Labor Demand Dynamics and The Structure of Adjustment Costs: Evidence From French Firms

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EXTENDED ABSTRACT

Abstract

This paper studies the dynamics of labor demand at the firm level. Recent studies emphasize the importance of non-convex components in the structure of hiring and firing costs in the form of either fixed or linear adjustment costs. Building from Cooper al. (2005) model and Rota (2004) econometric strategy, we estimate a structural model using Aguirregabiria and Mira (2002) algorithm on a panel of 50 000 French firms for the period 1994-2000. Our results imply that it is important to depart from the standard specification of convex and symmetric adjustment costs: French firms do not continually adjust their employment level but when they do it, they fully resorb the accumulated disequilibrium without smoothing. Although some ambiguities exist about the nature of the asymmetry and contrary to existing empirical evidence, our results indicate that it is more costly to expand employment than to contract it. And the fixed part is more important than the kinked one. To us it indicates that adjustment costs are mainly implicit and that attempt to directly measure them is is probably time wasted.

1 Introduction

The persistence of high unemployment, and the rise of non-employment for some groups such as less-skilled, in various European countries has reignited academic and political debate over the design of labor market regulation, especially employment protection and working time. On the subject, we focus on microeconomic flexibility, which is at the core of economic growth in modern market economies, by facilitating the ongoing process of creative-destruction. The main obstacle faced by microeconomic flexibility is adjustment costs. Some of these costs are purely technological, others are institutional. Chief among the latter is labor market regulation, in particular job security provisions. More precisely employment protection legislation is often pointed out as the most important source of rigidity on continental European labor markets.

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This paper studies the dynamics of labor demand at the firm level and provide a quantitative evaluation of adjustments costs on the French labor markets. Assuming convex adjustment costs, the partial adjustment model is a vehicle for applied work, essentially because it is a tractable way of capturing some important dynamic aspects of market demand. This model implies a smooth and continuous adjustment of employment to shocks. Adjustment costs dampen the response to changes in current wage and productivity and yield smooth, gradual changes in employment over time. But, those properties conflict with evidence of inactivity and bursts at the firm level. An increasing number of studies emphasize the role of inaction in firms optimal decisions. Firms only make those changes in the labor input which are justified by sufficiently large departures of desired employment from their most recent choice of the number of employees. So, the adjustment process is lumpy and intermittent: following a shock, a firm may decide that it is optimal to maintain the same number of employees and to postpone adjustment to the future. From a theoretical point of view there are several potential characteristics of the decision problem that can explain that. We emphasize the importance of non-convex components in the structure of hiring and firing costs in the form of either fixed or kinked adjustment costs.

2 Theoretical Model

With adjustment costs, the simple conditions which states that the marginal productivity and the marginal costs of labor are equated in every period, is no longer efficient. The costs of hiring and firing require a firm to adopt a forward-looking employment policy. We assume that the firm maximizes the current discounted value of future cash flows. Current cash-flows are equal to:

$$\Pi(A_t, e_t, h_t, d_t) = R(A_t, e_t, d_t, h_t) - w_t(e_t + d_t)g(h_t) - C(d_t) \tag{1}$$

A_t represents an observable shock to the profitability of the firm at the beginning of period t. This shock could reflect variations in product demands or variations in the productivity of inputs. $R(.)$ represents the revenues which depend on the hours worked (h), the number of workers at the beginning of period t herited from the previous period(e_t), current hirings or firings (d_t) and the profitability shock. Others factors of production, such as capital, are assumed to be rented and optimization over these inputs are incorporated into $R(.)$. The Revenues function is continuous, twice differentiable, increasing in all the arguments. and strictly concave with respect to e_t, d_t and h_t.

The function $weg(.)$ is the total cost of hiring a worker when each supplies h units of labor time. This general specification allows for overtime pay and other provisions. We assume that this compensation function is increasing and convex with respect to hours: $g'(.) > 0, g''(.) > 0$.

$C(.)$ is the adjustment costs function and have the following structure:

$$C(d_t) = I\{d_t < 0\}(F^L - c^L d_t) + I\{d_t > 0\}(F^H + c^H d_t) \tag{2}$$

where F^L and F^H represent lump-sum firing and hiring costs, respectively, and c^L and c^H represent linear firing and hiring costs, respectively. So, we consider linear and fixed adjustment costs. One of the criticisms of the quadratic adjustment cost specification is the implications of continuous adjustment. At the plant level, as mentioned earlier, there is evidence that adjustment is much more erratic than the pattern implied by the quadratic model. Piecewise linear and fixed adjustment costs produce inaction. It is, also, relatively straightforward to introduce asymmetries into the model as they do not present any additional technical difficulties. Both w_t and A_t follow strictly exogenous processes. The transition rule for the number of employees is:

$$e_{t+1} = e_t + d_t + \xi_{t+1} \tag{3}$$

ξ is a shock in the number of retirements and voluntary quits of workers from the firm. It is observable to the firm at the beginning of period t+1 but not a period t. We assume that $\{\xi_t\}$ is strictly exogenous.

