The Impact of the Cost of Capital and of the Decision to Invest or to Divest on Investment Behaviour: An Empirical Investigation using a Panel of French Services Firms

Jean-Bernard CHATELAIN[1] and Jean-Christophe TEURLAI[2]

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Abstract :

It is usually difficult to exhibit a statistically significant effect of the cost of capital on investment. It is in contradiction with the common practice of the selection of investment project relies on expected discounted returns, where the discount factor is the tax adjusted weighted average cost of capital (WACC). In this practice, WACC plays a role first, as a cut-off value for investment decisions and second, as a cost limiting the amount of investment. We first test the idea that WACC matters very much for the investment or divestment *decisions*, which is in line with the common practice. This test is made on a panel of very small French Services firms, which includes a large number of firms who divest. On this basis, we are then able to deal with *endogenous selection* problems when we then investigate the relationship between the *quantity of investment or divestment* as a function of WACC and other variables. It turns then that the long run user cost elasticity of firms who invest is close to one whereas the long run user cost elasticity of firms who divest is close to zero. This suggests that the downward bias of the user cost elasticity on the full sample is due to an aggregation bias between firms who invest and firms who divest.

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Key Words: Investment, Divestment, Cost of Capital , Generalised Method of Moments.

[1] LEO, University of Orleans, Rue de Blois, B.P. 6739, 45067 Orléans, visitor at Cepremap. E-mail: jean-bernard.chatelain@univ-orleans.fr

[2] Crédoc, Département de dynamique des marchés, 142 Rue du Chevaleret, 75013 Paris.

1. INTRODUCTION

The effect of the user cost of capital on capital is generally difficult to find. The available evidence shows that the cost of capital channel of monetary policy has no effect on corporate investment in France at the macroeconomic level. Three French forecasting models developed in the 1990s do not include the cost of capital (see Amadeus by INSEE, Mosaïque by OFCE, and the model developed by the Banque de France), while INSEE's Metric model adds a relative factor cost whose parameter is small (-0.016) and not significant (see Assouline et al. [1998]). Herbet [2001] published a recent estimation of macroeconomic investment and recognised its failure to incorporate interest rate or user cost effects.

Five recent studies have focused on the effect of the user cost at the firm level. The results vary considerably. Using the BACH European database "aggregated by size and sector" based on Banque de France sample data, Beaudu and Heckel [2001] found a zero elasticity for the four largest euro area countries including France. Using the INSEE BIC-BRN database, Duhautois [2001] aggregated data by sector and size from 1985 to 1996. He found a real interest rate elasticity of -0.38 for the period 1985-1990 and of -0.27 for the period 1991-1996. Using a sample of individual firm accounts (INSEE BIC database), Crépon and Gianella [2001] obtained a user cost elasticity of -0.63 for industry and of -0.35 for services over the period 1990-1995. Using the BACH database, like Beaudu and Heckel [2001], Mojon Smets and Vermeulen [2001] obtained a high elasticity for the user cost for France (-0.75). Finally, Chatelain and Tiomo [2002] found a user cost elasticity of –0.26 for industrial firms. These relatively small user cost elasticities may stem from heterogeneity of firms if there is a threshold on the level of investment necessary to find a effect of the user cost on the amount invested.

The common practice of the selection of investment project relies on expected discounted returns, where the discount factor is the tax adjusted weighted average cost of capital (WACC). In this practice, WACC plays a role first, as a cut-off value for investment decisions and second, as a cost limiting the amount of investment. We first test the idea that WACC matters very much for the investment or divestment *decisions*, which is in line with the common practice. This test is made on a panel of very small French Services firms, which includes a large number of firms who divest. On this basis, we are then able to deal with *endogenous selection* problems when we then investigate the relationship between the *quantity of investment or divestment* as a function of WACC and other variables. It turns then that the long run user cost elasticity of firms who invest is close to one whereas the long run user cost elasticity of firms who divest is close to zero. This suggests that the downward bias of the user cost elasticity on the full sample is due to an aggregation bias between firms who invest and firms who divest.

The rest of the paper is organized as follows. Section 1 presents the theoretical model and the estimation method. Section 2 presents the data and the results. Section 3 concludes.

2. THE INTERTEMPORAL BEHAVIOUR OF FIRMS

2.1 Theoretical Model

We consider a profit-maximising firm which does not face adjustment costs of investment but does face tax deductibility of depreciation and interest charges as well as a marginal cost of debt increasing with leverage. A one-period model was developed by Auerbach [1983] and Hayashi [2000] presented an intertemporal continuous time version. Our presentation is based on discrete time intertemporal optimisation of firms facing uncertainty. With respect to King and Fullerton's [1984] approach, we do not take into account the differences in household taxation with respect to dividends and retained earnings nor the distinction between different capital goods for the computation of the net present value of depreciation allowances. We assume one financial constraint: the cost of debt increases with leverage. However, a firm can always get round this constraint using negative dividends or new share issues. We do not take into account other financial constraints such as positive dividends, a transaction cost for new share issues, or a debt ceiling constraint.

Analysing investment begins with an expression of the value of the firm, which in turn stems from the arbitrage condition governing the valuation of shares for risk-neutral investors. The return for the risk-neutral owners of firm i at time t reflects capital appreciation and current dividends. In equilibrium, if the owners are to be content holding their shares, this return must equal ρ_t the nominal return on other risky financial assets between period t and period $t+1$:[3]

$$(1) \qquad \frac{\left\lfloor E_t\left(V_{i,t+1} - \Psi_{i,t+1}\right) - V_{it} \right\rfloor + E_t\left(d_{i,t+1}\right)}{V_{it}} = \rho_t$$

In what follows, the subscript *i* always refers to firm *i* and the subscript *t* to year *t*, E_t is the expectation operator conditional on information known at time t, d_{it} are dividends, V_{it} is the firm's nominal market value (it is equal to the number of existing shares times the share price p_{it}^E), Ψ_{it} is new share issues. Solving this iterative arbitrage condition leads investors in firm i to choose the stock of capital and debt by maximizing the present value of dividends less new share issues at time t in a infinite horizon:

$$(2) \qquad \max_{\{K_{it}, B_{it}\}_0^\infty} V_{\mathrm{i,t=0}} = E_t\left[\sum_{t=0}^{\infty}\left(\prod_{s=0}^{t-1}\beta_s\right)\right]\left[d_{it} - \Psi_{it}\right] \ ,$$

where the firm's one-period nominal discount factor is $\beta_t = 1/(1+\rho_t)$. Investment I_{it} is defined by the capital stock K_{it} accounting identity:

$$(3) \qquad I_{it} = K_{it} - (1-\delta)K_{i,t-1} \ ,$$

δ is the constant rate of economic depreciation. The flow of funds equation defines corporate dividends. Cash inflows include sales, new share issues, and net borrowing, while cash outflows consist of dividends, factor and interest payments, and investment expenditures. Labour charges, interest charges and accounting depreciation are tax deductible. For simplification, we consider that accounting depreciation does not differ from economic depreciation. An investment tax credit rate itc_{it} is taken into account:

$$(4) \qquad \begin{aligned} d_{it} &= (1-\tau_t)\left[p_{it}F(K_{it}, N_{it}) - w_t N_{it} - i_{i,t-1}B_{i,t-1}\right] + \tau_t \delta p_{i,t-1}^I K_{i,t-1} \\ &\quad + p_{it}^S \Psi_{it} + B_{it} - B_{i,t-1} - (1-\mathrm{itc}_{it})p_{st}^I\left[K_{it} - (1-\delta)K_{i,t-1}\right] \end{aligned}$$

