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# INVESTMENT, THE COST OF CAPITAL, AND MONETARY POLICY IN THE NINETIES IN FRANCE: A PANEL DATA INVESTIGATION

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EUROSYSTEM MONETARY TRANSMISSION NETWORK

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BY JEAN-BERNARD CHATELAIN [1]
AND ANDRÉ TIOMO [2]

December 2001

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**The Eurosystem Monetary Transmission Network**

This issue of the ECB Working Paper Series contains research presented at a conference on “Monetary Policy Transmission in the Euro Area” held at the European Central Bank on 18 and 19 December 2001. This research was conducted within the Monetary Transmission Network, a group of economists affiliated with the ECB and the National Central Banks of the Eurosystem chaired by Ignazio Angeloni. Anil Kashyap (University of Chicago) acted as external consultant and Benoît Mojon as secretary to the Network.

The papers presented at the conference examine the euro area monetary transmission process using different data and methodologies: structural and VAR macro-models for the euro area and the national economies, panel micro data analyses of the investment behaviour of non-financial firms and panel micro data analyses of the behaviour of commercial banks.

Editorial support on all papers was provided by Briony Rose and Susana Sommaggio.


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## Contents

**Abstract**

Using a large panel of 6,946 French manufacturing firms, this paper investigates the effect of monetary policy on investment from 1990 to 1999 through the cost-of-capital and the cash-flow channels. 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. Asymmetries of effect of monetary policy are evaluated for different groups of firms which differ in terms of informational asymmetries.When dummy variables related to firms which are more sensitive to cash-flow are added in the model, the user cost elasticity is significant again.

*JEL classification:* C23, D21, D92.

*Key words:* Investment, Monetary Policy, Generalised Method of Moments, Cost of Capital.

**Non-technical summary**

In a monetary union, the impact and delays of reactions to monetary policy shocks differ from country to country, owing to differences between national monetary policy transmission channels. These differences can be altered by structural policy interventions. Understanding more precisely how monetary policy transmission channels differ in the euro area matters not only for monetary policy decisions but also for the monitoring of structural changes in euro area financial systems, which could decrease in part the heterogeneity of responses to monetary policy in the area. As in companion papers on corporate investment by the monetary transmission network of the Euro-system of central banks, we focus here on the interest rate channel of monetary policy, operating directly through the effect of the cost of capital on investment, and on the broad credit channel, operating in part through the effect of retained earnings or cash flow on investment. We use a large panel of 6,946 French manufacturing firms from 1990 to 1999.

We compare the estimations of several specifications of the neo-classical demand for capital, which depends on sales and the user cost of capital, adding cash flow to this model and taking into account transitory dynamics. The user cost elasticity with respect to capital is negative and statistically significantly different from zero using biased Within estimates (ranging from -0.31 to –0.67), or, as long as cash-flow is not added to the regression, using more precise Generalised Method of Moments estimates (user cost elasticity is then at most 0.26 in absolute terms). Asymmetries in the effects of monetary policy are evaluated for different groups of firms which differ the degree to which they are financially constrained to raise external funds, and, as a consequence, the degree to which their investment depends on retained earnings (cash flow). When dummy variables related to firms which are more sensitive to cash-flow are added to the model, the user cost elasticity with respect to investment is at most 0.26 in absolute terms for all the firms of our sample, using Generalised Method of Moments estimates. This confirms the direct effect of the interest rate channel on investment, operating through the cost of capital in France (there is also an indirect effect of monetary policy shocks on the macroeconomic growth of sales, which also affects corporate investment). We isolate three group of firms, for which investment is more sensitive to cash-flow (i.e. their investment cash flow excess sensitivity ranges from 0.20 to 0.36): firms facing a high risk of bankruptcy, firms belonging to the equipment 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 (0.22 up to 0.42), which represents about 20% of our sample, confirms the existence of a broad credit channel operating through corporate investment in France.

## 1. Introduction

It is a widespread belief among economists that monetary policy affects the investment of firms. However, applied researchers faced difficulties in obtaining a significant effect of the cost of capital (driven by interest rates) on investment in French macroeconomic time series and in French forecasting models, as well as on other factor demand related to the relative cost of factors (see Dormont [1997]). This suggests that maybe monetary policy works through a broad credit channel rather than through an interest rate channel for firms investment in France.. In this context, the emphasis has been put on asymmetries between firms, explained by different degrees of informational asymmetries leading to specific behaviour by financial intermediaries and financial markets (endogenous rationing and/or risk premium). This specific behaviour with respect to informational asymmetries is at the root of asymmetries in the transmission of monetary policy to different economic agents. As a consequence, using microeconomic data allows us to identify which groups of agents (firms, banks, households) are driving the effects of monetary policy throughout the economy. This approach avoids aggregation which might blur the overall effect. For example, some firms may be more sensitive to cash-flow changes and may drive the behaviour of the aggregate variables whereas a large number of other firms may be directly affected by a rise in interest rates, and so decrease their output and factor demand. This paper aims at providing additional results with respect to the common paper of the monetary transmission network on investment. In particular, it compares 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]). Then, different sample splits are evaluated. In all cases, we compared the neo-classical demand for capital model with a case in which cash-flow is added into the regressions of this neo-classical demand for capital. This paper provides a range of estimates of elasticities for sales and user cost and of sensitivities of capital to cash-flow. It seeks to specify to what extent these estimates are reliable from a technical point of view, in particular as regards the user cost of capital. Once we have identified these estimates and the differential effects related to sample splits, we can use them as a starting point for a tentative overall evaluation of monetary policy channels as presented in the Chatelain et al. [2001] synthesis paper on investment of the monetary transmission network of the Eurosystem.

Section 2 gives an overview of investment and finance of French companies in the nineties. Sector 3 presents the theoretical model of investment and the estimation method. Section 4 describes the data set and empirical results. Section 5 concludes.

## 2. An overview of investment by and financing of French Firms.

### *2.1 Institutional and Macroeconomic Background.*

The financial deregulation of the French economy occurred in the mid 1980s. This led to considerable change in the money market. Quantitative credit regulation of banks was stopped. There were changes in the regulation of banks' activities. Treasury bills took on greater importance, new financial instruments appeared on the scene, and new equity markets were set up ("second marché"). Post-1990 saw a stabilisation in the gains from monetary and financial innovations obtained by small and medium size companies. This can be explained by several factors: a recession and low activity period 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, Cooke ratios for banks and so on.

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.[3] Monetary policy shifted from high nominal short-run interest rates from 1990 to 1993 to falling rates from 1994 to 1999. A striking feature was the inversion of the yield curve from 1991 to 1993 (see figure 6). The high return from short-run debt caused some firms to delay investment and to accumulate cash during this period.

Companies in the nineties can be characterised by the following macroeconomic patterns. 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

[3] These macro-economic movements are reflected in our micro-economic sample, as seen in figures 5 and 6.

investment. Therefore, a high self-financing ratio prevailed over the period except for the last two years (aggregate retained earnings/investment ratio were over 100% in 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 nineties, was a decrease in the leverage trend, 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.

### *2.2 Microeconomic background.*

It is interesting to check to what extent macroeconomic movements were reflected in individual firms' accounts. We now present the changes in balance sheet items over the nineties using the full sample of manufacturing firms of the Banque de France's Balance Sheet Data Centre. Its coverage was 55% of employment in manufacturing in 1997.

First, let us consider the composition of liabilities. The main financing sources of French companies are internal funds and debts (see figure 1 for mean values). French corporations improved their financial situation considerably in the first half of the nineties by raising their internal funds by more than 5 percentage points from 33% in 1990 to almost 38% in 1999. This increase was particularly pronounced in the accelerating economic upswing at the end of the eighties, but it also continued at a slower pace during the following recession.

