Investment and the Cost of Capital in the Nineties in France: A Panel Data Investigation

Jean-Bernard Chatelain, Andre Tiomo

Investment and the Cost of Capital in the Nineties in France: A Panel Data Investigation

by Jean-Bernard Chatelain and André Tiomo

in:

ifo Studien
Zeitschrift für empirische Wirtschaftsforschung

Jg. 48, Nr. 4, 2002, S. 655 –684

2002

ifo Studien ISSN 0018-9731
Herausgeber: Prof. Dr. Gerhard Illing
Schriftleitung: Dr. Marga Jennewein

Verlag:
ifo Institut für Wirtschaftsforschung
Poschingerstr. 5, 81679 München
Tel. +49-89-9224-0 www.ifo.de

Investment and the Cost of Capital in the Nineties in France: A Panel Data Investigation*

By *Jean-Bernard Chatelain* and *André Tiomo*

Contents

I. Introduction

It is a widespread belief among economists that monetary policy affects the investment of firms through the cost of capital and the credit channel. However, 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.

Four 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

* We thank a referee for his very helpful comments as well as *Steve Bond*, *Paul Butzen*, *Marcel Gérard*, *Anil Kashyap* and *Philip Vermeulen* and participants in the Monetary Transmission Network of the Eurosystem of Central Banks, in the related European Central Bank conference and in the conference about "Corporate and Capital Income Taxation in the EU" in Mons University.

Heckel (2001), Mojon Smets and Vermeulen (2001) obtained a high elasticity for the user cost for France (-0.75). These studies show that we obtain a high user cost elasticity if (1) the sample period is short and/or (2) the cash flow or the growth of sales is omitted from the regression and/or (3) within estimates are used instead of dynamic panel data estimates, as in the generalised method of moments (Arrelano and Bond (1991)) and/or (4) when defining the user cost, the marginal cost of debt is computed by a proxy at the firm level instead of an interest rate at the national level.

At the firm level, the existence of a broad credit channel of monetary policy in France is indirectly addressed. The main result is that financial variables (notably cash flow) affect the investment of groups of firms that are likely to be financially constrained (see Chatelain 2002). The interpretation of investment cash flow excess sensitivity for some group of firms as a signal of financial constraints has been challenged by Kaplan and Zingales (1997). However, if the sample separation criterion is itself a precise measure of financial constraints, (e.g. credit rating is a more precise criterion to identify financially constrained firms than the low dividend payout criterion used by Fazzari, Hubbard and Petersen (1988)), the investment cash flow excess sensitivity is more likely to signal financial constraints than demand effects. Models which define investment as a function of sales growth and cash flow have been around for a long time (see Bond et al. 1997; Hall, Mairesse, Mulkay 1999; 2000). Several recent studies have estimated the excess sensitivity of investment to liquidity variables, such as cash flow, the stock of cash, leverage and the coverage ratio. Crépon and Rosenwald (2001) showed that the leverage parameter was lower for small firms during the years of sustained activity, i.e. 1988 and 1989 (their estimation period was 1986-1993). This means that the agency premium was lower for these firms at that time. The neo-classical demand for capital estimated by Beaudu and Heckel (2001) led to greater investment cash flow sensitivity for small firms during years of monetary restriction. In Duhautois (2001), leverage explains small firms' investment from 1985 to 1996 in a regression where sales growth is an omitted variable. Using Euler investment equations, where the cost of debt increases with leverage, Chatelain and Teurlai (2000) showed a cash flow misspecification (which is an indirect test of investment cash flow excess sensitivity consistent with the Lucas critique) for firms with a low dividend/payout ratio or a low investment/retained earnings ratio. Finally, Chatelain and Teurlai (2001) found that small firms with a high variation of debt and a high share of capital financed by leasing displayed an investment leverage excess sensitivity during the economic downturn between 1993 and 1996.

This paper provides estimates of the elasticity of the user cost of capital and of investment cash flow excess sensitivities. We extend the analysis developed by Chatelain et al. (2001) by using more precise sample separation criteria to isolate financially constrained firms and by comparing several ways of testing auto-regressive distributed lags models of the neo-classical demand for capital on a panel data of French manufacturing firms in the nineties (see Bond, Elston, Mairesse, Mulkay 1997 and Hall, Mairesse and Mulkay 2000; Harhoff and Ramb 2001; Chirinko, Fazzari and Meyer 1999).

Section II presents the theoretical model of investment and the estimation method. Section III gives the macroeconomic background of investment and finance of French companies in the nineties, describes the data set and empirical results. Section IV concludes.

II. The Intertemporal Behaviour of Firms

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 $t+1$:[1]

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

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

[1] 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.

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

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) $$\begin{aligned} d_{it} &= (1-\tau_t)\left[p_{it}F(K_{it},N_{it}) - w_t N_{it} - i_{i,t-1}B_{i,t-1}\right] + \tau_t \delta p^I_{i,t-1}K_{i,t-1} \\ &+ p^S_{it}\Psi_{it} + B_{it} - B_{i,t-1} - (1-\text{itc}_{it})p^I_{st}\left[K_{it} - (1-\delta)K_{i,t-1}\right] \end{aligned}$$

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

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:

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

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).

With respect to the *monetary transmission channels*, this cost of capital takes into account the interest rate channel, a part of the credit channel (leverage), the asset price channel (inflation rate of asset prices such as firms' property prices, and the price of collateralisable assets used in leverage), as well as potential reactions to monetary policy of tax policies supporting corporate investment. But it does not take into account other credit channel effects due to the existence of a positive dividends constraint, whose Lagrange multiplier would alter the Euler equation.

2. Parameterization and Econometric Model

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

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

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:

$$k_{it} = \left(\sigma + \frac{1-\sigma}{\upsilon}\right) s_{it} - \sigma . c_{it} - \frac{1-\sigma}{\upsilon} ln(A_{it}) + \sigma \, ln(\upsilon . a) \tag{10}$$

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) and the time dummies.

