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Labor Adjustment Dynamics: An Application of System GMM

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Keywords: Labor demand, Adjustment dynamics, Adjustment costs, System GMM, Median adjustment lag

* The opinions expressed in this article represent the views of the authors and do not necessarily correspond to those of the Portuguese Ministry of Economy and Employment.

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1 Introduction

This paper provides an empirical investigation of the labor adjustment dynamics in the Portuguese labor market. We propose to evaluate the level of rigidity present in workforce adjustments through a System GMM estimation procedure using micro data. Additionally, we provide the median adjustment lag (a related measure of adjustment speed) and short- and long-run labor demand elasticities with respect to firms' wages and sales.

Even though economists have tried to understand the determinants of business cycles in an attempt to attenuate fluctuations, they are still around. Firms will inevitably need to adjust their input factors in response to changes in the demand throughout the business cycle; therefore, rigidities in factor input adjustment are of the greatest importance at both the microeconomic and macroeconomic levels (Hamermesh and Pfann, 1996). At the microeconomic level, the dynamics of labor adjustment allow for optimal labor market policy design. Only if elasticities of factor demand relatively to shocks are known can the government predict the market response and thus decide on the optimal policy to implement. At the macroeconomic level, rigidities in factor markets partly determine the speed and depth of factor adjustment throughout the business cycle and, consequently, the dynamics of investment, employment and output.

Although a rigid labor legislation contributes actively to decrease cyclical fluctuations in product supply, it also prevents a rapid adjustment when necessary; and since the demand side of the economy is generally less rigid, short run discrepancies between supply and demand for goods will be harder to accommodate the more stringent labor legislation is. The effects of the often-called *eurosclerosis*[1] have been well documented. Countries with overprotectionist labor legislation, which imposes costs to the operating firms and causes sluggishness in the labor adjustment process, evolve to have inefficient outcomes on several economic dimensions. For instance, Bentolila and Bertola (1990) find that high firing costs imply slower and more uncertain growth and Heckman (2002) finds that incentives to innovate, to acquire skills, and to take risks have been thwarted by the welfare state.

Section 2 provides an overview and the theoretical framework of the consequences of adjustment costs. Section 3 contains a brief summary of the Portuguese labor market statistics and legislation important for the determination of rigidities. Section 4 sets out the estimation procedure to assess the level of sluggishness in the Portuguese labor market. Section 5 describes the dataset used and Section 6 the results obtained. Lastly, Section 7 provides some concluding remarks.

[1]The European economic-disease where poor job creation dynamics appear as symptoms of employment-protectionist policies.

2 Factor Demand and Adjustment Costs

Firms' demand for inputs depends primarily on the level of economic activity, *i.e.*, on the business cycle. During an expansion firms would like to hire inputs so as to face the increased demand by consumers for their products or services, whereas during a downturn firms would like to cut back on input usage to avoid wasting resources, which ultimately lead to inefficient outcomes.

Consider the two main inputs in the production function: capital and labor; capital is usually assumed to be fixed in the short-run, this meaning that firms do not adjust their capital input instantaneously (following a shock to aggregate demand, for instance). One of the reasons is that it may be physically impossible, as is in the case of industrial firms, where capital is usually in the form of heavy machinery and buildings which take time to build and to set up. This can be viewed as a friction in capital adjustment that prevents an immediate response following a shock. To face this short-run rigidity firms can, alternatively, adjust less rigid inputs provided there is a degree of substitutability between them, and labor is a candidate for just that (see for instance Arrow *et al.*, 1961). So, in general, we assume capital to be a fixed factor and labor to be a variable factor, in the short-run.

Following Hamermesh and Pfann (1996), we will concentrate not on the physical impossibility explanation for sluggishness in input adjustment, but on adjustment costs. First, because for labor we can not usually rely on the first explanation to justify rigidities; and second, because it can be viewed as a generalization, since physical restrictions also imply a cost: the opportunity cost of time. The existence of adjustment costs implies that firms may not adjust factor inputs immediately after a shock (or may not adjust at all). Although this can be due to shortsightedness or myopia by the firms, we can not in general discard the possibility that it may be a rational decision. Suppose firms expect (correctly) that a current positive aggregate demand shock will last for only two periods. If the adjustment process takes one period and is costly, then it may be optimal to not adjust at all, if adjustment costs overweight the expected net benefits of making the adjustment and reverting it.

2.1 Typology of Adjustment Costs

For the factor input *labor* the essential distinction for our discussion of the topic of adjustment costs is among *fixed costs*, those unaffected by the quantity of adjustment in the labor input (provided that is an adjustment); and *variable costs*, those directly dependent on the size of the adjustment. If we now think that labor can actually take the form of either *workers* hired or *hours* hired by the firms, there is the possibility of substituting one for the other if they do not entail the same adjustment cost structure.

In practice, we can think of a variety of labor adjustment costs for both worker- and hour-adjustments. In any hiring process there is always the screening cost of selecting a new worker which involve advertisement of job vacancies, tests and interview sessions, administrative costs and on-job training of newly hired workers. Additionally, new hirees will possibly hinder, only if temporarily, the efficiency level of the firm during the adjustment phase; possibly, some costs related to the readjustment of the production process will also arise. Contrarily to other input factors, however, there are additional costs if the company decides to part with an employee. Often legislation obliges firms to severance pay in case of separation. Besides, the sole act to firing a worker implies a great deal of administrative costs and efficiency losses. This suggests that costs are inherent to the process of hiring and firing a worker, not just to changes in the size of the workforce, and also hints at a possible asymmetry in the labor adjustment process. Hiring an extra hour of work from an existing worker entails a considerable lower diversity of costs. Although firms are obliged to pay overtime wages (equal to the base wage rate plus a premium) and all the costs that are dependent on the number hours of work, they may be able to avoid a significant amount of costs, especially future separation costs. This suggests that there may be differences on the balance between the employment of workers and the dependence on extra-time hours of work. The balance would naturally be a function of the cost structure of each type of labor.

