Real Wages and the Business Cycle: Accounting for Worker, Firm, and Job Heterogeneity*

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Abstract

Using a longitudinal matched employer-employee data set for Portugal over the 1986-2007 period, this study analyzes the heterogeneity in wages responses to aggregate labor market conditions for newly hired workers and existing workers within the same firm. Accounting simultaneously for worker, firm, and job heterogeneity, the data support the hypothesis that

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entry wages are more procyclical than current wages. A one-point increase in the unemployment rate decreases wages of newly hired workers within a given firm-job by around 2.7 percent and by just 2.2 percent for stayers within the same firm-job. This difference in the behavior of real wages between new hires and stayers seems to be driven by the evolution of the wage cushion over the cycle. In fact, for stayers, wage cyclicality is mostly driven by changes in bargained wages, whereas for new hires the wage cushion also plays an important role in explaining the cyclical behavior of real wages. Finally, the results reveal, for all workers, a one-for-one wage response to changes in labor productivity.

JEL classification: J31; E24; E32

Keywords: wage cyclicality; hires; firm-specific effects; job-specific effects; labor productivity

1 Introduction

The cyclical behavior of real wages has been the subject of many studies since the debate of Keynes (1939), Dunlop (1938), and Tarshis (1939). Earlier studies based on aggregate data showed some ambiguous results. One reason why these studies have reached no definitive conclusions resides in the fact that they have been performed at the aggregate level. In particular, they have ignored the changes in the composition of the workforce over the cycle. Furthermore, aggregation assumes that the relationship between real wages and the business cycle is the same for all individuals or groups of individuals. If wrong, the estimates of real wage cyclicality are plagued by a specification bias.

Over the last two decades, a number of studies based on micro-panel data for the U.S. (and recently, for Britain) point quite decisively toward a procyclical behavior of real wages.[1] Panel microdata also show that real wage changes of job movers are much more procyclical than real wage changes of job stayers [see Solon *et al.* (1994), Shin (1994) and Devereux (2001) for the U.S. and Devereux and Hart (2006) and Hart (2006) for Britain].

Recent microeconometric evidence on wage cyclicality also gave a new insight to the discussion about business cycle fluctuations of unemployment and vacancies and wage stickiness. Indeed, some authors argue that the Mortensen-Pissarides search and matching model [Mortensen and Pissarides (1994) and Pissarides (2000)] cannot explain the cyclical volatility of unemployment and vacancies [Hall (2005a) and Shimer (2005a)]. They show that real wages do not vary as much as the Nash

[1] For insightful surveys see Brandolini (1995) and Abraham and Haltiwanger (1995).

bargaining approach implies and, thus, if the hypothesis of rigid wages is introduced, the model performs much better in matching fluctuations in unemployment and vacancies.

Exploring the idea that in the search and matching model job creation is driven by the difference between the expected productivity and the expected cost of labor in new matches, Pissarides (2009) shows that the wage that has impact on employment dynamics, influencing the decision of opening or not a vacancy, is the wage of newly hired workers. Furthermore, Pissarides claims that the empirical evidence favors the hypothesis that wages in new matches are more procyclical than those of existing workers within the same firm. Haefke *et al.* (2008) also share this point of view. Using the Current Population Survey (CPS) they found that wages of newly hired workers are much more volatile than aggregate wages and respond one-for-one to changes in labor productivity.

However, as pointed out by Gertler and Trigari (2009) without a proper data set that matches workers with their firms it is "... not possible to directly compare new hires with existing workers in the same firm." They argue forcefully that the presence of job cyclical movements, say for example a skilled machinist taking a cab-driver position during a recession would, under current methodologies, create a false illusion of wage cyclicality even if wages for those jobs do not change with the business cycle.

The presence of compositional effects has attracted much attention in the last years and the seminal studies based on individual-level panel data for the U.S. showed that composition bias plays an important role on real wage behavior along the business cycle [see Mitchell *et al.* (1985), Bils (1985), Keane *et al.* (1988) and Solon *et al.* (1994)]. In fact, cyclical changes in the composition of the work force may induce a countercyclical bias in the aggregate real wage. Aggregate measures of real wages tend to give more weight to low-skill workers during expansions than during recessions. The argument is that if less-skilled workers are more vulnerable to layoff, they will account for a smaller share of employment in recessions than in expansions.

It is also widely agreed that industry composition may also change over the cycle. As pointed out by Okun (1973), if some industries/firms offer rents to workers and if these sectors are also more cyclically sensitive, workers can switch into high-paying jobs during booms because such jobs are less tightly rationed during these times. This inter-industry/firm mobility of workers generates, per si, a procyclical behavior of wages. Barlevy (2001) also showed that job changers' wages are more procyclical because in booms they obtain jobs that pay a compensating differential for the risk of layoff. In this case, workers who change jobs during booms may not realize true gains from

the higher wages they receive, since these gains are typically offset during recessions.

Finally, even after controlling for worker and firm heterogeneity, it can always be argued that the composition and the quality of jobs within a firm is also likely to vary over the business cycle. If firms' promotions and hiring standards exhibit a cyclical pattern, overall wage cyclicality is mainly driven from workers changing job titles rather than from wage changes within job titles (see Solon *et al.*, 1997). The same line of reasoning applies, if match quality among new hires falls in a recession as shown by Bowlus (1995) or firms hire proportionally more workers into low-skilled jobs in a recession than in a expansion.

To be able to test the hypothesis that wages in new matches are more volatile than those in continuing jobs within the same firm, we need to fully control for changes in the composition of jobs/workers over the cycle that might driven wage cyclicality. The question whether changes in the aggregate wage are driven by changes in the composition of jobs/workers or by within-job changes in the wage is interesting in itself, since the answer is important to clarify whether we can hope to understand wage dynamics in a representative agent model or we need to model heterogeneity in the labor market.[2]

This paper revisits the issue of real wage cyclicality with the aim of contributing to clarify how firms adjust wages in response to business cycle fluctuations. Two novel aspects are introduced in the analysis of this topic. First of all, this study uses a unique and rich matched employer-employee dataset that allows us to address a number of issues that cannot be adequately answered in the absence of employer-reported data. Specifically, we are able to control for firm and job characteristics in order to explicitly deal with the potential cyclical upgrading/downgrading due to the movement of workers from low-paid to high-paid jobs between or within firms over the cycle. This is crucial to analyze the impact of the business cycle on real wages of new hires versus stayers within the same firm. Moreover, we employ a nationally representative data set that covers the population of firms with wage earners in the private sector in Portugal. Currently, the data set collects information on about 3 million employees, 350,000 firms and 30,000 occupational categories.