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 two lags with respect to explanatory variables (ADL(2,2)), as in Hall, Mairesse, Mulkay (2000). We consider four ways of estimating such a model on panel data. The first one is exactly the ADL(2,2) specification:

$$\begin{aligned} k_{it} &= \gamma_1 k_{i,t-1} + \gamma_2 k_{i,t-2} + \beta_0 s_{it} + \beta_1 s_{i,t-1} + \beta_2 s_{i,t-2} - \sigma_0 c_{it} - \sigma_1 c_{i,t-1} - \sigma_2 c_{i,t-2} \\ &+ \theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p^I_{s,t-2} K_{i,t-3}} + \alpha_i + \alpha_t + \varepsilon_{it} \end{aligned} \tag{11}$$

where α_i is an individual constant (fixed effect), α_t is a time constant (year effect) and ε_{it} is a random shock. 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 $\beta_{LT} = (\beta_0 + \beta_1 + \beta_2)/(1 - \gamma_1 - \gamma_2)$ and the long-run elasticity of the cost of capital is given by $-\sigma_{LT} = -(\sigma_0 + \sigma_1 + \sigma_2)/(1 - \gamma_1 - \gamma_2)$. Return to scale is given by $v = (1 - \sigma_{LT})/(\beta_{LT} - \sigma_{LT})$. As explained later, we estimate this model in first differences using the generalised method of moments (GMM). The endogenous variable is then Δk_{it} where Δ is the first difference operator ($\Delta k_{it} = k_{it} - k_{i,t-1}$).

In model ADL-I, the aim is only to write the investment ratio as the explanatory variable. We subtract $k_{i,t-1}$ from both sides in order to use the approximation $\Delta k_{it} = (I_{it} / K_{i,t-1}) - \delta$. The Taylor rest of the power series:

$$R_{it} = \sum_{j=2}^{+\infty} (1/j)(-1)^j \left([I_{it} / K_{i,t-1}] - \delta\right)^j$$

is neglected. (We computed the stock of capital using the perpetual inventory method with a constant depreciation rate δ.)

$$\begin{aligned} \frac{I_{it}}{K_{i,t-1}} &= (\gamma_1 - 1)\frac{I_{i,t-1}}{K_{i,t-2}} + (\gamma_2 + \gamma_1 - 1) k_{i,t-2} + \beta_0 s_{it} + \beta_1 s_{i,t-1} + \beta_2 s_{i,t-2} \\ &- \sigma_0 c_{it} - \sigma_1 c_{i,t-1} - \sigma_2 c_{i,t-2} + \theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p^I_{s,t-2} K_{i,t-3}} \\ &+ \alpha_i + \alpha_t + \varepsilon_{it} \end{aligned} \tag{12}$$

Estimated with GMM first differences, the endogenous variable is now the first difference of a growth rate. Due to the approximation, model ADL-I has the drawback that the error term includes power series of the endogenous variable as the differences of the Taylor rest: $R_{it} - R_{i,t-1}$. We intend to verify whether this approximation matters. Note that, as the value of current investment is deflated by the price of current investment, we use the same deflator for cash flow.

The next model is the error correction model ECM(2,2) used on panel data by Hall, Mairesse and Mulkay (2001) among others. They transform model ADL-I as follows:

$$\begin{aligned}\frac{I_{it}}{K_{i,t-1}} &= (\gamma_1 - 1)\frac{I_{i,t-1}}{K_{i,t-2}} + \beta_0 \Delta s_{it} + (\beta_0 + \beta_1)\Delta s_{i,t-1} + (\gamma_2 + \gamma_1 - 1)(k_{i,t-2} - s_{i,t-2}) \\ &+ (\beta_0 + \beta_1 + \beta_2 + \gamma_2 + \gamma_1 - 1)s_{i,t-2} - \sigma_0 c_{it} - \sigma_1 c_{i,t-1} - \sigma_2 c_{i,t-2} \\ &+ \theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p^I_{s,t-2} K_{i,t-3}} + \alpha_i + \alpha_t + \varepsilon_{it}\end{aligned} \tag{13}$$

Error correction models have been introduced in time series analyses of co-integration. In particular, the long-run relationship is often estimated in a first step, with residuals which are integrated of order zero, and the ECM is estimated for transitory dynamics as a second step. An argument is that the ECM(2,2) on panel data can deal better with the unit root of the explained variable than the ADL(2,2) and ADL-I. First differences can remove the autocorrelation of one of the variables in the case of a unit root. A very high autocorrelation in panel data on firms is observed (Hall and Mairesse 2001). A drawback of the ECM is that the test for necessary lags is not direct (in particular lag 2) whereas they are directly obtained with the ADL specification. These tests are important because adding not significant lags can change dramatically the value of long run elasticities, while these long run elasticities remain significant even with one or more not significant lags. One needs to recover parameters and standard errors of the ADL(2,2) and ADL-I models from the ECM parameters and variance-covariance matrix. For this reason, it is more practical to estimate directly the ADL(2,2) and ADL-I models. We also estimate this ECM(2,2) model to check its differences with the ADL(2,2) and ADL-I.

Using the same approximation as in model ADL-I so that the investment ratio appears as the explanatory variable instead of the log of capital, Chatelain et al. (2002), among others, used first differences of all the variables of the ADL(2,2) model and then added cash-flow. We label this the "difference ADL" model:

$$\begin{aligned}\frac{I_{it}}{K_{i,t-1}} &= \gamma_1 \frac{I_{i,t-1}}{K_{i,t-2}} + \gamma_2 \frac{I_{i,t-2}}{K_{i,t-3}} + \beta_0 \Delta s_{it} + \beta_1 \Delta s_{i,t-1} + \beta_2 \Delta s_{i,t-2} \\ &- \sigma_0 \Delta c_{it} - \sigma_1 \Delta c_{i,t-1} - \sigma_2 \Delta c_{i,t-2} + \theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p^I_{s,t-2} K_{i,t-3}} \\ &+ f_i + \Delta\varepsilon_{it} + \alpha_t\end{aligned} \tag{14}$$

The argument put forward for such a model is that productivity of each firm is affected not only by a fixed effect on the productivity level but also by another fixed effect on the productivity growth rate denoted f_i. Another argument is that the stock of capital includes measurement errors, mostly due to the initial condition in the perpetual inventory method. This argument holds for Within estimations but not for the ADL(2,2), ADL-I and ECM model estimated in first differences with GMM, as long as the level of the stock of capital is not used as an instrument. As seen before, differences in the log of capital do not depend on the initial condition for computing the stock of capital with the perpetual inventory method.

To get rid of the fixed effect on growth rate, one can estimate the difference ADL model using first differences again. When cash-flow is not taken into account, this amounts to estimating second differences of the ADL(2,2) model with instruments in first differences. Conversely, the estimation of the ADL(2,2) model in GMM first differences amounts to an estimation of the level of the difference ADL. Note that cash-flow is related to investment in the difference ADL model. It is seemingly related to investment in the ECM model, but, in the equivalent ADL model, the first differences of cash-flow/capital are related to the investment rate.

