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Jouko Vilmunen
Research Department
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Dynamics of investment behaviour in Finland: aggregate and firm level evidence

Suomen Pankin keskustelualoitteita
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Dynamics of investment behaviour in Finland: aggregate and firm level evidence

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Abstract

In this paper we estimate reduced form investment equations for Finland using aggregate as well as firm-level panel data. We obtain significant estimates of the accelerator and user-cost effects on investment with both aggregate and firm level data, but these effects appear to be stronger at the aggregate level. Although the response of firms' investment spending to shifts in monetary policy seems to be quantitatively nontrivial, it is surprisingly weak according to the results with firm-level data, and a considerable amount of heterogeneity also exists across firms in this respect. The firm-level estimates do not provide evidence for the existence of binding financing constraints in firms' investment spending, at least among the sampled large firms, as we cannot obtain a significant coefficient estimate on the cash flow variable.

Key words: accelerator, user cost, transmission of monetary policy, panel data

Investointien dynamiikka Suomessa: kokonaistaloudellisia ja yritystason tuloksia

Suomen Pankin keskustelualoitteita 22/2002

Jouko Vilmunen
Tutkimusosasto

Tiivistelmä

Tässä tutkimuksessa tarkastellaan empiirisesti koko kansantalouden ja yksittäisten yritysten investointidynamiikkaan vaikuttavia tekijöitä Suomessa. Tulosten mukaan kysynnän ja reaalikoron muutokset vaikuttavat investointeihin tilastollisesti merkitsevästi sekä kokonaistaloudellisen että yritystason aineiston perusteella. Vaikutukset näyttävät kuitenkin vahvemmilta koko talouden tasolla tehdyssä analyysissä kuin yritystasolla. Vaikka rahapolitiikan vaikutukset yritysten investointeihin eivät olekaan mitättömiä, ne näyttävät silti yritystason aineistolla saatujen tulosten perusteella yllättävän vähäisiltä ja myös yrityskohtaiset erot rahapolitiikan investointivaikutuksissa ovat huomattavia. Yritysten kassavirran muutoksilla ei sen sijaan ole tilastollisesti merkitsevää erillistä vaikutusta niiden investointimenoihin, joten ainakaan käytetyn otoksen suuret yritykset eivät näytä investointipäätöksissään olleen rahoitusrajoitteisia.

Asiasanat: akseleraattori, pääoman käyttäjäkustannus, rahapolitiikan välittyminen, paneeliaineisto

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1 Introduction

There is a large empirical literature on models of dynamic investment behaviour and capital accumulation.The bulk of this literature strongly indicate that financial variables, such as cash flow and profits, enter as significant regressors for current investment. Most often the empirical finding of significant financial variables appears in empirical investment analyses based on the Q theory of investment, although studies building on Euler-equation approach to investment dynamics have produced similar results. As also noted by Russell and Ejarque[1] these findings have been very influencial indeed, since they appear to underlie the position that capital market imperfections are necessary to explain observed investment behaviour.

Basically the Q theory of investment implies that in a firm's investment optimum, the firm optimally weighs current marginal costs of investment against the future marginal returns. Consequently, expectations about the future marginal profitability of the firm's capital stock is the principal dynamic driver for its current investment spending. This involves, inter alia, strongly forward looking investment behaviour on the part of the firm. Now, under specific homogeneity restrictions concerning firm's profit and adjustment cost functions the marginal gain or return can be proxied by the value of the firm relative to its capital stock or, to put it in more familiar term, by the *average* Q. To appreciate the power of this approach to investment we only need to realize that an observable, average Q, completely summarizes the expected discounted value of additional investment. Hence, financial variables in general and profits in particular should not have any additional contribution to explaining current investment. These remarks to a large extent apply also to the Euler equation models of dynamic investment behaviour, since theoretically we just need to reorganise the first order necessary conditions for a firm's profit maximising level of investment spending to represent the firm's investment optimum as a Euler equation instead of the Q model. In particular, given the current difference between the marginal product of capital and the user cost, all relevant information about expected future profitability is in the Euler approach to investment determination summarised by the one-step ahead forecast of discounted marginal adjustment cost.

The natural conclusion, shared by many economists, from the finding that financial variables and profits are significant in investment equations appears to be that it represents evidence of capital market imperfections.Consequently, the numerous theories of credit frictions could well be motivated in the light of these results. Furthermore, the particular conclusion from the statistical significance of financial variables together with the large adjustment costs generally found in empirical papers have given rise to the conclusion that the Q theory and, for that matter, Euler equation approach are empirical failures.

This paper brings in evidence that bears on the question of the statistical as well as economic significance of financial variables in explaining variations in firms' investment spending in Finland. Using a panel data set incorporating annual time series observations on 500 largest firms in Finland, we estimate

[1] Russell-Ejarque (2001, p. 1).

a reduced model for the investment ratio, ie. the ratio of investment to the capital stock, where, in addition to lagged investment ratios, the empirical specification displays properties familiar from accelerator models of investment behaviour. That is firms' current investment spending responds positively to perceived increases in the (anticipated) demand for its output, whcih in the empirical model is captured by including a real income, output or sales variable in the set of right hand side variables. The empirical model is extended to allow for financial factors as well as user costs to affect firms' investment spending. This extension is important for two reasons. Firstly, we want to test for the significance of financial factors and users costs in firms' investment decisions per se. Peirhaps more importantly, finding statistically significant financial effects of financial factors and user costs on investment spending potentially suggests channels through which monetary policy could conceivably affect investment behaviour and, in the end, aggregate demand in the economy. Althought the empirical model estimated in this paper essentially reflects the common emprical approach to modelling investment in the research work organised within the Monetary Transmission Network,[2] the empirical approach followed in this paper provides a flexible and relatively efficient framework to capture the relevant empirical correlations present in the data set.

The rest of paper is organised as follows. Section two presents a survey of the relevant research on firms' investment behaviour in Finland, with a particular emphasis on the estimated role of financial factors in explaining investment spending. Section three reviews the basic theoretical backround that underlies the bulk of models on firms' dynamic investment behaviour. Section four presents the data, discusses the estimation methods and reviews the results. Finally, section five concludes. The two appendices give tables summarising the data as well as reports the estimation results.

2 Financial factors and investment in Finland: existing literature

Most of the empirical studies on financial factors and firms' investment behaviour in Finland use data that is strongly affected by the growth experience of the economy during the boom-bust cycle in late 1980's and early 1990's. The general pattern observed then in the development of some key macroeconomic variables is consistent with an operative financial accelerator. In fact, a number of studies have produced econometric evidence suggesting that borrower balance sheets occupied a critical role in the growth cycle. For example, Brunila (1994) finds in a panel of Finnish firms covering most of the boom-bust cycle that their investments in fixed assets was adversely affected by indebtedness, whereas a positive contribution over time could be found from cash flow. Honkapohja and Koskela (1999), using a similar panel data set, conclude that the sensitivity of investment to cash flow is higher among firms classified, a

[2] See Angeloni et al (2002) for a balanced summary of the results of, and the relevant references to the various individual investment studies.

priori, as financially constrained. The time series evidence in Kajanoja (1995) agrees with Honkapohja and Koskela.

