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

Jean-Bernard Chatelain[1] and André Tiomo[2]

Ce travail a été réalisé dans le cadre d'un réseau de recherche organisé par la Banque Centrale Européenne avec l'ensemble des Banques Centrales Nationales de la zone euro. Ce réseau intitulé « Monetary Transmission Network » a fonctionné du mois de juin 1999 au mois de décembre 2001, date à laquelle s'est tenue la conférence de clôture. Ces travaux seront publiés dans un ouvrage collectif à paraître chez Cambridge University Press.

This work is part of the production of a network including the European Central Bank and Central National Banks about "Monetary Transmission". This network has been active between June 1999 and December 2001, when a final conference was held in Frankfurt. All the papers are to be published in a collective volume forthcoming at Cambridge University Press.

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Résumé :

En utilisant un panel d'environ 6.946 entreprises manufacturières françaises de 1990 à 1999, nous nous intéressons dans cet article aux effets de la politique monétaire sur l'investissement via le coût du capital et l’autofinancement. Nous comparons plusieurs spécifications de la demande néoclassique du capital, en tenant compte des dynamiques transitoires. Nous montrons que le coût du capital a une élasticité négative et significative dans le cas d’une estimation par la méthode “Within”, ou dans le cas d’une estimation par la méthode des moments généralisés tant que l’autofinancement n’est pas pris en compte dans les variables explicatives. Les asymétries de l'effet de la politique monétaire sont aussi évaluées sur plusieurs groupes d’entreprises qui diffèrent selon les asymétries d’information.

Mots clés: Investissement, politique monétaire, Méthode des Moments généralisés, coût du capital.

Abstract:

Using a large panel of about 6,946 French manufacturing firms, this paper investigates the effect of monetary policy from 1990 to 1999 on investment through the cost of capital and the cash-flow channels. We compare several specifications of the 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 the traditional within estimates, or as long as cash-flow are not added in the regression when using Generalized Method of Moments estimates. Asymmetries of effect of monetary policy are evaluated on different groups of firms which differ with respect to informational asymmetries.

Keywords: Investment, Monetary Policy, Generalized Method of Moments, Cost of Capital.

JEL Classification: C23, D21, D92.

1. Introduction

It is a widespread belief among economists that monetary policy affects the investment of firms. However, applied researchers faced difficulties to obtain a significant effect of the cost of capital (driven by interest rates) on investment on French macro-economic 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 feature leads to stress a broad credit channel of monetary policy with respect to the interest rate channel. In this context, the emphasis has been put on asymmetries between firms, explained by different extent of informational asymmetries leading to specific behaviour by financial intermediaries and financial markets (endogenous rationing and/or risk premium). These specific behaviours with respect to informational asymmetries are at the root of asymmetries in the transmission of monetary policy on different economic agents. As a consequence, using micro-economic data allows to isolate which groups of agents (firms, banks, households) are driving the effects of monetary policy in the whole economy. It avoids aggregation which may blur the overall effect. For example, some firms may be more sensitive to cash-flow changes and can drive the behaviour of the aggregate variables whereas a large number of other firms may be directly affected by a rise of interest rate, and decrease their output and factor demand. This has been one of the targets of the monetary transmission network.

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 e.g. 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 the case where cash-flow are added in the regressions of this neo-classical demand for capital. This paper provides a range of estimates of elasticities of sales and user cost and of sensitivities of capital to cash-flow. It intends to precise to which extent these estimates are reliable from a technical point of view, in particular for the user cost of capital. Knowing these estimates and the differential effects related to sample splits allows to use them as a starting point for temptative overall evaluation of monetary policy channels as presented in the Chatelain et al. [2001] synthesis paper on investment of the network.

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 are given in section 5. Section 6 concludes.

2. An overview of investment and finance of French Firms.

2.1 Institutional and Macroeconomic Background.

The financial deregulation of the French economy has been implemented in the mid 1980's. Considerable change occurred in the monetary market. Quantitative credit regulation of banks was stopped. There were changes in the regulation of banks activities, as well as the development of treasury bills, of new financial instruments and of new equity markets ("second marché"). After 1990, a stabilization of the gains due to monetary and financial innovations obtained by small and medium size companies occurred. This is explained by several factors: a recession and low activity period leading to a high number of firms failures, a large amount of bad loans for banks, an important part of them being related to the end of the bubble in firms real estate, Cooke ratios for banks and so on.

The business cycle is characterized by the 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 on years 1994 and 1995 which were following an exceptionally low investment level during the 1993 recession.[3] Monetary policy shifted from high nominal short run interest rate from 1990 to 1993 to a decline from 1994 to 1999. A striking feature has been the inversion of the yield curve from 1991 to 1993 (see figure 6). The high return from short run debt has lead some firms to delay investment and to accumulate cash during this period.

Firms Characteristics in the Nineties can be described by the following macro-economic patterns. Distribution of value added, which turned at the advantage of firms profits since 1983, consolidated to historically high levels over the 90's. This feature, as well as low demand due to low activity years and low investment, have led to a remarkable feature. The loss of sales affected much less aggregate profits than aggregate 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 rate for some firms in the early nineties, has been to a decreasing trend of leverage, and in particular, of the share of bank debt in total liabilities. Conversely, this meant an increase of the share of equity. What is more, the fall of interest rates from 1995 to 1999 and the decrease of debt has led to a decrease of aggregate debt repayments, which in turn increased again

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

aggregate retained earnings. This decrease of 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 Micro-economic background.