At least three factors may explain the differences between the GMM results of the ADL(2,2), ADL-I (or ECM) and the difference ADL: first, fixed effects on the growth rate of productivity may exist; second, in the difference ADL model, the lagged dependant variable and residuals are differened twice $\Delta^2\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{i,t-2}$ (differening once more changes the correlation between residuals and the lagged dependant variable); third, first differences of growth rates enter into the regression in the difference ADL instead of growth rates in the ADL/ECM model. The hypothesis of a fixed effect on productivity growth is not so common. It means that firms are able to differ individually with respect to growth, during an estimation period which should, in principle, be short. Measurement errors cannot be avoided by differencing twice with GMM. First differences of the growth rate are smaller and less auto-correlated than growth rates. From an econometrics theory viewpoint, none of the above arguments leads to one of the models being definitively rejected with respect to the other one (ADL/ECM versus difference ADL).

Below, we compare the estimations of the ADL(2,2), ADL-I and ECM(2,2) model with the difference ADL model put forward for France in the comparative exercise in Chatelain et al. (2001). Our aim is to check what the estimation of these models changes with respect to other estimations done in the monetary transmission network (ECM and difference ADL).

In the econometric models, we estimate the year effects by including time dummies. The estimation of these econometric models presents three potential groups of problems. First, there may be a correlation between explanatory variables and the fixed effect on productivity level α_i (ADL/ECM model) and/or the fixed effect on productivity growth f_i in the difference ADL model. 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.

III. Data and Econometric Results

1. Macroeconomic Background

Financial deregulation in France occurred in the mid-1980s. This led to considerable changes in the money market. Treasury bills took on greater importance, new financial instruments appeared on the scene, and new equity markets were set up ("second marché"). There were changes in the regulation of banks' activities. Quantitative credit regulation of banks by the central bank was stopped. All these reforms decreased the effect of the credit channel of monetary policy with respect to what it was before the mid-1980s. Post-1990 saw a stabilisation in the gains from monetary and financial innovations obtained by small and medium sized firms. This can be explained by several factors: a recession and a period of low activity leading to a high number of failures, a large amount of bad loans for banks, many of which were related to the end of the bubble in corporate real estate, the regulation of capital ratios for banks and so on. Finally, venture capital finance really started and grew sharply from 1996 to 2000, with the help of government intervention.

In the 1990s, companies can be characterised by the following macroeconomic pattern. Distribution of value added, which had worked to the advantage of corporate profits since 1983, consolidated at historically high levels over the 1990s. This feature, combined with low demand due to low-activity years and low investment, had a remarkable effect. The loss of sales affected aggregate profits far less than aggregate investment. Therefore, a high self-financing ratio prevailed over the period except for the last two years (the aggregate retained earnings/investment ratio exceeded 100% for several years of the decade). A direct consequence of this flow of internal income and, perhaps, of "high" real interest rates for some firms in the early 1990s, was a decrease in leverage, and, in particular, of the share of bank debt in total liabilities. Conversely, this meant an increase of the share of equity. Furthermore, the fall in interest rates from 1995 to 1999 and the decrease of debt led to a decrease in aggregate debt repayments, which in turn further increased aggregate retained earnings. This decrease in the relative size of bank credit to firms may have affected banks' behaviour and their portfolios. In 2000, firms increased their leverage at the aggregate level.

The business cycle is characterised by relatively high aggregate investment in the first year (1990) and the last years (1998 and 1999) of our study. Between these dates, low investment prevailed: low aggregate investment during the years 1991, 1992, 1996 and 1997, with slightly higher investment in 1994 and 1995, which followed an exceptionally low investment level during the 1993 recession. Monetary policy shifted from high nominal short-run interest rates from 1990 to 1993 to falling rates from 1994 to 1999. This fall was anticipated on the bonds market, so that there was an inversion of the yield curve from 1991 to 1993. The high return from short-run debt caused some firms to delay investment and to accumulate cash during this period.

2. Data

The data set consists of firms' annual accounts and additional information from surveys collected by the Banque de France in the Balance Sheet Data Centre's database. For our econometric study, we selected an unbalanced sample of N = 6,946 firms in the manufacturing sector, over the period 1985-1999 (see appendix for details). The estimation period is ten years (1990-1999). This sample was obtained after deleting outliers for several variables and after selecting firms that were present for at least six years consecutively (see the data appendix for the sample selection).[2] A comparison with some samples used in previous studies shows that our panel is rather large and includes a larger set of small firms. Descriptive statistics for variables used in the regressions are presented on table 1.

Table 1

Summary Statistics on the Complete Cleaned Data Set
(Number of Firms: 6,946. Number of Observations: 61,237)

	Mean	Std. Dev.	Minimum	25%	Median	75%	Maximum
I_t/K_{t-1}	0.122	0.141	0.00	0.04	0.08	0.15	1.43
$\Delta\log S_t$	0.0296	0.153	-1.78	-0.05	0.03	0.11	1.36
$\Delta\log UC_t$	-0.009	0.14	-0.34	-0.11	-0.015	0.09	0.36
CF_t/K_{t-1}	0.33	0.33	-0.45	0.16	0.26	0.41	4.32
$\text{Log } S_t$	8.83	1.38	4.51	7.84	8.61	9.60	17.2
$\text{Log } UC_t$	-1.77	0.14	-2.26	-1.86	-1.77	-1.67	-1.27

[2] We are not able to find out how many state owned enterprises are contained in the sample. They could be some of the largest firm of our sample but we expect there are not many of them included in it: State owned enterprises are rather large firms in France, whereas the median size of around sixty employees in our sample.

These statistics are presented after the removal of outliers and firms that had not been present for at least six years consecutively (see data appendix). The evolution of these variables over time is presented in figures 1 and 2 and corresponds to macroeconomic evolution described in section III.1.

Figure 1

Investment, User Cost, Cash-Flow and Growth of Sales (Means)

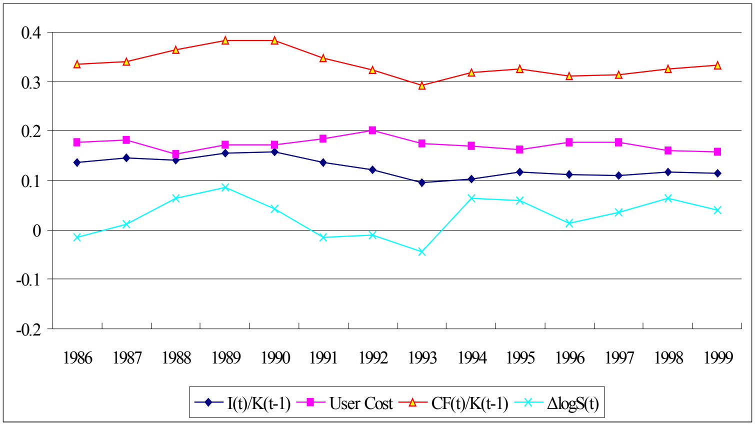
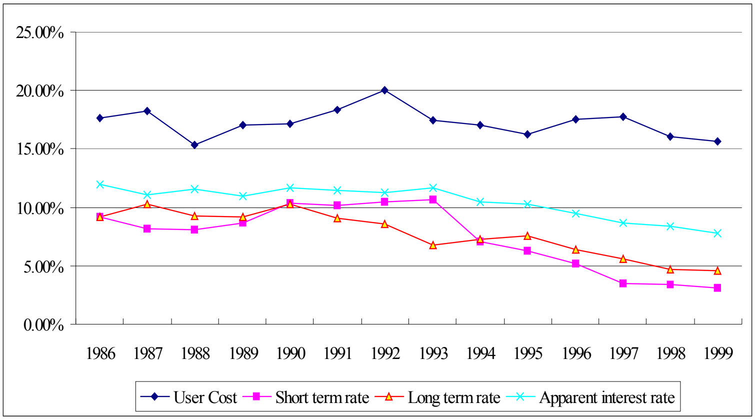