As far as the role of financial intermediaries in generating the growth cycle is concerned, we need, as is well known, some identification scheme which would enable us to infer from the data that supply rather than demand factors accounted for the behaviour of banks' credit stocks. Saarenheimo (1995) worked on such a scheme in his empirical analysis based on a VAR consisting of bank loans, money, the loan rate and fixed investment. His results suggest that new additions to credit stocks accounted for most of the increase in the level of private fixed investment during the boom years of 1987–1990. The flip side of his results is that during the bust years investment would have been higher were there no shocks to credit. In terms of size credit appears to have affected investment asymmetrically; effects appeared to be larger during the boom years.[3]

3 Theoretical considerations

In this section we shall briefly review the basic elements involved in modelling firms' dynamic investment demand. Quite plausibly, the key notion in this context appears to be 'adjustment costs'. The motivation for introducing costs of adjustment is to account for the observation that adjustment in the level of factor inputs in general and capital stock in particular takes time to complete. Put in another way, dynamic models of investment with adjustment costs can account for the empirical failure of those models that assume adjustment to be costless and immediate.[4] Of course, theotically, the assumption that an acitivity is costly is a natural way for an economist to rationalise why more of it does not take place, but it is not the only one.[5]

3.1 The Q model

Think of a firm producing single output with capital K, labour L and other current inputs M (materials). The firm faces the following optimisation problem

$$V_t\left(K_{t-1}\right) = \max_{L_t, M_t, I_t} \left\{\Pi\left(K_t, L_t, M_t, I_t\right) + \beta_{t+1}\, \mathrm{E}_t\left[V_{t+1}\left(K_t\right)\right]\right\} \tag{1}$$

[3] Naturally, firms financial decisions as well as the relationship between firms' financial structure and investment can be affected by the structure of taxation. Virolainen's (1998) analysis on tax incentives and firms' borrowing decision clearly indicate that taxes are important to firms' financial structure, even to the extent as to give rise to an internal financial equilibrium for the firm without resorting to institutional borrowing constraints. Also, Vihriälä (1997) and Kinnunen and Vihriälä (1999) clearly suggest that financial factors affect the real economy not only through firm and household finances, but also through bank behaviour.

[4] See Bond – Van Reenen (2002, p. 13).

[5] We can, in principle, introduce exogenous delays (eg delivery lags) to explain investment dynamics, or consider limited substitution possibilities between installed capital and variable factors of production. See eg Jorgenson (1971) and Nickell (1978) for surveys.

where the maximised value of the firm in period t is denoted by V_t. $\Pi_t(.)$ denotes the net revenue function and $\beta_{t+1} = (1+\rho_{t+1})^{-1}$ is the firm's discount factor with the risk free rate of interest between period t and $t+1$ denoted by ρ_{t+1}. The law of motion of the captital stock is given by

$$K_t = (1-\delta) K_{t-1} + I_t \tag{2}$$

where δ is the, by assumption exogenously fixed, rate of depreciation. The firm's net revenue function, on the other hand, can be written as

$$\Pi_t(K_t, L_t, M_t, I_t) = P_t [F(K_t, L_t, M_t) - G(K_t, I_t)] - P_t^K I_t - W_t L_t - P_t^M M_t \tag{3}$$

where $F(.)$ is the production function and where P_t, P_t^K, W_t and P_t^M denote, respectively the price of the firm's output, the price of capital goods, the wage rate and the price of current inputs in period t. I_t denotes gross investment in period t. So the assumption here is that the firm owns and purchases capital inputs while labour is hired. This involves no loss of generality and the alternative institutional arrangement would be to assume that firms hire capital inputs as well. Finally the adjustment costs are captured by the function G; here, by construction, the firm incurs costs only when adjusting the capital stock, not when adjusting e.g. labour inputs. This is a theoretical simplification, motivated mainly by the fact that we want to concentrated on the dynamics of investment. Adjustment costs thus take the form of foregone production while the adjustment cost function is assumed to strictly convex in (gross) investment.

Denoting by λ_t the shadow value of inheriting one additional unit of capital in period t, ie

$$\lambda_t = \frac{1}{1-\delta}\left(\frac{\partial V_t}{\partial K_{t-1}}\right) \tag{4}$$

(since only $(1-\delta) K_{t-1}$ of the capital stock in period $t-1$ is left in period t) so that λ_t satisfies

$$\lambda_t = \frac{\partial \Pi_t}{\partial K_t} + (1-\delta)\beta_{t+1} \mathrm{E}_t(\lambda_{t+1}) \tag{5}$$

we can write the investment equilibirium of the firm as

$$\frac{\partial G}{\partial I_t} = \frac{\lambda_t}{P_t} - \frac{P_t^K}{P_t} = \left(\frac{\lambda_t}{P_t^K} - 1\right)\frac{P_t^K}{P_t} \equiv (q_t - 1)\frac{P_t^K}{P_t} \tag{6}$$

Moreover, the solution to λ_t is given by

$$\lambda_t = \mathrm{E}_t\left[\sum_{s=0}^{\infty} (1-\delta)^s \beta_{t+s}\left(\frac{\partial \Pi_{t+s}}{\partial K_{t+s}}\right)\right] \tag{7}$$

Consequently, the shadow value of an additional unit of capital is a forward-looking measure of current and expected future values of the marginal revenue product of capital, where the discounting reflects the diminuation of each unit of capital over time through depreciation, as well as standard compensation for delay.[6] Note that in the static version of the model, ie the one with $G(K,I) \equiv 0$, optimal capital stock is characterised by $\lambda_t = P_t^K$, so that $q_t = 1$.That is the marginal q, or the ratio of shadow value to purchase cost is equal to unity. With strictly convex costs of adjustment, marginal adjustment costs are increasing in gross investment, so that equation (6) shows that investment is an increasing function of the deviation of the actual value of marginal q from its desired long-run level of unity.[7] Note in particular the striking result that all influences of expected future profitability on current investment are summarised in marginal q, through the shadow value of capital.

To obtain an empirical investment model we need, firstly, to measure marginal q; in essence this is achieved by imposing condition under which the marginal and average q are equal. The basic requirement here is that the net revenue function Π is homogenous of degree one, a sufficient condition for which is that both the production function and the adjustment cost function display homogeneity of degree one. In this case we have

$$\begin{gathered} g'\left(\frac{I_t}{K_t}\right) = (q_t - 1)\frac{P_t^K}{P_t} \\ \lambda_t = \frac{V_t}{(1-\delta)K_{t-1}} \text{ so that } q_t = \frac{V_t}{(1-\delta)P_t^K K_{t-1}} \end{gathered} \tag{8}$$

where the function g is defined by $G(K,I) = Kg\left(\frac{I}{K}\right)$. Consequently, the marginal q is equal to the ratio of the maximised value of the firm in period t to the replacement cost value in period t of the capital stock that the firm inherits from the previous period, ie it is equal to the Tobin's q. Secondly, Tobin's q can in principle be measured and the usual way to do it is to use a firm's stock market valuation. Naturally, this requires that share prices are not affected by bubbles or fads, so that they really reflect the 'fundamental' value of firms. Anyway, an emprical model is provided by

$$g'\left(\frac{I_t}{K_t}\right) = \left(\frac{V_t}{(1-\delta)P_t^K K_{t-1}} - 1\right)\frac{P_t^K}{P_t} \equiv Q_t \tag{9}$$

3.2 The Euler equation

The poor empirical performance of the Q-model is certainly well known; in particular the prediction that Q_t is a sufficient statistic for investment has been generally rejected in empirical tests, and the empirical power of the Q_t variable is often found to be very weak when other variables such as sales and cash flow are added ato the econometric model.[8] However, we do not need to take the approach outlined above to model firms dynamic investment behaviour. Specifically, the Euler equation approach not only can relax such assumptions as the linear homogeneity of the net revenue function and can

[6] Bond – Van Reenen (2002, p. 17).