Where N_{it} is a vector of variable factors of production, $F(K_{it}, N_{it})$ is the firm's revenue function ($F_K > 0, F_{KK} < 0$), w_t is a vector of nominal factor prices, i_{it} is the nominal interest

[3] To be more precise, ρ is an expected return on a large number of risky financial assets between date t and date $t+1$. Applying the law of large numbers leads this expected return to be considered as realized ex-post and therefore known with certainty ex-ante.

rate on debt, B_{it} is the value of net debt outstanding, p_{it} is the price of final goods, p^I_{st} is the sectoral price of capital goods; p^S_{st} is the price of new share issues; τ_t is the corporate income tax rate, against which interest payments and depreciation are assumed to be deductible.

The nominal interest rate on debt at time t depends on an agency premium which increases with debt and decreases with capital taken as collateral and therefore valued by the current resale price of investment. We assume that the debt interest rate increases with the debt/capital ratio: $i_{it}(B_{it} / p^I_{st} K_{it})$, with $i^{'}_{it} > 0$.

After substitution of dividends by the flow of funds and of investment using the capital stock equation, we provide first order conditions for the maximisation of the firm's value. First, the Euler equation with respect to debt is:

$$(5)\ldots \quad \begin{aligned} &1-\beta_{it}\left[1+E_t(1-\tau_{t+1})\left(i_{it}+\frac{\partial i_{it}}{\partial B_{it}}B_{it}\right)\right]=0 \\ &\Rightarrow \rho_t-(1-E_t\tau_{t+1})i_{it}=E_t(1-\tau_{t+1})\left(\frac{B_{it}}{p^I_{st}K_{it}}\right)i^{'}_{it}>0 \end{aligned}$$

This condition shows that the optimal debt/capital ratio is independent from the choice of capital (the optimal debt/capital ratio is unique if for example $2i^{'}+i^{''}>0$). This optimal debt/capital ratio results from the trade-off between the tax advantage of debt and the increase of the agency costs premium. It is such that the optimal gap between the rate of return on equity (i.e. the opportunity cost of equity) and the net-of-tax marginal cost of debt is positive. The Euler equation with respect to capital is:

$$(6) \quad \begin{aligned} &(1-\tau_t)p_{it}F_K(K_{it},N_{it})-(1-\mathrm{itc}_{it})p^I_{st} \\ &+\beta_t E_t\left[(1-\mathrm{itc}_{i,t+1})(1-\delta)p^I_{s,t+1}+\tau_{t+1}\delta p^I_{st}+(1-\tau_{t+1})\left(\frac{B^2_{it}}{p^I_{st}K^2_{it}}\right)i^{'}_{it}\right]=0 \\ &\Rightarrow F_K(K_{it},N_{it})=C_{it}=\frac{p^I_{st}}{p_{it}}\frac{(1-\mathrm{itc}_{it})}{(1-\tau_t)}[1-c_1-c_2-c_3]. \end{aligned}$$

where the components of the cost of capital C_{it} are:

$$c_1 = \frac{(1-\delta)}{(1+\rho_t)} \frac{E_t(1-\mathrm{itc}_{i,t+1})p^I_{s,t+1}}{(1-\mathrm{itc}_{it})p^I_{st}}, \; c_2 = [\rho_t - (1-E_t\tau_{t+1})i_{it}] \frac{B_{it}}{(1-\mathrm{itc}_{it})p^I_{st}K_{it}}, \; c_3 = \frac{\delta E_t \tau_{t+1}}{(1-\mathrm{itc}_{it})}.$$

Each of these three components depends on tax policy. The term $1-c_1$ leads to the Hall and Jorgenson (1967) formula for the cost of capital without tax distortions between means of finance and between depreciated assets. Taxation matters via the investment tax credit which decreases the price of investment. The term c_2 is obtained after substitution using the Euler condition on debt. It decreases the cost of capital due to the tax deductibility of interest charges under the constraint of an increasing cost of debt as leverage increases. In this respect, a higher optimal leverage decreases the cost of capital. The term c_3 decreases the cost of capital due to the deductibility of depreciated capital. To take into account the case where accounting depreciation differs from constant economic depreciation, one has to cancel the third term of the cost of capital c_3 and substitute the correction of the investment price $(1-\mathrm{itc}_{it})$ everywhere it appears by $(1-\mathrm{itc}_{it}-z_{it})$, where z_{it} is the net present value of depreciation allowances (Hayashi [2000, p.60]).

Using a first order approximation with respect to the rate of depreciation, to the tax-corrected inflation rate of the price of investment goods and to the rate of return on equity, one finds a weighted average cost of capital used by applied researchers (the cost of equity and the after-tax cost of debt are weighted by their relative share with respect to capital):

$$(7) \quad \begin{aligned} 1-c_1-c_2-c_3 = {} & \left(\frac{B_{it}}{(1-itc_{it})p^I_{st}K_{it}}\right)(1-E_t\tau_{t+1})\, i_{it} + \left(1-\frac{B_{it}}{(1-itc_{it})p^I_{st}K_{it}}\right)\rho_t \\ & + \left(1-\frac{E_t\tau_{t+1}}{(1-itc_{it})}\right)\delta - \left(\frac{E_t(1-\mathrm{itc}_{i,t+1})p^I_{i,t+1} - (1-\mathrm{itc}_{it})p^I_{it}}{(1-\mathrm{itc}_{it})p^I_{it}}\right) \end{aligned}$$

The Hayashi [2000, p.80] formula can be obtained by setting the investment tax credit itc_{it} to zero and by assuming a constant corporate income tax rate ($\tau_{it} = E_t\tau_{i,t+1}$). In our applied work, we use :

$$(8) \quad UC = \frac{p_t^{\,I}}{p_{st}} \frac{1}{(1-\tau_t)} \left[\left(\frac{B_{it}}{B_{it}+E_{it}}\right)(1-\tau_t)AI_{it} + \left(\frac{E_{it}}{B_{it}+E_{it}}\right)\rho_t + (1-\tau_t)\delta_{st} - \frac{p_{t+1}{}^I - p_t{}^I}{p_t{}^I} \right]$$

We set the investment tax credit rate to zero. The investment tax credit rate is 0% for more than 80% of companies and over 95% for 5% of companies (hence creating many outliers with near zero user cost), we finally did not take it into account. We used an accounting measure of capital in leverage instead of an economic one: the denominator of leverage is the accounting sum of debt B and of equity E instead of the stock of capital computed by the perpetual inventory method. This is empirically justified on the grounds that it is the accounting proportions of debt or of equity which matter for tax deductibility. Using the stock of capital computed by the perpetual inventory method does not guarantee that the share of debt in capital and the share of equity in capital sum to one. We use a proxy for the marginal cost of debt which has the drawback of being an average rate AI_{it} (the ratio of interest and similar charges to gross debt) but which as the advantage of providing information at the firm level and of increasing the variance of the user cost (61237 observations) with respect to a national annual rate that we use for the opportunity cost of equity (10 observations, as the estimation period lasts 10 years).

