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Wage cyclicality and labour market institutions

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Abstract: Do labour institutions influence how wages respond to the business cycle? Such responsiveness can then shape several economic outcomes, including unemployment. In this paper, we examine the role of two key labour market institutions – collective bargaining and temporary contracts – upon wage cyclicality. Our evidence is drawn from rich, 2002-2020 matched data from Portugal. We find that workers not covered by collective agreements exhibit much higher wage cyclicality, especially new hires, compared to covered workers. In contrast, workers under temporary contracts do not exhibit sizable differences in cyclicality compared to counterparts under permanent (open-ended) contracts. Our findings highlight a novel angle through which labour institutions influence the labour market and the economy.

JEL codes: J31, J52, J64.

Keywords: Real wages, Business cycles, Collective bargaining, Temporary contracts, Employment Law, Matched data.

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1. Introduction

Real wages have evolved remarkably differently across the OECD in the recent years. For instance, when comparing 2022 and 2023, in the aftermath of the pandemic and in the context of the war in Ukraine, real wages have dropped by 0.7% in the US, by 1.8% in France, by 3.3% in Germany, and by 7.3% in Italy.

While the real wage cyclicality (RWC, henceforth) behind such large international differences can be driven by several factors, in this paper we explore the role of a dimension largely ignored so far – labour market institutions. We argue that such institutions can be an important driver of wage cyclicality across countries given the large international differences in labour institutions and their important role in wage determination. Indeed, these institutions can shape the bargaining power of firms and workers, their outside options, and their productivity. Labour institutions can therefore influence not only the sharing of the surplus from each employment relationship but also the surplus itself. Critically, labour market institutions may influence the likelihood and extent of wage renegotiations in different business cycle environments and for different workers, with direct consequences upon RWC.

Our analysis is focused on two major labour market institutions, namely collective bargaining (CB), and more specifically its coverage, and employment contract type (permanent or temporary contracts).[5] These institutions may have important

[5] CB is generalised in most OECD countries, but with significant differences in coverage and the institutional framework (OECD, 2019; Jäger et al., 2022; OECD, 2023). Temporary contracts (defined here as all contracts that are

consequences in terms of RWC and explain the heterogeneity of RWC across time periods and countries. Depending on each country's labour institutions, different types of macroeconomic responsiveness may emerge. Such heterogeneity may be particularly important in regions such as the Eurozone where CB can have a relevant role in the wage setting process (OECD, 2023). In this case, policy reforms around these institutions can make wages more responsive to the business cycle and thus potentially reduce macroeconomic volatility.

CB can introduce major changes in wage determination with respect to the classical model of spot labour markets or the search and matching model (Mortensen and Pissarides, 1994; Morin, 2017)[6]. Collective bargained wages also imply that as soon as a worker is covered by a CB agreement, she will typically be protected against wage cuts during downturns. For instance, CB wage floors can make it difficult for nominal wages to fall during a recession, especially in the case of workers in continuing employment spells and paid at these wage floors or close to them (Adamopoulou, Díez-Catalán and Villanueva, 2022). This may be especially the case for workers under permanent contracts (see more below). On the other hand, collective agreement renegotiations leading to wage increases may take a longer time to take effect, leading to longer lags in wage increases during expansions.

not permanent or open-ended, with an expected short duration, such as fixed-term employment contracts and employment contracts with temporary work agencies) also have a relevant role in European labour markets (Booth et al., 2002; OECD, 2015). For example, in 2022, 24 million people aged 15–64 worked under temporary contracts in the EU (EUROSTAT, 2023).

[6] For instance, in Morin (2017), RWC may be lower in the context of collective bargained wages. In this model, the volatility of CB wages depends on the total value of the match, as predicted by the canonical search and matching model, but also on the workers' share of the surplus, which is argued to move in a countercyclical way, decreasing the volatility of wages and increasing that of employment.

Regarding temporary contracts, they are seen to increase labour market flexibility. This will be the case in comparison to permanent contracts that are protected by restrictive legal provisions against dismissal, including high levels of firing costs (Booth et al., 2002). Consequently, besides the cases of temporary or seasonal needs, the volume of temporary work may serve as a buffer stock which allows firms to adjust their employment to changes in business cycle conditions (Varejão and Portugal, 2007).

As well as the ease of adjusting employment volumes over the business cycle, temporary contracts may also be associated to distinct RWC levels. In fact, the significant wage gaps between temporary and permanent workers, in favour of the latter (Booth et al., 2002; OECD, 2015) may have its counterpart in different levels of RWC for these two groups of workers. Several explanations have been proposed for the (static) wage gaps, including compensating wage differentials (Rosen, 1986)[7] and worker screening under uncertainty about match quality (Jovanovic, 1979; Faccini, 2014), in which, workers may accept lower wages in the temporary period in the expectation of a higher wage following conversion to permanent (Booth et al., 2002). The wage gap between temporary and permanent workers can also be rationalised within the insider-outsider framework (Bentolila and Dolado, 1994): permanent workers (the insiders) are in better position than temporary (the outsiders) to bargain for higher wages.

[7] According to this explanation, wages should be an increasing function of the level of insecurity of the job and, consequently, the wages of temporary workers should be higher than that of permanent. However, most of the empirical evidence points in the opposite direction (OECD, 2015), with some exceptions (Albanese and Gallo, 2020).

Both the insider-outsider and the screening hypotheses point to a higher wage cyclicality of temporary workers in downturns. However, in the upswings, it should be the permanent workers that experience higher wage increases in face of their higher bargaining power and lower uncertainty about their skills and the quality of the match. Therefore, across the business cycle, the net effect of contract temporality on wage cyclicality is not clear. It may depend on the business cycle distribution between upswings and downturns and the distribution of workers between temporary and permanent and the respective shares of new hires.

Recently, these two institutions have been studied in the context of the growing literature on labour market power. Considering the cases of six European countries, (Bassanini et al., 2024) find that labour market concentration reduces wages moderately while it has a large effect in increasing the prevalence of temporary contracts. These differences can be explained by the dominance of sectoral collective bargaining across the countries and its focus on wage setting compared to contract type setting. Dodini et al. (2022) also find that (exogenously) high levels of unionization mitigate the negative wage and employment effects generated by imperfect competition.

Previous research on RWC based on microeconomic longitudinal data (Martins, 2007; Carneiro et al., 2012; Martins et al., 2012; Stüber, 2017; Verdugo, 2016; Dapi, 2020; Gertler et al., 2020; among many others) mostly assumed the labour market as homogeneous, not considering the framework of bargaining wages or the workers'

contract type. In general, these studies concluded that real wages are considerably procyclical. Moreover, some concluded that RWC is higher for new matches than for continuous workers (Pissarides, 2009; Carneiro et al., 2012; Martins et al., 2012), whereas others found no significant differences between both groups, mainly when controls for the quality of the match are considered (Gertler and Trigari, 2009; Gertler et al., 2020; Stüber, 2017; Dapi, 2020; Grigsby et al., 2021).

To the best of our knowledge only Devereux and Hart (2006) and Gartner et al. (2013) consider CB coverage. The first paper presents some evidence that the wages of internal movers (within firms) uncovered by collective agreements are more responsive to unemployment than those of their covered counterparts. In other cases, the differences are not significant. The evidence in the second paper is not significant as regards to the different effects of unemployment on wages according to coverage.

Direct empirical evidence on the effects of employment contract type on RWC is also scarce. To the best of our knowledge only De la Roca (2014) and Font et al. (2015) distinguish between temporary and permanent workers in their analyses of RWC in Spain, concluding that RWC is higher for temporary contracts. However, these papers don´t distinguish between stayers and new hires of each one of these categories, a fundamental distinction according to the search and matching model.

In our analysis, the CB dimension is analysed in terms of its coverage, considering both what we refer to as an extensive margin (a worker being covered or not by a collective agreement) and an intensive margin (a worker being paid at the collectively agreed minimum wage or at a higher wage). This distinction may be important in RWC because, as Card and Cardoso (2022) show, an important part of the workers covered by collective agreements receive wages above the floors established for their job titles. This 'cushion' between the CB floor and the wage that workers effectively receive may change according to the business cycle conditions, representing wage flexibility in the CB system. Therefore, it is of particular interest compare the RWC between both covered groups, but also between the covered and the uncovered, as the latter is fully free from CB constraints (at least assuming no spillovers from the covered upon the uncovered). Finally, the contract dimension concerns the employment contract of the worker – permanent or temporary. Our aim is to understand whether the contract type contributes to RWC in each bargaining regime and whether the effect of the contracts changes according to the bargaining regime? This is particularly important because, in the uncovered sector, wages are not protected by the CB floors of each job title. Therefore, temporary workers are presumably in a weaker bargaining position in the uncovered sector because they do not have the protection of the collective bargaining floors that apply indistinctly to both contract types.

Our research adds to previous literature in several ways. First, we simultaneously analyse the role of CB coverage and of temporary/permanent contracts in RWC. Moreover, we consider possible interactions between them. Second, CB coverage is

considered both in terms of its extensive and intensive margins (covered/uncovered but also paid at or above the CB floor). Third, the effect of contract type on RWC is considered both for stayers and new hires, whereas previous research did not distinguish between these groups, despite the fact that the relevant RWC for job creation in terms of the search and matching model is concerned with new hires (Pissarides, 2009). Fourth, our control for composition effects over the business cycle is stronger than that of previous studies on RWC and labour market institutions: previous studies considered only worker fixed effects, whereas in this paper we also include firm-job fixed effects. Fifth, we present a systematic set of tests comparing the different industrial bargaining regimes and labour contracts in terms of RWC. Finally, we assess how the relationship between new hires' wages and labour productivity is shaped by both institutions (CB coverage and contract type).

Our empirical case study considers the case of Portugal, where CB and temporary contracts are widespread (see section 2). Our empirical evidence is drawn from a rich matched employer-employee dataset, which allow us to control for several sources of composition changes over the business cycle. We find that labour institutions can indeed greatly influence RWC. This is the case of CB coverage. This result is consistent with the hypothesis that CB changes the relative bargaining power and outside options of workers and employers. In a related result also of macroeconomic relevance, we also find that CB coverage greatly influences the relationship between new hires' wages and labour productivity. Specifically, only in the case of uncovered workers is the wage-productivity relationship proportional. Finally, we also conclude that not all labour

institutions matter necessarily in terms of RWC. We find that the contract type does not play a relevant role in RWC, unlike CB coverage.

The remaining of the paper is organised as follows. The next section presents a description of the institutional framework of labour law, CB and temporary contracts in Portugal. Section 3 presents the data set and descriptive statistics of the labour market institutions considered. Section 4 presents our methodological approach. Section 5 presents our baseline empirical results. Section 6 extends our baseline empirical model considering asymmetric effects over the business cycle and presents the robustness analysis. Section 7 concludes.

2. Institutional Framework: Collective Bargaining and Temporary Contracts

2.1. Collective Bargaining

In Portugal, the Labour Code (LC) establishes the general framework of labour relations and the minimum working conditions that are to be followed in (individual and collective) employment contracts. At the same time, the LC allows (upward or downward) deviations from several of its minimum provisions if determined by CB (when workers are represented by one or more trade unions). The deviations set in a collective agreement can be less favourable to employees, provided that the overall agreement is regarded as more favourable than the LC benchmark or the previous version of the collective agreement, which is assumed to follow from the trade unions' signature.

Trade unions have the constitutional right to negotiate formal collective agreements with the employers' representatives (while informal collective agreements can be conducted by works councils, typically topping up sectoral agreements conducted by trade unions). Collective agreements establish a set of working conditions, including minimum wages for each job title set in the agreement (a particular occupation of relevance in the firm or industry where the agreement applies). These wage levels remain in force until the agreement is revised or until a new agreement is established, which can take two or more years and may introduce nominal wage rigidity and real wage flexibility. Most of the agreements are published by the Ministry of Employment between January and April of each year (Cardoso and Portugal, 2005). However, as these wage conditions are typically bargained over several months, the relation between wage conditions and the business cycle may not be highly synchronized.

