CESifo WORKING PAPERS

7392
2018

December 2018

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
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Editors: Clemens Fuest, Oliver Falck, Jasmin Gröschl
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CESifo *Working Paper No. 7392*
Category 4: Labour Markets

The Sources of the Union Wage Gap: The Role of Worker, Firm, Match, and Job-title Heterogeneity

Abstract

Using matched employer-employee-contract data for Portugal – a country with near-universal union coverage – we find evidence of a sizable effect of union affiliation on wages. Gelbach's (2016) decomposition procedure is next deployed to ascertain the contributions of worker, firm, match, and job-title heterogeneity to the union wage gap. Of these the most important is the firm fixed effect, followed at some distance by union workers gaining from elevated job titles and/or more generous promotion policies. For its part, unobserved worker quality plays only a very weak role, while there is even less suggestion that improved match quality bolsters the union premium.

JEL-Codes: J310, J330, J410, J510, J520.

Keywords: union density, union wage gap, worker/form/job-title fixed effects, match quality, Gelbach decomposition, Portugal.

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The authors benefited from the comments of session participants at the 2017 ASSA Annual Meeting in Chicago, and those of seminar discussants at the CEP-LSE and the Bank of Portugal. They also wish to thank Alan Manning, Stephen Machin, Pedro Martins, and Steve Pischke for their helpful remarks. Lucena Vieira provided outstanding computational assistance. Addison is indebted to the Riegel and Emory Human Resources Center at the University of South Carolina for generous research support, and Vilares acknowledges financial support from the ESRC through grant #1642247.

1 Introduction

In continental Europe, the architecture of wage bargaining systems typically leads to coverage rates that exceed union density rates, and often by a considerable margin. The pervasive presence of extension mechanisms that generalize union wage agreements throughout industry is responsible for this asymmetry. One might easily be led to conclude in these circumstances that unions have an indistinguishable effect on wages across firms. *Vulgo*: how can a union premium arise when all workers are covered?

In this study, we are nevertheless able to identify a substantial union (affiliation) premium in a situation of near-universal coverage, not only for the total wage of the worker but also with respect to its major components. Further, we are also able to take advantage of an exceptional longitudinal dataset with unique worker, firm, wage contract, and job-title identifiers, combined with a novel decomposition procedure, to address a number of questions aimed at providing a better understanding of what lies behind the union wage gap.

In searching for the constituent mechanisms, the present treatment explores four potential candidates. First, are the affiliation decisions of workers systematically related to heterogeneous firm wage policies (e.g. Hirsch and Addison, 1986)? Second, do unionized workers possess unobserved characteristics that make them more productive (e.g. Hirsch, 2004; Card, 1996)? Third, by analogy with the controversy often-surrounding public-sector pay, do we consistently observe more higher-paying job-titles, or more generous promotion policies, within unionized firms? Finally, is the union-wage premium materially influenced by a better matching of workers with their employers, as might be produced by different hiring and retention policies (e.g. Torres et al., 2018)?

In order to tackle these issues, we first estimate the impact of union density on wages using a conventional linear functional form. We then account for non-linearities in the impact of union density using two alternative approaches; firstly, a third-degree polynomial function; and, secondly,

a nonparametric regression analysis. Next, the main thrust of this inquiry extends the decomposition procedure first suggested by Gelbach (2016) to disentangle the three-fold contributions of worker, firm, and job-title fixed effects to the union wage gap. In other words, we quantify the impact of each of the above mentioned high-dimensional fixed effects on the relationship between wages and union density. Finally, we integrate job match into the decomposition exercise, ultimately allowing us to arrive at the match quality component of the union wage gap.

The plan of the paper is as follows. To set the scene, section 2 outlines the machinery of collective bargaining in Portugal. Section 3 describes the unique matched employer-employee datasets used in this inquiry. The modeling strategy underpinning the estimation of the union wage gap and its sources while also accommodating the possibility that union presence promotes better job matches is carefully developed in section 4. Presentation of the detailed empirical results is provided in section 5. Section 6 revisits the machinery of collective bargaining to demonstrate how the union (bargained) wage gap is attenuated in practice. Section 7 concludes.

2 The Bargaining Framework

Portuguese law makes provision for three types of collective bargaining. First, there are firm-level agreements between an individual company and one or more unions. These so-called *Acordos de Empresa* (or AEs) are important in the oil sector and transport and communications. Second, there are collective agreements signed by several employers that are not part of an employers' association and one or more trade unions, known as *Acordos Colectivos de Trabalho* (or ACTs), that are significant in the financial sector and utilities. However, it is industry-level or sectoral agreements, so-called *Contratos Colectivos de Trabalho* (CCTs), negotiated between one or more employers' associations and one or more unions, that predominate.

The vast majority of those agreements are signed by unions linked to the two major union confederations: the CGPT-IN or General Confederation

of Portuguese Workers, and the UGT or General Workers' Union. They are intended to improve upon the wage floors set under national minimum wage machinery, defined after the consultation with the self-same confederations.

The impact of collective bargaining agreements is far from being limited to the signatory parties. The most potent mechanism shaping the formation of wages has traditionally been the systematic extension, via so-called *Portarias de Extensão*, of industry-wide agreements (and occasionally ACTs) by the Ministry of Employment, following a request from either or both of the parties to the agreement.[1] The upshot of this near automatic procedure is that even those wage agreements reached by trade unions and employersâ associations with very low representation have had a strong impact in setting wage floors.

To all intents and purposes the regulations replicate the signatory agreements. Beyond establishing a substantive set of rules on working conditions, the latter are at once both extensive and general in their wage setting mechanisms. They are extensive insofar as they cover many categories of workers. On average, branch agreements have historically set wages for around 100 job titles, or *categorias profissionais*. However, the contents are general. That is, collectively agreed wages (or "bargained wages") establish wage floors alone. Firms frequently pay more than the bargained wage. Research has exploited this difference between actual wages and the contract wage — termed the *wage cushion* — to offer an explanation for considerable wage flexibility (and low unemployment) in the past despite institutional structures that *prima facie* might be expected to impart rigidity (see, in particular, Cardoso and Portugal, 2005).

Altogether, both agreements and their subsequent extensions explain levels of collective bargaining coverage in the order of 90 percent of workers

[1] Additionally, in the absence of one of the representatives, or in the presence of strategic delays in negotiations/refusals to negotiate, the Ministry of Employment can regulate the sector directly through an Ordinance of Working Conditions, or *Portarias de Condições de Trabalho*. An arbitration process, either mandatory or voluntary, may be set in motion to unfreeze "blockages".

at a time when union density is a little over 10 percent. As a result, between 70 and 80 percent of the labor force have benefited from collective agreements without being members of the organizations that signed them. The extension mechanism, in conjunction with the large number of job titles set down in the typical sectoral agreement, explain Portugal's recent portrayal as having no less than 30,000 minimum wages (Martins, 2014). We note parenthetically that quite apart from this disaggregated or informal minimum wage apparatus, the share of workers receiving the national minimum wage has risen dramatically in recent years (e.g. Carneiro et al., 2012) and currently exceeds 20 percent.[2]

In analyzing the effect of union density on wages, therefore, our own analysis will not only exploit actual wages but also the (estimated) contractually bargained wage and the difference between the two (or wage cushion). Further, since Portuguese contracts set other minimum conditions in addition to the bargained wage — most typically, allowances for meals, overtime, shifts, and bonuses not having a basis in productivity — our analysis will perforce investigate the impact of union density on these other components of actual earnings as well.[3]

3 The Datasets

The data sources used in this exercise are the *Quadros de Pessoal* (Personnel Tables), 1986-2009, and the successor *Relatório Único* (Single Report), 2010-2013.[4] Each longitudinal matched employer-employee-contract-job title database is identical other than in one main respect: the follow-up survey contains data on the union density of the firm that for the first time permit accurate estimates of union density to be obtained.

[2]For detailed review of recent developments in collective bargaining and extension arrangements in Portugal, see Hijzen and Martins (2016) and Addison et al. (2017).

[3]Historically, Portuguese collective agreements remained in place until a new agreement was signed. However, recent changes in the Portuguese labor code mean that collective agreements can now expire if they are not renewed, although the expiry period is protracted.

[4]The *Quadros de Pessoal* was not administered for two years, 1990 and 2001.

Beginning with the *Quadros de Pessoal*, the survey is mandatory in nature and is administered by the Ministry of Employment and Social Security on an annual basis for all establishments with at least one wage earner. All workers employed by the firm in the reference month (March of each year until 1993, October thereafter) are reported, although civil servants and workers in domestic service are not covered while the coverage of agriculture is necessarily spotty because of the importance of the informal sector/low share of wage earners in this sector. In short, the entire population of private-sector firms in manufacturing and services with wage earners is covered. Further, by virtue of its mandatory nature, the high response rate in the *Quadros de Pessoal* ensures that problems commonly associated with panel data are much attenuated. This is underscored by the requirement that the data be made publicly available at the place of work.

The dataset reports the firm's location, industry, employment, sales, ownership, and legal basis. Worker information includes gender, age, skill, broad occupation, schooling completed, starting date with the firm, earnings, and working hours. In addition, the survey also records the collective bargaining arrangement and the specific job title held by the worker under collective bargaining.[5] The wage variable is recorded in considerable detail, indicating the worker's gross monthly earnings (the actual or total wage), which sum is split into the following four components: the base wage (i.e. the gross pay for normal hours of work), overtime pay, and regularly and irregularly paid supplements. Normal monthly hours worked and overtime hours are also reported. Note that for the year 2010 alone, an upgraded version of the dataset distinguishes between the three regularly paid supplements, namely the meals subsidy, shift pay, and other benefits not linked to productivity.

The following restrictions were placed on the data. First, the analysis

[5]Those workers not covered by any collective agreement are coded as such (i.e. "non-covered workers"). According to Addison et al. (2017), they comprised less than 11 percent of the sample between 2010 and 2013.

was confined to full-time employed workers in receipt of what was contractually defined for the reporting month. Second, workers from the agriculture, fisheries, and energy products/extraction sectors were excluded. Third, workers aged less than 18 years and greater than 65 years were excised, as also were those whose monthly wages were less than 80 percent of the mandatory minimum wage, corresponding to the lowest admissible wage for apprentices. Fourth, workers whose job-title was not properly defined were eliminated. Finally, observations not belonging to the largest connected group were dropped, amounting to some 1 percent of the total number of observations.[6]

The successor *Relatório Único* was initiated in 2010. Our database ends with the 2013 survey. As in the later versions of the *Quadros de Pessoal*, the database is collected in October of each year. As noted earlier, the distinguishing feature of this successor dataset is that it allows us to construct a measure of union density at firm level. Specifically, the survey asks of the manager respondent: "Indicate the number of workers for whom you have knowledge of their membership in a union (because they are union officials, because you deduct membership dues from their salary, or because the worker informed you about his/her membership so as to determine which particular collective regulation is applicable to their case)."[7] The sum of such workers whose personal union status is unknown (thereby precluding use of an individual union membership variable) divided by the number of workers employed by the firm provides our measure of union density.