[7] See Bond – Van Reenen (2002, pp. 18–21) for a deeper discussion of the strengths and weaknesses of the Q-model.

[8] See eg Bond – Van Reenen (2002).

avoid using the share price data, but, more importantly, avoids the need to parameterise the expectations formation process.[9]

The Euler equation for the firm's optimal investment can be found by noting that $\lambda_t = -\partial\Pi_t/\partial I_t$:

$$-\frac{\partial\Pi_t}{\partial I_t} = -(1-\delta)\,\beta_{t+1}\,\mathrm{E}_t\left(\frac{\partial\Pi_{t+1}}{\partial I_{t+1}}\right) + \frac{\partial\Pi_t}{\partial K_t} \tag{10}$$

which, given the net revenue function, reduces to

$$\frac{\partial G}{\partial I_t} = \mathrm{E}_t\left[\psi_{t+1}\frac{\partial G}{\partial I_{t+1}}\right] + \left[\frac{\partial F}{\partial K_t} - \frac{\partial G}{\partial K_t} - \mu\left(\frac{R_t}{P_t}\right)\right] \tag{11}$$

where the real user cost of capital $(R/P)_t$ in period t is defined as

$$\left(\frac{R}{P}\right)_t = \left[1-(1-\delta)\,\beta_{t+1}\,\mathrm{E}_t\left(\frac{P^K_{t+1}}{P^K_t}\right)\right]\frac{P^K_t}{P_t} \tag{12}$$

and where $\psi_{t+1} = (1-\delta)\,\beta_{t+1}\left(\frac{P_{t+1}}{P_t}\right) = (1-\delta)/\left(1+\rho_{t+1}\right)$ denotes the real discount factor. $\mu = \epsilon/(\epsilon-1)$, where ϵ denotes the price elasticity of demand for the firms output, is the mark-up factor; thus we allow for imperfect competition in the goods market. In comparison to the relevant investment equation under the Q-model, we can say that the two terms on the r.h.s. of equation (11) contain essentially the same information as marginal q. More specifically, given the current difference between the marginal product of capital and the user cost, all relevant information about expected future profitability is here summarised by the one-step ahead forecast of discounted marginal adjustment cost.[10]

3.3 Financing constraints

One of the topics currently high on the agenda in microeconmetric research on firm level investment is to test for the possibility that firms seek for optimal investment under binding finance constraints. Both the Q model and the Euler equation approach above is based on the assumption of perfect capital markets in the sense that a representative firm can borrow as much as it desires at some required rate of return (ρ_{t+1}) that is exogenously given to it. In this case the firm's investment decision is separable from its financial decisions, and investment depends only on the price at which finance is available. Consequently, quantitative indicators of the availability of internal finance (profits, cash flow etc.) should affect investment only to the extent that they convey information about its likely future profitability. Econometrically, then, these financial

[9] The contribution by Abel and Blanchard (1986) is relevant in this context. They suggest constructing an estimate of the shadow value of capital using an auxiliary econometric model based on equation (7) in the main text. This procedure involves specifying the marginal revenue product of capital in terms of observable variables and a forecasting model for these variables.

[10] Bond – Van Reenen (2002, p. 24).

variables should not appear as significant variables in an investment equation after controlling for a measure of marginal q, if the maintained structure of the Q model is correct.[11]

Of course, non-separability between a firm's real and financial decisions could hold if the firm faces imperfect capital markets, which, in essence, entails that internal and external sources of investment funds are not perfect substitutes. Firm could be defined to be financially constrained if a windfall increase in the supply of internal funds results in a higher level of investment spending.[12] Although firms are not financially constrained in the basic Q model outlined above, bu their investment may be financially constrained in 'hierarchy of finance' or 'pecking order' models of corporate finance, wherein, essentially, external sources of funds are assumed to be more expensive than internal ones.

To make a simple illustrations of this idea, assume that all the assumptions underlying the Q model except that there is an additional cost associated with external funds. Following Bond – Van Reenen, assume specifically that there is an explicit transaction cost (f_t) per unit of new shares issued. The value of the firm is now given by

$$V_t = \mathrm{E}_t \left[\sum_{s=0}^{\infty} \beta_{t+s} \left(D_{t+s} - N_{t+s} \right) \right] \tag{13}$$

which builds on the distinction between dividends paid (D_t) and the value of new shares issued (N_t), while the sources and uses of funds identity links dividends and new share issues to the net revenue (Π_t) in period t

$$D_t = \Pi_t + (1 - f_t) N_t \tag{14}$$

The relevant F.O.N.C. for optimal investment is now

$$-\left(1 + \nu_t^D\right) \left(\frac{\partial \Pi_t}{\partial I_t} \right) = \lambda_t \tag{15}$$

and the Euler equation for the shadow value of capital, λ_t, is now given by

$$\lambda_t = \left(1 + \nu_t^D\right) \left(\frac{\partial \Pi_t}{\partial K_t} \right) + (1 - \delta) \beta_{t+1} \mathrm{E}_t \left(\lambda_{t+1} \right) \tag{16}$$

In addition to these more standard condition we now also have the necessary condition for optimal new share issues, which for $N_t > 0$ ($\nu_t^N = 0$) gives

$$\left(1 + \nu_t^D\right) = \frac{1}{1 - f_t} \tag{17}$$

while for positive dividends $D_t > 0$ ($\nu_t^D = 0$) we have $\nu_t^N = f_t$. Under perfect competition and given the net revenue function in (3) optimal investment necessarily satisfies

$$\frac{\partial G}{\partial I_t} = \left(\frac{q_t}{1 + \nu_t^D} - 1 \right) \frac{P_t^K}{P_t} \tag{18}$$

[11] Bond – Van Reenen (2002, p. 58).

[12] See Bond – Van Reenen (2002, p. 58). A windfall increase in internal funds means a change in funds which conveys no new information about athe profitability of current investment.

where $q_t = \lambda_t / P_t^K$ is the marginal Q.