It is interesting to check to which extent macro-economic movements were reflected in individual firms accounts. We now present the evolution of balance sheet components over the nineties using the full sample of manufacturing firms of Centrale des Bilans at Banque de France. 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 phase of 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 firms, except for large firms during 1997 to 1999 (figure 2). A leverage ratio provides a mirror image of these trend (figure 3). Firms reduced their leverage by more than 6 percentage points between 1990 and 1999. This decreasing trend has been relatively insensitive to cyclical fluctuations. A declining trend in the share of bank debt as a percentage of total liabilities has also been observed. According to the weighted mean the average indebtedness of French manufacturing firms to credit institutions is slightly decreasing 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). The tangible fixed assets first increased slightly up to 1991/92, which tend to display a relatively continuous strategy of reducing corporate investment in production capacity.

It may be the case that the long-term trend of tangibles mirrors not only the investor expectations, but to some extent also the growing tendency towards external growth. It seems that a large proportion of (large) manufacturing enterprises 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 Firms Investment.

a) Macro-economic investigations.

Empirical work on French macro-economic data faces difficulties to find a significant effect of the user cost of capital affecting 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 labor. In five French forecasting models used in the nineties, three of them do not include the cost of capital (Amadeus from INSEE, Mosaïque from OFCE, the Banque de France forecasting model), while the model Metric from INSEE 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 to be one (Hermes model, Ecole Centrale). Herbet [2001] published a recent estimation of macro-economic investment and recognized its failure to incorporate interest rate or user cost effects.

b) Micro-economic and sectorial investigations

- Effect of the User Cost.

A few recent studies investigate the effect of the user cost on French micro-economic 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 for 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 of the user cost for France (-0.75) and for large countries in the Euro-area (-0.90). Conversely, on the same database, Beaudu and Heckel [2001] estimated a first differenced neo-classical demand for capital adding cash-flow in 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 sharp differences on investment and user cost. They used a limited amount of the statistical informations that was available to them. They used instrumental variables but not generalized method of moments (GMM) estimators. They recovered in an indirect way an 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) on the period 1991-1996. None of these papers include an estimation of a user cost elasticity on French micro-economic data using 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 estimated for long (Hall, Mairesse, Mulkay [2000]). We mention only a few recent papers using French micro-economic data and estimating asymmetries of sensitivities between firms with respect to liquidity variables.

Using investment Euler 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 that 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 matter (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 et 1989 (their estimation period was 1986-1993). It 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] lead to a higher investment/cash flow sensitivity of small firms during monetary restrictions years. In Duhautois [2001], leverage explains significantly investment of small firms form 1985 to 1996 in a regression where the growth of sales is an omitted variable.

3. The Intertemporal Behaviour of the Firm

3.1 Theoretical Model

We consider a profit maximizing firm which does not face adjustment costs of investment but faces 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's [2000] presented an intertemporal continuous time version. Our presentation is based on discrete time intertemporal optimization of firms facing uncertainty. With respect to King and Fullerton's [1984] approach, we do not take into account the differences of households taxation between 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 is increasing with leverage. But a firm can always turn around 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 of new share issues and a debt ceiling constraint.

Analyzing investment begins with an expression for the value of the firm, which in turn stems from the arbitrage condition governing the valuation of shares for risk neutral investors. The return to the risk neutral owners of the 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 $t+1$:[4]

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

In what follows, the subscript *i* always refer to firm *i* and the subscript *t* for the year *t*, E_t is the expectation operator conditional on information known at time t, d_{it} are dividends, V_{it} is the firm 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 in maximizing the present value of dividends less new share issues at time t in a infinite horizon:

[4] 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 number leads to consider this expected return as realized ex-post and therefore known with certainty ex-ante.

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

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

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

δ is the constant rate of economic depreciation. The flow of funds equation defines firm 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:

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

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 sectorial 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: $i_{it}\left[\dfrac{B_{it}}{p^I_{st}K_{it}}\right]$, with $i^{'}_{it} > 0$.

After substitution of dividends by the flow of funds and of investment using the capital stock equation, we can proceed for the optimization of the firm value. First, the Euler equation with respect to debt is:

$$1-\beta_{it}\left[1+E_t(1-\tau_{t+1})\left(i_{it}+\frac{\partial i_{it}}{\partial B_{it}}B_{it}\right)\right]=0$$

$$\Rightarrow \rho_t-(1-E_t\tau_{t+1})i_{it}=E_t(1-\tau_{t+1})\left(\frac{B_{it}}{p^I_{st}K_{it}}\right)i^{'}_{it}>0 \qquad (5)$$

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 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:

$$(1-\tau_t)p_{it}F_K(K_{it},N_{it})-(1-\text{itc}_{it})p^I_{st}$$

$$+\beta_t E_t\left[(1-\text{itc}_{i,t+1})(1-\delta)p^I_{s,t+1}+\tau_{t+1}\delta p^I_{st}+(1-\tau_{t+1})\left(\frac{B^2_{it}}{p^I_{st}K^2_{it}}\right)i^{'}_{it}\right]=0 \qquad (6)$$

$$\Rightarrow F_K(K_{it},N_{it})=C_{it}=\frac{p^I_{st}}{p_{it}}\frac{(1-\text{itc}_{it})}{(1-\tau_t)}[1-c_1-c_2-c_3].$$