Initially, collective agreements cover the workers that are simultaneously members of the subscribing union(s) and that are employed by the firm(s) which subscribe to the agreement, either directly (firm-level agreements) or indirectly through membership of the subscribing employers' association(s) (sector-level agreements). However, in practice, most firms extend their collective agreements to non-unionised workers (*erga omnes*), for equity and practical reasons. Furthermore, the coverage of the agreements is usually extended beyond the subscribing firms. This framework of low representation and high coverage is driven by widespread administrative (government-determined)

extensions. These extension mechanisms have been widely applied in Portugal[8], as in many other European countries (most notably France), imposing a vast set of minimum wages (and other regulations) on specific occupations across a large share of private sector employees, despite low trade union density (Addison, Portugal and Vilares, 2017); Martins, 2021a). This architecture of the CB system has advantages, but also disadvantages, such as the amplification of nominal wage rigidity, which may limit the ability of the labour market to deal with negative shocks, particularly in times of low inflation, and exacerbate employment fluctuations (Bewley, 1999)

Despite the minimum wage for each job title set by collective agreement, firms are free to pay wages above this minimum. Indeed, a substantial part of the workers receives wages above this minimum (Cardoso and Portugal, 2005). Consequently, these workers are somewhat outside the wage constraints imposed by the CB process. These workers may be regarded as closer to the decentralised market mechanisms than in the cases of workers whose base wages are equal to the minima set by CB, despite both groups being covered.

Another aspect of Portuguese CB is the possibility of the unilateral cessation of collective agreements, without replacement by another agreement or another version of the same agreement bargained by the same parties. This possibility was introduced by the LC in

[8] The exception was the period 2011-2014, when objective representativeness criteria were in force. Overall coverage did not decline significantly but coverage by new agreements (or revised versions of existing agreements) declined considerably. We do not distinguish between these two types of coverage, which creates a downward bias in our estimates of the effect of CB coverage upon RWC. In other words, if we excluded workers covered only by older vintages of collective agreements, our estimates of the increased RWC of uncovered workers would have been even larger than those that we present later.

2003.[9] Note that, even after the agreement is terminated, its provisions continue to apply to employees that were hired when the agreement was in force.

Although most workers in Portugal have their wages (and other working conditions) set in the context of CB, there is also a growing percentage of workers whose wages are established outside the CB system: this percentage increased from about 5% in 2002 to about 16% in 2020 - see section 3. The drivers of the growth of uncovered workers have not yet been analysed. However, some factors may have favoured this growth, including the cases of emerging economic activities not covered by unions or employers' associations (e.g., IT, software, logistics), changing attitudes towards unionisation (in particular amongst younger workers), increased international competition, and reduced government intervention through mandatory regimes.

2.2. Temporary Contracts

Another important institution of labour markets is the temporary contract. In Portugal, they are used widely, accounting for 22% of total employment, as of 2019. This contract is also important in other countries, most notably Spain (25%) and Poland (23%) – (Malherbet and Martins, 2024). Temporary contracts as defined here include those involving a fixed duration determined in advance, a fixed duration but conditional on a subsequent event (e.g., the conclusion of the construction of a building), or an

[9] Until then, labour law established in principle an indefinite duration of a collective agreements as these were only allowed to end if all signatory parties agreed (through the establishment of a new agreement or a revision of the earlier agreement). Moreover, this indefinite duration provision was also included in many collective agreements before 2003. In order to allow these older agreements to potentially also be terminated, a transition procedure (ultra-activity) was established in 2003. This system involved a duration of three to five years between the time at which one of the parties of the agreement indicated their will to terminate the collective agreement and the time when the agreement would come to an end.

employment contract with a temporary agency (which places the worker for a temporary period with a different, 'user' firm). [10]

An important driver of such a large percentage of temporary contracts in Portugal may be the very restrictive legal provisions against (individual) dismissals in permanent contracts. Indeed, despite reforms towards more flexibility in 2012, Portugal still has one of the most restrictive regimes in such dismissals in the OECD (OECD, 2017). The large employment shares of potentially more seasonable or volatile sectors in Portugal (tourism, agriculture, construction, etc) may also contribute to the large percentage of temporary contracts, although such large shares may also be endogenous to the severe legal restrictions on permanent contracts.

Temporary contracts are allowed in the LC (articles 140 and 148) when enterprises have a "temporary need and only during the time period of that need". In addition, over the period studied in this paper, temporary contracts are also permitted for new firms, when existing firms launched a new activity of uncertain duration or a new establishment (Cahuc et al., 2023), or to recruit workers that are long-term unemployed or searching for their first permanent job.

The admissibility conditions, the number of renewals and the maximum duration of these contracts have been subject to several reforms over time (Silva et al., 2018; Martins, 2021b). In general, these contracts can have a maximum duration of three

[10] These definitions follow closely the European Union Fixed-Term work Directive of 1999, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31999L0070

years, including up to three renewals. If a recruitment under a temporary contract did not meet these and other legal restrictions, that worker can challenge the contract type before the labour inspectorate or a court and demand the conversion of the contract to permanent, with all the additional job protection involved. A worker whose temporary contract is not renewed or converted may also challenge the legality of the temporary contract and demand reinstatement in the firm. From a legal perspective, workers under temporary contracts cannot be discriminated against their colleagues under permanent contracts. The former should therefore be paid the same wages as the latter if they are equally productive.

Finally, consistently with (Bassanini et al., 2024), collective agreements in Portugal make very limited references to temporary contracts, in striking contrast to their major provisions regarding wages. Typically, collective agreements simply repeat the contents of the LC regarding the recruitment restrictions above.

3. Data Description and Preliminary Analysis

3.1 Data Description

We use *Quadros de Pessoal* (QP), a matched employer-employee panel data set from Portugal's Ministry of Employment. This is a mandatory annual census of all enterprises in the private sector in Portugal with at least one employee. QP is submitted annually by each employer, providing information about the month of October, including detailed characteristics of workers, establishments, and firms. Worker information includes

individual wages (base wage, variable pay, and total earnings), normal and overtime hours of work, age, tenure with the firm, schooling, occupation,[11] collective agreement, and collective agreement job level[12]. Firm-level information includes industry, region, capital equity, and annual sales. QP also includes time invariant unique firm and worker identifiers, which allows firms and workers to be tracked over time (panel dimension) and controls for multiple types of fixed effects.

Since 2002, QP also includes information on workers employed by public entities but under private sector employment contracts. As will be seen below, an important part of these workers is uncovered by collective agreements. Hence, starting the analysis in 2002 is a necessary condition for comparable and reliable data about uncovered workers. In addition, temporary contract status is also only available from 2000. Finally, we note that the data set does not provide information about the unemployed, civil servants, the self-employed and the armed forces. The data set contains a total of 41,526,425 observations corresponding to 5,800,343 workers and 701,106 firms from 2002 to 2020.[13]

[11] We used the three-digit level classification of the CPP-2010 system of occupations adopted in 2010 This classification is available for workers covered and uncovered by collective agreements. We converted the occupational categories of the previous system (CNP-1994), used in QP over the period 2002–2009, to the new CPP-2010 code, using the 2010 modes of 2009 occupations of continuing employees.

[12] The collective agreement job level is the job or occupation definition adopted in each collective agreement.

[13] We impose a small number of inclusion criteria on our final data set: at least 120 hours of work in the reference month (October) of each year and age 18 to 64. When a worker has more than one employment in October of a given year, we only consider the one with the highest number of hours worked. Workers in agriculture, unpaid family workers, apprentices, and workers whose base wage is less than 80% of the national minimum wage are excluded.

3.2 Variables

As dependent variables, we use the log of hourly earnings and the log of hourly base wage. Both wage measures are at 1985 constant prices, deflated by the private consumption deflator. The independent variables include education dummies, age and its square, tenure, and a dummy identifying new hires (workers whose tenure with the firm is less than one year).

Concerning to the institutional framework of bargaining wages, workers are divided into two major groups: the covered and the uncovered by collective agreements. The former group is also divided between $W_{base} = W_{CBT}$ workers and $W_{base} > W_{CBT}$ workers. The first sub-group corresponds to workers whose base wage (W_{base}) is equal to the contractual wage established in their collective agreement for their job title (W_{CBT}), henceforth $W_{base} = W_{CBT}$ workers. The minimum contractual wage is computed as the mode of the base wage for each worker category within a given collective agreement and year (Cardoso and Portugal, 2005; Martins, 2021a). The second sub-group corresponds to workers whose base wage is higher than the minimum contractual, $W_{base} > W_{CBT}$, for their job title, henceforth $W_{base} > W_{CBT}$ workers. The latter group is somewhat outside the constraints imposed by the CB process as firms pay these workers more than the CB minimum wage that they were required to pay. Therefore, this group of workers is closer to the market mechanisms than other workers whose base wage is binding.

We also distinguish workers regarding their contract type, namely temporary or permanent, following our discussion above. Finally, information about the unemployment rate, labour productivity and aggregate employment was obtained from Statistics Portugal. Table 1b in the appendix 2 provides the descriptive statistics of the main variables used in this study.

3.3 Preliminary Analysis

Table 1 presents the evolution of the percentage of workers covered and uncovered by collective agreements over the period 2002–2020. Most workers are covered by collective agreements, but this percentage decreased from 95% in 2002 to about 84% in 2020. Within the covered sector, the largest group is that of workers that are paid above the applicable CB minimum wage. This category has been decreasing over time representing between 54% and 43% of the total number of private sector employees. The second largest group of workers is that of individuals paid exactly at their CB minimum wage, ranging between 38% and 43%.[14] Consequently, there is an increasing percentage of uncovered workers over the same period (5% to 16%). Amongst covered workers, most of the relative decline is found amongst workers paid above their CB minimum wage.

[14] Regarding the distribution of firms between the covered and uncovered groups, most of them either have only covered or uncovered workers (Table 1). The percentage of firms that employs both covered and uncovered workers is small, although it has increased slightly over time. Finally, the percentage of firms in each one of these groups has closely followed the evolution of the respective percentage of workers.

Another important dimension to contrast these workers concerns their observable characteristics. On average, the uncovered group displays higher hourly wages,[15] are younger, have lower number of years of tenure with their firms, and are more likely to be university graduates. Their firms are larger in sales and in employees, at least in 2020. Moreover, their firms also exhibit a higher percentage of public and foreign capital ownership than the covered group (see Table 2).[16]

Second, as regards the industry distribution for each coverage type, the uncovered sector is more concentrated in manufacturing, information and communication, administrative and support service activities (the leading industry in 2020, accounting for 16% of the uncovered employees), and human health and social work activities (15% of the uncovered employees in 2020). In contrast, the leading covered industries are manufacturing (24% of all covered employees, again considering 2020 figures), wholesale and retail trade (20%), and accommodation and construction (9%). Hence, in addition to the administrative extensions of collective agreements (and their changes over time) and the business cycle, there may be other factors (workers' and firms' characteristics, including their industries) which also influence CB coverage.

[15] Card and Cardoso (2022) found a similar result for Portugal using the same data set. These findings for Portugal contrast with those for other countries (the US, the UK, Canada and Germany) where, typically, the uncovered workers receive lower wages than their covered counterparts (Card et al., 2004; Addison et al., 2016; Jäger et al., 2022).

[16] Another relevant difference between the covered and the uncovered sectors concerns the firms' average age, which is lower in the last sector. Therefore, the growth of this sector was pushed up by new firms and, eventually, by new activities. Indeed, the analysis of the industrial and occupational structures of both sectors shows that there are relevant differences between them. First, the uncovered group is more concentrated at the top of the occupational structure (professionals, technicians and associate professionals and clerks), whereas the covered group has higher predominance in less skilled occupations (service workers and shop and market sales workers, craft and related trades workers and plant and machine operators and assemblers).

With regard to temporary and permanent contracts in Portugal, the former are the most relevant means of hiring, i.e., from a flows perspective (Table 3). Moreover, considering the different types of workers according to their status on the CB coverage (above the collective agreement minimum wage, at such minimum wage, and uncovered workers), we always find that temporary contracts represent at least half of all new hires, but usually this percentage is higher than 70%. In striking contrast, the percentage of temporary contracts amongst stayers (defined here as workers hired in previous years) is much lower, at no more than 24%.