Overall, the joint dataset includes 36,616,379 observations of worker-year pairs, of which 6,237,187 are from the *Relatório Único*. The joint dataset has a basis in the records of 6,043,164 workers matched by identifying social

[6] A connected group links the job-title and the firm to the rest of the group such that all the fixed effects are connected. Restricting the analysis to this subset of the data ensures that the estimates of the fixed effects are comparable (see Guimarães et al., 2010).

[7] We noted earlier that our sample period ends in 2013. Although the *Relatório Único* currently extends to 2016, the publicly available waves since 2013 do not contain the union question.

security number, 652,555 firms matched by identifying number, 133,022 job-titles matched by the code of the collective agreement occupational category, and 10,671,230 worker-firm matches that were followed since 1986. The *Relatório Único* covers 2,335,258 workers, 246,757 firms, and 51,588 job-titles, followed between 2010 and 2013.

4 Modeling

We next describe the procedures used, firstly, to estimate the union wage gap and, secondly, to account for the component contributions of firm compensation policies, worker ability, and detailed occupational premiums via the estimation of firm, worker, and job-title fixed effects, respectively.

4.1 Estimation of the Union Wage Gap

We begin with a standard Mincerian wage equation, augmented to include union density, as follows:

$$w_{it} = \boldsymbol{x'_{it}}\boldsymbol{\beta_0} + \delta_{0_t} + \gamma_0 U_{F(i,t)} + \epsilon_{0_{it}}, \tag{1}$$

where w_{it} is the natural logarithm of worker i monthly compensation at year t, $\boldsymbol{x'_{it}}$ is a vector of observed characteristics of the worker and his/her employer, $\boldsymbol{\beta_0}$ is a vector of coefficients for the observed characteristics of workers and firms, $U_{F(i,t)}$ is the level of union density of employer F in year t, γ_0 is the coefficient associated with the level of union density, δ_{0_t} are calendar year fixed effects included to capture the macroeconomic environment (business cycle), and $\epsilon_{0_{it}}$ is an error is assumed to be uncorrelated with the covariates. The explanatory variables (or observed characteristics) of workers and firms are age, age squared, seniority, seniority squared, and dummies for gender, education, firm size, and industry.[8]

[8]The subscript **0** denotes the base regression model specification.

To allow for a non-proportional impact of union density on wages we will consider two alternative approaches: a parametric one, where we employ a third-degree polynomial in union density:

$$w_{it} = \boldsymbol{x'_{it}}\boldsymbol{\beta_0} + \delta_{0_t} + \gamma_{0_1} U_{F(i,t)} + \gamma_{0_2} U^2_{F(i,t)} + \gamma_{0_3} U^3_{F(i,t)} + \epsilon_{0_{it}}; \tag{2}$$

and a non-parametric one, where the impact of union density is captured by the presence of fixed effects $\psi_{0u_{F(i,t)}}$ (one for each different level of union density U):

$$w_{it} = \boldsymbol{x'_{it}}\boldsymbol{\beta_0} + \delta_{0_t} + \psi_{0u_{F(i,t)}} + \epsilon_{0_{it}}. \tag{3}$$

Information contained in the union fixed effects while necessarily complete is rather noisy and âstaccato.â Thus, in a second step, we will estimate a kernel regression linking the estimates of the union density fixed effects and actual union density at firm level, as follows:

$$\widehat{\psi_u} = K(U) + \upsilon_u, \tag{4}$$

where $\widehat{\psi_u}$ is the union density fixed effect estimate obtained from the first step, U is the prevailing union density of the firm, υ_u is the disturbance term, and K is a standard Epanechnikov kernel function (Silverman, 1986).

The estimation of local weighted union wage gaps, as well as the third degree polynomial specification, result in smoothed estimates of a union wage gap curve. To facilitate the interpretation of the results, a convenient normalization in the nonparametric case requires that the fixed effect in the absence of workplace unionism be set equal to zero. No further restrictions are implied by this assumption as the union wage gap represents the relative difference in wages for workers at firms with different levels of union density, controlling for the observed characteristics of workers and firms.

4.2 Estimation of the Sources of the Union Wage Gap

Given the estimate of the union wage gap it is useful to decompose this

outcome measure into its constituent mechanisms; that is, to identify the contributions of worker, firm, and job-title time-invariant heterogeneity. To this end, we adapt the conditional decomposition of Gelbach (2016).

For purposes of benchmarking, we provide the decomposition for the standard OLS approach.[9] Thus, as a full-specification model, we include in equation (3) the sources of time-invariant heterogeneity, namely, the worker fixed effect (α_{1_i}), the firm fixed effect ($\lambda_{1_{F(i,t)}}$) and the job-title fixed effect ($\theta_{1_{J(i,t)}}$), exploiting the methodology first introduced in Carneiro et al. (2012). The model thus becomes:[10]

$$w_{it} = \boldsymbol{x}'_{\boldsymbol{it}}\boldsymbol{\beta_1} + \delta_{1_t} + \gamma_1 U_{F(i,t)} + \alpha_{1i} + \lambda_{1_{F(i,t)}} + \theta_{1_{J(i,t)}} + \epsilon_{1_{it}}. \tag{5}$$

In general the identification of the worker, firm, and job title fixed effects is assured by the restriction that the sample identifies the largest connected set. A connected set is defined when at least one element of a worker, firm, and job title links the rest of the group (Abowd et al. (1999)). The largest connected group represents more than 99 percent of the sample.

At this stage, we calculate the independent contribution of each fixed effect to the union wage gap. For this purpose we adapt the methodology developed in Gelbach (2016), which appeals to the omitted variables bias formula to compute a detailed decomposition. Departing from a baseline specification to which covariates are added, Gelbach's procedure allows us to compute the contribution of each new covariate to the change in the estimate of the coefficient of the variable under scrutiny. In our case, it allows us to unambiguously disentangle the contribution of each excluded variable (each fixed effect) to the variation of the coefficient estimate(s) of the union density variable(s).

To better understand our decomposition exercise it is useful to present

[9] This decomposition will be replicated for each set of observed characteristics considered in our benchmark exercise described previously. In the interests of economy, we shall describe the method for one arbitrary set of controls throughout.

[10] The subscript **1** denotes the full model specification.

the benchmark wage regression equation, emphasising the union effects, in a matrix formulation as:

$$\boldsymbol{W} = \mathbf{X}\boldsymbol{\beta_0} + \mathbf{U}\boldsymbol{\gamma_0} + \boldsymbol{\epsilon_0}, \tag{6}$$

where $\mathbf{W}$ stands for vector of wages, $\mathbf{X}$ denotes the matrix of control variables, including the year dummies, $\boldsymbol{\beta_0}$ is a vector of regression coefficients, $\mathbf{U}$ collects the union density variable(s), $\boldsymbol{\gamma_0}$ represents the union wage gap, and $\boldsymbol{\epsilon}$ is the vector containing the error terms.

Making use of the Frisch-Waugh-Lovell theorem, we can express the OLS estimate of $\boldsymbol{\gamma_0}$ by running a regression of $\boldsymbol{W}$ on $\mathbf{U}$ after partialing out the effect of $\mathbf{X}$ on both variables. More to the point:

$$\widehat{\boldsymbol{\gamma_0}} = (\mathbf{U}'\mathbf{M_X}\mathbf{U})^{-1}\mathbf{U}'\mathbf{M_X}\mathbf{W}, \tag{7}$$

where, $\mathbf{M_X} = I - X(X'X)^{-1}X'$ is the residual-maker, or "annihilator" matrix.

More compactly, we can write:

$$\widehat{\boldsymbol{\gamma_0}} = \mathbf{A_X}\mathbf{W}. \tag{8}$$

We now define the the full regression model, where we incorporate the worker effects (identified via the matrix $\mathbf{D}$), the firm effects (identified via the matrix $\mathbf{F}$), and the job-title effects (identified via $\mathbf{J}$). The estimated full regression can be now expressed as:

$$\boldsymbol{W} = \mathbf{X}\widehat{\boldsymbol{\beta_1}} + \mathbf{U}\widehat{\boldsymbol{\gamma_1}} + \mathbf{D}\widehat{\boldsymbol{\alpha_1}} + \mathbf{F}\widehat{\boldsymbol{\lambda_1}} + \mathbf{J}\widehat{\boldsymbol{\theta_1}} + \widehat{\boldsymbol{\epsilon_1}}, \tag{9}$$

where $\widehat{\boldsymbol{\alpha_1}}$, $\widehat{\boldsymbol{\lambda_1}}$, and $\widehat{\boldsymbol{\theta_1}}$ denote the worker, firm, and job-title fixed effects, respectively.

At this stage, we build on the approach suggested by Gelbach (2016), which makes use of the OLS omitted variable bias formula, to decompose the union wage gap in terms of individual self-selection in unionized firms

(worker component) and sorting across firms with different wage policies and differently remunerated job titles. This can be achieved by multiplying both terms of the full regression by $\mathbf{A_X}$, leading to:

$$\widehat{\boldsymbol{\gamma_0}} - \widehat{\boldsymbol{\gamma_1}} = \mathbf{A_X D}\widehat{\boldsymbol{\alpha_1}} + \mathbf{A_X F}\widehat{\boldsymbol{\lambda_1}} + \mathbf{A_X J}\widehat{\boldsymbol{\theta_1}} = \widehat{\boldsymbol{\tau_{\alpha_1}}} + \widehat{\boldsymbol{\tau_{\lambda_1}}} + \widehat{\boldsymbol{\tau_{\theta_1}}} \tag{10}$$

as, by construction, $\boldsymbol{A_X}\widehat{\boldsymbol{\epsilon_1}} = \mathbf{0}$.

