

Brunila, Anne

Working Paper

Investment and financing considerations: Evidence from Finnish panel data

Bank of Finland Discussion Papers, No. 4/1994

Provided in Cooperation with:

Bank of Finland, Helsinki

Suggested Citation: Brunila, Anne (1994) : Investment and financing considerations: Evidence from Finnish panel data, Bank of Finland Discussion Papers, No. 4/1994, ISBN 951-686-398-1, Bank of Finland, Helsinki,
<https://nbn-resolving.de/urn:nbn:fi:bof-201808031877>

This Version is available at:

<https://hdl.handle.net/10419/211692>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

BANK OF FINLAND DISCUSSION PAPERS 4/94

Anne Brunila

Economics Department

21.1.1994

**Investment and Financing Considerations:
Evidence from Finnish Panel Data**

ISBN 951-686-398-1
ISSN 0785-3572

Suomen Pankin monistuskeskus
Helsinki 1994

Abstract*

This paper presents a simple intertemporal model for the determination of corporate investment when the required rate on debt financing depends on the financial risk involved. When the actual lending rate does not fully reflect the financial risk, the balance sheet position of firms affects investment, as do the lending rate and demand factors. Specifically, the model implies that investment decreases with the amount of debt financing and increases with the availability of new equity financing and cash flow. Moreover, the financing conditions should be more important the greater the leverage.

Empirical results using Finnish panel data over the period 1985–92 conforms with the predictions of the theoretical model.

Tiivistelmä

Tutkimuksessa analysoidaan yritysten investointitoiminnan määräytymistä, kun investointien tuotto on stokastinen ja luottorahoituksen korko riippuu rahoitukseen liittyvästä riskistä. Jos yritysten investointeihin liittyvä riski ei täysin heijastu todellisessa luottokorossa, investoinnit riippuvat koron ja kysyntätekijöiden lisäksi yritysten rahoitusasemasta; velkaantuneisuuden kasvu vähentää investointeja, kun taas osake- ja tulorahoituksen kasvu lisää investointeja. Yritysten velkaantuneisuuden kohotessa rahoitusaseman vaikutus investointeihin voimistuu.

Empiirinen analyysi perustuu Etlatieto Oy:n suuryritystietokantaan vuosilta 1985–92. Paneliestimoinneista saadut tulokset ovat sopuosoinnussa teoreettisen mallin tulosten kanssa.

* I am indebted to Erkki Koskela, Reija Lilja and Paavo Peisa for helpful comments and discussion.

Contents

	page
Abstract	3
1 Introduction	7
2 A Theoretical Framework	9
2.1 Investment with given interest rate	9
2.2 Determination of the lending rate	11
3 Data sample and summary statistics	15
4 Estimation results	18
4.1 Specification of the empirical model	18
4.2 Results	18
5 Conclusions	21
Appendix 1.	22
Appendix 2. Investment function in the infinite-horizon case	24
Appendix 3.	26
References	27

1 Introduction

Corporate investment in Finland has traditionally been highly volatile. However, the ups and downs in the investment cycle before the liberalization of capital movements and deregulation of the domestic financial sector during the second half of the 1980s, seem moderate compared to the movements thereafter. The late 1980s were characterized by an exceptionally strong investment boom, buoyant asset markets and low real rates of interest; the years after 1990 have been marked by a severe recession, collapsing investment and asset prices and high real rates of interest.¹ This unusually large change in corporate investment that occurred in conjunction with major changes in firms' financing opportunities raises the question of the extent to which financing conditions can affect corporate investment.

From the point of view of traditional investment theories with perfect capital markets, firms' investment and financing conditions should be independent in the sense that financial policy of firms should not matter for investment decisions (Modigliani and Miller 1958). Recently, this Modigliani-Miller proposition has been challenged in the theoretical and empirical literature emphasizing the role of asymmetric information in capital markets.

Many of the theoretical arguments posed in connection with asymmetric information are based on the distinction between insiders or firm management, who have full information about the firm's investment prospects, and outsiders, e.g. debt and equity holders, who may correctly perceive the prospects for a group of firms but cannot make such distinctions between individual firms. This informational asymmetry may lead to a 'pecking' order concept of capital structure whereby retained earnings is preferred to debt and debt is preferred to new equity (Greenwald, Stiglitz and Weiss 1984; Myers and Majluf 1984).