The ratio of equity to total liabilities demonstrates parallel movements whatever the size of the firm, except for large firms during 1997 to 1999 (figure 2). A leverage ratio provides a mirror image of this trend (figure 3). Firms reduced their leverage by more than 6 percentage points between 1990 and 1999. This decreasing trend was relatively insensitive to cyclical fluctuations. We also observed a declining trend in the share of bank debt as a percentage of total liabilities. According to the weighted mean, the average indebtedness of French manufacturing firms to credit institutions decreased slightly, from 18% in 1990 to 12.2% in 1999 for small firms (from 10.8% to 6.7% for large firms).

Let us now consider the composition of assets. According to the overall weighted mean, it seems that French firms more or less maintained their stock of tangible fixed assets with respect to total assets, with the exception of larger businesses, which significantly reduced their capital stock in the period under review (figure 4). Tangible fixed assets first increased slightly up to 1991/92, followed by a reduction of corporate investment in production capacity.

It may be the case that the long-term trend of tangibles mirrors not only investor expectations, but to some extent also the growing tendency towards external growth. It seems that a large proportion of (large) manufacturing firms decided in the first half of the nineties to channel a major part of their cash flow into the acquisition of financial assets, especially participating interests, rather than to invest in new tangible fixed assets. The financial fixed assets ratio increased sharply from 15.6% in 1990 to 22.8% in 1999 due to the development of the financial market and the rise of equity prices at the end of the nineties.

### *2.3 Econometric Evidence on Corporate Investment.*

a) Macroeconomic investigations.

Empirical work on French macroeconomic data faces difficulties when trying to find a significant effect of the user cost of capital on investment, a problem which has been shared with U.S. data. According to Blanchard [1986], "*it is well known that to get the user cost to appear at all in the investment equation, one has to display more than the usual amount of econometric ingenuity, resorting most of the time to choosing a specification that simply forces the effect to be there*".

The absolute value of the elasticity of the stock of capital with respect to the user cost is the elasticity of substitution between capital and labour. Three of the five French forecasting models used in the nineties do not include the cost of capital (Amadeus from INSEE, Mosaïque from OFCE, and the Banque de France's model), while INSEE's Metric model adds a relative cost of factors whose parameter is small (-0.016) and not significant (Assouline et al. [1998]). A fifth model assumes a Cobb Douglas production function where the elasticity of substitution between capital and labour is fixed at one (Hermes model, Ecole Centrale). Herbet [2001] published a recent estimation of macroeconomic investment and recognised its failure to incorporate interest rate or user cost effects.

b) Microeconomic and sectoral investigations

- Effect of the User Cost.

A few recent studies investigate the effect of the user cost on French microeconomic data. The results depends on the computation of the user cost, on the data selection and the estimation period, on the estimation method and, finally, on the estimated model and on the choice of explanatory variables.

As for U.S. data (Chirinko, Fazzari and Meyer [1999]), the Within estimations are successful in delivering high significant elasticities. Using the "aggregated by size and sector" European dabase BACH, Mojon Smets and Vermeulen [2001] estimated an error correction model omitting cash-flow. They obtained a very high elasticity for the user cost for France (-0.75) and for large countries in the euro area (-0.90). Conversely, using the same database, Beaudu and Heckel [2001] estimated a first differenced neo-classical demand for capital, adding cash-flow into the regression. They computed the user cost as the three-month short-run interest rate deflated by value-added price instead of a linear function of the firms' apparent debt rate as in Mojon, Smets and Vermeulen [2001]. They estimated this model in first differences without lags, using ordinary least square corrected for heteroscedasticity. They found a significant elasticity of (-0.02) pooling all countries and a 0 elasticity for the group of large countries including France.

Using a sample of individual firms' accounts (BIC, Bénéfices Industriels et Commerciaux) at INSEE, Crépon and Gianella [2001] estimated neo-classical capital and labour demand simultaneously. In their estimated capital demand equation, they did not add cash-flow nor lags of explanatory variables. They selected two years of their panel (1990 and 1995 taken from the period 1984 to 1997) with considerable differences in investment and user cost. They used a limited amount of the statistical informations that was available to them. They used instrumental variables but not generalised method of moments (GMM) estimators. They indirectly obtained a user cost elasticity of (-0.63) for industry and of (-0.35) for services. Using the BRN (bénéfices normaux réels) sample of the BIC sample, Duhautois [2001] aggregated data by sector and size from 1985 to 1996. He estimated investment as a function of earnings before interest and taxes, leverage and a real apparent interest rate, omitting the growth of sales. Using the Within estimator, he found a real interest rate elasticity of (–0.38) from 1985 to 1990 and of (–0.27) for the period 1991-1996. None of these papers includes an estimation of user cost elasticity using French microeconomic data and GMM estimates.

- Effect of Liquidity or Financial Variables.

Cash-flow, cash stock, leverage and coverage ratio are some of the liquidity variables which reflect at least partly the broad credit channel of monetary policy. Models estimating investment as a function of sales growth and cash-flow have been around for a long time (Hall, Mairesse, Mulkay [2000]). We mention only a few recent papers using French microeconomic data and estimating asymmetries in firms' sensitivity to liquidity variables.

Using Euler investment equations where the cost of debt increases with leverage, Chatelain and Teurlai [2000a] show that the investment of some firms which are financially "healthy" with respect to criteria such as a high dividend/payout ratio or high investment/retained earnings depends on leverage (i.e. already a credit channel effect), whereas other firms are subject to another kind of financial constraints where cash-flow matters (their estimation period is 1993-1996). Using individual data on leasing, Chatelain and Teurlai [2000b] found that small firms with a high share of capital financed by leasing were also more sensitive to the credit channel. Crépon et Rosenwald [2001] showed that the leverage parameter is lower for small firms during the high activity years 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 et Heckel [2001] led to a higher investment/cash flow sensitivity of small firms during monetary restriction years. In Duhautois [2001], leverage explains investment of small firms from 1985 to 1996 in a regression where sales growth is an omitted variable.

## 3. The Intertemporal Behaviour of Firms

### *3.1 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 $\rho_t$ the nominal return on other risky financial assets between period $t$ and period $t+1$ :[4]

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

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 $p_{it}^{E}$ ), $\Psi_{it}$ is new share issues. Solving this iterative arbitrage condition

[4] To be more precise, $\rho$ 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.

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:

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

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:

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

$\delta$ 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 $\mathrm{itc}_{it}$ is taken into account:

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

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; $\tau_t$ 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:

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

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:

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

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

$$
c_1=\frac{(1-\delta)}{(1+\rho_t)}\frac{E_t(1-\text{itc}_{i,t+1})p_{s,t+1}^I}{(1-\text{itc}_{it})p_{st}^I}, \qquad c_2=[\rho_t-(1-E_t\tau_{t+1})i_{it}]\frac{B_{it}}{(1-\text{itc}_{it})p_{st}^I K_{it}},
$$

$$
c_3=\frac{\delta E_t\tau_{t+1}}{(1-\text{itc}_{it})}.
$$

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. The term $c_2$ is obtained after substitution using the Euler condition on debt. It decreases the cost of capital due to the 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 $(1-\text{itc}_{it})$ everywhere it appears by $(1-\text{itc}_{it}-z_{it})$, 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):

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

The Hayashi [2000, p.80] formula can be obtained by setting the investment tax credit $\text{itc}_{it}$ to zero and by assuming a constant corporate income tax rate ($\tau_{it}=E_t\tau_{i,t+1}$). In our applied work, we set the investment tax credit rate to zero for reasons detailed in the data appendix and we used an accounting measure of leverage instead of an economic one (the denominator is accounting debt and equity 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 taxation.