Equation (10) yields an exact, unambiguous and conditional decomposition of the union wage gap. The interpretation of this equation is that we can split the wage gap into three components: the worker component ($\widehat{\boldsymbol{\tau_{\alpha_1}}}$), the firm component($\widehat{\boldsymbol{\tau_{\lambda_1}}}$) and the job-title component ($\widehat{\boldsymbol{\tau_{\theta_1}}}$). In practice, all we need to do is to run a regression for each type of fixed effect on all regressors of the benchmark regression (X and U) and extract the union regression coefficient estimates.

Mutatis mutandis, we can apply the same principle of the Gelbach decomposition to the union wage gap curve given in equation (2) and to the union fixed effect specification in equation (3). In the latter, the difference between the union density fixed effects of the full and base models can be decomposed into three fixed effects:

$$\widehat{\boldsymbol{\psi_{0_u}}} - \widehat{\boldsymbol{\psi_{1_u}}} = \mathbf{A_{X_u} D}\widehat{\boldsymbol{\alpha_{1_u}}} + \mathbf{A_{X_u} F}\widehat{\boldsymbol{\lambda_{1_u}}} + \mathbf{A_{X_u} J}\widehat{\boldsymbol{\theta_{1_u}}} = \widehat{\boldsymbol{\tau_{\alpha_u}}} + \widehat{\boldsymbol{\tau_{\lambda_u}}} + \widehat{\boldsymbol{\tau_{\theta_u}}}, \tag{11}$$

where the subscript u is used to emphasize that we are in the presence of a wage regression with union density fixed effects. In practice, and as before, the decomposition is achieved by estimating three auxiliary regressions in which the worker, firm, and job-title fixed effects become the dependent variables and the regressors match those of equation (3). Then, by smoothing these estimates via a kernel function, we can provide a graphical representation of the components union wage gap.

Before turning to our empirical results, however, we should resist the

notion that the union density fixed effect is simply to be equated with a firm fixed effect. Even if union density were not to change over time, the union density fixed effect is to be seen as subsumed in the firm fixed effect in the same way that the gender fixed effect is subsumed in the worker fixed effect. Contrary to intuition, this fact does not preempt the decomposition of the union density effect along its worker, firm, and job-title dimensions for the same reason that the gender effect can be disentangled along the worker, firm, and job-title dimensions (Cardoso et al., 2016).[11] A clear indication that the dominant role of the firm is not mechanically implied by the fact that the union density variable is computed at the firm level will be given by the decomposition exercise below.

4.3 Accounting for match quality

To further investigate the sources of the union wage gap we build on Woodcock (2008, 2015) who extends the worker and firm fixed effect model of Abowd et al. (1999) to account for match quality heterogeneity. Taking into account match quality may be important to the extent that the presence of unions promotes better job matches. In this setup, the match quality effects measure the value of the wage boost (or deflation) of the firm-worker interaction. The four-way high-dimensional fixed effects regression model can be written as:[12]

$$w_{it} = \boldsymbol{x}'_{\boldsymbol{it}}\boldsymbol{\beta_2} + \delta_{2_t} + \gamma_2 U_{F(i,t)} + \alpha_{2_i} + \lambda_{2_{F(i,t)}} + \mu_{iF_{(i,t)}} + \theta_{2_{J(i,t)}} + \epsilon_{2_{it}}, \quad (12)$$

where we have added $\mu_{iF_{(i,t)}}$ to account for quality of the job match of worker i while he/she is working for firm F (that is, for the job match $iF(i,t)$).[13]

[11] Cardoso et al. (2016) extend the Gelbach procedure and prove that it is applicable even in settings where the omitted variables are fixed effects and the coefficient under scrutiny refers to a variable (viz. gender) that is subsumed in one of the fixed effects.

[12] The subscript **2** denotes the full model specification extended to incorporate the match quality fixed effect.

[13] The index $J_{(i,t)}$ indicates the job title j at which worker i was employed in period t,

Without additional assumptions, the identification of match quality effects poses the greatest challenges given that model (12) is over-parameterized, making it impossible to disentangle the worker, firm, and match quality effects. In this model, the quality of the worker-firm match is indistinguishable from a good employee working in a good firm.

A feasible procedure - one that enables us to consistently estimate all the regression parameters except the components of the job match fixed effect (the worker, firm, and match quality fixed effects) - is to replace these three fixed effects with a job match fixed effect. The extended full model is now written as:

$$w_{it} = \boldsymbol{x}'_{\boldsymbol{it}}\boldsymbol{\beta_2} + \delta_{2_t} + \gamma_2 U_{F(i,t)} + \phi_{2_{iF(i,t)}} + \theta_{2_{J(i,t)}} + \epsilon_{1_{it}}, \tag{13}$$

where the job match fixed effect - $\phi_{2_iF(i,t)}$ - corresponds to each worker-firm pair and collapses the three separate components of worker (α_{2_i}), firm ($\lambda_{2F(i,t)}$), and match quality ($\mu_{iF(i,t)}$).[14]

This regression model incorporates two high-dimensional fixed effects and will be estimated, as before, employing the algorithm offered by Guimarães et al. (2010).[15]

The estimated extended full regression model can also be expressed in matrix notation as:

$$\boldsymbol{W} = \mathbf{X}\widehat{\boldsymbol{\beta_2}} + \mathbf{U}\widehat{\boldsymbol{\gamma_2}} + \mathbf{Q}\widehat{\boldsymbol{\phi_2}} + \mathbf{J}\widehat{\boldsymbol{\theta_2}} + \widehat{\boldsymbol{\epsilon_2}}, \tag{14}$$

where the job matches are identified through the matrix $\mathbf{Q}$. Applying, again, the omitted variable bias formula, we obtain the following decomposition:

$$\widehat{\boldsymbol{\gamma_0}} - \widehat{\boldsymbol{\gamma_2}} = \mathbf{A_X}\mathbf{Q}\widehat{\phi_2} + \mathbf{A_X}\mathbf{J}\widehat{\theta_2} = \widehat{\boldsymbol{\tau_{\phi_2}}} + \widehat{\boldsymbol{\tau_{\theta_2}}}. \tag{15}$$

$F_{(i,t)}$ indicates the firm in which worker i was employed in period t, and $iF(i,t)$ the job match at which worker i was employed in period t.

[14] To avoid semantic confusion we shall refer to the job match fixed effect as the sum of the worker, firm and match quality fixed effects.

[15] In estimating the high-dimensional fixed effect regression models, we employed the Stata ado file *reghdfe* (Correia, 2016).

The interpretation of this equation is that we can split the union wage gap into two components: the job match component ($\widehat{\boldsymbol{\tau_{\phi_2}}}$) and the job-title component ($\widehat{\boldsymbol{\tau_{\theta_2}}}$). In practice, all we need to do is to run a regression for each type of fixed effects on all regressors of the benchmark regression (X and U) and extract the union density regression coefficient estimates.

To further disentangle the impact of worker self-selection, sorting among firms with different wage policies, and the allocation into job matches with distinct match quality, it is not necessary to obtain explicitly the estimates of the match quality fixed effects. All that is needed is to obtain the estimates from the following regression model:

$$\mathbf{Q}\widehat{\boldsymbol{\phi_2}} = \mathbf{X}\widehat{\boldsymbol{\zeta}} + \mathbf{D}\widehat{\boldsymbol{\Omega}} + \mathbf{F}\widehat{\boldsymbol{\Lambda}} + \mathbf{U}\widehat{\boldsymbol{\tau_\mu}} + \widehat{\boldsymbol{\nu}}, \tag{16}$$

which is no more than a regression of the job match fixed effects on the union variable, accounting for the covariates ($\mathbf{X}$), the worker fixed effects ($\mathbf{D}\widehat{\boldsymbol{\Omega}}$), and the firm fixed effects ($\mathbf{F}\widehat{\boldsymbol{\Theta}}$). $\widehat{\boldsymbol{\nu}}$ is a residual term. Now, the union coefficient $\widehat{\boldsymbol{\tau_\mu}}$ provides the estimate of the match quality component of the union wage gap.

Equivalently, $\widehat{\boldsymbol{\tau_\mu}}$ can be compactly presented, making use of the omitted variable bias formula:

$$\widehat{\boldsymbol{\tau_\mu}} = \mathbf{A_Z}\mathbf{Q}\widehat{\boldsymbol{\phi_2}}, \tag{17}$$

where $\mathbf{Z} = [\mathbf{XDF}]$, making it explicit that we are now adding the worker and the firm fixed effects. It is also made transparent that we do not need to spell out the match quality fixed effect contained in $\mathbf{Q}\widehat{\boldsymbol{\phi_2}}$. Proceeding in this way, we avoid the need to make any assumption regarding the manner in which the match quality fixed effect is related to the worker and the firm fixed effects.[16]

[16] In practice, this decomposition can also be achieved by simply comparing the union density effects in the full regression model (9) with the union density effects of a regression model that, instead of the job match fixed effects, includes the worker and the firm fixed effects. This equivalence was first noted by Figueiredo et al. (2014).

Once we obtained the estimates from equation (17), the firm sorting component of the union wage gap loss can be obtained as:

$$\widehat{\boldsymbol{\tau}_{\boldsymbol{\lambda_2}}} = \mathbf{A_X F \widehat{\Lambda}}, \tag{18}$$

which is simply the outcome from a regression of the firm fixed effects on the union variable, controlling for the explanatory variables included in the benchmark specification [**X**].

Finally, the role of worker productivity (as proxied by the worker fixed effect) driving the union wage gap, can be residually obtained as $\widehat{\boldsymbol{\tau}_{\boldsymbol{\alpha_2}}} = \widehat{\boldsymbol{\tau}_{\boldsymbol{\phi_2}}} - \widehat{\boldsymbol{\tau}_{\boldsymbol{\lambda_2}}}$, or, more directly as:

$$\widehat{\boldsymbol{\tau}_{\boldsymbol{\alpha_2}}} = \mathbf{A_X D \widehat{\Omega}}. \tag{19}$$

5 Main Findings

5.1 The Union Wage Gap Curve for Total Earnings

In Portugal evidence of sizable wage differentials associated with a firm's degree of unionization is unmistakable, despite the fact that near every worker benefits from union bargaining. For example, the heuristic distributions of the logarithm of total hourly wages shown in Figure 1 display meaningful differences in both shape and mean when unionized and non-unionized workplaces are considered.[17]

[17]The values of zero and greater than zero were chosen because of the large plurality of firms without union members.