Second, to the best of our knowledge, this is the first study that attempts to accurately deal with the potential sources of composition bias in wage cyclicality using an empirical strategy that allows to account simultaneously for worker, firm, and job heterogeneity in order to identify the relevant moments. For this purpose a new iterative procedure which provides the exact OLS solution to a

[2] We thank an anonymous referee for suggesting us this interpretation.

three high-dimensional fixed effects model will be employed for the first time.

Our results are in line with earlier studies based on micro panel data that show that real wages are procyclical. Moreover, we found that within the same firm-job, entry wages are more responsive to the business cycle than the wages of existing workers. This behavior seems to be explained, in large part, by differences in the evolution of the wage cushion over the cycle.[3] In fact, for existing workers, wage cyclicality is mostly driven by changes in bargained wages (wage levels determined by collective wage agreements), whereas for new hires the wage cushion also has an important role in explaining the cyclical behavior of real wages.

Following Shimer (2005b), disentangling between the job finding and the job separation probability we are able to show that real wages react positively to changes in the job finding probability and negatively to changes in the job separation probability. In this case, however, no significant difference is found in the behavior of real wages between new hires and stayers.

Finally, considering the labor productivity as the source of business cycle fluctuations as in most search models, we present further evidence that real wages are quite flexible in the Portuguese labor market for both stayers and new hires responding one-for-one to changes in labor productivity.

The remainder of the paper is organized as follows. Section 2 presents the architecture of the Portuguese wage setting system. In Section 3 the empirical strategy and the data are described. The main results are discussed in Section 4. Some robustness checks are reported in Section 5. Conclusions are outlined in Section 6.

2 The Architecture of the Portuguese Wage Setting System

2.1 Collective Bargaining

The Portuguese Constitution provides the juridical principles of collective bargaining and grants unions the right to negotiate. The effects of the agreements are formally recognized and considered valid sources of labor law.

Concerning the bargaining mechanisms, a distinction should be made between the *conventional* regime and the *mandatory* regime. Conventional bargaining results from direct negotiation between

[3] To the difference between the actual wage and the bargained wage we call wage cushion. This is distinct from the notion of wage drift, which is usually employed for differences in wage variations, rather than levels (see Cardoso and Portugal, 2005).

employers' and workers' representatives. A mandatory regime, on the other hand, does not result from direct bargaining between workers and employers, being instead dictated by the Ministry of Labor. The Ministry can extend an existing collective agreement to other workers initially not covered by it or it can create a new one, if it is not viable to extend the application of an existing document. A mandatory regime is applied when workers are not covered by unions, when one of the parties involved refuses to negotiate, or bargaining is obstructed in any other way.[4] Therefore, the impact of collective bargaining goes far beyond union membership and the distinction between union and non-union workers or firms becomes largely meaningless.

Usually collective negotiations are conducted at the industry or, to a lesser extent, occupation level. Firm-level negotiation, which for a time was a common practice in large public enterprises, has lost importance. The law does not establish mechanisms of coordination between agreements reached in different negotiations; however preference is given to vertical over horizontal agreements, and the principle of the most favorable condition to the worker generally applies.

Since most collective agreements are industry-wide, covering companies with very different sizes and economic conditions, their contents tend to be general, setting minimum working conditions, in particular the base monthly wage for each category of workers, overtime pay and the normal duration of work. Moreover, only a narrow set of topics is updated annually, and therefore the content of collective agreements is often pointed out as being too immobile and containing little innovation.

Whatever the wage floor agreed upon for each category of workers at the collective bargaining table, firms are free to pay higher wages, and they often deviate from that benchmark, adjusting to firm-specific conditions [see Cardoso and Portugal (2005)].[5]

2.2 Minimum Wages

A mandatory minimum monthly wage was set for the first time in Portugal in 1974, covering workers aged 20 or older and excluding agriculture and domestic servants. Currently, there is a single legal minimum wage that applies to all workers. Workers formally classified as apprentices receive just

[4] Beyond the existence of compulsive extension mechanisms, voluntary extensions are also possible, when one economic partner (workers' representative or employer) decides to subscribe to an agreement that it had initially not signed.

[5] It should be noted that in Portugal nominal wage reductions are forbidden. Periods of high inflation favor, of course, larger downward real wage adjustments.

80 percent of the full rate.

The minimum wage is updated annually by the parliament, under government proposal.[6] Decisions on the level of the minimum wage are taken on a discretionary basis, usually taking into account past and predicted inflation and after consulting the social partners.

In 2007, the minimum monthly wage level was 403 €, representing 47 percent of the average monthly base wage in the private sector. In this same year the proportion of full-time workers that received the minimum legal wage was about 6 percent.[7]

3 Methodology and Data

3.1 Empirical Methodology

The empirical model that will be used to test for real wage cyclicality is a level wage equation with controls for worker observed and unobserved (permanent) heterogeneity, firm and job (permanent) unobserved heterogeneity, and business cycle conditions.

The model's baseline specification is:

$$\ln w_{ijft} = \lambda_i + \gamma_f + \theta_j + \mathbf{x}_{it}\boldsymbol{\beta} + \alpha_0 t + \alpha_1 t^2 + \phi hire_{ijft} + \xi_s cycle_t + \xi_h cycle_t * hire_{ijft} + u_{ijft} \quad (1)$$

where w_{ijft} is the real hourly earnings of individual i, in job j, in firm f, at time t, λ_i is a worker fixed effect, γ_f a firm-specific fixed effect, θ_j a job-specific fixed effect and u_{ijft} is a zero-mean random term with constant variance. $\mathbf{x}_{it}$ is a vector of time-varying individual characteristics such as age and education. t and t^2 are, respectively, a time trend and its square and $cycle_t$ is a cyclical indicator such as the aggregate unemployment rate. Since we are particularly interested in comparing the behavior of real wages over the cycle between stayers and new hires a dummy variable that equals one if the worker has tenure lower than 12 months ($hire_{ijft}$) is included as well as an interaction term between the latter and the cycle indicator. The coefficients of interest are ξ_s and ξ_h. If the cyclical indicator corresponds to the unemployment rate, the parameter ξ_s measures the semi-elasticity of real wages with respect to the unemployment rate for stayers. The coefficient ξ_h measures the differential in the semi-elasticity of wages with respect to the unemployment rate between new hires and stayers. As mentioned before, the job finding and the

[6] The only exceptions are 1982, when it was not updated, and 1989, when it was updated twice.