The essential point of this model is that it has three distinct financial regimes[13]: Retained earnings are the cheapest source of finance, so if the firm has sufficient earnings to finance its desired investment, it will issue no new shares ($\nu_t^D = 0$ in this case). In this case, the basic Q model describes the firm's investment. If expenditure on desired investment exceeds retained earnings, $\nu_t^D > 0$, ie the shadow value of internal funds is positive. Consequently, the firm has to decide whether or not to finance additional investment through the more expensive external source of finance. This, in turn, depends on whether investment projects are sufficiently productive. More specifically, if the investment project that would be foregone by not issuing shares are sufficiently profitable compared to the higher cost of external funds, the firm decides to issue shares, so that its optimal investment will be given by

$$\frac{\partial G}{\partial I_t} = \left((1 - f_t)\, q_t - 1 \right) \frac{P_t^K}{P_t} \tag{19}$$

On the other hand, in the case where the investment projects are not sufficiently profitable, the firm will not issue new share. Consequently, the firm will be in a financially constrained in which both dividends and new share issues are zero. Since $D_t = 0 = N_t$, we have $\Pi_t = P_t \left[F(K_t, L_t, M_t) - G(K_t, I_t) \right] - W_t L_t - P_t^M M_t - P_t^K I_t = 0$ or $P_t^K I_t = P_t \left[F(K_t, L_t, M_t) - G(K_t, I_t) \right] - W_t L_t - P_t^M M_t = CF_t$. That is, the firm's investment expenditure is constrained to the level of cash flow CF_t. The implication here is that in this financially constrained regime, windfall changes in cash flow have a direct effect on the firm's investment, holding marginal q constant.[14]

Clearly, then, this model implies that the simple relationship between the investment rate and the marginal Q no longer holds in the presence of financing constraints. If one wants to maintain the structure of the Q model, a simple test of the hypothesis of no financing constraints can be obtained by including additional financial variables, such as cash flow, on the r.h.s. of the econometric model for the investment rate and testing for the statistical significance of the additional variables. In an aggregate context, if a non-trivial share of firms' investment expenditure is generated under binding financing constraints, these additional financial variables should enter signficantly. In a panel of firms, on the other hand, statistical significance of these financial variables should emerge among those firms who faces binding financing constraints.[15]

Finally, it is worth emphasising[16] that the equality between marginal and average q does not necessarily break down, although the simple relationship between marginal Q and the investment rate does under binding financing

[13] Bond – Van Reenen (2002, p. 60).

[14] The logic of the hierarchy of finance model can be nicely illustrated by the graphical device introduced by Hayashi (1985; see also Bond – Van Reenen, 2002).

[15] Many of these significance tests are of the form of 'excess sensitivity' tests actively used in testing the validity of the permanent income hypothesis of consumption against the alternative of binding liquidity or finance constraints faced by the representative household. When implementing these singnificance tests, naturally, proper care should be taken of the possible endogeneity of current financial variables.

[16] Bond – Van Reenen (2002, p. 63).

constraints. It is still true that

$$(1-\delta)\lambda_t K_{t-1} = \mathrm{E}_t \left[\sum_{k=0}^{\infty} \beta_{t+k} \left(1+\nu_{t+k}^D\right) \Pi_{t+k} \left(K_{t+k}, L_{t+k}, M_{t+k}, I_{t+k}\right) \right] \quad (20)$$

But, it is also true that

$$\left(1+\nu_t^D\right) \Pi_t = D_t - N_t \quad (21)$$

in each of the three financial regimes. In particular, then, the basic Q model continues to characterise the investment of those firms that are currently paying positive dividends and issuing no new shares. This implies, in turn, that the parameters of the cost function can in principle be identified from this sub-sample. However, as stressed by Bond and Van Reenen[17], the literature has focused on testing the non-significance of financing constraints, for which the equality between marginal and average q under the alternative hypothesis of the presence of binding financing constraints is not essential.

4 Taking models to Finnish data; structural vs reduced form

4.1 Data

In this section we shall review the results from estimating, basically, a reduced form investment equation on Finnish. The specification that we postulate is a generalisation of the linearised Euler equation derived from (11)

$$\begin{aligned} \left(\tfrac{I}{K}\right)_{t+1} = \Psi_0 + \Psi_I \left(\tfrac{I}{K}\right)_t - \Psi_{I^2} \left(\tfrac{I}{K}\right)_t^2 - \mu \Psi_{CF} \left(\tfrac{C}{K}\right)_t \\ + \mu \Psi_{UC} \left(\tfrac{R}{P}\right)_t + \left(\tfrac{\mu}{\epsilon}\right) \Psi_Y \left(\tfrac{Y}{K}\right)_t + \upsilon_{t+1} \end{aligned} \quad (22)$$

by allowing for richer dynamic effects of the variables. Here C denotes cash flow and Y ourput net of adjustment costs. μ and ϵ, on the other hand, denote the mark-up and price elasticity of the firm's output demand. All the Ψ_is are positive. In the final specification we chose to ignore the quadratic term. Preliminary testing indicated that the term does not enter significantly. However, before going into the details of the estimation results, we will give a short statistical summary of aggregate investment dynamics as well as a description of the data that we use in our estimations.

4.1.1 Aggregate investment ratio is very persistent

The data on aggregate investment ratio I/K, ie the ratio of aggregate investment to the aggregate (net) private sector capital stock suggests that it is generated by a highly persistent process. This is clearly evident in the following table which gives the values of the autocorrelation function of the investment ratio up to the 10^{th} lag:

[17] Bond – Van Reenen (2002, p. 63).

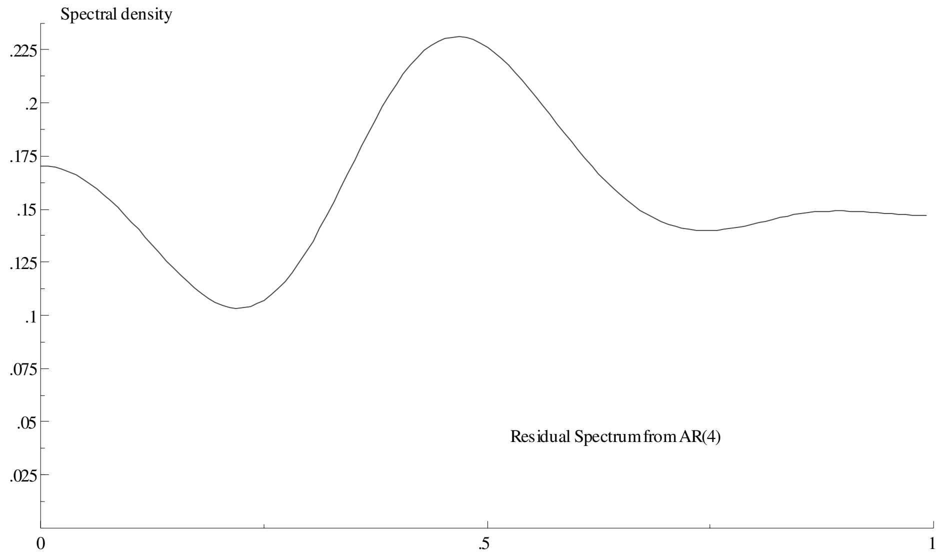

Figure 1: Residual spectrum from fitting an AR(4) model to the aggregate investment ratio

Table 1. Autocorrelations of the aggregate investment ratio

Lag τ	1	2	3	4	5	6	7	8	9	10
$r(\tau)$	0.96	0.93	0.88	0.83	0.76	0.68	0.60	0.52	0.44	0.35

These autocorrelation are not too far from being generated by an AR(1) process. In fact, an autoregressive model

$$\left(\frac{I}{K}\right)_t = \widehat{c} + 0.944\left(\frac{I}{K}\right)_{t-1} + \widehat{\varepsilon}_t \tag{23}$$

does a remarkably good job in capturing the bulk of the observed variation in the aggregate investment ratio, apart from the fact that some statistically significant autocorrelation is still present in the residual process $\widehat{\varepsilon}_t$. To remove it through autoregressive filtering we need actually an AR(6) model for the aggregate investment ratio, which is a surprisingly rich parameterisation. The underlying reason for the long autoregression is, most likely, the considerable amount of energy in the series around the seasonal cycle, as is evident from the following graphs on the residual spectra from an AR(4) and AR(6) model respectively.