2.2 Theoretical Framework

Let us now examine how the presence of adjustment costs might influence firms' decisions. Hamermesh (1993) provides a thorough survey on dynamics of labor demand and adjustment cost. To understand the impact of adjustment costs on adjustment dynamics, we must analyze firms' decisions. Consider a representative profit-maximizing firm with profits given by

$$\Pi = \int_0^\infty e^{-rt} \left[F\left(L_t\right) - w_t L_t - C(\dot{L}_t) \right]. \tag{1}$$

For simplicity, we assume that firms have a production function F which depends only on labor, L_t; they face a cost function C which depends on the size of the adjustment, $\dot{L}_t$; and they face exogenous wage rate w and discount rate r. Firms will then maximize, at each period in time, the discounted future net value of their production. Since we are interested in studying the effects of labor adjustment costs, which will enter the firms' maximization problem through the cost function, we will bypass the problems related to the determination of wages and the interest rate here. What can we expect from this firm's behavior in the presence of adjustment costs? As for most typical economic problems, and this one is no exception, it depends; considering the forward-looking nature of this optimization problem, the labor adjustment pattern following a shock should be fundamentally determined by the functional form of C and by other factors such as the firm's expectations about the size and duration of the shock. Let us consider the two main categories of adjustment costs: *variable* costs and *fixed/lumpy* costs under static expectations.[2]

If we consider symmetric quadratic variable costs,

$$C(\dot{L}_t) = a|\dot{L}_t| + b\dot{L}_t^2 \tag{2}$$

with $a, b > 0$ what we would expect is a slow, lagged adjustment towards the equilibrium level of employment following an unexpected shock. To see this, observe the general functional form of the cost function, which tells us that the cost of making an adjustment $\dot{L}_t$ rises quadratically with the level of the adjustment. For the firm, this means that large adjustments are disproportionately expensive and so, when facing the trade-off *slow adjustment* (maintaining a gap relatively to the optimum level of employment for many periods, which is inefficient, but a low cost of adjustment per period) versus *fast adjustment* (few gap-periods but a high cost of adjustment per period) the firm will spread out the adjustment across several periods. How spread out the adjustment is will depend ultimately on the size of the parameters a and b. Also, following an unexpected shock, firms will only start the adjustment a period after it occurs (remember firms' expectations are static). Hence we have a slow and lagged adjustment. A special case can be obtained if $b = 0$. In that case, the firm faces a linear adjustment cost function and the optimal behavior is to adjust immediately and fully, so as to minimize the losses generated by an off-equilibrium situation.

If we consider fixed costs,

$$C(\dot{L}_t) = \begin{cases} k & , |\dot{L}_t| > 0 \\ 0 & , |\dot{L}_t| = 0 \end{cases} \tag{3}$$

with $k > 0$ what we would expect is a step-like, lagged adjustment towards the equilibrium. Again, a firm has to weight the net benefits of a fast adjustment against the net benefits of a slow adjustment. In this case, the firm faces a cost k if it decides to adjust, regardless of the size of the adjustment, and no cost otherwise. Given this cost function, the firm will choose either to adjust fully or not adjust at all. Since the cost incurred is independent of the level of adjustment, if the firm is going to adjust it might as well adjust completely to equilibrium so as to minimize inefficiencies. From this it follows that, for a given level of k, there is a threshold level, $\dot{L}_t^{\tau}$, that leads the firm to make the adjustment whenever $\dot{L}_t > \dot{L}_t^{\tau}$. This is of course a function of the severity of adjustment costs, and the expected long-term net benefits of an immediate adjustment. In the end, this means that firms will be willing to accommodate with an 'inefficient' outcome if the costs of adjustment are sufficiently high and/or the necessary adjustment to equilibrium is small (*i.e.*, inefficiency losses are small).

[2] Firms' expectation for all future equilibrium levels of employment, L_{t+1}^*, is simply its last observed value. More formally, $\mathbb{E}_t\left[L_{t+j}^*\right] = L_t^*$ for all t and all $j > 0$.

Notice that we can compare both these cases with the trivial case of *no adjustment costs*, efficiency-wise. In the later, where $C(\dot{L}_t) = 0$ for all levels of $\dot{L}_t$. Adjustment is not costly, which means that the optimal response is always to adjust fully and immediately to equilibrium after a shock. In the former cases, where some form of adjustment cost is present, the optimal decision will possibly imply a partial adjustment through time, imposing a loss of efficiency at the level of the firm.

Of course, in reality the structure of adjustment costs that firms face should be a combination of these two extreme cases, that is, most adjustment processes will entail a component of variable costs and a component of fixed costs. As such, we should expect a firm's adjustment process to lie somewhere in between the two cases described above, *i.e.*, we should observe no adjustment for small changes in the equilibrium level of employment (due to lumpy costs) and smooth adjustment for changes in equilibrium that are higher than the threshold level (due to quadratic costs). With significant labor adjustment costs, labor will be sticky and it can be said that labor is a quasi-fixed input.