Assuming stationarity of the exogenous processes, we get the following dynamic programming problem:

$$V(A, e) = \operatorname*{Max}_{d,h} \Pi(A, e, d, h) + \beta E[V(A', e')|A, e, d] \tag{4}$$

2.1 Employment Adjustment

Firms' optimal actions are based on the shadow value of labor, defined as the marginal increase in the discounted cash flow of the firm if it hires one additional unit of labor. When a firm increases the employment level by hiring an infinitesimally small unit of labor while keeping the hiring and firing decisions unchanged, the objective function defined varies by an amount of:

$$\lambda(A_t, e_t, h_t, d_t) = E_t\left[\sum_{i=0}^{\infty} \beta^i \left(\frac{\partial R(A_{t+i}, e_{t+i}, d_{t+i}, h_{t+i})}{\partial d_{t+i}} - w_{t+i} g(h_{t+i})\right)\right]$$

per unit of additional employment. If the hiring (or firing) levels d_{t+i} the right hand side of this equation are the optimal ones, λ_t measures the marginal contribution of an infinitesimally small labor input variation around the optimally chosen one. This follows from the envelope theorem which implies that infinitesimally small variations in the employment level do not have first order effects on the value of the firm.

2.1.1 Labor Demand Dynamics with Kinked Adjustments Costs

Without fixed costs (ie. $F^L = F^H = 0$), the optimal choices of the firm are obvious if we express them in terms of the shadow value of labor. First of all, the marginal value of labor cannot exceed the costs of hiring an additional unit of labor. Otherwise the firm could increase profits by choosing a higher employment level, contradicting the hypothesis that employment maximizes profits. Hence, given that the costs of a unit increase in employment are equal to c^H, while the marginal value of this additional unit is $\lambda(A_t, e_t, h_t, d_t)$ we must have $\lambda(A_t, e_t, h_t, d_t) \leqslant c^H$. Similarly, if $\lambda(A_t, e_t, h_t, d_t) \leq -c^L$, the firm could increase profits immediately by firing workers at the margin: the immediate cost of firing one unit of labor c^L would be more than compensated by an increase in the cash flow of the firm. Again, this contradicts the assumption that firms maximize their profits. Hence, we must have:

$$-c^L \leq \lambda(A_t, e_t, h_t, d_t) \leq c^H \qquad \text{for each } t \tag{5}$$

Moreover, either the first or the second inequality turns into an equality sign if $d_t \neq 0$. Formally, at an interior optimum for the hiring and firing policies of a firm we have the following. Whenever the firm prefers to adjust the employment level rather than wait for better or worse circumstances, the marginal cost and benefit of that action need to equal each other. If the firm hires (at least) a worker we have: $\lambda(A_t, e_t, h_t, d_t) = c^H$, which implies that the marginal benefit of an additional worker are equal to the hiring costs.

Similarly, if a firm fires workers it must be true that: $\lambda(A_t,\, e_t,\, h_t,\, d_t) = -\, c^L$, that is the negative marginal value of a redundant worker needs to be compensated exactly by the cost of firing this worker c^L.

2.1.2 Labor Demand Dynamics with Lump-Sum Adjustment Costs

Without linear adjustment costs, the optimal decision rule is qualitatively similar, in the sense that, there is inaction and no smoothing but must be adapted as the marginal costs of adjustments is always zero. First, we need to define a threshold function that indicates when it is optimal to adjust employment

$$\gamma(A, e) = \left\{\Pi(A, e, d^*, h^*) - \Pi(A, e, 0, \tilde{h})\right\} + \beta\{E[V(A', e')|d^*] - E[V(A', e')|0]\} \\ - I\{d^* < 0\}F^L - I\{d^* > 0\}F^H$$

where d^* is such that $\lambda(A_t,\, e_t,\, h^*) = 0$. h^* and $\tilde{h}$ are the optimal hours worked if the firm adjust or not her number of employees (defined formally below). Then, the firm applies the following rule. If $\gamma(A,\, e) > 0$, the firm chooses d^*, else she chooses inaction.

2.1.3 The General Case

We are now able to derive the optimal decision rule of the dynamic programming problem (4):

$$d_t \text{ is } s.t. \qquad \lambda(A_t, e_t, h^*) = \begin{cases} c^H & \text{if } \gamma(A, e) \geq 0 \text{ and } \lambda(A_t, e_t, \tilde{h}, 0) \geq c^H \\ -c^L & \text{if } \gamma(A, e) \geq 0 \text{ and } \lambda(A_t, e_t, \tilde{h}, 0) \leq -c^L \end{cases} \tag{6}$$

Otherwise, the firm does not adjust her employment: $d_t = 0$.