We also estimated an autoregressive distributed lag (ARDL) model for the investment ratio, where we assume that a distributed lag on the ratio of output to capital and a measure of user costs, constructed according to the definition by Jorgenson (1971), is able to capture, on top of the postulated autoregression, the observed variation in the investment ratio. Aggregate investment as well as output are normalised by aggregate capital stock in order to induce stationarity. We use quarterly data over the period 1975q1–2001q1. To the

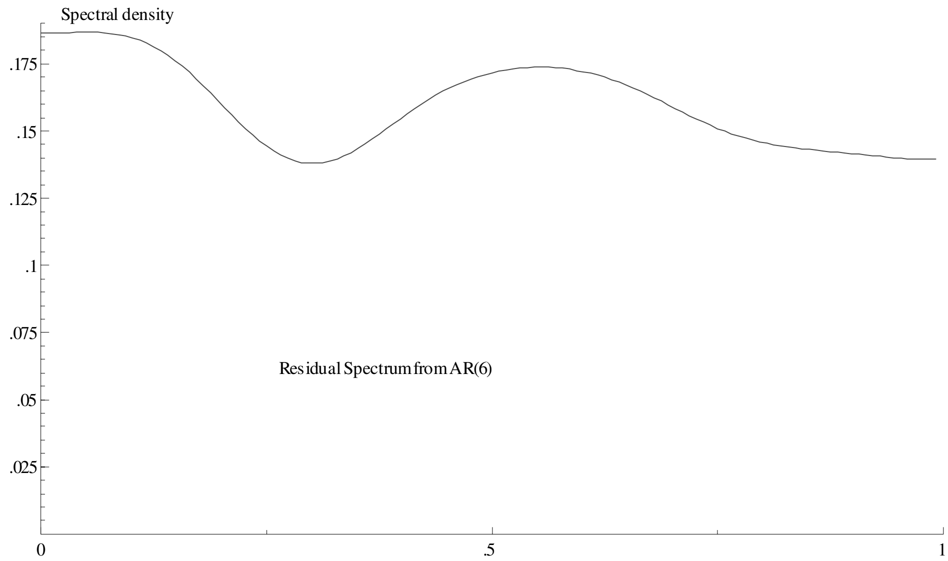

Figure 2: Residual spectrum from fitting an AR(6) model to the aggregate investment ratio

end, the estimates seem to indicate that there is an accelerator effect and a weak user cost effect on aggregate investment:[18]

$$\begin{aligned}
&\Big(1 - \underset{(0.114)}{0.59}\,L - \underset{(0.130)}{0.24}\,L^2 - \underset{(0.128)}{0.14}\,L^3 - \underset{(0.109)}{0.09}\,L^4\Big)\left(\tfrac{I}{K}\right)_t \\
&= \widehat{c} + \Big(\underset{(0.070)}{0.40} - \underset{(0.100)}{0.16}\,L + \underset{(0.096)}{0.03}\,L^2 - \underset{(0.097)}{0.22}\,L^3 - \underset{(0.089)}{0.05}\,L^4\Big)\left(\tfrac{Y}{K}\right)_t \qquad (24)\\
&+ \Big(\underset{(0.041)}{-0.01} + \underset{(0.041)}{0.09}\,L - \underset{(0.042)}{0.08}\,L^2 + \underset{(0.042)}{0.01}\,L^3 - \underset{(0.039)}{0.07}\,L^4\Big)\,UC_t
\end{aligned}$$

Eyeballing the graphical results, see the graphs in Appendix A, indeed suggest that this model is in statistical terms reasonable. However, a battery of diagnostic test seem to indicate that the residual autocorrelation is statistically marginal which, once again, reflects the presence of cycles in the aggregate investment ratio at frequencies near the seasonal one. Note that the aggregate effect of output and user costs on investment are not particularly strong: the sum of the DL-coefficients on output and user cost is, respectively, 0 and -0.06, or counting in only statistically significant and marginal ones, 0.18 (0.02) and -0.06. This implies a unit long-run output elasticity and a user cost elasticity of -0.35, using only significant autoregressive coefficients in the calculations.

[18] The statistical tests indicate the presence of some system autocorrelation in the residuals. However, the investment equation of the system survives a battery of diagnostic tests. In table 2 '*', '**' and '***' mean significant at 10, 5 and 1 percent respectively.

4.1.2 Firm level data

The firm level panel data set is based on the database of the Research Institute of the Finnish Economy ETLA. It incorporates annual information about financial statements of the 500 largest firms in Finland. In the present studey we use the data set that covers the time period 1986–1999. That is $T = \max_i T^i = 14$, where T^i denotes the length of the time series for firm i in the data set. The panel is unbalanced and the effective number of observations available in our estimations is bounded by $14 \cdot 322 = 4508$. A description of the data are given in appendix C, which summarises the main features of the firm level data.

Table C1 gives some indication on what the effective coverage of the sample of firms used in this study could conceivably be, both relative to the size of the economy as well as relative to the size of the private sector. Firstly, the number of firms has taken a complete swing during the 14 year period covered by the panel, starting for 177 firms in 1986, peaking at 322 firms in 1993 wherefrom it has come down to 170 firms in 1999. Since this is a sample, the underlying reason for such a swing may be difficult to find, but probably the deep recession coupled with the extraordinarily high rate of exit and banruptcy, not forgetting restructuring through mergers etc., explains at least partly the post 1993 fall in the number of firms. Secondly, all the major indicators seem to suggest that the coverage of the sample has been falling in the post 1993 period; no matter whether we look at employment, gross value added, gross investment or exports, the relative size of the aggregate of firms covered by the sample, either relative to the size of the private sector or of the whole economy, has been shrinking after 1993. The fall has been most dramatic in terms of employment and exports, approximately 40%, and perhaps also in terms of gross investment, approximately 35%. Note, however, the striking feature of the data that in terms of the value added, the sample appears to be, relative to the whole economy, as representative as it was in 1993!