The basic, empirically testable, hypothesis that arises from the asymmetric information approach is that if a firm has difficulty in obtaining external financing, its investment should display excess sensitivity to the availability of internal funds.² Accordingly, the equilibrium level of financially feasible investment depends on the balance sheet positions of investing firms. A strong balance sheet position, i.e. low indebtedness and high internal net value, means that the firm has more resources available to either use directly for investment financing or as collateral in obtaining external funds. A strong balance sheet position may also lead to increased investment by reducing outsiders' informational costs as well as firms' cost of external funds.

Although financial factors are claimed to be the initial motivation for positing the influence of internal financing on corporate investment, other considerations too can lead firms to prefer internal financing to borrowing. Accordingly, if a financial risk grows in proportion to indebtedness, the financial structure of the

1 See Charts 1–4 in Appendix 1.

2 Numerous panel data studies have provided evidence that cash flow and balance sheet positions have a significant effect on firms' investment spending, see Fazzari, Hubbard and Petersen, 1988; Gertler and Hubbard, 1988; Oliner and Rudebusch, 1992; Gilchrist and Himmelberg, 1993; Hubbard and Kashyap 1992; Hubbard, Kashyap and Whited, 1993; Whited, 1992.

firm can constrain the amount of actual investment. Furthermore, one can show that when profits are random this solvency³ constraint imposes a maximum ratio of indebtedness. Under the solvency constraint, investment becomes an increasing function of expected profits and a decreasing function of credit controls, the initial indebtedness ratio and the debt interest rate (Malinvaud 1982).

In what follows, we construct theoretical model linking the firm's investment and financing conditions in the presence of financial risk and stochastic rates of return on investment. The model draws heavily on the ideas presented in Smith (1972) and Koskela (1983). The implications of the model are then evaluated using panel data on the balance sheets and income statements of the largest 500 or so nonfinancial corporations in Finland over the period 1985–92.

Section 2 presents a simple intertemporal model for the determination of investment demand in a situation where the lending rate depends on the financial risk involved. This is done in two steps. First, a Tobin's q-type investment function is derived for a given lending rate. Second, the determinants of the lending rate in the presence of financial risk is analyzed from the point of view of the lender. Data and variables are presented in section 3, and an empirical model for investment equation is specified and estimation results are reported in section 4. Section 5 concludes the paper.

3 The obligation for a firm to pay interest on its debts and reimburse them at maturity.

2 A Theoretical Framework

2.1 Investment with given interest rate

The relationship between the firm's investment and financing decisions is analyzed in a simple two period model, where the firm's intertemporal consumption tradeoff is represented by the opportunity to save or borrow at a given interest rate. With positive interest rates, any amount of funds saved in the first period will return interest plus principal at the beginning of the second period, whereas borrowed funds must be repayed with interest. The owner of the firm is assumed to choose consumption C_1 and investment I_1 so as to maximize

$$\max V = u(C_1) + \beta u(C_2) \quad (2.1)$$

Consumption in the the first period is determined by the revenue R_1 generated by the production function $F_1(K_1)$ with initial capital stock K_1 , and by the firm's decisions to save (borrow) S_1 and invest I_1 . The function $\phi(I_1/K_1)$ denotes installation costs per unit of investment with $\phi' > 0$ and $\phi'' > 0$. In the second period the owner of the firm consumes the amount produced according to the production function $F_2(K_1 + I_1)$ with $F_2' > 0$ and $F_2'' < 0$, and the proceeds from savings $(1 + r) S_1$,⁴ where r is the given interest rate. Thus

$$C_1 = R_1 - \left[S_1 + I_1 + K_1 \phi \left(\frac{I_1}{K_1} \right) \right]$$

and

$$(2.2)$$

$$C_2 = (1 + r)S_1 + F_2(K_1 + I_1) \\ = F_2(K_1 + I_1) + (1 + r) \left[R_1 - C_1 - I_1 - K_1 \phi \left(\frac{I_1}{K_1} \right) \right]$$

The first-order conditions for the maximization of V in terms C_1 and I_1 are:

$$V_{C_1} = u'(C_1) - \beta(1 + r)u'(C_2) = 0 \quad (2.3a)$$

$$V_{I_1} = \beta u'(C_2) \left[F_2'(K_1 + I_1) - (1 + r) \left(1 + \phi' \left(\frac{I_1}{K_1} \right) \right) \right] = 0 \quad (2.3b)$$

where primes refer to derivatives in the case of functions of one argument and subscripts refer to partial derivatives in the case of many arguments.