Figure 2

User Cost of Capital and Nominal Interest Rates (Means)



3. Estimation Results Assuming Firms Homogeneity

In table 2, we compare estimations on our French sample using the ECM model, used by Gaïotti and Generale (2001) and Mojon, Smets and Vermeulen (2001), and using the difference ADL model used in Chatelain et al. (2001), Valderrema (2001), Chirinko and Von Kalckreuth (2001) and Butzen, Fuss and Vermeulen (2001).

It is important to define now how we compute the auto-regressive component for the four models we investigate. It is the sum of the auto-regressive parameters which appears in the ADL(2,2) and the difference ADL(2,2): $\gamma_1 + \gamma_2$. This auto-regressive component enters at the denominator of long run elasticities of the user cost and of sales and the long run investment cash flow sensitivity not only for the ADL(2,2) and the difference ADL(2,2) models *but also* for the ADL-I and ECM(2,2) models. The higher this auto-regressive component, the higher the long run elasticities and sensitivities. We need to precise this point, as in the ADL-I and the ECM(2,2), the "apparent" auto-regressive parameter is $\gamma_1 - 1$, although the underlying auto-regressive component for computing long run elasticities and sensitivities is $\gamma_1 + \gamma_2$.

Table 2

Econometric Results: I(t)/K(t-1) as Dependent Variable

	Error Correction Model (2,2)				**Difference-ADL(2,2)**			
	Within Estimations		**GMM Two-Steps**		**Within Estimations**		**GMM Two-Steps**	
	Coeff.	T-Stats	Coeff.	T-Stats	Coeff.	T-Stats	Coeff.	T-Stats
I(t-1)/K(t-2)	-0.248	-25.71	-0.111	-3.64	-0.102	-11.41	0.088	8.94
I(t-2)/K(t-3)					-0.107	-16.31	0.012	1.81
Log S(t)	0.118	20.85	0.027	0.75	0.084	15.79	0.004	0.11
Log S(t-1)	0.134	20.22	0.043	1.17	0.065	11.76	0.039	5.36
Log S(t-2)					0.028	5.30	0.008	1.47
(LogK-LogS) (t-2)	-0.329	-40.32	-0.204	-5.93				
Log S(t-2)	-0.167	-22.69	-0.165	-5.26				
Log UC(t)	-0.237	-29.48	-0.018	-0.63				
Log UC(t-1)	0.017	2.46	0.003	0.19				
Log UC(t-2)	0.000	-0.06	0.015	1.52				
Log UC(t)					-0.197	-28.25	-0.008	-0.34
Log UC(t-1)					-0.116	-16.84	-0.011	-0.91
Log UC(t-2)					-0.065	-11.01	0.004	0.58
CF(t)/K(t-1)	0.024	4.12	0.019	0.70	0.063	9.71	0.102	3.72

CF(t-1)/K(t-2)	0.036	6.98	0.030	2.09	0.069	11.64	0.075	5.56
CF(t-2)/K(t-3)	0.006	1.33	-0.001	-0.10	0.044	7.82	0.0z16	2.47
Auto-regressive coeff.	**0.671***		**0.796***		**-0.209***		**0.100***	
Long term eff. Sales	**0.493***		**0.188***		**0.146***		**0.057***	
Long term eff. User Cost	**-0.669***		**0.001**		**-0.313***		**-0.016**	
Long term eff. C.-Flow	**0.201**		**0.239***		**0.146***		**0.215***	
AR2			-1.746	p=0.081			-1.737	p=0.082
Sargan			164.03	p=0.133			156.27	p=0.247
Estimation method: 2-step GMM estimates, time dummies and Within estimates. Instruments: lags 2 to 5 of all explanatory variables.								

Using a Within estimator for the ECM(2,2), we find a similar result to that obtained by Mojon, Smets, Vermeulen (2001) who use the BACH database and omit cash-flow in their regression. The long-term user cost elasticity is very high (-0.67) and significant. Short-run elasticity is -0.24. It is interesting to see that we find these similar results with a very high number of disaggregated observations. Part of our sample is used for constructed French data aggregated by size and sector in the BACH database. Note that the years of estimation differ between our study and the one by Mojon, Smets and Vermeulen (2001).

In the Within estimation for the difference ADL(2,2) model, the sum of short-run user cost elasticities is higher (-0.38) than in the ECM(2,2) model (-0.24), but the long-run user cost elasticity is now (-0.31), i.e. about half of the one with ECM(2,2) (-0.67). One observes a similar decrease for long-run sales growth elasticity when shifting from the ECM model (0.493) to the difference ADL model (0.146). These differences for long-run elasticities are explained by the auto-regressive component of each model. In Within estimations, the auto-regressive coefficient for the log of capital is 0.671 for the ECM. The explained variable in the difference ADL model is first differences of investment/capital ratios, which are much less auto-regressive in absolute value, and even negative (-0.209). However, the gap between investment cash-flow long-term sensitivities is smaller when shifting from the ECM model to the difference ADL model (from 0.201 to 0.146). This is because the sum of short-run investment cash-flow sensitivities is three times higher in the difference ADL model (0.176) than in the ECM model (0.066).

Using first difference GMM estimations, these auto-regressive parameters increase in the ECM with respect to the Within estimations, which were biased downwards (from 0.671 to 0.796). Due to a very low standard error, this parameter is significantly different from one. The increase of the auto-regressive parameter from Within to GMM estimator is also found in the difference ADL model (from -0.209 to 0.10, no longer negative). However the gap between the auto-regressive parameter of the ECM and the difference ADL remains very large in the GMM estimation (0.796 to 0.1). Therefore, one gets the long-run coefficients by multiplying by 5 the sum of short-run coefficients in the ECM and by multiplying by 1.10 the sum of short-run coefficients in the difference ADL.