[7] Source: Ministry of Labor and Social Solidarity (GEP) - Earnings Survey, April 2009.

job separation probabilities, as well as aggregate labor productivity will also be used as measures of the business cycle conditions.[8]

The option to define the wage equation in levels is justified by the need to estimate the model for workers' hires since, by construction, panel data are not available for newly hired workers that come from non-employment.[9] Hence, in order to account simultaneously for worker, firm and job unobserved heterogeneity, the fixed-effects estimator will be used instead of the standard first-differences estimator. A major advantage of this strategy is that avoids restricting the sample to solely employed workers over two consecutive periods, as is the typical approach in earlier studies based on microdata.

3.2 Data Description

Data for this study come from a unique and rich matched employer-employee data set - *Quadros de Pessoal* (*QP*). *QP* is a mandatory annual employment survey collected by the Portuguese Ministry of Labor and Social Solidarity, which covers virtually all establishments with wage earners.[10] Indeed, each year every establishment with wage earners is legally obliged to fill in a standardized questionnaire. Requested data cover the establishment itself (location, industry, and employment), the firm (location, industry, employment, sales, ownership, and legal setting) and each of its workers (gender, age, education, skill, occupational category, admission date, earnings, and duration of work). The information on earnings is very complete. It includes the base wage (gross pay for normal hours of work), regular and non-regular benefits, and overtime pay, as well as the mechanism of wage bargaining. Information on normal and overtime hours of work is also available.

Twenty spells of *QP*, from 1986 to 2007, were available for this study.[11] From 1986 to 1993 the information refers to the month of March of each year, and since 1994, to October.

There are three main reasons that make this survey a good source for the study of wage cyclicality. The first is its coverage and reliability. The data covers virtually all firms employing paid labor in the private sector in Portugal. Currently, the data set collects data on about 350,000 firms

[8] We thank Olivier Blanchard for having suggested to disentangle between the job finding and job separation probabilities.

[9] From now on the term non-employment refers to all individuals that come from unemployment, out of the labor force, self-employment or from the public sector.

[10] Public administration and non-market services are excluded.

[11] Worker level files are not available for the years of 1990 and 2001.

and 3 million employees. By law, the questionnaire is made available to every worker in a public space of the establishment. This requirement facilitates the work of the services of the Ministry of Labor that monitor compliance of firms with the law (e. g., to check to whether firms obey to the wage floors determined by the collective wage agreement). Thus, the administrative nature of the data and its public availability implies a high degree of coverage and reliability. Second, this survey is conducted on a yearly basis, and its identifying scheme allows accurate identification of firms and workers, making it possible to track them over the years. Each firm entering the database is assigned a unique identifying number and the Ministry implements several checks to ensure that a firm that has already reported to the database is not assigned a different identification number. Using this identifier it is possible to pinpoint all firms that have entered and exited economic activity. The workers' identification number is based on the social security number. Finally, this source enables the matching of firms and their workers, which allows us to classify the situation of the worker on the job (stayer/mover, accession/separation) and to control for match characteristics. Moreover, employer-reported wage information is known to be subject to less measurement error than worker-reported data.

Naturally, this data source also has its own limitations. The most important one for our purposes is the short time period covered. Nevertheless, over the analyzed period unemployment rates, job finding and job separation rates varied widely as can be seen in Table A.1 in Appendix A.

In essence, our data set includes the population of full-time wage earners in the private non-farm sector that worked at least 120 hours in the reference month, aged between 17 and 61, and earning at least 80% of the minimum wage.[12]

The data includes 31,631,954 (years×individuals) observations for both genders, which correspond to around 6.4 million individuals matched by identifying number, sex and year of birth, 624,171 firms matched by identifying number and 115,822 jobs matched by the code of the collective agreement occupational category. Of these, 26,259,470 observations correspond to stayers and

[12] Full-time workers are identified based on the number of hours worked in the reference month, and the normal duration of work in their occupational category which is set in the collective agreement. A worker is classified as a full-time worker, if the number of hours worked in the reference month is equal or higher than the normal duration of worker for his occupational category.

It should also be noted that when a worker is present in the QP registers in more than one firm in a given year, we then retain the record for the firm in which the worker had the highest number of hours worked.

5,172,484 refer to new hires.[13] As discussed above, a 'stayer' is identified as a worker with tenure in the current employer equal or higher than 12 months, i. e., a worker that is employed in the same firm for two consecutive years. A 'new hire' is defined as a worker with tenure lower than 12 months. Therefore, the group of newly hired workers includes those individuals that come from non-employment as well as between-firm movers as long as tenure in the destination firm for the latter is less than 12 months. To be more explicit, an individual that is not observed in the *QP* files for a given year and has tenure less than 12 months in the subsequent period is a worker newly hired out of non-employment. A worker employed for two consecutive years in the *QP* files with tenure under than 12 months in the second year can be identified as a mover.

3.3 Estimation Strategy

Controlling simultaneously for worker, firm and job-specific effects requires the introduction of three high-dimensional fixed effects in the linear regression model. To illustrate our estimation strategy consider the following linear regression model in matrix form

$$\mathbf{Y} = \mathbf{Z}\beta + \mathbf{D}_1\lambda + \mathbf{D}_2\gamma + \mathbf{D}_3\theta + \epsilon,$$

where $\mathbf{Z}$ is a matrix of explanatory variables and $\mathbf{D}_1, \mathbf{D}_2$ and $\mathbf{D}_3$ are high-dimensional matrices for the fixed effects. The normal equations may be rewritten