4. Methodology

To estimate the response of real wages to the business cycle according to the workers' institutional framework, we adopt the following detailed specification of an augmented Mincerian equation:

$$lnw_{i,f,j,t} = \beta_{g,c,s} I_{g,c,s} + \mu_{0,g,c} I_{g,c} \times stayer \times bcy_t + \mu_{1,g,c} I_{g,c} \times newhire \times bcy_t +$$

$$+ X_{it}\gamma + time\ trend_t + fe_{i,f,j} + error_{i,f,j,t} \qquad (1)$$

The dependent variable, $lnw_{i,f,j,t}$ is the log of real hourly earnings of the worker *i* in firm *f,* job *j* at year *t*. The first term on the right side of equation (1) are the set of indicator variables $I_{g,c,s}$ identifying each specific combination of workers' characteristics regarding the CB institutional setting (g), type of contract (c) and seniority status (s) of the worker *i* in firm *f* at the year *t.* The CB setting includes the covered (g = 1, 2) and the

uncovered (g = 3) workers. The former group is divided between $W_{base} > W_{CBT}$ workers (g = 1) and $W_{base} = W_{CBT}$ workers (g = 2). The contract types, in turn, are divided between the permanent (c=1) and the temporary (c=2). The seniority status concerns stayers (s=1) and new hires (s=2). This corresponds to a set of 12 indicator variables (and their respective β parameters): three collective bargaining types times two contract type times two seniority groups.

The second term of equation on the right side of equation (1) interacts these workers' characteristics (g, c) with a business cycle indicator (bcy_t) for stayers (s=1), whereas the third term does the same interaction for the new hires (s=2). The next terms of equation (1) are the vector X_{it} of individual characteristics, such as education and age, plus a time trend. We also add worker and firm-occupation fixed effects ($fe_{i,f,j}$) to control for time-invariant heterogeneity, composition effects across the business cycle (Solon et al., 1994; Abraham and Haltiwanger, 1995; Brandolini, 1995) and also for the quality of the match, avoiding the problem of biased estimates in consequence of the failure to control for cyclical job up and downgrading (Gertler and Trigari, 2009; Stüber 2017); $error_{i,f,j,t}$ is the error term. In practice, we consider the largest group, of $W_{base} > W_{CBT}$ stayers in permanent contracts, as the reference and estimate the differential cyclicality for the remaining 11 groups.

Equation (1) is specified in levels, which allows us to analyse the real wage cyclicality of new hires, as the data set by construction does not include non-employed workers coming either out of the labour force or unemployment (for whom wage information

would be available), the self-employed and civil servants. A first differences estimator would imply restricting the sample to employed workers over two consecutive periods, thus excluding the new hires coming from groups not included in QP.

The explanatory variables included in equation (1) vary in both the individual and the time dimension. However, the business cycle indicator and its interactions with the institutional variables are group variables that only change over time and between groups. Therefore, these variables are subject to the problem pointed out by Moulton (1990) of downward-biased standard errors and spurious inference in regressions with both individual and group variables. One possible way to overcome this potential problem would be to estimate equation (1) with clustered standard errors at year level, the largest unit of aggregation included in our base specification (Angrist and Pischke 2009; Carneiro et al., 2012; Dapi, 2020). However, as the number of years (clusters) covered in our panel is relatively small and the number of observations in each cluster is large (Cameron and Miller, 2015), more reliable estimates can be obtained with the two-step procedure widely used in the empirical literature of real wage cyclicality (Solon et al., 1994; Angrist and Pischke, 2009; Stüber 2017).

Hence, in the first step of this procedure, we estimate the following equation where the business cycle indicator of equation (1) is replaced by year dummies T_t (with respect to 2002). From the coefficients of these dummies, we obtain the mean group estimates $\widehat{\psi_{0,g,c,t}}$ and $\widehat{\psi_{1g,c,t}}$, which measure the variation in wages beyond the part that is explained by variable characteristics and time-invariant heterogeneity:

$$lnw_{i,f,j,t} = \beta_{g,c,s} I_{g,c,s} + \psi_{0,g,c,t} I_{g,c} \times stayer \times T_t + \psi_{1,g,c,t} I_{g,c} \times newhire \times T_t + X_{it}\gamma + fe_{i,f,j} + error_{i,f,j,t} \quad (2)$$

In the second step, the year estimates from the first step ($\widehat{\psi_{0,g,c,t}}$ and $\widehat{\psi_{1,g,c,t}}$) are regressed separately on the business cycle indicator (bcy_t) and in a time trend to obtain the estimates of real wage cyclicality:

$\widehat{\psi_{0,g,c,t}} = \mu_{0g,c} bcy_t + time\ trend + error$, for g=1,2,3; c=1, 2; s=1 (3)

$\widehat{\psi_{1,g,c,t}} = \mu_{1,g,c} bcy_t + time\ trend + error$, for g=1,2,3; c=1, 2; s=2: (4)

The μ_{0gc} terms are the estimates of the impact, on wages, for stayers (tenure ≥ 1 year), of the business cycle indicator, according to the CB situation (g = 1, 2, 3) and the contract type (c = 1, 2) of the worker. The μ_{1gc} terms, in turn, quantify the differential impact on the new hires' wages of the business cycle indicator, according to g and c. Hence, assuming the base category as the stayers with g=1, c=1, the corresponding semi-elasticity of wages to unemployment is $\mu_{0,1,1}$. Consequently, the implied semi-elasticities of the new hires (g, c) are given by: $\mu_{\mathbf{0,1,1}}$+$\mu_{\mathbf{1,g,c}}$.[17]

[17] Equations (3) and (4) are a special case of seemingly unrelated regressions (Zellner, 1962) as the regressors and the data are the same in all the equations. In this case, these equations can be estimated separately by OLS (Wooldridge, 2002) as in previous studies on RWC. In the next section, we carry out several tests comparing the response of wages to the business cycle for workers under different bargaining regimes and contract types. These tests involve parameters estimated in different models (equations 3 and 4), but on the same data. To carry out these tests, we used the Stata *suest* command, which builds a simultaneous matrix of variance-covariance for the estimates in different equations based on the sandwich estimator (Cameron and Trivedi, 2022).

Our baseline estimations are carried out with a quadratic time trend. In the robustness analysis we consider an alternative method to detrend the data, the Hodrick-Prescott filter. The lagged unemployment rate is used as business cycle indicator since wages in Portugal are typically set between six months to one year in advance. Finally, the second step estimates are weighted by the number of observations/year for each category of workers (Devereaux, 2001;Angrist and Pischke, 2009).

5. Main results

Our empirical analysis starts with the model that takes the labour market as homogeneous (model 1, table 4). This model does not distinguish workers either as regard to the institutional arrangement of bargaining – individual or collective – or the contract type – temporary or permanent. This homogenous market model corresponds to the standard specification considered in the literature of real wage cyclicality (Carneiro et al., 2012; Stüber, 2017; Dapi, 2020; Gertler et al., 2020; among many others). Progressively, we relax this assumption allowing for a potential role played by labour market institutions, namely temporary contracts and CB coverage. The detailed specification of models 1 to 6 is presented in appendix 1.

In the model that considers the labour market as homogeneous (model 1), our estimates of real wage cyclicality (Tables 4 and 5) indicate that real wages are procyclical and the new hires' semi-elasticity is significantly higher than that of stayers – about 38% more. This is in line with most previous longitudinal studies (Abraham and Haltiwanger, 1995; Brandolini, 1995), including those for Portugal (Martins, 2007; Carneiro et al., 2012; Martins et al., 2012). However, the estimated semi-elasticities to unemployment are

considerably lower (in absolute values) than those of previous studies, covering earlier periods: about -2.00 for stayers and -2.80 for new hires (Carneiro et al., 2012), whereas our estimates are, respectively, -0.549 and -0.757 in an equivalent specification.[18] These RWC estimates are also considerably lower than those of some recent studies such as Stüber (2017) for Germany or Dapi (2020) for Norway. However, the estimates presented here are close to those of Gertler et al. (2020) for the USA in their first differences estimator and in their analysis of new hires free from composition effects.[19]

Next, we extend the basic RWC model, separating temporary and permanent contract workers (model 2, Tables 4 and 5), maintaining the hypothesis of homogeneity relative to wage setting. The estimates show that workers' wages are procyclical for both contracts and that the new hires' wages are again more responsive to the business cycle than those of stayers (Table 4, model 2). As the relevant parameter for job creation in terms of the search and matching model is the new hires' semi-elasticity to unemployment, in Table 5 we test the hypothesis that this semi-elasticity is equal for workers under temporary or permanent contracts. This hypothesis is not rejected, as the point estimate of the new hires' semi-elasticity for the workers under temporary contracts is (only) 10% higher. At this level of disaggregation, the wages of workers of different contract types do not appear to respond differently to the business cycle.

[18] Martins (2021c) shows that real wage cyclicality decreased dramatically in Portugal from 1992 due to the change of macroeconomic regime as the country prepared to join and later joined the European Monetary Union. This process required and then contributed to much lower levels of inflation than those common in the country until the 1980s. Therefore, previous RWC estimates for Portugal (which cover periods starting in the 1980s – a period of high inflation - and stop in the early 2000s) and ours (which cover the 2000s and 2010s) are not comparable from the perspective of the macroeconomic context. Future work may consider the role of the recent growth of inflation, following the pandemic crisis.

[19] Gertler et al. (2020) consider the new hires from unemployment free of composition effects (job upgrading). We control for those effects through the firm-job fixed effect in the first step as it is not possible to know with certainty the origin of the new hires from non-employment in our data set.

Consequently, firms seem to follow a similar wage policy over the cycle for all workers, independently of they have a temporary or a permanent contract.

We now introduce the effect of bargaining – individual or collective – on RWC. Initially, we do not separate temporary and permanent workers. The estimates displayed in Tables 4 and 5 show again that wages are procyclical and that the new hires' wages are more procyclical than those of stayers, either for covered or uncovered workers. In terms of the key parameter of interest, the semi-elasticity of wages of the new hires, it is about 66% higher in the uncovered sector than in the covered. This finding shows that the architecture of the bargaining system influences significatively how wages react to the business cycle and that wages bargained directly between the worker and the firm, as considered in the search and matching model, are considerably more cyclical than those bargained between workers' and firms' representatives. We regard this as an important finding and contribution of this study.[20]

Model 4 divides the covered and the uncovered workers' categories between those that have temporary and permanent contracts. The incremental effects are significant in general, and the signs are as expected (Table 4), including the incremental effects of the new hires, which are typically higher than those of the corresponding category of stayers (except the covered temporary group). The tests shown in Table 5, regarding the new

[20] In previous RWC studies that considered workers covered and uncovered by collective agreements (Devereux and Hart, 2006; Gartner et al., 2013), only Devereux and Hart (2006) present some evidence of different wage responses to the business cycle according to workers' industrial bargaining regime. Our findings are obtained with a broader set of fixed effects than those of Devereux and Hart, as we consider both worker and firm-job fixed effects, whereas Devereux and Hart only consider worker fixed effects.

hires' semi-elasticities to unemployment, also reject the hypothesis of a homogeneous labour market. The point estimates of these semi-elasticities for the uncovered group are higher than those of the covered, either for temporary (+57%) or open ended (+80%) contracts, and these differences are statistically significant (Table 5).

Are all these differences explained by the bargaining regime, or does the contract type play some role from interactions with the bargaining regime? To address this question, assuming that the magnitude of the effect of the bargaining regime is the same for temporary and permanent contracts, we can test the null hypothesis that the difference in semi-elasticities between permanent contracts is the same as the difference between temporary contracts. The statistic of the test given in Table 5 regarding model 4 (irrelevance of contracts between bargaining regimes) does not reject this null hypothesis. Therefore, we cannot reject the hypothesis that the bargaining regimes – covered or uncovered – explain all the difference in semi-elasticities, either for temporary or permanent contracts. In other words, contract type does not appear to interact with the bargaining regime to change the differences of semi-elasticities between bargaining regimes. [21]

Still regarding model 4, within each bargaining regime, only in the case of the covered group does a significant difference in RWC arise between contracts and even so at the 10% significance level. In the uncovered sector, firms seem to follow a very similar wage policy for temporary and permanent contracts over the business cycle.

[21] This test and others that we present in this paper were carried out with the SUEST and TEST commands in STATA (see section 3).

In the next stage (model 5), we analyse the RWC effects of separating the covered group into $W_{base} > W_{CBT}$ and $W_{base} = W_{CBT}$ workers, whereas the uncovered group is as in model 3. This division implies a different wage policy within the constraints of the same collective agreement. Therefore, a natural question that arises is whether these different policies also change over the business cycle. In that case, the RWC of these groups of workers should be significantly different.