Table 1: OLS Estimation of the Union Wage Gap for Total Monthly Wages

Variable	Linear Specification	Polynomial Specification
Union density	0.1619	−0.3844
	(0.0139)	(0.0845)
Union density squared	-	1.9030
		(0.3083)
Union density cubed	-	−1.4400
		(0.2371)
Worker's age	0.0281	0.0282
	(0.0003)	(0.0004)
Worker's age squared	−0.0002	−0.0002
	(0.0000)	(0.0000)
Tenure of the worker	0.0156	0.0156
	(0.0003)	(0.0003)
Tenure of the worker squared	−0.0002	−0.0002
	(0.0000)	(0.0000)
Female	−0.2108	−0.2107
	(0.0019)	(0.0019)
Primary school	0.1257	0.1257
	(0.0014)	(0.0014)
Basic school	0.2377	0.2377
	(0.0017)	(0.0017)
Elementary school	0.3612	0.3612
	(0.0021)	(0.0021)
Secondary school	0.5009	0.5009
	(0.0025)	(0.0025)
Post-secondary school	0.6488	0.6488
	(0.0047)	(0.0047)
University attendance	0.8973	0.8973
	(0.0029)	(0.0029)
College degree	1.0397	1.0397
	(0.0036)	(0.0036)

Table 1 (cont.)

Variable	Linear Specification	Polynomial Specification
Firms with 50 to 99 employees	0.1526	0.1526
	(0.0010)	(0.0010)
Firms with 100 to 499 employees	0.2162	0.2162
	(0.0014)	(0.0014)
Firms with 500 to 999 employees	0.2690	0.2690
	(0.0041)	(0.0041)
Firms with 1000 to 4999 employees	0.2992	0.2992
	(0.0052)	(0.0052)
Firms with more than 5000	0.2521	0.2521
	(0.0093)	(0.0093)
R^2	0.5373	0.5375

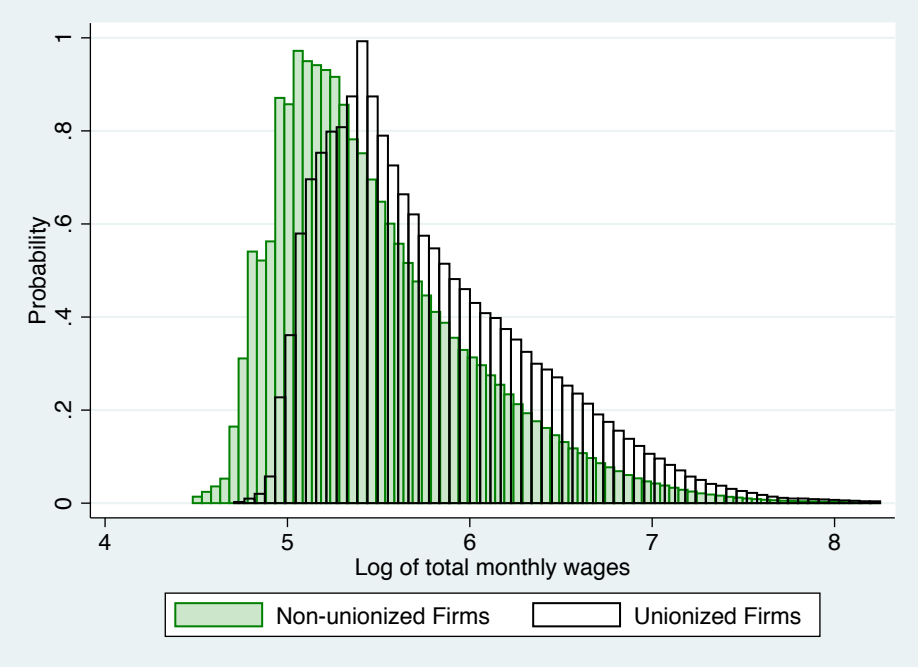
Notes: Dependent variable: total monthly wages (in logs). The controls also include 25 sector of activity dummies, and 3 year dummies. The number of observations is 36,616,379. Robust clustered firm-year standard errors are in parentheses: all coefficients are statistically significant at the 0.01 confidence level.
Source: Relatório Único, 2010-2013.

This stylized fact is confirmed by our benchmark results presented in Table 1 which chart the impact of union density on wages after having controlled for the full set of observed worker and firm characteristics, as described in section 4. For the linear specification given in the first column of the table, the estimated union wage gap is 17.6 percent $[(e^{0.1619}-1)\times 100]$; a sizable union wage differential that is either on a par with or exceeds, U.S. estimates.[18] This wage gap is to be interpreted in the following way: it represents the wage difference between two identical workers, one of whom

[18]See the early studies of Blanchflower and Bryson (2003), and Hirsch (2004); and, especially, the more recent plant-level studies of Frandsen (2012) and Lee and Mas (2012).

is employed in a fully unionized firm and the other in an otherwise identical non-unionized firm.

Figure 1: Distribution of Total Monthly Wages by Union Status



Source: Relatório Único, 2010-2013.

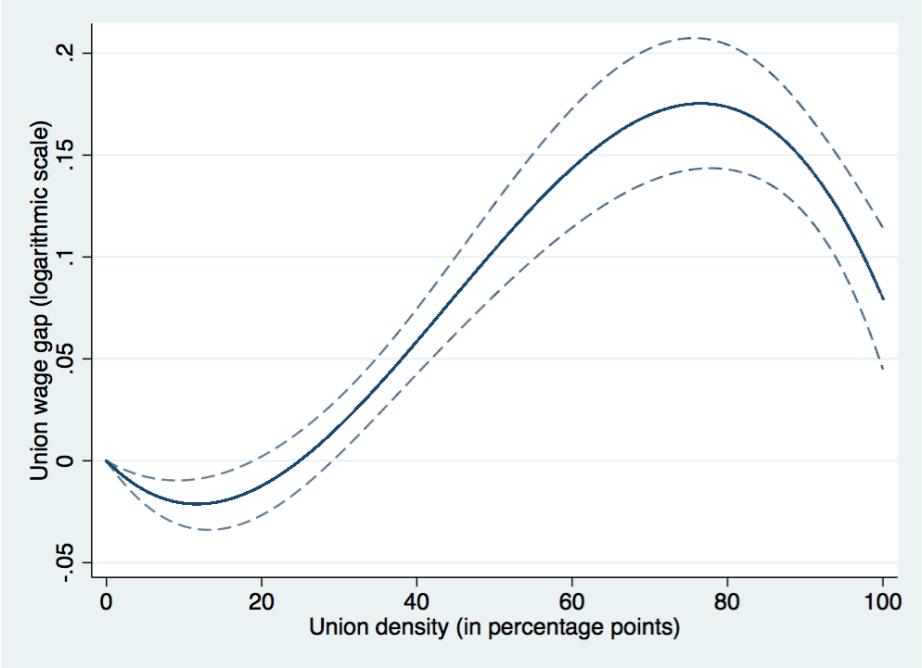
The preceding methodology implies that the value of the union wage gap for each point in the continuum of union density is determined by and conforms to a linear relationship. However, an important issue is whether the marginal change in the union wage gap is in fact the same when a newly unionized worker joins a union-free workforce as opposed to a situation in which, say, a plurality of workers is organized. In seeking to estimate a union wage gap without assuming constant marginal effects throughout, we shall follow the two procedures described earlier to estimate the union wage

gap curve.

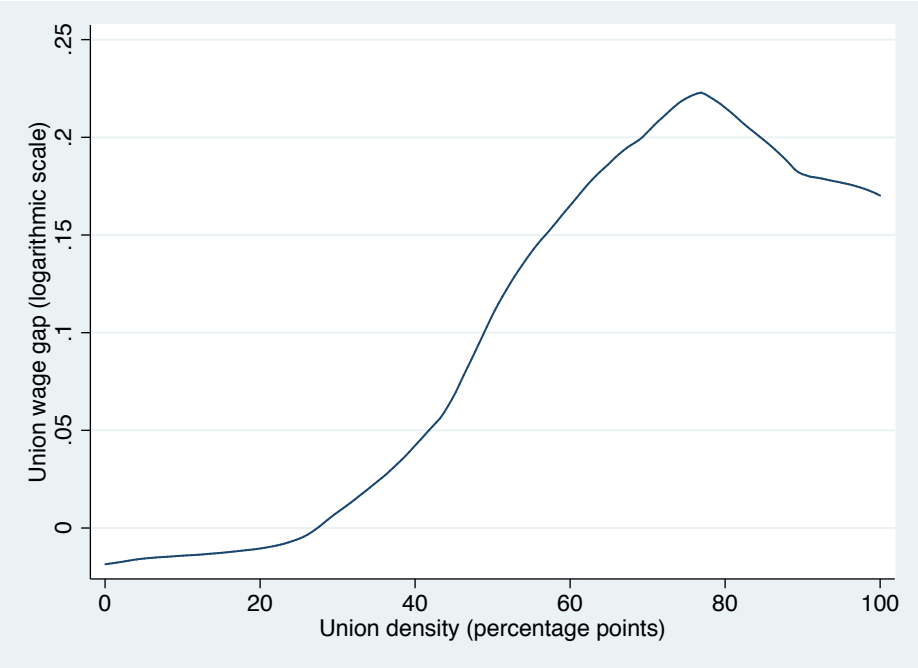
These estimates are shown in Figure 2. Clearly, the linear approach is misleading; in particular, unions need some critical mass (of unionized workers) in order to materially influence wages. Panel A of the figure is based on a third-degree polynomial function and indicates that union density attains statistical significance at around 30 percent, with a maximum wage gap of 17 log points being achieved once union density reaches approximately 70 percent (see also the first three rows of the second column of Table 1). Panel B of the figure, which gives the more flexible kernel smoother, shows that although the polynomial is a sensible parsimonious approximation to the wage gap curve it understates the peak premium (now in excess of 24 log points) and overstates the decline in the premium thereafter.

Figure 2: The Union Wage Gap Curve for Total Monthly Wages

Panel A



Panel B



Notes: The base model includes as regressors a quadratic term in age, a quadratic term in tenure, schooling dummies (10), a gender dummy, firm size dummies (5), and sector dummies (25). Robust clustered firm-year standard errors were used. In Panel A, the 95 percent confidence interval is indicated.
Source: Relatório Único, 2010-2013.

