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Abstract:
This empirical analysis assesses the determinants of firms' capital retirement. Particular attention is paid to the impact of the business cycle and the capital usage intensity. Compared to previous studies, we directly control for the capital utilization and disentangle the short-run mechanisms from the long-run ones. The analysis is carried out with an original and large firm-level dataset.

The main results of the analysis may be summarized as follows: i) The retirement rate increases during slowdowns and decreases during booms. This corresponds to a countercyclical capital retirement; ii) The capital retirement rate increases with the capital usage intensity in the long run. This corresponds to a wear and tear effect, which is small compared to the countercyclical one; iii) The capital retirement rate increases with the average age of capital; iv) The profit rate and the wage cost per capita do not have a significant impact on the retirement rate.

Key words: Capital; Capital measure; Capital retirement; Capital utilisation
JEL codes: E22 ; D24 ; O16

Résumé :
Cette étude empirique vise à évaluer l'importance des différents déterminants du déclassement du capital. Nous nous attachons en particulier à mesurer l'influence des cycles d'activité et de l'intensité d'utilisation du capital. Comparativement aux études antérieures, nous prenons en compte directement l'effet de l'utilisation du capital dont nous séparons les effets de cout terme des effets de long terme. Les données utilisées sont originales et couvrent un grand nombre d'entreprises.

Les principaux résultats des estimations de modèles de déclassements du capital peuvent être résumés ainsi : i) Le taux de déclassement augmente durant les phases de ralentissement de l'activité et diminue durant les périodes d'expansion ; ii) Le taux de déclassement est croissant avec l'intensité d'utilisation des équipements à long terme, ce qui correspond à un effet d'usure, qui est toutefois d'une importance secondaire par rapport à l'effet contracyclique iii) Le taux de déclassement du capital augmente avec l'âge moyen du capital ; iv) Le taux de rentabilité et le coût du travail par tête n'ont pas d'influence significative sur le taux de déclassement.

Mots clés : Capital ; Mesure du capital ; Déclassement du capital ; Utilisation du capital
Codes JEL : E22 ; D24 ; O16

1. Introduction

The macroeconomic literature underlines the decisive role of capital stock in estimating potential output, but also in determining the position of the economy in the business cycle and inflationary pressures. Unsurprisingly, investment plays an important role in this literature, which, nevertheless, generally ignores generally capital retirement.

To our knowledge, assessments of the fixed capital stock conducted by national statistics institutes always assume invariant distributions of the life span of fixed assets (law of obsolescence) over time for each one of the different products that make up capital (for a summary, see OECD, 2009). The measures of the retirement rate of capital that result from these approaches may then vary over time due to: i) changes in the product structure of the capital if the laws of obsolescence differ for each product; ii) changes in the age structure of the capital if the laws of obsolescence suppose that the retirement rate varies according to the age of equipment. Given how difficult it is to model and estimate in all its complexity companies' capital retirement behaviour, the assumption of invariant obsolescence laws by product adopted by national accountants seems prudent, especially as its divergence with economic reality probably has no significant consequence for the analysis of growth factors over relatively long periods or between periods characterized by similar cyclical pressures. However, it may have more significant consequences in short-term analyses or in the event of large cyclical shocks. For example, the sharp fall in capacity utilisation rate indicators during the 2008 crisis was probably accompanied by an acceleration in capital retirement. Assessments drawing on capital series based on the assumption of time-invariant obsolescence laws could show a bias of an uncertain scale. Thus, measures of potential GDP based on such assessments of capital could overestimate potential GDP, and therefore the output gap (in absolute terms) as well as the disinflationary pressures caused by the crisis.

The aim of our study is to empirically analyse firms' capital retirement behaviour, using for this individual French firm data. The estimated model characterises the companies' capital retirement behaviour, and pays particular attention to both the cyclical and structural effects on the retirement rate.

Intuition suggests that the intensity of capital utilisation must probably have an impact on the retirement rate through two channels: i) The first, which is structural, corresponds to a simple wear and tear effect: the retirement rate increases with the intensity of capital utilisation; ii) The second, more cyclical, results from the slow speed of adjustment of the capital stock to its targeted level through investment alone owing to rigidities. The need to adjust the stock of capital rapidly results in the short run in an adjustment that occurs at least partially via capital retirement. The capital retirement would add its effects to the investment ones to adjust the capital to its targeted level. In this second channel, the retirement rate would decrease with the rise in pressures on capital utilisation. Therefore, a capital retirement decelerator mechanism would correspond to the investment accelerator one. Beyond the mere structural and cyclical effects of capital utilisation, the literature also suggests that other variables have an impact on firms' capital retirement behaviour: the firm's financial situation, the average age of capital and the wage cost per capita.

Our analysis is based on unique firm-level data, including the utilisation rate of production factors. More precisely, our empirical analysis is based on a database which merges two sets of individual company data collected by the Banque de France: those from the FIBEN database and those obtained from a specific survey on the utilisation of production factors. FIBEN is a very large individual company database that draws on annual tax statements, including balance sheets and profit and loss accounts. This database may be used to calculate retirement rates, changes in output, corporate profitability, the average age of capital and the wage cost per capita. The survey on the degree of utilisation of production factors has been carried out every year since 1989 by the Banque de France at the plant level. Companies are questioned about the changes in the workweek of capital and their use of shift work. This information gives us an indication of the intensity of capital utilisation and its cyclical variations. Merging these two databases results in an unbalanced sample of 35,679 observations over the period 1989-2008. Given the lag structure used for estimations, these may be carried out on 8,055 observations corresponding to 1,834 companies over the period 1994-2008. To our knowledge, this individual company database is unique for conducting an empirical analysis of the effects of the intensity of capital utilisation on companies' capital retirement behaviour. The empirical analysis of companies' capital retirement behaviour is conducted using these data and adjusted for endogeneity biases by means of instrumental variables.

The main results of the analysis may be summarized as follows: i) The retirement rate increases during slowdowns, as measured by the changes in output; and decreases during booms, as measured by changes in the capital workweek. This corresponds to countercyclical capital retirement; ii) The capital retirement rate increases with the intensity of capital utilisation in the long run.This corresponds to a wear and tear effect, which is nevertheless small compared to the countercyclical one; iii) The capital retirement rate increases with the average age of capital; iv) The profit rate and the wage cost per capita do not have a significant impact on the retirement rate. Compared to previous studies, our main contribution is to directly control for the capital utilization rate and to disentangle the short-run drivers from the long-run ones.

These empirical results give some perspective to the theoretical studies on growth or those based on calibrated models, which often assume that the retirement rate increases with the intensity of capital utilisation (see, for example, among others, Greenwood, *et al.* , 1988, and Burnside and Eichenbaum, 1996). To use the same terminology as above, these studies usually assume that the structural wear and tear effects outweigh any other effects on capital retirement. This assumption is, however, not based on any empirical evidence. It is challenged by some papers using vintage capital growth models (Boucekkine and Ruiz-Tamarit, 2003, and Boucekkine *et al.*, 2009), which insist on the role of the capital utilization rate. In this paper, we document the magnitude of these effects. This paper is thus also related to the literature on the assessment of the short-term impact of shocks (technological or others) on growth, since capital retirement influences the expected rate of return of investment (see Veracierto, 2002).

