\theta) = \frac{mL'(\theta)}{N\xi\gamma(\theta)} = \frac{n+m}{N} \frac{\delta(\delta + \kappa\lambda)}{[\delta + \kappa\lambda\overline{K}(\theta)]^2}.$$

The exit rate from a firm with rank θ is $\mathrm{qr}(\theta) = \delta + \kappa\lambda\overline{K}(\theta)$.

OA.6.2 Within-Firm Values at Matching Firms

This subsection derives the within-firm distribution of outside-option ranks used in Section 3.6 under flat posted contracts. Let $G(W \mid p)$ be the distribution of workers' job values W within a matching firm of productivity p, and let $l(p) = L'(p)$. For $\underline{W} \leq W \leq \Omega(p)$, the within-firm flow condition is

$$\begin{aligned} ml(p)G(W \mid p) &\left[\delta + \kappa\lambda\xi\overline{\Gamma}(\Omega^{-1}(W)) + \kappa\lambda(1-\xi)\overline{F}(W)\right] \\ &= \left[u\lambda + \kappa\lambda m L(\Omega^{-1}(W)) + \kappa\lambda n G(W)\right]\xi\gamma(p) \\ &= \left[(n+m)\delta + \kappa\lambda m L(\Omega^{-1}(W)) + \kappa\lambda n G(W)\right]\xi\gamma(p). \end{aligned}$$

Changing variables to $W = \Omega(t)$ and using the baseline closed form for H (Section OA.6.1 above) gives

$$ml(p)G(\Omega(t) \mid p) = (n+m)\frac{\delta(\delta + \kappa\lambda)}{[\delta + \kappa\lambda\overline{K}(t)]^2}\xi\gamma(p).$$

Dividing by $ml(p)$ gives the distribution of outside-option ranks inside a matching firm with productivity p:

$$\mathcal{G}(t \mid p) = \left[\frac{\delta + \kappa\lambda\overline{K}(p)}{\delta + \kappa\lambda\overline{K}(t)}\right]^2, \qquad t \in [\underline{w}, p],$$

with a mass point at $t = \underline{w}$. The wage distribution within a matching firm of productivity p is the distribution of $T(t,p)$ induced by $t \sim \mathcal{G}(\cdot \mid p)$.

OA.6.3 Baseline Wage-Change Sign Restrictions

Proof sketch. In the baseline ($g_j = 0$), $w_P(\tau; x_j) = \omega(\tau; x_j) = \theta_j$ at all tenures. Consider a job-to-job move from a firm of rank θ to one of rank $\theta' > \theta$ (the inequality is the standard poaching condition). Posting-to-posting: origin wage θ, destination wage $\theta' > \theta$. Matching-to-posting: origin wage $T(t,\theta) \le t \le \theta$ for $t \le \theta$, destination wage $\theta' > \theta$. Both moves entail a strict wage increase. Posting-to-matching: origin wage θ, destination wage $T(\theta,\theta') = \theta - \int_\theta^{\theta'} \frac{\kappa\lambda\xi\overline{\Gamma}(x)}{r+\delta+\kappa\lambda(1-\xi)\overline{\Psi}(x)}\,dx \le \theta$, with strict inequality whenever the integrand is positive on a set of positive measure; the move therefore entails a weak wage cut. The mechanism is that matching firms equate the worker's continuation value, not the worker's current wage; because the matching protocol itself provides future option value, the same continuation value is delivered at a lower current wage.

OA.7 Numerical Computation of the Equilibrium

This appendix describes the finite-firm computation corresponding to the continuous allocation in Appendix A.4 of the main paper. The existence of the rank-distribution fixed point referenced here is established in the proof sketch of Proposition 1. Given firm classifications, posting-firm contract vectors x_j, matching-firm productivities p_j, and parameters, the allocation is computed by two nested fixed points. In the main empirical specification, $x_j = (\theta_j, g_j)$, where θ_j is the scalar starting wage and g_j is the slope before the common plateau $\bar{\tau}$.