Evidence shows that labor adjustments costs are indeed quite significant. Hamermesh (1993) reviews the significance of these costs. A survey in 1980 for Los Angeles documents average hiring and training costs of \$5110 for production workers and \$13790 for salaried workers, while firing separation costs are around \$370 and \$1780, respectively. More recently, Abowd and Kramarz (2003) estimated the annual adjustment costs of replacing a worker, by age group and job type, with results ranging from 2.8% to 9.7% of total annual compensation.

2.3 Consequences

The fact that hiring and separation costs exist will impact negatively on adjustment dynamics not only during a downturn (when a firm would like to lay off workers), but also during an expansionary phase (when a firm would like to hire more workers). On the one hand, firms will not adjust fast during a recession. They will employ a higher labor force than the necessary and bear some inefficiency costs. On the other hand, if firms are forward-looking, they will anticipate the costs faced with future eventual separations, and will refrain from increasing employment during expansions as well. Therefore, adjustment costs and a strict labor law impose costs at all states of the business cycle. Because firms can not resize downwards they will be contained in their expansions as well. This (rational) firm behavior will imply a gap between the optimal workforce and the one observed at each moment in time, a gap which increases with the level of adjustment costs. The intuition is that a higher level of adjustment costs will shift firms' incentives either towards a choice of a smaller workforce relatively to the optimal level thus implying a higher inefficiency level. This happens because the net benefits of hiring an additional worker shrink in the presence of adjustment costs; the reverse behavior might also be observed, *i.e.,* firms having a larger labor force than 'optimal'—see, for instance, Bentolila and Saint-Paul (1994); Dixit (1997); Pfann and Palm (1993); Nickell (1978); Fay and Medoff (1985); Fair (1985). The final outcome is not only bad news for employment, but bad news for economic growth as well.

Another perverse effect of sizable adjustments costs comes through the weakened matching opportunities. In a rigid labor market where direct and indirect hiring and firing costs are high, worker flows are small. This pleases the employed, but should also worry them, as were they to become unemployed new job prospects would be scarce—see, for instance, Lazear (1990). Worse than this is the fact that the whole economy could benefit, maintaining the same people employed and unemployed, by simply reallocating them to more appropriate jobs—creating better matches. Rigidities actually work to make firms not willing to fire misplaced workers (bad matches) and workers not willing to quit firms where they are not happy and most productive (bad matches as well). Efficiency is evidently impaired.

3 The Portuguese Labor Market

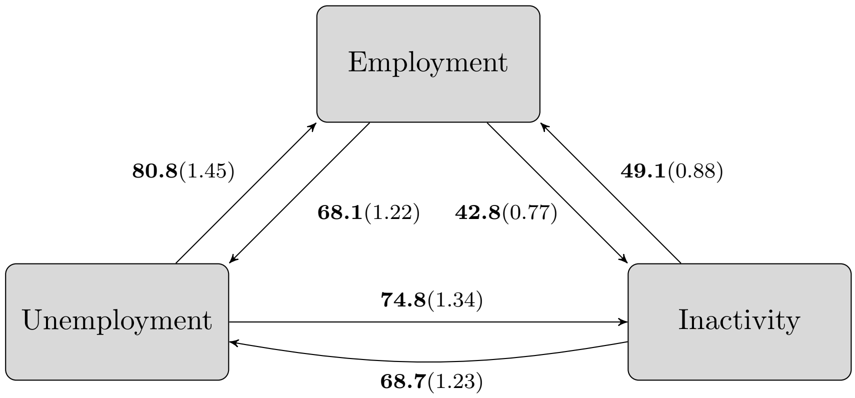
3.1 Indicators and Statistics

A number of studies have ranked Portugal among the countries with highest level of employment protection. For instance, the OECD reports some employment protection indicators for OECD countries. The analysis of Table A.1 (Appendix) shows that Portugal has consistently ranked among the most protectionist OECD countries. The situation is specially serious in the *regular employment* category where Portugal has ranked first in both 1998 and 2008, this meaning that, besides the very rigid labor market we inherited from previous generations, no effective changes were made—or they did not work out as expected—during this 10-year period for this particular branch of the labor market. Regarding *temporary employment* and *collective dismissals*, rigidity levels are less serious and improvements are visible. Overall, there has been an improvement in flexibility since 1998, showed by the overall strictness index. Still, as of 2008, Portugal remains well above the OECD average.

Worker flows provide another sign of rigidities in the Portuguese labor market. Blanchard and Portugal (2001) document the worker flows and job creation and destruction for Portugal and the United States. Table A.2 is a partial reproduction of the authors Tables 6 and 7. We can clearly observe, analyzing the first four columns, a higher flexibility of the American market, with larger flows and higher job creation and destruction dynamics. The remaining three columns show the worker flows from employment to (i) unemployment (ii) non-activity (iii) employment. Again, flows in the Portuguese labor market are smaller (on average 1/3) than those of the United States.