In the literature, capital retirement is mainly looked at from a macroeconomic perspective. Several papers underline the complexity of measuring capital retirement (see for example Hulent and Wykoff, 1996), indicating that this measurement should be linked to assumptions concerning technological progress, incorporated or not (see for example Diewert and Wykoff, 2006, or Bitros *et al.*, 2007), and that it could use available data on the second-hand capital market (for a survey, see Jorgenson, 1996). Firm-level studies usually consider very specific assets: Cockburn and Franck (1992) focus on the retirement of oil tankers, Das (1992) on "kilns" used in the cement industry, and Golsbee (1998) on aircrafts. Erumban (2008a) studies the retirement pattern of three types of assets: computers, machinery and transport equipment. Our study is, with that of Mairesse and Dormont (1985), one of the rare ones to link the business cycle to capital retirement behaviour on a broad scale.

Section 2 presents a short survey of the empirical literature and section 3 presents the data used in the empirical analysis. Sections 4 and 5 present the results of model estimations first by taking no account of the degree of capital utilisation, then by factoring it in. Section 6 concludes.

2. Key concepts and empirical evidence: a survey of literature

We briefly recall the main depreciation concepts and the empirical evidence highlighted in the literature. In her survey, Fraumeni (1997) defines depreciation as "*the change in value associated with the aging of an asset*". As an asset grows older, it yields less production in the current and future periods, because of wear and tear or accidents. Depreciation measures the changes in the price of an asset when it ages, due to a physical effect leading to a decline in efficiency. In addition to this pure physical effect, the value of an asset can increase or decrease due to any other factor but aging. This is called revaluation, which captures numerous phenomena such as inflation, rarity and obsolescence. What is commonly called retirement, discards or scrapping, refers to the assets withdrawn from service. In the OECD manual on measuring capital (OECD, 2009), retirement and discards mean the removal of an asset from the capital stock for any reason, such as selling for scrap, dismantling or abandoning.

Contrary to investment, retirement is not the subject of an abundant empirical literature. The paper by Mairesse and Dormont (1985) is, to our knowledge, the first empirical micro study to consider that capital retirement is not solely determined by engineering considerations, but also depends on market conditions. The decision to retire an asset depends on its productive services in the current and future periods, and thus on an opportunity cost. One therefore should not expect the retirement behaviour to remain invariant along the business cycle. Further micro studies dedicated to retirement cyclicality include Cockburn and Franck (1992), Das (1992), Golsbee (1998) and Erumban (2008a). Analyses using firm-level data are essentially asset-specific: Cockburn and Franck (1992) focus on the retirement of oil tankers, Das (1992) on "kilns" used in the cement industry, and Golsbee (1998) on aircrafts. Erumban (2008a) studies the retirement pattern of three types of assets: computers, machinery and transport equipment. The study by Mairesse and Dormont (1985) is the most global, comparing retirement in the manufacturing industry in France, Germany and the United States.

The empirical literature suggests a number of potential determinants of retirement dynamics at firm level. The most consensual results can be stated as follows: retirement is positively related to the average age of capital and to factor prices, i.e. fuel prices (Cockburn and Franck, 1992, Das, 1992, Golsbee, 1998, and Erumban, 2008a). Mairesse and Dormont (1985), Das (1992) and Golsbee (1998) further highlight that retirement is more likely to occur in recessions, because the costs of capital reallocation are low, or when a firm displays good financial performances. The macro literature gives us further insights. Using vintage capital growth models, Boucekkine and Ruiz-Tamarit (2003) and Boucekkine *et al.* (2009) show that the depreciation rate varies with the capital utilization rate. These studies also show that an asset is scrapped when its profitability drops to zero, implicitly suggesting a negative relationship between retirement and profitability.

We follow an agnostic path and include in our specification the variables highlighted by these contributions. We set up a model comprising the state of the cycle, the firm's financial performance, the average age of capital, factor prices and the capital utilization rate. Further details on the variables used in our specficiation are given below.

3. Data

The empirical analysis is based on a database that results from the merger of two sets of individual company data collected by the Banque de France: those contained in the FIBEN database and those obtained from a specific survey on the utilisation of production factors.

FIBEN is a large individual company database that draws on annual tax statements including balance sheets and profit and loss accounts. It covers all French companies with an annual turnover of over EUR 0.75 million or with a bank loan of at least EUR 0.38 million. It contains annual account data for roughly 200,000 companies. It may be used to calculate for every company i (i=1,..., I) and for every year t (t=1,..., T) the stock of capital (K_{it}) and the volume of investment (I_{it}). From these two variables, we deduce the retirement rate (RR_{it}):[1]

- The real capital stock (K_{it}) is computed from the volume of capital before deducting accounting depreciation. The capital goods available in our data are buildings and equipment. For these two products, we have information on their historical cost (gross book value). To convert the historical series into current ones, we first need to adjust for the age structure and then switch from a nominal price to a real one. We achieve this transformation by dividing the gross capital stock at historical cost by an investment price index supplied by national accounts, this index being lagged by the average age of capital. The average age of capital (AK_{it}) is calculated for each of these two products using the share of depreciated capital in the capital stock at historical cost.[2] We add together the series for buildings and equipment and end up with a measure of the real capital stock that is adjusted for the age of capital goods and does not depend on accounting depreciation.

- The volume of investment (I_{it}) is calculated by dividing productive investment in nominal terms (investment in tangible fixed assets minus the variation in gross land stock when it is positive) by an investment price index obtained from the national accounts.

- Capital retirement in real terms (R_{it}) is calculated as the variation in the volume of capital minus the volume of investment ($R_{it} = \Delta K_{it} - I_{it}$). We deduce the retirement rate (RR_{it}) by dividing the capital retirement in the year under consideration by the real capital stock at the end of the previous year ($RR_{it} = R_{it}/K_{it-1}$). The retirement rate therefore gives us the value of the capital retired each year as a percentage of the capital stock.

We also compute covariates, such as the real value added (Q_{it}), the profit rate (PR_{it}) and the wage cost per capita (W_{it}):

- The real value added (Q_{it}) is calculated by dividing the nominal value added by a sectoral value added price index supplied by the national accounts. The nominal value added is the maximum of both the value added (output minus intermediate consumption) and the compensation of employees.

- The profit rate (PR_{it}) is calculated by dividing the gross operating surplus by the stock of capital in nominal terms, i.e. by capital stock in real terms multiplied by an investment price index supplied by the national accounts. The gross operating surplus is the difference between value added and the compensation of employees.

[1] In this study, the variables in upper or lower case indicate respectively their level or their natural (napieren) logarithm, and Δ before a variable corresponds to its change compared with the previous period.

[2] The average age of capital is evaluated at the end of the time period t, therefore after the retirement already occurred in t. This raises an obvious simultaneity problem between the retirement rate and the contemporaneous average age of capital. We will account for it in the estimations using the lagged values of the average age of capital and instrumental variables.

- The wage cost per capita (W_{it}) is calculated by dividing the compensation of employees by their number. We divide the series by a sectoral value added price index to express it in real terms. Using the comsumer price index would not make any sense here, as we are interested in wages as a factor price and not as an income.

The survey on the degree of utilisation of production factors has been conducted every year since 1989 by the Banque de France among 1,500 to 2,000 companies. These companies are those usually questioned in the framework of the Banque de France's monthly business survey. In the survey on the degree of utilisation of production factors, companies are questioned about the changes in the workweek of capital compared to the previous year and their use of shift work. These variables give us an indication of the intensity of capital utilisation. Two variables from this database are used in the following empirical analysis: the change in the workweek of capital from one period to the next and the proportion of years during which the firm uses shift work:

- The change in the workweek of capital (Δcw_{it}) is obtained by answering the question: "*What is (in %) the change in the workweek of capital between the reference week of year t-1 and that of year t (no decimals)?"*. The explanatory note attached to the questionnaire provides a definition of the workweek of capital: it is defined as the average number of hours during which the capital is used over the reference period. It does not include maintenance time, but covers all the time during which the machine is running, including the time required to prepare production.