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

### *3.2 Econometric Model*

We set the production function as a CES production function ($S_{it}$ is sales):

$$(8)\quad S_{it} = F\left(K_{it}, N_{it}\right) = A_{it}\left[aK_{it}^{\sigma-1/\sigma} + bL_{it}^{\sigma-1/\sigma}\right]^{\left(\frac{\sigma}{\sigma-1}\right)\upsilon}$$

*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:

$$(9)\quad k_{it} = \left(\sigma + \frac{1-\sigma}{\upsilon}\right)s_{it} - \sigma.c_{it} - \frac{1-\sigma}{\upsilon}\ln\left(A_{it}\right) + \sigma\ln\left(\upsilon.a\right)$$

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 $-[(1-\sigma)/\upsilon]\ln\left(A_{it}\right) + \sigma\ln\left(\upsilon.a\right)$ 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:

$$(10)\quad \begin{aligned} k_{it} &= \gamma_1 k_{i,t-1} + \gamma_2 k_{i,t-2} + \beta_0 s_{it} + \beta_1 s_{i,t-1} + \beta_2 s_{i,t-2} - \sigma_0 c_{it} - \sigma_1 c_{i,t-1} - \sigma_2 c_{i,t-2} \\ &+ \theta_0 \frac{CF_{it}}{p_{st}^I K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p_{s,t-1}^I K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p_{s,t-2}^I K_{i,t-3}} + \alpha_i + \alpha_t + \varepsilon_{it} \end{aligned}$$

where $\alpha_i$ is an individual constant (fixed effect), $\alpha_t$ is a time constant (year effect) and $\varepsilon_{it}$ is a random shock. We add cash-flow (otherwise a potentially omitted variable) 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 $\nu = (1-\sigma_{LT})/(\beta_{LT} - \sigma_{LT})$. As explained later, we estimate this model in first differences using the generalised method of moments (GMM). The endogenous variable is then $\Delta k_{it}$ where $\Delta$ 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.)

(11)

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

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:

(12)

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

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. Up to now, applied econometric papers using panel data with a small number of years and a large number of firms did not take into account co-integration. An argument put forward by Hall, Mairesse and Mulkay [2001] is that the ECM(2,2) on panel data can deal better with the collinearity of variables than the ADL(2,2) and ADL-I. . But introducing first differences does not remove the potential collinearity between two variables. First differences can remove the auto-correlation of one of the variables in the case of a unit root. A drawback of the ECM is that the test for necessary lags is not direct (in particular lag 2). 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, Von Kalckreuth [2001], 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:

(13)

$$\frac{I_{it}}{K_{i,t-1}} = \gamma_1 \frac{I_{i,t-1}}{K_{i,t-2}} + \gamma_2 \frac{I_{i,t-2}}{K_{i,t-3}} + \beta_0 \Delta s_{it} + \beta_1 \Delta s_{i,t-1} + \beta_2 \Delta s_{i,t-2}$$

$$- \sigma_0 \Delta c_{it} - \sigma_1 \Delta c_{i,t-1} - \sigma_2 \Delta c_{i,t-2} + \theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p^I_{s,t-2} K_{i,t-3}}$$

$$+ f_i + \Delta \varepsilon_{it} + \alpha_t$$

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 andECM 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 thesemodels 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 $\alpha_i$ (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.

## 4. Data and Econometric Results

### 4.1. Data Description

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). A comparison with some samples used in previous studies shows that our panel is rather large and includes a larger set of small firms (tables 2 and 3).

Descriptive statistics for components of the user cost are presented on table 1 and for variables used in the regressions on table 2. The evolution of these variables over time is presented in figures 5 and 6. 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).

### 4.2. Estimation Results with Entire Sample

In table 3, 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 $\gamma_1 + \gamma_2$.

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 (-0.209However, 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. This result shows why  unit root problems can be set aside. 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.

As the difference ADL model was dealt with in detail in the Chatelain et al. [2001] paper, we focus in the next section on the ADL(2,2) and ADL-I model. Our next step is to compare the above GMM results with the ones obtained estimating the ADL(2,2) model and ADL-I model(see table 4). In these two models, it was easy to check immediately whether lags of order 2 were necessary or not. It turned out that lags of order 2 for sales, user cost and cash-flow were not significant, whatever the set of instruments we tried. We decided to remove these lags from our baseline equation. Nonetheless, lag 2 of the stock of capital remained very often significant and was kept in the regressions.

In both models, the sum of the coefficient of the auto-regressive term was around 0.7 to 0.8 (this result corresponds to a coefficient of *ln(K(t-2))* of –0.2 in model ADL-I). This auto-regressive component is identical to the one estimated in the ECM. When excluding cash flow from regressions in the ADL model and in model ADL-I (table 4, regressions 1 to 4), we found fairly similar results in both models, even when removing the instrument I(t-2)/K(t-3) (table 4, regression 1 and 2). The user cost is not significant in model ADL-I when this instrument is added (the Sargan test of over-identifying restrictions is then rejected), whereas it remains significant for the ADL model with an estimate of -0.23. Sales are significant with a long-run elasticity between 0.3 and 0.5.

Introducing cash-flow to the regression leads to dramatic changes in the results. User cost and sales growth are no longer significant. The investment cash-flow long-run sensitivity is significant with a value of around 0.15.[5] These results are very close between

[5] Removing some instruments changes the results, with a sharp increase in the Sargan statistic, so that the 5% threshold is rejected for its p-value. For the ADL model, we used lags of I(t)/K(t-1) instead of lags of *Ln*(K(t))

the two models (ADL and model ADL-I) so that the change of dependent variable and the approximation of the first difference of *Ln*(K(t)) by the investment ratio does not affect the results much. They are also close to the GMM results from the ECM and the difference ADL model, although these models include additional lags of order 2.

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).

How can we explain that the effect of the introduction of cash-flow drives down the user cost elasticity to zero, whereas it is significantly different from zero when cash-flow are omitted?

as instruments, because the stock of capital includes measurement errors. In so doing, we retained similar instruments for the ADL and model ADL-I.

First, the user cost definition we retained is a linear function of a microeconomic apparent interest rate which includes an agency premium. According to the broad credit channel theory (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 (e.g. 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 decrease of the elasticity of the user cost, 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), i.e. we face a collinearity problem, which is not solved by GMM.

A second explanation is related 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 the microeconomic level: some firms may depend much more on cash-flow than others. In that case, the omission of a dummy variable selecting these firms may bias the estimations results. This is what we investigate in the following section.

### 4.3. Sample Split Results

We tried several sample splits to isolate firms more sensitive to cash-flow. Descriptive statistics with respect to sectors and other sample splits are presented on table 5. Sample splits with respect to size, to the share of intangibles and to the dividend pay-out ratio did not bring relevant statistical and economic results.

First, we checked the sensitivity of estimated coefficients of the ADL(2,2) ? model with respect to sectors (we considered five manufacturing sectors: the food industry, intermediate goods, equipment goods, consumption goods and the car industry). We did not find significant differences between sectors. But the differential coefficients which were the closest to being significant were related to the equipment goods sector. We then introduced a dummy variable related to the equipment goods sector vis-à-vis the other sectors. When cash-flow is not an explanatory variable, the differential coefficients for sales and user cost are not significantly different from zero (table 6). When cash-flow is an explanatory variable, its short-run (respectively long-run) *differential* coefficient is significantly different from zero (+0.082, respectively +0.363). Thus, the equipment goods sector is much more sensitive to cash-flow than others. It is remarkable that the user cost is now significant for all firms with a long-run elasticity of -0.26 and sales growth with a long-run elasticity of 0.3.

Then, we considered a dummy variable for firms with a lower share of trade credit in total liabilities (more precisely, firms for which this statistic is below the upper quartile). This situation may be a signal that these firms are experiencing difficulties in securing external finance . In the model without cash-flow, there are no significant differences for those firms. When cash-flow is added, firms with low trade credit are no longer significantly dependant on cash-flow, which is consistent with the above interpretation. Note that this time, for all firms, sales growth is significant with a higher elasticity of 0.427, but user cost is not significant.

