A Work Project presented as part of the requirements for the Award of a Masters Degree in Economics from the Faculdade de Economia da Universidade Nova de Lisboa

LABOR ADJUSTMENT DYNAMICS: AN APPLICATION OF SYSTEM GMM

PEDRO MIGUEL ESPERANÇA GRILO #249

A Project carried out under the supervision of:
Prof. Pedro Portugal

6th June 2011

Labor Adjustment Dynamics: An Application of System GMM[1]

Pedro M. Esperança

6th June 2011

Abstract: This paper reviews how adjustment costs and rigid labor legislation affect input factor adjustment throughout the business cycle. Estimates of adjustment speed of different types of labor are provided and their causes and consequences discussed.

Keywords: Labor Demand, Adjustment Dynamics, System GMM

[1]Initial guidance in Stata is gratefully acknowledged to Sónia Félix.

1 Introduction

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 both at 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 rigid labor legislation contributes actively to decrease cyclical fluctuations in supply, it also prevents a rapid adjustment from peaks or troughs towards the smoothed path. And since the demand side of the economy is generally less rigid, short run discrepancies between supply and demand will be harder to accommodate the more stringent labor legislation is. The effects of the often-called *eurosclerosis*[2] have been well documented. Countries with over protectionist 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

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

of the Portuguese labor market's statistics. Section 4 sets out the estimation procedure to assess the level of sluggishness. Section 5 describes the dataset used and the results obtained. And Section 6 provides some concluding remarks.

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. 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 cannot 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 hires will possibly hinder temporarily the efficiency level 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 and efficiency-loss costs. All these costs suggest that costs are inherent to the process of hiring and firing a worker, not just to changes in the size of the workforce. 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 separation costs. This suggests that there may be differences on balance between the employment of workers and the dependence on extra-time hours of work, and that this balance is 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

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

We assume 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 interest rates 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.[3] If we consider symmetric quadratic variable costs,

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

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

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

generated by an off-equilibrium situation. If we consider fixed costs,

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

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 k, there is a threshold level of adjustment that leads the firm to make the adjustment. 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). Notice that we can compare both these cases with the trivial case of *no adjustment costs*, efficiency-wise. In the later, where $C\left(\dot{L}_t\right) = 0$ for all levels of $\dot{L}$. 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 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 cannot 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. The result is that this gap will be increasing with adjustment costs. The intuition is that a higher level of adjustment costs will shift firms' incentives 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 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. 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 severed.

3 The Portuguese Labor Market

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 1 shows that Portugal has consistently ranked among the most protectionist countries in the OECD. The situation is specially serious in the *regular employment* category where Portugal has ranked first in 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 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 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 which once more argues in favor of a sclerotic market: employed people tend to keep their jobs for a long time and unemployed have a hard time finding a job, since few vacancies are made available. Although more volatile, the long-term unemployment has risen from 42% to 56%, quite startling figures.

4 Econometric Model

4.1 Model Specification

The empirical analysis conducted here aims at shedding some light on the dynamics of labor adjustment. What we seek is a measure of how sluggish employment adjustment is. 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 $E[u_i] = E[v_{it}] = E[u_i v_{it}] = 0$ (the firm-specific and idiosyncratic error terms have mean zero and are orthogonal) and $E[v_{it}v_{jt}] = 0$ 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 the wages. This gives us a parsimonious representation of the dynamics of the labor demand as well as a measure of the adjustment speed, through the coefficient α. The model can of course be augmented with lags of the explanatory variables and further lags of the dependent variable. We can think of the adjustment process as given by a Partial Adjustment model in discrete time. With static expectations

$$\triangle L_t = \delta \left[L^*_{t-1} - L_{t-1} \right] \tag{6}$$

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 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 (which deliver downward-biased coefficient estimates for the lagged dependent variable, an effect known as *dynamic panel bias* or *Nickell bias*)[4], since these unobserved effects may be correlated with one or more of the explanatory variables in $\mathbf{x}_{it}$ leading to endogeneity. If that is the case, OLS would produce 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

[4]Nickell (1981).

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. The joint contributions of Arellano, Bond, Bover and Blundell provide 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 (4) 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.

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[5]. 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 thus shall refrain from using the Sargan test which is a special case of Hansen's J statistic 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] e.g.: Tauchen (1986), Windmeijer (2005) and Roodman (2009a).