Conversely, short-run coefficients of sales, user cost and cash-flow are smaller in ECM estimations than in the difference ADL. This result goes hand in hand with the fact that the auto-regressive parameters explain much more of the variance in the ECM model. For this reason, long-run elasticities are generally higher in the ECM model than in the difference ADL, if ever the short-run elasticities are significant. However, in both models, the user cost elasticity is not significantly different from zero when cash-flow and its lags are explanatory variables. Sales growth elasticity is significant and lower than in the Within case (where they were biased upwards). Long-term investment cash-flow sensitivities are slightly increased using a GMM estimation (they were biased downwards using Within estimates). The large differences between GMM and Within estimates stress endogeneity and/or heteroscedasticity problems in the Within estimations. As the GMM estimator has been designed to deal properly with these econometric problems, we make no further reference to Within estimations in the following section.

In Chatelain and Tiomo (2001), we check that the ECM(2,2) results are very close to the ADL(2,2) and ADL-I(2,2) results, where lag 2 of explanatory variables (except the lag 2 of the dependant variable) are not significant and are removed. In particular, introducing cash-flow to the regression leads to dramatic changes in the results: User cost (and sometimes sales growth) are no longer significant.

The result that the introduction of cash-flow drives down to zero the elasticity of the user cost with respect to investment (which was significant and negative before the introduction of cash-flow) is robust to changes of the model: it holds for the ADL/ECM and the difference ADL model. Not surprisingly, it is robust to the number of lags used in each models. It holds for other computations of the user cost such as the apparent interest rate alone, a user cost definition without taxation, a user cost including more individual information related to investment tax credit, accounting depreciation instead of a constant depreciation rate, or the “phi” parameter used by Crépon and Gianella (2001) in order to take into account in an ad hoc manner the tax differentials between dividends and capital gains. It is robust to soft trimming of the growth rate of the user cost (removing 1% tails of its distribution) or to hard trimming of the growth rate of the user cost (removing 5% tails of its distribution). It is robust to the removal of interest charges from cash-flow in order to avoid a potential collinearity problem between the apparent interest rate included in the user cost and cash-flow. It is also robust to the substitution of cash-flow/capital by the log of liquidity (cash stock).

However, this result is not robust to data and period selection: Chatelain (2001) obtained a significant elasticity of the user cost excluding taxation on a sample more or less included in the one we used in this study (a balanced panel of 4,025 firms from 1988 to 1996, estimated over the period 1993-1996). But this last result was only obtained after strict upward testing procedures leading to the selection of highly exogenous instruments (starting from a small set of very exogenous instruments and testing additional instruments one by one, see Andrews 1999). On this larger sample, a non-significant user cost was robust to systematic changes of the instrument sets including lagged explanatory variables using either upward testing procedures or downward testing procedures (starting from a large number of instrument sets and removing some of them).

4. Do Some Firms Experience a Tighter Liquidity Constraint

Why does the introduction of cash flow drive the user cost elasticity down to zero, whereas it is significantly different to zero when cash flow is omitted?

First, we define the user cost as a linear function of a microeconomic apparent interest rate, which includes an agency premium. According to the broad credit channel theory (see Gertler and Hubbard 1988), this agency premium decreases with respect to collateral, which depends on expected profits, which in turn are very much dependant on expected sales, among other factors (for example, Oliner and Rudebush 1996 state that the agency premium increases with the risk-free interest rate). Due to the correlation between future profits and past profits, a potential explanation of the decline in the user cost elasticity, when cash flow is added to the regression, may lie in the joint correlation between cash flow, sales and the apparent interest rate (hence user cost). We may face a collinearity problem, which is not solved by the generalised method of moments.

A second explanation relates to an aggregation bias and to the prevalence of self-financing during the 1990s for some firms observed in the descriptive statistics, both at the macroeconomic and microeconomic level: some firms may depend much more on cash flow than others. In that case, omitting a dummy variable when selecting these firms may lead to a bias in the *estimate* and the *standard error* of the user cost parameter. This is what we investigate in this chapter.

We found three sample separation dummy variables able to isolate firms such that their long run investment cash flow excess sensitivity (*differential* coefficient) is significantly different to zero. [3] Descriptive statistics with respect to sectors and other sample separation criteria are presented in table 3.

Sample separation with respect to size (Chatelain et al. (this volume)), to the share of intangibles and to the dividend payout ratio did not yield relevant statistical and economic results, by contrast with other countries.

We considered a dummy variable for firms with a lower share of trade credit in total liabilities (more precisely, firms for which this ratio is below the upper quartile). This situation may be a signal that these firms are experiencing difficulties in securing external finance. Investment cash flow sensitivity is 0.25 for firms with high trade credit to total liabilities ratios, whereas it is zero for other firms, which is consistent with the above interpretation (table 4). For all firms, sales growth elasticity is 0.43, but the user cost elasticity is not significantly different to zero.

We introduced a dummy variable relative to the capital goods sector, which is more sensitive to business cycle fluctuations than other sectors. Long run investment cash flow sensitivity is 0.42 for the capital goods sector, whereas it is only 0.07 for firms in other industrial sectors. Long run sales growth elasticity is 0.29. It is remarkable that the user cost is now significant for all firms with a long run elasticity of -0.26.

[3] We run regressions on the full sample including dummy variables related to a sample separation criteria instead of running different regressions on each sample. This has the advantages of keeping the highest number of observations and of providing directly statistical tests of significance of the differential coefficients related to dummy variables and leaves a room to instrument these dummy variables when using the generalized method of moments.

Table 3

Descriptive Statistics of Various Groups of Firms (Average Values. Number of Observations: 61,237)

		Number	**Main Variables**					
		of Firms	I(t)/K(t-1)	LogS(t)	LogUC(t)	CF(t)/K(t-1)	LogS(t)	LogUC(t)
	All sectors	**6946**	**0.122**	**0.0296**	**-0.009**	**0.33**	**8.83**	**-1.77**
Sectors	Food products	929	0.12	0.01	-0.014	0.27	9.3	-1.8
	Intermediate	3371	0.11	0.04	-0.005	0.29	8.8	-1.7
	products							
	Equipment	1227	0.12	0.04	-0.008	0.37	8.7	-1.8
	goods							
	Consumption	1286	0.15	0.01	-0.02	0.47	8.7	-1.8
	goods							
	Car industry	133	0.12	0.03	-0.02	0.31	9.8	-1.8
Scoring	No score	481	0.12	0.003	0.004	0.30	9.0	-1.8
Function								
	Risky Firms	1293	0.12	0.03	-0.008	0.30	8.6	-1.8
	Neutral Firms	1169	0.11	0.01	-0.007	0.28	8.5	-1.7
	Riskness Firms	4003	0.13	0.04	-0.01	0.36	8.9	-1.8
Trade Credit	< Q3	5910	0.13	0.06	-0.003	0.33	8.8	-1.8
	> Q3	1736	0.12	0.02	-0.011	0.33	8.8	-1.8

I/K: investment over capital; S: sales; CF/K: cash flow over capital; UC: user cost.