The explanation for the robust evidence on the importance of union density to wage setting has to do with the intensive margin of representation. The mere realization that a bargaining instrument covers a given worker does not seem to shed sufficient light on the properties of an agreement, namely the specific environment in which it was agreed. Moreover, wage setting is not identical for every covered worker, and firms do not have a homogeneous approach to compensation policies, irrespective of union presence, either at firm or sectoral level.

The importance of considering the intensive margin is also implicit in the shape of our union wage gap curves. A plausible explanation for the configuration of the fitted curves relies on the idea that the bargaining power of a union is a function of its ability to credibly threaten the employer through a withdrawal of labor (e.g. Farber, 1986). It is reasonable to assume that unions need some minimum complement of unionized workers to effectively impose costs on the employer in the event of a failure to agree. With a preponderance of the workforce organized, the capability to impose a total shutdown is implied, such that further increases in union density are not to be equated with higher union wage premia.

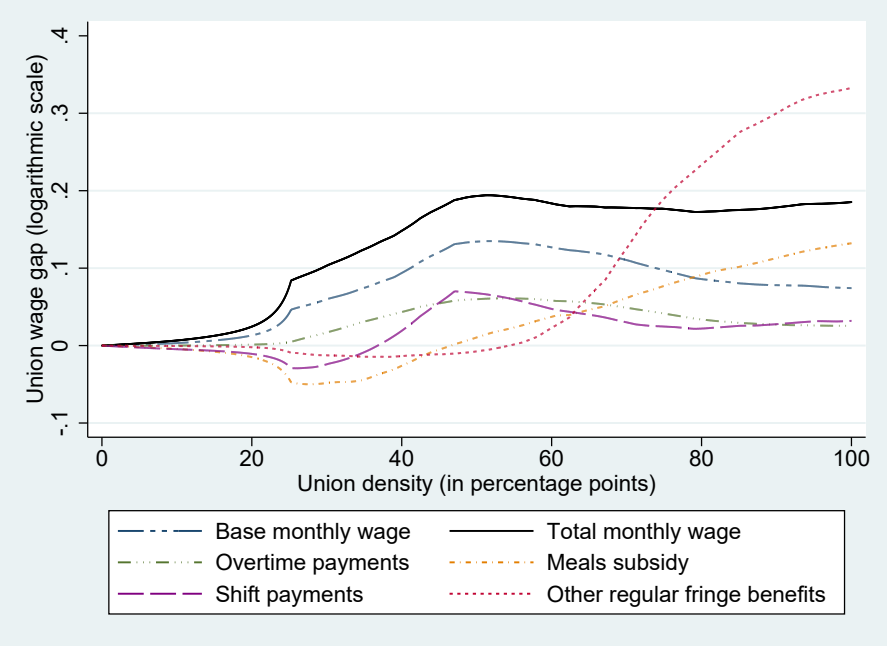
5.2 Union Wage Gap Curves by Component of Total Earnings

The total monthly compensation of a worker can be divided into several components. One part of a worker's compensation is a function of working time and the work schedule. Thus, the worker receives a fixed monthly wage (called the 'base wage'), namely monthly compensation for the normal work period. As appropriate, there are also overtime or shift payments. Workers are also commonly entitled to fringe benefits. For example, by law, a worker is entitled to a fixed daily meals allowance for each day worked. Additionally, there are other more diffuse regular fixed fringe benefits, which may include a job seniority bonus (*diuturnidades*), employer contributions to employees' private pension plans, health insurance, and even child allowances. In addition to the above components of regular compensation, workers may also be entitled to productivity bonuses that are ordinarily distributed once a year.

For 2010, which is the only year for which we have detailed information on these earnings categories, we can construct a series of union wage gap curves for the components of a workerâs regular compensation, using the kernel regression methodology. Five such additional curves are constructed in Figure 3. Our breakdown of monthly compensation distinguishes between the base wage, overtime pay, shift pay, the meals subsidy, and other regular

fringe benefits received. The wage gap for the total monthly wage, described earlier, is broadly supported by the pattern of differentials obtaining for each component of the workerâs regular compensation, but it is elevated in the case of fringe benefits that are not related to working time. In a material sense, these payments are the same for a sizable share of workers in the firm, irrespective of their job titles. For example, the meals subsidy is often of an equal amount per worker, while for their part the tenure-related payments that represent a major share of the other regular fringe benefits are more a function of job tenure than of job-title.

Figure 3: The Union Wage Gap Curve, by Component of Total Monthly Wages



Notes: The union wage gap *curve* for total compensation differs slightly from that presented earlier in Figure 2, because the present figure contains information only from the 2010 wave of the Relatório Único whereas Figure 2 uses information from the 2010-2013 waves.
Source: Relatório Único, 2010.

As far as the share of compensation linked to working time and the work schedule is concerned, it is noticeable that both elements contribute to a reduction in the union wage gap soon after or even before union density encompasses a majority of the workforce. By comparison with the fringe benefits unrelated to working time, this latter tendency suggests a union preference away from working-time related compensation toward non-working-time related compensation. Thus, when capable of exerting a meaningful influence on the firm's compensation policy, unions seemingly prefer to acquire sizable wage differentials in those components of compensation that by default are equal for every worker, even as they countenance a reduction of wage gaps in the other components of compensation. This finding is consistent with the canonical evidence that wage differentials for variables such as age and education are smaller in more heavily unionized environments.

Furthermore, this reshuffling of the firm's compensation policy is likely not unrelated to the tax environment. For the United States, Felix and Hines (2009) have reported that unions and firms take taxation into account in their negotiations, in effect bargaining over the distribution of potential tax savings. Portuguese tax policy has typically favored certain fringe benefits over wages. Even if this more favorable tax treatment[19] has been diluted in the contemporary era of crises, it nevertheless has served to pull the bargaining parties in a direction allowing for tax optimization on the part of firms. Therefore, as Rees (1960) noted long ago, unionization and preferable tax treatment are engines behind the increasing share of private supplements in workers' compensation.

5.3 The Sources of the Union Wage Gap for Total Earnings

The union wage gap for total earnings that we have estimated constitutes an average differential between the wages of two observationally identical

[19]For example, the meals subsidy is not taxed below a certain daily rate, while private health insurance plans and private retirement schemes that complement social security are subject to special exemptions.

workers in two observationally identical firms with distinct levels of unionization. What are the potential sources of this sizable union wage gap? As leading contenders, we next consider the contributions of heterogeneity in the compensation policies of firms, the rules governing how the workforce is assigned to the compensation tables of the collective agreement, and the allocation of workers of different unobserved ability.

In principle, the conditional influence of unions on earnings compensation can arise from other sources than these. However, to anticipate one of our key findings, we report that after accounting for firm, job-title, and worker fixed effects the portion of the union wage gap remaining to be explained is vestigial, even when an alternative specification to accommodate potential job-match quality effects is considered. This is the case for both the linear approach and the fitted union wage gap curve. In decomposing the union wage gap, therefore, our focus will be upon the contributions of each of these three sources of unobserved heterogeneity. In what follows, the major difference between the two (decomposition) approaches resides in the flexibility of the estimates, namely the improved estimation offered by the union wage gap curve over the restrictive linear approach.

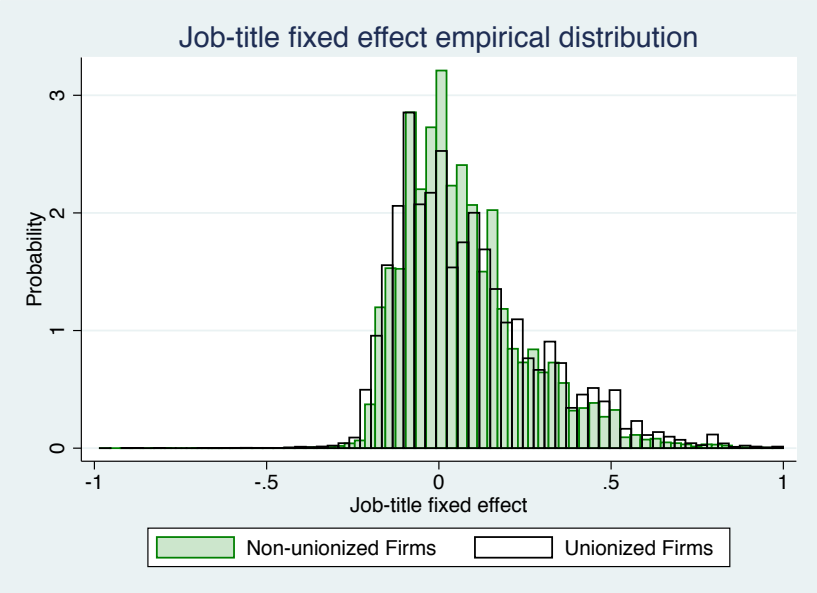
Job title refers to the worker's assigned role at the firm, as explicitly defined in the collective sectoral agreement governing the employment relationship. This defined "occupation" most importantly determines a floor for the base wage that a worker is legally entitled to receive. Note that the base wage set at sectoral level (which we call the *bargained wage*) does not necessarily equal the actual base wage paid by the firm. Indeed, a majority of firms pay more than the bargained wage. The difference between the base wage and the base wage floor or bargained wage is determined at firm level.

Thus, the job-title fixed effect summarizes the influence of the compensation floor defined for each worker. Note that under this definition of job title, two workers with the same job description (i.e. performing the same tasks and having the same responsibilities) covered by different bargaining

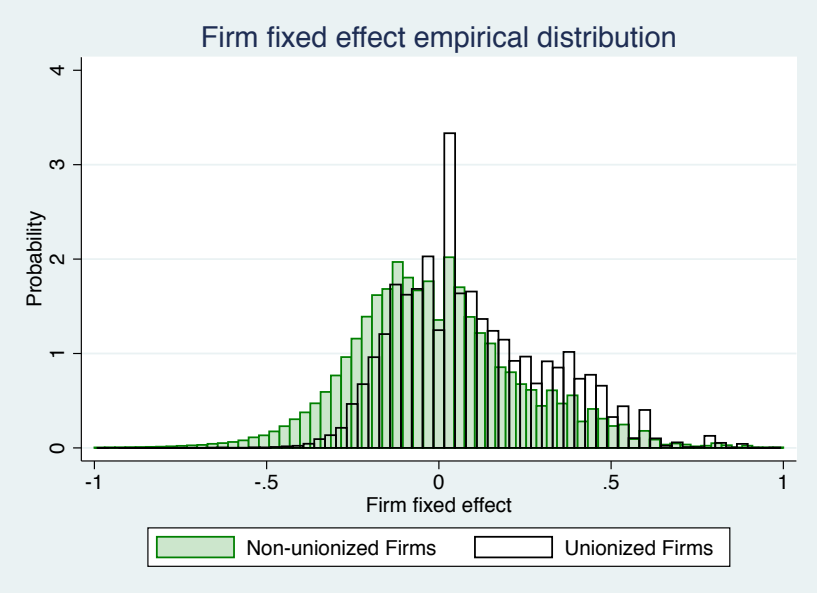
arrangements will often have different job-titles. There results a (very) disaggregated set of occupations (as noted earlier, around 30,000 according to Martins, 2014), when every collective bargaining instrument is considered. The inclusion of job-title fixed effects may be viewed as building upon a first generation Mincerian wage equation that recognizes only a broad definition of job descriptions.