2.2 Parameterization and Econometric Model

We parameterize the production function as a constant elasticity of substitution (CES) production function ($\mathrm{Q_{it}}$ is sales):

$$(9)\quad Q_{it} = F(K_{it}, N_{it}) = A_{it}\left[aK_{it}^{\sigma-1/\sigma} + bL_{it}^{\sigma-1/\sigma}\right]^{\left(\frac{\sigma}{\sigma-1}\right)\upsilon}$$

A, a, and *b* are productivity parameters, υ represents returns to scale and σ is the elasticity of substitution between capital and labour. Computing the marginal productivity of capital and taking logs (small letters represent logs of capital letters), we obtain this long-run demand for capital:

$$(10)\quad \mathrm{k_{it}} = \left(\sigma + \frac{1-\sigma}{\upsilon}\right)\mathrm{q_{it}} - \sigma.\mathrm{c_{it}} - \frac{1-\sigma}{\upsilon}\ln(\mathrm{A_{it}}) + \sigma\ln(\upsilon.\mathrm{a})$$

For simplification, productivity is assumed to be of the form $A_{it} = A_i^{\eta 1} A_t^{\eta 2}$, so that the constant and the productivity term $-[(1-\sigma)/\upsilon]\ln(A_{it}) + \sigma\ln(\upsilon.a)$ are taken into account by the constant related to individual firms (fixed effect) α_{i} and the time dummies α_{t}.

We assume an econometric adjustment process in the form of an auto-regressive distributed lag model with two lags with respect to the auto-regressive term and one or two lags with respect to explanatory variables, as in Hall, Mairesse, Mulkay [2000].

$$k_{it} = \gamma_1 k_{i,t-1} + \gamma_2 k_{i,t-2} + \beta_0 q_{it} + \beta_1 q_{i,t-1} - \sigma_0 c_{it} - \sigma_1 c_{i,t-1} + \theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (11)$$

where ε_{it} is an error term normally distributed. We add cash-flow (otherwise a potentially omitted variable, among other variables) on the grounds that our model does not take fully into account financial constraints. The long-run elasticity of sales is given by $\beta_{LT} = (\beta_0 + \beta_1)/(1 - \gamma_1 - \gamma_2)$, the long-run elasticity of the cost of capital is given by $-\sigma_{LT} = -(\sigma_0 + \sigma_1)/(1 - \gamma_1 - \gamma_2)$, the long run capital cash flow sensitivity is given by $\beta_{LT} = (\theta_0 + \theta_1)/(1 - \gamma_1 - \gamma_2)$ Returns to scale are given by $\nu = (1 - \sigma_{LT})/(\beta_{LT} - \sigma_{LT})$.

3. ESTIMATION METHOD

The estimation of this econometric model presents three potential groups of problems. First, there may be a correlation between explanatory variables and the fixed effect on productivity level α_i. This feature is corrected by taking first differences in the ADL/ECM model or by taking second differences in the difference ADL model. Second, explanatory variables can be endogenous, so that an instrumental variables method is recommended. Third, there is heteroscedasticity of disturbances. A method which takes into account these problems is the generalised method of moments on first differences (GMM) (Arellano and Bond [1991]). The GMM estimation proceeds in two steps. A first step is an instrumental variable estimation which provides estimated residuals. The second step takes into account heteroscedasticity. Both first and second step estimates are consistent. The second step estimates are efficient while the first ones are not (see Matyas [1999] for a detailed presentation of GMM estimations). We estimate all models with first differences GMM and instruments in levels with the Arellano and Bond [1991] method, using the DPD98 programs on Gauss.

We also estimate the effect of the user cost of capital and the effect of cash flow on capital demand according to investment or divestment decisions:

$$k_{it} = \gamma_1 k_{i,t-1} + \gamma_2 k_{i,t-2} + \beta_0 q_{it} + \beta_1 q_{i,t-1} - (\sigma_0 + z_{it}\sigma_0^{'})c_{it} - (\sigma_1 + z_{it}\sigma_1^{'})c_{i,t-1}$$

(12)

$$+ (\theta_0 + z_{it}\theta_0^{'})\frac{CF_{it}}{p_{st}^I K_{i,t-1}} + (\theta_1 + z_{it}\theta_1^{'})\frac{CF_{i,t-1}}{p_{s,t-1}^I K_{i,t-2}} + \alpha_i + \alpha_t + \varepsilon_{it}$$

where z_{it} is a dummy variable equal to one if the firm *i* has strictly positive net investment on date *t* else equal to zero. More generally, the regression models are:

(13) $$k_{it} = x_{it}^{'}\beta + \mu_i + \nu_{it} \qquad \text{if } z_{it} = 1,$$

(14) $$k_{it} = s_{it}^{'}\delta + \alpha_i + \psi_{it} \qquad \text{if } z_{it} = 0.$$

where $x_{it}^{'}$ and $s_{it}^{'}$ are vectors of explanatory variables included in the vector of explanatory variables of equation (12), μ_i are firm fixed effect when it has strictly positive net investment, ν_{it} and ψ_{it} are random terms for each regime. To take into account the endogenous selection problem, we use a Tobit model. The selection process related to the net investment/net divestment decision is described as follows:

(15)
$$z_{it}^* = w_{it}^{'}\gamma + \zeta_i + \eta_{it},$$
$$z_{it} = 1 \qquad \text{if } z_{it}^* > 0,$$
$$z_{it} = 0 \qquad \text{if } z_{it}^* \leq 0,$$

(16)
$$\begin{cases} \Pr ob(z_{it} = 1) = F(w_{it}^{'}\gamma + \zeta_i), \\ \Pr ob(z_{it} = 0) = 1 - F(w_{it}^{'}\gamma + \zeta_i). \end{cases}$$

z_{it}^* a latent variable and $w_{it}^{'}$ the vector of explanatory variables of the decision to invest or to divest z_{it}^* detailed later on. The Tobit model includes three individual effects ζ_i, μ_i et α_i taking into account the observed heterogeneity of individuals.

The problem when estimating equations (13) or (14) is that random disturbances of these models may not be independent from the selection rule (*i.e.* $\text{cov}(\mu, \zeta) \neq 0$ and/or $\text{cov}(\nu, \eta) \neq 0$). In this case, estimators may be biased. Nijman and Verbeek [1992, 1996] proposed to adapt Heckman's [1981] two steps procedure on cross sections to panel data.