As before, this analysis is initially carried out without separating workers regarding contract type. Table 4 shows that the wages of $W_{base} = W_{CBT}$ stayers are significantly less procyclical than those of $W_{base} > W_{CBT}$ stayers – about -14%. Moreover, as in model 3, the wages of the stayers uncovered by collective agreements are significantly more procyclical than both categories of stayers covered by collective agreements. These findings once again highlight the difficulty in adjusting stayers' real wages in times of low inflation and with significant levels of nominal wage rigidity (Carneiro et al., 2014; Grigsby et al., 2021; Schmitt-Grohé and Uribe, 2013), particularly for workers whose base wage is binding, i.e., $W_{base} = W_{CBT}$ workers. For $W_{base} > W_{CBT}$ workers, firms have the chance of not following the wage policy of the collective agreement, adjusting it to the business cycle conditions and regaining wage flexibility within the constraints of the collective agreement. Therefore, it seems that as well as having a different wage policy within the covered group, firms also adjust that policy over the business cycle, that is, the wage cushion is not constant (Card and Cardoso, 2022).

As regards the wage cyclicality of the new hires, the respective differential effects are all significant even in relation to their respective stayers (Table 4; A-tests). The largest semi-elasticity is (once again) in the uncovered group (Table 5). Within the covered group, the difference between the semi-elasticities of the new hires is insignificant, although the magnitude of that difference is higher than that between stayers – 18% versus 14% (Table 5). This may be a consequence of the greater uncertainty in the estimates of the new hires in face of the smaller number of observations involved.

Now we extend the previous framework of $W_{base} = W_{CBT}$ workers, $W_{base} > W_{CBT}$ workers and workers uncovered by collective agreements, considering also temporary and permanent contracts in each group (model 6, our more extended model). We find that the pattern of previous results remains largely invariant, with the differential effects being significant and having the expected signals (Table 4, model 6). Of particular interest are also the incremental effects of the new hires, which are in general significant, particularly for the uncovered workers, and higher than the corresponding group of stayers (except for the temporary $W_{base} = W_{CBT}$ workers).

However, as in model 5, there is no strong evidence of the importance of the division of the covered group between $W_{base} = W_{CBT}$ and $W_{base} > W_{CBT}$ workers. In fact, considering temporary and permanent contracts, the only significant effect is for $W_{base} = W_{CBT}$ stayers with permanent contracts. In this case, RWC is somewhat lower (-13.6%) than that of the base category (10% significance level). This demonstrates again the difficulties of wage adjustment within the CB framework, particularly when the base wage is binding (Martins, 2021c).

Table 5 (model 6) presents the tests comparing the various industrial bargaining regimes for each of the labour contracts considered. As before, this analysis is carried out in terms of the implied semi-elasticities of the new hires. The first hypothesis to consider is that all industrial bargaining regimes, independently of the contract under which workers are employed, are not significatively different in terms of RWC. This is the hypothesis of a homogeneous labour market (model 1), which is again clearly rejected.

The next hypothesis we test is the homogeneity across industrial bargaining regimes according to the contract type. This hypothesis is also rejected for both contracts. We add more detail to the analysis, testing comparisons of industrial regimes, pair by pair, according to the contract type. In this case, the differences are mainly significant when both covered groups are compared with the uncovered group, independently of the contract type; between the covered sub-groups, they are only significant (at 10%) for the new hires with permanent contracts. We also test the homogeneity between temporary and permanent contracts within each group. For the uncovered group, as in model 4, there are no significant differences. For the covered sub-groups, only in the case of $W_{base} = W_{CBT}$ workers are the differences statistically significant (10% significance level).

Finally, as in models 2 and 4, we also test whether RWC differences between bargaining regimes depend only on the bargaining regime or also on the contract type.[22] In other

[22] As before, this test is based on the hypothesis that the influence of the bargaining regime on RWC is the same either for temporary or for open-ended contracts.

words, we test whether the pairwise differences in RWC between bargaining regimes for temporary and permanent contracts are statistically different. Furthermore, a global test for the equality of all the differences between temporary and permanent contracts across bargaining regimes is also computed. All these tests do not reject the hypothesis that the difference between temporary and permanent contracts is constant across bargaining regimes. Therefore, there is no evidence of an interaction between contract type and bargaining regimes (Table 6, block of irrelevance of contracts). This is another important finding as it indicates that, the workers with possibly less bargaining power, those uncovered under temporary contracts, are not exposed to more wage cyclicality than other uncovered workers.

6. Additional results

6.1 Asymmetric effects

Previous estimates of RWC may hide real wages behaving differently or asymmetrically during upswings and downturns. Such potential asymmetry may overestimate the real capacity of adjustment of real wages to absorb the increased unemployment during the downturns. That would be the case, for instance, if RWC were fundamentally driven by periods of decreasing unemployment, whereas in the periods of increasing unemployment, real wages were inelastic, as various mechanisms of nominal wage rigidity (minimum wages, CB minimum wages, workers' psychology, etc.) may constrain the wage adjustment. Here we analyse this hypothesis of asymmetric effects on RWC: Table A (appendix 2) presents the estimates of model 6 but considering an asymmetric response of wages to unemployment over the business cycle.

In general, the coefficient estimates indicate a higher sensibility of wages to unemployment when it is decreasing than when it is increasing. Most of these differences are significant (Table A, fourth column, test (1) = (2)). Hence, these estimates suggest that the response of wages to unemployment is higher in the upswings than in the downturns.

Table B (appendix 2) complements this analysis with estimates of the implied semi-elasticities for new hires, which are again somewhat higher in the upswings. These differences are significant, most of them at the 10% significance level. Moreover, the difference in magnitude of the semi-elasticities in the different phases of the business cycle is at most around 20%. The asymmetry in the response of wages to the business cycle is therefore not very large and the estimates of the semi-elasticities in the downturns are close to the average estimates for the entire period (Table 5). This finding may be influenced by the fact that in most years of our sample (12 out of 19), the unemployment rate increased.

We also find the institutional influences on RWC that we found for the entire business cycle remain valid when it is split between upswings and downturns. In particular, the main institution influencing RWC is still CB coverage. Contract types continue to have a limited effect on RWC and only within the covered workers' group. Finally, the hypothesis of constant differences in RWC between temporary and permanent

contracts across bargaining regimes remains valid in the different phases of the business cycle.[23]

6.2. Robustness checks

To assess the robustness of our results, we consider several typical business cycle indicators, such as contemporaneous unemployment rate, (log) lagged employment and (log) contemporaneous aggregate productivity. In addition, we also consider two more recent measures of compression/tightness in the labour market (Moscarini and Postel-Vinay, 2016;Moscarini and Postel-Vinay, 2017; Autor et al., 2023)[24]. These measures attribute a relevant role to job-to-job transitions for workers to extract rents from their employers, whereas in the canonical search and matching model the main role is that of the job finding rate which determines the unemployment rate. Therefore, job-to-job separation rates have an independent power in predicting wage growth (Moscarini and Postel-Vinay, 2017). This analysis can be seen as a complementary way of analysing how labour market institutions - CB and contract types - shape wage flexibility.

The first of these indicators of tightness is an aggregate measure of the employment-to-employment transition rate in the private sector in Portugal. This measure was computed as the percentage of workers that changed employer (firm) between two consecutive years in Quadros de Pessoal[25]. The second measure, similar to Autor et al.,

[23] The working paper version also includes an analysis along the gender dimension.
[24] These measures were suggested by one of the referees, which we would like to thank.
[25] In 2001 there is no workers information in QP. Therefore, the employment level of 2001 and the number of job-to-job transitions between 2000-2001 and 2001-2002, had to be estimated. Regarding the former, we assumed that employment in QP grew at same rate as aggregate employment in the Portuguese economy between 2000 and

2023), combines in a single indicator (tightness) the standardized values of the percentage of job-to-job transitions and of the unemployment rate[26]. This tightness indicator is given by:

$$tightness_{t-1} = (\frac{Job\ transitions_{t-1} - Job\ transitions_{mean}}{job\ transitions_{sd}} - \frac{U_{t-1} - U_{mean}}{U_{sd}})$$

The terms with a 'mean' subscript indicate means (of the percentage of job-to-job transitions and of the unemployment rate), whereas the 'sd' subscript indicates their standard deviations. So, tightness in the labour market increases (decreases) with the increase (decrease) of the percentage of job-to-job transitions and with the decrease (increase) of the unemployment rate. In the second-step regressions (equation 2), we use the lagged values of both tightness indicators (for the same reason that we used the lagged values of the unemployment rate in our base specification).

Among the alternative business cycle indicators, the coefficient of a regression of real hourly wages on aggregate labour productivity for new hires also assumes special interest as a measure of wage rigidity. In fact, if wages are perfectly flexible, then the new hires' wages should respond in an approximately proportional way to labour productivity and, consequently, this elasticity should be equal or close to one; on the contrary, if wages on the new matches are perfectly rigid, this elasticity should be zero (Pissarides, 2009; Haefke et al., 2013). To the best of our knowledge, this is the first time that this test is carried out in the context of comparing different industrial bargaining

2001, 1,72%; regarding the latter, we divided the total number of job transitions between 2000 and 2002 equally between 2000-2001 and 2001-2002.

regimes (covered/uncovered) and type of contract in relation to RWC. This gains special interest as CB imposes constraints on wage formation that do not exist in the case of uncovered workers. Therefore, the link between productivity and new hires' wages should be stronger for uncovered workers.

Beyond the alternative business cycle indicators, we also consider an alternative approach to detrend the data, the Hodrick-Prescott filter,[27] an alternative measure of wages, the hourly base wage, and a different set of fixed effects in the first step of our methodological approach (worker, firm and job). Regarding the hourly base wage, it corresponds to the monthly base pay divided by the normal hours of work, whereas the hourly earnings include the base wage, regular benefits and overtime pay, divided by the total hours of work. The measure of wages based on earnings should be more cyclical as it includes components which are more flexible/variable and therefore more exposed to the business cycle (Verdugo, 2016; Swanson, 2007). The alternative set of fixed effects (worker, firm and job fixed effects, instead of worker and firm-job fixed effects) does not control to the same extent for the quality of the match but is a more common specification in the literature.

Table C (appendix 2) displays the second-step estimates for the different robustness tests considered in our analysis. The general pattern of these estimates is quite similar to that found in our base model (Table 4, model 6), independently of the business cycle

[27] The smoothing parameter for the HP filter as $\lambda = 100$ as in Backus and Kehoe (1992) and Stüber (2017).

indicator, the measure of wages and the method of detrending the data. Hence, in general, wages are procyclical, this procyclicality being higher for the new hires than for stayers, mainly for the uncovered workers (temporary and permanent contracts) and for $W_{base} > W_{CBT}$ workers with permanent contracts.

The findings using the indicator of job-to-job transitions deserve some further attention. First, in general, wages are quite responsive to changes in the percentage of workers changing of employer: for the base category, a percentage point increase in the rate of changing of employer, implies an expected increase of about 1.2 percent in wages. Second, this sensitivity is particularly evident for the uncovered workers and for the $W_{base} > W_{CBT}$ workers, although to a lesser extent. So, for the workers that are totally or partially free of the constraints of the CB process, wages are quite sensitive to changes in the aggregate rate of changing employer. For these groups, this effect is reinforced for the new hires. This may suggest that these workers are more exposed to movements between employers than of movements between unemployment and employment. Third, the wages of the stayers of these groups also react positively to changes in the transition rate, but those of the $W_{base} = W_{CBT}$ workers do not exhibit positive significant differential effects, even for the new hires. This may be compatible with the hypothesis of wage raises to prevent quits from external offers (Moscarini and Postel-Vinay, 2017) for the stayers of both groups ($W_{base} > W_{CBT}$ workers and uncovered workers).

Table D (appendix 2) displays the implied semi-elasticities for the new hires, according to the indicator in the robustness analysis and the corresponding tests as in Table 5. The

pattern of the estimates is again qualitatively quite stable in relation to the base estimates shown in Table 5. The major sources of uncertainty (variation) concern the test of equality between temporary and permanent contracts for $W_{base} = W_{CBT}$ workers and the difference in RWC between $W_{base} = W_{CBT}$ and $W_{base} > W_{CBT}$ workers with permanent contracts. As in the base model, these tests were not unequivocally significant either, some variation in them according to the measure of robustness seems normal.