More recent indicators are also available. Figure 1 presents the quarterly labor market flows between *employment*, *unemployment* and *inactivity* for Portugal in 2010. In a given quarter, on average, none of the flows exceeded 1.5% of active population, which again illustrates the slow dynamics of the Portuguese labor market. Table A.3 presents some statistics on duration of employment and unemployment and incidence of long-term employment and unemployment for the period 2001-2010. The duration of both employment and unemployment has been increasing for this period, from 118 to 130 and 18 to 25 weeks, respectively. This, once more, argues in favor of a sclerotic labor market: employed people tend to keep their jobs for a longer time and unemployed have a harder time finding a job, since few vacancies are made available. Although more volatile, the long-term unemployment has also been on the rise, from 42% to 56% over this period.

Figure 1: *Average quarterly flows in the Portuguese labor market*
Values in ***thousands*** *(% of active population). Source: Relatório Anual 2010, Banco de Portugal*



3.2 Legislation

Behind the statistics just described there is certainly the impact of adjustment costs, which are partly imposed by the labor law. In sum, legislation "imposes a long, complex and costly process on employers", implying "a sequence of time-consuming and potentially production-disruptive administrative procedures" as Blanchard and Portugal (2001) put it. OECD (2009) overviews the Portuguese situation on matters of employment legislation. Firms must notify employees 15 to 75 days (depending to tenure) prior to the proposed separation date, and also the workers organization or union in the case of a collective dismissal. After this, employees have 60 days to claim an unfair dismissal, and then a 90 to 240 days trial period follows (according to the nature of the position held), in which the issue must be settled. In the case of a sporadic dismissal, firms are obliged to severance pay amounting to one monthly salary for year of tenure, with a minimum of three salaries. In the case of collective dismissals, compensation is not defined by the law, and should be negotiated between employers and employees/unions. Even thought seemingly less strict, collective dismissals are rarely approved.

4 Econometric Model

The empirical analysis conducted here aims at shedding some light on the dynamics of labor adjustment. This adjustment can vary in speed and length depending on demand-sided (demand for the firms' products) and supply-sided (structure of adjustment costs and legislation) economic conditions. What we seek is a measure of how sluggish employment adjustment is.

4.1 Model Specification

Consider the extension of the Autoregressive Distributed Lag model to panel data

$$y_{it} = \alpha y_{i,t-1} + \mathbf{x}'_{it}\beta + \varepsilon_{it} \tag{4}$$

$$\varepsilon_{it} = u_i + v_{it} \tag{5}$$

where the subscript $i = 1, 2, ..., N$ designates firms and the subscript $t = 1, 2, ..., T$ designates time. For each firm i, $y_{it_{[T\times 1]}}$ is a column vector containing the realizations of the dependent variable; $\mathbf{x}'_{it_{[T\times k]}}$ is matrix containing the information of the k explanatory variables; α and $\beta_{[k\times 1]}$ are parameters to be estimated; and $\varepsilon_{it_{[T\times 1]}}$ is a column vector of error terms, containing a firm-specific and time-independent effect (fixed effect) u_i and an idiosyncratic shock (random effect) v_{it}. Also, we assume $\mathbb{E}[u_i] = \mathbb{E}[v_{it}] = \mathbb{E}[u_i v_{it}] = 0$ (the firm-specific and idiosyncratic error terms have mean zero and are orthogonal) and $\mathbb{E}[v_{it}v_{jt}] = 0$ for $i \neq j$ (the idiosyncratic error terms are orthogonal across firms).

An application to the "employment equation" is directly obtained by allowing the dependent variable to be a measure of employment, such as the number of workers or hours worked, and including other explanatory variables such as the demand for the firms' products and wages. This gives us a family of parsimonious representations of the dynamics of the labor demand, for instance

$$e_{it} = \alpha e_{i,t-1} + \beta_{s0}s_{i,t} + \beta_{s1}s_{i,t-1} + \beta_{w0}w_{i,t} + \beta_{w1}w_{i,t-1} + \varepsilon_{it} \tag{6}$$

where e_{it} is the level of employment of firm i at time t which will be measure by the number of *workers* (n_{it}) or the number of *hours* worked (h_{it}). A measure of the adjustment speed can be obtained through the coefficient α. The model can of course be augmented with lags of the explanatory variables and further lags of the dependent variable. It should be clear that the structure of adjustment costs is not considered here in determining the speed of adjustment in the labor market.

As already mentioned, our main parameter of interest is the autoregressive parameter α, a proxy for the sluggishness of the labor market. We can think of the adjustment process as given by a Partial Adjustment model in discrete time. With static expectations

$$\triangle L_t = \delta\left[L^*_{t-1} - L_{t-1}\right] \tag{7}$$

where L^* is the equilibrium employment level. Changes that affect L^* will trigger an adjustment process of L towards the new equilibrium level. The process will be slower the more severe the adjustment costs, as explained earlier. The parameter δ moderates the adjustment in each period, which is given by a fraction of the distance to the equilibrium level. A lower δ implies a lower adjustment speed, hence a higher rigidity level. The interpretations via α or δ are qualitatively symmetrical since α is a rigidity parameter (high for slow adjustment) whereas δ is a flexibility parameter (high for fast adjustment).

4.2 Estimation

Estimation of the model proposed above requires the use of nonstandard procedures. Several remarks can be made from the outset, regarding the nature of the model: (i) in the presence of fixed effects (unobservable firm-specific characteristics that imply different responses for each firm) we can no longer make use of the standard OLS estimation procedures, since the unobserved effects may be correlated with one or more of the explanatory variables in $\mathbf{x}_{it}$, thus leading to endogeneity. Additionally, OLS delivers downward-biased coefficient estimates for the lagged dependent variable, an effect known as *dynamic panel bias* or *Nickell bias*—see Nickell (1981). In such situations, OLS produces biased and inconsistent estimates; (ii) another type of endogeneity—simultaneity—may also be present; if explanatory variables are not strictly exogenous but predetermined by their past values, they will be correlated with past error terms. This renders the same estimation problems as the first point; (iii) the random component of the error term may be heteroskedastic, showing different patterns for different firms. This is a less serious problem, affecting only efficiency and not consistency, but still corrections may be necessary for valid inference purposes.