- The proportion of years during which the firm uses shift work (SW_i) is obtained by dividing the number of years during which the firm uses shift work by the total number of years during which the firm appears in our estimation period (1996-2008). The use of shift work is obtained from the answer ("*yes*" or "*no*") to the question: "*Have you practiced shift work during the reference week?"*. Chart A1-1 in Appendix 1 is a histogram of this variable, showing that 81% of the observations are concentrated around 0 and 1: the use of shifwork is a permanent choice for most firms over the period under review.

The survey on the workweek of capital is conducted at plant level, while the FIBEN data concern companies that may be composed of several plants. When several plants of the same company are covered by the survey on the utilisation of production factors, their replies are aggregated. The survey variables are then calculated at company level by means of a sum weighted by the share of each plant in the company's total employment. The database only includes the companies for which the sum of the staff employed by the different plants is at least equal to 50% of employees contained in the FIBEN database. In total, only 64 observations of the database used here correspond to multi-plant companies.

The merger of these two databases results in an unbalanced database of 35,679 observations over the 1989-2008 period. Due to the lag structure of our instrumental variables, estimations may be performed on 8,055 observations corresponding to 1,834 companies over the 1994 - 2008 period. To our knowledge, this individual company database is unique for conducting an empirical analysis of the effects of the intensity of capital utilisation on capital retirement.

Our retirement rate variables display descriptive statistics similar to the ones found in the literature. Chart A1-2 presents kernel density estimates of the retirement rate. The distribution is highly concentrated around its mode and looks like a log-normal distribution, with a median of 3.7% and almost half of the observations ranging between 1% and 6.5% (Table A1-1). Zero retirement observations represent 12% of the total, and the right-hand tail is far longer than the left-hand tail given the lower bound at 0. Mairesse and Dormont (1985) report similar average retirement rates, of around 3% to 6% in the 1970s in France. Our firm-level retirement rate dynamics follow a spiky pattern, with positive discards in one year followed by zero discards in subsequent years (see Chart A1-2 for an example). This is similar to the retirement pattern depicted in Erumban (2008b) and recalls the investment pattern at the micro level, see for example Nilsen and Schiantarelli (2003). Retirement and investissment are thus both lumpy over time at the firm level.

Longitudinal variations in the retirement rate are much more important than cross-sectional variations. The average retirement rates calculated for each company range between 0% and 39%, with a between standard deviation of 4% and a within standard deviation of 7%. This represents an incentive to study retirement rate dynamics using a panel of firms.

4. A reduced-form model in line with the empirical literature

The first part of our approach builds on an accelerator – profit model, in line with Eisner (1977) and Mairesse and Dormont (1985). It is a reduced form model mostly used for the analysis of corporate investment (see Bond and Van Reenen, 2007, for a survey). This allows us to examine the behaviour of the covariables so as to set up our specification, and to compare the first results with the ones highlighted in the literature.

4.1. A reduced form model

The first relation we study is a reduced form of the accelerator – profit model. The underlying idea of these models is that the adjustments can occur with lags owing to rigidities. We first relate the capital retirement rate to current and past production, profits, age of capital and labour cost. The relation has the following general form:

$$(1)\quad RR_{it} = \beta_0 + \beta_{10}.\Delta q_{it} + \beta_{11}.\Delta q_{it-1} + \beta_{12}.\Delta q_{it-2} + \beta_{20}.PR_{it} + \beta_{21}.PR_{it-1} + \beta_{22}.PR_{it-2} + \beta_{31}.AK_{it-1} + \beta_{32}.AK_{it-2} + \beta_{40}.W_{it} + \beta_{41}.W_{it-1} + \beta_{42}.W_{it-2} + d_t + \mu_i + \varepsilon_{it}.$$

Equation (1) relates the capital retirement rate RR_{it} to the value added growth rate Δq_{it}, the profit rate PR_{it}, the average age of capital AK_{it} and the labour cost per capita W_{it}. All of these variables are contemporaneous (except the average age of capital) and lagged up to two periods. The average age of capital in *t* refers to the capital installed at the end of year *t*, and consequently the contemporaneous average age measurement for year *t* is more a consequence than a possible cause of the retirement behaviour during the same year *t*. For this reason, only lagged values of the average age of capital are taken into account in this relation. This specification also includes year indicators d_t , a fixed effect μ_i capturing the unobserved heterogeneity at firm level, and lastly an *i.i.d* gaussian error terms ε_{it}. The number of lags is arbitrarily set at two, as will be obvious in Section 4.2.

The role of demand is captured in equation (1) through the value added changes. Indeed, the firm adjusts to its optimal level of active capital, knowing that insufficient capacities may prevent it from satisfying its demand, whereas excess capacities raise maintenance and opportunity costs. Mairesse and Dormont (1985), Cockburn and Franck (1992), Das (1992), Golsbee (1998) and Erumban (2008a) find that retirement is negatively related to the business cycle. This decelerator effect of the activity level on the capital retirement rate is related to the willingness to keep a substantial capital stock in the event of a positive demand shock. Conversely, companies use phases of slow activity to reallocate their capital, reduce the costs related to overcapacities, and enhance their productivity in scrapping obsolete equipment.

The financial state of the firm enters equation (1) through its' profit rate. Indeed, the most profitable firms can more easily finance new productive capital, and thus more easily scrap the equipment with a low performance. Golsbee (1992) includes cash flow among the explanatory variables to capture whether new investments are more costly because of poor financial performance. The less profitable firms can hardly fund new equipment and therefore reduce capital retirement to retain the capital stock. Contrary to this intuition, the theoretical literature on vintage models suggests a negative relationship between retirement and profitability, as an asset is scrapped when its profitability drops to zero. We thus include in our model a measure of the firms' profitability, the effect of which is not clearly predicted by the literature. Mairesse and Dormont (1985) do not find a clear effect of profitability on capital retirement.

The average age of capital in equation (1) captures several mechanisms. It can be a pure physical effect, as wear and tear reduces equipment productive services. It can also capture embodied technical progress, as the emergence of new and more productive assets has a positive effect on the scrapping of older ones. The average age of capital therefore measures both depreciation and obsolescence. Intuitively, these mechanisms imply a positive relationship between the retirement rate and the age of capital. This relation can nevertheless be negative in some settings. Schuette (1994) proposes a model where firms may try to preserve their financial situation in downturns, and thus defer replacements, if there is any uncertainty as to the length of the downturn. They can hold on older vintage equipments if they expect a huge technical change in the near future. We directly include the average age in the specification, so that an increase in the average age of capital (AK_{it-1}) of one year always yields an increase in the retirement rate of magnitude β_{31} the following year.

The wage cost per capita enters equation (1) to capture factor costs. As the wage cost goes up, profits from older assets decrease and result in a higher pace of replacement. Interactions between factors and capital are documented from an empirical viewpoint in Cockburn and Franck (1992), Das (1992) and Goolsbee (1998). We therefore expect a positive relation between wage cost per capita and retirement.

