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How do firms adjust production factors to the cycle? The role of rigidities[1]

Gilbert Cette
Banque de France
Université d'Aix-Marseille (GREQAM)

Rémy Lecat
Banque de France

Ahmed Ould Ahmed Jiddou
Banque de France

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Abstract:

We study production factor adjustment taking into account factor utilisation in all its dimensions (labour and capital working time, capital capacity utilisation) through a unique survey among French manufacturing firms. This survey also allows us to examine the impact of obstacles to increasing capital operating time on this adjustment path. These obstacles may be regulatory, technical or due to the poor quality of labour relations. This survey, merged with balanced sheet and profit and loss accounts from fiscal reports, yields an unbalanced panel of 6,066 observations over 1993-2010.

Factor utilisation adjusts the most rapidly, first through capital capacity utilisation, then the capital workweek and finally labour working time. The adjustment is slow for the number of employees and even slower for the capital stock. In case of a change in factor volume targets, the three factor utilisation degrees adjust to offset the very slow reaction of factor volumes. Obstacles to increasing the capital operating time lead to a slower adjustment of the capital stock gap through capital capacity utilisation and capital operating time, the short-term adjustment relying more on labour level and utilisation. Regulatory obstacles appear to be the most stringent obstacle, while union or labour opposition mostly constraint adjustment through labour or capital workweek.

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1. Introduction

Firms continuously face demand or supply shocks that should lead them to adjust fluidly their production factors. This adjustment process is a key element of a well functioning economy: it allows firms to maintain their performances at their best through an optimal factor allocation at any time.

However, it has been shown that firms adjust production factors, and especially capital, in spikes (Caballero *et al.*, 1995, and Doms and Dunne, 1998, for capital; Caballero *et al.*, 1997, for employment). First, adjustment costs for capital and labour prevent a smooth change in the level of production factors (Hamermesh and Pfan, 1996, for a literature review). These costs may be technical (hiring and training costs of employees, installation costs of new capital goods...) as well as regulatory (severance pay, regulation of depreciation in tax schedules...). They may be, at least partly, non-convex both for capital (Cooper and Haltiwanger, 2006) and for labour (Caballero *et al.*, 1997). Second, capital expenditures tend to be irreversible as secondary markets for used capital are illiquid. In a context of uncertain long-run projects return, this leads to a lumpy behaviour of investment, as waiting before making an investment decision provides managers with increased information (Bernanke, 1983). Mumtaz and Zanetti (2012) have shown on US aggregated data that these costs are procyclical and amounts to 2% of output, in line with the estimates on disaggregated data by Bloom (2009).

These costs of adjustment and irreversibility of capital spending lead to a suboptimal path of factors level adjustment relying on short-term overreaction of factor utilisation. As factor levels cannot reach their long-term target immediately, the working time of capital and labour or the capital capacity utilisation may differ temporarily from their long-term target in order to produce the desired level of output. Nadiri and Rosen (1969, 1973) have first emphasised this role of factor utilisation in short term adjustment dynamics. They merged empirical capital and labour functions and showed capital and labour demands were interrelated. They provided an estimation of the factor adjustment path in case of, for example, a demand shock: immediately, factor utilisation degrees overshoots their long-term targets to offset the lack of adjustment of the capital and labour stock levels; the number of employees is slowly adjusted to its target level (and slightly more to offset the capital gap) and the capital stock is even more slowly adjusted to its target level. During this adjustment process of labour and capital stocks, factor utilisations come progressively back to their initial optimal rates.

Regulation may alter the adjustment process. Eslava *et al.* (2010) have showed on the Colombian case how deregulation of labour and financial markets in 1990 and 1991 has lead to a quicker adjustment of production factors, and especially a faster downward adjustment of labour level, as it became cheaper to dismiss workers, and faster capital formation.

From this point of view, France is a particularly interesting case for studying the factor adjustment process. Working time regulation has been substantially modified at the turn of the 2000s, becoming more flexible with a substantial role given to collective bargaining: the threshold of overtime premium was decreased from 39 hours to 35 hours a week but in the same time, should a firm or branch agreement be reached, the workweek length could be measured on an annual basis, giving large leeway to adjust factor utilisation throughout the year.

We study here production factor adjustment taking into account factor utilisation in all its dimensions (labour and capital working time, capital capacity utilisation) through a unique survey among French manufacturing firms. This survey also allows us to examine the impact of obstacles to increasing capital operating time on this adjustment path. These obstacles may be regulatory, technical or due to the poor quality of labour relations. This survey, merged with balanced sheet and profit and loss accounts from fiscal reports, yields an unbalanced panel of 6,066 observations over 1993-2010.

We show that factor utilisation adjusts the most rapidly, first through capital capacity utilisation, then the capital workweek and finally labour working time. The adjustment is slow for the number of employees and even slower for the capital stock. In case of a change in the capital stock target, the three factor utilisation degrees, as well as employment in a lesser proportion, adjust to offset the very slow reaction of the capital stock. Similarly, in case of a change in the employment target, the three factor utilisation degrees offset the slow adjustment of this factor. Among the three factor utilisation degrees, these balancing reactions are higher for capital utilisation rate than for capital operating time, and higher for capital operating time than for labour working time. These results confirm and deepen those of previous analysis, as those of Nadiri and Rosen (1969, 1973). But to our knowledge, it is the first time that this role of factor utilisation degrees adjustment to offset the slow adjustment of factor volumes, and mainly of capital volume, is estimated on firm individual data.

Obstacles to increasing the capital operating time lead to a slower adjustment of the capital stock gap through capital capacity utilisation and capital operating time, the short-term adjustment relying more on labour level and utilisation. This feature holds true for all kinds of obstacles, but regulatory obstacles appear to be the most stringent, while union or labour opposition mostly constraint adjustment through labour or capital workweek. Moreover, it appears that the 35-hour week regulation led to a more reactive adjustment through the capital and labour workweek. Finally, in times of deteriorated prospects for the economy as a whole, capital capacity utilisation and capital operating time tend to overreact to offset the capital gap: capital utilisation degrees play a major role in the adaptation of firms to crisis periods. This second set of results is also, in our knowledge, original in the literature.

Section 2 describes the databases used, section 3 presents the model and estimation strategy, section 4 the results and section 5 some robustness tests.

2. Data set

Our empirical analysis is based on an original and rich French individual data on factor utilisation. Precisely, we merge two firm-level annual datasets constructed by the Banque de France: the FiBen database and the survey on factor utilisation degrees (FUD hereafter).

FiBEn is a very large individual company database that includes balance sheets and profit and loss accounts from annual tax statements. It features all French firms with sales exceeding €750,000 per year or with a credit outstanding higher than €380,000. This database allows computing firm-level value added (Q), the capital stock (K), the volume of employment (L), the labour cost (W) and the user cost of capital (C):

- The value added volume (Q) is computed by dividing value added in value (production in value minus intermediate consumptions) by a national accounting index of value added price at the industry level.

- The volume of capital (K) sums gross capital volumes for buildings and equipment. Gross capital at historical price (as reported in FiBEn) is divided by a national index for investment price, lagged with the mean age of gross capital (itself calculated from the share of depreciated capital in gross capital, at historical price). This measure corresponds to the volume of capital, usually by the end of a fiscal year.

- The average employment level (L) is directly available in FiBEn.

- The labour cost (W) is obtained by summing wages, salaries and social charges (per capita).

- The user cost of capital (C) is calculated from the following formula, from Jorgenson (1963), which stems from the investment decision of a firm maximizing its profit over two periods under simplifying assumptions:

$$C = investment\ price * (interest\ rate - growth\ rate\ of\ investment\ price + capital\ depreciation\ rate)$$

The interest rate used is that of government bonds plus a risk premium of 2%. The capital depreciation rate is computed as follows:

$$Capital\ depreciation\ rate = 2.5\% * \frac{Buildings}{Capital\ stock} + 10\% * \frac{Equipment}{Capital\ stock}$$

- The relative factor cost (*RC*) is easily deduced from the ratio of the two previous costs.

The FUD survey has been carried out every September since 1989 by the Banque de France at the plant level. 1,500 to 2,500 plants are covered by this survey, depending on the year. This dataset directly provides for each plant the annual growth rate of capital workweek (*HK*), the level of labour workweek (HL), and indirectly the production capacity utilisation rate (*CU*). From now on, we denote by ΔZ the growth rate of a variable Z, Δ being the first difference operator, lower case variables standing for log values and Z* the firm optimal level of the variable Z (from maximizing profit).

- Data on the annual growth rate of capital workweek or capital operating time (Δhk) stem from the question: "*What is the past evolution, over the last twelve months, of your productive equipment operating time, in percentage?* ". A notice attached to the survey explains that productive operating time refers to a specific September full week.

- Data on the level of labour workweek or labour working time (*HL*) stem from the question: "*What is the average usual working time of your employees in hours during the specific poll week …*" and the same specific week as for capital workweek is specified.

- One question in the survey asks "*What is the potential percentage of production increase which would be feasible for your plant without any change in your equipment (possibly augmenting the number of employees and working time if it is consistent with public regulations, but without any modification in the shift work organisation)?*". We denote this data by *CA*, and the capital capacity utilisation rate *CU* is approximated as follows: $CU = 1 - CA$.

This approximation provides in fact much more plausible results than those obtained with the exact formula: $1/(100 + \mathrm{CA})$.

The survey also gives information on the level of employment (*L*) and percentage of employees organised in shift work (*SW*).

The FUD survey not only provides rich insights about firm-level factor utilisation, but also a unique appraisal of rigidities faced by firms in increasing their capital workweek. Firms are directly asked to declare the presence of such rigidities and to characterize their legal, social and technical nature. More precisely, entrepreneurs answered the following question: " *If you had to increase your capital operating time, and if your sales potential could justify it, would you meet obstacles or brakes such as … ?* ". The considered obstacles are: worker opposition (*WOPP*), union opposition (*UOPP*), absence of qualified workforce (*ABS*), bottleneck on commodities or supply (*BOTT*), technical obstacles (*TOBS*), legal or regulatory constraint (*REG*), branch agreement (*BRA*), firm agreement (*FIR*), and other.

Beyond reporting obstacles, firms were also asked to rank them. Given the heterogeneity - and sometimes irrelevance - of these suggestive rankings, we preferred to particularly focus on the *presence* of an obstacle and made some methodological choices. On the one hand, considering that an obstacle is present as soon as it is reported may imply uneasy interpretations, as some firms report all of them. On the other hand, considering only obstacles ranked in first position may rule out any possibility to analyse firms facing many rigidities. We therefore chose to consider an obstacle as *present* if it is declared and ranked either in first, second or third position.