For the first step, one estimates parameters γ of the Probit model (with maximum likelihood). The second step consists to add an additional regressor (Mills' ratio) in the regression model which corrects from endogenous selection computed with the help of estimates γ obtained at the first step. With panel data, Nijman and Verbeek [1992, 1996] demonstrated that individual fixed effects lead to add in the regression in the second step model two regressors, denoted A_{1i} et A_{2it} , which corresponds to covariances between fixed effects μ_i et ξ_i for the first one, and between random terms η_{it} et ν_{it} for the second one. More precisely :

(17)

$$A_{1i} = \frac{1}{\sigma_\eta^2 + T\sigma_\zeta^2} \sum_{s=1}^{T} E\{\zeta_i + \eta_{is} / z_i\},$$

$$A_{2it} = \frac{1}{\sigma_\eta^2}\left[E\{\zeta_i + \eta_{it} / z_i\} - \frac{\sigma_\zeta^2}{\sigma_\eta^2 + T\sigma_\zeta^2} \sum_{s=1}^{T} E\{\zeta_i + \eta_{is} / z_i\}\right].$$

where:

(18)

$$E\{\zeta_i + \eta_{it} / z_i\} = \int_{-\infty}^{+\infty} [\zeta_i + E\{\eta_{it} / z_i, \zeta_i\}] f(\zeta_i / z_i) d\zeta_i$$

with :

(19)

$$E\{\eta_{it} / z_i, \zeta_i\} = r_{it}\sigma_\eta \frac{\Phi\left(\frac{w_{it}\gamma + \zeta_i}{\sigma_\zeta}\right)}{\Phi\left(r_{it}\frac{w_{it}\gamma + \zeta_i}{\sigma_\zeta}\right)}$$

and

(20)

$$f(\zeta_i / z_i) = \frac{\left[\prod_{s=1}^{T_i} \Phi\left(r_{it}\frac{w_{it}\lambda + \zeta_i}{\sigma_\zeta}\right)\right] \frac{1}{\sigma_\zeta}\phi\left(\frac{\zeta_i}{\sigma_\zeta}\right)}{\int_{-\infty}^{+\infty} \prod_{s=1}^{T_i} \Phi\left(r_{it}\frac{w_{it}\lambda + \zeta_i}{\sigma_\zeta}\right) \frac{1}{\sigma_\zeta}\phi\left(\frac{\zeta_i}{\sigma_\zeta}\right) d\zeta_i}.$$

We use Moreau [2000] SAS IML program to estimate our Probit model with random effects on unbalanced panel data. This program provides variables A_{1i} et A_{2it} , (inverses of Mills ratios) (see Moreau [2000] and Blanchard [2001]). We then added these additional variables in the capital demand equation with dummy variables related to investment or divestment decision, which we estimated with the Generalized Method of Moments.

3. DATA AND ECONOMETRIC RESULTS

3.1 Data

Data are annual balance sheets of French services firms (except holdings) collected in the Diane database from 1996 to 2000. NAF Sectors are hotels and restaurants (HH), transports and telecommunications (II), financial services (JJ) housing, renting services (KK), education (MM), health and social services (NN), collective social and personal services (OO), domestic services (PP). We cleaned the data set from outliers (see appendix) and reach a final number of firms which amount to 6143 firms (see appendix A1 and A2 for further details). Table 1 provides the average value of variables used in the computation of the user cost of capital.

Table 1 : Average value of the cost of debt and of the user cost of capital

Years	pi/pva	Leverage	Apparent interest rate	investment price growth rate	depreciation rate	user cost of capital
1996	0,981	0,784	0,116	0,015	0,08	0,146
1997	0,989	0,722	0,127	0,013	0,08	0,156
1998	0,991	0,704	0,124	0,010	0,08	0,151
1999	0,997	0,690	0,112	0,014	0,08	0,140
2000	1,017	0,672	0,123	0,014	0,08	0,146
Average	**0,995**	**0,714**	**0,120**	**0,013**	**0,08**	**0,148**

The average user cost of capital for these services firms is lower than the one of industrial firms during the same period (14,8% over the period 1996-2000 versus 17%, over the same period on the industrial firms sample used by Chatelain and Tiomo [2001]).

Descriptive statistics shows that more than half of these services firms has a negative growth rate of capital of –3,6% : their level of investment was lower than the economic depreciation rate (table 2).

Table 2 : Descriptive Statistics over the period 1996-2000 for services firms
(24 740 observations, 6 143 firms)

Variables	Average	standard error	minimum	25%	median	75%	Maximum
I/K_{-1}	0,128	0,412	-0,785	-0,001	0,045	0,166	6,220
log(K)	5,341	1,400	-0,174	4,400	5,300	6,230	12,05
log(Q)	8,270	0,859	5,179	7,706	8,148	8,740	14,07
log(UC)	-1,973	0,339	-3,336	-2,165	-1,999	-1,823	-1,000
CF/K-1	4,590	15,35	-333,2	0,667	1,693	4,263	635,8
$\Delta log(K)$	-0,005	0,316	-1,998	-0,085	-0,036	0,083	1,965
$\Delta log(Q)$	0,064	0,198	-0,996	-0,031	0,047	0,150	0,997
$\Delta log(UC)$	-0,023	0,249	-0,998	-0,132	-0,011	0,097	0,998

By contrast, half of those firms faced a sales growth rate higher than 4.6% over the period 1996-2000, and for a quarter of them, a sales growth rate higher than 15%. More than half of those firms faced a decrease of their user cost of capital.

We check for potential sectoral discrepancies (table 3a and 3b). We found relatively little sectoral discrepancies with respect to growth rates of capital, of sales and of the user cost. Cash flow is particularly high for the financial sector. The average size of firms is higher for the health and social action sector.

Table 3a : Descriptive statistics by sectors

	Hotels and restaurants (NT = 4173)		Transport and communication (NT = 5288)		Financial services (NT = 425)		Housing, renting and firms services (NT = 10959)		Education (NT = 285)		Health and social action (NT = 2090)		Collective, social and personal services (NT = 1520)	
	mean	**std**	**mean**	**std**	**mean**	**std**	**mean**	**std**	**mean**	**std**	**mean**	**std**	**mean**	**std**
Employees	12,3	20,1	21,6	70,3	10,7	20,4	17,0	67,3	11,9	15,4	34,9	49,4	18,0	61,8
CF/K-1	1,4	3,6	1,9	5,9	12,0	29,5	7,5	20,9	3,4	13,1	2,5	6,9	2,8	6,3
Dlog(K)	0,0	0,2	0,0	0,3	0,0	0,3	0,0	0,4	0,1	0,4	0,0	0,2	0,0	0,3
Dlog(Q)	0,1	0,2	0,1	0,2	0,1	0,2	0,1	0,2	0,1	0,2	0,0	0,1	0,1	0,2
Dlog(UC)	0,0	0,2	0,0	0,3	0,0	0,2	0,0	0,3	0,0	0,3	0,0	0,2	0,0	0,2

Table 3b : Number of firms by size and by sectors

	Hotels and restaurants (NT = 4173)	Transport and communication (NT = 5288)	Financial services (NT = 425)	Housing, renting and firms services (NT = 10959)	Education (NT = 285)	Health and social action (NT = 2090)	Collective, social and personal services (NT = 1520)
0-9 Employees	2464	2675	309	6831	178	623	934,0
10-19 employees	1018	1216	68	2118	54	474	273,0
20-49 employees	598	1028	36	1427	49	544	241,0
50-99 employees	73	193	4	365	4	257	52,0
<100 employees	20	176	8	218	0	192	20,0

The size distribution shows that our sample consists mostly of small and medium size firms (less than 50 employees).