Even though the problems of this type of model seem overwhelming, solutions have been designed to overcome them. As typical for models plagued with endogenous variables, instrumentation offers a promising way out. Building on the work of Holtz-Eakin, Newey and Rosen (1988) and predecessors, Arellano, Bond, Bover and Blundell's joint contribution provides the econometric framework necessary to address these same concerns in the contexts of dynamic panel data models. They have proposed two Generalized Method of Moments (GMM) estimators. The first one by Arellano and Bond (1991), called Difference GMM; and the second one by Arellano and Bover (1995) and Blundell and Bond (1998), called System GMM. The Difference GMM estimator transforms equations (6) and (5) by using first differences of variables to eradicate fixed effects from the model (remember that fixed effects are time-independent—they vary only across firms—thus disappear in first differences) under the assumption of serially uncorrelated errors. System GMM uses instrumental variables to overcome the same problem and relies on a two-equation model (the original level equation and a differenced equation). In both cases, we will eventually have to deal with endogenous variables (whether or not correlated with fixed effects), hence instrumental variables are bound to enter the picture. However, given the statistical importance of good instruments and the typical data availability problems of empirical studies, the immediate solution itself raises another concern. The methods applied here actually resolve the main problems present in this type of analysis. By using lags of the regressors as instruments for the regressors themselves, and estimating a model in first-differences, we can overcome both types of endogeneity without the need for *outsider* instruments. Both procedures are designed (*i.e.*, best suitable) for panels with a large number of firms and a small number of time periods (large N, small T), compactible with our dataset to be described further ahead. Corrections are also available to solve heteroskedasticity, based on two-step estimates that are asymptotically consistent.

4.3 Known biases and the proliferation of instruments

With large datasets the number of potential instruments becomes very large. We might be tempted make use several lags to instrument each variable, under the principle that more information is always beneficial, but this turns out not to be so simple. The system that produces the parameter estimates is usually overidentified (with more instrument than endogenous variables) and postestimation procedures should be used to check the validity of the instruments used. As noted in the literature, if the matter of proliferation of instruments is not attended to, significant bias is to be expected in parameter estimates (overfitting bias) and test statistics (commonly the Sargan or Hansen's J statistics, used to validate instruments used) that rely on estimated standard errors that perform poorly under overproliferation of instruments—see for instance Tauchen (1986), Windmeijer (2005) and Roodman (2009a, 2009b). Windmeijer (2005) suggests a correction to the traditional two-step standard errors that performs very well in simulations, making them asymptotically robust to heteroskedasticity. We shall refrain from using the Sargan test which is a special case of Hansen's J statistic and is not robust to heteroskedasticity; we shall apply the Windmeijer correction whenever appropriate; and we shall keep the instrument count in check. A bold rule-of-thumb is to keep the number of instruments well below the number of groups (in this case firms) in the sample.

5 Data

The dataset uses micro data collected by the Portuguese National Institute of Statistics (INE) and is composed of an unbalanced panel spanning 11 years (1995-2005) of monthly data from 3887 firms (large N, small T) of the industry sector. Firms are identified by a fiscal number (npc) and an industry-sector number (cae, rev.2.1). The dataset provides information on the total number of workers (n), total number of hours worked (h), firm sales (s), total wages (wn) and wages per worker (w).

Table 1: *Employment equation (Difference GMM, exogenous variables)*

	One-step		**Two-step**	
	(1)	(2)	(3)	(4)
Dependent Variable: e_{it}	$e_{it} = n_{it}$	$e_{it} = h_{it}$	$e_{it} = n_{it}$	$e_{it} = h_{it}$
$e_{i,t-1}$	0.711 (0.123)*	0.780 (0.165)*	0.608 (0.060)*	0.743 (0.072)*
$e_{i,t-2}$	-0.005 (0.035)	0.009 (0.016)	-0.027 (0.016)	0.017 (0.013)
s_{it}	0.257 (0.027)*	0.309 (0.048)*	0.255 (0.017)*	0.300 (0.028)*
$s_{i,t-1}$	-0.055 (0.027)*	-0.091 (0.043)*	0.001 (0.019)	-0.060 (0.025)*
$s_{i,t-2}$	0.001 (0.009)	-0.009 (0.013)	0.013 (0.007)	-0.009 (0.010)
w_{it}	-0.111 (0.049)*	-0.060 (0.087)	-0.195 (0.026)*	-0.209 (0.041)*
$w_{i,t-1}$	0.024 (0.034)	0.028 (0.040)	0.048 (0.027)	0.006 (0.026)
Long-run Elasticities				
sales	0.691	0.991	0.641	0.963
wages	-0.294	-0.152	-0.350	-0.850
Autocorrelation in FD				
Arellano–Bond AR(1)	0.000	0.000	0.000	0.000
Arellano–Bond AR(2)	0.004	0.221	0.015	0.274
Exogeneity of Instruments				
Difference in Hansen	0.002 (13)	0.020 (13)	0.020 (13)	0.259 (13)
Observations/Groups	16543/3199	16541/3199	16543/3199	16541/3199
Instruments	71	71	71	71

Notes: (i) GMM-type instruments used for lagged dependent variables only (ii) Columns (1) and (2) represent robust one-step and two-step estimates using workers (n). Columns (3) and (4) represent the same for hours (h). Standard errors in parentheses with stars indicating statistical significance at 5% level; (iii) All variables are in logs (iv) Time dummies were included (v) Tests shown are P-values (d.f.)—higher is better.