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 failure of firms. When cash-flow is omitted in the regression, firms which are risky according to the Banque de France score (i.e. when the score statistic is below –0.3) have a significantly lower elasticity with respect to sales than others. But this result is no longer valid when cash-flow is added to the regression. Note however that the Sargan test is only accepted at the 3% threshold. The differential coefficient on cash-flow is significant in the short run (+0.216 in the long run). This result was expected, as these firms experience more difficulties when trying to get external finance. As for the equipment goods sector, the user cost elasticity is significant for all firms (-0.207) as is sales growth elasticity (0.646).

These three dummy variables were able to isolate firms sensitive to cash-flow. We found that omitting these dummy variables led to bias downwards to zero the estimate of the elasticity of the user cost once cash-flow was included in the regression. When dummy variables related to firms which are more sensitive to cash-flow are added to the model, *the user cost elasticity with respect to investment is at most 0.26 in absolute terms for all the firms of our sample*, using Generalised Method of Moments estimates in the ADL model. This confirms the direct effect of the interest rate channel on investment, operating through the cost of capital in France (there is also an indirect effect of monetary policy shocks on the macroeconomic growth of sales, which also affects corporate investment).

We isolated three group of firms, for which investment is more sensitive to cash-flow (i.e. their investment cash flow *differential* sensitivity ranges from 0.20 to 0.36): firms facing a high risk of bankruptcy, firms belonging to the equipment 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 (0.22 up to 0.42), which represents about 20% of our* *sample, confirms the existence of a broad credit channel operating through corporate investment in France.*

## 5. Conclusion

We investigated the properties of the ADL(2,2), ADL-I and ECM(2,2) model with respect to the difference ADL model. These four models have been used in companions papers of the MTN network: the MTN synthesis paper on firms by Chatelain et al. [2001] and Von Kalckreuth [2001] focused on a difference ADL(3,3), Valderrama [2001] focused on a difference ADL(1,1), Butzen, Fuss and Vermeulen on a difference ADL(4,4), while Mojon, Smets and Vermeulen [2001] and Generale and Gaiotti [2001] focused on an Error Correction Model of order 2. We considered an ADL specification of the neo-classical demand for capital with a firm-specific user cost of capital to test for investment behaviour in France, as the difference ADL estimation had already been investigated for France in the MTN synthesis paper on firms by Chatelain et al. [2001]. Whatever the capital demand model and its number of lags, we found the following set of results on our data set of French manufacturing firms, for the estimation period 1990-1999:

- Without dummy variables related to sample splits, the user cost of capital has a negative and significant elasticity with respect to capital using the traditional Within estimates, or as long as cash-flow is not added to the regression when using Generalised Method of Moments estimates. Using GMM, the elasticity has a lower absolute value than in the Within case.

- When cash-flow is added to the regression without dummy variables related to sample splits, the sales elasticity of capital has a lower value and the user cost elasticity is no longer significant when using Generalised Method of Moments.

- When we introduce dummy variables related to sample splits (in particular risky firms or equipment goods), we isolate a strong cash-flow effect for some groups of firms, with the result that sales growth and user cost become significant for all firms. With a dummy variable related to the trade credit criterion, the user cost is not significant but sales growth is. These results show that there are distributional effects of monetary policy on investment, driven by an asymmetric cash-flow channel. Risky firms, high trade credit firms and equipment goods firms are more sensitive to cash-flow than other firms.

These results provide a first set of microeconomic results for the investment of French manufacturing firms. They 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 as developed in Chatelain et al. [2001] and Angeloni et al. [2001].

## References


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

Andrews, D. (1999), "Consistent Moment Selection Procedures for Generalized Method of Moments Estimation", *Econometrica*, 67(3), pp. 543-64.

Arrelano, M. and Bond, S. (1991): "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equation", *The Review of Economic Studies,* 58, pp. 277-97.

Auerbach A.J. (1983). "Taxation, Corporate Financial Policy and the Cost of Capital". *Journal of Economic Literature.* 21, pp: 905-40.

Beaudu A. and Heckel T. (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, pp. 117-141.

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

Bond, S., Elston, J., Mairesse, J. and Mulkay, B. (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., Fuss C. and Vermeulen P. (2001). "The interest rate and credit channel in Belgium: an investigation with micro-level firm data". *European Central Bank Working Paper, 107* .

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. and Kashyap, A. (2000): "Issues regarding estimation of the firm level investment equations", *European Central Bank*, Mimeo.

Chatelain, J.B. and Teurlai, J.C. (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 Teurlai, J.C. (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., Generale A., Hernando I., Vermeulen P. and von Kalckreuth U. (2001): "Firm Investment and Monetary Transmission in the Euro Area". *European Central Bank Working Paper*, 112.

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

v. Kalckreuth, Ulf (2001): "Monetary transmission in Germany: New perspectives on finance constraints and investment spending". Bundesbank. *European Central Bank Working Paper*, 109.

Crépon, B. and Gianella, C. (2001): "Fiscalité et coût d'usage du capital: incidence sur l'investissement, l'activité et l'emploi", *Economie et Statistique, 341-342*(1/2), pp. 107-28.

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

Dormont, B. (1997): "L'influence du coût salarial sur la demande de travail", *Economie et de Statistique, 301-302,* pp. 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), pp. 47-66.

Gaiotti, E. and Generale, A. (2001) "Does Monetary Policy Have Asymmetric Effects ? A Look at the Investment Decisions of Italian Firms". *European Central Bank Working Paper,* 110.

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

Hall, R.E. and Jorgenson, D.W. (1967): "Tax Policy and Investment Behavior ", *American Economic Review,* 59 (3),pp. 921-47.

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

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

Hayashi, F. (2000): "The Cost of Capital, Q, and the Theory of Investment" in *Econometrics and the Cost of Capital,* Lawrence J. Lau ed., 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, pp.85-106.

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

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

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

Oliner S.D. and Rudebush G.D. (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", *Oesterreichische National Bank*, *European Central Bank Working Paper* forthcoming

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:

$$UC = \frac{P_t^I}{P_{st}}\left(1-\mathrm{itc}_t\right)\left[AI_{it}\left(\frac{B_{it}}{B_{it}+E_{it}}\right)+\frac{LD_t}{\left(1-\tau_t\right)}\left(\frac{E_{it}}{B_{it}+E_{it}}\right)-\frac{\left(1-\delta\right)}{\left(1-\tau_t\right)}\frac{\Delta P_{t+1}^{\;I}}{P_t^I}+\delta_{st}\right]$$

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 $\tau_t$ 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.[6]

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:

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

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 $T_{\text{mean}}$ years before the date when the first book value was available, where $T_{\text{mean}}$ represents the corrected average age of capital (this method of evaluation of capital is sometimes called the "stock method"). The average age of capital $T_{\text{mean}}$ 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 $\text{DEPR}_{it0}^{BV} / (p_{st0}^{K} K_{it0})$ ($\text{DEPR}_{it0}^{BV}$ is the total book value of depreciation allowances in year $t_0$ according to the following formula[7]:

[6] 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, in the end we did not take it into account.
[7] This formula is used by Jacques Mairesse in the Bond et al. [1997] paper.

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

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

The book value of depreciation allowances $\text{DEPR}_{it0}^{BV}$ 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, 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).