The estimates with the EE-separation rate indicate that wages react more to changes in the aggregate rate of job-to-job transition than to the lagged unemployment rate. Besides, the differences between bargaining regimes are now wider, suggesting, as we mentioned before, that there are workers' groups, particularly the $W_{base} > W_{CBT}$ and the uncovered, that are more involved in job-to-job transitions than in movements of unemployment to employment[28]. The estimates with the composite measure of the lagged unemployment rate and of the EE-transition rate, keep, in general, the same pattern of the base specification.

Of special interest are also the results for the influence of labour productivity on the new hires' wages and how they differ among bargaining regimes. These findings show that, in the case of the uncovered workers, there is a significant and proportional (or

[28] For example, the difference of semi-elasticities of the new hires' wages between the $W_{base}=W_{CBT}$ and the $W_{base} > W_{CBT}$ workers with permanent contracts is of about 26% when the business cycle indicator is the Ut-1 and of about 49% with the EE-separation rate. So, the difference between the covered and uncovered groups enlarges when the EE-separation rate is considered as business cycle indicator.

near proportional) relation between productivity and the new hires' wages, as the estimated elasticity is very close to one. Conversely, when wages are set in the context of CB, the relation between productivity and the new hires' wages is weaker as the estimated elasticity is lower than 1 – but significant – for $W_{base} > W_{CBT}$ new hires, whereas for $W_{base} = W_{CBT}$, it is insignificant.

As stated earlier, these are novel and important results in the context of RWC studies, even if they also correspond to what could be expected *a priori*. Indeed, when wages are bargained directly between the worker and the firm, there are no other legal constraints, beyond the national minimum wages, to new hires' wages reflecting workers' expected productivity directly. Conversely, the CB process imposes constraints on wages as they cannot be lower than that established in CB tables for a given job title. In this way, in the case of $W_{base} = W_{CBT}$ new hires, the wages are not really bargained by these workers, but by the continuing workers that have voice and power within the union that bargains wages with the firm(s). Therefore, the link between productivity and wages is broken because the wages of continuing workers do not follow the evolution in productivity as closely as the wages of the new hires with real capacity to bargain (Haefke et al., 2013). The positive – but lower than 1 – elasticity in the case of $W_{base} > W_{CBT}$ new hires reflects precisely the fact that firms and workers in this case have some margin to bargain wages, but even so are constrained by the terms of the collective agreement.

The estimates of the base model considering a different set of fixed effects (worker, firm and job) do not evidence major qualitatively differences in relation to those of the base specification. In spite of this, the estimated semi-elasticities are slightly higher. This is a normal finding as this alternative set of fixed effects does not control for the quality of the match to the same extent.[29]

7. Conclusions

Several important conclusions arise from this study. First, we provide evidence that labour market institutions matter for real wage cyclicality (RWC). This result opens up a new, macroeconomic channel for labour institutions to influence real variables. Second, a specific labour institution, collective bargaining (CB) coverage is found to be a key institution, at least in our case study of Portugal but most likely also in other continental European countries with similar institutional contexts. According to our results, CB coverage may weaken considerably the relationship between real wages and the business cycle, here proxied by unemployment and other variables. In fact, the response of the new hires' real wages to unemployment is at least 50% higher for uncovered workers than for covered workers. Coverage is even more important than the CB minimum wage bite in the sense that most differences are found to arise between covered and uncovered workers and not within the covered group (between workers at

[29] A similar pattern was found by Carneiro et al. (2012) in a previous study for Portugal. Table E in the appendix shows the tests of equal differences between the semi-elasticities of the different bargaining regimes according to contract type and robustness analysis indicator. These tests, virtually in all cases, do not reject the hypothesis that the difference in RWC between temporary and permanent contracts is equal between bargaining regimes. Therefore, we cannot exclude the hypothesis that the differences of cyclicality between contract type between bargaining regimes are explained by differences of bargaining power and not by other factors.

or above the CB floors). Moreover, the differences of wage flexibility according to CB are even stronger when the aggregate employer-to-employer/separation rate is considered as an alternative business cycle indicator. These findings also suggest that the workers paid above the collective bargaining floors and the uncovered are more involved in job-to-job transitions and benefit more from that.

Third, employment contract type does not play a significant role in RWC. In fact, a CB-covered firm's wage policy is established by their collective agreements, which apply in the same way to both contract types. Moreover, we also found no significant differences in RWC between temporary and permanent contracts even for uncovered workers.

Fourth, a theoretical proportionality (unitary elasticity) in the relationship between new hires' real wages and productivity over the business cycle arises only for uncovered new hires. For those covered, this relationship is less than proportional (elasticity < 1) for workers paid above the CB level and not significant for workers paid at CB minimum wages. In this sense, CB weakens the relationship between new hires' wages and labour productivity as their wages are partly or totally bargained by incumbent workers and not by the new hires. This result speaks to debates about the representativeness of social partners and its effects on real economic outcomes.

Overall, our findings remain qualitatively invariant to different business cycle indicators, different wage measures, a different method of detrending the data, and a different set

of fixed effects. However, we find some evidence of asymmetric effects in the relationship between real wages and unemployment between different phases of the business cycle (upswings and downturns), with greater responsiveness during the former.

Regarding policy implications, our evidence indicates that CB constrains the response of real wages to unemployment. In this sense, CB weakens the capacity of the economy to absorb shocks. Introducing flexibility into the CB framework, for example as has been done in Germany (Jäger et al., 2022), and not imposing collective agreements on non-signatory parties may help the economy to absorb shocks at a lower unemployment cost. Hence, specific policy measures may be considered, such as opt-out (hardship) and opening clauses (Dustmann et al., 2014; OECD, 2017) in collective agreements, restricting administrative extensions, not imposing mandatory regimes on uncovered workers, and restricting the ultra-activity of expired, but not renewed, agreements. While CB may serve to counteract employer market power (Dodini, 2022) and its negative effects on wages (but not on the adoption of temporary contract – Bassanini et al. (2024)), its macroeconomic implications may be more substantial than previously considered.

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MAIN TABLES

Table 1: Distribution of employment in the private sector in Portugal (%), 2002-2020

Year	Workers covered by collective agreements			Uncovered workers	Firms (%)		
	$W_{base} > W_{CBT}$	$W_{base} = W_{CBT}$	total		uncovered	With covered and uncovered employees	covered
2002	52.4	42.5	94.9	5.1	3.3	0.4	96.3
2003	53.5	41.4	94.8	5.2	3.3	0.5	96.2
2004	53.8	39.7	93.5	6.5	3.6	1.3	95.1
2005	52.2	39.9	92.0	8.0	4.0	1.4	94.6
2006	51.9	38.4	90.3	9.7	5.0	1.6	93.4
2007	52.4	38.1	90.5	9.5	5.8	1.8	92.4
2008	51.6	38.7	90.4	9.6	6.5	1.9	91.6
2009	51.7	38.5	90.2	9.8	6.7	1.9	91.4
2010	52.4	39.2	91.6	8.4	4.7	0.6	94.7
2011	52.2	38.9	91.0	9.0	5.0	0.6	94.4
2012	50.4	38.9	89.3	10.7	7.1	0.7	92.2
2013	49.7	39.1	88.8	11.2	7.6	0.8	91.6
2014	47.7	40.9	88.6	11.4	8.2	0.9	91.0
2015	49.4	38.8	88.2	11.8	8.6	0.9	90.4
2016	47.5	39.6	87.1	12.9	9.2	1.0	89.8
2017	46.2	40.1	86.2	13.8	10.3	1.0	88.7
2018	46.1	39.5	85.6	14.4	11.1	1.0	87.8
2019	46.1	38.7	84.8	15.2	12.0	1.1	86.9
2020	43.4	40.2	83.6	16.4	12.9	1.2	85.9

Notes: Authors' calculations based on the "Quadros de Pessoal" data set. W_{base}: base wage; W_{CBT}: minimum contractual wage for a given job title within a given collective agreement. Firms uncovered: firms where all employees are not covered by collective agreements; firms covered: firms whose employees are all covered by collective agreements.

Table 2: Means of selected variables, workers covered and not covered by collective agreements, Portugal, 2002 and 2020

	2002		2020	
	Covered workers	Uncovered workers	Covered workers	Uncovered workers
Real hourly earnings (log)	.3 (.54)	.58 (.67)	.43 (.47)	.55 (.52)
Real hourly base wage (log)	.15 (0.5)	.43 (.66)	.26 (.44)	.39 (52)
Age (in years)	37.33 (10.67)	35.35 (10.11)	41.65 (10.99)	39.12 (10.63)
Tenure (in years)	8.05 (11.51)	5.09 (9)	8.37 (9.31)	6 (7.74)
Lower secondary education	.18	.15	.27	.18
Upper secondary education	.17	.25	.32	.31
University degree	.08	.25	.21	.39
Number of employees	886.84 (2625.43)	487.72 (830.62)	1058.52 (3520.23)	1295.04 (2758.29)
Sales (log) – current prices	15.05 (2.79)	15.21 (2.7)	15.41 (2.83)	15.86 (2.57)
Majority of capital: public	.04	0.11	.04	0.13
Majority of capital: foreign	.09	0.09	.15	0.23
Firm age (in years)	21.55 (32.59)	18.22 (28.17)	30.51 (44.61)	22.53 (21.39)
Legislators, Senior Officials and managers	.02	.03	.04	.04
Professionals	.05	.2	.11	.24
Technicians and associate professionals	.11	.18	.11	.14
Clerks	.15	.19	.13	.19
Service workers and shop and market sales workers	.18	.15	.21	.12
Skilled agricultural and fishery workers	0	.01	0	.01
Craft and related trades Workers	.22	.07	.16	.08
Plant and machine operators and assemblers	16	.06	.12	.07
Elementary occupations	.11	.11	.11	.11
N	1,840,764	98,906	1,947,116	381,983

Notes: Authors' calculations based on the "Quadros de Pessoal" data set. The variables related to education, occupations, industries and majority of capital, represent the share of workers in the selected sample.

Table2 (cont.): Means of selected variables, workers covered and not covered by collective agreements, Portugal, 2002 and 2020

	2002		2020	
	Covered workers	Uncovered workers	Covered workers	Uncovered workers
Agriculture, forestry and fishing	0	0	0	.01
Mining and quarrying	.01	0	0	0
Manufacturing	.31	.09	.24	.12
Electricity, gas, steam and air conditioning supply	.01	.01	0	0
Water supply; sewerage, waste management and remediation activities	0	.06	0	.04
Construction	.13	.01	.09	.03
Wholesale and retail trade; repair of motor vehicles and motorcycles-	.19	.03	.2	.07
Transportation and storage	.08	.07	.06	.03
Accommodation and food service activities	.07	.01	.08	.02
Information and communication	.02	.14	.03	.11
Financial and insurance activities	04	.01	.03	.03
Real estate activities	.01	.01	.01	.01
Professional, scientific and technical activities	.03	.09	.04	.09
Administrative and support service activities	.03	.1	.06	.16
Public administration and defence; compulsory social security	0	.12	0	.02
Education	.01	.03	.02	.04
Human health and social work activities	.07	.09	.1	.15
Arts, entertainment, and recreation	0	.05	.01	.02
Other service activities	.01	.09	.02	.03
Activities of extraterritorial organisations and bodies	0	0	0	0
N	1840764	98906	1947116	381983

Notes: Authors' calculations based on the "Quadros de Pessoal" data set. The variables related to education, occupations, industries and majority of capital, represent the share of workers in the selected sample. Industries are organised according to the statistical classification of economic activities in the European Community, NACE rev. 2.