A possible confusion between different obstacles close in their label led us to adopt an aggregation procedure, so as to reduce some potential interpretation biases. The aggregation used was obtained by adopting a hierarchical clustering procedure to further aggregate obstacles while keeping a strong explanatory power (see Cette, Dromel, Lecat and Paret, 2012). The following table summarizes the aggregation procedure outcome:

Table …: **Aggregation procedure**

Aggregated obstacles …	**… from originally declared obstacles**
Workforce or union opposition (*OPP*)	- Workforce opposition (*WOPP*) - Union opposition (*UOPP*)
Skills, supply or technical constraints (*TEC*)	- Absence of qualified workforce (*ABS*) - Bottleneck on commodities or supply (*BOTT*) - Technical obstacles (*TOBS*)
Regulatory constraint (*REG*)	- Legal or regulatory constraint (*REG*)
Branch or Firm Agreement (*AGR*)	- Branch Agreement (*BRA*) - Firm Agreement (*FIR*)

While the FUD survey is carried out at the plant level, FiBEn gives information at the firm level. A difficulty in the data merge lies in the fact that some firms are multi plants. When several plants of a single firm were covered by the FUD survey, we aggregated for each year all plants of this firm, weighting them by their share in the firm's total employment. We considered the FUD survey answers to be representative enough when the employment level corresponding to this aggregation was higher than 50 % of the one reported in FiBEn (otherwise, the firm was dropped from the final dataset). Each time one observation was missing for a given firm, we interpolated its value taking the average of its one-period past and one-period next observations.

The merger of these two databases results in an unbalanced sample of 6,066 observations corresponding to 1597 companies, over the period 1993-2010. To our knowledge, this individual company database is unique for allowing an empirical analysis concerning a Nadiri-Rosen type model of factor adjustment.

Many variables in our dataset may potentially be prone to measurement biases, which are quite standard in firm-level panel data of the FiBEn's type. However, the originality of the FUD proves useful to discuss some of its specific potential measurement issues. First, the questions asked in this survey are uncommon for managers. For this reason, small discrepancies are often not taken into account in the answers. Second, working time measurement is particularly affected by several legal issues. Three notions of working time coexist in the French Labour Code: the legal working time over which hours worked benefit from overtime legal and conventional premiums; the contractual working time which is explicit in the individual labour contracts, and which can differ from the legal working time; and the effective working time which is factually respected and paid, and which can be superior to the contractual time. Plants can answer the survey using any of these three notions. In addition, during the period covered, the legal weekly working time were decreased from 39 to 35 hours in 2000 for firms of 20 employees or more, and in 2002 for all other firms. For capital capacity utilisation, an ambiguity may as well exist as the feasible production increase may be relative to the physical capacity of the equipments or relative to the sustainable profitability of the firm. These measurement problems will be dealt with using instrumental variables.

Descriptive statistics are available for all variables in Appendix A.

3. <u>Model and estimation strategy</u>

3.1. The model

The model gets mainly its inspiration from Nadiri and Rosen (1969, 1973), Pouchain (1980), or Shapiro (1986).

We assume for each firm *i* the five factors Cobb-Douglas production function:

$$Y_{i,t} = A_i \,.\, e^{\gamma_{s,t}} \,.\, \prod_{j=1}^{5} F_{i,j,t}{}^{\alpha_j}$$

Where $0 < \alpha_j < 1\ \forall\ j$; $Y_{i,t}$ is the volume of value-added ; A_i is a scale firm specific parameter; $e^{\gamma s,t}$ is the industry-year level of the total factor productivity, which corresponds to a Hicks neutral technological progress impact; $F_{i,1,t} = K_{i,t}$ is the volume of capital stock; $F_{i,2,t} = L_{i,t}$ is the volume of labour stock number of employees; $F_{i,3,t} = CU_{i,t}$ is the capital capacity utilization rate; $F_{i,4,t} = HK_{i,t}$ is the capital workweek; $F_{i,5,t} = HL_{i,t}$ is the labour workweek.

We assume constant returns to scale on the stock of factors ($\alpha_2 = 1 - \alpha_1$), the elasticity of the capital capacity utilization and of the capital workweek to be the same as the one of the capital stock ($\alpha_3 = \alpha_4 = \alpha_1$) and the elasticity of the labour workweek to be the same as the one of the labour stock ($\alpha_5 = \alpha_2$).

From this, the production function becomes:

$$Y_{i,t} = A_i \,.\, e^{\gamma s,t} \,.\, (CU_{i,t} \,.\, HK_{i,t} \,.\, K_{i,t})^{\alpha_1} \,.\, (HL_{i,t} \,.\, L_{i,t})^{1-\alpha_1}$$

Turning to logs (lower case), the output at of the firm *i* at date *t* can be written as:

(1) $$y_{i,t} = a_i + \gamma_{s,t} + \alpha_1 \,.\, (cu_{i,t} + hk_{i,t} + k_{i,t}) + (1 - \alpha_1) \,.\, (hl_{i,t} + l_{i,t})$$

We assume that optimal quantities of utilisation degrees are constant:

$$CU^*_{i,t} = \overline{CU}_i, HK^*_{i,t} = \overline{HK}_i, HL^*_{i,t} = \overline{HL}_i$$

This assumption is consistent to the fact that the average and the median change of these three degrees are nil over the period (see Appendix).

At the optimum, from the profit optimization program of the firm we get:

$$K^*_{i,t} = \overline{CU}_i{}^{-\alpha_1} . \overline{HK}_i{}^{-\alpha_1} . \overline{HL}_i{}^{-(1-\alpha_1)} . A^{-1} . (\frac{\alpha_1}{1-\alpha_1})^{1-\alpha_1} . Y_{i,t} \,.\, (\frac{W_{i,t}}{C_{i,t}})^{1-\alpha_1} \,.\, e^{-\gamma_{s,t}}$$

$$L^*_{i,t} = \overline{CU}_i{}^{-\alpha_1} . \overline{HK}_i{}^{-\alpha_1} . \overline{HL}_i{}^{-(1-\alpha_1)} . A^{-1} . (\frac{1-\alpha_1}{\alpha_1})^{\alpha_1} . Y_{i,t}\ (\frac{W_{i,t}}{C_{i,t}})^{-\alpha_1} . e^{-\gamma_{s,t}}$$

With $W_{i,t}$: compensation per employee and and $C_{i,t}$: user cost of capital.

Turning in logs and matrix notation we get, from previous relations:

(2) $Mf^*_{i,t} = MC1 * Md_{i,t}$
$(5{,}1) = (5{,}7) * (7{,}1)$

With: $Mf^*_{i,t} = \begin{pmatrix} k^*_{i,t} \\ l^*_{i,t} \\ cu^*_{i,t} \\ hk^*_{i,t} \\ hl^*_{i,t} \end{pmatrix}$; $Md_{i,t} = \begin{pmatrix} \overline{cu}_i \\ \overline{hk}_i \\ \overline{hl}_i \\ y_{i,t} \\ (w_{i,t} - c_{i,t}) \\ \gamma_{s,t} \\ 1 \end{pmatrix}$

and $MC1 = \begin{pmatrix} -\alpha_1 & -\alpha_1 & -(1-\alpha_1) & 1 & 1-\alpha_1 & -1 & -a + (1-\alpha_1) * \log\left(\frac{\alpha_1}{1-\alpha_1}\right) \\ -\alpha_1 & -\alpha_1 & -(1-\alpha_1) & 1 & -\alpha_1 & -1 & -a + \alpha_1 * \log\left(\frac{1-\alpha_1}{\alpha_1}\right) \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix}$

*Mf** being the vector of factor optimal levels, in log, *Md* the vector of factor optimal level determinants, in log, and *MC1* a matrix of coefficients.

Concerning factor adjustments, the firm minimizes the sum of two costs: the cost of deviation from the optimum factor mix ($CD_{i,t}$) and the cost of change in factors ($CC_{i,t}$). Each of these costs is assumed to be symmetric, and can be for example represented by a quadratic sum:

$CD_{i,t} = \sum_j cd_j . [f^*_{i,j,t} - f_{i,j,t}]^2$ and $CC_{i,t} = \sum_j cc_j . [f_{i,j,t} - f_{i,j,t-1}]^2$

From this, variations of each factor will depend on deviation from the optimum of this factor and other factors:

$$f_{i,j,t} - f_{i,j,t-1} = \sum_{k=1}^{5} \beta_{j,k} . (f^*_{i,k,t} - f_{i,k,t-1})$$

$\beta_{j,k}$ corresponds to the adjustment of the factor *j* correcting the adjustment gap of the factor *k* observed in the previous period. We have:

(3) $\beta_{j,k} \geq 0, \forall\, j, k$

Turning in matrix notation:

(4) $\Delta Mf_{i,t} = M\beta * (Mf^*_{i,t} - Mf_{i,t})$
$(5{,}1) = (5{,}5) * (5{,}1)$

With: $M\beta = \begin{pmatrix} \beta_{1,1} & \cdots & \beta_{1,5} \\ \vdots & \ddots & \vdots \\ \beta_{5,1} & \cdots & \beta_{5,5} \end{pmatrix}$

Mf being the vector of factor levels, in log, and *Mβ* the matrix of adjustment parameters.

For some estimates, we also consider a non-linear model where the capital adjustment gap is, for the firms concerned by the non-linear effect, corrected by an extra adjustment of the four other production factors.

In this case, we have:

(4') $\Delta Mf_{i,t} = M\beta'' * (Mf^{*}_{i,t} - Mf_{i,t})$
$(5{,}1) = (5{,}5) * (5{,}1)$

With: $M\beta'' = \begin{pmatrix} \beta''_{1,1} & \cdots & \beta_{1,5} \\ \vdots & \ddots & \vdots \\ \beta''_{5,1} & \cdots & \beta_{5,5} \end{pmatrix}$ and $\beta''_{j,1} = \beta_{j,1} + (I_{nl} * \beta'_{j,1})$

I_{nl} being equal to one for firms concerned by the non-linear effect and to zero for others.