Step 1: posting-rank fixed point. Start from a candidate distribution $\Psi^{(m)}$. Construct

$$h^{(m)}(w) = r + \delta + \kappa\lambda(1-\xi)\overline{\Psi}^{(m)}(w).$$

For each posting firm j, solve

$$\omega'_{x_j}(\tau) = h^{(m)}(\omega_{x_j}(\tau))[\omega_{x_j}(\tau) - w(\tau; x_j)]$$

using the boundary condition in Appendix A.2: solve backward from $\omega_{x_j}(\bar{\tau}) = \theta_j + g_j\bar{\tau}$, with $\omega_{x_j}(\tau) = \theta_j + g_j\bar{\tau}$ for $\tau \ge \bar{\tau}$. Compute

$$\mu_j^{(m)} = \mu(x_j; \Psi^{(m)}) = \omega_{x_j}(0; \Psi^{(m)}).$$

Below, write $\omega_j(\tau) \equiv \omega_{x_j}(\tau)$ when the firm is fixed. Form the preliminary update $\widetilde{\Psi}^{(m+1)}$ as the smoothed empirical distribution of $\{\mu_j^{(m)} : z_j = P\}$. In population notation, this is the induced distribution $\Psi(y) = F_X\{x : \mu(x) \le y\}$. Use a damped update,

$$\Psi^{(m+1)} = \alpha\widetilde{\Psi}^{(m+1)} + (1-\alpha)\Psi^{(m)}, \qquad \alpha \in (0,1],$$

and iterate until Ψ and the implied $\omega_{x_j}(\tau)$ paths are stable.

Step 2: worker-rank fixed point. Given Ψ, construct the offer-rank distribution

$$K(y) = (1-\xi)\Psi(y) + \xi\Gamma(y).$$

Start from a candidate worker-weighted current-rank distribution $H^{(m)}$. For each posting firm, compute

$$I_j^{P,(m)} = \frac{1-u}{N}\left[\delta + \kappa\lambda H^{(m)}(\mu_j)\right],$$

$$n_j^{P,(m)}(\tau) = I_j^{P,(m)}\mathcal{S}_j(\tau), \qquad \mathcal{S}_j(\tau) = \exp\left(-\int_0^\tau q(\omega_j(s))\,ds\right),$$

and

$$\ell_j^{P,(m)} = \int_0^\infty n_j^{P,(m)}(\tau)\,d\tau.$$

These are the finite-firm counterparts of the continuum stock density $m_P(x,\tau)$ in Appendix A.4. For each matching firm, compute

$$\ell_j^{M,(m)} = \frac{1-u}{N}\frac{\delta + \kappa\lambda H^{(m)}(p_j)}{\delta + \kappa\lambda\overline{K}(p_j)}.$$

Update H using

$$H^{(m+1)}(y) = \frac{1}{1-u}\left[\sum_{j:z_j=P}\int_0^\infty \mathbf{1}\{\omega_j(\tau)\le y\}n_j^{P,(m)}(\tau)\,d\tau + \sum_{j:z_j=M}\mathbf{1}\{p_j\le y\}\ell_j^{M,(m)}\right].$$

Iterate this mapping, with damping if needed, until H and the implied firm sizes are stable. The output is the collection $\{\omega_j(\tau),\mu_j\}$, the offer-rank distribution K, the worker-rank distribution H, firm sizes, and the objects entering T and the likelihood.

OA.8 Common-Rank Construction under Positive Worker Bargaining Power

This appendix shows that the firm-level classification of Section 5 extends to positive worker bargaining power $\alpha \in [0,1)$ at matching firms. The framework with $\alpha > 0$ is the mixed-protocol environment of Flinn and Mullins (2026), who generalise the Nash-bargaining model of Cahuc et al. (2006) to the presence of posting firms. We do not re-derive the wage map—which is established in Flinn and Mullins (2026)—but show that the classification signatures used in Section 5 are preserved under $\alpha > 0$, so that the empirical classification is robust.

Throughout, $\Omega(p)$ denotes the maximum worker value at a matching firm of productivity p (equation (3)), $W_P(\tau; x)$ the posting-firm contract value (equation (4)), and $\omega \equiv \Omega^{-1}(W)$ the common rank (equation (5)); $K = (1-\xi)\Psi + \xi\Gamma$ is the aggregate offer-rank distribution.

Posting firms: rank ODE and Proposition 1 unchanged. Posting firms do not renegotiate at any α, so $W_P(\tau; x)$ solves the same Bellman (4) as at $\alpha = 0$. The common rank $\omega(\tau; x) = \Omega^{-1}(W_P(\tau; x))$ remains a sufficient statistic for a posting-firm worker's continuation value, and the rank ODE of Lemma 1—obtained by differentiating this identity in τ—holds verbatim with the same $h(y) = r + \delta + \kappa\lambda(1-\xi)\overline{\Psi}(y)$. Proposition 1 (existence of the equilibrium rank distribution Ψ) therefore goes through unchanged at any $\alpha \in [0, 1)$.