**Figure 1: Structure of Liabilities**

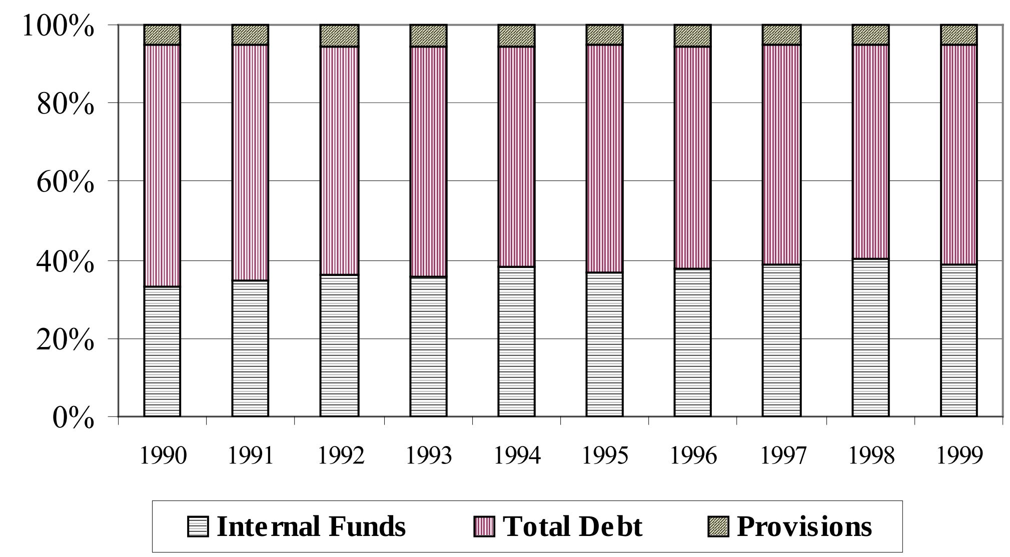


**Figure 2: Internal Funds / Total Liabilities (Median by size)**

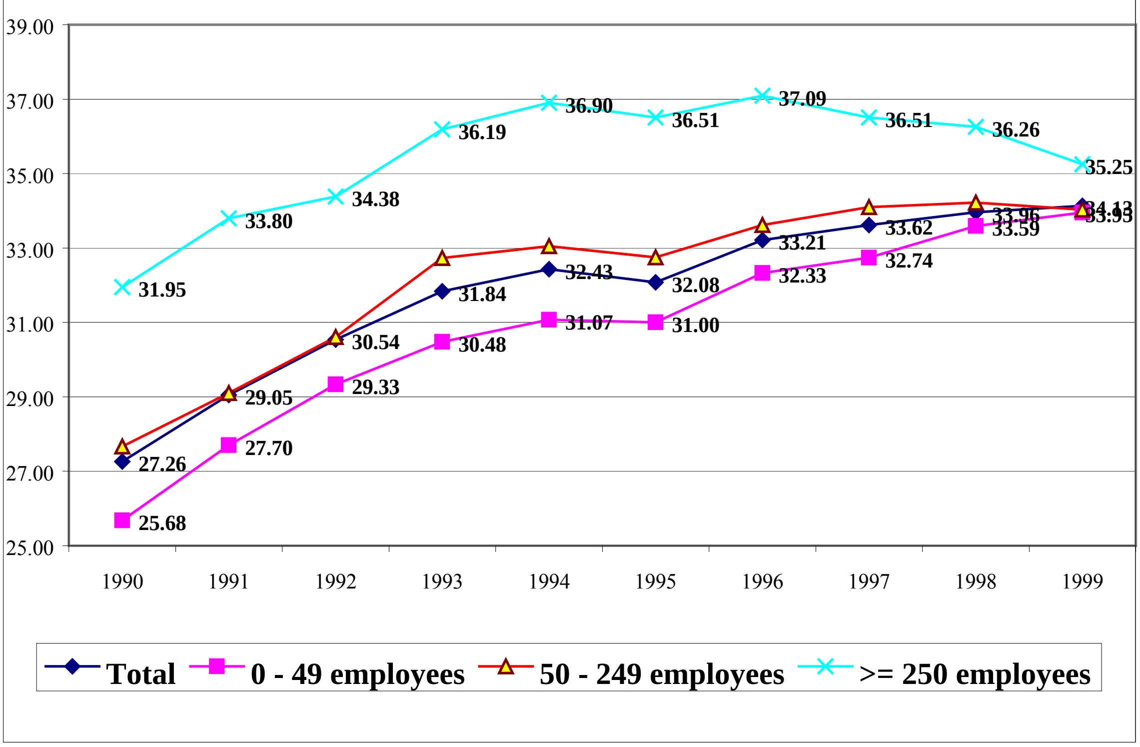

**Figure 3: Debt / Total Liabilities (Median by size)**

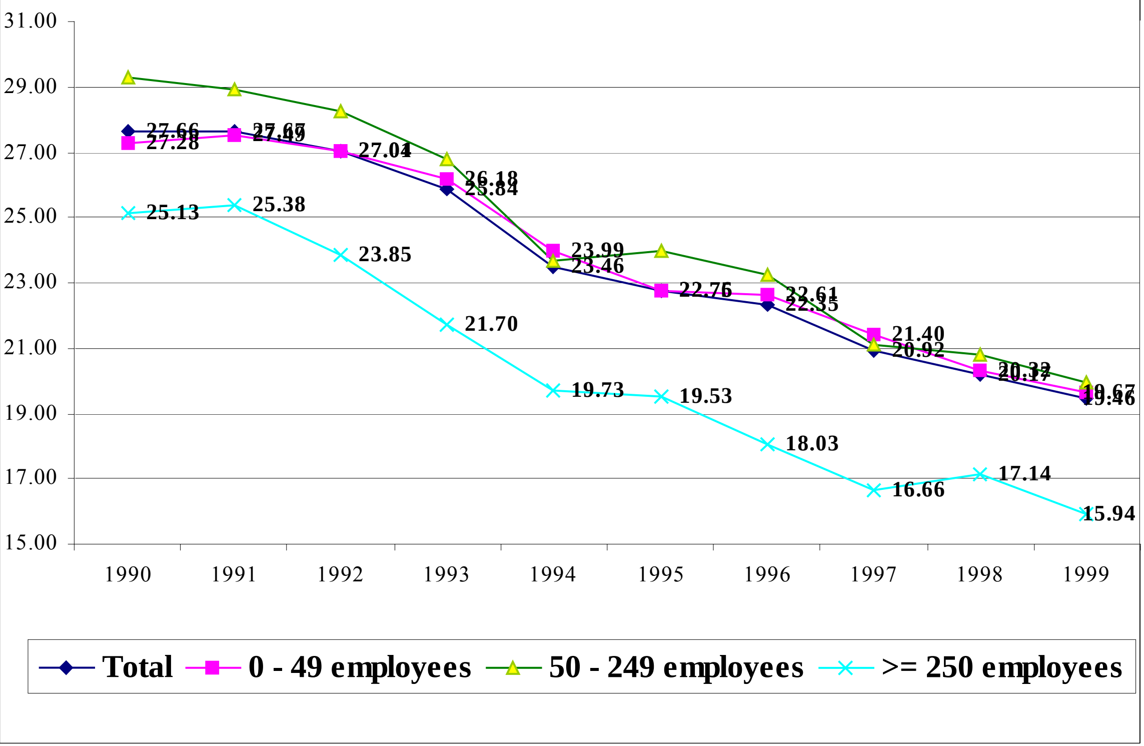


**Figure 4: Structure of assets**

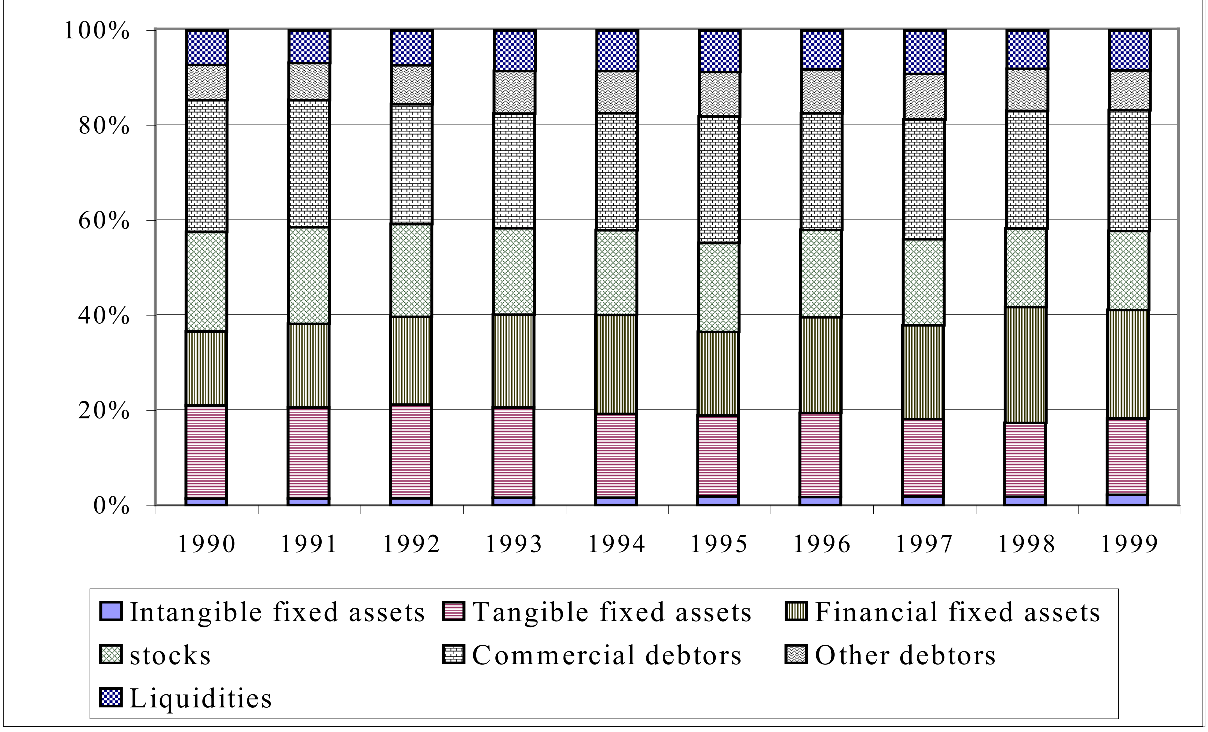

**Table 1: Average Values of the Cost of Equity, the Cost of Debt and the User Cost of capital**

| Year | pi/pva | Leverage | Apparent Interest Rate | Cost of Equity | Growth of pi | Depreciation | User Cost |
|---|---|---|---|---|---|---|---|
| 1986 | 0.99 | 0.55 | 0.12 | 0.16 | 0.03 | 0.08 | 0.18 |
| 1987 | 0.99 | 0.51 | 0.11 | 0.18 | 0.03 | 0.08 | 0.18 |
| 1988 | 0.98 | 0.48 | 0.12 | 0.15 | 0.04 | 0.08 | 0.15 |
| 1989 | 1.00 | 0.48 | 0.11 | 0.14 | 0.02 | 0.08 | 0.17 |
| 1990 | 0.99 | 0.47 | 0.12 | 0.16 | 0.03 | 0.08 | 0.17 |
| 1991 | 1.00 | 0.46 | 0.11 | 0.13 | 0.02 | 0.08 | 0.18 |