Figure 4: Distribution of Worker, Firm, and Job-title Fixed Effects by Union Status

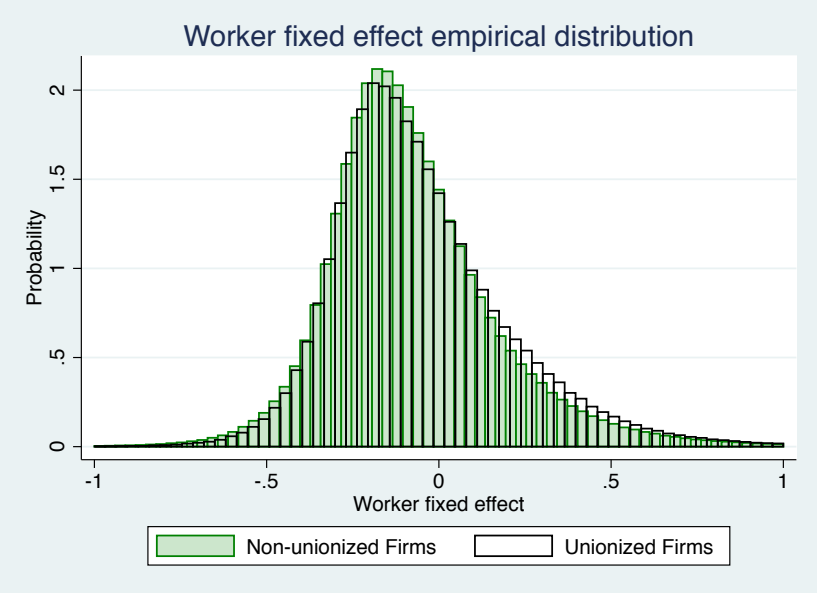
Panel A



Panel B



Panel C



Notes: In addition to the fixed effects, the model includes as regressors a quadratic term in age, a quadratic term in tenure, schooling dummies (10), a gender dummy, firm size dummies (5), and sector dummies (25).
Sources: Quadros de Pessoal 1986-2009; *Relatório Único*, 2010-2013.

Panel A of Figure 4 shows the empirical distribution of the job-title fixed effects, contrasting workers in 'union' firms with their counterparts in 'nonunion' firms. For the former, the distribution of job-title fixed effects is visibly displaced to the right. The implication is that that better-paid job titles tend to be more heavily populated by workers of unionized firms (after taking into account firm and worker heterogeneity).

For its part, the firm fixed effect captures the (constant) wage policy of the firm, including the relative standing of the firm's wage tables, after having controlled the placement of workers into the distinct job categories presented in such tables which fully captures the previously discussed job-title fixed effect. Firms with generous compensation policies will exhibit positive firm fixed effects, while firms with compensation policies close to the bargained wage will generate negative fixed effects. In Panel B of Figure 4 we contrast the distribution of the firm fixed effects for workers in union and nonunion firms.[20] Clearly, unionized workers disproportionately populate high-paying firms.

Finally, the empirical distribution of the worker fixed-effects is presented in Panel C of Figure 4. The worker fixed effects capture the influence of the constant characteristics of individuals on their wages. They are essentially a proxy for the portable human capital (or productivity) of the worker. The pattern revealed is one in which more unionized firms seemingly employ relatively more skilled individuals. This outcome can be the result of observed characteristics (such as schooling or gender) or unobserved factors (ability), and we shall subsequently address the specific role of the latter.

[20] Observe, however, that in this comparison the influence of variables such as industry or firm size is still subsumed in the firm fixed effect. The subsequent Gelbach decomposition will enable us to filter out the impact of the firm fixed effect on the wage gap from the variable included in the benchmark specification.

Table 2: The Conditional Decomposition of the OLS Estimation of the Union Wage Gap for Total Monthly Wages

Variables	Base Model (γ_0)	Full Model (γ_1)	Gelbach Decomposition
Union Wage Gap	0.1619***	−0.0024	–
	(0.0139)	(0.0060)	
τ_{α_1} (Worker FE)	–	–	−0.0039
			(0.0033)
τ_{θ_1} (Job-title FE)	–	–	0.0541***
			(0.0103)
τ_{λ_1} (Firm FE)	–	–	0.1139***
			(0.0080)
R^2	0.5373	0.8801	

Notes: Decomposition based on Gelbach (2016). Robust clustered firm-year standard errors are in parentheses: ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. The base model includes as regressors a quadratic term in age, a quadratic term in tenure, schooling dummies (10), a gender dummy, firm size dummies (5), and sector dummies (25). The number of observations is 36,616,379.
Sources: Quadros de Pessoal 1986-2009; *Relatório Único*, 2010-2013.

Table 2 presents the results of the Gelbach decomposition for the linear specification. The coefficient estimate contained in the first column of the table simply recalls the estimated union wage gap (of 16.2 log points) obtained from equation (1) and reported earlier in Table 1. The estimated union wage gap, after the inclusion of the three high dimensional fixed effects (equation (5)), is no longer statistically significant and is given in the second column of the table (-0.24 log points). The third column provides the contribution of each fixed effect to the change in the estimated union

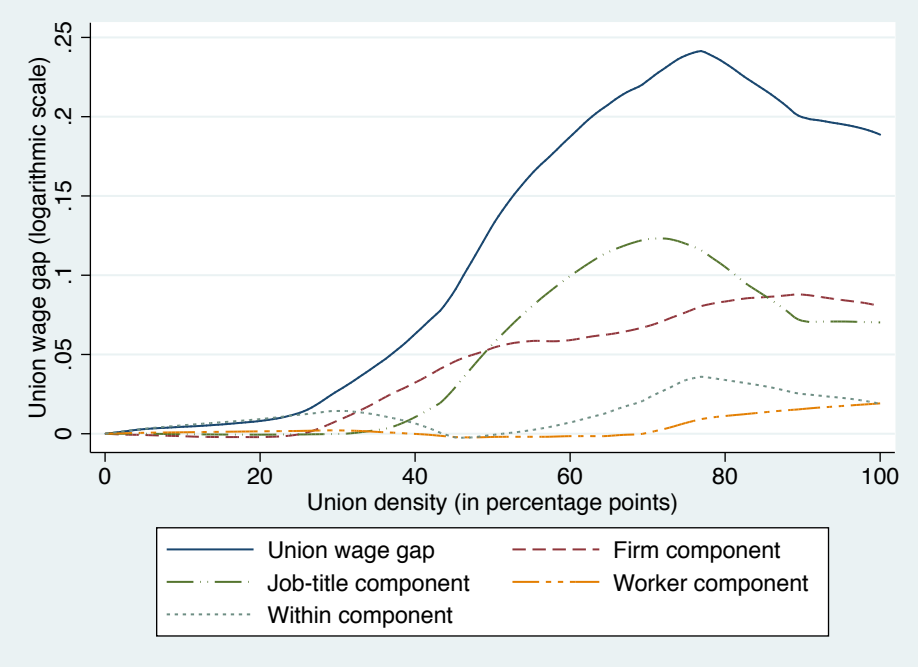
wage gap (equation (10)).[21] The differences in firms' compensation policies explain a large fraction of the union wage gap. After accounting for the observable characteristics of the worker and the firm, the constant unobserved characteristics of workers, and the process of job-title placement, the worker compensation policies of firms are responsible for 11.4 log points of the union wage gap of some 16.2 log points. Put differently, if every worker was faced with a neutral stance of his or her firm regarding its compensation policies, the union wage gap would be reduced by about 70 percent.

Next, consistent with the evidence provided in Panel A of Figure 4, we find that the allocation of workers into job titles â either directly, or indirectly through promotion decisions, contributes 5.4 log points (or another 33.3 percent) of the estimated union wage gap. Implicitly, therefore, trade unions achieve real success in either creating or in placing their members into higher paying job categories.

Turning to the worker dimension, and after accounting for observable traits as well as their sorting into firms and job-titles, it can be seen that individuals working in a fully-unionized firm receive compensation for their permanent unobserved characteristics that is estimated to be just 0.4 log points lower than in the case of a non-unionized firm. But to all intents and purposes there are no statistically significant differences between unionized and non-unionized workers in terms of (unobserved) ability.

[21] In practice, as presented before, the application of the Gelbach decomposition in the current framework amounts to running three auxiliary OLS regressions identical to equation (1), but where the dependent variable is successively replaced by the corresponding estimated fixed effects. By construction, this decomposition is both exact (being the sum of the contributions corresponding to the difference between the two union wage gap estimates) and unambiguous.

Figure 5: The Gelbach Decomposition of the Union Wage Gap Curve for Total Monthly Wages



Sources: Quadros de Pessoal, 1986-2009; *Relatório Único*, 2010-2013.

Estimates of the Gelbach decomposition of the union wage gap curve obtained from the kernel regression (equations (3) and (11)) are depicted in Figure 5. The figure broadly confirms the principal result of the linear approach, namely the leading roles reserved for job titles and the compensation policies of firms (viz. the job-title and firm fixed effects). The flexibility of this approach indicates that the major source of non-linearity stems from the job-title component. Also, the figure provides a more informative picture of the sources of the union wage gap: in particular, the assignment of workers to job titles reveals that there is a zone or a relevant region of union densities (roughly between 50 and 85 percent) where its contribution to the wage gap is elevated, reaching almost 12.5 log points. However, once

again, worker unobserved heterogeneity plays no role, irrespective of union density. Note, finally, that the part of the union wage gap remaining after having allowed for the three high dimensional fixed effects, and identified in the figure as the 'within component,' is essentially zero up to 70 percent density after which it increases to only a little over 2 log points at 100 percent density.