6 Results

A number of studies have been carried out on this topic. For European countries, Abraham and Houseman (1999) apply a generalized Koyck model to the same problem, using data on *workers* and *hours* for several manufacturing sectors in Germany, France, Belgium and the United States, but disregarded the problem of endogeneity altogether. Such is a case with a number of other studies. In the source papers of on-set GMM instrumentation Arellano and Bond (1991) and Blundell and Bond (1998) provide not only the theory but also applications for their methods using annual microeconomic firm data for the United Kingdom. These two studies shall be kept as a benchmark against which to compare the result obtained here for Portugal.

We start by reproducing the methodology of Arellano and Bond (1991) for Portugal. After annualizing our dataset, the model is estimated through Difference GMM, assuming the explanatory variables to be strictly exogenous, except for the lagged dependent variable which is taken to be endogenous (thus instrumented via GMM procedures with own past lags).

Results are given in Table 1. Columns labeled (1) and (3) provide one-step and two-step estimates using the number of *workers* as a measure of employment, which are directly comparable with the estimates from columns (a1) and (a2) of Table 4 in Arellano and Bond (1991), the only difference being the fact that we do not include *capital* in the equation as it is not available in our dataset. We observe a first-lag coefficient of 0.711 and 0.608 for

Table 2: *Employment equation (Difference GMM, endogenous variables)*

	One-step		Two-step	
	(5)	(6)	(7)	(8)
Dependent Variable: e_{it}	$e_{it} = n_{it}$	$e_{it} = h_{it}$	$e_{it} = n_{it}$	$e_{it} = h_{it}$
$e_{i,t-1}$	0.810 (0.074)*	0.834 (0.064)*	0.767 (0.031)*	0.794 (0.033)*
$e_{i,t-2}$	0.032 (0.042)	0.027 (0.018)	0.001 (0.012)	0.035 (0.009)*
s_{it}	0.159 (0.046)*	0.218 (0.050)*	0.182 (0.017)*	0.199 (0.018)*
$s_{i,t-1}$	-0.080 (0.020)*	-0.101 (0.025)*	-0.041 (0.011)*	-0.061 (0.012)*
$s_{i,t-2}$	-0.011 (0.011)	-0.018 (0.012)	-0.001 (0.005)	-0.021 (0.007)*
w_{it}	-0.089 (0.056)	-0.073 (0.051)	-0.125 (0.020)*	-0.122 (0.021)*
$w_{i,t-1}$	0.052 (0.029)	0.047 (0.027)	0.085 (0.012)*	0.063 (0.010)*
Long-run Elasticities				
sales	0.428	0.709	0.603	0.686
wages	-0.235	-0.187	-0.172	-0.344
Autocorrelation in FD				
Arellano–Bond AR(1)	0.000	0.000	0.000	0.000
Arellano–Bond AR(2)	0.001	0.069	0.004	0.079
Exogeneity of Instruments				
Difference in Hansen	0.294 (8)	0.332 (8)	0.294 (8)	0.332 (8)
Observations/Groups	16543/3199	16541/3199	16543/3199	16541/3199
Instruments	190	190	190	190

Notes: (i) GMM-type instruments used for all variables (ii) Columns (5) and (6) represent robust one-step and two-step estimates using workers (n). Columns (7) and (8) represent the same for hours (h). Standard errors in parentheses. Notes (iii), (iv) and (v) from Table (1) apply.

models (1) and (3), respectively. These contrast with Arellano and Bond's 0.686 and 0.629. As one would expected, Portugal shows a higher first-order autoregressive coefficient for *workers* implying a higher level of rigidity (the second-order coefficient is small and not statistically significant for both studies), although the same is not true for *hours*. The two models provide similar coefficients for the remaining variables, with two-step estimates being more precise as given by standard errors. Columns (2) and (4) display the same results but using *hours*, rather than *workers*, as a measure of employment. Estimates of the main parameter of interest, 0.780 and 0.743, are higher than the estimates for *workers*, again, an effect contrary to our *a priori* intuition. Regarding the explanatory variables, we can measure the short-run (or impact) elasticities given by the contemporaneous impact of x_{it} on y_{it}, $\partial y_{it}/\partial x_{it}$, and the long-run elasticities given by the corresponding cumulative effect, *i.e.*, the impact of x_{it} on the equilibrium level of y_{it}, $\sum_{j=0}^{\infty} \partial y_{it}/\partial x_{i,t-j}$. For *sales* these elasticities have the expect sign with the short-run elasticity varying between 0.255 and 0.309 and the long-run elasticity between 0.641 and 0.991. For *wages*, short-run elasticities have in general small coefficients while long-run elasticities vary between -0.152 and -0.850.