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

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

The term $1-c_1$ leads to the Hall and Jorgenson (1967) formula of the cost of capital without tax distortions between means of finance and on 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 increase. With 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 to 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 is weighted by their relative share with respect to capital):

$$1-c_1-c_2-c_3=\left(\frac{B_{it}}{(1-itc_{it})p_{st}^I K_{it}}\right)(1-E_t\tau_{t+1})\,i_{it}+\left(1-\frac{B_{it}}{(1-itc_{it})p_{st}^I K_{it}}\right)\rho_t$$
$$+\left(1-\frac{E_t\tau_{t+1}}{(1-itc_{it})}\right)\delta-\left(\frac{E_t(1-\mathrm{itc}_{i,t+1})p_{i,t+1}^I-(1-\mathrm{itc}_{it})p_{it}^I}{(1-\mathrm{itc}_{it})p_{it}^I}\right) \tag{7}$$

The Hayashi [2000, p.80] formula can be obtained by setting the investment tax credit itc_{it} to zero and 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 ground 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 buildings prices, and the price of collateralizable assets used in leverage), besides potential reactions to monetary policy of tax policy supporting firms 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):

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

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

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

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 $-\frac{1-\sigma}{\upsilon}\ln(A_{it}) + \sigma\ln(\upsilon.a)$ are taken into account by the constant related to individual firms (fixed effect) and the time dummies.

We assume an econometric adjustment process under 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:

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

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 (else a potentially omitted variable) on the ground that our model does not take fully into account financial constraints. The long run elasticity of sales is given by $\beta_{LT} = \frac{\beta_0 + \beta_1 + \beta_2}{(1-\gamma_1-\gamma_2)}$ and the long run elasticity of the cost of capital is given by $-\sigma_{LT} = \frac{-\sigma_0 - \sigma_1 - \sigma_2}{(1-\gamma_1-\gamma_2)}$. Return to scale are given by $\nu = \frac{1-\sigma_{LT}}{\beta_{LT} - \sigma_{LT}}$. As explained later, we estimate this model in first differences using the generalized method of moments (GMM). The endogenous variables is then Δk_{it} where Δ is the first difference operator ($\Delta k_{it} = k_{it} - k_{i,t-1}$).

In model 2, 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 $\Delta k_{it} = \frac{I_{it}}{K_{i,t-1}} - \delta$. The Taylor rest of the power series $R_{it} = \sum_{j=2}^{+\infty}\left(\frac{1}{j}\right)(-1)^j\left(\frac{I_{it}}{K_{i,t-1}} - \delta\right)^j$ is neglected (We computed the stock of capital using the perpetual inventory method with a constant depreciation rate δ).

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

$$
-\sigma_0 c_{it} - \sigma_1 c_{i,t-1} - \sigma_2 c_{i,t-2} + \theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p^I_{s,t-2} K_{i,t-3}} \quad (11)
$$

$$
+\alpha_i + \alpha_t + \varepsilon_{it}
$$

Estimated with GMM first differences, the endogenous variable is now first differences of a growth rate. Due to the approximation, model 2 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 check if this approximation matters. One remarks 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 2 as follows:

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

$$
+(\beta_0 + \beta_1 + \beta_2 + \gamma_2 + \gamma_1 - 1)s_{i,t-2} - \sigma_0 c_{it} - \sigma_1 c_{i,t-1} - \sigma_2 c_{i,t-2} \quad (12)
$$

$$
+\theta_0 \frac{CF_{it}}{p^I_{st} K_{i,t-1}} + \theta_1 \frac{CF_{i,t-1}}{p^I_{s,t-1} K_{i,t-2}} + \theta_2 \frac{CF_{i,t-2}}{p^I_{s,t-2} K_{i,t-3}} + \alpha_i + \alpha_t + \varepsilon_{it}
$$

Error correction model have been introduced in time series analysis of co-integration. In particular, the long run relationship is often estimated in a first step, with residual 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 on panel data can deal better with the collinearity of variables than the ADL. 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 model from the ECM parameters and variance-covariance matrix. For this practical reason, it is more practical to use the ADL model. We estimate also this ECM model to check its differences from the ADL.

Using the same approximation used in model 2 so that the investment ratio appears as the explanatory variable instead of the log of capital, Chirinko and Von Kalckreuth [2001] among others, used first differences of all the variables of the ADL model and then they added cash-flow. We label this model "difference ADL":

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

The argument put forward for such a model is that the productivity at the firm level is affected not only by a fixed effect on its level but also by another fixed effect on its 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 estimation but not for the ADL/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 of 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 estimate second differences of the ADL model with instruments in first differences. Conversely, the estimation of the ADL 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 (or ECM) and the difference ADL: first, fixed effects on growth rate may exist; second, in the difference ADL model, residuals are differenced twice $\Delta^2 \varepsilon_{it} = \varepsilon_{it} - \varepsilon_{i,t-2}$ as well as the lagged dependant variable (differencing once more changes the correlation between residuals and lagged dependant variable), third, first differences of growth rates enters 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 be in principle short. Measurement errors may not be avoided in differencing twice with GMM. First differences of growth rate are smaller and less auto-correlated than growth rates. From an econometrics theory viewpoint, none of the above arguments lead to reject definitely one of the model with respect to the other one (ADL/ECM versus difference-ADL).

In what follows, we compare the estimations of the three versions of ADL/ECM model with the difference-ADL put forward for France in the comparative exercise in Chatelain et al. [2001]. Our aim is to check what the estimation of the ADL model 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) or/and 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 generalized 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 estimation). We estimate all models with first differences GMM and instruments in levels with Arellano and Bond [1991] method, using the programs DPD98 on Gauss.