4.2. Estimates of the accelerator – profit model

Table 1 shows estimates derived from equation (1). Results are obtained using the *within* estimator that assumes all explanatory variables to be exogenous. We examine, in particular, the lag structure that is pertinent under this assumption.

Table 1

Estimates of relation (1) with different lags and exogeneity assumptions

Estimator	**W**	**W**	**W**
Δq_{it}	**-2.28***	**-2.48***	**-2.72***
	(-3.78)	(-4.20)	(-5.56)
Δq_{it-1}	0.70	0.26	
	(1.11)	(0.49)	
Δq_{it-2}	0.64		
	(1.21)		
PR_{it}	-0.42	-0.33	
	(-0.92)	(-0.74)	
PR_{it-1}	-0.92	-0.65	**-0.72***
	(-1.91)	(-1.55)	(-2.04)
PR_{it-2}	0.34		
	(0.82)		
AK_{it-1}	**0.01***	**0.01***	**0.01***
	(6.22)	(6.14)	(8.22)
AK_{it-2}	**0.00***	**0.00***	
	(2.70)	(2.67)	
W_{it}	-0.00	-0.00	

	(-0.29)	(-0.20)	
W_{it-1}	0.00	0.00	**0.00***
	(1.39)	(1.66)	(2.19)
W_{it-2}	-0.00		
	(-0.12)		
Year dummies	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Instrumental variables	No	No	No
N	8055	8055	8055

Notes: - the Student statistics are in brackets;
- the coefficients in bold are significant at the 5% threshold.

All the *within* estimates indicate lower value-added change coefficients for lagged values than for the current one. Only the coefficient for contemporary values is significant, and negative as expected. Conversely, the coefficient for the profit rate is slightly significant with a one-year lag only when the contemporary and the two-year lagged values of the profit rate are not taken into account as explanatory variables. A similar weak relation between the profit rate and the retirement behaviour was obtained by Mairesse and Dormont (1985). As expected, the average age of capital has, with a one-year lag, a strong positive and significant impact on the retirement rate. The two-year lagged measure of the average age of capital has a slight positive significant impact on the retirement rate, but as we observe an important and significant correlation between these two measures of the average age of capital (more than 0.49), it seems more appropriate to keep only the one-year lagged one. Finally, we observe that the coefficient of the wage cost per capita is slightly significant with a one-year lag only when the current and the two-year lagged values of the wage cost are not taken into account as explanatory variables.

Taking all the specifications together, we observe that an increase in value-added has a negative impact on the capital retirement rate. This countercyclical effect, already identified by Mairesse and Dormont (1985), means that in the event of a cyclical positive demand shock, companies partly adjust their production capacity by reducing retirements. Conversly, in the event of weak business, firms step up the retirement of useless equipment. These results suggest that it could be relevant to take into account some indicators of changes in capital utilization to explain more accurately firms' capital retirement behaviour.

5. Extension to different cycle effects, utilization rates and endogeneity

The second part of our paper extends the previous model in several directions. Our core specification includes the capital utilization rate, asymmetries in the business cycle and corrects for endogeneity. We subsquently focus on the permanent level of capital retirement at firm level.

5.1. An extended reduced-form model

We extend the accelerator-profit model with the predictors deduced from the previous section in several directions. We first want to assess whether the effect of the activity on retirement is constant throughout the cycle. Indeed, there can be costs or irreversibilities implying different responses of the scrapping rate to a positive or negative demand shock. We therefore want to assess whether the negative relation between retirement and activity observed in the previous section varies over the different phases in the cycle. We thus separate the valued added increases and decreases to allow for the possibility that both effects differ in sign and magnitude.

We also add variables measuring the workweek of capital to account for differences in the capital utilization rate across companies. Boucekkine (2009) considers a model where a vintage of equipments is scrapped when its profitability is lower than its maintenance cost, the latter being an increasing function of the utilization of the vintage. In practice, work may be organized in different ways due to technological and market peculiarities (shift work with daily interruption, weekly interruption, production schedule varying over the year or from one year to the next, etc.). This results in different capital workweeks, which may vary both cyclically (longitudinally) and structurally (in cross-section).

We first focus on cyclical variations in the utilization rate and include in the specification the variations over the last 12 months of the workweek of productive capital (Δcw_{it}). As variations in capital utilisation do not necessarily have symmetrical effects on capital retirement, we therefore distinguish between increases and decreases in the capital workweek:

(2) $RR_{it} = \beta_0 + \beta_{10I}.I\_\Delta q_{it} + \beta_{10D}.D\_\Delta q_{it} + \beta_{21}.PR_{it-1} + \beta_{31}.AK_{it-1} + \beta_{41}.W_{it-1} + \beta_{50I}.I\_\Delta cw_{it} + \beta_{50D}.D\_\Delta cw_{it} + d_t + \mu_i + \varepsilon_{it},$

where $I\_\Delta q_{it}$ and $D\_\Delta q_{it}$ measure increases and decreases in value added ($I\_\Delta q_{it}$ is always positive and $D\_\Delta q_{it}$ negative), and $I\_\Delta cw_{it}$ and $D\_\Delta cw_{it}$ denote increases and decreases in the workweek of productive capital over the last 12 months. The expected sign of the coefficients β_{50I} and β_{50D} is at first unknown. Indeed, variations in the workweek of capital help to adjust production capacities to their desired level in accordance with the retirement rate. A negative β_{50I} (β_{50D} respectively) corresponds to - in the case of an increase (decrease) in the capital workweek - a higher (lower) intensity of capital utilisation and lower (higher) retirement, i.e., all other things being equal, to an acceleration (a deceleration) in capital accumulation. These two mechanisms lead to an increase (decrease) in production capacities and are, in this respect, complementary. Conversely, when β_{50I} (or β_{50D}) is positive, the capital workweek and the stock of capital move in conflicting directions (as in Boucekkine, 2009). In this case, variations in the capital workweek can be seen as softening the impact of retirement on production capacities.

Let us now study the impact of the structural workweek of capital on capital retirement. To do this, we first require variations between firms of a measure of retirement that is net of cyclical effects. This measure consists in the estimated firm fixed effects $\hat{\mu}_i$ obtained by estimating equation (2).[3] They can be regressed on the firm characteristics averaged over the time period:

(3) $\hat{\mu}_i = \gamma_0 + \gamma_1 SW_i + \gamma_2 IND_i + \gamma_3 SIZ_i + u_i,$

where SW_i is the proportion of years during which part of the workforce of firm *i* works on shifts. It only varies from one firm to the next with the number of years in which work is organized in successive shifts. It is therefore only related to the length of the period of tense capital workweek. As shown in Chart A1-1 (Appendix 1), 81% of the firms never or always have recourse to shift work. It is thus nearly a permanent characteristic of a firm. Variables IND_i and SIZ_i are sets of industry and size dummies. This simple specification enables us to avoid any cyclicality in the measure of both the permanent retirement rate (when all other covariates are null) and the average workweek of capital. Furthermore, it provides estimated standard errors adjusted for any correlation of the error terms within firms.

[3] A method to estimate the firm fixed effects in a linear model for panel data is provided in Wooldridge (2001, p. 273).