$$\left[\begin{array}{l} \beta = (\mathbf{Z}'\mathbf{Z})^{-1}\mathbf{Z}'(\mathbf{Y} - \mathbf{D}_1\lambda - \mathbf{D}_2\gamma - \mathbf{D}_3\theta) \\ \lambda = (\mathbf{D}_1'\mathbf{D}_1)^{-1}\mathbf{D}_1'(\mathbf{Y} - \mathbf{Z}\beta - \mathbf{D}_2\gamma - \mathbf{D}_3\theta) \\ \gamma = (\mathbf{D}_2'\mathbf{D}_2)^{-1}\mathbf{D}_2'(\mathbf{Y} - \mathbf{Z}\beta - \mathbf{D}_1\lambda - \mathbf{D}_3\theta) \\ \theta = (\mathbf{D}_3'\mathbf{D}_3)^{-1}\mathbf{D}_3'(\mathbf{Y} - \mathbf{Z}\beta - \mathbf{D}_1\lambda - \mathbf{D}_2\gamma) \end{array}\right]$$

suggesting an iterative solution that alternates between estimation of β, λ, γ and θ. However, during the estimation process we do not need to deal with the high-dimensional matrices $\mathbf{D}_1, \mathbf{D}_2$ and $\mathbf{D}_3$ because $\mathbf{D}_1\lambda$, $\mathbf{D}_2\gamma$ and $\mathbf{D}_3\theta$ are entered as column vectors and $(\mathbf{D}'\mathbf{D})^{-1}\mathbf{D}'$ are generic matrices

[13] Table A.2 in Appendix A describes the data for stayers and newly hired workers.

that consist of simple group mean transformations. Moreover, it is possible to use the within-transformation to sweep out one of the fixed effects. In this case the iterative procedure described above is applied to the transformed variables but estimation is simplified because we work with just two high-dimensional fixed effects. In our application we first make use of the Frisch-Waugh-Lovell theorem to remove the influence of the three high-dimensional fixed effects from each individual variable and in a second step implement the final regression using the transformed variables. With a correction to the degrees of freedom this approach will give the exact least squares solution for the coefficients and standard errors.[14]

4 Empirical Results

4.1 Real Wage Sensitivity to the Unemployment Rate

Results based on the general specification defined in equation (1) are reported in Table 2. The dependent variable is defined as the natural log of real hourly earnings. Hourly earnings correspond to the ratio between total regular payroll (base wages and regular benefits) including overtime pay and the total number of hours worked (normal and overtime) in the reference month. The wages were deflated using the Consumer Price Index (CPI) and are expressed in 1985 Euros.[15] Since wages are set at least six months to one year in advance, there is a delayed relationship between wages and economic growth. To capture this lagged effect we use the unemployment rate of the previous year.[16] As discussed before, besides the aggregate unemployment rate, each regression includes age (and its square) as proxy for labor market experience, a set of dummies for education levels, a quadratic time trend, a dummy for new hires and an interaction term between the latter and the cycle indicator.[17]

The estimates of the semi-elasticity of real hourly earnings with respect to the aggregate unemployment rate for stayers (ξ_s) are presented in column 1, whereas the estimates of the incremental effect for new hires (ξ_h) are shown in column 2. Even though our baseline specification corresponds

[14] See Guimarães and Portugal (2009).

[15] Between 1986-93 the inflation rate corresponds to March of year $t-1$ to March of year t, whereas from 1994 to 2007 the inflation rate corresponds to October of year $t-1$ to October of year t. Thus, between 1993 and 1994 there is an adjustment of a year and a half because in 1993 wages refer to March and in 1994 to October.

[16] This also applies to the other measures of the cycle that will be used in the next Sections.

[17] For a detailed description of the variables see Table A.2 in Appendix A.

to a model with three high-dimensional fixed effects, the standard OLS estimates as well as the estimates with one or two fixed effects are also reported for comparison purposes.[18]

In line with earlier studies the worker-fixed effect estimates exhibit a strong procyclical behavior of real wages for both stayers and new hires (see row 2). A 1-percentage point (p. p.) decrease in the national unemployment rate raises real hourly earnings by 1.87 percent for stayers and by 2.47 percent for newly hired workers. As Table 2 also makes clear, when we compare these estimates with the OLS ones in row 1, accounting for worker heterogeneity removes a countercyclical bias generated by the fact that low-skilled workers tend to bear the brunt of increased unemployment.

Controlling, in addition, for firm unobserved heterogeneity does not affect much the estimates of the semi-elasticity of wages with respect to the unemployment rate (see row 3).[19] Once worker and firm heterogeneity are taken into account, a 1 p. p. increase in the aggregate unemployment rate generates a decrease on real wages of 1.85 percent and 2.6 percent for stayers and new hires, respectively.[20]

Finally, in the fourth row a third fixed effect was added in order to account for job heterogeneity. The job specific effect is defined based on the code of the collective agreement occupational category. It is worth noting that the main reason why the Ministry of Labor collects the *Quadros de Pessoal* dataset is to enable the officers of the Ministry of Labor to check if employers are complying with the wage floors agreed for the occupational categories. Recall that in each year we have information on about 30,000 occupational categories. Hence, this notion corresponds to a very fine definition of job.

Controlling for job heterogeneity enhances the role of wage flexibility to the business cycle (see row 4). The results indicate that a 1 p. p. increase in the unemployment rate is associated with a decrease in real wages of 2.20 percent and 2.67 percent for stayers and new hires, respectively. Hence, the difference between stayers and new hires, which is statistically significant at conventional

[18] In the standard OLS model a dummy for gender was also included.

[19] In any case, the F-test for joint significance of the firms fixed effects rejects the null hypothesis that all γ_f are simultaneously equal to zero.

[20] In this same spirit, and in order to test whether entry wages are sensitive to cyclical fluctuations after taking into account industry-specific measures of labor market tightness, we redo equation (1) including a worker fixed effect and 29 industry-year specific effects. Obviously, this procedure enables us to identify the impact of the business cycle solely for newly hired workers. For the latter, we found an estimate of the incremental effect for new hires of -0.63 (with estimated standard error 0.12).

levels, stands at 0.47 p. p.[21] These results also seem to vindicate Pissarides' (2009) presumption that a good explanation for the unemployment volatility puzzle needs to be consistent with a semi-elasticity of wages with respect to unemployment of 3.

Table 2: Real Wage Sensitivity to the Unemployment Rate

Portugal, 1986-2007 (N=31,631,954)

Dependent variable: log real hourly earnings

	Stayers	Incremental Effect for New Hires
1. OLS estimator		
Cycle variable: Unemployment Rate	-1.61***	-0.38
	(0.53)	(0.22)
2. Within estimator, worker fixed effect		
Cycle variable: Unemployment Rate	-1.87***	-0.60***
	(0.56)	(0.16)
3. OLS solution with worker and firm fixed effects		
Cycle variable: Unemployment Rate	-1.85***	-0.75***
	(0.56)	(0.22)
4. OLS solution with worker, firm, and job fixed effects		
Cycle variable: Unemployment Rate	-2.20***	-0.47***
	(0.60)	(0.16)

Notes: (i) cluster-robust standard errors in parentheses;

(ii) *** significant at 1%; ** significant at 5%; * significant at 10%.