4. Data and Econometric Results

4.1 Data Description

The data set consists of annual companies accounts and additional information from surveys collected by the Banque de France in the "Centrale des Bilans" database. For our econometric study, we selected a unbalanced sample of N=6,946 firms, still in the manufacturing sector, over the period 1985-1999 (see appendix for details). The estimation period is over ten years (1990-1999). This sample was obtained after deleting outliers for several variables and after selecting firm at least present during six years consecutively (see the data appendix for the sample selection). A comparison with some samples used in previous studies show 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 along time are presented on figures 5 and 6. These statistics are presented after the removal of outliers and selecting firms which are present 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 of the ECM model used by Gaïotti and Generale [2001] and Mojon, Smets and Vermeulen [2001] and the difference ADL model used in Chatelain *et al.* [2001], Valderrema [2001], Chirinko and Von Kalckreuth [2001] and Butzen, Fuss and Vermeulen [2001]. Using Within estimator for the ECM(2,2), we found a similar result than Mojon, Smets, Vermeulen [2001] who were using the BACH database and omitting 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 sectors 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) but the long run user cost elasticity is now (-0.31), i.e. half of the one with ADL(2,2). One observes a similar decrease for the 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 growth rates, 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 due to a three time higher sum of short run investment cash-flow sensitivities 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 consolidates the point of neglecting unit root problems. 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 Within case (where they were biased upwards). Long term investment cash-flow sensitivities are slightly increased using GMM estimation (they were biased downwards using Within estimates). The large differences between GMM and Within estimates stresses endogeneity and/or heteroscedasticity problems in the Within estimations. As the GMM estimator has been designed to deal properly with these econometric problems, we do not refer anymore to Within estimations in what follows.

As the difference ADL model has been dealt with in detail in the Chatelain *et al.* [2001] paper, we focus in what follows on the ADL/ECM model. Our next step is to compare the above GMM results with the ones obtained estimating the ADL model and model 2 (see table 4). In these two models, it was easy to check immediately lags of order 2 were necessary or not. It turned out that lags of order 2 of sales, of user cost and of 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 were around 0.7 to 0.8 (this result corresponds to a coefficient of log*(K(t-2)*) of –0.2 in model 2). This auto-regressive component is identical to the one of the ECM. When excluding cash flow from regressions in the ADL model and in model 2 (table 4, regressions 1 to 4), we found rather 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 2 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 in 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 around 0.15.[5] These results are very close between the two models (ADL and model 2) so that the change of dependent variable and the approximation of the first difference of log(K(t)) by the investment ratio does not affect much the results. They are also close to the GMM results of the ECM model and the difference ADL, although these models include additional lags of order 2.

The result that the introduction of cash-flow driving 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, an user cost definition without

[5] Removing some instruments changes the results with a sharp increase of 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

taxation, an 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.

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 4025 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 has been 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 set 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?

First, the user cost definition we retained is a linear function of a micro-economic 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, 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 are added in the regression, is 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 1990's for some firms observed in the descriptive statistics both a the macro-economic and the micro-economic level: some firms may depend much more on cash-flow than others. In that case, the omission of a dichotomous variable selecting these firms may bias the estimations results. This is what we investigate in what follows.

lags of log(K(t)) as instruments, because the stock of capital includes measurement errors. In so doing, we retained similar instruments for the ADL and model 2.

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 split 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 model with respect to sectors (we considered five manufacturing sectors: food industry, intermediate goods, equipment goods, consumption goods and car industry). We did not find significant differences between sectors. But the differential coefficients which where the closest to be significant were related to the equipment goods sector. We then introduce a dichotomous 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). This 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, as well as sales growth with a long run elasticity of 0.3.

Then, we considered a dichotomous variable for firms having a lower share of trade credit in total liabilities (more precisely, firms for which this statistic is below the upper quartile). This behavior may be a signal for difficulties to get external finance for these firms. In the model without cash-flow, there is no significant differences for those firms. When cash-flow are 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 of the Banque de France is a combination of several criteria which allows to measure the risk of failure of firms. When cash-flow is omitted in the regression, firms which are risky according to the score of the Banque de France (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 are added in 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 have more difficulties to get external finance. As for the equipment goods sector, the user cost elasticity is significant for all firms (-0.207) as well as sales growth elasticity (0.646).

These three dichotomous variables were able to isolate firms sensitive to cash-flow. Omitting these dichotomous variables lead to bias estimate where the elasticities of sales and user cost were not significant once cash-flow were included in the regression. Once these dichotomous variables are included, the user cost and sales growth elasticities are again significant and close to the estimates found without adding cash-flow.

5. Conclusion

We investigated the properties of the ADL/ECM model with respect to the difference ADL model. These two models have been used in companions papers of the MTN network: the MTN synthesis paper on firms by Chatelain *et al.* [2001] and Chirinko 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. Then, we have focused on an ADL specification of the neo-classical demand for capital with a firms specific user cost of capital to test for investment behaviour in France, as the difference ADL estimation was already 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 dichotomous variables related to sample splits, the user cost of capital has a negative significant elasticity with respect to capital using the traditional within estimates, or as long as cash-flow are not added in the regression when using Generalized Method of Moments estimates. Using GMM, the elasticity has a lower absolute value than in the within case.

- When cash-flow are added in the regression without dichotomous 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 Generalized Method of Moments.

- When we introduce dichotomous variables related to sample split (in particular risky firms or equipment goods), we isolate a strong cash-flow effect for some groups of firms, so that the sales growth and the user cost turn to be significant for all firms. With a dichotomous variable related to the trade credit criterion, the user cost is not significant but sales growth are. 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 micro-economic results for the investment of French manufacturing firms grounding further investigations of the effects of monetary policy on individual investment, and their macro-economic consequences for the monetary transmission channels as developed in Chatelain et al. [2001] and Angeloni et al. [2001].