From relations (2) and (4) we get:

(5) $Mf_{i,t} = MC2 * Md_{i,t} + (I - M\beta) * Mf_{i,t-1} + \varepsilon_{i,t}$

Whith: *MC2 = Mβ * MC1*

In case of non-linear estimates, *MC2* become *MC2''*, with *MC2'' = Mβ'' * MC1.*
We introduce an error term $\varepsilon_{i,t}$ in model (5). More precisely, the perturbation is modeled as the sum of a component specific to the firm constant through time and a time varying component:

$$\varepsilon_{i,t} = u_i + e_{i,t}.$$

u_i is the unobserved heterogeneity and $e_{i,t}$ the idiosyncratic errors varying cross i and t. The term u_i depends only on the firm i and does not vary over time. Thus, it summarizes permanent behavioral differences between firms, which are not taken into account by the explanatory variables and that nevertheless influence the dependent variable.

We assume that the fixed effect is correlated with the explanatory variables, a quite plausible assumption when the company observes u_i and maximizes its profit: in its optimization program, the firm cannot ignore the value of the individual effect and thus incorporates it in its decision. This assumption is also obvious as we are dealing with a dynamic panel model. By definition, the autoregressive model implies a problem of correlation between the error term and the lagged dependent variable.

We also assume weak exogeneity: only past values of explanatory variables are uncorrelated with time varying components.

And finally, Individual effects are uncorrelated with the time varying component.

The estimated model comes from the differentiation of relation (5),

(6) $\Delta Mf_{i,t} = MC2 * \Delta Md_{i,t} + (I - M\beta) * \Delta Mf_{i,t-1} + \Delta e_{i,t}$

3.2 The estimation strategy

From the differentiation of relation (5), the coefficient *a* disappears in relation (6). So, the coefficient to be estimated are the adjustment ones $\beta_{j,k}$ and the capital elasticity α_1.

Concerning the coefficients $\beta_{j,k}$, in most of the estimates, we assume that the impact on the output of the adjustment gap of each factor (in terms of difference with its optimal level) is exactly offset by the adjustment gap of the four other factors. This constraints means:

$$(7)\quad \begin{cases} \beta_{1,1} + \frac{1-\alpha_1}{\alpha_1}.\beta_{2,1} + \beta_{3,1} + \beta_{4,1} + \frac{1-\alpha_1}{\alpha_1}.\beta_{5,1} = 1 \\ \frac{\alpha_1}{1-\alpha_1}.\beta_{1,2} + \beta_{2,2} + \frac{\alpha_1}{1-\alpha_1}.\beta_{3,2} + \frac{\alpha_1}{1-\alpha_1}.\beta_{4,2} + \beta_{5,2} = 1 \\ \beta_{1,3} + \frac{1-\alpha_1}{\alpha_1}.\beta_{2,3} + \beta_{3,3} + \beta_{4,3} + \frac{1-\alpha_1}{\alpha_1}.\beta_{5,3} = 1 \\ \beta_{1,4} + \frac{1-\alpha_1}{\alpha_1}.\beta_{2,4} + \beta_{3,4} + \beta_{4,4} + \frac{1-\alpha_1}{\alpha_1}.\beta_{5,4} = 1 \\ \frac{\alpha_1}{1-\alpha_1}.\beta_{1,5} + \beta_{2,5} + \frac{\alpha_1}{1-\alpha_1}.\beta_{3,5} + \frac{\alpha_1}{1-\alpha_1}.\beta_{4,5} + \beta_{5,5} = 1 \end{cases}$$

In case of non-linear estimates, $\beta_{j,1}$ becomes $\beta''_{j,1} = \beta_{j,1} + (I_{nl} * \beta'_{j,1})$.

Concerning the capital elasticity α_1, we observe that the share of the capital in the value added is equal to 0.3037 in average. So, in most of the estimates, we assume the constraint:

(8) $\alpha_1 = 0.3$

We will see later in the robustness checking section that if we estimate α_1 and do not calibrate this parameter, the estimated values of the other coefficients (and then of the $\beta_{i,j}$) are not modified.

To estimate the model, we first eliminate the individual effect by differentiation, so that estimation is consistent. However, it is not sufficient for solving the estimation biases. As fixed effect and weak exogeneity are by construction present in our case due to the dynamic character of the model, usual estimators are not consistent.

In this framework, estimation of model (5) can be performed using the First-difference GMM estimator. The difference GMM uses first-differences to transform model (5) into model (6). Thus, fixed firm-specific effects are removed by differencing instead of within-transforming. The first-differenced lagged dependent variable is then instrumented with its past levels from 2 periods and more. By this method, efficient estimates are obtained. We use in fact the following moments:

$$E\left[Mf_{i,t-m}\Delta e_{i,t}\right] = 0 \text{ and } E\left[Md_{i,t-m}\Delta e_{i,t}\right] = 0 \; for \; m \geq 2; t = 3, \dots, T$$

Due to overidentification (more excluded instruments than endogenous variables), it is not possible in general to solve the equation exactly. In this case of over-identification, the method is to make as close to zero as possible the norm of the empirical counterpart of orthogonality conditions in a certain metric:

$$J_{S_N}(\theta) = \overline{g(z_\iota,\theta)}' S_N \overline{g(z_\iota,\theta)}$$

The estimator is then defined by:

$$\hat{\theta}_{S_N} = Arg \min_{\theta} J_{S_N}(\theta)$$

For a chosen norm S_N.

Under regularity conditions, the estimator $\hat{\theta}_{S_N}$ is consistent and asymptotically normal. The efficient GMM estimator is the GMM estimator with an optimal weighting matrix S_N, one which minimizes the asymptotic variance of the estimator. Optimal weighting and therefore efficient estimation is assessed by using the inverse of the moment covariance matrix. As the optimal weighting matrix is unknown, it is usually not possible to directly implement the optimal GMM estimator. We have to proceed in several steps. We first estimate the model with any weighting matrix, for example with a weighting matrix identity, thereby giving the same weight to different orthogonality conditions. This gives a consistent but not efficient estimator $\hat{\theta}_1$ of the vector of parameters θ. Then, from this estimator of θ, we construct an estimator of the optimal weighting matrix, which is equal to the inverse of the variance of orthogonality conditions. The second step is to use this estimator of the optimal weighting matrix for deriving a consistent and efficient estimator $\hat{\theta}$ of the parameters θ. This estimator $\hat{\theta}$ is called the two-Step GMM estimator.

We resort to numerical methods to solve the minimization program under the previous constraints on the coefficients. However, the identification problem must precede the estimation question. We reason with parameters identification equation by equation. A necessary condition for identifying a structural equation is that there are at least as many exogenous variables excluded from the equation as endogenous variables appearing in this equation (order condition). The order condition is not sufficient as the system may have more equations than parameters, in which case the system may not be regular. The sufficient condition for identification is the rank condition. In practice, checking the rank condition is difficult to implement. One should always check the order condition before estimating the model, which is ensured in our case through the use of external instruments. We estimate the model and check ex-post the rank condition. Especially, the poor quality of estimation results of the equation (estimators with a high variance) is an indication that the rank condition is not satisfied.

Performance of the First-difference GMM estimator depends strongly on the validity of the instruments. In fact, as Blundell and Bond have shown, the First-difference GMM estimator gives biased results in finite samples when instruments are weak. The System-GMM estimator is much more powerful than the First-difference GMM estimator to tackle the problem of weak instruments. In our case, we cannot directly implement the System-GMM estimator because the latter combines first-difference equations with equations in levels: differences are instrumented with levels and levels with differences. We use in fact a variable that is not available in level in our sample: it is the capital operating time (Δhk). We must therefore pay particular attention to the relevance of the instruments (correlation with the endogenous variables).The relevance condition may be easily tested by examining the fit of the first-stage regressions. The first-stage regressions correspond to regressions of the endogenous variables on the full set of instruments. We focus on the explanatory power of the excluded instruments in these regressions. The F-statistic of the joint significance of the excluded instruments in the first-stage regressions is not sufficiently informative for models with multiple endogenous variables. Thus, we focus on partial tests of significance (see Appendix B for results).

4. <u>Results</u>

Estimation results of model (6) with constraints (3), (7) and (8) are reported in Table 1.

Column (1) presents the GMM results on the whole dataset. It appears that the adjustment of each factor to its own previous-year gap differs a lot among factors. Within a year, this adjustment would be close to 20 % for the capital volume ($\beta_{1,1}$ = 0.192), 50 % for the labour volume ($\beta_{2,2}$ = 0.435) and the labour working time ($\beta_{5,5}$ = 0.501), 75 % for the capital working time ($\beta_{4,4}$ = 0.723) and 90 % for the capital utilization rate ($\beta_{3,3}$ = 0.899). This hierarchy is the same as in Nadiri and Rosen (1969, 1973) and it is consistent with the supposed ranking of factor adjustment costs. It appears also that capital volume gaps are slightly corrected by adjustments of labour working time ($\beta_{5,1}$ = 0.032) and labour volume ($\beta_{2,1}$ = 0.096), slightly more by adjustments of capital operating time ($\beta_{4,1}$ = 0.142) but mostly by adjustments of the capital utilization rate ($\beta_{3,1}$ = 0.369). The labour volume adjustment gaps are slightly corrected by adjustments of labour working time ($\beta_{5,2}$ = 0.024) and capital volume ($\beta_{1,2}$ = 0.092), much more by adjustments in the capital operating time ($\beta_{4,2}$ = 0.374) but mostly by adjustment in the capital utilization rate ($\beta_{3,1}$ = 0.797). Labour working time adjustment gaps are also corrected by adjustments of the capital operating time and of the capital utilization rate ($\beta_{1,5} \approx \beta_{2,5} \approx 0$ and $\beta_{4,5}$ = 0.404 and $\beta_{3,5}$ = 0.746), capital operating time adjustment gaps are also slightly corrected by adjustments of the labour working time and of the capital utilization rate ($\beta_{1,4} \approx \beta_{2,4} \approx 0$ and $\beta_{5,4} \approx$

$\beta_{3,4} \approx 0.07$) and capital utilization rate adjustment gaps are also very slightly corrected by adjustments of the labour working time and of the capital operating time ($\beta_{1,3} \approx \beta_{2,3} \approx 0$ and $\beta_{5,3} = 0.015$ and $\beta_{4,3} = 0.052$).

So, the main significant results of these estimates are that: i) factor volumes do not correct the adjustment gaps of factor utilization degrees; ii) the adjustment gaps of factor volumes are slowly corrected by their own adjustment and in a first stage by adjustments of the capital operating time and of the capital utilization rate; iii) changes in factor utilization degrees correct their own adjustment gaps and the adjustment gaps of other factors with a clear hierarchy in terms of flexibility, labour working time being the less flexible degree, correcting only slightly other factor adjustment gaps, capital utilization rate being the most flexible and contributing to correct in an important proportion all other factor adjustment gaps, capital operating time being in an intermediate situation. All these results correspond to the ones obtained by Nadiri and Rosen (1969, 1973). On the dataset restricted to firms which have changed at least once their capital operating time during the period, it appears that the capital volume adjustment gaps are more corrected by changes in the capital volume itself but also by changes in the capital operating time, and less by changes in the capital utilization rate (Table 1, column 2 compared to column 1).