Table 3: Temporary contracts (%), Portugal, 2002-2020

Year	Workers covered by collective agreements				Uncovered Workers		total		
	$W_{base} > W_{CBT}$		$W_{base} = W_{CBT}$						
	Stayers	New hires	Stayers	New hires	Stayers	New hires	Stayers	New hires	total
2002	12.10	54.31	13.49	53.63	18.26	62.51	12.97	54.56	20.33
2003	12.89	60.24	14.02	59.91	21.27	76.05	13.75	61.30	21.08
2004	13.52	60.62	14.06	59.88	24.40	81.99	14.35	62.86	21.56
2005	13.25	59.95	14.16	60.38	27.51	85.03	14.56	63.72	23.09
2006	13.67	63.49	14.78	62.25	27.37	78.39	15.32	64.90	24.19
2007	14.78	66.50	16.30	63.97	29.82	76.12	16.68	66.54	26.36
2008	15.96	67.84	18.15	67.64	27.81	73.21	17.87	68.37	27.31
2009	16.51	68.13	19.14	66.76	23.71	72.78	18.16	68.12	26.44
2010	11.35	62.04	13.69	64.98	15.82	70.74	12.59	64.33	21.11
2011	12.66	66.70	15.22	67.29	16.68	71.49	13.96	67.52	22.28
2012	13.55	68.06	17.06	68.88	18.08	72.18	15.35	68.97	22.32
2013	14.13	70.43	17.21	72.41	17.95	75.13	15.72	71.96	23.90
2014	14.38	71.16	18.15	73.81	18.17	76.93	16.28	73.24	26.02
2015	15.32	70.63	19.37	71.74	19.34	75.56	17.27	71.89	27.36
2016	16.37	71.82	20.17	73.66	19.40	76.17	18.18	73.38	28.79
2017	17.43	71.98	21.32	74.56	20.10	77.00	19.27	74.03	30.51
2018	18.49	72.34	22.51	75.42	22.96	73.26	20.62	73.87	31.99
2019	18.76	69.74	22.90	73.47	22.52	72.90	20.83	71.99	31.86
2020	18.10	64.78	22.51	69.68	23.20	70.58	20.60	68.29	28.98

Notes: W_{base}: base wage; W_{CBT}: minimum contractual wage for a given job title within a given collective agreement. Authors' calculations based on the "Quadros de Pessoal" data set. New hires: workers whose tenure <1; Stayers: workers whose tenure>=1

Table 4: two-step estimator; N first step = 39,255,694; dependent variable: real hourly earnings (log); N second step = 19; quadratic time trend in the second step; business cycle indicator: unemployment rate (t-1), Portugal, 2002-2020.

	model 1	model 2	model 3	model 4
1. Business cycle indicator	-0.549*** (0.161)	-0.521*** (0.157)	-0.530*** (0.158)	-0.502*** (0.154)
2. Differential effects				
Stayers, temporary contract		-0.173*** (0.0450)		
Stayers, uncovered			-0.227*** (0.0500)	
Stayers, covered, temporary contract				-0.174*** (0.0417)
Stayers, uncovered, temporary contract				-0.368*** (0.0953)
Stayers, uncovered, permanent contract				-0.232*** (0.0498)
New hires, total	-0.208*** (0.0538)			
New hires, covered workers			-0.169*** (0.0538)	
New hires, uncovered workers			-0.629*** (0.0951) A***	
New hires, temporary contract		-0.281*** (0.0694) A***		
New hires, permanent contract		-0.206*** (0.0506)		
New hires, covered workers, temporary contract				-0.244*** (0.0699) A
New hires, covered workers, permanent contract				-0.161*** (0.0446)
New hires, uncovered workers, temporary contract				-0.672*** (0.117) A***
New hires, uncovered workers, permanent contract				-0.689*** (0.137) A***

Notes: These estimates are based on seemingly unrelated regressions in the second step. The second step estimates were weighted by the number of observations / year for each category of workers; A - tests of the null hypothesis: incremental effect for $stayers_g$= incremental effect for $new\text{-}hires_g$; The stars indicate the level of significance at which the null is rejected; Tests were carried out with the Stata commands 'suest' and 'test'; Standard errors are in parentheses; ***, **, *: significant at: 1%, 5% and 10%, respectively. model 1: homogeneous labour market; model 2: model 1+ temporary and permanent contracts; model 3: with workers covered and uncovered by collective agreements; model 4: model 3 + temporary and permanent contracts.

Table 4 (cont): two-step estimator; N first step = 39,255,694; dependent variable: real hourly earnings (log); N second step = 19; quadratic time trend in the second step; business cycle indicator: unemployment rate (t-1), Portugal, 2002-2020.

	model 5:	model 6:
1. Business cycle indicator	-0.554***	-0.527***
	(0.152)	(0.149)
2. Differential effects		
Stayers ($W_{base} = W_{CBT}$)	0.0769*	
	(0.0431)	
Stayers (uncovered)	-0.209***	
	(0.0520)	
Stayers ($W_{base} > W_{CBT}$) - temporary		-0.179***
		(0.0488)
Stayers ($W_{base} = W_{CBT}$), temporary		-0.0590
		(0.0727)
Stayers ($W_{base} = W_{CBT}$), permanent		0.0718*
		(0.0398)
Stayers (uncovered), temporary		-0.336***
		(0.0960)
Stayers (uncovered): permanent		-0.218***
		(0.0499)
New hires, uncovered workers	-0.596***	
	(0.101)	
	A***	
New hires, uncovered workers, temporary		-0.633***
		(0.123)
		A***
New hires, uncovered workers, permanent		-0.671***
		(0.139)
		A***
New hires, workers ($W_{base} > W_{CBT}$)	-0.164**	
	(0.0626)	
New hires, workers ($W_{base} = W_{CBT}$)	-0.0568	
	(0.0820)	
	A***	
New hires, workers ($W_{base} = W_{CBT}$), temporary		-0.132
		(0.0916)
		A
New hires, workers ($W_{base} = W_{CBT}$), permanent		-0.0375
		(0.0783)
		A**
New hires, workers ($W_{base} > W_{CBT}$), temporary		-0.227**
		(0.0831)
New hires, workers ($W_{base} > W_{CBT}$), permanent		-0.185***
		(0.0529)

Notes: These estimates are based on seemingly unrelated regressions in the second step. The second step estimates were weighted by the number of observations / year for each category of workers; A - tests of the null hypothesis: incremental effect for $stayers_g$= incremental effect for $new\text{-}hires_{g;}$ The stars indicate the level of significance at which the null is rejected; Tests were carried out with the Stata commands 'suest' and 'test'; Standard errors are in parentheses; ***, **, *: significant at: 1%, 5% and 10%, respectively. model 5: workers ($W_{base} > W_{CBT}$) + workers ($W_{base} = W_{CBT}$) + uncovered workers; model 6: model (5) + temporary and permanent contracts.

Table 5: implied semi-elasticities to the business cycle indicator for new hires and equality tests between different institutional arrangements
first step dependent variable: log hourly earnings; business cycle indicator: Ut-1; quadratic time trend, Portugal, 2002-2020.

	Implied semi-elasticities for new hires			**Test**	**Implied semi-elasticities for new hires**		**Test**
	all	temporary	permanent	temporary=permanent	covered	uncovered	covered=uncovered
model 1	-0,757***						
model 2		**-0.802*** **	**-0.727*** **	**2.447**			
model 3					-0.699***	-1.159***	43.96***

Implied semi-elasticities for new hires				**Tests**		
covered		uncovered			temporary = permanent, within category	
temporary	permanent	temporary	permanent	all equal	covered	uncovered
-0.746***	-0.663***	-1.174***	-1.191***	64.254***	**3.041***	0.015

Tests	
covered = uncovered, between bargaining regimes	
temporary	Permanent
20.733***	26.876***

Irrelevance of contracts, between bargaining regimes	
	Uncovered
Covered	0.505

Table 5 (cont.): implied semi-elasticities to the business cycle indicator for new hires and equality tests between different institutional arrangements, first step dependent variable: log hourly earnings; business cycle indicator: Ut-1; quadratic time trend, Portugal, 2002-2020.

	Implied semi-elasticities for new hires				**Tests**		
model 5	**($W_{base} > W_{CBT}$)**	**($W_{base} = W_{CBT}$)**	**uncovered**	**All equal**	**($W_{base} > W_{CBT}$) =($W_{base} = W_{CBT}$)**	**($W_{base} > W_{CBT}$) = uncovred**	**($W_{base} = W_{CBT}$)= =uncovered**
	-0.719* **	**-0.611*** **	**-1.151*** **	**54.057*** **	**2.656**	**33.65*** **	**50.82*** **
	Implied semi-elasticities for new hires						
	($W_{base} > W_{CBT}$)		**($W_{base} = W_{CBT}$)**		**uncovered**		
	temporary	**permanent**	**temporary**	**permanent**	**temporary**	**permanent**	
	-0.754* **	**-0.711*** **	**-0.659*** **	**-0.564*** **	**-1.159*** **	**-1.198*** **	
	Tests						
	temporary = permanent, within group				**temporary, between groups**		
	all equal	($W_{base} > W_{CBT}$)	($W_{base} = W_{CBT}$)	uncovered	all equal	($W_{base} > W_{CBT}$) =($W_{base} = W_{CBT}$)	($W_{base} > W_{CBT}$)=uncovered
model 6	78.852***	0.443	**3.668***	0.077	29.615***	2.131	14.949***
	temporary, between groups		**permanent, between groups**				
	($W_{base} = W_{CBT}$) =uncovered	**all equal**	($W_{base} > W_{CBT}$) =($W_{base} = W_{CBT}$)	($W_{base} > W_{CBT}$) =uncovered		($W_{base} = W_{CBT}$) =uncovered	
	29.199***	39.306***	3.492*	18.241***		39.051***	
	Irrelevance of contracts, between bargaining regimes						
		($W_{base} > W_{CBT}$)	$W_{base} = W_{CBT}$)	uncovered		All	
	($W_{base} > W_{CBT}$)	-----	1.039	0.243		0.243	
	($W_{base} = W_{CBT}$)			1.105			

Notes: these estimates are based on seemingly unrelated regressions in the second step. These estimates were weighted by the number of observations / year for each category of workers. In each block of tests we display the qui-squared statistic for the null hypothesis considered; these tests were carried out with the Stata commands 'suest' and 'test'; ***, **, *: significant at: 1%, 5% and 10%, respectively. model 1: homogeneous labour market; model 2: model 1+ temporary and permanent workers; model 3: with workers covered and uncovered by collective agreements; model 4: model 3 + temporary and permanent workers; model 5: workers ($W_{base} > W_{CBT}$) + workers ($W_{base} = W_{CBT}$) +uncovered workers; model 6: model (5) + temporary and permanent workers.

Appendix 1: Models 1 to 6, two-step estimator

Model 1

Homogeneous labour market, there is no distinction either of workers or of contracts. Workers differ only in their seniority status.

{s=1: stayer; s=2=new hire}

base category: s=1;

General model of RWC

$$lnw_{i,f,j,t} = \beta_2 newhire + \mu_0 \times bcy_t + \mu_1 newhire \times bcy_t + X_{it}\gamma + time\ trend_t + fe_{i,f,j} + error_{i,f,j,t}$$

Two step estimator:

1st step:

$$lnw_{i,f,j,t} = \beta_2 newhire + \psi_{0,t}T_t + \psi_{1,t}T_t newhire_{it} + X_{it}\gamma + fe_{i,f,j} + error_{i,f,j,t}$$

2nd step:

$\widehat{\psi_{0,t}} = \mu_0 bcy_t + time\ trend + error$, for s=1

$\widehat{\psi_{1,t}} = \mu_1 bcy_t + time\ trend + error$, for; s=2:

μ_0: implied semi -elasticity for stayers;

implied semi-elasticity for the new hires: $\mu_0+\mu_1$.