2.2 Hours Adjustment

Conditionally of the firm having optimally chosen employment, the choice of hours is static. Formally,

$$\frac{\partial R(A_t, e_t, d_t, h_t)}{\partial h_t} = w_t e_t g'(h_t) \qquad \text{for each } t \tag{7}$$

The firm weighs the gains to the increasing labor input against the marginal cost (assumed to be increasing in hours) of increasing hours. This condition shows that if the firm does not adjust the number of workers following a positive shock, hours will increase to accommodate part of the shock. Conversely, if firms adjust the number of workers, she fully resorb the accumulated disequilibrium without smoothing. So firm will eventually let hours at their legal level to avoid paying a wage premium as overtime is remunerated at a premium rate.

Note that the conditions based on the shadow value are not in themselves sufficient to formulate a solution for the dynamic optimization problem in order to calculate λ_t as in we need to know the distribution of $\{N_{t+i},\, i = 0, 1, 2, \ldots\}$ and thus we already need to have solved the optimal demand for labor.

3 Econometric Strategy

We extend on several points Cooper and al. (2005) paper. Their paper constitutes a central contribution in the economic analysis of adjustment costs and on their aggregate implications. They implement a simulated-method of moments procedure which rely exclusively on the use of policy functions to compute descriptive moments and create a simulated data set. Our approach consists in not relying as much as they did on simulation. We use French data on 50 000 manufacturing firms for the period 1994-2000.

3.1 Production and Compensation Function Estimation

First, we estimate a production function with Blundell and Bond (1998) procedure. Building from Bond and Soderbom (2005) and using simulated data from our theoretical model, we justify the consistency of the estimator obtained if first, one's is willing to accept a Cobb-Douglas production function and second, adjustment costs are significants (which is the main point of our paper). An interest of our approach is to add a new input (average hours worked) to the preceding literature. We, also, estimate a more general compensation function.

3.2 The weaknesses of a simulated-method-of-moments procedure

Second, we motivate the weaknesses of a simulated-method-of-moments procedure to estimate such a model. The main point of our criticism is the difficulty to find an adequate auxiliary model. Cooper and al. (2005) use descriptive statistics at the plant level and a VAR on the number of workers and hours. We create several simulated data-set to compute VAR coefficients for different values for adjustment costs. We then show that it is quite hard to find a monotonic link or even a sign expected with such an approach. But a point that this experiment put clearly to the fore is the negative co-movement between hours per worker and the number of employees at plant level-observation. It supports non-convex adjustment costs because the convex adjustment cost model is unable to generate the observed negative co-movement.

Before turning to the structural estimation of the model, we estimate a reduced-form ordered probit model. The intuition is the following. We consider the decision of adjusting the number of employees as a discrete decision. Firms only make those changes in the labor input which are justified by sufficiently large departures of desired employment from their most recent choice of the number of employees. The adjustment process is lumpy and intermittent: following a shock, a firm may decide that it is optimal to maintain the same number of employees and to postpone adjustment to the future; a type of behavior described as an (S,s) rule. The former is defined as the following: if the number of employees is above (below) or equal to a critical threshold then the firm decides to reduce (increase) employment to its desired level. Otherwise it leaves it unchanged. Hence there is a zone of non-adjustment delimited by two critical values. We consider the (unobserved) gap between desired and actual employment as a latent variable, with a two sided (S,s) rule translating into an ordered probit model with correlated random effects. When a firm is hit by a profitability shock, a gap naturally emerges between the current level of employment and the level the firm would choose if there were no costs of adjustment. A two-sided (S,s) rule is defined as the following: if the number of employees is above (below) or equal to a critical threshold then the firm decides to reduce (increase) employment to its desired level, otherwise it leaves it unchanged. The estimated lower threshold is negative (as expected) and is lower (in absolute term) than the estimated upper threshold. But standards tests indicate that the difference is not significant. Even if informative, those results do not allow the identification of the kinked and fixed adjustment costs parameters.

3.3 Structural Estimation

Our structural approach is closed to Rota (2004) which estimate a discrete-choice structural model using Hotz and Miller (1993) method but do not model hours. Basically, one could say we use Cooper and al. (2005) theoretical model and extend Rota econometric method. In order to get a more tractable model with only one decision variable we use the propriety that, conditionally of the firm having optimally chosen employment, the choice of hours is static. Instead of directly solving the Bellman equation, we reduce the model to a directly estimable form following the method suggested by Aguirregabiria and Mira (2002). They define a nested pseudo likelihood algorithm. In a inner algorithm, for a given solution of the dynamic programming model, it maximizes a pseudo likelihood function. In the outer algorithm, it updates solution of the dynamic problem. This outer circle corresponds to policy iteration, that is, Newton stepping, which is an efficient way of solving the Bellman fixed point problem. For the first outer iteration, it correspond to Hotz and Miller (1993). When estimates have converged with several outer iterations, the estimator is equivalent to Rust's nested fixed point estimator We obtain several estimations for different specifications of the model according to the dimension of the state space and different hypothesis on the adjustment costs.

The results underline the importance and significance of non convexities in the costs of adjusting employment. And the fixed part is more important than the kinked one. Although some ambiguities exist about the nature of the asymmetry and contrary to existing empirical literature on French data, our results indicate that it is more costly to expand employment than to contract it.