This is illustrated by figures 1 and 2 which presents in levels and changes the impact of a 1% positive shock on value added. Due to this shock, the targets for the factor volumes (capital and labour) increase also each by 1% and the targets of the three factor utilisation degrees do not change (see relation (2)). Factor volumes adjust slowly to their targets, capital adjusting much slower than employment. Factor utilisation degrees increase immediately to offset the slow adjustment of factor volumes, this immediate reaction being stronger for capital utilisation rate than for capital operating time, and stronger for capital operating time than for labour working time. It means that during the whole process of slow capital adjustment, capital is below its target and factor utilisation degrees above their targets. It even appears that the capital adjustment process is so slow that labour volume offset during some years the capital gap, leading employment to overshoot its target during this sub-period. The adjustment process is slow: it takes more than 10 years for capital and for labour to fully adjust to their new targets, and consequently for the three factor utilisation degrees to come back to their initial level.

The results obtained for OLS estimates of the same model are very close to the ones obtained with the GMM estimates (Table 1, columns 3 and 4 compared to column 1 and 2), which gives a first robustness check of the results.

Table 2 presents the estimation results of model (6), with constraints (3), (7) and (8), for firms facing, at least one year in the period, obstacles to increase in the capital workweek. The non-linear model is estimated, non-linear terms being introduced for each firm only when at least one obstacle to increase in the capital workweek is declared. Column 2 shows that, compared to firms not facing any obstacle, firms facing at least one obstacle correct the capital volume gaps less by capital utilisation rate and capital workweek, and more by labour volume and labour workweek. Column 3 shows that these corrections are about the same if obstacles stem from regulation. Column 4 shows that, if obstacles are technical, capital volume gaps are less corrected by capital utilisation rate and more by labour workweek. Column 5 shows that, if obstacles stem from workers or union opposition, capital volume gaps are less corrected by capital workweek and more by labour workweek. And column 6 shows that, if obstacles stem from branch or firm agreement, capital volume gaps are less corrected by capital utilisation rate and by capital workweek and more by the capital volume itself, labour volume and labour workweek. The non-linear negative coefficient $\beta'_{3,1}$ is, in absolute value, important, suggesting that the main impact of agreement is to decrease adjustment through intensity of factor use.

Table 3 presents similar estimates, splitting several aggregated obstacles: workers (column 4) or unions (column 5) opposition; branch (column 6) or firm (column 7) agreements. It appears that, compared to worker opposition, in case of union opposition, capital volume gaps are more corrected by employment volume and capital workweek and less by capital utilisation rate and the capital volume itself. And compared to obstacles coming from branch agreement, in case of firm agreement, capital volume gaps are more corrected by capital utilisation rate.

Factor adjustments could differ in crisis period. Table 4 presents estimates of the non linear model, the non linearity aiming at distinguishing crisis adjustments from more usual ones. Column 3 introduces a non linearity for the years when the level of the business sentiment indicator from the Banque de France survey on industry is below its long-term average. It appears that, compared to upswings, in downswings, the capital volume adjustment gaps are less corrected by employment and working time adjustments and more corrected by capital utilisation rate and capital workweek. Column 4 introduces a similar non linearity for more severe crisis sub-periods, when the business sentiment indicator is below its average over the period by at least two standard deviations. The results commented before for less severe crisis sub-period are exacerbated, with capital volume adjustment gaps being even less corrected by changes in the capital volume itself. These results indicate that capital utilisation degrees play a very important role in the output level adjustments during crisis periods.

Table 4 also presents the results from estimates before and after 2000, when the 35-hour labour workweek was fully implemented for firms in our sample. The 35-hour regulation led both to more constraints on the utilization of labour as the workweek length above which a wage premium has to be paid was lowered from 39 hours to 35 hours, but also more leeway as the workweek length could be measured over the course of a whole year should an agreement be reached between employers and employees. It appears that after 2000, the adjustment process has indeed significantly changed. Adjustment proceeds less through factor volumes and more through factor utilisation, capital capacity utilisation, capital operating time and the labour workweek. It would comfort the idea that firms in the manufacturing sector have benefitted from the leeway regulation offered in their factor adjustment process.

5. Robustness tests

We focus here on the robustness of our benchmark estimation in table 1, column 1. In table 5, we test its robustness to different specifications and in table 6 to the relaxation of the constraints.

In table 5, we first remove the three years (1998, 1999 and 2000) during which the transition to the 35-hour workweek has been implemented (column 2).[2] The regulatory change from the 39-hour to the 35-hour workweek may indeed have biased the estimates of the role of labour utilisation, although the sector-year dummies may have alleviated that problem. The comparison with the benchmark results may be tricky as the sample is smaller in this estimate, but we can see that the main results are unchanged. The main differences are that capital is no longer a substitute for the labour gap, which was a marginal effect in our benchmark equation and that labour utilisation coefficients are slightly altered: the adjustment of labour utilisation to its target is faster and labour utilisation makes up more for the gap in labour volume, but less for the capital stock or the capital workweek gaps.

We constrain non significant coefficients in the benchmark equation to be null, in order to reduce multicollinearity biases (column 3). The results are almost unaltered.

Finally, we run the estimates on the subsample of firms organised in shift work (column 4). These firms may have more leeway in changing their capital operating time. One surprising result is that the capital stock now adjusts faster to its target and makes up more for the labour volume and utilisation gap. The capital workweek now substitutes more for the labour volume and adjusts faster to its target, but it is not the most prominent effect. One hypothesis is that firms organised in shift work are more capital intensive and may have more leeway to adjust their capital stock as it is larger.

2 The implementation of the 35-hour workweek became compulsory for medium and large firms, which constitute our sample, from 2000 onwards. Beforehand, the implementation of this measure was announced in 1998 and financial incentives to implement it were set in place.

In table 6, we relax the constraints one by one. First, we relax constraint (7), which sets that the impact on the output of the adjustment gap of each factor (in terms of difference with its optimal level) is exactly offset by the adjustment gap of the four other factors (column 2). Hence, we allow here an overreaction of some factors to the adjustment gap of other factors, which would have no impact on output. It turns out that the main changes are that the adjustment to its target of the capital and labour volumes are slower, but the adjustment of the capital workweek is faster. We have a large overreaction of capital capacity utilisation to the labour utilisation gap, while labour utilisation does not significantly substitute for the labour or capital volume gaps any more. Results for the capital workweek still hold, although the capital workweek now makes up less for the capital and labour volume. This overreaction of capital capacity utilisation to the labour utilisation gap may due to the impact of the implementation of the 35-hour workweek: as we can see from the column 2, table 5, when removing the years of this implementation, this coefficient decreases significantly.

We then relax the positivity constraint on the beta coefficients (column 3). This means that we may reveal complementarities between two factors. Most coefficients are unaltered. Only two coefficients turn out to be negative: the capital stock tends to decrease with the capital workweek gap and labour volume with the hours worked gap. This may reveal a sweeping change in the organisation of the firm, leading to an adjustment of its size and capacity, which goes beyond the adaptation to the cycle: if, for example, a firm turns to shift work, its capital workweek will increase, creating a negative gap, while the firm may also buy new equipments to accompany its reorganisation.

Finally, we relax the constraint on α_1 to be equal to the capital share in revenue. Due to measurement errors, this coefficient may be particularly difficult to estimate and downward biased (Grilliches and Mairesse, 1998). The estimate of α_1 is below 0.3, although not significantly different from it (column 4). Other coefficients are not strongly altered in sign and significance, but there are a few changes in magnitude: the capital volume makes up more for the labour volume gap and capital capacity utilisation for capital operating time gap.

6. Conclusion

Using a very original dataset of an unbalanced panel of 6,066 observations on French firms over 1993-2010, we have studied production factor adjustment taking into account factor utilisation in all its dimensions (labour and capital working time, capital capacity utilisation).

Our main results are the following: i) Factor utilisation adjusts the most rapidly, first through capital capacity utilisation, then the capital workweek and finally labour working time. The adjustment is slow for the number of employees and even slower for the capital stock; ii) In case of a change in the capital stock target, the three factor utilisation degrees, as well as employment in a lesser proportion, adjust to offset the very slow reaction of the capital stock. Similarly, in case of a change in the employment target, the three factor utilisation degrees offset the slow adjustment of this factor; iii) Among the three factor utilisation degrees, these balancing reactions are stronger for capital utilisation rate than for capital operating time, and stronger for capital operating time than for labour working time; iv) Obstacles to increasing the capital operating time lead to a slower adjustment of the capital stock gap through capital capacity utilisation and capital operating time, the short-term adjustment relying more on labour level and utilisation. This feature holds true for all kinds of obstacles, but regulatory obstacles appear to be the most stringent, while union or labour opposition mostly constraint adjustment through labour or capital workweek; v) The 35-hour week regulation led to a more reactive adjustment through the capital and labour workweek; vi) In times of deteriorated prospects for the economy as a whole, capital capacity utilisation and capital operating time tend to overreact to offset the capital gap: capital utilisation degrees play a major role in the adaptation of firms to crisis periods.

These results confirm and deepen those of previous analysis, as those of Nadiri and Rosen (1969, 1973). But in our knowledge, it is the first time that the role of factor utilisation degrees to offset the slow adjustment of factor volumes, and mainly of capital volume, is shown on individual firm data, and that the role of different types of obstacles to changes in the production process is empirically raised.

These results lead to several policy conclusions. Flexible factor utilisation degrees are essential to offset the inertia of factor volumes, and mostly capital. Obstacles to this flexibility could prevent output adjustment, which could lead to higher production costs (if factor volumes or inventories are oversized) or inflationary pressures (if firms are unable to adapt their production to demand fluctuations). Means to ease this flexibility have to be considered. For example, regulatory obstacles should, whenever possible, be replaced by collective agreements between social partners. From a better adaptation to each firm specificities and needs, social collective bargaining is more appropriate than regulations to allow firm to get the most appropriate factor adjustments to external shocks as for example demand ones.