5 Data and Results

The complete dataset (IVNEI) is composed of a panel spanning 11 years (1995-2005) of monthly data for 3887 firms (large N, small T). For some of these firms information is not available for all years, which leaves us with a total of 345965 observations. Firms are identified by a fiscal number (*npc*) and an industry-sector number (*cae*). The dataset provides monthly 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). For computational reasons, we shall restrict the sample by using only firms belonging to traditional transforming industry (coded with a *cae* number between 10,000 and 19,999).

A number of studies have been carried on. For European countries, Abraham and Houseman (1999) has applied 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 Blundel and Bond (1998) provide not only the theory but also applications for their methods using annual microeconomic firm data for the United Kingdom. We start by reproducing the methodology of Arellano and Bond (1991) for Portugal. After annualizing our dataset, the model in equation (4) 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 (4). Columns labeled (1) and (2) 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 0.827 and 0.753 for models (1) and (2), respectively. These contrast with Arellano and Bond's 0.686 and 0.629. As expected, Portugal shows a higher first-order autoregressive coefficient implying a higher level of rigidity (the second-order coefficient is small and not statistically significant for both studies). The two models provide very similar coefficients, with two-step estimates lower in absolute value than one-step estimates expect for w_{it}. Two-step estimates are more precise as given by standard errors. Columns (3) and (4) display the same results but using *hours*, rather than *workers*, as a measure of employment. Estimates of the main parameter of interest, 0.791 and 0.767, are only slightly lower than the estimates for *workers*. Abraham and Houseman (1999) also find this effect, but with larger differences between the adjustment in workers and hours. Regarding the explanatory variables, we can measure the short-run (or impact) elasticities given by the contemporaneous impact of x_{it} on y_{it}, $\frac{\partial y_{it}}{\partial x_{it}}$, 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}, $\sum_{j=0}^{\infty} \frac{\partial y_{it}}{\partial x_{i,t-j}}$. For *sales* these elasticities have the expect sign with the short-run elasticity varying between 0.228 and 0.246 and the long-run elasticity between 0.677 and 0.738. For *wages*, short-run elasticities have very small coefficients and even a positive coefficient in model (3) while long-run elasticities vary between 0.132 and 0.851, which goes completely against economic theory. These positive elasticities and their wide variability suggest that treating wages as exogenous is incorrect.

Although test statistics for overidentifying restrictions and exogeneity of instruments turn out favorable, we should be uncomfortable with the assumption of strictly exogenous *sales* and *wages*, especially given the senseless results for *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, wages and sales are jointly determined, yielding unsatisfactory the assumption of strict exogeneity. Table 5 reports the results of endogenizing *wages* and *sales*. A decrease in the rigidity parameter is more prominent for *hours*, although also present for *workers*, with *hours* showing lower rigidity, although only slightly. Precision, however, is significantly improved as shown by the lower standard errors. Short-run elasticities of *sales* are increased in all models (varying between 0.256 and 0.342) and long-run elasticities in all but the second model (varying between 0.694 and 0.838). Short-run elasticities of *wages* have the expected sign but are still small, whereas long-run elasticities for the models using the number of *workers* remain positive.

Next, 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 in two frequencies: annual and quarterly, presented in Table 6. For the number of *workers*, the autoregressive coefficient ranges from 0.870 in yearly frequency to 0.921 in quarterly frequency. Using *hours*, these range from 0.857 to 913. Notice the number of hours worked seems to be more flexible than the number of workers (for both frequencies), although, once again, just slightly. Second, validity tests are favorable for the annual specification, although they seem to breakdown in the quarterly model, as a result of the large number of instruments used (about 27% the number of groups). All elasticities have the expected signs. Using annual data, short-run elasticities of *sales/wages* are 0.464/-0.416 for the number of *workers* and 0.511/-0.456 for the number of *hours*, respectively, comparable to Blundel and Bond's (1998) estimates from a similar model (using annual data, 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. Using quarterly data, elasticities of *sales/wages* become 0.100/-0.042 for the number of *workers* and 0.129/-0.204 for the number of *hours*.

6 Conclusions

The annual-frequency System GMM model of Table 6 delivers 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 0.870 and long-run elasticities of 0.89 and -1.48 for *sales* and *wages*, respectively. Blundel 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 a 4- and 3.5-year period for 50% of the adjustment in *workers* and *hours* to take place, respectively. This compares with the 2.3 years for the number of *workers* in the UK (Blundel 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)). Contrarily to what we could initially expect, adjustmebt in the number of workers and the number of hours does not differ considerably. 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.