Table 4

Auto-Regressive Distributed Lags Model with log(K) as Endogenous Variable

	Coeff.	T-Stats	Coeff.	T-Stats	Coeff.	T-Stats
Log K(t-1)	0.822	31.370	0.835	34.427	0.827	30.713
Log K(t-2)	-0.050	-5.670	-0.052	-6.206	-0.066	-5.339
Log S(t)	0.075	2.788	0.041	1.743	0.091	3.210
Log S(t-1)	0.023	0.826	0.022	0.944	0.064	2.697
Log UC(t)	-0.035	-1.306	-0.049	-3.019	-0.034	-1.824
Log UC(t-1)	0.003	0.226	-0.007	-0.777	-0.016	-1.707
CF(t)/K(t-1)	0.058	2.406	-0.004	-0.185	-0.015	-0.636
CF(t-1)/K(t-2)	-0.001	-0.033	0.018	2.025	0.019	2.147
Differential coef. For:	***Low Trade Credit***		***Equipment Goods***		***Risky firms***	
Log K(t-1)	0.003	0.195	0.026	0.901	-0.050	-0.689
Log K(t-2)	0.000	0.598	0.001	0.717	0.086	1.542
Log S(t)	0.004	0.919	0.004	0.411	0.014	0.401
Log S(t-1)	-0.004	-0.236	-0.008	-0.322	-0.046	-1.489
Log UC(t)	-0.011	-0.481	0.004	0.172	0.023	1.067
Log UC(t-1)	-0.002	-0.195	-0.001	-0.067	0.007	0.425
CF(t)/K(t-1)	-0.083	-3.413	0.082	3.260	0.077	2.328
CF(t-1)/K(t-2)	0.026	1.392	-0.014	-0.903	-0.034	-2.114

Long term eff. Sales	**0.43***		**0.29***		**0.65***	
L.T. eff. User Cost	**-0.14**		**-0.26***		**-0.21***	
L.T. eff. Cash-Flow	**0.25***		**0.07***		**0.02***	
Differential coef. For:	***Low Trade Credit***		***Equipment Goods***		***Risky firms***	
Long term eff. Sales	**0.01**		**0.02**		**-0.04**	
L.T. eff. User Cost	**-0.06**		**-0.02**		**0.11**	
L.T. eff. Cash-Flow	**-0.25***		**0.36***		**0.22***	
AR2	-2.266	p = 0.023	-2.077	p = 0.038	-1.993	p = 0.046
Sargan	288.22	p = 0.088	275.48	p=0.204	300.91	p = 0.031
Instruments used in the regressions are all explanatory variables lagged 2 to 5.						

It is indeed possible that one criterion alone may not be sufficient. The "score" allocated by the Banque de France is a combination of several criteria which makes it possible to measure the risk of company failure. According to the Banque de France scoring system, risky firms (i.e. those whose score function is below -0.3) present a long run investment cash flow sensitivity of 0.24, whereas it is only 0.02 for other firms. This result was expected, as these firms experience more difficulties in getting access to external financing. Sales growth elasticity is now 0.65. As for the capital goods sector, the user cost elasticity is significant for all firms with a long run value of -0.21.

Finally, we present the results obtained by using the risky firm dummies when the cash stock replaces the cash flow. For some authors, investment cash flow excess sensitivities are not valid measures of the financing constraint (see Kaplan and Zingales 1997). One could argue that they are more likely to be valid measures when the sample separation criterion measures, as much as possible, the risk of bankruptcy, such as the last one we used. The stock of a firm's cash plays the same role as the cash flow, as it is an indicator of the firm's ability to shield future investment from an expected tightening of borrowing conditions. The stock of cash may be less affected by the difficulty in interpreting investment cash flow sensitivity, as liquidity is less likely to be a proxy of expectations of future profits, which is supposed to determine investment behaviour without financial constraints. The stock of cash is also less correlated with sales than cash flow, which partially removes some multicollinearity-related problems in the investment equation.

When the stock of cash replaces the cash flow in the investment regression and when dummy variables relative to company risk are added to the regression, the user cost elasticity also becomes significant, reaching a nearly unchanged estimate of -0.23 (see table 5).

This is an additional robustness check for the user cost elasticity. The previous year's cash stock is a significant determinant of current investment, as a proportion of the previous year's cash may finance this year's investment. However, unlike investment cash flow excess sensitivity, investment cash stock excess sensitivity is not significant for more risky firms, but, at the same time, risky firms' elasticity of investment with respect to sales is significantly lower than that of other firms. This means that the investment of risky firms reacts much less to sales than that of other firms, but it could also suggest a misspecification of financial constraints in the investment equation.

Table 5

Auto-Regressive Distributed Lags Model with log(K) as Endogenous Variable and Cash Stock as Liquidity Variable

	Coeff.	T-Stats
	Less Risky Firms	
Log K(t-1)	0.785	36.2
Log K(t-2)	-0.053	-4.4
Log S(t)	0.094	3.79
Log S(t-1)	0.106	4.80
Log UC(t)	-0.053	-3.01
Log UC(t-1)	-0.011	-1.12
Cash(t)/K(t-1)	-0.007	-0.42
Cash(t-1)/K(t-2)	0.041	2.93
Differential coef. for:	***Risky Firms***	
Log K(t-1)	-0.033	-0.54
Log K(t-2)	0.055	1.10
Log S(t)	0.029	1.02
Log S(t-1)	-0.091	-3.38
Log UC(t)	0.006	0.31
Log UC(t-1)	0.011	0.67
Cash(t)/K(t-1)	0.022	1.02
Cash(t-1)/K(t-2)	-0.021	-1.13
	Less risky firms	
Long term eff. Sales	**0.743***	
L.T. eff. User Cost	**-0.238***	
L.T. eff. Cash Stock	**0.125***	
Differential coef. For:	**Risky Firms**	
Long term eff. Sales	**-0.339***	
L.T. eff. User Cost	**n.s.**	
L.T. eff. Cash Stock	**n.s.**	
AR2	-1.694	p = 0.090
Sargan	292.01	p = 0.066
Instruments used in the regressions are all explanatory variables lagged 2 to 5. (n.s. : not significant).		