Overall, the results reveal that failure to control for firm heterogeneity does not seem to constitute a serious problem, while failure to control for job heterogeneity appears to lead to a counter-cyclical bias in wages, specially for workers that stay with the same firm. For the latter, ignoring job heterogeneity partly offsets the negative impact of a downturn period on wages. Thus, these results do not seem to corroborate the hypothesis of a job cyclical up/downgrading due to the movement of

[21] This result is robust to the definition of different thresholds for tenure, i. e., less than 3 or 6 months. Furthermore, we found that for workers with tenure higher than 5 years the incremental effect coefficent for new hires becomes statistically insignificant.

workers from low-paid to high-paid jobs/firms during expansions, and vice-versa during recessions. In this line of reasoning, we conjecture that workers employed in low-paying jobs seem to bear the brunt of unemployment. In fact, if low-paying/low-quality jobs are more likely to be destroyed in a recession (as low skilled workers are more likely to be displaced during business downturns), they will account for a smaller share of employment in recessions than in expansions. In this context, ignoring job heterogeneity will lead to a countercyclical bias in wages as is observed in our data.

4.2 Decomposing the Real Wage Response to the Business Cycle between the Bargained Wage and the Wage Cushion

Here we examine the extent to which contractual wages (wage floors agreed for each of the occupational categories), on the one hand, and firm-specific wage arrangements, in the form of the wage cushion, on the other, are sensitive to the business cycle. Cardoso and Portugal (2005) showed that in Portugal the wage cushion works as a mechanism to overcome the constraints imposed by collective bargaining, granting firms a certain freedom when setting wages. In this context, it will be interesting to analyze the extent to which contractual wages and firm deviations from contractual wages vary over the business cycle.

The contractual wage was computed adopting the procedure suggested by Cardoso and Portugal (2005). Thus, the bargained wage was defined as the mode of the monthly base wage for each collective agreement occupational category. The wage cushion was computed as the log difference between the current actual wage (the real monthly base wage) and the current bargained wage for that occupational category (the real monthly bargained wage).

It should also be noted that in the regressions for bargained wages, by definition, firm and job cyclical up/downgrading do not play any role and, in this sense, constitute a reasonable alternative to test to whether real wages are sensitive to the cycle.

Table 3 reports the unemployment rate coefficient estimates for the bargained wage, the wage cushion and, for comparison purposes, for the monthly base wage. As exhibited in the Table, the bargained wage is very sensitive to the evolution of the unemployment rate. A 1 p. p. increase in the unemployment rate is associated with a decline on real bargained wages of 1.99 percent and 2.12 percent for, respectively, stayers and new hires (see row 1). For the latter, the wage cushion also plays an important role in explaining the cyclical behavior of real wages. Indeed, comparing row 2

with 3 in the second column, we found that most of the difference in the cyclicality of real wages between incumbents and new hires is driven by the behavior of the wage cushion. This evidence seems also to be in the spirit of Hall (2005a) and Gertler and Trigari (2009) that assume that the contract wage for existing workers provides the wage norm for newly hired workers with similar productivity. Unions seem to be successful at equalizing wages between new hires and incumbents, but firm level wage arrangements change the results considerably [see Cardoso and Portugal (2005)].

Table 3: Sensitivity of Bargained Wages and the Wage Cushion to the Unemployment Rate

OLS solution with worker, firm, and job fixed effects (N=31,631,954)

Portugal, 1986-2007

	Stayers	Incremental Effect for New Hires
1. Dependent variable: log real bargained wage		
Cycle variable: Unemployment Rate	-1.99***	-0.13**
	(0.42)	(0.06)
2. Dependent variable: wage cushion		
Cycle variable: Unemployment Rate	-0.10	-0.46***
	(0.19)	(0.11)
3. Dependent variable: log real monthly base wage	-2.09***	-0.59***
Cycle variable: Unemployment Rate	(0.39)	(0.15)

(i) cluster-robust standard errors in parentheses;

(ii) *** significant at 1%; ** significant at 5%; * significant at 10%.

4.3 Disentangling between Job Finding and Job Separation Probabilities

Following Shimer (2005b), in this Section we disentangle between the job finding probability (or the unemployment to employment transition probability) and the job separation probability (or the employment to unemployment transition probability) in order to test if the impact of the unemployment rate on wages really reflects labor-market tightness.

Hence, the job finding and the job separation probabilities in period $t-1$ were jointlly included in the wage equation as alternative measures of the business cycle.[22] The results are shown in Table

[22] These probabilities were calculated according to Shimer (2005b). The job separation probability is given by

4. Even though previous empirical work by Shimer (2005b) and Hall (2005b) for the U.S. and Torres (2009) for Portugal show that unemployment fluctuations are mainly driven by fluctuations in the job finding probability, our results indicate that both measures have a significant impact on wages - a positive effect for the job finding probability and a negative one for the job separation probability.[23]

Considering our preferred specification in row 4, a 1-p. p. increase in the job finding probability is associated, ceteris paribus, with a wage increase of 0.45% for stayers, whereas an increase of 1-p. p. in the probability of job separation corresponds to a real wage decrease of 6.6% for stayers. Thus, these figures are consistent with the unemployment rate estimates, though their magnitudes cannot be directly compared.

Furthermore, despite the dissimilitude of the estimates, these two variables generate real wage fluctuations of identical amplitude. Indeed, even though the impact of the job separation probability on real wages appears to be high, given that the highest increase in that rate over the analyzed period is only 0.6 p. p., a decrease on real wages of 4% is the maximum that can be expected. In this same line of reasoning, a real wage increase of around 6.3%, is the maximum that can be expected for an increase of 14 p. p. in the job finding probability over the same period.[24]

Finally, the results indicate a similar behavior of real hourly earnings over the cycle across stayers and new hires. Indeed, considering specification 6, the incremental effects for new hires are not statistically significant at the conventional levels.