References

[1] Abowd, J.M. and F. Kramarz (2003). "The costs of hiring and separations", *Labour Economics*, 10(5): 499-530.

[2] Abraham, K. and S.N. Houseman (1999). "Does employment protection inhibit labor market flexibility? lessons from Germany, France and Belgium", *Upjohn Institute for Employment Research*, working paper No. 93.16.

[3] Arellano, M. and S. Bond (1991). "Some tests of specification for panel data: monte carlo evidence and an application to employment equations", *The Review of Economic Studies*, 58(2): 277-297.

[4] Arellano, M. and O. Bover (1995). "Another look at the instrumental variable estimation of error-components models", *Journal of Econometrics*, 68(1): 29-51.

[5] Bentolila, S. and G. Bertola (1990). "Firing costs and labour demand: how bad is eurosclerosis?", *The Review of Economic Studies*, 57(3): 381-402.

[6] Blanchard, O. (2006). "Adjustment within the euro. The difficult case of Portugal", *Portuguese Economic Journal*, 6: 1-21.

[7] Blanchard, O. and P. Portugal (2001). "What hides behind an unemployment rate: comparing Portuguese and US unemployment", *American Economic Review*, 91(1): 187-207.

[8] Blundell, R. and S. Bond (1998). "Initial conditions and moment restrictions in dynamic panel data models", *Journal of Econometrics*, 87(1): 115-143.

[9] Cahuc, P. and A. Zylberberg (2004). *Labor Economics*, chapter 4, The MIT Press.

[10] Hamermesh, D.S. (1993). *Labor Demand*, Princeton University Press.

[11] Hamermesh, D.S. and G.A. Pfann (1996). "Adjustment costs in factor demand", *Journal of Economic Literature*, 34(3): 1264-1292.

[12] Heckman, J. (2002). "Flexibility and job creation: lessons for Germany", *NBER*, working paper No. 9194.

[13] Nickell, S. (1981). "Biases in dynamic models with fixed effects", *Econometrica*, 49(6): 1417-1426.

[14] OECD (2010). *Employment Outlook*, Paris, OECD.

[15] Portugal, P. and J. Varejão (2007). "Spatial and temporal aggregation in the estimation of labor demand functions", *Bank of Portugal*, working paper No. 4/2007.

[16] Oi, W.Y. (1962). "Labor as a Quasi-Fixed Factor", *The Journal of Political Economy*, 70(6): 538-555.

[17] Roodman, D.M. (2009a). "A note on the theme of too many instruments", *Oxford Bulletin of Economics and Statistics*, 71(1): 135-158.

[18] Roodman, D.M. (2009b). "How to do xtabond2: an introduction to Difference and System GMM in Stata", *Stata Journal*, 9(1): 86-136.

[19] Tauchen, G. (1986). "Statistical properties of generalized method-of-moments estimators of structural parameters obtained from financial market data", *Journal of Business and Economic Statistics*, 4: 397–416.

[20] Windmeijer, F. (2005). "A finite sample correction for the variance of linear efficient two-step GMM estimators", *Journal of Econometrics*, 126: 25-51.

Appendix

Table 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	-	1.6	-	1.7	-	0.6	-	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	-	2.3	-	2.8	-	3.8	-	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 Total	**2.2**	**2.1**	**2.1**	**2.1**	**1.9**	**1.8**	**3.0**	**3.0**
Portugal Ranking	**1st**	**5th**	**1st**	**1st**	**8th**	**10th**	**14th**	**28th**