IV. Conclusion

We reach two major conclusions. First, by introducing sample separation dummy variables, which enable us to isolate more precisely those firms which are more sensitive to cash flow, we improve the precision of the results presented in Chatelain et al. (this volume) for France. *The user cost elasticity with respect to investment is at the most 0.26 in absolute terms for all the firms of our sample.* This result is obtained using generalised method of moments estimates for dynamic panel data, unlike other recent papers which assess user cost effects at the firm level in France. This confirms the direct effect of the interest rate channel on investment, operating through the cost of capital.

Second, we find three groups of firms for which investment is more sensitive to cash flow: firms facing a high risk of bankruptcy, firms belonging to the capital goods sector (which are more sensitive to business cycle fluctuations) and firms making extensive use of trade credit, a potential substitute for short-term bank credit. *The rather high investment cash flow sensitivity of these firms (between 0.24 up and 0.42), which represent about 20% of our sample, confirms the existence of a broad credit channel operating through corporate investment in France.* For other firms, investment cash flow sensitivity is close to zero.

These results offer a basis for further investigations into the effects of monetary policy on individual investment, and the macro-economic consequences for the monetary transmission channels.

Summary

Using a large panel of 6,946 French manufacturing firms, this paper investigates the effect of the cost of capital and on cash flow on investment from 1990 to 1999. We compare several specifications of neo-classical demand for capital, taking into account transitory dynamics. The user cost of capital has a significant negative elasticity with respect to capital using traditional Within estimates, or as long as cash-flow is not added to the regression when using Generalised Method of Moments estimates. When dummy variables related to firms more sensitive to cash flow are added in the model, the user cost elasticity is significant again and its estimate s is at most -0,26.

References

Assouline, *M*. et al. (1998), Stuctures et propriétés de cinq modèles macro-économiques français, Economie et Prévision 134 (3), 1–97.

Andrews, *D*. (1999), Consistent Moment Selection Procedures for Generalized Method of Moments Estimation, Econometrica 67 (3), 543–564.

Angeloni, *I*., *A. Kashyap*, *B. Mojon*, and *D. Terlizzese* (2001), Monetary Transmission in the Euro-Area, European Central Bank working paper 114.

Arrelano, *M*. and *S. Bond* (1991), Some tests of specification for panel data: Monte Carlo evidence and an application to employment equation, The Review of Economic Studies 58, 277–297.

Auerbach, *A.J.* (1983), Taxation, Corporate Financial Policy and the Cost of Capital, Journal of Economic Literature 21, 905–940.

Beaudu, *A*. and *T. Heckel* (2001), Le canal du crédit fonctionne-t-il en Europe? Une étude de l'hétérogénéité des comportements d'investissement à partir de données de bilan agrégées, Economie et Prévision 147, 117–141.

Blanchard, *O.J*. (1986), Comments and Discussion on Investment, Output and the Cost of Capital, Brookings Paper on Economic Activity (1), 153–158.

Bond, *S*., *J. Elston*, *J. Mairesse*, and *B. Mulkay* (1997), A Comparaison of Empirical Investment Equations using Company Panel Data for France, Germany, Belgium and the UK, NBER working paper n°5900.

Butzen, *P*., *C. Fuss* and *P. Vermeulen* (2001), The Interest Rate and Credit Channel in Belgium: an investigation with micro-level firm data, European Central Bank working paper 112.

Chatelain, *J.B*. (2001), Investment, the Cost of Capital and Upward Testing Procedures for Instrument Selection on Panel Data, Banque de France, presented at the Monetary Transmission meeting, March.

Chatelain, *J.B*. (2002), Structural Modelling of Financial Constraints on Investment: Where do we Stand, Paper presented at the National Bank of Belgium Conference on Investment.

Chatelain, *J.B*., *A. Generale*, *I. Hernando*, *P. Vermeulen*, and *U. von Kalckreuth* (2001), Firm Investment and Monetary Transmission in the Euro Area Countries, European Central Bank working paper 113.

Chatelain, *J.B*. and *A. Kashyap* (2000), Issues regarding estimation of the firm level investment equations, European Central Bank, mimeo.

Chatelain, *J.B*. and *J.C. Teurlai* (2000a), Comparing Several Specifications of Financial Constraints and of Adjustment Costs in Investment Euler Equation, Banque de France, presented at the European Meeting of the Econometric Society.

Chatelain, *J.B*. and *J.C. Teurlai* (2000b), Investment and the Cost of External Finance: An Empirical Investigation according to the Size of Firms and their Use of Leasing, Banque de France, presented at the Money, Macro and Finance conference.

Chatelain, *J.B*. and *A. Tiomo* (2001), Investment, the Cost of Capital and Monetary Policy in the Nineties in France: A Panel Data Investigation, European Central Bank working paper 106.

Chirinko, *R*., *S. Fazzari*, and *A. Meyer* (1999), How Responsive is Business Capital Formation to its User Cost? An Exploration with Micro Data, Journal of Public Economics 74, 53–80.

Kalckreuth, *v. Ulf* (2001), Monetary transmission in Germany: New perspectives on finance constraints and investment spending, Bundesbank, European Central Bank working paper 110.

Crépon, *B*. and *C. Gianella* (2001), Fiscalité et coût d'usage du capital: incidence sur l'investissement, l'activité et l'emploi, Economie et Statistique 341–342 (1/2), 107–128.

Crépon, *B*. and *F. Rosenwald* (2001), Des contraintes financières plus lourdes pour les petites entreprises, Economie et Statistique 341–342 (1/2), 29–46.

Dormont, *B*. (1997), L'influence du coût salarial sur la demande de travail, Economie et de Statistique 301–302, 95–109.

Duhautois, *R*. (2001), Le ralentissement de l'investissement est plutôt le fait des petites entreprises tertiaires, Economie et Statistique 341–342 (1/2), 47–66.

Fazzari, *S.M*., *R.G. Hubbard*, and *B.C. Petersen* (1988), Financing Constraint and Corporate Investment, Brookings Papers on Economic Activity, 141–195.

Gaiotti, *E*. and *A. Generale* (2001), Does Monetary Have Asymmetric Effects? A Look at the Investment Decisions of Italian Firms, European Central Bank working paper 111.

Gertler, *M*. and *R.G. Hubbard* (1988), Financial Factors in Business Fluctuations, in: Financial Market Volatility, Federal Reserve Bank of Kanses City, 43–64.

Hall, *R.E*. and *D.W. Jorgenson* (1967), Tax Policy and Investment Behavior, American Economic Review 59 (3), 921–947.

Hall, *B.H*. and *J. Mairesse* (2001), Testing for Unit Roots in Panel Data: An Exploration Using Real and Simulated Data, mimeo.