$\frac{u^S_{t+1}}{e_t}$, where u^S_{t+1} is the number of short-term unemployed persons in quarter $t+1$ (unemployed for fewer than three months) and e_t corresponds to the level of employment in quarter t. The job finding probability is given by $\frac{u_t - u_{t+1} - u^s_{t+1}}{u_t}$, where u_t refers to the stock of unemployed persons in quarter t.

[23] This result holds even when the unemployment rate is jointly included in the regression model with the job finding and job separation probabilities. The latter are statistically significant at the conventional levels, while the unemployment rate is not. However, the interaction term with the unemployment rate for new hires remains statistically significant.

[24] Table A.2 in Appendix A displays the evolution pattern of the job finding and job separation probabilities over the period under analysis.

Table 4: Real Wage Sensitivity to the Job Finding and Job Separation Probability

Portugal, 1986-2007 (N=31,631,954)

Dependent variable: log real hourly earnings

	Stayers	Incremental Effect for New Hires
1. OLS estimator		
Cycle variable: Job Finding Probability	0.393***	0.063
	(0.085)	(0.070)
Cycle variable: Job Separation Probability	-6.352**	1.104
	(2.903)	(1.247)
2. Within estimator, worker fixed effect		
Cycle variable: Job Finding Probability	0.440***	0.061
	(0.097)	(0.051)
Cycle variable: Job Separation Probability	-6.304*	0.965
	(3.498)	(1.500)
3. OLS solution with worker and firm fixed effects		
Cycle variable: Job Finding Probability	0.427***	0.110**
	(0.097)	(0.054)
Cycle variable: Job Separation Probability	-6.367*	0.973
	(3.508)	(1.400)
4. OLS solution with worker, firm, and job fixed effects		
Cycle variable: Job Finding Probability	0.448***	0.054
	(0.088)	(0.037)
Cycle variable: Job Separation Probability	-6.607*	1.001
	(3.616)	(0.962)

Notes: (i) cluster-robust standard errors in parentheses;

(ii) *** significant at 1%; ** significant at 5%; * significant at 10%.

4.4 Real Wage Sensitivity to Aggregate Labor Productivity

An alternative approach to analyze the cyclical behavior of wages, which is more closely rooted in the Mortensen and Pissarides theoretical framework, is to estimate the elasticity of the wage with respect to aggregate labor productivity. As pointed out by Haefke *et al.* (2007), in a standard stochastic search model like the one described in their paper, this elasticity provides an intuitive measure of wage rigidity. If wages are perfectly flexible, they respond one-for-one to changes in productivity, whereas an elasticity of zero corresponds to perfectly rigid wages.

In order to analyze the reaction of real wages to labor productivity, the unemployment rate was replaced with an indicator of aggregate labor productivity in the Portuguese private sector. The aggregate labor productivity measure is defined as the Gross Domestic Product (GDP) per worker in the private sector (in logs). Aggregate labor productivity was deflated using the GDP deflator.[25]

Considering our baseline specification in row 4, Table 5 reports an elasticity of wages with respect to aggregate labor productivity of 1.01 and 1.07 for stayers and new hires, respectively. This estimate is in line with the theoretical notion that it should be one, that is, a one-for-one wage response to changes in labor productivity and reinforce our previous findings that real wages are quite flexible in Portugal.[26]

Once again, the results point to the importance of controlling for worker, firm, and job composition effects over the cycle. In general, ignoring them may induce a countercyclical bias in the estimates of the effects of the business cycle on real wages.

[25] Table A.2 in Appendix A displays the evolution of aggregate labor productivity over the 1985-2007 period.

[26] Alternatively, using the total factor productivity (in logs) as the cycle indicator similar results are obtained for our baseline specification, i. e., an estimate of 0.919 for stayers and 1.01 for new hires, both statistically significant.

Table 5: Real Wage Sensitivity to Aggregate Labor Productivity

Portugal, 1986-2007 (N=31,631,954)

Dependent variable: log real hourly earnings

	Stayers	Incremental Effect for New Hires
1. OLS estimator		
Cycle variable: log real Labor Productivity	0.806**	0.064**
	(0.310)	(0.022)
2. Within estimator, worker fixed effect		
Cycle variable: log real Labor Productivity	0.895**	0.030
	(0.354)	(0.020)
3. OLS solution with worker and firm fixed effects		
Cycle variable: log real Labor Productivity	0.860**	0.074***
	(0.365)	(0.015)
4. OLS solution with worker, firm, and job fixed effects		
Cycle variable: log real Labor Productivity	1.010***	0.059***
	(0.388)	(0.011)

Notes: (i) cluster-robust standard errors in parentheses;

(ii) *** significant at 1%; ** significant at 5%; * significant at 10%.

4.5 Robustness Checks

4.5.1 Alternative Wage Measures

In order to check if our results are robust to alternative definitions of wages, equation (1) was re-estimated using two other measures of wages: the monthly base wage and the monthly earnings. The monthly base wage is defined as the monthly base pay corresponding to the normal hours of work, whereas monthly earnings correspond to total regular payroll (base wages and regular benefits) including overtime pay in the reference month. As mentioned above, the wages were deflated using the CPI.

The three high-dimensional fixed effects estimates for the semi-elasticity of wages with respect

to the aggregate unemployment rate are presented in Table 6. For comparison reasons the unemployment coefficient estimates for log real hourly earnings are reported in the first row.

As Table 6 makes clear, the results are robust to the use of an alternative measure of wages supporting once again the hypothesis that entry wages within the same firm-job are more responsive to the cycle than wages of existing workers.[27]

Table 6: Real Wage Sensitivity to the Unemployment Rate

Portugal, 1986-2007 (N=31,631,954)

Alternative Wage Measures

OLS solution with worker, firm, and job fixed effects

	Stayers	Incremental Effect for New Hires
Dependent variable		
1. log real hourly earnings	-2.20***	-0.47***
	(0.60)	(0.16)
2. log real monthly earnings	-2.19***	-0.47***
	(0.44)	(0.15)
3. log real monthly base wage	-2.09***	-0.59***
	(0.39)	(0.15)

Notes: (i) cluster-robust standard errors in parentheses;

(ii) *** significant at 1%; ** significant at 5%; * significant at 10%.