3.2. The impact of the user cost of capital on investment, without taking into account the investment/divestment decision

Table 4 below shows estimates of the ADL model using Within transformation, GMM first differences with instrumental variables in level (Arrelano and Bond [1991]) and GMM simultaneous system estimates of the model in first differences with instruments in levels and of the model in levels with instruments in first differences (Arrelano and Bover [1995]). Instrumental variables are listed below the table. The choice of instruments have been made according an upward testing procedure described by Andrews [1999] and Chatelain [2001].

Within estimates are all significantly different from zero, but their estimates are small and with little economic sense. As predicted by econometric theory, the auto-regressive parameter is downward biased (0,009): within estimates are not able to provide unbiased estimates of this endogenous regressor.

Columns labeled GMM deals with Arrelano and Bond [1991] method. The auto-regressive parameter is then much higher (0,48). Sargan exogeneity test is successful but the lack of second order autocorrelation test (Arrelano and Bond's m2) is rejected.

Columns labeled SYSMMG presents Arrelano and Bover's [1995] estimates. Sargan exogeneity test and the lack of autocorrelation of order two (m2 test) are respectively accepted at the 28% threshold and the 5% threshold. The autoregressive estimate (0,54) is close to the difference GMM (0,48). By contrast, short run sales and user cost elasticities are far smaller in absolute value. The discrepancies between GMM and SYS-GMM estimates suggest a potential specification problem.

Table 4 : Estimates of the ADL model (Within, (DIF-)GMM, SYS-GMM)

	WITHIN		DIF-GMM		SYS-GMM		WITHIN		DIF-GMM		SYS-GMM	
	coef.	*T stats*	*coef.*	*T stats*	*coef.*	*T stats*	*coef.*	*T stats*	*coef.*	*T stats*	*coef.*	*T stats*
$logK_{t-1}$	0,063	*5,0*	0,478	*4,0*	0,447	*2,8*	0,061	*4,8*	0,498	*4,5*	0,421	*1,8*
$logK_{t-2}$	0,028	*2,3*	0,003	*0,1*	0,089	*0,8*	0,026	*2,1*	0,001	*0,0*	0,142	*0,9*
$logQ_{t}$	0,210	*11,6*	1,284	*1,9*	0,428	*1,9*	0,212	*11,5*	1,179	*2,0*	0,828	*2,8*
$logQ_{t-1}$	0,118	*6,5*	-0,546	*-1,6*	-0,213	*-1,0*	0,120	*6,5*	-0,478	*-1,5*	-0,630	*-2,2*
$logCU_{t}$	-0,197	*-12,7*	-0,763	*-1,8*	-0,371	*-3,3*	-0,197	*-12,7*	-0,742	*-1,9*	-0,336	*-2,3*
$logCU_{t-1}$	-0,040	*-2,7*	0,151	*1,6*	0,053	*1,3*	-0,040	*-2,7*	0,146	*1,7*	0,065	*1,5*
CF_{t}/K_{t-1}							0,000	*-0,6*	0,001	*0,3*	-0,001	*-0,1*
CF_{t-1}/K_{t-2}							0,000	*-0,8*	0,000	*-0,2*	0,011	*1,7*
Sum of auto-regressive coefficients	0,091		0,481		0,536		0,088		0,499		0,563	
Long term sales elasticities	0,361		1,422		0,924		0,364		1,398		0,453	
Long term user cost elasticities	-0,260		-1,180		-0,801		-0,260		-1,190		-0,623	
Long term cash flow sensitivities							n.s		n.s		0,023	
AR2			-2,44	P=0,015	-1,95	P=0,050			-2,487	P=0,013	-1,19	p=0,230
Sargan			5,03	P=0,540	13,16	P=0,280			7,303	P=0,504	9,35	p=0,580

Note : Lags 2 and 3 of explanatory variables are used as instruments in the first differences GMM estimations. For system GMM estimations, we use $logK_{t-3}$, $logQ_{t-2}$, $logQ_{t-3}$, $logUC_{t-2}$, $logUC_{t-3}$ ($logCF_{t-3}$ for the model with cash flow) for instruments of the first difference equation, and first differences of $logK_{t-3}$, $logQ_{t-2}$, $logQ_{t-3}$, $logUC_{t-2}$, $logUC_{t-3}$ as instruments for the level equation.

In order to test for misspecification, we added cash flow as a potentially omitted variable in the former regressions (among others). These results are reported on right hand side of table 4 (columns 7 to 12). The parameter of lag 2 of cash flow is significantly different from zero only in the System GMM estimates, with a rather small short run estimate (0,01) and long run estimate (0,023). In the system GMM, due to collinearity between cash flow and sales, the sales coefficient are modified, whereas auto-regressive parameters and user cost change slightly. We then investigate another potential misspecification problem. Descriptive statistics show that more than 25% of firms in the sample divested (net fixed assets (purchase less sales) is zero or less than zero) Those firms are likely to be less sensitive to the user cost, as they are able to finance their purchases of fixed assets (if they do invest) by their sales of fixed assets.[4] Next section tests the impact of the net investment decision on the determinant of the amount of investment.

3.2 The Elasticity of Capital with respect to its User Cost depends on the Investment/Divestment Decision.

3.2.1 Explaining the Investment/Divestment Decision

We first analyse desciptive statistics for each group of firms : those who exhibit strictly positive net investment and the others (table 5). Indeed, capital growth rate is much higher for the first group (an average of 10,8%, a median capital growth rate of 2,3%) with respect to the other group (-26% average, -14,7% median). The growth rate of the user cost of capital is much lower for the first group (-3,5% average, -1,9% median) than for the other group (0,4% average and 0,6% median). The growth rate of sales is higher for the first group (8% average and 5,9% median) with respect to the second group (2,8% average and 2,4% median).

[4] Available statistics in the database provided only net fixed assets (purchases less sales) and did not allow us to distinguish between purchases and sales.