Matching firms: Nash split, retention, and wage-map endpoints. At a matching firm of productivity p, a worker with inherited outside-option rank $t \le p$ has Nash-bargained continuation value

$$W_M(t, p) \;=\; (1-\alpha)\,\Omega(t) \;+\; \alpha\,\Omega(p), \tag{OA.5}$$

as in Cahuc et al. (2006). The full flow-wage map $T_\alpha(t, p)$ at matching firms in the presence of posting firms is established in Flinn and Mullins (2026). For the classification argument that follows, we use only two properties of T_α:

Wage-map endpoints and continuity. $T_\alpha(t, p)$ is continuous in α on $[0, 1]$, with $T_0(t, p) = T(t, p)$ (the $\alpha = 0$ matching-firm wage of Lemma 2) and $T_1(t, p) = p$ (the worker captures the entire matching-firm rent at $\alpha = 1$).

Retention at matching firms is governed by productivity alone. The matching firm bids against any poacher up to its full rent $\Omega(p)$, so a poacher of rank μ (entry rank if posting, productivity if matching) triggers a move only when $\mu > p$; otherwise the worker stays at p with the outside option updated to μ if $\mu > t$. The job-to-job separation hazard at a matching firm is therefore

$$q_M(p) \;=\; \delta + \kappa\lambda\,\overline{K}(p), \tag{OA.6}$$

the same as in the main text (equation (11)) and independent of both t and α. The state pair (t, p) is needed for the wage, but retention is governed by p alone.

Three classification signatures preserved under $\alpha > 0$. The classification in Section 5 rests on three observable signatures. We show each is preserved in direction at every $\alpha \in [0, 1)$.

(i) Within-firm wage dispersion at M-firms. The wage $T_\alpha(t, p)$ is increasing in t at fixed p

for any $\alpha < 1$ (a worker with a better outside option earns more), and at $\alpha = 1$ collapses to p uniformly in t. Heterogeneity in the outside-option rank t across workers at the same matching firm therefore generates strictly positive within-firm wage dispersion at every $\alpha < 1$; the dispersion vanishes only at $\alpha = 1$. The classification signature (M-firm within-firm dispersion exceeds P-firm within-firm dispersion) therefore holds at every $\alpha < 1$.

(ii) $P \to M$ wage-cut sign. On a $P \to M$ move from posting firm j at rank $\omega = \omega(\tau; x_j)$ to matching firm j' with productivity $p_{j'} \geq \omega$, the destination wage $T_\alpha(\omega, p_{j'})$ moves continuously from $T(\omega, p_{j'}) \leq \omega$ at $\alpha = 0$ (the wage cut of Lemma 2) to $p_{j'} \geq \omega$ at $\alpha = 1$. By continuity at $\alpha = 0$, there exists $\alpha_0(\omega, p_{j'}) > 0$ such that $T_\alpha(\omega, p_{j'}) \leq \omega$ for every $\alpha \in [0, \alpha_0(\omega, p_{j'}))$; the wage-cut sign is therefore preserved on an interval of α extending strictly above zero, with magnitude attenuating continuously toward zero.

(iii) Tenure–separation gradient. The separation hazard $q_M(p)$ at matching firms is tenure-flat and α-invariant by the retention argument above. At posting firms, $q\big(\omega(\tau; x_j)\big)$ rises with tenure because $\omega(\tau; x_j)$ climbs deterministically with the structural slope $g_j > 0$ (Lemma 1). The gradient signature distinguishing M- from P-firms is therefore preserved at any $\alpha \in [0, 1)$.

Summary. At posting firms, the common-rank construction extends to $\alpha \in [0, 1)$ with Lemma 1 and Proposition 1 unchanged. At matching firms the framework is the mixed-protocol model of Flinn and Mullins (2026); we use only retention (p alone), the wage endpoints $T_0 = T$ and $T_1 = p$, and continuity of T_α in α. The three classification signatures—higher within-firm dispersion at M, the $P \to M$ wage-cut sign, and the steeper tenure–separation gradient at P—are preserved in direction at every $\alpha < 1$, with the wage-cut sign holding on an interval $[0, \alpha_0(\omega, p_{j'}))$ and the dispersion gap and wage-cut magnitude attenuating continuously toward zero at $\alpha = 1$. The firm-level classification recovered in Section 5 is therefore robust to introducing positive worker bargaining power.