References

- Bernanke, B.S. (1983), “Irreversibility, uncertainty and cyclical investment”, The Quarterly Journal of Economics, MIT Press, vol. 98(1), pages 85-106, February.
- Bloom, N. (2009), “The impact of uncertainty shocks”, Econometrica, Vol. 77, No. 3, 05, pages 623-685.
- Caballero R.J., E.M.R.A. Engel and J.C. Haltiwanger (1995), "Plant-Level Adjustment and Aggregate Investment Dynamics," Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, vol. 26(2), pages 1-54.
- Caballero R.J., E.M.R.A. Engel and J.C. Haltiwanger (1997), "Aggregate Employment Dynamics: Building from Microeconomic Evidence," American Economic Review, American Economic Association, vol. 87(1), pages 115-37, March.
- Cette, G., N. Dromel, R. Lecat and A.-C. Paret (2012), “Labour relations quality and productivity: An empirical analysis on French firms”, Banque de France Working Paper n°389.
- Cooper, R.W. and J.C. Haltiwanger (2006), "On the Nature of Capital Adjustment Costs," Review of Economic Studies, Wiley Blackwell, vol. 73(3), pages 611-633, 07.
- Doms, M.E. and T.Dunne (1998), "Capital Adjustment Patterns in Manufacturing Plants," Review of Economic Dynamics, Elsevier for the Society for Economic Dynamics, vol. 1(2), pages 409-429, April.
- Eslava M., J.Haltiwanger, A.Kugler and M.Kugler (2010), "Factor Adjustments after Deregulation: Panel Evidence from Colombian Plants," The Review of Economics and Statistics, MIT Press, vol. 92(2), pages 378-391, May.
- Griliches, Z. and J.Mairesse. 1998. "Production Functions: The Search for Identification." In Z.Griliches, ed., Practicing Econometrics: Essays in Method and Application (Chentenham, England: Edgar Elgar), pp. 383-411.
- Hamermesh D.S. and G.A.Pfann (1996), "Adjustment Costs in Factor Demand," Journal of Economic Literature, American Economic Association, vol. 34(3), pages 1264-1292, September.
- Jorgenson, D. (1963), “Capital Theory and Investment Behavior”, American Economic Review, Papers and Proceedings, LIII, pages 247-259.
- Mumtaz, H. and F.Zanetti (2012), “Factor Adjustment Costs: A Structural Investigation”, Bank of England Working Paper No. 467.
- Nadiri, M.I. and S.Rosen (1969), "Interrelated Factor Demand Functions," American Economic Review, American Economic Association, vol. 59(4), pages 457-71, Part I Se.
- Nadiri, M.I. and S.Rosen (1973), "A Disequilibrium Model of Demand for Factors of Production”, National Bureau of Economic Research, Inc.
- Pouchain, M. (1981), “Estimations de demandes de facteurs en termes d’ajustements croisés », Annales de l’INSEE, n° 38-39, Apr.-Sept., pp. 259-286.
- Shapiro, M. (1986), « The Dynamic demand for capital and labor », NBER Working Papers Series, n° 1899, April.

Table 1: Benchmark results

Parameters	Adjusted factor:	to offset gap in:	Benchmark - gmm whole sample	Benchmark - gmm Δdue ≠ 0	Benchmark - OLS whole sample	Benchmark - OLS Δdue ≠ 0
β_{11}	k	k	0,192***	0,319***	0,262***	0,28***
			(0,012)	(0,009)	(0,008)	(0,015)
β_{12}	k	l	0,092***	0,15***	0,081***	0,039**
			(0,015)	(0,010)	(0,011)	(0,020)
β_{13}	k	cu	0,006	0,004	0	0
			(0,009)	(0,010)		
β_{14}	k	hk	0	0	0	0
β_{15}	k	hl	0,014	0,002	0	0
			(0,055)	(0,035)		
β_{21}	l	k	0,096***	0,054***	0,104***	0,092***
			(0,008)	(0,006)	(0,005)	(0,007)
β_{22}	l	l	0,435***	0,36***	0,543***	0,515***
			(0,011)	(0,008)	(0,006)	(0,010)
β_{23}	l	cu	0,004	0,011*	0	0
			(0,007)	(0,006)		
β_{24}	l	hk	0,018	0	0	0
			(0,022)			
β_{25}	l	hl	0	0	0	0
β_{31}	cu	k	0,369***	0,247***	0,076***	0,086***
			(0,017)	(0,012)	(0,008)	(0,012)
β_{32}	cu	l	0,797***	0,595***	0,196***	0,256***
			(0,024)	(0,014)	(0,010)	(0,016)
β_{33}	cu	cu	0,899***	0,816***	1	1
			(0,018)	(0,016)		
β_{34}	cu	hk	0,072*	0,311***	0,117***	0,147***
			(0,042)	(0,016)	(0,013)	(0,022)
β_{35}	cu	hl	0,746***	0,343***	0	0
			(0,065)	(0,048)		
β_{41}	hk	k	0,142***	0,232***	0,08***	0,109***
			(0,009)	(0,009)	(0,004)	(0,009)
β_{42}	hk	l	0,374***	0,583***	0,181***	0,274***
			(0,013)	(0,015)	(0,005)	(0,012)
β_{43}	hk	cu	0,052***	0,105***	0	0
			(0,008)	(0,012)		
β_{44}	hk	hk	0,723***	0,62***	0,883***	0,853***
			(0,024)	(0,018)	(0,013)	(0,022)
β_{45}	hk	hl	0,404***	0,361***	0	0
			(0,038)	(0,048)		
β_{51}	hl	k	0,032***	0,033***	0,145***	0,133***
			(0,003)	(0,002)	(0,004)	(0,006)
β_{52}	hl	l	0,024***	0,07***	0,261***	0,241***
			(0,004)	(0,004)	(0,005)	(0,008)
β_{53}	hl	cu	0,015***	0,021***	0	0
			(0,003)	(0,002)		
β_{54}	hl	hk	0,07***	0,029***	0	0
			(0,008)	(0,004)		
β_{55}	hl	hl	0,501***	0,697***	1	1
			(0,024)	(0,021)		
Nb. Obs.			6066	2395	6066	2395
Hansen J-stat			754,1	522,1		
P-value			1	1		

Note: Standard errors in parentheses;* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates of equation 6 by GMM and OLS. $\beta_{41} = 0.14$ in the first column means that the capital operating time makes up for 14% of the capital stock gap. The column "Δdue ≠ 0" indicates estimations for firms which declared having changed their capital operating time over the period.

Table 2: Obstacles to increasing capital operating time

Table 2

Parameters	Adjusted factor:	to offset gap in:	Benchmark	With obstacles	obst REG	obst TEC	obst OPP	obst AGR
β_{11}	k	k	0,192***	0,172***	0,185***	0,18***	0,183***	0,17***
			(0,012)	(0,018)	(0,016)	(0,016)	(0,016)	(0,013)
β_{12}	k	l	0,092***	0,078***	0,086***	0,09***	0,094***	0,096***
			(0,015)	(0,015)	(0,015)	(0,016)	(0,016)	(0,015)
β_{13}	k	cu	0,006	0,003	0,004	0,003	0,003	0,004
			(0,009)	(0,010)	(0,010)	(0,010)	(0,010)	(0,010)
β_{14}	k	hk	0	0	0	0	0	0
β_{15}	k	hl	0,014	0,087	0,117*	0,099	0,085	0,072
			(0,055)	(0,067)	(0,068)	(0,065)	(0,071)	(0,067)
β_{21}	l	k	0,096***	0,062***	0,07***	0,087***	0,083***	0,071***
			(0,008)	(0,011)	(0,010)	(0,011)	(0,010)	(0,009)
β_{22}	l	l	0,435***	0,418***	0,43***	0,426***	0,419***	0,427***
			(0,011)	(0,011)	(0,012)	(0,012)	(0,012)	(0,011)
β_{23}	l	cu	0,004	0,003	0,009	0,004	0,005	0,008
			(0,007)	(0,007)	(0,007)	(0,007)	(0,007)	(0,007)
β_{24}	l	hk	0,018	0,005	0	0,002	0,007	0,003
			(0,022)	(0,022)		(0,023)	(0,023)	(0,020)
β_{25}	l	hl	0	0	0	0	0	0
β_{31}	cu	k	0,369***	0,464***	0,437***	0,417***	0,373***	0,44***
			(0,017)	(0,026)	(0,022)	(0,024)	(0,025)	(0,019)
β_{32}	cu	l	0,797***	0,832***	0,803***	0,809***	0,826***	0,801***
			(0,024)	(0,026)	(0,027)	(0,026)	(0,026)	(0,026)
β_{33}	cu	cu	0,899***	0,912***	0,9***	0,909***	0,909***	0,9***
			(0,018)	(0,018)	(0,019)	(0,018)	(0,018)	(0,018)
β_{34}	cu	hk	0,072*	0,059	0,063**	0,05	0,045	0,069*
			(0,042)	(0,044)	(0,026)	(0,043)	(0,045)	(0,041)
β_{35}	cu	hl	0,746***	0,612***	0,582***	0,618***	0,693***	0,717***
			(0,065)	(0,081)	(0,079)	(0,079)	(0,084)	(0,081)
β_{41}	hk	k	0,142***	0,211***	0,172***	0,159***	0,194***	0,16***
			(0,009)	(0,014)	(0,012)	(0,013)	(0,013)	(0,011)
β_{42}	hk	l	0,374***	0,379***	0,378***	0,384***	0,373***	0,389***
			(0,013)	(0,013)	(0,014)	(0,014)	(0,014)	(0,014)
β_{43}	hk	cu	0,052***	0,043***	0,046***	0,048***	0,043***	0,047***
			(0,008)	(0,007)	(0,008)	(0,008)	(0,008)	(0,009)
β_{44}	hk	hk	0,723***	0,753***	0,733***	0,732***	0,723***	0,725***
			(0,024)	(0,026)	(0,023)	(0,026)	(0,026)	(0,025)
β_{45}	hk	hl	0,404***	0,402***	0,394***	0,414***	0,4***	0,43***
			(0,038)	(0,045)	(0,045)	(0,045)	(0,045)	(0,046)
β_{51}	hl	k	0,032***	0,003	0,018***	0,017***	0,024***	0,027***
			(0,003)	(0,004)	(0,003)	(0,005)	(0,003)	(0,004)
β_{52}	hl	l	0,024***	0,029***	0,027***	0,024***	0,027***	0,021***
			(0,004)	(0,005)	(0,005)	(0,005)	(0,005)	(0,005)
β_{53}	hl	cu	0,015***	0,015***	0,013***	0,013***	0,014***	0,013***
			(0,003)	(0,003)	(0,003)	(0,003)	(0,003)	(0,003)
β_{54}	hl	hk	0,07***	0,076***	0,088***	0,091***	0,092***	0,085***
			(0,008)	(0,010)	(0,009)	(0,010)	(0,009)	(0,010)
β_{55}	hl	hl	0,501***	0,528***	0,532***	0,515***	0,495***	0,477***
			(0,024)	(0,033)	(0,033)	(0,033)	(0,033)	(0,034)
β'_{11}	k	k		0,02	0,017	0,026	0,003	0,113***
				(0,030)	(0,040)	(0,030)	(0,033)	(0,044)
β'_{21}	l	k		0,046***	0,095***	0,007	0,018	0,124***
				(0,018)	(0,021)	(0,019)	(0,019)	(0,021)
β'_{31}	cu	k		-0,178***	-0,282***	-0,12***	0,045	-0,404***
				(0,039)	(0,042)	(0,039)	(0,041)	(0,049)
β'_{41}	hk	k		-0,139***	-0,111***	-0,026	-0,166***	-0,071**
				(0,022)	(0,025)	(0,023)	(0,023)	(0,029)
β'_{51}	hl	k		0,081***	0,066***	0,044***	0,032***	0,031***
				(0,008)	(0,010)	(0,009)	(0,008)	(0,011)
Nb. Obs.			6066	5638	5638	5638	5638	5638
Obstacle declarations				3041 (53.94%)	1525 (27.05%)	2387 (42.34%)	2011 (35.67%)	803 (14.24%)
Hansen J-stat			754,1	711,9	696,2	707,5	706,5	706,3
P-value			1	1	1	1	1	1