Table 5 : Descriptive statistics according to net investment sign

	Net Investment >0 (NT = 17185; 69% observations)		Net Investment<=0 (NT=7554; 31% observations)	
	Average	*Median*	*Average*	*Median*
I/K_{-1}	0,237	0,103	-0,121	-0,057
log(K)	0,108	0,023	-0,261	-0,147
log(Q)	8,323	8,185	8,155	8,064
log(UC)	-1,992	-2,013	-1,929	-1,964
CF/K-1	4,651	1,827	4,457	1,401
iB/B	0,114	0,069	0,138	0,079
$\Delta log(K)$	0,108	0,023	-0,26	-0,147
$\Delta log(Q)$	0,08	0,059	0,028	0,024
$\Delta log(UC)$	-0,035	-0,019	0,0047	0,0064

Descriptive statistics allows to check discrepancies between the two groups variable by variable (univariate analysis). We use Probit estimation with random effects for multivariate analysis (tables 6a and 6b). Table 6a provides estimated parameters and Student's statistics. Table 6b provides marginal effects for each of the variables. RHO correlation coefficient (table 6a) measures the share of the variance of the individual random effects in the total variance of the error term (cf. Moreau [2000] for details). This share is around 14% and significantly different from zero, which justifies ex post the use of the random effect model (results of the Probit model without random effect are given in appendix A3).

The probability of a strictly positive net investment decision increases with the growth rate of sales and decreases with the growth rate of the user cost. The effect of these two variables of the neo-classical investment model is rather large (-0,585 for the user cost at the average point of the sample). The probability of net investment increases with the size of the firm. In large firms includes, several production units have different investment needs, so that net net aggregated investment inside the firm is more likely to be positive. The probability of net investment is higher for hotel and restaurants (HH), education (MM), health and social action (NN) and social and personal services (OO) than for transportation and telecommunications

(II), financial services (JJ), housing and leasing services (KK). Financial variables such as cash flow and leverage (measured by the debt/capital ratio) exhibit parameters significantly different from zero, but with marginal effects at the average point of the sample close to zero (table 6b).

Table 6a : Random Effect Probit estimation of the probability of strictly positive net investment

	coefficient	T stats
Constant	0,686	23,5
Size of Firms		
0-9 employees	*ref*	-
10-19 employees	0,058	2,2
20-49 employees	0,140	4,8
50-99 employees	0,220	4,2
<100 employees	0,267	4,1
Firms Sectors		
Hotels and Restaurants (HH)	0,279	9,3
Transports and communications (II)	-0,053	-2,0
Financial Services (JJ)	0,051	0,7
Housing and Renting Services to Firms (KK)	*ref*	-
Education (MM)	0,242	2,5
Health and Social Action (NN)	0,309	7,2
Collective, Social and Personal Services (OO)	0,266	6,0
Real and Financial Variables		
Sales Growth Rate: $\Delta \log Q_t$	0,866	18,9
Cash-flows : CF_t/K_{t-1}	-0,004	-6,6
Leverage: B_t/P_iK_t	-0,001	-10,5
User Cost of Capital : Cu_t	-1,818	-12,4
RHO	0,141	13,9
theta	0,574	

Table 6b : Estimation of marginal effects at the average point of the sample

	Effect	Standard Error	T stats	Mean
Constant	0,221	0,009	24,7	1,000
Size of Firms				
0-9 employees	*ref*	-	-	-
10-19 employees	0,019	0,009	2,2	0,211
20-49 employees	0,045	0,009	4,8	0,159
50-99 employees	0,071	0,017	4,2	0,038
<100 employees	0,086	0,021	4,1	0,026
Firms Sectors				
Hotels and Restaurants (HH)	0,090	0,010	9,3	0,169
Transports and communications (II)	-0,017	0,009	-2,0	0,214
Financial Services (JJ)	0,016	0,025	0,7	0,017
Housing and Renting Services to Firms (KK)	*ref*	-	-	-
Education (MM)	0,078	0,032	2,5	0,012
Health and Social Action (NN)	0,099	0,014	7,2	0,084
Collective, Social and Personal Services (OO)	0,086	0,014	6,0	0,061
Real and Financial Variables				
Sales Growth Rate: Δ $\log Q_t$	0,279	0,015	18,9	0,064
Cash-flows : CF_t/K_{t-1}	-0,001	0,000	-6,6	4,485
Leverage: B_t/P_iK_t	0,000	0,000	-10,6	12,849
User Cost of Capital : Cu_t	-0,585	0,047	-12,4	0,148

3.2.2 Endogenous Selection and Investment Behaviour

In this last step of our analysis, we check whether firms who exhibit strictly positive net investment are more sensitive to the user cost of capital than the other group of firms. Table 7 presents estimations of the auto-regressive distributed lag model described by equation (12). The dummy variable related to strictly positive net investment multiplies the log of the cost of capital and of cash flow and their first lag. Multiplying sales by this dummy variable did not lead to goods results in terms of statistical tests (Sargan test and m2 test). As this dummy variable leads to endogenous selection (as shown in the preceding section), we added corrective terms A_{1i} and A_{2it} according to Nijman and Verbeek's [1992, 1996] procedure. We instrumented those additional variables by some of their lags (the list of instruments is given below table 7).

Four results are striking in these estimations. First, the short run user cost elasticity for firms who exhibit a strictly positive net investment (Id(I>0)*Log(CU(t) variable) is equal to –0,3. This estimate does not change according to the estimation method (« First differences GMM » and « System GMM ») neither according to the instrument set[5]. By contrast, the short run user cost (and its lag) elasticities for firms with net divestment are not significantly different from zero for all the regressions we run with various instruments set (and not only the four which are reported here).

[5] In regressions which do not take into account the investment/divestment decision, the user cost elasticity was – 0,76 with first differences GMM estimations whereas it was –0.37 with system GMM estimations..