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APPENDIX

A.1 Sample Selection

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

A first elimination of outliers has been done on a larger unbalanced sample on manufacturing firms without holdings. The exclusion of outliers was done on ratios built on common information to the two databases. A first step consisted of 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 accounting period is 12 months. We deleted firms for which the number of employees, sales, value added, assets, investment, debt are negative. The second step consists of 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 the 99th percentile of apparent interest rate
- first and the 99th percentile of debt over capital
- first and the 99th percentile of sales growth
- first percentile and the two upper percentiles of user cost
- below 5% percentile and upper the 95% percentiles of the growth rate of the user cost

From the initial Centrale des Bilans 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 of the French General Tax Code provided by firms and numbered by the tax administration (D.G.I.) from 2050 to 2058. We provide the code of each data omitting the two first number of each leaflet. For example, we denote “[50].FN”' the box FN of the tax form 2050. The second source is the Banque de France survey of the “Centrale des bilans”. 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.

The construction of data common to monetary transmission network papers has been made according to the Chatelain and Kashyap's note (2000).

Sales are total net sales [52].FL, change in inventories of own production of goods and services [52].FM, own production of goods and services capitalized [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 the decreases by transfers of tangible assets under construction [54].MY, of the decreases by transfers of deposits and prepayments [54].NC less [cdb65].031.

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

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

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 the stockholder's 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 where the rate is set to zero for these firms on 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:

[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, we finally 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 sectorial price of capital is equal to the sectorial 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 labeled as the "stock method"). The average age of capital T_{mean} is computed by using the sectorial useful life of capital goods $T_{\max}$ and of the share of goods which has been already depreciated on the first available year in the firms accounts $\frac{\text{DEPR}_{it0}^{BV}}{p_{st0}^{K} K_{it0}}$ (DEPR_{it0}^{BV} is the total book value of depreciation allowances in year t_0 according to the following formula[7]:

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

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

The book value of depreciation allowances DEPR_{it0}^{BV} is obtained by the sum of the depreciation, amortization 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 sectorial 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 Sectorial Variables**

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

Investment goods deflators p_{st}^{I} of NES16 sectorial classification are taken from the Annual National Accounts (base 1995).

Gross value added deflators p_{st} of NES16 sectorial classification are taken from the Annual National Accounts (base 1995).

[7] This formula is used by Jacques Mairesse in the Bond et al. [1997] paper.