Model 2: model 1 + temporary and permanent contracts

General model of RWC

$$lnw_{i,f,j,t} = \beta_{c,s} I_{c,s} + \mu_{0,c} I_c \times stayer \times bcy_t +$$

$$\mu_{1,c} I_c \times newhire \times bcy_t + X_{it}\gamma + time\ trend_t + fe_{ifj} +$$

$$+ error_{i,f,j,t} \quad (1)$$

base category: c=1; s=1

Two step estimator:

1st step:

$$lnw_{i,f,j,t} = \beta_{c,s} I_{c,s} + \psi_{0,c,t} I_c \times stayer \times T_t$$

$$+ \psi_{1c,t} I_c \times newhire \times T_t + X_{it}\gamma + fe_{i,f,j} + error_{i,f,j,t} \quad (2)$$

2nd step:

$\widehat{\psi_{0,c,t}} = \mu_{0,c} bcy_t + time\ trend + error$, for c=1, 2; s=1

$\widehat{\psi_{1,c,t}} = \mu_{1,c} bcy_t + time\ trend + error$, for c=1, 2; s=2:

$\mu_{0,c}$: semi-elasticity for the base category and incremental effects for stayers;

Implied semi-elasticity for the base category: $\mu_{0,1}$

$\mu_{1,c}$: incremental Effect for the new hires (s=2) with contract (c)

Implied semi-elasticities for the new hires (c=1,2): $\mu_{\mathbf{0,1}}+\mu_{\mathbf{1},c}$

Model 3: model 1 + workers divided between covered and uncovered by Collective Bargaining

group (g) = {covered=1, uncovered=2};

seniority (s)= {stayer=1, new hire=2}

base category: g=1; s=1

General model of RWC

$$lnw_{i,f,j,t} = \beta_{g,s} I_{g,s} + \mu_{0,g} I_g \times stayer \times bcy_t +$$

$$\mu_{1,g} I_g \times newhire \times bcy_t + X_{it}\gamma + time\ trend_t + fe_{ifj} +$$

$$+ error_{i,f,j,t} \quad (1)$$

Two step estimator:

1st step:

$$lnw_{i,f,j,t} = \beta_{g,s} I_{g,s} + \psi_{0,g,t} I_{g,c} \times stayer \times T_t +$$

$$+ \psi_{1,g,t} I_g \times newhire \times T_t + X_{it}\gamma + fe_{i,f,j} + error_{i,f,j,t} \quad (2)$$

2nd step:

$\widehat{\psi_{0,g,t}} = \mu_{0,g} bcy_t + time\ trend + error$, for g=1,2; s=1

$\widehat{\psi_{1,g,t}} = \mu_{1,g} bcy_t + time\ trend + error$, for g=1,2; s=2.

$\mu_{0,g}$: implied semi-elasticity for the base category and incremental effects for stayers;

semi-elasticity: $\mu_{0,1}$ for covered stayers.

Incremental effect for new hires: $\mu_{1,g}$

Implied semi-elasticity for new hires [(g=1,2); s=2]= $\mu_{0,1}+\mu_{1,g}$

Model 4: model 3 with temporary and permanent contracts

group (g) = {covered=1, uncovered=2}

contracts (c)= {permanent=1; temporary=2}

seniority (s)= {stayer=1, new hire=2}

base category: g=1; c=1; s=1;

General model of RWC:

$$lnw_{i,f,j,t} = \beta_{g,c,s} I_{g,c,s} + \mu_{0,g,c} I_{g,c} \times stayer \times bcy_t + \mu_{1,g,c} I_{g,c} \times newhire \times bcy_t +$$

$$X_{it}\gamma + time\ trend_t + fe_{ifj} +$$

$$error_{i,f,j,t} \quad (1)$$

Two step estimator:

1st step:

$$lnw_{i,f,j,t} = \beta_{g,c,s} I_{g,c,s} + \psi_{0,g,c,t} I_{g,c} \times stayer \times T_t +$$

$$+ \psi_{1,g,c,t} I_{g,c} \times newhire \times T_t + X_{it}\gamma + fe_{i,f,j} + error_{i,f,j,t} \quad (2)$$

2nd step:

$\widehat{\psi_{0,g,c,t}} = \mu_{0g,c} bcy_t + time\ trend + error$, for g=1,2; c=1,2; s=1

$\widehat{\psi_{1,g,c,t}} = \mu_{1,g,c} bcy_t + time\ trend + error$, for g=1,2; c=1,2; s=2

$\mu_{0,g,c}$: semi-elasticities (base category) and incremental effects for stayers;

semi-elasticity (base category): $\mu_{0,1,1}$

$\mu_{1,g,c}$: incremental Effects for the new hires (s=2) of group (g) and contract (c)

Implied semi-elasticities for new hires (g,c): $\mu_{0,1,1}+\mu_{1,g,c}$

Model 5:

workers: [g=1: ($W_{base} > W_{CBT}$) workers; g=2 ($W_{base} = W_{CBT}$) workers; g=3 uncovered workers]; contracts: no distinction; seniority {s=1=stayers; s=2=new hires}

General model of RWC

$$lnw_{i,f,j,t} = \beta_{g,s} I_{g,s} + \mu_{0,g} I_g \times stayer \times bcy_t +$$

$$\mu_{1,g} I_g \times newhire \times bcy_t + X_{it}\gamma + time\ trend_t + fe_{ifj} +$$

$$+error_{i,f,j,t} \quad (1)$$

Two step estimator:

1st step:

$$lnw_{i,f,j,t} = \beta_{g,s} I_{g,s} + \psi_{0,g,t} I_{g,c} \times stayer \times T_t$$

$$+\psi_{1,g,t} I_g \times newhire \times T_t + X_{it}\gamma + fe_{i,f,j} + error_{i,f,j,t} \quad (2)$$

2nd step:

$\widehat{\psi_{0,g,t}} = \mu_{0,g} bcy_t + time\ trend + error$, for g=1,2,3; s=1

$\widehat{\psi_{1,g,t}} = \mu_{1,g} bcy_t + time\ trend + error$, for g=1,2,3; s=2

$\mu_{0,g}$: implied semi-elasticity for the base category and incremental effects for stayers;

Implied semi-elasticity: $\mu_{0,1}$ for covered stayers.

Incremental effect for new hires: $\mu_{1,g}$

Implied semi-elasticity for new hires [(g=1,2,3); s=2]= $\mu_{0,1}+\mu_{1,g}$

General model of RWC (model 6)

workers: {g=1: ($W_{base} > W_{CBT}$) workers; g=2 ($W_{base} = W_{CBT}$) workers; g=3 uncovered workers}; contracts (c)= {permanent=1; temporary=2}; seniority {s=1=stayers; s=2=new hires}

$$lnw_{i,f,j,t} = \beta_{g,c,s} I_{g,c,s} + \mu_{0,g,c} I_{g,c} \times stayer \times bcy_t +$$

$$\mu_{1,g,c} I_{g,c} \times newhire \times bcy_t + X_{it}\gamma + time\ trend_t + fe_{i,f,j} +$$

$$+error_{i,f,j,t} \quad (1)$$

$I_{g,c,s}$: dummies identifying the simultaneous set of workers' characteristics regarding the CB institutional setting (g=1, 2, 3), kind of contract (c=1, 2) and seniority status (s=1,2).

X_{it}= age, age^2, education dummies.

$fe_{i,f,j}$: fixed effects

Base category: g=1; c=1; s=1.

T_t: year dummies

Two step estimator:

<u>1st step:</u>

$$lnw_{i,f,j,t} = \beta_{g,c,s} I_{g,c,s} + \psi_{0,g,c,t} I_{g,c} \times stayer \times T_t$$

$$+\psi_{1,g,c,t} I_{g,c} \times newhire \times T_t + X_{it}\gamma + fe_{i,f,j} + error_{i,f,j,t} \quad (2)$$

<u>2nd step:</u>

$$\widehat{\psi_{0,g,c,t}} = \mu_{0g,c} bcy_t + time\ trend + error, \text{ for g=1,2,3; c=1, 2; s=1} \quad (3)$$

$\widehat{\psi_{1,g,c,t}} = \mu_{1,g,c} bcy_t + time\ trend + error$, for g=1,2,3; c=1, 2; s=2. (4)

$\mu_{0,g,c}$: semi-elasticity of wages (base category) and incremental effects for stayers;

semi-elasticity (base category): $\mu_{\mathbf{0,1,1}}$

$\mu_{1,g,c}$: incremental Effect for the new hires (s=2) of group (g) and contract (c)

Implied semi-elasticities of the new hires (g,c): $\mu_{\mathbf{0,1,1}}+\mu_{\mathbf{1},g,c}$

Appendix 2: Additional tables

Table 1b: descriptive statistics, selected variables, Portugal, 2002-2020

Variable	Mean / share	
	Initial sample	Largest connected set
Age (years)	39.37	39.52
	(10.65)	(10.57)
Education (share of workers)		
Non-defined	0.01	0.00
Less than basic school	0.01	0.01
Basic school	0.16	0.16
Preparatory	0.18	0.18
Lower secondary	0.24	0.24
Upper secondary	0.24	0.24
University degree	0.16	0.17
New hire	0.18	0.16
Temporary contract	0.26	0.25
Uncovered workers	0.11	0.11
($W_{base} > W_{CBT}$) workers	0.50	0.50
($W_{base} = W_{CBT}$) workers	0.39	0.39
Hourly earnings (log)	0.35	0.36
	(0.53)	(0.53)
Hourly base wages (log)	0.19	0.20
	(0.51)	(0.51)
Number of firms	701,106	559,625
Number of workers	5,800,343	4,636,607
Firms#jobs	2,459,016	1,524,885
N	41,526,425	39,255,694

Note: standard deviations are in parenthesis. The largest connected set corresponds to the largest group of workers and firm/occupations that are linked through employment relationships

Table A: model 6, asymmetric effects, 2nd step estimates; N first step = 39,255,694; N second step = 19; dependent variable: real hourly earnings (log); quadratic time trend in the second step; business cycle indicator: unemployment rate (t-1), Portugal, 2002-2020.

	unemployment increasing (1)	unemployment decreasing (2)	test (3): (1) = (2)
1. Business cycle indicator	-0.533***	-0.599***	0.892
	(0.153)	(0.141)	
2. Differential effects			
Stayers ($W_{base} > W_{CBT}$) - temporary	-0.187***	-0.273***	29.818***
	(0.0370)	(0.0487)	
Stayers ($W_{base} = W_{CBT}$), temporary	-0.0650	-0.131	3.572*
	(0.0744)	(0.102)	
Stayers ($W_{base} = W_{CBT}$), permanent	0.0701	0.0535	0.747
	(0.0426)	(0.0584)	
Stayers (uncovered), temporary	-0.351***	-0.537***	40.143***
	(0.0679)	(0.0888)	
Stayers (uncovered): permanent	-0.225***	-0.308***	12.417***
	(0.0393)	(0.0546)	
New hires, uncovered workers, temporary	-0.626***	-0.766***	22.756***
	(0.106)	(0.124)	
	A***	A***	
New hires, uncovered workers, permanent	-0.657***	-0.772***	3.879**
	(0.124)	(0.123)	
	A***	A***	
New hires, workers ($W_{base} = W_{CBT}$), temporary	-0.135	-0.196	2.252
	(0.0896)	(0.118)	
	A	A	
New hires, workers ($W_{base} = W_{CBT}$), permanent	-0.0366	-0.0975	3.618*
	(0.0740)	(0.0904)	
	A***	A***	
New hires, workers ($W_{base} > W_{CBT}$), temporary	-0.231***	-0.325***	16.486***
	(0.0703)	(0.0793)	
	A	A	
New hires, workers ($W_{base} > W_{CBT}$), permanent	-0.183***	-0.255***	24.196***
	(0.0320)	(0.0344)	

Notes: These estimates are based on seemingly unrelated regressions in the second step; the second step estimates were weighted by the number of observations / year for each category of workers; A - tests of the null hypothesis: incremental effect for $stayers_g$= incremental effect for $new\text{-}hires_g$; The stars indicate the level of significance at which the null is rejected; In column (3) is displayed the qui-squared statistic for the hypothesis considered; these tests were carried out with the Stata commands 'suest' and 'test'; Standard errors are in parentheses; ***, **, *: significant at: 1%, 5% and 10%, respectively.

Table B: model 6, asymmetry tests in the response of wages to unemployment, business cycle indicator Ut-1, quadratic time trend in the second step, Portugal, 2002-2020.