Table 3: The Conditional Decomposition of the OLS Estimation of the Union Wage Gap for Different Model Specifications

Variables	Base Model (γ_0)	Full Model (γ_1)	Gelbach Decomposition
Standard Model			
Union Wage Gap	0.1619***	−0.0024	–
	(0.0139)	(0.0060)	
τ_{α_1} (Worker FE)	–	–	−0.0039
			(0.0033)
τ_{θ_1} (Job-title FE)	–	–	0.0541***
			(0.0103)
τ_{λ_1} (Firm FE)	–	–	0.1139***
			(0.0080)
R^2	0.5373	0.8801	
Standard Model without Firm Size and Sector Dummies.			
Union Wage Gap	0.4216***	−0.0201	–
	(0.0159)	(0.0052)	
τ_{α_1} (Worker FE)	–	–	0.0071
			(0.0044)
τ_{θ_1} (Job-title FE)	–	–	0.0096***
			(0.0070)
τ_{λ_1} (Firm FE)	–	–	0.4251***
			(0.0094)
R^2	0.4442	0.8799	

Table 3 (cont.)

Variables	Base Model (γ_0)	Full Model (γ_1)	Gelbach Decomposition
Standard Model without Education, Firm Size and Sector Dummies.			
Union Wage Gap	0.6643***	−0.0184	–
	(0.0303)	(0.0080)	
τ_{α_1} (Worker FE)	–	–	0.0691***
			(0.0072)
τ_{θ_1} (Job-title FE)	–	–	0.1502***
			(0.0173)
τ_{λ_1} (Firm FE)	–	–	0.4632***
			(0.0141)
R^2	0.2044	0.8797	

Notes: Decomposition based on Gelbach (2016). Robust clustered firm-year standard errors are in parentheses: ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. The standard model includes as regressors a quadratic term in age, a quadratic term in tenure, schooling dummies (10), a gender dummy, firm size dummies (5), and sector dummies (25). The number of observations is 36,616,379.
Sources: Quadros de Pessoal, 1986-2009; *Relatório Único*, 2010-2013.

Given the previous discussion, one might be misled into concluding that the worker dimension and to a much lesser extent the job-title dimension are largely absent from the process of union wage gap formation precisely because union membership is collected at firm level. If this were the case, it would induce an artificial mechanical relationship between union membership and the firm fixed effect, capable of obscuring the true influence of the other two components. To address this concern, Table 3 offers alternative sets of observable controls to test for the presence of such a relationship that would rule out any sizable role for job-title and/or worker heterogeneity irrespective of the specification considered.

We first consider in the broad middle row of the table a specification

that removes the firm size and sector dummies. It is apparent that firm size and sectoral affiliation are strongly associated with union density. That is to say, the union wage gap would increase to 42.2 log points if those controls were absent. Firm fixed effects, of course, largely absorb the role of firm size and industry. For its part, worker unobserved ability still plays a negligible role. A different story is told when controls for education are excluded in the bottom panel of the table. Because unionized workers in Portugal tend to be better educated, the union wage gap increases to 66.4 log points, which change will be mainly captured by the worker fixed effect (whose contribution is now 6.9 log points), and also by the job-title fixed effect (15 log points).

Thus, while setting the union wage gap ignoring the observed heterogeneity of workers (and their working environments) would bias the results, the especial relevance of the above exercise is that it demonstrates that the dominance of the firm fixed effect is not a mechanical contrivance. Indeed, the heterogeneity in firm compensation policies is the leading explanation of the estimated union wage gaps.

5.4 The Role of Match Quality in (Not) Driving the Union Wage Gap

Having established that there is no indication that high wage (high productivity) workers select themselves into more unionized firms — despite the fact that high-paying firms tend to be more unionized — there remains the question of whether trade unions may nevertheless promote better job matches. This outcome may result from the role of trade unions as a *voice* of worker concerns and aspirations. Alternatively, it may occur as a reaction on the part of the firmâs managers to the threat of unionization.

In other words, we can speculate whether unionized workplaces are characterized by more productive worker-firm specific combinations; that is, represent higher match quality. To investigate this issue, we expanded our regression model to include a job match fixed effect (see equation (14)).

This job match effect is to be seen as combining the worker, firm, and match quality components. An initial and rather transparent signal that the match quality effect does not in fact play a significant role is given by the fact that the regression coefficient estimate of the union density variable changes very little (see Table 4). If we were to assume that the match quality component is orthogonal to the worker and firm fixed effects, the difference between the coefficient estimates (-0.0041 as compared with -0.0031) could be fully attributed to match quality. Be this as it may, the contribution of match quality is a negligible, and statistically insignificant, 0.1 log point.

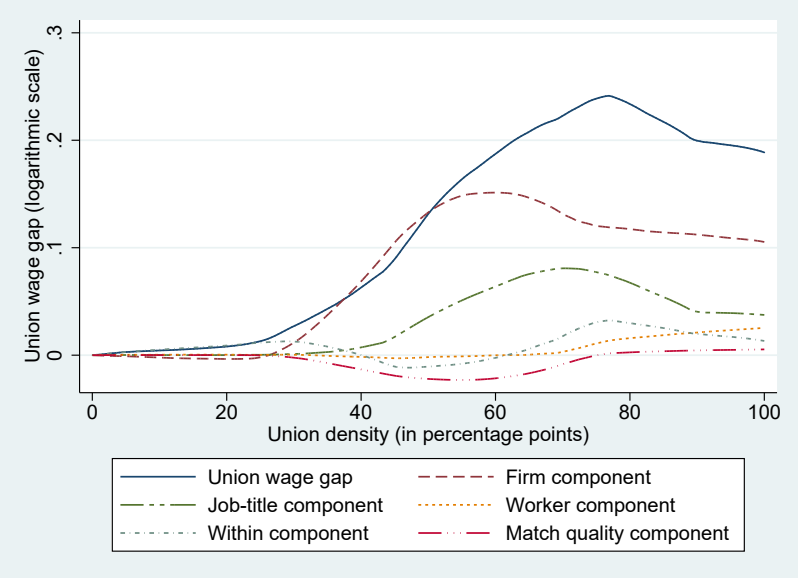
Table 4: The Conditional Decomposition of the OLS Estimation of the Union Wage Gap for Total Monthly Wages, Having Introduced a Match Quality Component

Variables	Base Model (γ_0)	Full Model (γ_1)	Full Model (γ_2)	Gelbach Decomposition
Union Wage Gap	0.1624***	−0.0031	−0.0041	–
	(0.0139)	(0.0060)	(0.0066)	
τ_μ (Match Quality FE)	–	–	–	−0.0000
				(0.001)
τ_{θ_1} (Job-title FE)	–	–	–	0.038***
				(0.0079)
τ_{λ_1} (Firm FE)	–	–	–	0.1306***
				(0.0076)
τ_{α_1} (Worker FE)	–	–	–	−0.0022
				(0.0039)
R^2	0.5372	0.8800	0.9121	

Notes: Decomposition based on Gelbach (2016). Robust clustered firm-year standard errors are in parentheses: ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. The base model includes as regressors a quadratic term in age, a quadratic term in tenure, schooling dummies (10), a gender dummy, firm size dummies (5), and sector dummies (25). The number of observations is 36,577,017.
Sources: Quadros de Pessoal, 1986-2009; *Relatório Único*, 2010-2013.

If, on the other hand, we rely on the more natural decomposition of the match fixed effect given by equation (16), the role of match quality in driving the union wage gap goes to zero. This is not to say that match quality plays no role in driving wages. Indeed, the presence of the match quality increases the explained coefficient of determination of the wage regression from 0.88 to 0.91. What these results tell us is that the match quality mechanism does not operate through the presence of trade unions. Not surprisingly, in comparing Tables 2 and 4, the presence of the match quality in the wage regression does not materially alter the relative contribution of the firm, worker and job-title fixed effects. If anything, the importance of sorting into firms is slightly reinforced (from 11.3 to 13.1 log points) and the relevance of allocation into job titles weakens slightly (from 5.4 to 3.8 log points). The worker self-selection effect remains negative and very small (changing from −0.4 to −0.2 log points).

Figure 6: The Gelbach Decomposition of the Union Wage Gap Curve for Total Monthly Wages Having Introduced a Job Match Component



Sources: Quadros de Pessoal, 1986-2009; *Relatório Único*, 2010-2013.

As before, the graphical representation of the decomposition of the union wage gap given in Figure 6 shows that the effect of unionization is far from being linear in union density. The graph also shows that the contribution of match quality to the union wage gap is either zero or negative. Sorting into firms with more generous wage policies clearly now plays now a more pivotal role in comparison with sorting into differently paying job titles.

6 A Peek Inside the Mechanisms of Wage Setting

In a complementary exercise, so as to better understand the role of trade unions in Portugal, we now split total compensation into two components, namely the bargained wage and the wage cushion.

The bargained wage is the base wage floor as defined in the relevant collective agreement for the worker job title. For its part, the wage cushion corresponds to the difference between the total compensation and the bargained wage. As information on bargained wages is not contained in the dataset, we follow the methodology proposed in Cardoso and Portugal (2005), and define the bargained wage as the mode of the actual base wage within each year and job-title.[22] The wage cushion has two components. The first is simply the difference between the actual base wage and the bargained wage, as firms often pay a base wage above the bargained wage. The second component is the sum of the wage supplements received by the worker, such as those described earlier (see Figure 3).

We shall estimate two separate wage regressions, one for the (log) bargained wage and the other for the (log) wage cushion, where the wage cushion is expressed in relative terms.[23] A useful way to look at the bargained

[22] Having documented contractual wages in three industries employing around 10 percent of full-time workers in manufacturing and services, these authors show that the mode of the wage distribution of the base wage for each worker category within each collective agreement matches quite well the mandatory floors for each job-title at collective bargaining level.

[23] Formally, $W_{Total} = W_{Bargained} \times \frac{W_{Total}}{W_{Bargained}} = W_{Bargained} \times W_{cushion}$. After a logarithmic transformation, we have $log(W_{Total}) = log(W_{Bargained}) + log(W_{Cushion})$.

wage regression is to think of an artificial exercise in which all workers collect the enacted wage floor, corresponding to their job titles, as signed in the applicable collective bargaining, and no more. On this basis, and as shown in Table 5, the union wage gap would amount to 28.36 log points.