4.5.2 Alternative Time Periods

One decade on from the change in the monetary regime in Portugal, with the emergence of the Euro Area, in the presence of historically high rates of unemployment, it is important to revisit the relationship between wages and the unemployment rate. To address this issue, we run equation (1) including a dummy variable that takes the value one for the 1997-2007 period (Y9707) and two interaction terms between the latter and the unemployment rate coefficients. The results are

[27] We also re-estimate our baseline specification using the GDP deflator instead of the CPI deflator. It should be noted that the GDP deflator does not allow us to adequatly track intra-annual changes in prices. The resulting coefficient estimates for the unemployment rate are -1.29 (0.49) for stayers and -0.40 (0.14) for the incremental effect for new hires.

reported in Table 7.

The estimates presented in Table 7 show evidence of wage flexibility in the period between 1986 and 1996, above all for newly hired workers. Even though the estimates of the unemployment rate coefficients for the 1997 to 2007 period are not statistically significant, there is an indication that the cyclical sensitivity of wages may have fallen significantly over the past 10 years, a decade characterised by low inflation.

Table 7: Real Wage Sensitivity to the Unemployment Rate

Portugal, 1986-2007 (N=31,631,954)

Alternative time periods

OLS solution with worker, firm, and job fixed effects

Dependent variable: log real hourly earnings

	Stayers	Incremental Effect for New Hires
1. Cycle variable: Unemployment Rate	-2.89***	-0.67***
	(0.90)	(0.14)
2. Cycle variable: Unemployment Rate*Y9707	1.10	0.31
	(0.95)	(0.21)

Notes: (i) cluster-robust standard errors in parentheses;

(ii) *** significant at 1%; ** significant at 5%; * significant at 10%.

4.5.3 Two-step Estimator

In this Section some further robustness checks are made based on a two-step approach. In order to show that, within the two-way fixed effects estimation, the two-step approach and the full-blown high-dimensional fixed effects produce identical estimates, the unemployment rate coefficient estimates for the former are reported in row 1 in Table 8.[28] As can be shown, the results are quite similar to the ones reported in row 3 in Table 2.

To test whether our results are sensitive to alternative methods to detrend the data, we re-estimate the model with worker and firm fixed effects using the HP-filter, instead of a quadratic

[28] In the first step, log real hourly earnings are regressed on λ_i, γ_f, age (and its square), the education dummies, year dummies and on the interaction terms between the latter and the dummy for new hires. In the second step, the two sets of year dummies estimates are regressed separately on the cycle variable.

time trend, based on a two-step approach.[29] The estimates for the aggregate unemployment rate and the aggregate labor productivity coefficients are presented, respectively, in rows 2 and 3 in Table 8, and provide similar results to those in Tables 2 and 5 (row 3).

Table 8: Real Wage Sensitivity to the Unemployment Rate

Portugal, 1986-2007

Results based on a two-step approach

Dependent variable: (change) log real hourly earnings

	Stayers	Incremental effect for New Hires
1. Two-step OLS solution with worker and firm fixed effects		
(N_{1step}=31,631,954; N_{2step}=20)		
Cycle variable: Unemployment Rate	-2.05***	-0.75***
	(0.76)	(0.19)
2. Two-step OLS solution with worker and firm fixed effects, HP-filtered		
(N_{1step}=31,631,954; N_{2step}=22)		
Cycle variable: Unemployment Rate	-2.02***	-0.65***
	(0.57)	(0.11)
3. Two-step OLS solution with worker and firm fixed effects, HP-filtered		
(N_{1step}=31,631,954; N_{2step}=22)		
Cycle variable: log real Labor Productivity	0.79**	0.19**
	(0.29)	(0.07)
4. Two-step first-differences approach		
(N_{1step}=18,478,028; N_{2step}=17)		
Cycle variable: $\triangle$Unemployment Rate	-1.40	-0.65**
	(1.10)	(0.28)

Notes: (i) standard errors in parentheses;

(ii) *** significant at 1%; ** significant at 5%; * significant at 10%.

[29] The smoothing parameter for the HP filter was $\lambda = 400$, as suggested by Correia *et al.* (1992).

Finally, we re-estimate the model adopting a first-differences approach. Notice that these results should be read with some caution as the sample size drops remarkably. As discussed before, one of the main drawbacks of a first-differences approach is related to the exclusion of individuals with a weak labor force attachment, which points out to a potentially serious sample selection problem if those individuals who are observed for two consecutive years do not correspond to a random sample of the population under study.[30] Row 4 in Table 8 presents the coefficient estimates for the change in the aggregate unemployment rate for two consecutive periods based on the standard two-step least squares approach.

Thus, and apart from the potential sample selection problem, we conclude that the wages of between-firm movers are more responsive to the cycle than the wages of existing workers, which is in line with previous findings for the U.S. and the U.K. as discussed in the first section above.[31] A one-point fall in the rate of unemployment is associated with a 2.1 percent increase in movers' hourly earnings. This same estimate is around 1.4 percent for stayers, even though not statistically significant at the conventional levels. Although these elasticities are below the ones obtained based on the model with worker fixed effects (see row 2 in Table 2), they confirm the hypothesis that entry wages are more flexible than wages of workers on ongoing relationships.

4.6 Comparison with Previous Literature

To our knowledge there are no studies that use data comparable to ours to analyze wage cyclicality using an estimation procedure that allows to account simultaneously for worker, firm, and job heterogeneity to test to whether entry wages are more flexible than wages of existing workers within the same firm-job. Nevertheless, before concluding it is important to see how our results compare with previous empirical work on this issue.

Our estimates based on a model with worker fixed effects are remarkably close to the ones obtained by Hart (2006) and Devereux and Hart (2006) using the British New Earnings Survey

[30] In fact, all individuals who are not observed for two consecutive years are dropped, including all those newly hired workers that arrive from non-employment. Additionally, due to the missing data problem for the years of 1990 and 2001 we are not able to identify wage changes between 1990-1991 and 2001-2002.

[31] Recall that the expression *mover* corresponds to a worker employed for two consecutive years in the *QP* files with tenure under than 12 months in the second year. Thus, here the group of movers correspond to a sub-sample of newly hired workers.

Panel Data (NESPD) for the 1975-2001 period. Based on a first-differences approach, they report a semi-elasticity of wages with respect to unemployment that lies between -1.46 for male stayers within a single job and -1.97 for internal company movers. For between-company male movers they found a semi-elasticity of -2.90. Our figures of -1.86 for stayers and -2.46 for new hires are very close to the ones reported for Britain and slightly above the most recent ones reported for the U.S. by Devereux (2001). Using the PSID data for the 1970-1991 period Devereux reports a semi-elasticity of -1.16 and -0.81 for, respectively, the full sample and the sample of job stayers.