| 1992 | 1.00 | 0.46 | 0.11 | 0.12 | -0.002 | 0.08 | 0.20 |
| 1993 | 0.99 | 0.44 | 0.12 | 0.09 | 0.006 | 0.08 | 0.17 |
| 1994 | 1.01 | 0.42 | 0.11 | 0.10 | 0.01 | 0.08 | 0.17 |
| 1995 | 1.00 | 0.42 | 0.10 | 0.11 | 0.02 | 0.08 | 0.16 |
| 1996 | 1.03 | 0.41 | 0.09 | 0.09 | 0.001 | 0.08 | 0.18 |
| 1997 | 1.03 | 0.40 | 0.09 | 0.09 | -0.004 | 0.08 | 0.18 |
| 1998 | 1.03 | 0.39 | 0.08 | 0.08 | 0.00 | 0.08 | 0.16 |
| 1999 | 1.05 | 0.38 | 0.08 | 0.07 | 0.00 | 0.08 | 0.16 |
| **Mean** | **1.01** | **0.43** | **0.10** | **0.11** | **0.01** | **0.08** | **0.17** |

Pi/pva is the relative price of investment (base year 1995, 5 manufacturing sectors, NES16, retropolated before 1993), Growth of pi is the inflation rate of investment goods. Leverage is debt/(debt+equity), and not debt/total liabilities. The apparent interest rate is (debt service/debt). Cost of equity : long run rate on government bonds corrected by the corporate income tax rate. C is the user cost.