Table 7 : Effects of the net investment decision on investment determinants

	DIF-GMM				SYS-GMM			
	coefficien	*T stats*	*coefficien*	*T stats*	*coefficien*	*T stats*	*coefficien*	*T stats*
$logK_{t-1}$	1,120	2,9	1,100	2,8	0,676	*2,2*	0,603	*2,5*
$logK_{t-2}$	-0,327	-1,1	-0,350	-1,1	0,151	*0,6*	0,136	*0,7*
$logQ_t$	0,667	1,6	0,838	1,8	0,289	*1,3*	0,314	*1,5*
$logQ_{t-1}$	-0,235	-0,9	-0,225	-0,9	-0,208	*-1,0*	-0,188	*-1,0*
$logCU_t$	-0,252	-0,5	-0,372	-0,7	0,066	*0,6*	0,018	*0,2*
$logCU_{t-1}$	0,062	0,7	0,128	1,0	0,078	*1,1*	0,068	*1,2*
CF_t/K_{t-1}	0,002	0,5	0,002	0,5	-0,004	*-1,0*	-0,002	*-0,7*
CF_{t-1}/K_{t-2}	0,002	0,6	0,002	0,7	-0,002	*-1,1*	0,001	*0,8*
Differential Coefficients for Firms with $I_t>0$								
$Id_{(I>0)}.logCU_t$	-0,303	-2,6	-0,300	-2,5	-0,284	*-4,2*	-0,305	*-6,5*
$Id_{(I>0)}logCU_{t-1}$	0,149	1,1	0,109	0,7	-0,039	*-0,3*	-0,029	*-0,3*
$Id_{(I>0)}CF_t/K_{t-1}$	-0,004	-1,1	-0,005	-1,2	0,003	*0,6*	0,000	*-0,1*
$Id_{(I>0)}CF_{t-1}/K_{t-2}$	-0,003	-0,7	-0,004	-0,8	0,013	*1,9*	0,001	*0,3*
Probit Model Variables Correcting for								
A1							-0,009	-2,8
$A2_t$			0,002	0,6			-0,009	-2,7
Long Term Coefficients								
Sum of Auto-regressive Parameters	0,792		0,749		0,827		0,739	
Long Term Sales Elasticities	3,207		3,341		*n.s*		1,201	
For Firms with $I_t<=0$								
Long Term User Cost Elasticities	*n.s*		*n.s*		*n.s*		*n.s*	
Long Term Cash Flow Sensitivities	*n.s*		*n.s*		*n.s*		*n.s*	
For Firms with $I_t>0$								
Long Term User Cost Elasticities	-1,457		-1,196		-1,640		-1,165	
Long Term Cash Flow Sensitivities	*n.s*		*n.s*		0,077		*n.s*	
AR2	-1,96	p=0,05	-2,012	P=0,04	-1,940	P=0,05	-1,800	p=0,07
Sargan	2,16	P=0,99	1,57	P=0,99	8,00	P=0,89	13,60	P=0,94

Instruments used for first difference GMM : $logk_{t-3}$, $logQ_{t-2}$, $logQ_{t-3}$, $logUC_{t-2}$, $logUC_{t-3}$, $logCF_{t-2}$, $logCF_{t-3}$, $id_{(I>0)}.logUC_{t-3}$, $id_{(I>0)}.logCF_{t-3}$, A1 and $A2_{t-3}$
Instruments used for system GMM (a) equation in first differences : $logk_{t-3}$, $logQ_{t-2}$, $logQ_{t-3}$, $logUC_{t-2}$, $logUC_{t-3}$, $logCF_{t-3}$, $id_{(I>0)}.logUC_{t-3}$ and $id_{(I>0)}.logCF_{t-3}$
We added $logCF_{t-2}$, $id_{(I>0)}$.A1 and id(I>0).$A2_{t-4}$ when the estimated model includes Nijman and Verbeek's (1992, 1996) corrective terms.

Instruments used for system GMM (b) equation in levels: first differences of the following variables : $logK_{t-3}$, $logQ_{t-3}$, $logQ_{t-2}$, $logUC_{t-3}$, $logUC_{t-2}$, $id_{(I>0)}.logUC_{t-3}$, $id_{(I>0)}.logUC_{t-2}$. We added $A2_{t-3}$, $A2_{t-2}$ $ID_{(i>0)}.A2_{t-3}$ $_a$ and $ID_{(i>0)}.A2_{t-2}$ when the estimated model includes Nijman and Verbeek's (1992, 1996) corrective terms.

The sum of the auto-regressive component is not significantly different from 0.7 in all regressions. Hence, the long run user cost elasticity for firms who exhibit net investment is close to -1 (-0,3/(1-07)), which corresponds to the Cobb-Douglas production function with an elasticity of substitution between capital and labour equal to unity (this elasticity is the opposite of the elasticity of capital with respect to its user cost.

By contrast, the short run and long run user cost elasticity is not significantly different from zero for firms with non positive net investment. The amount of the decrease of their net capital stock is not driven by the user cost, whereas the decision of a net negative investment (Probit model) depends a lot on the user cost. This striking discrepancy with respect to user cost elasticity suggests that the user cost elasticity lack precisions when the net investment/net divestment is not taken into account in the determinants of the net amount of funds invested or divested.

The second results deals with the elasticity of the capital stock with respect to sales. Estimates vary a lot according to regressions and are significantly different from zero at most at the 8% threshold. This result is a recurrent weakness of estimations of the neo-classical capital demand equations on panel data. In particular, it leads frequently to estimates of returns to scale which are obviously too high or too low (Hall, Mairesse, Mulkay [1999]), The discrepancy of estimated sales elasticities when using « first differences GMM » and « system GMM » has also been found in Hall, Mairesse, Mulkay [1999].

The third result concerns investment cash flow sensitivities which are not significantly different from zero. Little effect of cash flow was also found in the net investment/divestment decision. This suggests that the neo-classical model written with sales and user cost fit the data (although alternative models may also fit the data), so that a cash flow add-on (related to discounted cash flow measures (Tobin's Q) or a proxy for financial constraint) is not necessary in these regressions.

The fourth result concerns the variables A_{1i} et A_{2it} , which corrects endogenous selection related to the endogeneity of the dummy variable signalling the net investment/divestment decision. These two variables exhibit parameters significantly different from zero (column 7 and 8) although their estimates are small. They lead to rather small corrections of the estimated parameters of other variables of the regression, but on the other hand, they increase the acceptation threshold for AR2 test and Sargan's exogeneity of over-identifying restrictions test.

Finally, the most sensible results are rather given by the system GMM estimation than by the first differences estimation, which fits with Arellano and Bover suggestion of better estimates when using the system GMM estimation.

CONCLUSION

We reached three major conclusions about the effect of the user cost on capital demand. First, the user cost of capital has a large impact on the investment/divestment decision. As a consequence, it is useful to take into account the endogeneity of the investment decision in an investment equation on panel data.

Second, taking into account the endogeneity of the investment/divestment decision, if the firm invest, we found a long run user cost elasticity not significantly different from unity (a feature which corresponds to a high substitutability of capital and labor in the neo-classical model). Third and by contrast, when the firm does not invest or when it divest, the user cost elasticity is not significantly different from zero. Once a company had decided to divest (and her decision depends very much on the user cost level), then the user cost has no effect on the *amount* of divestment. This result suggest that the second hand value of capital depends much more on other factors than the cost of capital.

These asymmetries between user cost elasticities according to the investment/divestment decision suggests that omitting the investment/divestment decision may lead to a downward aggregation bias of the elasticities of capital with respect to the user cost. Hence, we showed that taking into account the investment/divestment decision and its endogeneity may improve the estimates of the user cost elasticities.

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APPENDIX

A1. Sample Selection

The sample consists of balance sheets of French services firms included in the database Diane from 1994 to 2000. These firms corresponds, in NAF classification to hotel and restaurants (HH), transports and telecommunications (II), financial services (JJ) housing and renting services (KK), education (MM), health and social action (NN), collective, social and personal services (OO), and finally to domestic services (PP).