Tests for the exogeneity of instruments turn out rather poor, which is not surprising given the assumption of strictly exogenous *sales* and *wages*. For the explanatory variables with more than one lag, the more recent lags are, at least in part, determined by the older lags, rendering these variable predetermined and, therefore, not strictly exogenous. Besides this, economic theory alone provides sufficient reasoning to suspect that employment,

Table 3: *Employment equation (System GMM, endogenous variables)*

	One-step		**Two-step**	
	(9)	(10)	(11)	(12)
Dependent Variable: e_{it}	$e_{it} = n_{it}$	$e_{it} = h_{it}$	$e_{it} = n_{it}$	$e_{it} = h_{it}$
$e_{i,t-1}$	0.878 (0.027)*	0.859 (0.045)*	0.877 (0.023)*	0.889 (0.033)*
s_{it}	0.690 (0.056)*	0.941 (0.093)*	0.609 (0.056)*	0.849 (0.070)*
$s_{i,t-1}$	-0.566 (0.065)*	-0.799 (0.115)*	-0.488 (0.065)*	-0.745 (0.085)*
w_{it}	-0.671 (0.062)*	-0.935 (0.107)*	-0.582 (0.061)*	-0.846 (0.079)*
$w_{i,t-1}$	0.457 (0.085)*	0.660 (0.148)*	0.393 (0.081)*	0.669 (0.104)*
Median Adjustment Lag[a]	5.34	4.56	5.30	5.92
Long-run Elasticities				
sales	1.016	1.009	0.985	0.941
wages	-1.762	-1.950	-1.542	-1.594
Autocorrelation in FD				
Arellano–Bond AR(1)	0.000	0.000	0.000	0.000
Arellano–Bond AR(2)	0.149	0.038	0.213	0.049
Exogeneity of Instruments				
Difference in Hansen				
$e_{i,t-1}$	0.807 (03)	0.386 (03)	0.807 (03)	0.386 (03)
s_{it}	0.129 (15)	0.480 (15)	0.129 (15)	0.480 (15)
$s_{i,t-1}$	0.222 (15)	0.575 (15)	0.222 (15)	0.575 (15)
w_{it}	0.067 (16)	0.776 (16)	0.067 (16)	0.776 (16)
$w_{i,t-1}$	0.074 (15)	0.108 (15)	0.074 (15)	0.108 (15)
Observations/Groups	23416/3482	23415/3482	23416/ 3482	23415/3482
Instruments	74	74	74	74

Notes: (i) GMM-type instruments used for all variables (ii) Columns (9) and (10) represent robust one-step estimates using workers (n) and hours (h), respectively. Columns (11) and (12) represent two-step estimates. Windmeijer robust standard errors in parentheses. Notes (iii), (iv) and (v) from Table 1 apply.
a) For all models, the Median Adjustment Lag is expressed in years.

wages and sales are jointly determined, yielding unsatisfactory the assumption of strict exogeneity.

Table 2 reports the results of endogenizing *wages* and *sales*. First-order rigidity parameters increase for all models as expected, with *hours* showing higher rigidity, although only slightly. Precision, however, is significantly improved as shown by the lower standard errors. Short-run elasticities of *sales* decrease in all models (varying between 0.159 and 0.218) as well as the long-run elasticities (varying between 0.428 and 0.709). Short-run elasticities of *wages* have the expected sign and remain small (between -0.073 and -0.125); long-run wage-elasticities are also small (between -0.172 and -0.344).

Finally, we exploit the System GMM estimator. Allowing for a larger system, it also allows for a larger number of instruments to be used (past levels and past differences). A parsimonious model is estimated and presented in Table 3; the analysis is done for the two-step estimates. The autoregressive coefficient is now equal to 0.877 and 0.899, for *workers* and *hours*, respectively. Notice the number of hours worked still shows up as being more rigid than the number of workers, although just slightly. Second, test results are favorable, supporting the validity of the specification used and estimation tools employed.

All elasticities increase in absolute value, with quite large differences in the wage-elasticities *viz-à-viz* the corresponding Difference GMM model. Short-run elasticities of *sales/wages* are 0.609/-0.582 for the number of *workers* and 0.849/-0.745 for the number of *hours*, respectively, comparable to Blundell and Bond's (1998) estimates from a similar model (for the number of workers but replacing *sales* with *capital)*, where they find a short-run elasticity of *wages* equal to -0.797 and a sluggishness parameter equal to 0.810.

7 Conclusions

System GMM provides the best-performing models in this context of high temporal rigidity (high level of α). Thus, models (11) and (12) of Table 3 deliver the most trustful results with all coefficients having the appropriate sign and all tests providing evidence in support of the validity of the instruments used. For the number of workers we find an autoregressive parameter equal to 0.877 and long-run elasticities of 0.985 and -1.542 for *sales* and *wages*, respectively. Blundell and Bond (1998) find an autoregressive parameter of 0.810 and a long-run elasticity of *wages* equal to -1.307 for the UK. We can also have a temporal measure of these levels of rigidity via the *median adjustment lag*, the time it takes the system to adjust halfway to a new equilibrium in response to a shock. Our results imply approximately 5- and 4.5-year periods for 50% of the adjustment in *workers* and *hours* to take place, respectively. This compares with the 3.3 years for the number of *workers* in the UK (Blundell and Bond, 1998) and 1.9, 3.1, 1.6 and 0.4 years for the number of *workers* in Germany, France, Belgium and United States, respectively, and 1.3, 2,1 and 0.3 years for the number of *hours* in Germany, France and United States (Abraham and Houseman, 1999).