5.2. Selection of instrumental variables

Numerous sources of endogeneity are likely to bias the estimates. First, we cannot be sure that our computed retirement rate is free of measurement errors. Furthermore, the variable measuring changes in the capital workweek displays values concentrated on a few points. Chart A1-3, in Appendix 1, is a histogram of the changes in the capital workweek over the previous year. Most variations are concentrated around -20%, -10%, -5%, 0%, 5%, 10% and 20%, whereas the variable should be continuous. It is therefore likely that there are measurement errors in the observed capital workweek changes. Second, it is very likely that we have simultaneity issues. Indeed, capital retirement and value added are determined simultaneously if the latter varies due to changes in intermediate consumption resulting from the retirement of obsolete capital. Lagged variables, which include the profit rate, the average age of capital and the wage cost per capita, can also be endogenous if they are correlated with the contemporaneous error term. This occurs, for example, if these variables are autocorrelated and their current value is further correlated with the contemporaneous error term.

We choose to correct the endogeneity biases with instrumental variables, using essentially lagged values of the explanatory variables, in the spirit of Blundell and Bond (1998). Lagged variables can be used as instruments under the weak exogeneity assumption, meaning the absence of correlation between ε_{it} and the retained lags of the explanatory variables. This assumption holds if the current level of capital retirement does not depend on lags greater than the ones included in model (2). This seems a reasonable assumption against the background of the results in Section 4.2.

Our instruments must satisfy two conditions in order to be valid: they must be free of any correlation with the error terms and be reasonably correlated with the potentially endogenous variables. Internal instruments are generally used in great numbers, whereas each one is only weakly correlated with the endogenous explanatory variables. This can lead to substantial biases. Angrist and Pischke (2009, pp. 205-216) describe the problems raised by the use of weak instruments. To restrict the number of instruments and include only the ones containing most of the information on the variables, we follow a pragmatic strategy. We first estimate model (2) including as instruments the lagged values of all the explanatory variables until *t-6.* Hence, based on the first stage results and Fisher statistics, we drop the weaker instruments. We are able to test the exogeneity of the instruments using the Sargan statistic and to test their correlation with the endogenous explanatory variables by means of the Cragg-Donald (1993) statistic associated with Stock and Yogo (2002) critical values. We hence obtain a set of instruments whose properties are discussed in Section 5.3.

We estimate equation (2) using the LIML estimator. This choice is motivated by several reasons. First, it is far less susceptible to biases than the usual two-stage GMM estimator in the presence of weak instruments and finite samples, as shown by the values tabulated in Stock and Yogo (2002) for the LIML and two-stage GMM, as well as by Hahn *et al.* (2004). Several other alternative estimators are less biased than the two-stage GMM estimator when the model is overidentified, as is the case here. The LIML estimator neverthess seems superior with respect to several criteria (Flores-Lagunes, 2007). Furthermore, Stock and Yogo (2002) provide tables for directly testing the assumption of weak instruments with the Cragg-Donald statistic. These tables are obtained under the assumption of *i.i.d* and homoscedastic errors. We are not aware of similar tables under the assumption of heteroscedastic errors, which could be used for example to validate instruments used by the CUE-GMM estimator of Hansen *et al.* (2006). As it seems of importance to us to both reduce as far as possible potential biases and to be able to discuss the relevance of the instruments, we decide to use the LIML estimator. Estimates are performed using Stata and the ivreg2 (Baum *et al.*, 2010) procedure. Firm fixed effects are eliminated using the *within* transformation.

5.3. Estimates of the extended model

This section presents the estimates of model (2). We first assess whether the decelerator effect highlighted in Section 4.1 is stronger during the ascending or descending phase of the cycle, using a specification that allows growth in value added to have asymmetrical effects on capital retirement. We then broaden this specification to assess how the decelerator effect reacts to variations in the capital workweek. All the results are obtained using the LIML estimator in order to correct the estimates for endogeneity problems.

Table 2
Estimates of relation (2)

Estimator	**LIML**	**LIML**	**LIML**
$\boldsymbol{I\_\Delta q_{it}}$	3.00	0.25	
	(0.78)	(0.06)	
$\boldsymbol{D\_\Delta q_{it}}$	**-7.63***	-6.46	**-6.21***
	(-2.13)	(-1.78)	(-2.58)
$\boldsymbol{PR_{it-1}}$	0.30	-0.31	
	(0.30)	(-0.29)	
$\boldsymbol{AK_{it-1}}$	**0.02***	**0.02***	**0.02***
	(5.61)	(5.92)	(6.12)
$\boldsymbol{W_{it-1}}$	0.00	0.00	
	(1.51)	(1.22)	
$\boldsymbol{I\_\Delta cw_{it}}$		**-0.17***	**-0.19***
		(-2.14)	(-2.58)
$\boldsymbol{D\_\Delta cw_{it}}$		-0.03	
		(-0.23)	
Year dummies	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Instrumental variables	Yes	Yes	Yes
Critical prob. of Sargan test	0.37	0.71	0.83
Cragg-Donald statistic	15.38	7.36	14.55
N	8055	8055	8055

Notes: - the Student statistics are in brackets;
- the coefficients in bold are significant at the 5% threshold.

We study in several ways the properties of the instruments used to obtain the results displayed in Table 2. Firstly, a valid instrument has to be exogeneous. For all models reported in Table 2, the absence of correlation between the residual and the instruments is accepted to at least the 37% level. Secondly, the instruments must not be weak. We document this property using Fisher and Cragg-Donald (1993) statistics. Indeed, Staiger and Stock (1997) suggest as a rule of thumb, in a model with a single endogenous variable, that instruments be considered as weak when their first stage Fisher statistic does not excess the threshold of 10. Our model comprises multiple endogeneous variables, and this rule does not apply here. We, however, report in Tables A2-1 and A2-2 (Appendix 2) respectively, the results of the first stage and the Angrist and Pischke (2009) Fisher statistics computed with the number of excluded instruments of the model in the second and last column of Table 2. An approach applicable to a model with multiple endogeneous variables is described by Stock and Yogo (2002). They propose testing the assumption of weak instruments by comparing the Cragg - Donald statistic with values that they tabulate. However, critical values are only tabulated for models with less than two endogeneous variables, where they are respectively of 3.50 and 3.58 for the LIML estimator of a model with 12 excluded instruments, and of 3.27 and 3.55 for a model with 16 excluded instruments (Stock and Yogo, 2002, Table 4, p. 61). These values are much lower than the Staiger and Stock (1997) threshold of 10. Our model comprises up to 7 endogeneous variables. A Cragg – Donald statistic of more than 14 for the last model suggests that the instruments are reasonably strong and that the biases are at most small.

Increases and decreases in value added have different effects. Unlike falls, rises have virtually no impact on capital retirement. A 1% fall in value added is associated with a rise in the retirement rate of magnitude $-\beta_{10D}$, i.e. 6% under the last two specifications. The adjustement of production capacities through retirement thus seems to occur only in a context of weak activity, with companies retiring useless overcapacities. The average age of capital has a low positive significant impact on retirement: a one-year older capital stock is associated with a 2% higher retirement rate. As before, the profit rate and the wage cost per capita have no impact on the retirement behaviour. These results are not impacted by the inclusion of variables measuring the capital workweek.

The effect of increases and decreases in the workweek of capital are also differenciated. Only capital workweek increases have a significant impact on the retirement behaviour: a 1% increase in the capital workweek is related to a decrease in retirement of magnitude β_{50D}, i.e. -0.19%. This suggests a short-term complementarity between capital retirement and more intensive capital workweeks to increase production capacity.