Standard errors in parentheses;* p < 0.1, ** p < 0.05, *** p < 0.01. Estimates by GMM of equation 6 with non linearities. "With obstacles" refers to the sample of firms which declared having met with an obstacle to increasing capital operating time: " Obst REG": firms which declared having met with a legal or regulatory constraint to increasing capital operating time. " Obst TEC": firms which declared having met with skills, supply or technical constraints to increasing capital operating time. " Obst OPP": firms which declared having met with Workforce or Union opposition as obstacle to increasing capital operating time. " Obst AGR": firms which declared having met with Branch or Firm agreement as constraint to increasing capital operating time.

Table 3: Obstacles to increasing capital operating time (2)

Table 3

Parameters	Adjusted factor:	to offset gap in:	Benchmark	obst OPP	obst AGR	W OPP	U OPP	B AGR	F AGR
β_{11}	k	k	0,192***	0,183***	0,17***	0,176***	0,192***	0,17***	0,201***
			(0,012)	(0,016)	(0,013)	(0,015)	(0,014)	(0,014)	(0,014)
β_{12}	k	l	0,092***	0,094***	0,096***	0,091***	0,08***	0,099***	0,142***
			(0,015)	(0,016)	(0,015)	(0,015)	(0,015)	(0,016)	(0,016)
β_{13}	k	cu	0,006	0,003	0,004	0,003	0,004	0,004	0,007
			(0,009)	(0,010)	(0,010)	(0,010)	(0,010)	(0,010)	(0,010)
β_{14}	k	hk	0	0	0	0	0	0	0
β_{15}	k	hl	0,014	0,085	0,072	0,079	0,079	0,069	0,131*
			(0,055)	(0,071)	(0,067)	(0,071)	(0,068)	(0,071)	(0,068)
β_{21}	l	k	0,096***	0,083***	0,071***	0,087***	0,085***	0,077***	0,092***
			(0,008)	(0,010)	(0,009)	(0,009)	(0,010)	(0,009)	(0,010)
β_{22}	l	l	0,435***	0,419***	0,427***	0,415***	0,435***	0,427***	0,446***
			(0,011)	(0,012)	(0,011)	(0,012)	(0,012)	(0,012)	(0,012)
β_{23}	l	cu	0,004	0,005	0,008	0,005	0,008	0,008	0,007
			(0,007)	(0,007)	(0,007)	(0,007)	(0,008)	(0,007)	(0,007)
β_{24}	l	hk	0,018	0,007	0,003	0,007	0,001	0,005	0,003
			(0,022)	(0,023)	(0,020)	(0,022)	(0,023)	(0,022)	(0,022)
β_{25}	l	hl	0	0	0	0	0	0	0
β_{31}	cu	k	0,369***	0,373***	0,44***	0,373***	0,389***	0,436***	0,336***
			(0,017)	(0,025)	(0,019)	(0,021)	(0,020)	(0,020)	(0,019)
β_{32}	cu	l	0,797***	0,826***	0,801***	0,832***	0,803***	0,803***	0,709***
			(0,024)	(0,026)	(0,026)	(0,026)	(0,026)	(0,027)	(0,025)
β_{33}	cu	cu	0,899***	0,909***	0,9***	0,908***	0,898***	0,9***	0,888***
			(0,018)	(0,018)	(0,018)	(0,018)	(0,019)	(0,019)	(0,018)
β_{34}	cu	hk	0,072*	0,045	0,069*	0,045	0,059	0,046	0,158***
			(0,042)	(0,045)	(0,041)	(0,045)	(0,045)	(0,043)	(0,042)
β_{35}	cu	hl	0,746***	0,693***	0,717***	0,697***	0,651***	0,72***	0,585***
			(0,065)	(0,084)	(0,081)	(0,082)	(0,080)	(0,083)	(0,076)
β_{41}	hk	k	0,142***	0,194***	0,16***	0,188***	0,156***	0,152***	0,159***
			(0,009)	(0,013)	(0,011)	(0,012)	(0,011)	(0,011)	(0,012)
β_{42}	hk	l	0,374***	0,373***	0,389***	0,372***	0,378***	0,389***	0,385***
			(0,013)	(0,014)	(0,014)	(0,014)	(0,014)	(0,014)	(0,014)
β_{43}	hk	cu	0,052***	0,043***	0,047***	0,045***	0,047***	0,048***	0,053***
			(0,008)	(0,008)	(0,009)	(0,008)	(0,008)	(0,009)	(0,008)
β_{44}	hk	hk	0,723***	0,723***	0,725***	0,725***	0,726***	0,728***	0,723***
			(0,024)	(0,026)	(0,025)	(0,027)	(0,026)	(0,026)	(0,026)
β_{45}	hk	hl	0,404***	0,4***	0,43***	0,413***	0,425***	0,433***	0,428***
			(0,038)	(0,045)	(0,046)	(0,045)	(0,046)	(0,046)	(0,047)
β_{51}	hl	k	0,032***	0,024***	0,027***	0,026***	0,028***	0,026***	0,039***
			(0,003)	(0,003)	(0,004)	(0,003)	(0,004)	(0,002)	(0,004)
β_{52}	hl	l	0,024***	0,027***	0,021***	0,03***	0,025***	0,019***	0,024***
			(0,004)	(0,005)	(0,005)	(0,005)	(0,005)	(0,004)	(0,005)
β_{53}	hl	cu	0,015***	0,014***	0,013***	0,014***	0,014***	0,012***	0,016***
			(0,003)	(0,003)	(0,003)	(0,003)	(0,003)	(0,003)	(0,003)
β_{54}	hl	hk	0,07***	0,092***	0,085***	0,092***	0,092***	0,092***	0,047***
			(0,008)	(0,009)	(0,010)	(0,009)	(0,010)	(0,008)	(0,010)
β_{55}	hl	hl	0,501***	0,495***	0,477***	0,49***	0,505***	0,477***	0,51***
			(0,024)	(0,033)	(0,034)	(0,033)	(0,033)	(0,034)	(0,033)
β'_{11}	k	k		0,003	0,113***	0,023	-0,088**	0,129**	0,088*
				(0,033)	(0,044)	(0,034)	(0,044)	(0,053)	(0,050)
β'_{21}	l	k		0,018	0,124***	0,002	0,062**	0,116***	0,099***
				(0,019)	(0,021)	(0,019)	(0,024)	(0,023)	(0,029)
β'_{31}	cu	k		0,045	-0,404***	0,054	-0,096**	-0,385***	-0,222***
				(0,041)	(0,049)	(0,041)	(0,046)	(0,051)	(0,055)
β'_{41}	hk	k		-0,166***	-0,071**	-0,159***	-0,044*	-0,03	-0,045
				(0,023)	(0,029)	(0,023)	(0,025)	(0,033)	(0,030)
β'_{51}	hl	k		0,032***	0,031***	0,033***	0,035***	0,007	-0,022**
				(0,008)	(0,011)	(0,008)	(0,010)	(0,010)	(0,011)
Nb. Obs.			6066	5638	5638	5638	5638	5638	5638
Obstacle declarations				2011 (35.67%)	803 (14.24%)	1816 (32.21%)	1018 (18.06%)	600 (10.64%)	642 (11.39%)
Hansen J-stat			754,1	706,5	706,3	706,8	706,1	706	708,1
P-value			1	1	1	1	1	1	1

Standard errors in parentheses;* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates by GMM of equation 6 with non linearities. Obstacles OPP (Workforce or Union Opposition) and AGR (Branch or Firm Agreement) are decomposed: " W OPP" refers to Workforce Opposition, "U OPP" to Union Opposition,"B AGR" to Branch Agreement and "F AGR" to Firm Agreement.