The rigidity can in the Portuguese labor market can also be observed by looking at the short- and long-run elasticities. For instance, model (11) in Table 3 provides short- and long-run wage-elasticities of -0.582 and -1.542, respectively. This compares with the values of -0.797 and -1.307 for the UK (Blundell and Bond, 1998). This implies that, although the Portuguese labor market has a larger (long-term) response to a change in wages than the UK does, these changes come about very slowly, as hinted by the lower short-run but larger long-run wage-elasticities for Portugal. These conclusions are not, however, independent of the conclusions obtain with the rigidity parameter, since it enters in the computational formulas of long-term elasticities.

Contrarily to what could be initially expected, adjustment in the number of workers and the number of hours does not differ considerably. In particular, we find no evidence that the adjustment through the number of *hours* is faster than the adjustment through the number of *workers*. One reason could be that the overtime premium for extra hours is sufficiently high so that firms do not have strong incentives to substitute hours for workers. Still, our main conjecture stands: adjustment dynamics in the Portuguese labor market are very slow, implying a range of structural problems typical of countries with a sclerotic labor market.

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Appendices

Table A.1: *Synthetic Indicators of Employment Protection*

	Overall strictness		**Strictness: regular employment**		**Strictness: temporary employment**		**Strictness: collective dismissals**	
	1998	2008	1998	2008	1998	2008	1998	2008
Australia	1.5	1.4	1.5	1.4	0.9	0.9	2.9	2.9
Austria	2.4	2.2	2.9	2.4	1.5	1.5	3.3	3.3
Belgium	2.5	2.5	1.7	1.7	2.6	2.6	4.1	4.1
Canada	1.1	1.1	1.3	1.3	0.3	0.3	2.6	2.6
Denmark	1.9	1.8	1.6	1.6	1.4	1.4	3.9	3.1
Finland	2.2	2.0	2.3	2.2	1.9	1.8	2.6	2.4
France	2.8	2.9	2.3	2.5	3.6	3.6	2.1	2.1
Germany	2.6	2.4	2.7	3.0	2.0	1.3	3.8	3.8
Greece	3.5	2.8	2.3	2.3	4.8	3.1	3.3	3.3
Hungary	1.5	1.9	1.9	1.9	0.6	1.4	2.9	2.9
Iceland	n.a.	1.6	n.a.	1.7	n.a.	0.6	n.a.	3.5
Ireland	1.2	1.3	1.6	1.6	0.3	0.6	2.4	2.4
Italy	3.1	2.4	1.8	1.8	3.6	2.0	4.9	4.9
Japan	1.6	1.5	1.9	1.9	1.4	1.0	1.5	1.5
Korea	2.0	1.9	2.4	2.4	1.7	1.4	1.9	1.9
Luxembourg	n.a.	2.3	n.a.	2.8	n.a.	3.8	n.a.	3.9
Mexico	3.2	3.2	2.3	2.3	4.0	4.0	3.8	3.8
Netherlands	2.8	2.1	3.1	2.7	2.4	1.2	3.0	3.0
New Zealand	0.8	1.2	1.4	1.6	0.4	1.3	0.4	0.4
Norway	2.7	2.7	2.3	2.3	3.1	3.1	2.9	2.9
Poland	1.9	2.2	2.1	2.1	0.8	1.8	4.1	3.6
Portugal	**3.5**	**2.9**	**4.3**	**4.2**	**3.0**	**2.1**	**2.9**	**1.9**
Spain	3.0	3.0	2.6	2.5	3.3	3.5	3.1	3.1
Sweden	2.5	2.2	2.9	2.9	1.6	0.9	3.8	3.8
Switzerland	1.6	1.6	1.2	1.2	1.1	1.1	3.9	3.9
Turkey	3.4	3.5	2.6	2.6	4.9	4.9	1.6	2.4
United Kingdom	1.0	1.1	1.0	1.1	0.3	0.4	2.9	2.9
United States	0.7	0.7	0.2	0.2	0.3	0.3	2.9	2.9
OECD Average	**2.2**	**2.1**	**2.1**	**2.1**	**1.9**	**1.8**	**3.0**	**3.0**
Portugal's Ranking	**1st**	**5th**	**1st**	**1st**	**8th**	**10th**	**14th**	**18th**

Source: OECD Employment Outlook 2010

Table A.2: *Quarterly worker flows from employment, job creation and job destruction*

	Workers Out	Workers In	Job Destruction	Job Creation	E to U	E to N	E to E
Portugal	4.3	3.6	3.0	2.3	1.0	1.0	1.0
United States	17.8-23.0	16.7-21.9	7.9	5.1	3.9	4.8	2.4-5-4

Notes: Partial reproduction of Tables 6 and 7 in Blanchard and Portugal (2001). In the last 3 columns, E=Employment, U=Unemployment and N=Inactivity. All values are percentages of employment.

Table A.3: *Work Mobility*

	Employment		Unemployment	
	Average Duration[a]	Long-term Employment[b]	Average Duration[a]	Long-term Unemployment[c]
2001	118	45	18	42
2002	119	45	18	38
2003	123	45	16	39
2004	126	46	20	48
2005	129	47	21	51
2006	128	45	23	53
2007	126	43	22	50
2008	125	43	23	51
2009	129	44	22	48
2010	130	44	25	56

(a) in months; (b) percentage of workers older than 45 and with more than 20 years of tenure; (c) percentage of unemployed that have been looking for a job for more than 12 months. Source: INE (Inqurito ao Emprego).