4.2 Panel data estimates

As noted above, we have also estimated a reduced form investment equation on the Finnish data. The basic motivation for doing this is twofold. Firstly, the actual adjustment process of the capital stock is likely to extremely complex, particularly when we consider that the data on investment at the firm level are an aggregate over many types of capital gdoods, and possibly over multiple plants.[19] On balance, the structural models of investment dynamics that have been proposed to date have not performed satisfactorily in describing this adjustment process. One possibility is the neglect of the aggregation issue alluded to above. Another is the existence of factors that generate profound non-convexities and/or asymmetries in the adjustment costs. If we keep on insisting that capital cannot be adjusted costlessly and immediately – static models will not do – one possibility is to rely on dynamic econometric

[19] Bond – Van Reenen (2002, p. 34).

specifications that are not explicitly derived as optimal adjustment behaviour for some particular structure of adjustment costs.[20] Secondly, a favourable interpretation of these reduced form models is that they represent empirical approximations to some complex underlying process that has generated the data.[21] However we think about these models, it is useful to take a look at the results from estimating these models.[22]

Consequently, we have also estimated the following reduced form dynamic model, and its extensions that allow for financial variables to enter the specification, for firms' investment on the firm level data

$$\frac{I_{i,t}}{K_{i,t-1}} = fi + \sum_{j=1}^{k} \omega_j \frac{I_{i,t-j}}{K_{i,t-j-1}} + \sum_{j=0}^{k} \theta_j \Delta y_{i,t-j} + \sum_{j=0}^{k} \sigma_j \Delta \rho_{i,t-j} + TDs + \varepsilon_{i,t} \quad (25)$$

where

I/K_{-1} = investment/lagged capital stock ratio

y = log of sales (output measure = $\log S$, S = Sales)

ρ = log of the user cost ($\log UC$, UC = User Cost); Jorgensonian definition, constructed using firm specific interest expenses

TDs = Time Dummies

fi = fixed effects

For further reference CF = Cash Flow

Δ = difference operator

Furthermore, ε_{it} represents (possibly) individual firm and time dependent error term. The form of this equation comes very close to the one displayed by the linearised Euler equation in (22) except, importantly, that no non-linear term in the investment ratio enters in (25) and no a priori coefficient restrictions are imposed, apart from the sign, on the reduced form specification. Furthermore, note that the coefficient on the user cost variable has a positive sign in the structural equation and the coefficient on the cash flow variable a negative sign. However, under the standard interpretation of the reduced form equation (25) – the one, in particular, used to investigate the effects of monetary policy shocks on firms' investment – the user cost variable is expected to enter negatively and cash flow positively. The former then sustains the interpretation that firms cut back on their investment spending in response to tighter monetary policy. Cash flow effects, on the other hand, reflect binding financial constraints faced by firms so that they will increase investment spending under positive cash

[20] Bond – Van Reenen (2002, p. 34).

[21] As Bond and Van Reenen note (2002, p. 34) a less favourable interpretation is these reduced form models compound the parameters of the adjustment process with the ones of the expectations formation process and are thus subject to Lucas critique.

[22] See Bond – Van Reenen (2002, pp. 34–39) for a more detailed discussion of the form and limitations of the reduced form models.

flow news. That is, under binding finance constraints windfall increases in cash flow affect firms' current investment spending positively.

Three sets of estimates of the reduced form equation are provided. In all, the lag length is fixed at three, $k = 3$ and a full set of time dummies is included to capture the effect of macro influences on firm individual investment. All of the estimation results can be found in Appendix B and the following table summarises the estimated long-run effect of the growth rate of sales, changes in the user cost of capital and (the ratio of) cash flow (to capital) on the investment rate.[23]

Table 2. Long-run effects of sales, user cost and cash flow on the investment rate

	Sales	User Cost	Cash Flow
WITHIN	0.209	−0.081	
GMM 1	0.405	−0.084	
GMM 2	0.329	−0.035	0.248

The WITHIN estimates of the coefficients are reported in TableB1. The WITHIN (group) estimator is OLS after transforming the data into deviations from the cross sectional means. All of the lagged dependent variables are dropped from the estimating equation, since it is well known that the WITHIN estimator is biased when lagged dependent variables are present. According to the results in TableB1, the coefficients on the sales variable have the expected positive sign. The implied accelerator effect is not, however, overly strong; a permanent one percentage increase in the growth rate of sales will, on aggregate, increase firms' investment ratio by 0.23 percentage points. Note further that neither is the estimated effect of changes in the user cost of capital on firms' investment very strong; on aggregate a permanent 100 bps increase in the user cost of capital gives rise to a 8 bps reduction in firms' investment ratio. Consequently, the results seem to suggest that this channel for the transmission of monetary policy shocks is weak.[24]

Since the WITHIN estimator can be further biased due to the endogeneity of sales and user cost, we also present results using the GMM-first difference estimator of Arellano-Bond (1991), see TableB2. This time lags of the dependent variable are included. The results are remarkably similar to the ones obtained using the WITHIN estimator in TableB1. The GMM estimates of the effects of changes in the growth rate of sales as well as of changess in the user cost of capital are almost identical to the WITHIN estimates. However, both the Sargan-Hansen test and the AR-tests indicate that the validity of the instrument set – including basically lags 2 to 5 of the investment ratio, lags 2 to 6 of the growth rate of sales and lags 2 to 6 of the user cost – may be in suspect here. All test statistics are marginal (at best) suggesting that a further check on the set of instruments to be used in the GMM estimation may be desirable.

[23] The three sets of estimates in Table 1 correpond to, respectively, the WITHIN estimates in Table B1, GMM estimates in Table B2 and B3.

[24] According to the AR-tests in TableB3 no significant serial correlation in the errors seem to be present.

Finally, TableB3 re-estimates the reduced form equation using GMM after allowing the cash flow variable to enter the estimated equation. The cash flow variable enters the equation as a ratio to the once lagged capital stock. The set of instruments is now extended to include lags 2 to 5 of the cash flow variable. On aggregate the cash flow variable impinges positively on firms' investment, but the effect is not statistically significant. Also, only the coefficients on the third and fourth lag are estimated to be positive. Overall, then, we can perhaps conclude that the cash flow effect on firms investment spending appears to be weak. Consequently, to the extent that monetary policy shocks impinge on firms' investment spending through their cash flows, the results also indicate that this channel is not particularly strong either. Furthermore, the estimated effect of user cost on firms' investment is now weaker and none of estimated coefficients on the lagged growth rate of sales is statitistically signficant. Nontrivial correlation between cash flow and sales growth is most likely the underlying reason for the lack of significant sales growth effects here.

Overall, all the panel estimates strongly suggest that both the accelerator and user cost effect is much weaker at the firm level than at the aggregate level. The fact that log-changes in sales and user costs are used in the panel estimation instead of the output-capital ratio and level of user costs as in aggregate estimation may of course at least partly explain the much weaker effects estimated on the firm level data. Also, the panel data estimations uses firm specific interest expenses ('apparent interest rate') in measuring user costs, whereas the aggregate data builds on market interest rates. However, it should be noted that, as can be readily verified from the estimated autoregressions in TableB2 and TableB3, the investment ratio appears to much less persistent at the firm level than at the aggregate level. The sum of the estimated autoregressive coefficients in the firm level estimations is typically about 0.30–0.35, whereas it is well above 0.8 in the aggregate estimation.Consequently the investment ratio or changes in the capital stock appear to be much smoother at the aggregate level than at the firm level.