	Implied semi-elasticities for new hires					
	($W_{base} > W_{CBT}$)		($W_{base} = W_{CBT}$)		uncovered	
	temporary	permanent	Temporary	permanent	temporary	permanent
(1): U -increasing	-.764***	-.716***	-.668***	-.57***	-1.159***	-1.19***
(2): U -decreasing	-.925***	-.854***	-.795***	-.697***	-1.365***	-1.371***
Test: (1) = (2)	**6.887*** **	**2.861***	**3.514***	**2.872***	**5.452** **	**3.45***

Tests

	temporary = Permanent, within category				**Temporary, between groups**		
	($W_{base} > W_{CBT}$)	($W_{base} = W_{CBT}$)	uncovered	All equal	($W_{base} > W_{CBT}$) = ($W_{base} = W_{CBT}$)	($W_{base} > W_{CBT}$) = uncovered	($W_{base} = W_{CBT}$) = uncovered
U - increasing	.557	3.759*	.046	33.661***	2.248	15.21***	32.897***
U - decreasing	1.382	3.244*	.002	41.997***	1.995	17.683***	41.458***
	All equal			**Permanent, between groups**			
U - increasing		119.063***		44.616***	3.55*	18***	43.914***
U - decreasing		79.73***		30.871***	3.04*	22.696***	29.102***

Irrelevance of contracts, between bargaining regimes

		($W_{base} > W_{CBT}$)	$W_{base} = W_{CBT}$)	uncovered	All
U - increasing	($W_{base} > W_{CBT}$)	----	.926	.22	0.22
	($W_{base} = W_{CBT}$)			.967	
U - decreasing	($W_{base} > W_{CBT}$)	-----	.438	.286	.286
	($W_{base} = W_{CBT}$)			.749	

Notes: these estimates are based on seemingly unrelated regressions in the second step. These estimates were weighted by the number of observations / year for each category of workers. In each block of tests, we display the qui-squared statistic for the null hypothesis considered; these tests were carried out with the Stata commands 'suest' and 'test'; ***, **, *: significant at: 1%, 5% and 10%, respectively.

Table C: robustness checks, model 6, 2nd step estimates for different business cycle indicators, time trend and dependent variable. N first step = 39,255,694; N second step = 19, Portugal, 2002-2020.

	Business cycle indicator				
	Ut	Employment$_{t-1}$ (log)	Labour productivity (log)	Tightness	EE-separation
1. Business cycle indicator	-0.295*	0.243***	0.441	0.00765***	1.227**
	(0.166)	(0.0608)	(0.272)	(0.00255)	(0.485)
2. Differential effects					
Stayers ($W_{base} > W_{CBT}$) - temporary	-0.0616	0.0868***	0.166	0.00270***	0.445***
	(0.0591)	(0.0228)	(0.0990)	(0.000716)	(0.120)
Stayers ($W_{base} = W_{CBT}$), permanent	0.106**	-0.0280	-0.196***	-0.00138**	-0.260**
	(0.0430)	(0.0197)	(0.0600)	(0.000626)	(0.104)
Stayers ($W_{base} = W_{CBT}$), temporary	0.0658	0.0361	-0.123	0.000699	0.0957
	(0.0701)	(0.0356)	(0.123)	(0.00112)	(0.192)
Stayers (uncovered): permanent	-0.0986	0.102***	0.244**	0.00322***	0.526***
	(0.0635)	(0.0208)	(0.0914)	(0.000737)	(0.134)
Stayers (uncovered), temporary	-0.0825	0.168***	0.203	0.00479***	0.762***
	(0.107)	(0.0434)	(0.182)	(0.00137)	(0.229)
New hires, workers ($W_{base} > W_{CBT}$), permanent	-0.129**	0.0897***	0.238***	0.00307***	0.530***
	(0.0470)	(0.0210)	(0.0753)	(0.000698)	(0.101)
New hires, workers ($W_{base} > W_{CBT}$), temporary	-0.144	0.109***	0.225	0.00363**	0.621**
	(0.0997)	(0.0363)	(0.134)	(0.00132)	(0.225)
	A	A	A	A	A
New hires, workers ($W_{base} = W_{CBT}$), permanent	0.0442	0.0234	-0.117	4.18e-05	-0.0481
	(0.0863)	(0.0366)	(0.100)	(0.00117)	(0.192)
	A	A***	A	A**	A**
New hires, workers ($W_{base} = W_{CBT}$), temporary	-0.0255	0.0678	-0.0241	0.00173	0.256
	(0.0925)	(0.0436)	(0.148)	(0.00135)	(0.221)
	A*	A	A	A	A
New hires, uncovered workers, permanent	-0.491***	0.312***	0.591***	0.0101***	1.667***
	(0.140)	(0.0507)	(0.192)	(0.00193)	(0.324)
	A***	A***	A***	A***	A***
New hires, uncovered workers, temporary	-0.385**	0.292***	0.684***	0.00933***	1.512***
	(0.152)	(0.0515)	(0.228)	(0.00176)	(0.311)
	A***	A***	A***	A***	A***

Notes: these estimates are based on seemingly unrelated regressions in the second step. The second step estimates were weighted by the number of observations / year for each category of workers. Standard errors are in parentheses. A - tests of the null hypothesis: incremental effect for stayers$_g$= incremental effect for new-hires$_g$; The stars indicate the level of significance at which the null is rejected . These tests were carried out with the Stata commands 'suest' and 'test'; Standard errors are in parentheses; ***, **, *: significant at: 1%, 5% and 10%, respectively. The smoothing parameter for the HP filter is λ=100 as in Backus and Kehoe (1992) and in Stuber (2017). Labour productivity (log)= Gross valued added per employee (log).

Table C: robustness checks (cont.)

	Detrend method - HP-filtered	Fixed effects: Worker, firm, job	Dependent variable - Hourly base wages
1. Business cycle indicator	-0.546***	-0.528***	-0.544***
	(0.144)	(0.150)	(0.162)
2. Differential effects			
Stayers ($W_{base} > W_{CBT}$) - temporary	-0.195***	-0.216***	-0.150***
	(0.0458)	(0.0531)	(0.0357)
Stayers ($W_{base} = W_{CBT}$), permanent	0.0509	0.0725*	0.0737*
	(0.0336)	(0.0381)	(0.0380)
Stayers ($W_{base} = W_{CBT}$), temporary	-0.112	-0.0872	-0.0223
	(0.0683)	(0.0716)	(0.0658)
Stayers (uncovered): permanent	-0.143***	-0.206***	-0.164***
	(0.0432)	(0.0510)	(0.0474)
Stayers (uncovered), temporary	-0.306***	-0.380***	-0.262***
	(0.0912)	(0.0985)	(0.0613)
New hires, workers ($W_{base} > W_{CBT}$), permanent	-0.184***	-0.224***	-0.235***
	(0.0597)	(0.0582)	(0.0618)
New hires, workers ($W_{base} > W_{CBT}$), temporary	-0.252***	-0.302***	-0.183***
	(0.0744)	(0.0837)	(0.0538)
	A	A*	A
New hires, workers ($W_{base} = W_{CBT}$), permanent	-0.0774	-0.0980	-0.0226
	(0.0859)	(0.0789)	(0.0746)
	A**	A***	A**
New hires, workers ($W_{base} = W_{CBT}$), temporary	-0.203**	-0.190**	-0.0867
	(0.0804)	(0.0856)	(0.0672)
	A*	A**	A**
New hires, uncovered workers, permanent	-0.613***	-0.661***	-0.567***
	(0.144)	(0.138)	(0.123)
	A***	A***	A***
New hires, uncovered workers, temporary	-0.635***	-0.678***	-0.343***
	(0.108)	(0.120)	(0.0597)
	A***	A***	A

Table D: model 6, implied semi-elasticities for the new hires and tests among industrial bargaining regimes, robustness checks, Portugal, 2002-2020

	Implied semi-elasticities for new hires					
	($W_{base} > W_{CBT}$)		($W_{base} = W_{CBT}$)		uncovered	
	temporary	permanent	Temporary	Permanent	temporary	permanent
bcy: ut-1	-0.754***	-0.711***	-0.659***	-0.564***	-1.159***	-1.198***
bcy: Ut	-.438***	-.423***	-.32*	-.251	-.68***	-.786***
bcy: employment-1 (log)	.352***	.333***	.311***	.266***	.535***	.555***
bcy: Tightness	.011***	.011***	.009***	.008***	.017***	.018***
bcy: EE-separation	1.848***	1.758***	1.483***	1.179**	2.739***	2.895***
HP-filtered	-.798***	-.729***	-.749***	-.623***	-1.181***	-1.158***
Labour productivity (log)	**.666****	**.679****	**.417**	**.324**	**1.125****	**1.032****
Hourly base wages	-.727***	-.778***	-.63***	-.566***	-.886***	-1.11***
Fixed effects: worker, firm, job	-.83****	-.752****	-.718****	-.626****	-1.206****	-1.189****

Tests	**temporary = permanent, within group**				**Temporary, between groups**		
	all equal	($W_{base} > W_{CBT}$)	($W_{base} = W_{CBT}$)	uncovered	all equal:	($W_{base} > W_{CBT}$) =($W_{base} = W_{CBT}$)	($W_{base} > W_{CBT}$)=uncovered
bcy: Ut-1	78.852***	0.443	3.668*	0.077	29.615***	2.131	14.949***
bcy: Ut	26.42***	.04	1.423	.464	8.077**	2.314	3.114*
bcy: employment-1 (log)	119.287***	.444	4.137**	.125	34.425***	1.772	16.711***
bcy: Tightness	116.928***	.33	4.389**	.164	49.623***	3.277*	10.073***
bcy: EE-separation	139.656***	.292	4.681*	.269	62.81***	4.244**	6.937***
HP-filtered	176.168***	1.307	10.307***	.018	16.929***	.955	13.443***
Labour productivity (log)	43.35***	.027	1.04	.345	41.272***	7.863***	8.722***
Hourly base wages	139.259***	1.841	7.93***	3.656*	17.419***	2.642	9.436***
Fixed effects: worker, firm, job	67.257***	1.621	4.856*	.019	31.567***	**2.953***	12.339***

Table D (cont.): model 6, implied semi-elasticities for the new hires and tests among industrial bargaining regimes, robustness checks, Portugal, 2002-2020

Tests	**Temp, (cont.)**	**permanent, between groups**			
	(W_{base} = W_{CBT})=uncovered	**All equal**	(W_{base} > W_{CBT}) =(W_{base} = W_{CBT})	(W_{base} > W_{CBT})=uncovered	(W_{base} = W_{CBT})=uncovered
bcy:Ut-1	29.199***	39.306***	3.492*	18.241***	39.051***
bcy: Ut	7.289***	22.303***	2.936*	7.396***	21.921***
bcy: employment-1 (log)	34.314***	51.716***	3.436*	24.431***	51.595***
bcy: Tightness	38.389***	55.522***	6.505**	17.28***	53.106***
bcy: EE-separation	33.541***	68.258***	10***	15.332***	58.129***
HP-filtered	16.924***	27.484***	1.555	11.766***	27.132***
Hourly base wages	15.817***	26.526***	6.128**	12.914***	26.335***
Fixed effects: worker, firm, job	29.817***	34.622***	**2.459**	14.18***	34.131***

Notes: these estimates are based on seemingly unrelated regressions in the second step. The second step estimates were weighted by the number of observations / year for each category of workers. In each block of tests, we display the qui-squared statistic for the null hypothesis considered; these tests were carried out with the Stata commands 'suest' and 'test'; ***, **, *: significant at: 1%, 5% and 10%, respectively. The smoothing parameter for the HP filter is λ=100 as in Backus and Kehoe (1992) and in Stuber (2017). Labour productivity (log)= Gross valued added per employee (log)

Table E: model 6, robustness checks, Irrelevance of contracts, Portugal, 2002-2020

	(W_{base} =W_{CBT})	uncovered	All
(W_{base} > W_{CBT})			
bcy:Ut-1	1.039	.243	.243
bcy: Ut	.781	.428	.428
bcy: employment-1 (log)	1.466	.345	.345
bcy: Tightness	2.593	.325	.325
bcy: EE-separation	4.05**	.421	.421
HP-filtered	.911	.054	.054
Labour productivity (log)	3.039*	.477	.477
Hourly base wages	9.955***	2.055	2.055
Fixed effects: worker, firm, job	.073	.15	.15
(W_{base} =W_{CBT})			
bcy:Ut-1		1.105	.243
bcy: Ut		1.375	.428
bcy: employmen$_{t-1}$ (log)		1.503	.345
bcy: Tightness		1.737	.325
bcy: EE-separation		2.238	.421
HP-filtered			
Labour productivity (log)		0	.477
Hourly base wages		6.737***	2.055
Fixed effects: worker, firm, job		.396	.15

Notes: these estimates are based on seemingly unrelated regressions in the second step. The second step estimates were weighted by the number of observations / year for each category of workers. In each block of tests, we display the qui-squared statistic for the null hypothesis considered; these tests were carried out with the Stata commands 'suest' and 'test'; ***, **, *: significant at: 1%, 5% and 10%, respectively. The smoothing parameter for the HP filter is λ=100 as in Backus and Kehoe (1992) and in Stuber (2017). Labour productivity (log)= Gross valued added per employee (log)

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