**Table 2: 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 |

**Figure 5. Investment, User Cost, Cash-Flow and Growth of Sales (Means)**

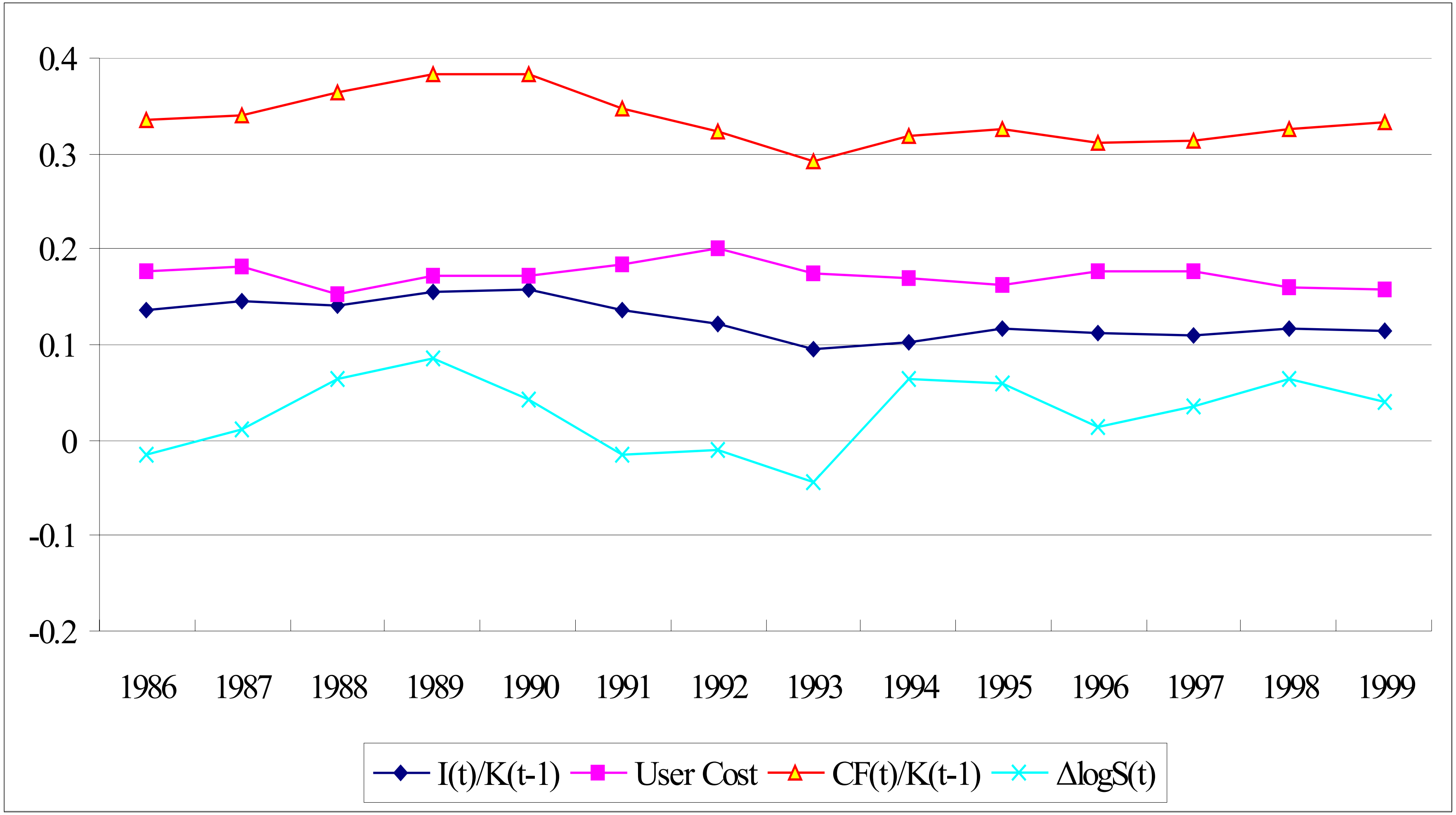

**Figure 6. User Cost of Capital and Nominal Interest Rates (Means)**

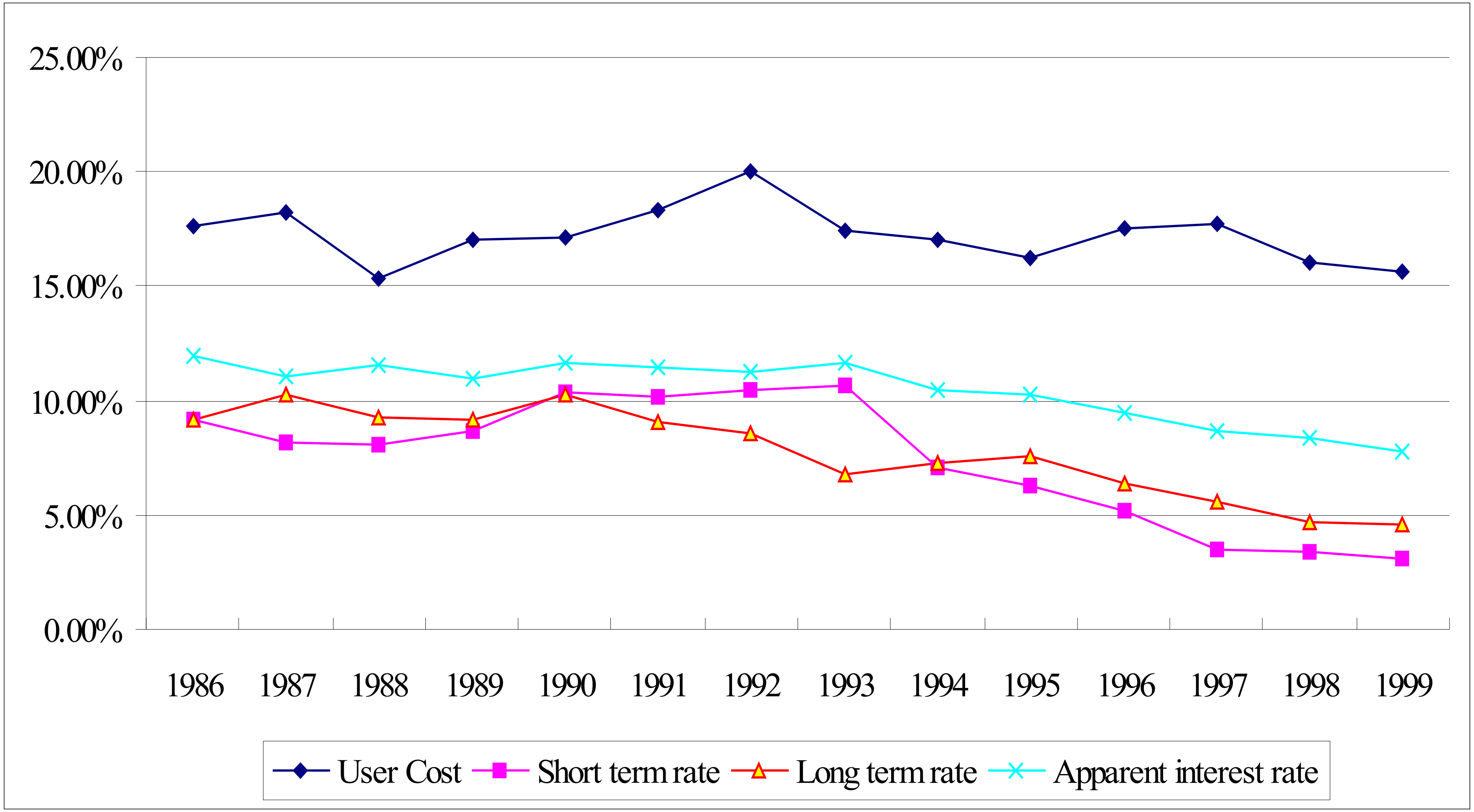

**Table 3: Econometric Results: I(t)/K(t-1) as dependent variable**

| | **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 |
| ΔLog S(t) | 0.118 | 20.85 | 0.027 | 0.75 | 0.084 | 15.79 | 0.004 | 0.11 |
| ΔLog S(t-1) | 0.134 | 20.22 | 0.043 | 1.17 | 0.065 | 11.76 | 0.039 | 5.36 |
| ΔLog 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 | | | | |
| ΔLog UC(t) | | | | | -0.197 | -28.25 | -0.008 | -0.34 |
| ΔLog UC(t-1) | | | | | -0.116 | -16.84 | -0.011 | -0.91 |
| ΔLog 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.

**Table 4: Econometric Results: Comparison of ADL and model ADL-I with or without Cash-Flow and using different types of instruments.**

| | **1: ADL(2,2)** | | **2: Model ADL-I** | | **3: ADL(2,2)** | | **4: Model ADL-I** | | **5: ADL(2,2)** | | **6: Model ADL-I** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variable | **log(K(t))** | | **I(t)/K(t-1)** | | **log(K(t))** | | **I(t)/K(t-1)** | | **log(K(t))** | | **I(t)/K(t-1)** | |
| | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats |
| K(t-1) | 0.700 | 12.82 | | | 0.810 | 37.31 | | | 0.852 | 32.44 | | |
| I(t-1)/K(t-2) | | | -0.266 | -4.99 | | | -0.211 | -4.12 | | | -0.126 | -5.17 |
| Log K(t-2) | 0.024 | 0.58 | -0.306 | -13.62 | -0.059 | -6.30 | -0.270 | -13.23 | -0.057 | -5.99 | -0.223 | -8.62 |
| Log S(t) | 0.064 | 2.19 | 0.072 | 1.94 | 0.060 | 2.02 | 0.007 | 0.21 | 0.036 | 1.21 | 0.033 | 0.85 |
| Log S(t-1) | 0.070 | 2.47 | 0.096 | 2.76 | 0.062 | 2.22 | 0.072 | 2.21 | 0.026 | 0.98 | 0.039 | 1.20 |
| Log UC(t) | -0.057 | -2.70 | -0.050 | -1.79 | -0.054 | -2.54 | -0.031 | -1.14 | -0.028 | -1.34 | -0.008 | -0.31 |
| Log UC(t-1) | -0.029 | -2.03 | -0.030 | -1.79 | -0.004 | -0.39 | -0.019 | -1.15 | -0.006 | -0.61 | -0.008 | -0.72 |
| CF(t)/K(t-1) | - | - | - | - | - | - | - | - | 0.012 | 0.55 | 0.007 | 0.25 |
| CF(t-1)/K(t-2) | - | - | - | - | - | - | - | - | 0.018 | 2.17 | 0.030 | 2.96 |
| **Auto-regressive coeff.** | **0.724*** | | **0.794*** | | **0.751*** | | **0.730*** | | **0.795*** | | **0.777*** | |
| **Long term eff. Sales** | **0.485*** | | **0.549*** | | **0.491*** | | **0.293*** | | **0.308** | | **0.325** | |
| **Long term eff. User Cost** | **-0.311*** | | **-0.262*** | | **-0.232*** | | **-0.183** | | **-0.163** | | **-0.074** | |
| **Long term eff. C.Flow** | **-** | | **-** | | **-** | | **-** | | **0.150*** | | **0.167*** | |
| | | | | | | | | | | | | |
| AR2 | -2.507 | p=0.012 | -2,316 | p = 0.021 | -2.03 | p=0.043 | -1,871 | p = 0.061 | -2,033 | p=0.042 | -1.87 | p = 0.062 |
| Sargan | 123.97 | p=0.06 | 123.07 | p = 0.067 | 129.45 | p=0.11 | 139.98 | p = 0.033 | 175.11 | p=0.063 | 171.44 | p = 0.091 |
| Instruments: lags of | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| I(t)/K(t-1) | 3 to 5 | | 3 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | |
| Log S(t) | 2 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | |
| Log UC(t) | 2 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | | 2 to 5 | |
| CF(t)/K(t-1) | - | | - | | - | | - | | 2 to 5 | | 2 to 5 | |

Estimation method: 2-step first differences GMM estimates, time dummies.