5.4. The effect of the capital usage structural intensity

In this section we discuss the results of model (3), so as to characterize the impact of the capital usage structural intensity on retirement. In this model, the permanent level of retirement is measured by the firm fixed effects $\hat{\mu}_i$, estimated using the last model in the previous section (Table 2, rightmost column). These fixed effects are regressed on the proportion of years during which company *i* organized its' work in successive shifts. This variable captures the effect of an intensive and durable use of equipment over the time period. We also include as control variables industry dummies (5 different industries are considered) and size dummies (4 different sizes, corresponding to the quartiles of the sizes). Results are provided in Table 3 below.

Table 3

Estimates of the structural effects

Estimator	OLS	OLS	OLS
SW_i	0.00	**0.01***	**0.01***
	(1.64)	(2.83)	(3.00)
Workforce size:			
- **first quartile**	-0.00		-0.00
	(-0.33)		(-0.37)
- **second quartile**	-0.01		-0.00
	(-1.94)		(-1.50)
- **third quartile**	**-0.01***		**-0.01***
	(-2.79)		(-2.45)
Industries:			
- **Food**		-0.00	-0.00
		(-0.06)	(-0.08)
- **consumer goods**		**0.02***	**0.02***
		(7.55)	(7.35)
- **automotive**		0.01	0.01
		(1.13)	(1.23)
- **capital goods**		**0.02***	**0.02***
		(5.10)	(5.03)
N	1922	1922	1922

Notes: - the Student statistics are in brackets;
- the coefficients in bold are significant at the 5% threshold;
- the industry reference category is intermediate goods;
- the workforce reference category is the fourth quartile.

Once the heterogeneity at industry and size level is accounted for, the coefficient of the structural intensity variable is positive and significant. The retirement rate hence increases when lasting pressure is put on the equipement. This result is in line with the intuition of a wear and tear effect. This is, however, a mechanism of low magnitude. A company managing its' workforce in successive shifts during all 14 years of the period under review has a 1% higher $\hat{\mu}_i$ - and thus a permanent retirement rate - than a similar firm that has never had recourse to shiftwork. Nevertheless, compared to the effect of value added or changes in the capital workweek, the impact of the wear and tear effect seems to be of minor importance.

Contrary to short-term variations in the capital workweek, which have a decelerator effect on capital retirement, long-term variations in the usage intensity have an accelerator effect. The capital workweek thus has two distinct and opposite effects: cyclically, the capital workweek contributes through retirement to the adjustment of production capacities, and structurally, capital retirement increases with the intensity of capital usage. In the short run, the stock of capital and the utilization rate complement each other, whereas in the long run, they are substitutes.

6. Conclusion

The empirical analysis of individual company data put forward in this study not only draws on company accounts data to calculate the retirement rate, variations in value added and the profitability rate, but also on other original data from a survey on the utilisation of production factors. The latter tells us to what extent companies have resorted to shiftwork and to what extent the workweek of capital has varied. The extent to which a company resorts to shift work is used to explain the capital usage structural intensity. Variations in the workweek of capital tell us more about cyclical variations in the capital usage structural. The sample used for the estimates includes 8,055 observations over the 1994-2008 period. This individual database is, as far as we know, unique for conducting an empirical analysis of the effects of the capital usage structural intensity on capital retirement. The empirical analysis of capital retirement behaviour is conducted with these data and adjusted for endogeneity biases by means of instrumental variables.

The main results of the analysis may be summarized as follows: i) The retirement rate increases during slowdowns, as measured by changes in output; and decreases during booms, as measured by changes in the capital workweek. This corresponds to a countercyclical capital retirement; ii) The capital retirement rate increases with the intensity of capital utilisation in the long run.This corresponds to a wear and tear effect, which is nevertheless small compared to the countercyclical one; iii) The capital retirement rate increases with the average age of capital; iv) The profit rate and the wage cost per capita do not have a significant impact on the retirement rate. Compared to previous studies, our main contribution is to directly control for the utilization rate of capital and to disentangle the short-run drivers from the long-run ones.

The approach proposed here is still very partial. A more in-depth representation of capital retirement behaviour should be based on a more complete model of the capital dynamics, analysing the relationship between capital accumulation and capital retirement. Nevertheless, the results obtained appear fairly robust and they comply with economic intuition. They suggest that during the 2008 crisis – which notably involved a sharp cyclical contraction in business activity and the capital usage structural intensity– capital retirement must have experienced a marked acceleration. An impact of this nature is not negligible in assessing the potential level of production, and consequently, in determining the position of the economy in the business cycle, for example, using output gap indicators.

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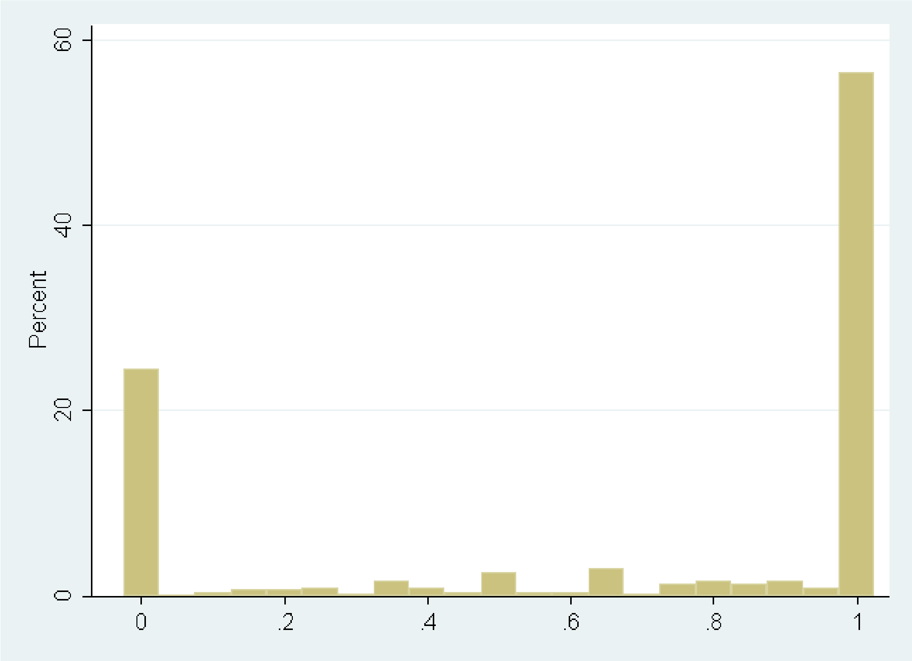
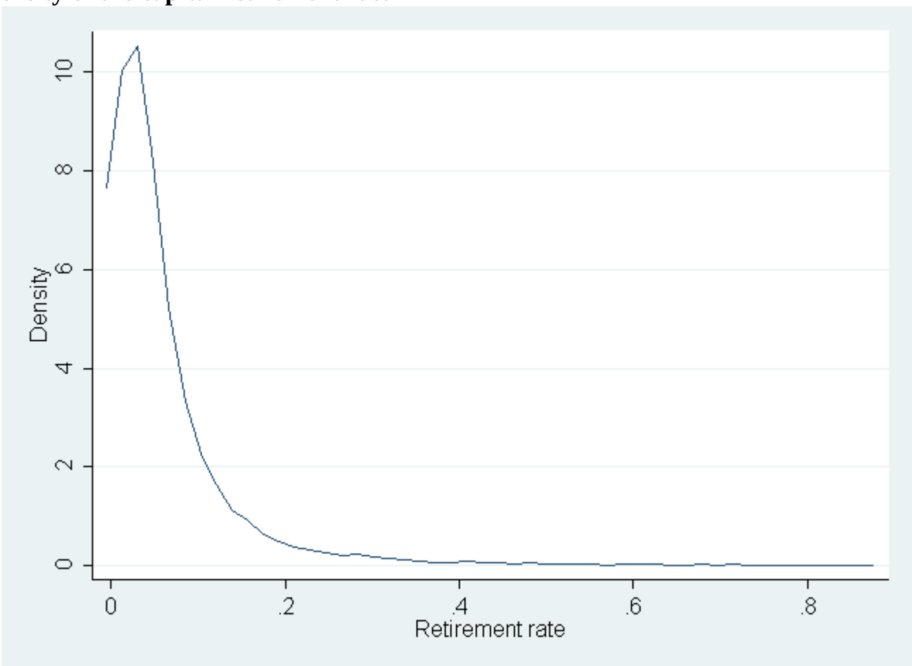
Appendix 1