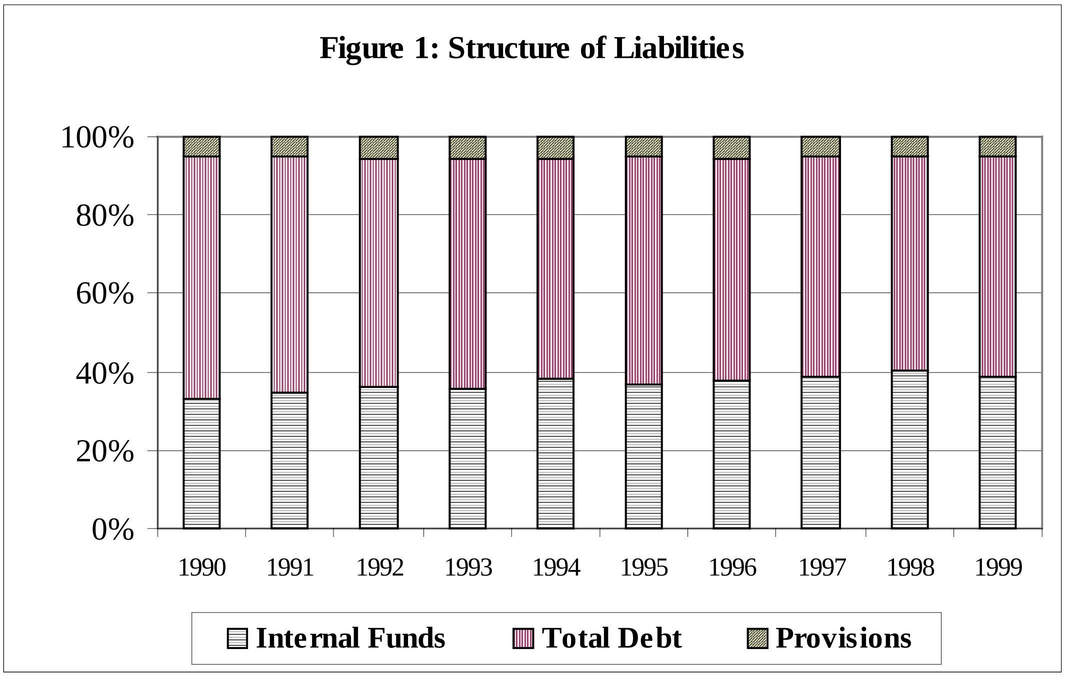

Figure 1: Structure of Liabilities

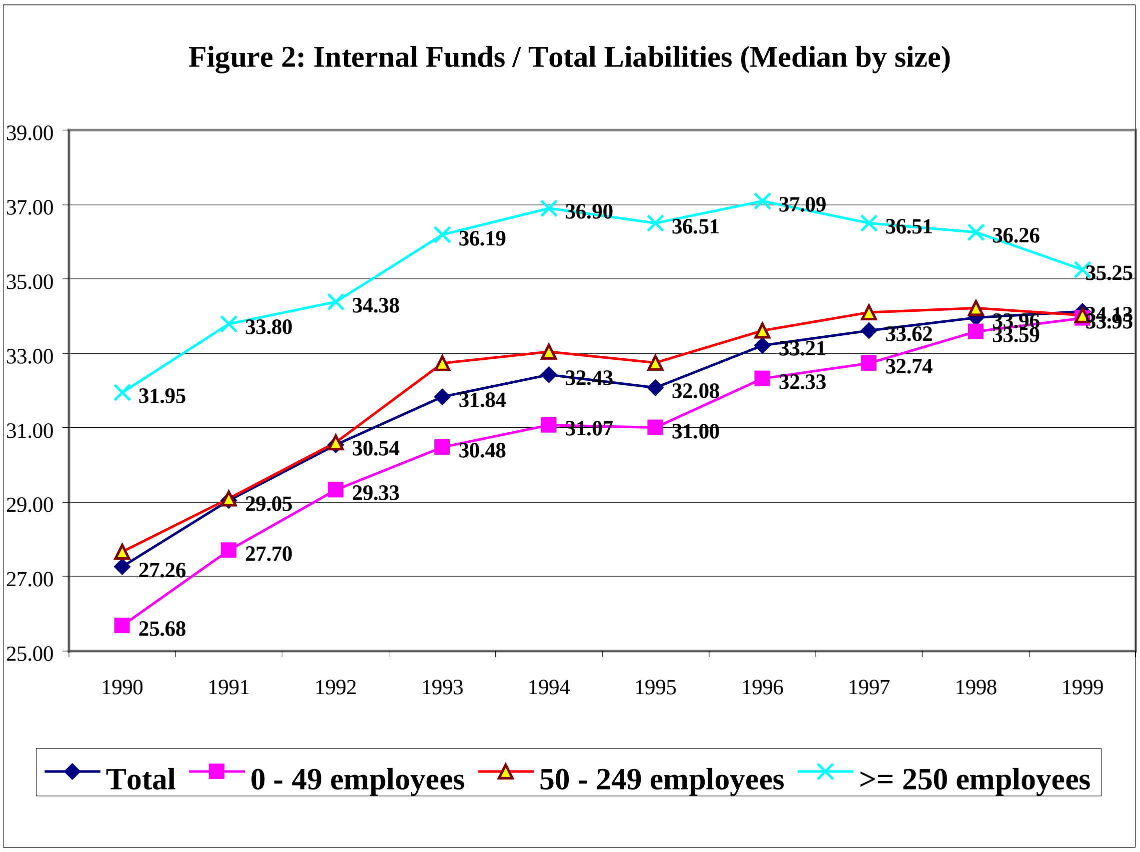

Figure 2: Internal Funds / Total Liabilities (Median by size)