Table 4: Adjustment in times of crisis

Table 4

Parameters	Adjusted factor:	to offset gap in:	Benchmark	Soft crisis	Serious crisis	Before 2000	Since 2000
β_{11}	k	k	0,192***	0,189***	0,237***	0,386***	0,146***
			(0,012)	(0,015)	(0,014)	0,0292	0,017
β_{12}	k	l	0,092***	0,107***	0,161***	0,473***	0,067***
			(0,015)	(0,016)	(0,016)	0,0425	0,023
β_{13}	k	cu	0,006	0,007	0,006	0,027	0,002
			(0,009)	(0,010)	(0,010)	0,0292	0,0105
β_{14}	k	hk	0	0	0	0	0
						0	0
β_{15}	k	hl	0,014	0	0,051	0,131	0
			(0,055)		(0,054)	0,2711	9,97E-14
β_{21}	l	k	0,096***	0,113***	0,111***	0,17***	0,068***
			(0,008)	(0,010)	(0,009)	0,0147	0,0116
β_{22}	l	l	0,435***	0,438***	0,45***	0,555***	0,384***
			(0,011)	(0,012)	(0,011)	0,0224	0,0166
β_{23}	l	cu	0,004	0,005	0,005	0,009	0,003
			(0,007)	(0,007)	(0,007)	0,0138	0,00882
β_{24}	l	hk	0,018	0,02	0,009	0,09***	0,012
			(0,022)	(0,023)	(0,022)	0,0341	0,0279
β_{25}	l	hl	0	0	0	0	0
						0	0
β_{31}	cu	k	0,369***	0,303***	0,284***	0,111***	0,328***
			(0,017)	(0,021)	(0,018)	0,0231	0,0259
β_{32}	cu	l	0,797***	0,789***	0,722***	0,25***	1,006***
			(0,024)	(0,025)	(0,024)	0,0359	0,0392
β_{33}	cu	cu	0,899***	0,898***	0,897***	0,903***	0,871***
			(0,018)	(0,018)	(0,018)	0,0335	0,0248
β_{34}	cu	hk	0,072*	0,115***	0,167***	0,166***	0,05
			(0,042)	(0,043)	(0,043)	0,0625	0,0601
β_{35}	cu	hl	0,746***	0,73***	0,637***	0,28	0,614***
			(0,065)	(0,052)	(0,064)	0,2469	0,0617
β_{41}	hk	k	0,142***	0,092***	0,099***	0,08***	0,169***
			(0,009)	(0,012)	(0,010)	0,0163	0,014
β_{42}	hk	l	0,374***	0,355***	0,334***	0,269***	0,364***
			(0,013)	(0,014)	(0,013)	0,0253	0,0203
β_{43}	hk	cu	0,052***	0,051***	0,051***	0,032**	0,056***
			(0,008)	(0,008)	(0,009)	0,0152	0,011
β_{44}	hk	hk	0,723***	0,767***	0,765***	0,57***	0,831***
			(0,024)	(0,027)	(0,025)	0,046	0,035
β_{45}	hk	hl	0,404***	0,361***	0,328***	0,9***	0,301***
			(0,038)	(0,036)	(0,038)	0,1875	0,0422
β_{51}	hl	k	0,032***	0,065***	0,052***	0,012**	0,085***
			(0,003)	(0,005)	(0,004)	0,00528	0,00613
β_{52}	hl	l	0,024***	0,026***	0,029***	0,02**	0
			(0,004)	(0,005)	(0,005)	0,00802	0
β_{53}	hl	cu	0,015***	0,014***	0,014***	0,007	0,027***
			(0,003)	(0,002)	(0,003)	0,00597	0,00438
β_{54}	hl	hk	0,07***	0,031***	0,02**	0,023	0,039***
			(0,008)	(0,010)	(0,009)	0,0144	0,0146
β_{55}	hl	hl	0,501***	0,533***	0,564***	0,439***	0,608***
			(0,024)	(0,025)	(0,025)	0,0799	0,0283
β'_{11}	k	k		0,015	-0,12***		
				(0,025)	(0,031)		
β'_{21}	l	k		-0,044**	-0,065***		
				(0,019)	(0,025)		
β'_{31}	cu	k		0,129***	0,229***		
				(0,039)	(0,054)		
β'_{41}	hk	k		0,096***	0,151***		
				(0,023)	(0,030)		
β'_{51}	hl	k		-0,059***	-0,047***		
				(0,007)	(0,008)		
Nb. Obs.			6066	6066	6066	2588	3478
Hansen J-stat			754,1	747	755,9	295,5	470,8
P-value			1	1	1	1	1

Standard errors in parentheses;* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates by GMM of equation 6 with non linearities. Soft crisis: 1990, 1993, 1995, 1996, 2001, 2003 2008 and 2009 ; Serious crisis: 1992, 1993, 2008 and 2009

Table 5: Robustness to different specifications

Parameters	Adjusted factor:	to offset gap in:	Benchmark	Without 1998, 1999 and 2000	Null coef.	Shiftwork ≠ 0
β_{11}	k	k	0,192***	0,177***	0,189***	0,281***
			(0,012)	(0,015)	(0,012)	(0,012)
β_{12}	k	l	0,092***	0,027	0,09***	0,202***
			(0,015)	(0,018)	(0,015)	(0,015)
β_{13}	k	cu	0,006	0,002	0	0,009
			(0,009)	(0,010)		(0,009)
β_{14}	k	hk	0	0	0	0
β_{15}	k	hl	0,014	0	0	0,224***
			(0,055)			(0,054)
β_{21}	l	k	0,096***	0,083***	0,098***	0,073***
			(0,008)	(0,011)	(0,008)	(0,006)
β_{22}	l	l	0,435***	0,45***	0,433***	0,412***
			(0,011)	(0,013)	(0,011)	(0,011)
β_{23}	l	cu	0,004	0,001	0	0
			(0,007)	(0,008)		
β_{24}	l	hk	0,018	0	0	0,026*
			(0,022)	(0,025)		(0,016)
β_{25}	l	hl	0	0	0	0
β_{31}	cu	k	0,369***	0,439***	0,367***	0,366***
			(0,017)	(0,024)	(0,016)	(0,013)
β_{32}	cu	l	0,797***	0,751***	0,801***	0,716***
			(0,024)	(0,029)	(0,024)	(0,020)
β_{33}	cu	cu	0,899***	0,914***	0,91***	0,926***
			(0,018)	(0,021)	(0,010)	(0,011)
β_{34}	cu	hk	0,072*	0,074	0,098***	0,074**
			(0,042)	(0,050)	(0,023)	(0,029)
β_{35}	cu	hl	0,746***	0,577***	0,751***	0,449***
			(0,065)	(0,059)	(0,050)	(0,049)
β_{41}	hk	k	0,142***	0,173***	0,14***	0,142***
			(0,009)	(0,012)	(0,009)	(0,008)
β_{42}	hk	l	0,374***	0,34***	0,374***	0,403***
			(0,013)	(0,016)	(0,013)	(0,012)
β_{43}	hk	cu	0,052***	0,051***	0,054***	0,043***
			(0,008)	(0,010)	(0,008)	(0,007)
β_{44}	hk	hk	0,723***	0,816***	0,736***	0,798***
			(0,024)	(0,029)	(0,021)	(0,021)
β_{45}	hk	hl	0,404***	0,302***	0,407***	0,387***
			(0,038)	(0,041)	(0,036)	(0,035)
β_{51}	hl	k	0,032***	0,008**	0,032***	0,017***
			(0,003)	(0,004)	(0,003)	(0,002)
β_{52}	hl	l	0,024***	0,071***	0,025***	0,022***
			(0,004)	(0,005)	(0,004)	(0,003)
β_{53}	hl	cu	0,015***	0,013***	0,015***	0,009***
			(0,003)	(0,003)	(0,003)	(0,002)
β_{54}	hl	hk	0,07***	0,047***	0,071***	0,03***
			(0,008)	(0,011)	(0,007)	(0,004)
β_{55}	hl	hl	0,501***	0,623***	0,504***	0,546***
			(0,024)	(0,026)	(0,024)	(0,018)
Nb. Obs.			6066	4776	6066	3836
Hansen J-stat			754,1	586,4	756,3	639,5
P-value			1	1	1	1

Standard errors in parentheses;* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates of benchmark equation in table 1 column 1 with different specifications.

Table 6: Robustness to constraints

Parameters	Adjusted factor:	to offset gap in:	Benchmark	Without equality constraints (=1)	Without positivity constraints	α_1 unconstrained
α_1			0,3	0,3	0,3	0,139
						(0,076)
β_{11}	k	k	0,192***	0,102***	0,223***	0,196***
			(0,012)	(0,012)	(0,012)	(0,012)
β_{12}	k	l	0,092***	0	0,144***	0,157***
			(0,015)		(0,016)	(0,020)
β_{13}	k	cu	0,006	0,001	-0,001	0,006
			(0,009)	(0,010)	(0,010)	(0,009)
β_{14}	k	hk	0	0	-0,239***	0
					(0,028)	
β_{15}	k	hl	0,014	0,06	0,028	0,029
			(0,055)	(0,075)	(0,058)	(0,055)
β_{21}	l	k	0,096***	0	0,088***	0,093***
			(0,008)		(0,008)	(0,010)
β_{22}	l	l	0,435***	0,157***	0,425***	0,494***
			(0,011)	(0,016)	(0,012)	(0,020)
β_{23}	l	cu	0,004	0	0,001	0,004
			(0,007)		(0,007)	(0,006)
β_{24}	l	hk	0,018	0,063	0,049**	0,01
			(0,022)	(0,047)	(0,021)	(0,020)
β_{25}	l	hl	0	0	-0,097**	0
					(0,042)	
β_{31}	cu	k	0,369***	0,217***	0,365***	0,249***
			(0,017)	(0,034)	(0,016)	(0,019)
β_{32}	cu	l	0,797***	0,305***	0,782***	0,797***
			(0,024)	(0,050)	(0,023)	(0,044)
β_{33}	cu	cu	0,899***	0,781***	0,894***	0,887***
			(0,018)	(0,028)	(0,018)	(0,018)
β_{34}	cu	hk	0,072*	0,227	0,105**	0,178***
			(0,042)	(0,146)	(0,042)	(0,045)
β_{35}	cu	hl	0,746***	1,622***	0,807***	0,69***
			(0,065)	(0,230)	(0,082)	(0,082)
β_{41}	hk	k	0,142***	0,069***	0,142***	0,129***
			(0,009)	(0,014)	(0,009)	(0,011)
β_{42}	hk	l	0,374***	0,149***	0,375***	0,431***
			(0,013)	(0,021)	(0,013)	(0,024)
β_{43}	hk	cu	0,052***	0	0,053***	0,057***
			(0,008)		(0,009)	(0,009)
β_{44}	hk	hk	0,723***	0,796***	0,739***	0,722***
			(0,024)	(0,060)	(0,024)	(0,026)
β_{45}	hk	hl	0,404***	0,746***	0,444***	0,466***
			(0,038)	(0,095)	(0,041)	(0,047)
β_{51}	hl	k	0,032***	0,001	0,028***	0,056***
			(0,003)	(0,001)	(0,003)	(0,004)
β_{52}	hl	l	0,024***	0	0,017***	0,024***
			(0,004)		(0,005)	(0,006)
β_{53}	hl	cu	0,015***	0,005**	0,022***	0,013***
			(0,003)	(0,002)	(0,003)	(0,003)
β_{54}	hl	hk	0,07***	0,089***	0,121***	0,023**
			(0,008)	(0,008)	(0,010)	(0,010)
β_{55}	hl	hl	0,501***	0,495***	0,549***	0,589***
			(0,024)	(0,025)	(0,025)	(0,025)
Nb. Obs.			6066	6066	6066	6066
Hansen J-stat			754,1	753	745,3	753,5
P-value			1	1	1	1

Standard errors in parentheses;* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates of benchmark equation in table 1 column 1 with alleviated constraints