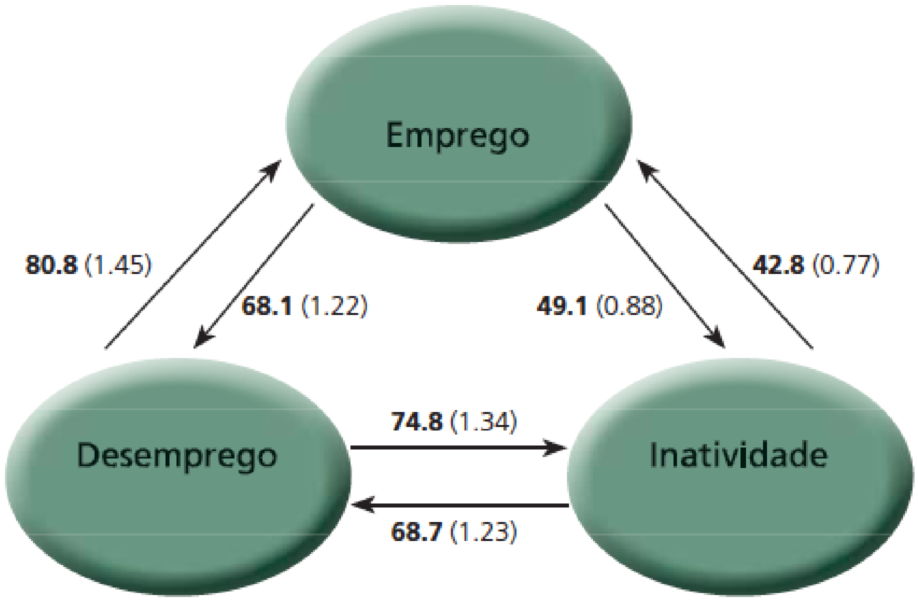
Source: OECD Employment Outlook 2010

Table 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	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 (1998). In the last 3 columns, E=Employment, U=Unemployment and N=Inactivity. All values are percentages of employment.

Figure 1: Average quarterly flows in the Portuguese labor market



*Notes: Values in **thousands** (% of active population). Source: Relatório Anual 2010, Banco de Portugal;*

Table 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] % of workers older than 45 and with more than 20 years of tenure;[c] % of unemployed that have been looking for a job for more than 12 months. Source: INE (Inquérito ao Emprego)

Table 4: Employment equation (Difference GMM, exogenous explanatory variables, annual data)

	Dependent Var: $\mathbf{e}_{it} = n_{it}$		**Dependent Var:** $\mathbf{e}_{it} = h_{it}$	
Independent Variables	(1)	(2)	(3)	(4)
$\mathbf{e}_{i,t-1}$	0.827 (0.167)	0.753 (0.083)	0.791 (0.207)	0.767 (0.080)
$\mathbf{e}_{i,t-2}$	-0.060 (0.037)	-0.029 (0.024)	-0.013 (0.036)	-0.024 (0.023)
s_{it}	0.230 (0.045)	0.228 (0.026)	0.246 (0.088)	0.244 (0.032)
$s_{i,t-1}$	-0.058 (0.044)	-0.031 (0.026)	-0.087 (0.063)	-0.070 (0.030)
$s_{i,t-2}$	0.008 (0.021)	-0.008 (0.016)	-0.001 (0.026)	0.007 (0.017)
w_{it}	-0.017 (0.100)	-0.055 (0.050)	0.107 (0.192)	-0.003 (0.063)
$w_{i,t-1}$	0.130 (0.064)	0.101 (0.036)	0.082 (0.086)	0.037 (0.039)
Autocorrelation in FD				
Arellano-Bond AR(1)	0.000	0.000	0.000	0.000
Arellano-Bond AR(2)	0.302	0.069	0.105	0.184
Overidentifying Restrictions				
Hansen J	0.374 (55)	0.374 (55)	0.695 (55)	0.695 (55)
Exogeneity of Instrument				
Hansen	0.342 (49)	0.342 (49)	0.826 (42)	0.826 (42)
Difference in Hansen	0.479 (13)	0.479 (13)	0.259 (13)	0.259 (13)
Observations/Groups	6506/1313	6506/1313	6506/1313	6506/1313
Instruments	70	70	70	70

Notes: (i) GMM-type instruments used for lagged dependent variables and IV-type instruments for remaining variables (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 (iii) All variables are in logs (iv) Time dummies were included (v) Tests shown are P-values (d.f.). Higher is better.

Table 5: Employment equation (Difference GMM, endogenous explanatory variables, annual data)