5 Conclusions

A lot of research has been devoted to testing the existence of binding financing constraints faced by firms in their investment decisions and also to estimating their potential effects on firms' investment quantitatively. The general view appears to be that financial regimes or financing constraints are important to firms' investment dynamics. However, it is not entirely clear whether this conclusions comes from having a consistent set of estimates available showing that these constraints are both qualitatively and quantitatively important, or from having to conclude that the empirical performance of the basic dynamic investment models derived from intertemporal optimisation – the Q model and the Euler equation – is too poor for the data on firms' investment spending to be generated by these models.

This paper basically explores the question of the importance of financial variables on firms' investment behaviour empirically using a panel of annual data on (large) Finnish firms covering the time period 1986–1999. The empirical approach taken to estimate the potential effects of financial variables on firms' investment provides some basis for evaluating, in turn, the likely effects of monetary policy (shocks) on firms' investment spending. In addition to the panel data estimations at the firm level this paper provided some evidence of investment dynamics at the aggregate level in Finland.

What should we then conclude from our estimation results? Firstly, investment appears to be much more persistent at the aggregate level than at the firm level. On the basis of the estimated autocorrelations, most of the serial correlation in the aggregate investment rate can be captured by a simple highly persistent AR(1) process, the one with the root around 0.95. Firm level data, on the other hand, suggests the sum of the AR coefficients is at best around 0.35, implying much less persistence. This results is, however, consistent with the international evidence from firm level data.

Secondly, in the firm level panel data the estimated effects of the user cost of capital and of the cash flow on firms' investment are both very small. The aggregate evidence, on the other hand, suggest stronger long-run user cost effect on investment, althought there too the short-run dynamic effects of changes in the user cost of capital on investment tend to be small. Anyway, the response of investment to changes in user costs appear to be more pronounced in the longer-run due to the high observed persistence in aggregate investment. However, the firm level data indicate that the implied effects of monetary policy (shocks) on firms' investment spending appear to be small; both the user cost and cash flow channels appear to be weak so that, quantitatively at least, these channels cannot be relied upon when monetary policy actions are taken with the purpose of counteracting inflationary pressures through the investment component of aggregate demand. Furthermore, the cash flow variable does not appear to enter significantly in the investment equation and the user cost variable is sometimes marginal. However, further work is clearly still needed to put us on a firmer ground on this particular issue. The estimation results definitely indicate that eg the GMM-estimates are perhaps not entirely satisfactory, since, in particular, we may have a weak instrument problem. Also, cash flow and sales are (highly) multicollinear. Finally, further work on measuring the user cost of capital is needed. Anyway, the results on the firm level data also indicate that the different estimators do agree on surprisingly weak user cost effects and this in itself should provide all the proper incentives for future research to innovate on approaches to modelling and measuring the interest rate sensitivity of firms' investment behaviour.

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A Graphical analysis of the ARDL model of the investment ratio

As indicated in the main text, this appendix contains material on the graphical analysis of the residual from fitting an ARDL model of the aggregate investment ratio to the data. There is still evidence of a considerable amount of autocorrelation in the residuals in a low order ARDL. This autocorrelation obviously reflects the aforementioned cycles in the aggregate investment ratio at frequencies near the cyclical one. One interpretation of this phenomenon is that there is a persistent, near unit root seasonal component in the aggregate investment ratio. Anyway, we have not tested for this hypothesis, nor for any other similar one. Instead, as also noted in the main text, we try to manage this phenomenon through sufficiently long lag length. In the set of graphs presented below we have, from the top to bottom, the actual and fitted series for the aggregate investment ratio, the estimated residual spectrum, the residual series and, finally, residual autocorrelations up to the 12^{th} lag. Note that although most of the residual autocorrelation has been removed by postulating a sufficiently long lag lengths, but not all. The spectrum suggests that a small amount of autocorrelation may still be present in the residuals. Actually, the test statistics are at this particular point somewhat marginal.

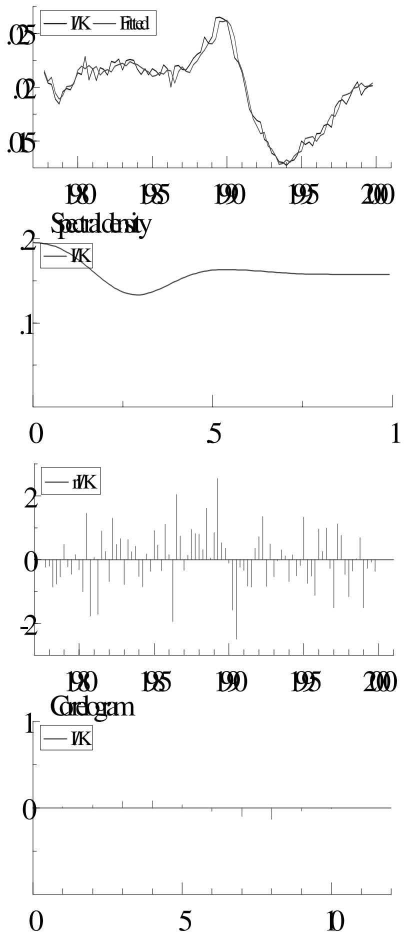
I/K
Fitted
Spectral density
I/K
.2
.1
0
.5
1
rI/K
2
0
-2
Correlogram
I/K
1
0
0
5

Figure 3:

B The investment equation: estimation relsults on Finnish firm level data

$$\frac{I_{i,t}}{K_{i,t-1}} = fi + \sum_{j=1}^{k} \omega_j \frac{I_{i,t-j}}{K_{i,t-j-1}} + \sum_{j=0}^{k} \theta_j \Delta y_{i,t-j} + \sum_{j=0}^{k} \sigma_j \Delta \rho_{i,t-j} + TDs + \varepsilon_{i,t} \quad (26)$$

Table B1: Models of Investment demand
WITHIN estimates, dependent variable $I_{i,t}/K_{i,t-1}$

Explanatory variable	**Finland**
$\Delta \log S_{i,t}$	0.117 (0.015)
$\Delta \log S_{i,t-1}$	0.040 (0.015)
$\Delta \log S_{i,t-2}$	0.012 (0.016)
$\Delta \log S_{i,t-3}$	0.040 (0.016)
Long-term eff. Sales	0.210 ()
$\Delta \log UC_{i,t}$	-0.017 (0.008)
$\Delta \log UC_{i,t-1}$	-0.023 (0.007)
$\Delta \log UC_{i,t-2}$	-0.015 (0.008)
$\Delta \log UC_{i,t-3}$	-0.026 (0.008)
Long-term eff. User cost	-0.081 ()
No. obs	1290
No. firms	338
$AR(1)$	0.23 (0.63)
$AR(2)$	1.39 (0.50)