Hall, *B.H*., *J. Mairesse*, and *B. Mulkay* (1999), Firm-level investment in France and the United States: an exploration of what we have learned in twenty years, Annales d'Economie et de Statistique, 55–56.

Hall, *B.H*., *J. Mairesse*, and *B. Mulkay* (2000), Firm-level investment and R&D in France and the United States: A Comparison, Annales d'Economie et de Statistique, 55–56.

Hall, *B.H*., *J. Mairesse*, and *B. Mulkay* (2001), Investissement des Entreprises et Contraintes Financières en France et aux Etats-Unis, Economie et Statistique, 341–342, 67–84.

Harhoff, *D*. and *F. Ramb* (2001), Investment and Taxation in Germany: Evidence from Firm-Level Panel Data, in: Deutsche Bundesbank (ed.), Investing today for the world of tomorrow, Berlin, Heidelberg, New York: Springer.

Hayashi, *F*. (2000), The Cost of Capital, Q, and the Theory of Investment, in:*J.L. Lau* (ed.), Econometrics and the Cost of Capital, The MIT Press.

Herbet, *J.B*. (2001), Peut-on expliquer l'investissement à partir de ses déterminants traditionnels au cours de la décennie 90?, Economie et Statistiques 341–342, 85–106.

Hubbard, *R.G.* (2000), Capital Market Imperfections, Investment, and the Monetary Transmission Mechanism, mimeo.

Kaplan, *S.N*. and *L. Zingales* (1997), Do Investment Cash Flow Sensitivities Provide Useful Measures of Finance Constraints?, Quarterly Journal of Economics 112, 169–215.

King, *M.A*. and *D. Fullerton* (1984), The Taxation of Income from Capital, Chicago: Chicago University Press.

Mojon, *B*., *F. Smets*, and *P. Vermeulen* (2001), Investment and Monetary Policy in the Euro Area, European Central Bank working paper 78.

Oliner, *S.D*. and *G.D. Rudebush* (1994), Is there a Broad Credit Channel for Monetary Policy?, Working paper series. Division of Research and Statistics. Board of Governors of the Federal Reserve System.

Valderrama, *M*. (2001), Credit Channel and Investment Behavior in Austria: a Micro-Econometric Approach, European Central Bank working paper 109.

Vermeulen, *P*. (2000), Business fixed investment: evidence of a financial accelerator in Europe, European Central Bank working paper 37.

Appendix

A.1. Sample Selection

The data source consists of compulsory accounting tax forms (collected by the Banque de France in its FIBEN database) and of additional information (in particular on leasing) taken from surveys collected by the Banque de France (the Balance Sheet Data Centre's database). These data are collected only from firms who are willing to provide them, a procedure which creates a bias (small firms of fewer than 20 employees are under-represented). No statistical sampling procedure has been used to correct this bias.

A first elimination of outliers was done on a larger unbalanced sample of manufacturing firms without holdings. Outliers were excluded using ratios built on information common to the two databases. The first step consisted in deleting firms with missing or inconsistent data: we selected firms with no more than one fiscal account on the same year and for which the length of the accounting period was 12 months. We deleted firms for which the number of employees, sales, value added, assets, investment or debt were negative. The second step consisted in removing the following data:

- first percentile and the two upper percentiles of investment over capital;
- first percentile and the two upper percentiles of cash-flow over capital;
- first and 99th percentile of the apparent interest rate;
- first and 99th percentile of debt over capital;
- first and 99th percentile of sales growth;
- first percentile and the two upper percentiles of user cost;
- below the 5% percentile and above the 95% percentiles of the growth rate of the user cost.

From the initial Balance Sheet Data Centre database (209,112 initial observations), we obtained an unbalanced panel of 61,237 observations i.e. 6,947 manufacturing firms observed over 14 years.

A.2. 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”. The second source is the Banque de France survey of the Balance Sheet Data Centre. The form 2065 provides information on mergers and acquisitions. The form 2066 provides information on leasing. For example, we denote "(cdb65).031" the item 031 of the survey form 2065. Data common to monetary transmission network papers are constructed according to Chatelain and Kashyap's note (2000).

Sales 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 divided by the value added deflator.

Cash flow is output ((52).FL+FM+FL+FO+FQ) minus intermediate consumption ((52).FS+FU+FT+FV+FW+FX) minus personal costs ((52).FY+FZ) plus net financial income ([52].GP-GU) minus corporate income tax ((53).HK) plus operating depreciation and provisions ((52).GA+GB+GC+GD+(56)(5T-UF)).

Productive gross investment is the sum of total increases by acquisition of tangible assets (54).LP minus the sum of (i) the decreases by transfers of tangible assets under construction (54).MY, and (ii) the decreases by transfers of deposits and prepayments (54).NC minus (cdb65).031.

The cost of capital is computed using an apparent interest rate in the following formula:

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

Gross debt B_{it} includes quasi equity (51).DO (proceeds from issues of participating securities plus subordinated loans), convertible bonds (51).DS, other bonds (51).DT, bank borrowings (51).DU, other borrowings (51).DV, other liabilities (51).EA and discount (58).YS minus the bond redemption premium (50).CM.

Apparent interest rate AI_{it} is the ratio of interest and similar charges (52).GR to gross debt.

Equity E_{it} is stockholders' equity (51).DL.

The long-term interest rate LD_t is the French ten-year government reference bond rate.

The statutory tax rate τ_t is (53).HK except for firms which were not paying corporate income tax on a given year. The rate is set at zero for these firms in this given year. [4]

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:

[4] As the investment tax credit rate ((51).DJ divided by investment) is 0% for more than 80% of companies and over 95% for 5% of companies (hence creating many outliers with near zero user cost), in the end we did not take it into account.

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

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:

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

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 $\text{DEPR}_{it0}^{BV}/(p_{st0}^{K}K_{it0})$ (DEPR_{it0}^{BV} is the total book value of depreciation allowances in year t_0 according to the following formula[5]

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

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

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.

[5] This formula is used by *Mairesse* in the *Bond* et al. (1997) paper.

The sectoral useful life of capital goods is $T_{\max} = 15$ years, except for sectors C4 ($T_{\max} = 13$), sector D0 ($T_{\max} = 16$), sectors E1 and E2 ($T_{\max} = 14$), sector E3 ($T_{\max} = 12$), and finally sector F1 ($T_{\max} = 17$).

The Sectoral Variables

We selected 5 NES16 sectors: food products, consumption goods industries, equipment goods industries, intermediate products industries, and the car industry.

Investment goods deflators p_{st}^{I} used for the NES16 sectors are taken from the Annual National Accounts (base 1995).

Gross value-added deflators p_{st} used for the NES16 sectors are taken from the Annual National (base 1995).