Table 5: Estimation of the Union Wage Gap for Total Monthly Wages, the Bargained Wage, and the Wage Cushion

Dependent variable	Base Model	R^2
Total Compensation	0.1619	0.5373
	(0.0139)	
Bargained Wage	0.2836	0.5095
	(0.0173)	
Wage Cushion	−0.1218	0.0994
	(0.0115)	

Notes: Robust clustered firm-year standard errors are in parentheses: all coefficients are statistically significance at 0.01 confidence level. The base model includes as regressors a quadratic term in age, a quadratic term in tenure, schooling dummies (10), a gender dummy, firm size dummies (5), and sector dummies (25). The number of observations is 36,616,379.
Sources: Quadros de Pessoal, 1986-2009; *Relatório Único*, 2010-2013.

At first glance, this may seem a puzzling result, as the union wage gap for total monthly wages is only 16.19 log points, while that for the wage cushion is negative and -12.18 log points. Similar results are obtained when union wage gap curves are estimated, as demonstrated in Figure 7. Here the union wage gap curve for the bargained wage attains levels of more than 30 log points when the large majority of the workforce is unionized, while the corresponding curve of the wage cushion declines up to minus 12 log points. What is going on here is that the union wage gap for total compensation hides the opposing effects of the two wage components.

Figure 7: The Union Wage Gap Curve for Total Monthly Wages, the Bargained Wage, and the Wage Cushion

Source: Relatório Único, 2010-2013.

The sizable union wage gap of the bargained wage is not surprising, as unions naturally seek to lock in a significant share of their gains through the mandatory dispositions of collective agreements. Thus, where collective agreements are signed in sectors with highly unionized firms, signifying enhanced union bargaining power, unions may be expected to succeed in securing higher base wage floors (bargained wages). Our results in the form of a negative union gap for the wage cushion gap do indeed suggest that the wage cushion is deployed by firms to attenuate the bargained wage gap. It follows that the union wage gap for total compensation is lower than that for the bargained wage. This compression may result from either lower wage supplements or by smaller drift between the actual base wage and the bargained wage floor. In other words, in high union density environments, union success in raising the bargained wage limits the ability of firms to pay

base wages in excess of bargained wages. In branches where trade unions are weaker, however, relatively low bargained wages offer scope for local improvement.

7 Conclusions

This paper has shown that in a regime of near-universal collective bargaining coverage one may nevertheless discern sharp union wage gaps due to the heterogeneous influence of unions in covered settings. Using linear and nonlinear models, we have provided estimates of the union density wage gap for total monthly earnings that top out at approximately 24 log points. Our preferred non-linear specification indicates not only that unions need to attain some critical mass to materially influence wages but also that that beyond some level further increases in union density do not add to a union's ability to credibly threaten the employer with a withdrawal of labor.

To better understand the collective bargaining process, we further investigated the union wage gap by first distinguishing between the base wage, regular wage supplements, and working-time related payments and then, in a separate section of the paper, between the mandatory and flexible components in the form of the bargained wage and the wage cushion. The former exercise suggested inter al. that unions prefer to acquire sizable differentials in those areas of compensation that by default are equal for every worker. The latter exercise indicated a peak union premium for the bargained wage that was considerably higher than for total earnings. More highly unionized firms are to be envisioned as not only increasing the total compensation of workers but also as diverting in a more significant manner part of the compensation to its mandatory component. That being said, as the association between union density and the wage cushion is in fact negative, less unionized firms have at the same time been able to exploit the opportunity to tailor wages at local level more to their individual circumstances and the attributes of their workers.

The second principal contribution of the paper has been to consider the

sources of the wage gap for total earnings. Our three-fixed-effects model evaluated the contributions of worker productivity, the occupational distribution of workers, and the wage policies of firms to the union wage gap. That is, the analysis accommodates worker heterogeneity, job-title heterogeneity, and unionized firms adjusting their compensation and human resources practices in response to union bargaining power. To this end, we deployed Gelbach's (2016) decomposition based on the formula for omitted variable bias.

One key result of the decomposition exercise for total earnings was that the union wage gap is substantially manifested through a firm fixed effect, implying that unions force firms to reposition themselves as far as their wage compensation policies are concerned, although in this endeavor they might admittedly be pushing on an open door. Rather less important was the job-title effect or 'occupation premium' generated by the placement of workers in the firm's wage tables. However, unobserved worker quality plays a very weak role in explaining the union wage gap.

Up to this point in our narrative, we had neglected the issue of whether match quality also undergirded the wage gap, thereby possibly contaminating our measurement of the three aforementioned components or, more particularly, the worker and firm components. Our indirect test procedure was predicated on ascertaining how much of the union wage gap remained unexplained after partialing out the explicitly considered sources. The results of this exercise pointed unequivocally to an absence of association between the degree of unionization at firm level and job match quality.

At the price of some repetition, the following answers were obtained to the questions posed in the introduction. First, the observed union wage gap would be very small were firms' wage policies set irrespective of unionism, and thus randomly defined from this perspective. It is not, precisely because a large chunk of the union wage gap accrues via the firm fixed effect. Second, estimates of worker fixed effects indicate that union workers are no more productive than their non-union counterparts. Third, that part of the wage

premium associated with union workers enjoying elevated job titles and/or benefiting from more generous promotion polices is important. Finally, in combining worker and firm fixed effects to allow for their interaction, our decomposition exercise provided scant evidence of a wage gap being sustained by better matches between workers and firms.

In sum, this paper makes three contributions. It uses a novel procedure to determine the union premium in a regime where almost all workers are covered by a collective agreement. It has provided a unique attribution of that differential to three types of heterogeneity that left almost no room for alterative explanations of wage variation. And it has offered an internally consistent set of results for bargained pay, total earnings, and the wage gap, at the same time as finding support for the emerging consensus in the wider wage determination literature as to the importance of firm effects.

References

Abowd, John M., Francis Kramarz and David N. Margolis, 1999. 'High Wage Workers and High Wage Firms', *Econometrica* **67**(2), 251–333.

Addison, John T, Pedro Portugal and Hugo Vilares, 2017. 'Unions and Collective Bargaining in the Wake of the Great Recession: Evidence from Portugal', *British Journal of Industrial Relations* **55**(3), 551–576.

Blanchflower, David and Alex Bryson, 2003. 'Changes Over Time in Union Relative Wage Effects in the UK and the USA Revisited', *In: Addison JT, Schnabel C (ed.). International Handbook of Trade Unions* pp. 197–245.

Card, David, 1996. 'The Effect of Unions on the Structure of Wages: A Longitudinal Analysis', *Econometrica* **64**(4), 957–979.

Cardoso, Ana Rute, Paulo Guimarães and Pedro Portugal, 2016. 'What Drives the Gender Wage Gap? A Look at the Role of Firm and Job-title Heterogeneity', *Oxford Economic Papers* **68**(2), 506–524.

Cardoso, Ana Rute and Pedro Portugal, 2005. 'Contractual Wages and the Wage Cushion under Different Bargaining Settings', *Journal of Labor Economics* **23**(4), 875–902.

Carneiro, Anabela, Paulo Guimarães and Pedro Portugal, 2012. 'Real Wages and the Business Cycle: Accounting for Worker, Firm, and Job-Title Heterogeneity', *American Economic Journal: Macroeconomics* **4**(2), 133–152.

Correia, Sergio, 2016. 'REGHDFE: Stata Module to Perform Linear or Instrumental-Variable Regression Absorbing any Number of High-dimensional Fixed Effects'.

Farber, Henry S, 1986. 'The Analysis of Union Behavior', *Handbook of Labor Economics* **2**, 1039–1089.

Felix, Alison and James R Hines, 2009. Corporate Taxes and Union Wages in the United States, Technical report, National Bureau of Economic Research.

Figueiredo, Octávio, Paulo Guimarães and Douglas Woodward, 2014. 'Firm-worker Matching in Industrial Clusters', *Journal of Economic Geography* **14**(1), 1–19.

Frandsen, Brigham R, 2012. 'Why Unions Still Matter: The Effects of Unionization on the Distribution of Employee Earnings', *Manuscript. Cambridge, MA: MIT* .

Gelbach, Jonah B, 2016. 'When Do Covariates Matter? And Which Ones, and How Much?', *Journal of Labor Economics* **34**(2), 509–543.

Guimarães, Paulo, Pedro Portugal et al., 2010. 'A Simple Feasible Procedure to Fit Models with High-dimensional Fixed Effects', *Stata Journal* **10**(4), 628–649.

Hijzen, Alexander and Pedro S Martins, 2016. *No Extension Without Representation? Evidence from a Natural Experiment in Collective Bargaining*, number WP/16/141, Washington, DC: Research Department, International Monetary Fund.

Hirsch, Barry T, 2004. 'Reconsidering Union Wage Effects: Surveying New Evidence on an Old Topic', *Journal of Labor Research* **25**(2), 233–266.

Hirsch, Barry T and John T Addison, 1986. *The Economic Analysis of Unions: New Approaches and Evidence*, Allen and Unwin.

Lee, David S and Alexandre Mas, 2012. 'Long-run Impacts of Unions on Firms: New Evidence from Financial Markets, 1961–1999', *The Quarterly Journal of Economics* **127**(1), 333–378.

Martins, Pedro S, 2014. '30,000 Minimum Wages: The Economic Effects of Collective Bargaining Extensions', *IZA Discussion Paper No. 8540* .

Rees, Albert, 1960. *New Measures of Wage-earner Compensation in Manufacturing, 1914-57*, National Bureau of Economic Research, Inc.

Silverman, Bernard W, 1986. *Density Estimation for Statistics and Data Analysis*, Vol. 26, CRC Press.

Torres, Sónia, Pedro Portugal, John T. Addison and Paulo Guimarães, 2018. 'The Sources of Wage Variation and the Direction of Assortative Matching: Evidence from a Three-way High-dimensional Fixed Effects Regression Model', *Labour Economics* **54**, 47 – 60.

Woodcock, Simon D., 2008. 'Wage Differentials in the Presence of Unobserved Worker, Firm, and Match Heterogeneity', *Labour Economics* **15**(4), 771 – 793.

Woodcock, Simon D., 2015. 'Match Effects', *Research in Economics* **69**(1), 100 – 121.