Chart A1-1
Proportion of time firms use shift work over the time period 1994-2008



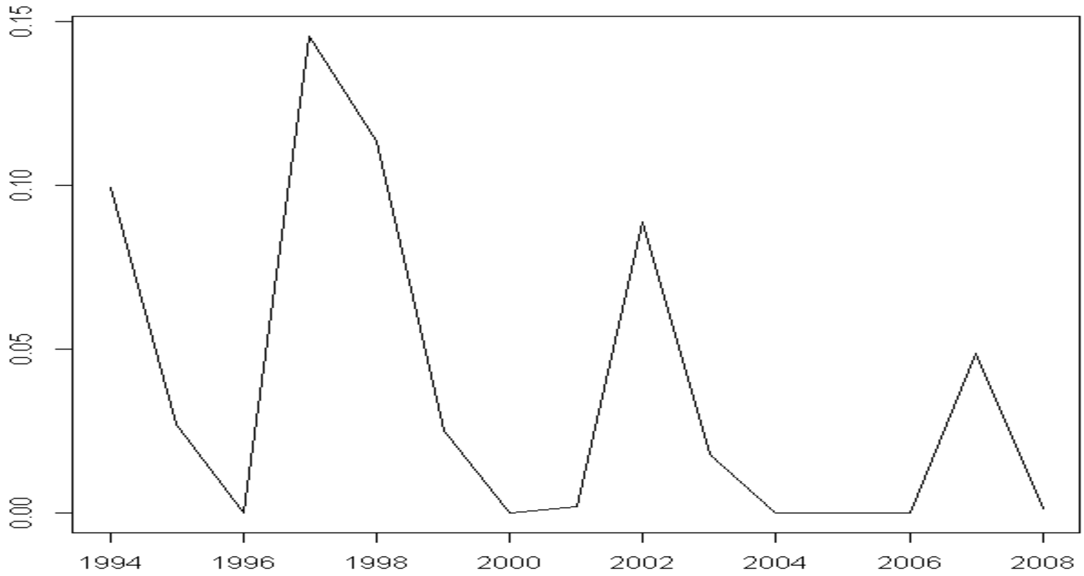
Source: FiBEn database and Survey on the Utilisation of Production Factors.

Chart A1-2
Estimated density of the capital retirement rate



Source: FiBEn database and Survey on the Utilisation of Production Factors. The density is estimated by a kernel method.

Chart A1-3
Example of the retirement rate dynamics for a given firm



Source: FiBEn database and Survey on the Utilisation of Production Factors.

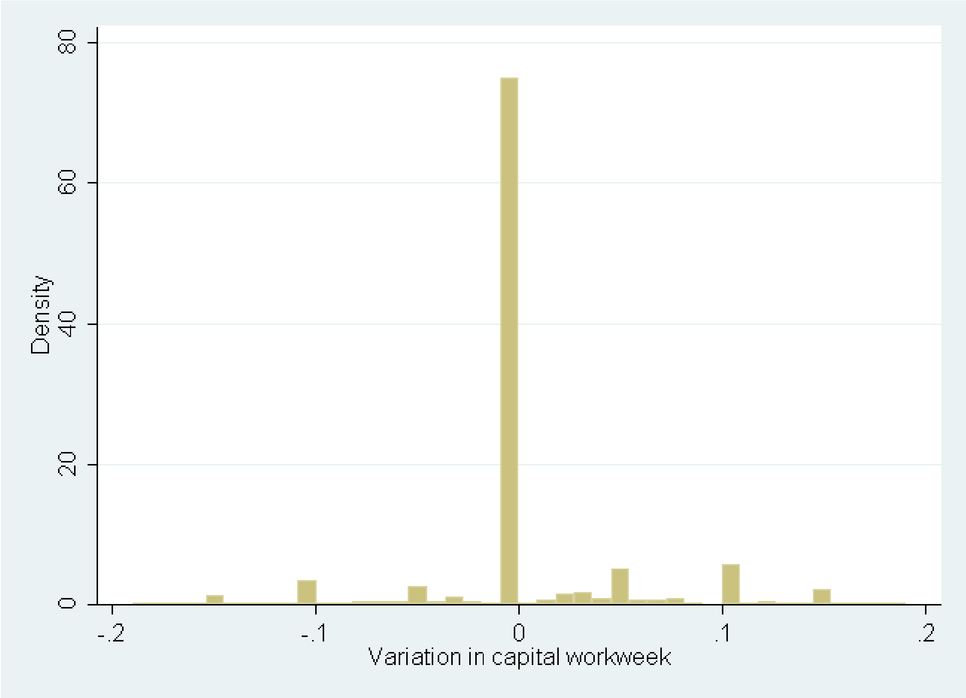
Table A1-1

Variable	Notation	Source*	1st decile	Median	9th decile	Average	Standard deviation
Retirement rate	RR_{it}	FiBEn	0.00%	3.72%	13.52%	5.94%	0.08
Change in real value added	Δq_{it}	FiBEn	-0.16%	0.02%	0.19%	0.01%	0.00
Profit rate	PR_{it}	FiBEn	0.03%	0.22%	0.68%	0.32%	0.00
Average age of capital	AK_{it}	FiBEn	5.00	6.00	7.00	5.74	0.96
Wage cost per capita	W_{it}	FiBEn	0.27	1.07	9.85	3.85	8.09
Increase in value added	$I\_\Delta q_{it}$	FiBEn	0.00%	0.02%	0.19%	0.06%	0.00
Decrease in value added	$D\_\Delta q_{it}$	FiBEn	-0.16%	0.00%	0.00%	-0.05%	0.00
Increase in the capital workweek	I_cw_{it}	EUFP	0.00	0.00	0.10	0.03	0.07
Decrease in the capital workweek	D_cw_{it}	EUFP	-0.05	0.00	0.00	-0.02	0.05

* : FiBen and EUFP are short for *Fichier Bancaire des Entreprises and Enquête sur l'Utilisation des Facteurs de Production* (Company Accounts Database) and *Enquête sur l'utilisation des facteurs de production* (Survey on the Utilisation of Production Factors).

Chart A1-4

Histogram of the variations in the capital workweek over the last 12 months



Source: FiBEn database and Survey on the Utilisation of Production Factors.