In a recent paper, Martins *et al.* (2010), using the *Quadros de Pessoal* data set for 1986-2007, report a semi-elasticity of -1.43 and -2.64 for stayers and movers, respectively, based on the standard first-differences approach.[32] Our estimates based on the same methodology are quite similar for stayers (-1.4), but a bit lower for movers (-2.1). They also report a semi-elasticity of -1.8 for entry wages in Portugal, even though their methodology can not be straightforwardly compared with ours.

Controlling for firm and job unobserved heterogeneity, our results indicate that new hires wages are more procyclical than wages of incumbent workers. This evidence contradicts the results obtained by Gertler and Trigari (2009) that found that once job heterogeneity is taken into account, new hires wages appear no more cyclically sensitive than existing workers' wages. In our view, the main drawback with their results stems from the short-time period covered in their data set - the Survey Income of Program Participation (SIPP) over the years 1990-1996. To replicate their analysis we redo equation (1) including just one fixed effect, λ_{if}, for each worker-firm match. Contrary to them, we found a sizable and statistically significant difference between stayers and new hires, i. e., an estimate for the incremental effect of -0.59.

Our results also support the well documented fact that failure to control for worker heterogeneity tends to induce a countercyclical bias in wages. Furthermore, they also reveal that job composition effects are important and ignoring them may yield, again, a countercyclical bias.

In what respects to labor productivity, our results are in accordance with Haefke *et al.* (2007) that found, based on the CPS for the U.S. and after controlling for individual heterogeneity, an elasticity of wages with respect to labor productivity for newly hired workers of one. Contrary to them, we also found that wages of incumbent workers are very responsive to changes in labor

[32] These estimates are much higher than the ones exhibited in Martins (2007) using the same data set for the 1986-2004 period and the same methodology.

productivity, which supports our results based on the unemployment rate that wages are quite flexible in Portugal for all workers.

The overall picture we get from these comparisons is, therefore, that the Portuguese data corroborate previous empirical findings that real wages are not rigid. This result holds even after taking into account the main sources of composition effects over the cycle. Furthermore, our results support the claim in Pissarides (2009) that entry wages are more volatile than current wages within the same firm-job.

5 Conclusions

The empirical findings emerging from this exercise are sixfold. First, accounting simultaneously for worker, firm, and job heterogeneity the data support the hypothesis that real wages in Portugal are quite flexible irrespective of the measure of the cycle used.

Second, we were able to show that entry wages are more responsive to the cycle than wages of existing workers within the same firm-job.

Third, the difference in the behavior of real wages between new hires and stayers seems to be driven by the evolution of the wage cushion over the cycle. While for newly hired workers firm-specific wage arrangements are quite sensitive to unemployment fluctuations, for existing workers those wage adjustments are not responsive to changes in unemployment.

Fourth, disentangling between the job finding and the job separation probability we showed that real wages react positively to changes in the job finding probability and negatively to changes in the job separation probability.

Fifth, and more directly related to the unemployment volatility puzzle debate, we found that wages for all types of workers exhibit a wage-productivity elasticity that is in line with the theoretical notion of a one-for-one wage response to changes in labor productivity.

And sixth, compositional bias plays a very important role. Overall, our results show that failure to account for worker and job unobserved heterogeneity may induce a countercyclical bias in wage cyclicality. This empirical evidence seems to support the hypothesis that low-skilled workers and low-quality/paying jobs account for a smaller share of employment in recessions than in expansions.

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APPENDIX A - Descriptive Statistics

Table A.1: Unemployment Rate, Job Finding Probability, Job Separation Probability and Aggregate Labor Productivity

Portugal, 1985-2007

	Unemployment Rate (%)	Job Finding Probability (%)	Job Separation Probability (%)	Real Aggregate Labor Productivity per Worker
1985	7.18	12.4	1.35	4.44
1986	7.42	17.4	1.41	4.61
1987	6.53	21.1	1.30	4.89
1988	5.72	20.3	1.16	5.02
1989	4.50	20.0	1.14	5.28
1990	5.10	25.7	1.24	5.40
1991	4.73	26.4	1.16	5.48
1992	3.89	21.1	1.26	5.51
1993	4.94	15.0	1.40	5.68
1994	5.96	17.5	1.59	5.78
1995	6.25	15.3	1.30	5.85
1996	6.35	15.1	1.23	5.92
1997	5.84	21.4	1.37	6.07
1998	4.95	26.2	1.26	6.18
1999	4.40	25.1	1.24	6.27
2000	3.90	24.4	1.11	6.32
2001	4.00	25.7	1.35	6.29
2002	5.00	19.5	1.71	6.35
2003	6.25	21.6	1.67	6.40
2004	6.65	15.8	1.56	6.54
2005	7.60	16.7	1.57	6.60
2006	7.60	16.7	1.69	6.60
2007	8.00	19.7	1.87	6.67

Source: Bank of Portugal and Torres (2009).

Table A.2: Means of Selected Variables (SDs in parentheses)

Portugal, 1986-2007

	Stayers Tenure ≥ 12	New Hires Tenure < 12
Age (in years)	36.6 (10.7)	30.7 (9.9)
Female = 1 (%)	39.7 (0.49)	40.2 (0.49)
Education Level (%)		
Less than Basic School	0.030	0.020
Basic School	0.374	0.305
Preparatory	0.207	0.228
Lower Secondary	0.155	0.189
Upper Secondary	0.161	0.177
Bachelor and College	0.071	0.079
Non-defined	0.002	0.002
Tenure (in months)	117.8 (102.1)	5.11 (3.4)
log real Hourly Earnings (in euros)	0.313 (0.60)	0.092 (0.50)
log real Monthly Earnings (in euros)	5.47 (0.58)	5.26 (0.49)
log real Monthly Base Wage (in euros)	5.27 (0.49)	5.07 (0.41)
log real Bargained Wage (in euros)	5.11 (0.41)	4.96 (0.30)
Wage Cushion [log real Monthly Base Wage - log real Bargained Wage]	0.189 (0.35)	0.156 (0.31)
N	26,459,470	5,172,484