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

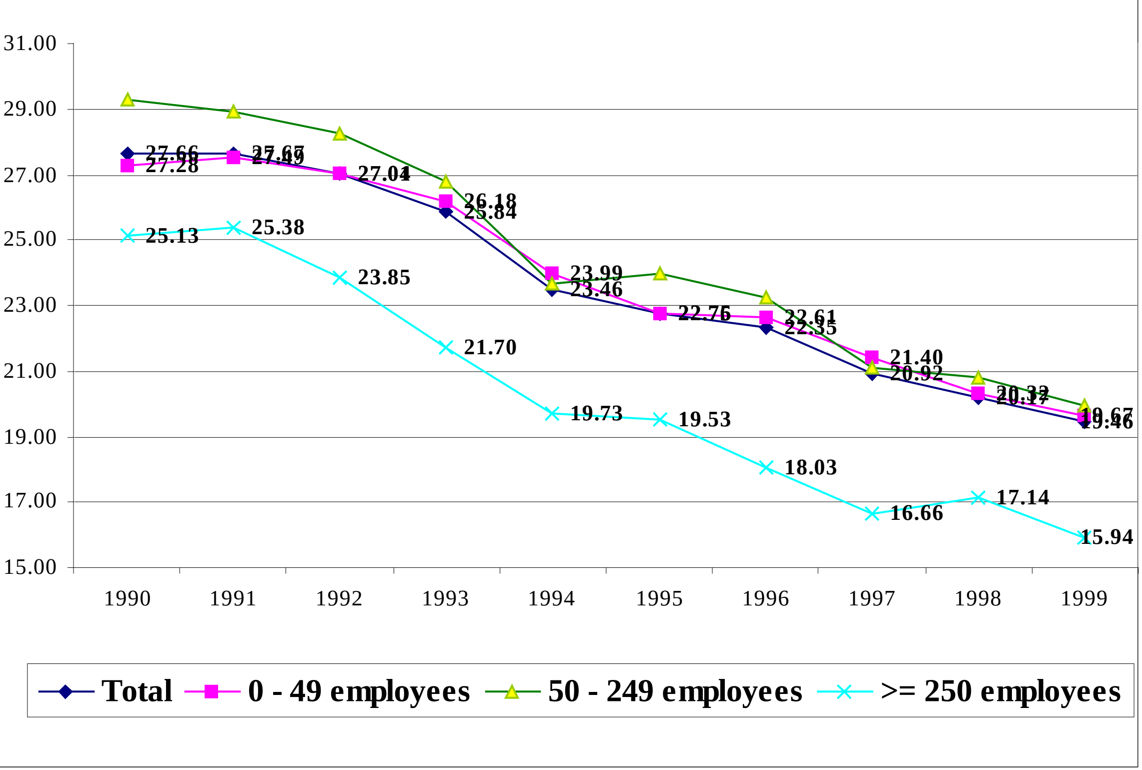

Figure 4: Structure of assets

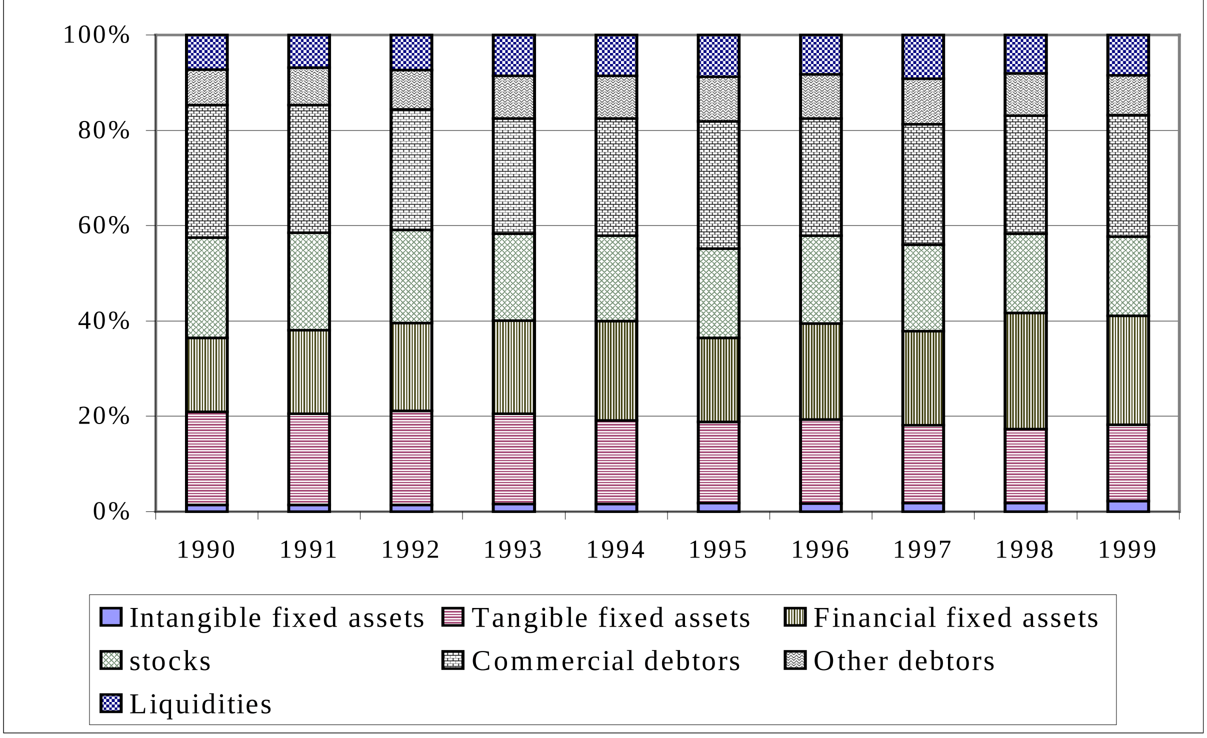

Table 1: Average Values of the Cost of Equity, the Cost of Debt and the User Cost of capital

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
0.08	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)