Appendix 2

Table A2-1

Results of the first stages of the estimates shown in Table 2, second column

Variable	$I\_\Delta q_{it}$	$D\_\Delta q_{it}$	PR_{it-1}	AK_{it-1}	W_{it-1}	I_cw_{it}	D_cw_{it}
$I\_\Delta q_{it-1}$	-0.25*	-0.06*	0.76*	-28.18*	134.58*	1.47	0.11
	(-19.06)	(-4.53)	(30.84)	(-4.44)	(12.72)	(1.86)	(0.18)
$I\_\Delta q_{it-2}$	-0.20*	-0.04*	0.18*	-28.32*	20.85	0.92	-0.40
	(-15.55)	(-2.74)	(7.34)	(-4.40)	(1.95)	(1.16)	(-0.62)
$I\_\Delta q_{it-3}$	-0.13*	0.02	0.17*	-21.13*	15.24	0.27	-0.50
	(-9.97)	(1.31)	(6.91)	(-3.42)	(1.48)	(0.36)	(-0.81)
$I\_\Delta q_{it-4}$	-0.13*	-0.00	0.08*	-14.03*	-10.34	1.12	0.07
	(-10.82)	(-0.34)	(3.68)	(-2.41)	(-1.07)	(1.55)	(0.13)
$D\_\Delta q_{it-1}$	-0.12*	-0.28*	0.61*	-4.58	89.73*	-1.45	0.52
	(-9.55)	(-20.59)	(25.19)	(-0.73)	(8.64)	(-1.88)	(0.83)
$D\_\Delta q_{it-2}$	-0.03*	-0.17*	0.24*	-0.21	31.22*	-2.88*	-0.08
	(-2.36)	(-11.66)	(9.29)	(-0.03)	(2.79)	(-3.46)	(-0.11)
$D\_\Delta q_{it-3}$	-0.06*	-0.15*	0.16*	-9.14	8.29	-3.28*	0.52
	(-4.75)	(-11.18)	(6.69)	(-1.45)	(0.79)	(-4.20)	(0.83)
$D\_\Delta q_{it-4}$	-0.00	-0.11*	0.14*	-3.11	10.02	-2.01*	0.07
	(-0.26)	(-8.48)	(5.66)	(-0.51)	(0.98)	(-2.64)	(0.12)
PR_{it-2}	-0.03*	-0.04*	0.45*	-6.58*	18.37*	0.08	-0.43
	(-5.67)	(-6.14)	(43.46)	(-2.48)	(4.17)	(0.23)	(-1.62)
$I\_\Delta cw_{it-1}$	0.00*	0.00*	0.00	-0.23*	0.86*	-0.09*	-0.04*
	(6.64)	(4.06)	(0.68)	(-2.26)	(5.01)	(-7.29)	(-3.64)
$I\_\Delta cw_{it-2}$	0.00	0.00	0.00	-0.25*	-0.06	-0.15*	-0.03*
	(0.89)	(0.58)	(1.67)	(-2.39)	(-0.37)	(-11.31)	(-2.97)
$I\_\Delta cw_{it-3}$	0.00*	0.00*	0.00	-0.27*	0.14	-0.10*	-0.01
	(2.66)	(2.01)	(0.24)	(-2.55)	(0.79)	(-7.41)	(-1.17)
$I\_\Delta cw_{it-4}$	0.00*	0.00	0.00	-0.21*	-0.07	-0.07*	-0.02
	(2.85)	(0.40)	(1.88)	(-2.10)	(-0.44)	(-5.45)	(-1.53)
$I\_\Delta cw_{it-5}$	-0.00	-0.00	0.00	-0.15	0.57*	-0.07*	0.01
	(-0.07)	(-0.16)	(0.87)	(-1.55)	(3.63)	(-5.93)	(1.23)
$D\_\Delta cw_{it-2}$	-0.00	-0.00	-0.00	-0.29*	0.52*	-0.04*	-0.11*
	(-0.82)	(-0.14)	(-0.60)	(-2.29)	(2.46)	(-2.58)	(-8.80)
$D\_\Delta cw_{it-3}$	-0.00	-0.00*	0.00	-0.17	0.30	0.02	-0.09*
	(-0.51)	(-4.53)	(0.49)	(-1.32)	(1.43)	(1.23)	(-6.90)
AK_{it-2}	-0.00	-0.00	0.00*	0.44*	0.03	-0.00	-0.00
	(-0.50)	(-1.39)	(4.85)	(39.39)	(1.75)	(-0.36)	(-1.18)
W_{it-2}	-0.00*	-0.00*	0.00*	-0.01	0.78*	-0.00	-0.00
	(-4.20)	(-4.43)	(2.87)	(-1.32)	(85.26)	(-0.92)	(-0.35)
N	8055	8055	8055	8055	8055	8055	8055
AP-F	25.77	28.47	107.64	134.88	551.42	17.42	11.39

Notes: - The Student *t* are in brackets;
- Angrist and Pischke multivariate Fisher statistics, estimated with the number of excluded instruments.

Table A2-2

Results of the first stage regressions of Table 2, last column

Variable	$D\_\Delta q_{it}$	AK_{it-1}	I_cw_{it}
$I\_\Delta q_{it-1}$	-0.06*	-28.18*	1.47
	(-4.53)	(-4.44)	(1.86)
$I\_\Delta q_{it-2}$	-0.04*	-28.32*	0.92
	(-2.74)	(-4.40)	(1.16)
$I\_\Delta q_{it-3}$	0.02	-21.13*	0.27
	(1.31)	(-3.42)	(0.36)
$I\_\Delta q_{it-4}$	-0.00	-14.03*	1.12
	(-0.34)	(-2.41)	(1.55)
$D\_\Delta q_{it-1}$	-0.28*	-4.58	-1.45
	(-20.59)	(-0.73)	(-1.88)
$D\_\Delta q_{it-2}$	-0.17*	-0.21	-2.88*
	(-11.66)	(-0.03)	(-3.46)
$D\_\Delta q_{it-3}$	-0.15*	-9.14	-3.28*
	(-11.18)	(-1.45)	(-4.20)
$D\_\Delta q_{it-4}$	-0.11*	-3.11	-2.01*
	(-8.48)	(-0.51)	(-2.64)
PR_{it-2}	-0.04*	-6.58*	0.08
	(-6.14)	(-2.48)	(0.23)
$I\_\Delta cw_{it-1}$	0.00*	-0.23*	-0.09*
	(4.06)	(-2.26)	(-7.29)
$I\_\Delta cw_{it-2}$	0.00	-0.25*	-0.15*
	(0.58)	(-2.39)	(-11.31)
$I\_\Delta cw_{it-3}$	0.00*	-0.27*	-0.10*
	(2.01)	(-2.55)	(-7.41)
$I\_\Delta cw_{it-4}$	0.00	-0.21*	-0.07*
	(0.40)	(-2.10)	(-5.45)
$I\_\Delta cw_{it-5}$	-0.00	-0.15	-0.07*
	(-0.16)	(-1.55)	(-5.93)
$D\_\Delta cw_{it-2}$	-0.00	-0.29*	-0.04*
	(-0.14)	(-2.29)	(-2.58)
$D\_\Delta cw_{it-3}$	-0.00*	-0.17	0.02
	(-4.53)	(-1.32)	(1.23)
AK_{it-2}	-0.00	0.44*	-0.00
	(-1.39)	(39.39)	(-0.36)
W_{it-2}	-0.00*	-0.01	-0.00
	(-4.43)	(-1.32)	(-0.92)
N	8055	8055	8055
AP-F	48.63	108.78	16.53

Notes: - The Student *t* are in brackets;
- Angrist and Pischke multivariate Fisher statistics, estimated with the number of excluded instruments.

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