Table B2: ADL Models of Investment demand GMM estimates, dependent variable $I_{i,t}/K_{i,t-1}$	
Explanatory variable	**Finland**
$I_{i,t-1}/K_{i,t-2}$	0.301 (0.60)
$I_{i,t-2}/K_{i,t-3}$	0.025 (0.29)
$I_{i,t-3}/K_{i,t-4}$	0.017 (0.27)
$\sum I_{i,t-j}/K_{i,t-j-1}$	0.343 ()
$\Delta \log S_{i,t}$	0.186 (0.640)
$\Delta \log S_{i,t-1}$	0.025 (0.014)
$\Delta \log S_{i,t-2}$	0.020 (0.016)
$\Delta \log S_{i,t-3}$	0.035 (0.013)
$\sum \Delta \log S_{i,t-j}$	0.266 ()
Long-term eff. Sales	0.405 ()
$\Delta \log UC_{i,t}$	-0.018 (0.013)
$\Delta \log UC_{i,t-1}$	-0.004 (0.009)
$\Delta \log UC_{i,t-2}$	-0.021 (0.009)
$\Delta \log UC_{i,t-3}$	-0.012 (0.012)
$\sum \Delta \log UC_{i,t-j}$	-0.055 ()
Long-term eff. User cost	-0.084 ()
No. obs	1184
No. firms	338
Sargan-Hansen test	21.19 (9 d.f. $0.01 < p < 0.025$)
$AR(1)$	4.02 (0.045)
$AR(2)$	4.09 (0.029)

Table B3: ADL Models of Investment demand + CF GMM estimates, dependent variable I_{it}/K_{it-1}	
Explanatory variable	**Finland**
$I_{i,t-1}/K_{i,t-2}$	0.212 (0.180)
$I_{i,t-2}/K_{i,t-3}$	0.108 (0.049)
$I_{i,t-3}/K_{i,t-4}$	0.014 (0.470)
$\sum I_{i,t-j}/K_{i,t-j-1}$	0.334 ()
$\Delta \log S_{i,t}$	0.157 (0.620)
$\Delta \log S_{i,t-1}$	0.041 (0.056)
$\Delta \log S_{i,t-2}$	0.007 (0.018)
$\Delta \log S_{i,t-3}$	0.014 (0.013)
$\sum \Delta \log S_{i,t-j}$	0.219 ()
Long-term eff. Sales	0.329 ()
$\Delta \log UC_{i,t}$	−0.008 (0.016)
$\Delta \log UC_{i,t-1}$	0.005 (0.009)
$\Delta \log UC_{i,t-2}$	−0.015 (0.009)
$\Delta \log UC_{i,t-3}$	−0.005 (0.009)
$\sum \Delta \log UC_{i,t-j}$	−0.023 ()
Long-term eff. User cost	−0.035 ()
$CF_{i,t}/K_{i,t-1}$	−
$CF_{i,t-1}/K_{i,t-2}$	−0.017 (0.226)
$CF_{i,t-2}/K_{i,t-3}$	0.129 (0.195)
$CF_{i,t-3}/K_{i,t-4}$	0.053 (0.048)
$\sum CF_{i,t-j}/K_{i,t-j-1}$	0.165 ()
Long-term eff. Cash flow	0.248 ()
No. obs	1184
No. firms	338
Sargan-Hansen test	18.77 (10 d.f. $p \approx 0.05$)
$AR(1)$	0.45 (0.50)
$AR(2)$	0.84 (0.65)

Appendix C

Table C1. **Financial structure of sampled firms**

	1986	1987	1988	1989	1990	1991	1992
Size of sample							
1 Total employment	350275	387705	478441	561486	604358	603705	566824
2 Total assets (million, euro)	35047	43660	60711	77285	88248	94468	100574
3 Total number of firms	177	212	238	262	278	300	320
Asset structure (as % of total assets)							
4 Total real fixed assets	37	38	36	36	38	42	43
5 Total financial assets	31	32	35	34	32	31	31
6 Total inventories	25	23	20	20	20	17	16
8 Total all other assets	7	7	8	9	9	10	10
Liabilities structure (as % of total liabilities)							
9 Loans	71	69	66	66	68	70	72
9a with maturity less than 1 year	35	35	34	35	35	33	34
9b with maturity more than 1 year	36	34	32	31	33	37	39
13 Equity and reserves	24	24	27	27	24	22	19
14 All other liabilities	5	6	7	8	8	8	8
Cash flow (as % of total assets)							
15 Gross investment	12	11	12	12	12	9	8
16 Cash flow	8	11	11	11	9	8	8
17 Net operating profit	1	3	4	3	1	2	2
18 Interest and similar charges	5	4	4	4	4	6	6

	1993	1994	1995	1996	1997	1998	1999
Size of sample							
1 Total employment	519461	488416	486512	444023	431739	404576	368098
2 Total assets (million, euro)	95739	83932	85167	76540	78469	68116	65269
3 Total number of firms	322	304	283	264	243	225	170
Asset structure (as % of total assets)							
4 Total real fixed assets	53	54	55	55	55	50	55
5 Total financial assets	30	30	28	30	30	34	30
6 Total inventories	14	14	16	14	14	15	15
8 Total all other assets	2	2	0	1	0	1	0
Liabilities structure (as % of total liabilities)							
9 Loans	70	64	61	61	59	57	51
9a with maturity less than 1 year	30	32	32	32	30	32	35
9b with maturity more than 1 year	37	32	29	29	29	25	16
13 Equity and reserves	29	34	37	37	38	40	46
14 All other liabilities	4	2	2	3	2	2	3
Cash flow (as % of total assets)							
15 Gross investment	7	7	8	10	11	9	9
16 Cash flow	11	13	15	14	13	12	20
17 Net operating profit	1	4	6	4	6	6	7
18 Interest and similar charges	6	4	3	3	2	2	2

Table C2. **The relative size of the aggregate of the sampled firms**

	1986	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
Firm structure							
Number of firms	177	212	238	262	278	300	320
Employment structure							
Total employment (data)	350275	387705	478441	561486	604358	603705	566824
(% of private sector empl)	18	20	25	29	32	34	35
(% of economy empl)	14	16	19	23	24	26	26
Capital structure (M euro)							
Total assets (data)	35072	43691	60755	77340	88312	94536	100646
Gross value added (data)	8901	11773	16614	20089	22574	22466	23936
(% of private sector)	17	21	26	29	31	33	36
(% of whole economy)	15	18	22	24	26	27	29
Gross investment (data)	3805	4728	7467	8990	10489	8325	8409
(% of private sector)	29	33	43	41	48	48	63
(% of whole economy)	25	28	37	37	42	41	52

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Firm structure							
Number of firms	322	304	283	264	243	225	170
Employment structure							
Total employment (data)	519461	488416	486512	444023	431739	404576	368098
(% of private sector empl)	35	33	32	29	27	25	21
(% of economy empl)	26	24	24	21	20	19	16
Capital structure (M euro)							
Total assets (data)	95739	83932	85167	76540	78469	68116	65269
Gross value added (data)	25218	25949	28291	24952	25300	30240	33806
(% of private sector)	37	36	36	31	28	31	33
(% of whole economy)	30	30	30	25	24	20	28
Gross investment (data)	7110	5566	6661	7795	8480		
(% of private sector)	63	50	51	55	53	48	40
(% of whole economy)	52	40	43	46	44	40	34

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