Appendix A: Descriptive statistics

Variable	Description	Unit	Source	P10	Q1	Median	Q3	P90	Standard Error
y	Value added in volume per year	Log '000 €	FiBEn	7,0	7,5	8,3	9,2	10,1	1,2
k	Capital stock in volume	Log '000 €	FiBEn	6,8	7,5	8,4	9,5	10,6	1,5
l	Average number of employees	Log full-time equivalent	FiBEn	3,3	3,8	4,6	5,4	6,2	1,1
tu	Capital capacity utilisation	%	FUDS	65,0	75,0	85,0	90,0	97,0	13,2
dt	Employee workweek length	Log hours	FUDS	3,6	3,6	3,6	3,7	3,7	0,1
w	Annual wage per employee	Log '000 €	FiBEn	3,2	3,3	3,5	3,6	3,8	0,2
c	User cost of capital	Log		-2,4	-2,2	-2,1	-2,0	-1,9	0,2
cr	Relative cost of labour	Log		5,3	5,4	5,6	5,8	6,1	0,3
Δy	Change in log value added	ΔLog '000 €	FiBEn	-0,2	-0,1	0,0	0,1	0,2	0,2
Δk	Change in log capital stock	ΔLog '000 €	FiBEn	0,0	0,0	0,0	0,1	0,1	0,2
Δl	Change in log number of employees	ΔLog full-time equivalent	FiBEn	-0,1	0,0	0,0	0,0	0,1	0,1
Δtu	Change in capital capacity utilisation	Δ%	FUDS	-13,4	-3,6	0,0	3,2	13,4	17,6
Δdue	Change in the workweek of capital	%	FUDS	-6,0	0,0	0,0	0,0	10,0	8,3
Δdt	Change in log employee workweek	ΔLog hours	FUDS	-0,04	0,00	0,00	0,00	0,01	0,03
Δw	change in log annual wage per employee	ΔLog '000 €	FiBEn	-0,1	0,0	0,0	0,1	0,1	0,1
Δc	change in log capital user cost	ΔLog		-0,3	-0,1	0,0	0,1	0,3	0,3
Δcr	Change in the relative cost of labour	ΔLog		-0,3	-0,1	0,0	0,1	0,3	0,3

Appendix B: First stage results

First stage regressions

Δy	**Coefficient**	**Standard-error**	**P-value**
k(t-2)	0.03011	0.02004	0.1330
l(t-2)	0.01931	0.02836	0.4959
tu(t-2)	-0.02200	0.01318	**0.0951**
cr(t-2)	0.00884	0.01003	0.3784
SW(t-2)	0.00718	0.00583	0.2181
k(t-3)	-0.03552	0.01988	**0.0741**
l(t-3)	-0.01570	0.02825	0.5784
cr(t-3)2	-0.00315	0.00966	0.7443
F-statistic :	3.45		
Prob > F :	<.0001		

Δlcr2	**Coefficient**	**Standard-error**	**P-value**
k(t-2)	0.04488	0.02642	**0.0894**
l(t-2)	0.09734	0.03734	**0.0092**
tu(t-2)	-0.01625	0.01737	0.3496
cr(t-2)	0.11871	0.01321	**<.0001**
SW(t-2)	0.00024768	0.00768	0.9743
k(t-3)	-0.05302	0.02621	**0.0432**
l(t-3)	-0.08699	0.03720	**0.0194**
cr(t-3)2	-0.06484	0.01272	**<.0001**
F-statistic :	2.65		
Prob > F :	<.0001		

L.Δlk	**Coefficient**	**Standard-error**	**P-value**
k(t-2)	0.08155	0.01157	**<.0001**
l(t-2)	0.10812	0.01635	**<.0001**
tu(t-2)	0.01562	0.00761	**0.0400**
cr(t-2)	-0.01503	0.00578	**0.0094**
SW(t-2)	0.01113	0.00336	**0.0009**
k(t-3)	-0.09255	0.01147	**<.0001**
l(t-3)	-0.09882	0.01628	**<.0001**
cr(t-3)2	0.00000430	0.00557	0.9994
F-statistic :	2.82		
Prob > F :	<.0001		

L.Δll	**Coefficient**	**Standard-error**	**P-value**
k(t-2)	0.06815	0.00899	**<.0001**
l(t-2)	0.10309	0.01271	**<.0001**
tu(t-2)	0.03051	0.00591	**<.0001**
cr(t-2)	0.02181	0.00450	**<.0001**
SW(t-2)	0.00313	0.00261	0.2317
k(t-3)	-0.06646	0.00892	**<.0001**
l(t-3)	-0.11121	0.01266	**<.0001**
cr(t-3)2	-0.00645	0.00433	0.1362
F-statistic :	3.83		
Prob > F :	<.0001		

L.Δtu2	**Coefficient**	**Standard-error**	**P-value**
k(t-2)	0.02885	0.01605	**0.0723**
l(t-2)	0.07084	0.02244	**0.0016**
tu(t-2)	-0.43375	0.01049	**<.0001**
cr(t-2)	-0.00751	0.00798	0.3464
SW(t-2)	0.00857	0.00463	**0.0639**
k(t-3)	-0.02527	0.01591	0.1122
l(t-3)	-0.06029	0.02236	**0.0070**
cr(t-3)2	0.00726	0.00770	0.3458
F-statistic :	11.17		
Prob > F :	<.0001		

L.Δlhk	**Coefficient**	**Standard-error**	**P-value**
k(t-2)	0.02077	0.00763	**0.0065**
l(t-2)	0.03951	0.01079	**0.0003**
tu(t-2)	-0.00225	0.00503	0.6547
cr(t-2)	0.00009761	0.00382	0.9796
SW(t-2)	0.00578	0.00222	**0.0092**
k(t-3)	-0.02290	0.00757	**0.0025**
l(t-3)	-0.03682	0.01075	**0.0006**
cr(t-3)2	-0.00216	0.00367	0.5558
F-statistic :	3.71		
Prob > F :	<.0001		

L.Δlhl	**Coefficient**	**Standard-error**	**P-value**
k(t-2)	0.00276	0.00336	0.4120
l(t-2)	-0.00004311	0.00475	0.9928
tu(t-2)	-0.00440	0.00221	**0.0465**
cr(t-2)	0.00069430	0.00168	0.6795
SW(t-2)	0.00023998	0.00097661	0.8059
k(t-3)	-0.00270	0.00333	0.4185
l(t-3)	0.00019209	0.00473	0.9676
cr(t-3)2	-0.00098320	0.00162	0.5435
F-statistic :	3.81		
Prob > F :	<.0001		

SW: shiftwork dummy
Sector-year dummies included not reported

Figure 1: Simulation of the impact of a 1% increase in value added, level (% gap with the benchmark levels)

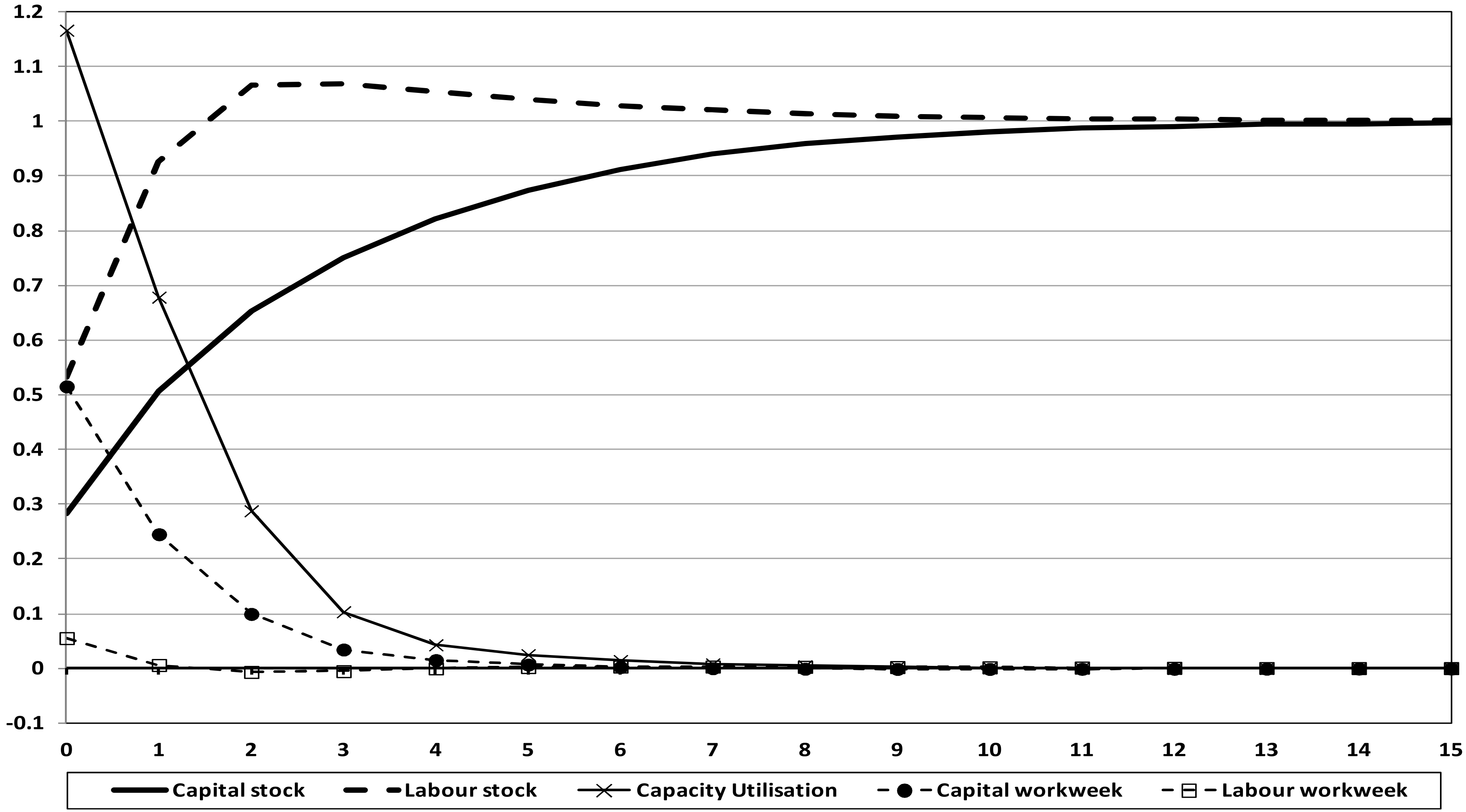

Figure 2: Simulation of the impact of a 1% increase in value added, changes (% change over the previous period)