	Dependent Var: $\mathbf{e}_{it} = n_{it}$		**Dependent Var:** $\mathbf{e}_{it} = h_{it}$	
Independent Variables	(1)	(2)	(3)	(4)
$\mathbf{e}_{i,t-1}$	0.796 (0.079)	0.730 (0.029)	0.639 (0.075)	0.598 (0.030)
$\mathbf{e}_{i,t-2}$	-0.055 (0.034)	-0.057 (0.014)	-0.009 (0.033)	-0.010 (0.014)
s_{it}	0.267 (0.062)	0.256 (0.016)	0.342 (0.083)	0.329 (0.015)
$s_{i,t-1}$	-0.050 (0.028)	-0.029 (0.012)	-0.041 (0.029)	-0.026 (0.012)
$s_{i,t-2}$	0.018 (0.017)	0.008 (0.007)	0.022 (0.018)	0.012 (0.008)
w_{it}	-0.102 (0.081)	-0.066 (0.027)	-0.074 (0.142)	-0.033 (0.032)
$w_{i,t-1}$	0.111 (0.041)	0.088 (0.017)	0.020 (0.054)	0.022 (0.018)
Autocorrelation in FD				
Arellano-Bond AR(1)	0.000	0.000	0.000	0.000
Arellano-Bond AR(2)	0.412	0.323	0.093	0.062
Overidentifying Restrictions				
Hansen J	0.225 (166)	0.225 (166)	0.334 (166)	0.334 (166)
Exogeneity of Instrument				
Hansen	0.129 (158)	0.129 (158)	0.289 (158)	0.289 (158)
Difference in Hansen	0.997 (8)	0.997 (8)	0.661 (8)	0.661 (8)
Observations/Groups	6506/1313	6506/1313	6506/1313	6506/1313
Instruments	181	181	181	181

Notes: (i) GMM instruments used for all variables. Notes (ii), (iii), (iv) and (v) from Table (4) apply.

Table 6: Employment equation (System GMM, endogenous explanatory variables)

Dependent Var: $\mathbf{e}_{it}$	**Annual**		**Quarterly**	
Independent Variables	(1) $\mathbf{e}_{it} = n_{it}$	(2) $\mathbf{e}_{it} = h_{it}$	(3) $\mathbf{e}_{it} = n_{it}$	(4) $\mathbf{e}_{it} = h_{it}$
$\mathbf{e}_{i,t-1}$	0.870 (0.030)	0.857 (0.038)	0.921 (0.026)	0.913 (0.218)
s_{it}	0.464 (0.095)	0.511 (0.087)	0.100 (0.038)	0.129 (0.043)
$s_{i,t-1}$	-0.338 (0.108)	-0.377 (0.099)	-0.058 (0.025)	-0.075 (0.033)
w_{it}	-0.416 (0.106)	-0.456 (0.100)	-0.042 (0.054)	-0.204 (0.044)
$w_{i,t-1}$	0.223 (0.123)	0.252 (0.120)	0.021 (0.037)	0.152 (0.037)
Median Adjustment Lag$^{(a)}$	4.0	3.5	1.8	1.6
Long-run Elasticities				
sales	0.89	0.94	0.53	0.62
wages	-1.48	-1.43	-0.27	-0.60
Autocorrelation in FD				
Arellano-Bond AR(1)	0.000	0.000	0.000	0.000
Arellano-Bond AR(2)	0.785	0.502	0.565	0.000
Overidentifying Restrictions				
Hansen J	0.240 (59)	0.325 (59)	0.002 (369)	0.000 (369)
Exogeneity of Instruments				
Hansen				
levels	0.291 (21)	0.176 (21)	0.003 (178)	0.000 (178)
$\mathbf{e}_{i,t-1}$	0.274 (56)	0.269 (56)	0.001 (314)	0.000 (314)
s_{it}	0.300 (44)	0.312 (44)	0.004 (289)	0.000 (289)
$s_{i,t-1}$	0.051 (44)	0.159 (44)	0.002 (289)	0.000 (289)
w_{it}	0.087 (43)	0.152 (43)	0.003 (289)	0.000 (289)
$w_{i,t-1}$	0.230 (44)	0.184 (44)	0.012 (290)	0.000 (290)
Difference in Hansen				
levels	0.292 (38)	0.538 (38)	0.077 (191)	0.042 (191)
$\mathbf{e}_{i,t-1}$	0.222 (03)	0.724 (03)	0.338 (55)	0.228 (55)
s_{it}	0.268 (15)	0.428 (15)	0.075 (80)	0.022 (80)
$s_{i,t-1}$	0.981 (15)	0.814 (15)	0.172 (80)	0.641 (80)
w_{it}	0.856 (16)	0.815 (16)	0.112 (80)	0.056 (80)
$w_{i,t-1}$	0.400 (15)	0.745 (15)	0.019 (79)	0.788 (79)
Observations/Groups	9360/1454	9359/1454	41168/1534	41153/1534
Instruments	74	74	417	417

Notes: (i) GMM-type instruments used for all variables (ii) Columns (1) and (2) represent robust *two-step* estimates using *workers* (n) and *hours* (h), respectively, for annual data. Columns (3) and (4) represent the same for quarterly data. Windmeijer robust standard errors in parentheses. Notes (iii), (iv) and (v) from Table (4) apply. $^{(a)}$ in years.