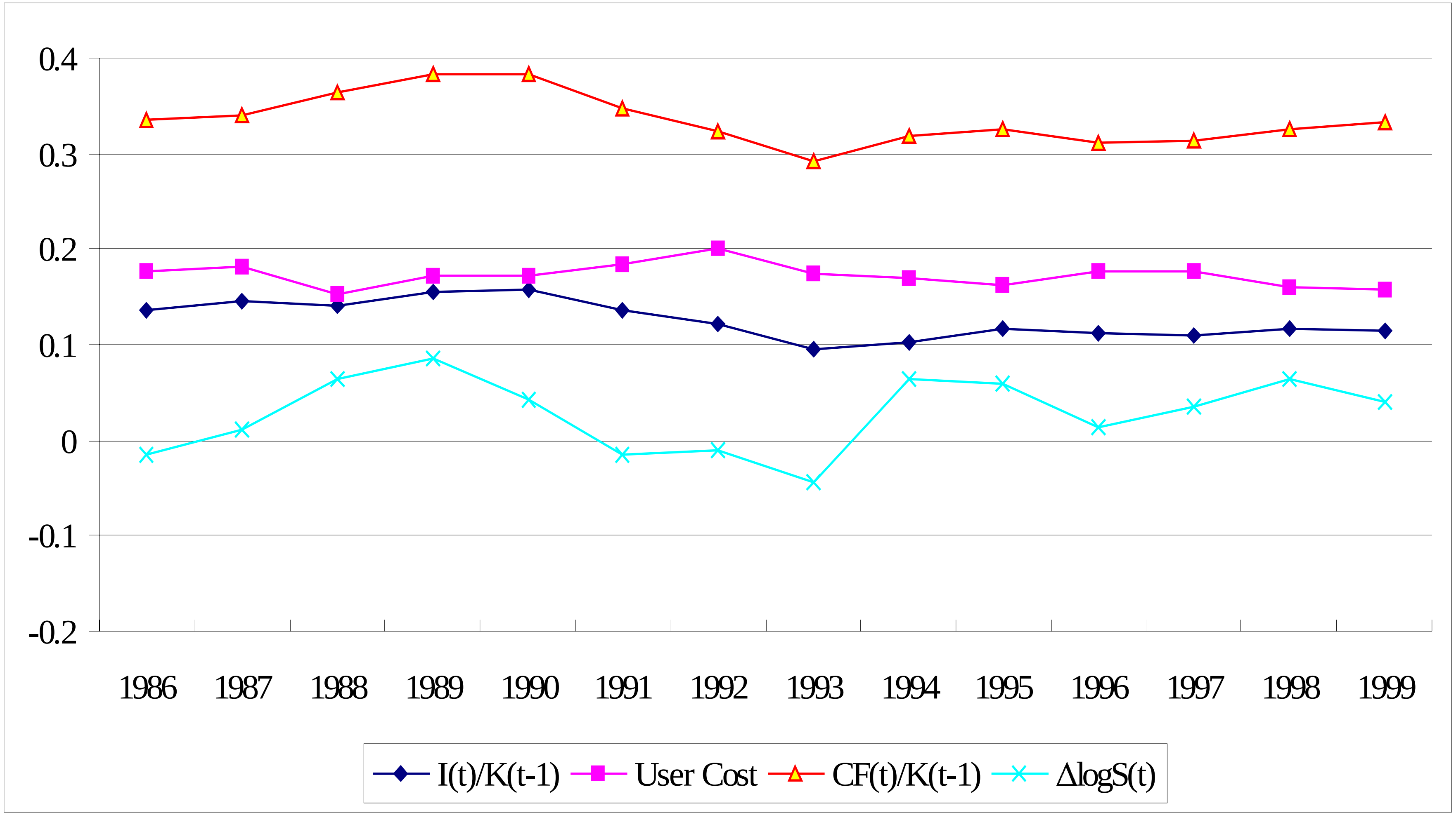

Figure 6. User Cost of Capital and Nominal Interest Rates (Means)

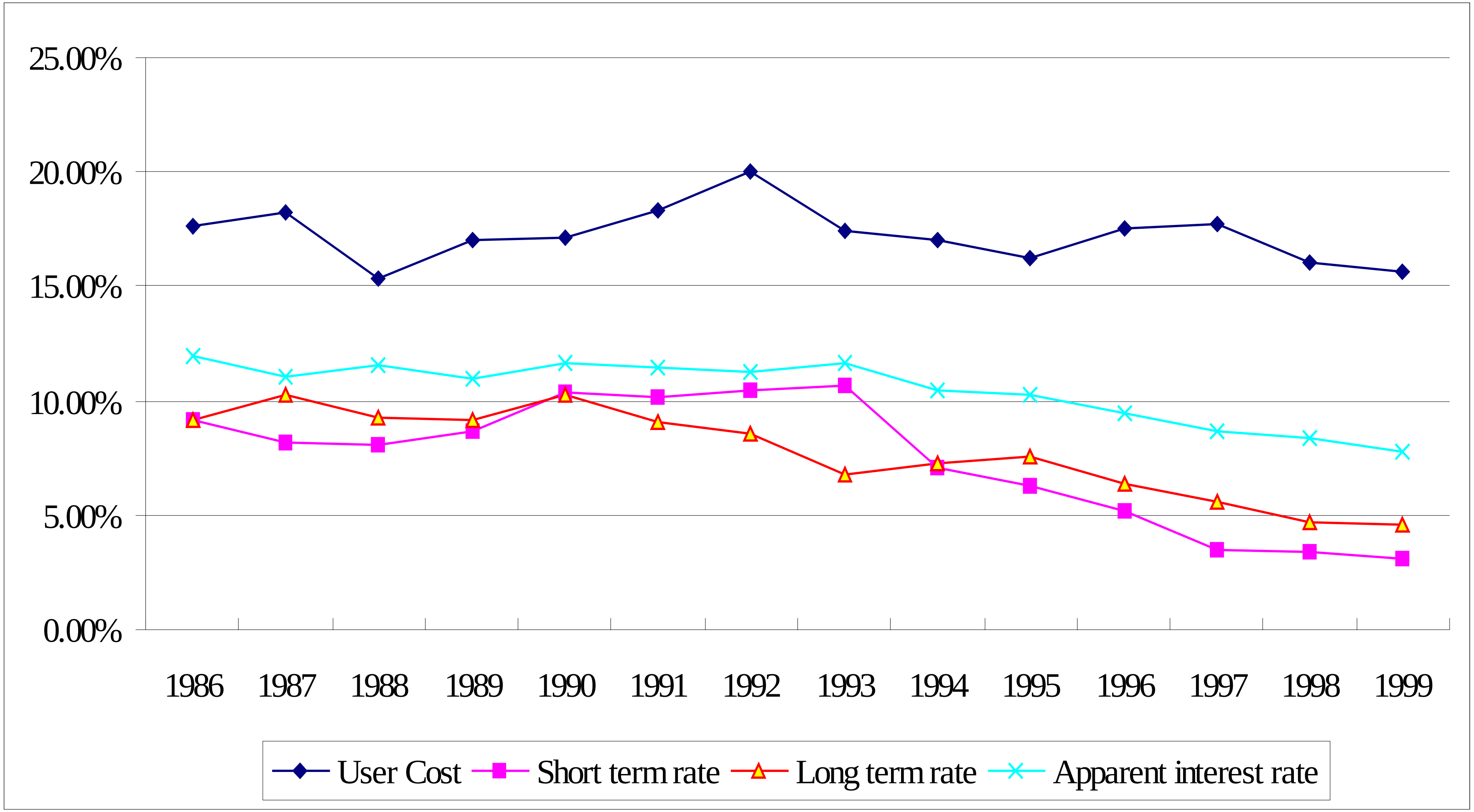

Table 3: Econometric Results: I(t)/K(t-1) as dependent variable

	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 2 with or without Cash-Flow and using different types of instruments.

	1: ADL(2,2)		**2: Model 2**		**3: ADL(2,2)**		**4: Model 2**		**5: ADL(2,2)**		**6: Model 2**	
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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