**Table 5: Descriptive Statistics of Various groups of firms**

| | | Number of Firms | Main Variables | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | I(t)/K(t-1) | ΔLogS(t) | ΔLogUC(t) | CF(t)/K(t-1) | LogS(t) | LogUC(t) |
| **Sectors** | | | | | | | | |
| | Food products | 929 | 0.12 | 0.01 | -0.014 | 0.27 | 9.3 | -1.8 |
| | Intermediate products | 3371 | 0.11 | 0.04 | -0.005 | 0.29 | 8.8 | -1.7 |
| | Equipment goods | 1227 | 0.12 | 0.04 | -0.008 | 0.37 | 8.7 | -1.8 |
| | Consumption goods | 1286 | 0.15 | 0.01 | -0.02 | 0.47 | 8.7 | -1.8 |
| | Car industry | 133 | 0.12 | 0.03 | -0.02 | 0.31 | 9.8 | -1.8 |
| **Employees** | | | | | | | | |
| | <100 | 5195 | 0.12 | 0.03 | -0.008 | 0.33 | 8.8 | -1.8 |
| | >100 | 1751 | 0.13 | 0.03 | -0.009 | 0.32 | 8.2 | -1.8 |
| | <250 | 6192 | 0.12 | 0.03 | -0.009 | 0.33 | 8.5 | -1.8 |
| | >250 | 754 | 0.12 | 0.03 | -0.009 | 0.36 | 11.3 | -1.8 |
| **Intangible Assets** | | | | | | | | |
| | < Q3 | | 0.13 | 0.03 | -0.011 | 0.42 | 8.7 | -1.8 |
| | > Q3 | | 0.12 | 0.03 | -0.007 | 0.30 | 8.9 | -1.8 |
| **Scoring Function** | | | | | | | | |
| | No score | 481 | 0.12 | 0.003 | 0.004 | 0.30 | 9.0 | -1.8 |
| | 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 | | 0.13 | 0.06 | -0.003 | 0.33 | 8.8 | -1.8 |
| | > Q3 | | 0.12 | 0.02 | -0.011 | 0.33 | 8.8 | -1.8 |
| **Dividends** | | | | | | | | |
| | < Q3 | | 0.12 | 0.02 | -0.02 | 0.40 | 9.2 | -1.8 |
| | > Q3 | | 0.12 | 0.03 | -0.005 | 0.31 | 8.7 | -1.8 |

**Table 6: Auto-regressive distributed lags model with log(K) as endogenous variable.**

| | **Sensitivity to risk** | | | | **Sensitivity to Trade Credit** | | | | **Sensitivity to Equipement Goods** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats | Coeff. | T-Stats |
| Log K(t-1) | 0.801 | 33.06 | 0.827 | 30.713 | 0.811 | 31.56 | 0.822 | 31.370 | 0.819 | 36.46 | 0.835 | 34.427 |
| Log K(t-2) | -0.070 | -5.07 | -0.066 | -5.339 | -0.059 | -6.36 | -0.050 | -5.670 | -0.055 | -6.06 | -0.052 | -6.206 |
| Log S(t) | 0.087 | 3.12 | 0.091 | 3.210 | 0.081 | 2.88 | 0.075 | 2.788 | 0.050 | 2.06 | 0.041 | 1.743 |
| Log S(t-1) | 0.105 | 4.29 | 0.064 | 2.697 | 0.051 | 1.68 | 0.023 | 0.826 | 0.026 | 1.04 | 0.022 | 0.944 |
| Log UC(t) | -0.057 | -2.96 | -0.034 | -1.824 | -0.035 | -1.22 | -0.035 | -1.306 | -0.047 | -2.66 | -0.049 | -3.019 |
| Log UC(t-1) | -0.012 | -1.26 | -0.016 | -1.707 | 0.002 | 0.13 | 0.003 | 0.226 | -0.006 | -0.59 | -0.007 | -0.777 |
| CF(t)/K(t-1) | | | -0.015 | -0.636 | | | 0.058 | 2.406 | | | -0.004 | -0.185 |
| CF(t-1)/K(t-2) | | | 0.019 | 2.147 | | | -0.001 | -0.033 | | | 0.018 | 2.025 |
| ***Differential coef. for:*** | ***Risky Firms*** | | ***Risky Firms*** | | ***Low Trade Credit*** | | ***Low Trade Credit*** | | ***Equipment Goods*** | | ***Equipment Goods*** | |
| Log K(t-1) | -0.045 | -0.54 | -0.050 | -0.689 | -0.010 | -0.506 | 0.003 | 0.195 | -0.021 | -0.69 | 0.026 | 0.901 |
| Log K(t-2) | 0.074 | 1.06 | 0.086 | 1.542 | 0.000 | 0.665 | 0.000 | 0.598 | 0.000 | -0.12 | 0.001 | 0.717 |
| Log S(t) | 0.050 | 1.51 | 0.014 | 0.401 | -0.002 | -0.457 | 0.004 | 0.919 | 0.011 | 0.83 | 0.004 | 0.411 |
| Log S(t-1) | -0.083 | -2.55 | -0.046 | -1.489 | 0.009 | 0.505 | -0.004 | -0.236 | 0.025 | 0.97 | -0.008 | -0.322 |
| Log UC(t) | 0.030 | 1.39 | 0.023 | 1.067 | -0.030 | -1.223 | -0.011 | -0.481 | 0.021 | 0.89 | 0.004 | 0.172 |
| Log UC(t-1) | 0.007 | 0.38 | 0.007 | 0.425 | 0.000 | 0.014 | -0.002 | -0.195 | -0.004 | -0.25 | -0.001 | -0.067 |
| CF(t)/K(t-1) | | | 0.077 | 2.328 | | | -0.083 | -3.413 | | | 0.082 | 3.260 |
| CF(t-1)/K(t-2) | | | -0.034 | -2.114 | | | 0.026 | 1.392 | | | -0.014 | -0.903 |
| **Long term eff. Sales** | **0.711*** | | **0.646*** | | **0.534*** | | **0.427*** | | **0.324*** | | **0.291*** | |
| **L.T. eff. User Cost** | **-0.258*** | | **-0.207*** | | **-0.133** | | **-0.140** | | **-0.222*** | | **-0.259*** | |
| **L.T. eff. Cash-Flow** | | | **0.018*** | | | | **0.251*** | | | | **0.066*** | |
| **Differential coef. for:** | **Risky Firms** | | **Risky Firms** | | **Low Trade Credit** | | **Low Trade Credit** | | **Equipment Goods** | | **Equipment Goods** | |
| **Long term eff. Sales** | **-0.051*** | | **-0.041** | | **0.006** | | **0.009** | | **0.110** | | **0.022** | |
| **L.T. eff. User Cost** | **0.124** | | **0.110** | | **-0.110** | | **-0.061** | | **0.085** | | **-0.021** | |
| **L.T. eff. Cash-Flow** | | | **0.216*** | | | | **-0.250*** | | | | **0.363*** | |
| AR2 | -1.871 | p = 0.061 | -1.993 | p = 0.046 | -2.077 | p = 0.038 | -2.266 | p = 0.023 | -2.194 | p = 0.028 | -2.077 | p = 0.038 |
| Sargan | 216.59 | p = 0.045 | 300.91 | p = 0.031 | 188.67 | p = 0.371 | 288.22 | p = 0.088 | 221.01 | p = 0.029 | 275.48 | p=0.204 |

Instruments used in the regressions are all explanatory variables lagged 2 to 5.

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