To select the sample, we excluded balance sheets with negative sales, value added, debt or assets. We eliminated firms for which the value of one of the variables of interest are over five times the inter-quartile interval below the first quartile or over the third quartile, each year for the investment ratio $\left(I_{it}/K_{i,t-1}\right)$, the profit rate $\left(EBE_{it}/K_{i,t-1}\right)$, cash-flows/capital $\left(CF_{it}/K_{i,t-1}\right)$, leverage $\left(B_{it}/K_{it}\right)$, the user cost of capital $\left(C_{it}\right)$, the "apparent" interest rate $(iB)_{it}/B_{it}$, the sales growth rate $\left(\Delta \ln Q_{it}\right)$ the capital growth rate $\left(\Delta \ln K_{it}\right)$, and the user cost growth rate $\left(\Delta \ln C_{it}\right)$. We ended with 103 264 observations over the period 1996-2000.

A2. Construction of the variables

- **The Individual Variables**

The first source is the compulsory accounting forms required under the French General Tax Code. These forms are completed by the firms and numbered by the tax administration (D.G.I.) from 2050 to 2058. We provide the code of each form omitting the first two numbers For example, we denote item FN of tax form 2050 as "[50].FN".

- *Value added at market price* $\left(Q_{it}\right)$ are total net sales [52].FL, plus the change in inventories of own production of goods and services [52].FM, plus own production of goods and services capitalised [52].FN less intermediate consumption ([52].FS+FU+FT+FV+FW+FX).

- Earnings before interest, taxes and depreciation allowances $(\mathrm{EBE}_{\mathrm{it}})$ corresponds to the sum of value added and of working subsidies (FO), less taxes (FX), wages (FY), and social security payments (FZ).

- C*ash-flows* $(\mathrm{CF}_{\mathrm{it}})$ corresponds to EBE plus other exploitation charges (GE), common operations (GH+GI), financial income (GJ+GK+GL+GM+GN+GO+GP), exceptional income (HA-HE), less financial transfers (GM), financial payments (GQ+GR+GS+GT), workers participation (HJ) and corporate income tax (HK).

- *Interest charges* $(\mathrm{i}_{\mathrm{it}})$ are given by item GR.

- *Financial Debt* $(\mathrm{B}_{\mathrm{it}})$ includes banking debt (DU) and other debt (DV).

- *Equity* $(\mathrm{E}_{\mathrm{it}})$ is given by item LP.

- *The Weighted average cost of capital* $(\mathrm{C}_{\mathrm{it}})$ is computed as follows :

$$\mathrm{C}_{\mathrm{it}} = \frac{\mathrm{P}_{\mathrm{t}}^{\mathrm{I}}}{\mathrm{P}_{\mathrm{st}}}(1-\mathrm{sub}_{\mathrm{t}})\left[\mathrm{AI}_{\mathrm{it}}\left(\frac{\mathrm{B}_{\mathrm{it}}}{\mathrm{B}_{\mathrm{it}}+\mathrm{E}_{\mathrm{it}}}\right)+\frac{\mathrm{LD}_{\mathrm{t}}}{(1-\tau_{\mathrm{t}})}\left(\frac{\mathrm{E}_{\mathrm{it}}}{\mathrm{B}_{\mathrm{it}}+\mathrm{E}_{\mathrm{it}}}\right)-\frac{(1-\delta)}{(1-\tau_{\mathrm{t}})}\frac{\Delta \mathrm{P}_{\mathrm{t+1}}^{\mathrm{I}}}{\mathrm{P}_{\mathrm{t}}^{\mathrm{I}}}+\delta_{\mathrm{st}}\right]$$

where $\mathrm{sub}_{\mathrm{it}}$ are investment subsidies (ligne DJ), $\mathrm{AI}_{\mathrm{it}}$ the apparent interest rate (computed by : $\mathrm{i}_{\mathrm{it}}/\mathrm{B}_{\mathrm{it}}$), and LD_{t} the 10 years French government bonds rate.

The capital stock is the value in replacement terms of the capital stock book value of property, plant and equipment. To convert the book value of the gross capital stock into its replacement value, we used the following iterative perpetual inventory formula:

$$K_{it} = \frac{p_{it}^{I}}{p_{st}^{I}} I_{it} - (1-\delta)K_{i,t-1}$$

where the investment goods deflator is denoted p_{st}^{I} and the depreciation rate is taken to be 8%. The initial capital stock is given by:

$$K_{it0} = \frac{K_{it0}^{BV}}{p_{st0}^{K}}, \text{ with } p_{st0}^{K} = p_{t0-T_{\mathrm{mean}}}^{I}$$

The book value of the gross capital stock of property, plant and equipment K_{it0}^{BV} on the first available year for each firm is obtained by the sum of land [50].AN, buildings [50].AP, industrial and technical plant [50].AR, other plant and equipment [50].AT, plant, property and equipment under construction [50].AV and payments in advance/on account for plant, property and equipment [50].AX. It is deflated by assuming that the sectoral price of capital is equal to the sectoral price of investment T_{mean} years before the date when the first book value was available, where T_{mean} represents the corrected average age of capital (this method of evaluation of capital is sometimes called the "stock method"). The average age of capital T_{mean} is computed by using the sectoral useful life of capital goods $T_{\max}$ and the share of goods which has been already depreciated in the first available year in the firm's accounts $\mathrm{DEPR}_{it0}^{BV}/(p_{st0}^{K}K_{it0})$ (DEPR_{it0}^{BV} is the total book value of depreciation allowances in year t_0 according to the following rule of thumb proposed by Mairesse in the Bond et al. [1997] paper:

$$T_{\mathrm{mean}} = T_{\max}\left[\frac{\mathrm{DEPR}_{it0}^{BV}}{p_{st0}^{K}K_{it0}}\right]-4 \quad \text{if } T_{\max}\left[\frac{\mathrm{DEPR}_{it0}^{BV}}{p_{st0}^{K}K_{it0}}\right] > 8,$$

$$T_{\mathrm{mean}} = \frac{1}{2}T_{\max}\left[\frac{\mathrm{DEPR}_{it0}^{BV}}{p_{st0}^{K}K_{it0}}\right] \quad \text{if } T_{\max}\left[\frac{\mathrm{DEPR}_{it0}^{BV}}{p_{st0}^{K}K_{it0}}\right] < 8.$$

The book value of depreciation allowances DEPR_{it0}^{BV} is obtained by the sum of depreciation, amortisation and provisions on land [50].AO, on buildings [50].AQ, on industrial and technical plant [50].AS, on other plant and equipment [50].AU, on plant, property and equipment under construction [50].AW and on payment in advance/on account for plant, property and equipment [50].AY. The sectoral useful life of capital goods is $T_{\max} = 15$ years.

- *Investment* $\left(\mathrm{I}_{\mathrm{it}}\right)$ is the difference of the book value of the gross capital stock between this year *t* and the previous year *t-1*.

- **Sectoral variables :** Sectoral Price for investment (denoted $\mathrm{p}_{\mathrm{st}}^{\mathrm{I}}$) and value added price (denoted P_{st}) are found in national accounts (base year 1995).
- **Aggregate variable :** The depreciation rate is 8%.