Equation (2.3b) requires that

⁴ In the case of borrowing, consumption in the second period is determined by the production function F_2 minus the interest expenses and repayment of debt.

$$M = F_2'(K_1 + I_1) - (1+r) \left(1 + \phi' \left(\frac{I_1}{K_1} \right) \right) = 0$$

The term $[1 + \phi'(I_1/K_1)]$ is the marginal cost of investment, i.e. Tobin's q . Hence, the condition for optimal investment can be written as the usual neoclassical investment formula,

$$\frac{F_2'(K_1 + I_1)}{(1+r)} = q_1 \quad (2.4)$$

This implies that investment is independent of the firm-owner's preferences and is carried out to the point, where the present value of marginal return, $(F_2'/(1+r))$, is equal to the marginal cost of investment.

Extension of the model to allow for imperfect competition in the product market is straightforward. The demand for the firm's product can be characterized by a downward-sloping demand curve of the following form:

$$Q = Ap^{-\varepsilon}, \quad \varepsilon > 1$$

where p is the price of the product and A an exogenous demand shift parameter. The corresponding inverse demand function is

$$p = A^{\frac{1}{\varepsilon}} Q^{-\frac{1}{\varepsilon}}$$

The total revenue R_2 is thus

$$pQ = pF_2 = A^{\frac{1}{\varepsilon}} F_2^{1-\frac{1}{\varepsilon}}$$

The necessary condition for the maximization of V in terms of I_1 can now be written as

$$M^* = A^{\frac{1}{\varepsilon}} \left(1 - \frac{1}{\varepsilon} \right) F_2(K_1 + I_1)^{-\frac{1}{\varepsilon}} F_2' - (1+r) \left(1 + \phi' \left(\frac{I_1}{K_1} \right) \right) = 0 \quad (2.5)$$

The sufficient condition for the maximum

$$M_{11}^* = A^{\frac{1}{\varepsilon}} \left(1 - \frac{1}{\varepsilon} \right) F_2^{-\frac{1}{\varepsilon}} \left[-\frac{1}{\varepsilon} F_2^{-1} (F_2')^2 + F_2'' \right] - (1+r) \phi'' \left(\frac{I_1}{K_1} \right) < 0 \quad (2.6)$$

holds under the assumptions made earlier. According to (2.5) the neoclassical investment formula in the case of imperfect competition in the product market can be written as

$$\frac{A^{\frac{1}{\varepsilon}} \left(1 - \frac{1}{\varepsilon}\right) F_2(K_1 + I_1)^{-\frac{1}{\varepsilon}} F_2'}{(1+r)} = q_1 \quad (2.7)$$

Equation (2.5) defines implicitly the optimal investment I_1 in terms of exogenous parameters r and A

$$I_1 = I(r, A), \quad (2.8)$$

with $I_{1r} < 0$ and $I_{1A} > 0$. The investment equation has the usual properties. A rise in the interest rate r will decrease investment, *ceteris paribus*. On the other hand, an increase in demand will boost investment under imperfect competition. The results of this two-period model under certainty apply also in a more general framework (see Appendix 2).

2.2 Determination of the lending rate

After the analysis of investment function the determinants of the lending rate in the presence of financial risk is studied for. The firm is assumed to finance its risky investment, I_1 , by issuing new equity (E) and debt (B) so that the total amount of funds to be invested is $I_1 = E + B$. The expected gross proceeds of the investment can be expressed as

$$z = \int_k^K (1 + \theta)(B + E) dG(\theta), \quad (2.9)$$

where θ is the stochastic rate of return on investment, with density function $G'(\theta) = g(\theta)$. For simplicity, θ is assumed to be distributed independently of the amount invested. In what follows the critical rate of return on investment, at which the firm is just able to repay the full principal and interest on debt, $(1 + r)B$, is denoted by θ^* .

The lending rate charged on the firm's debt is determined by the expected profit maximization of the lender. In the case where the lender finances risky investment projects its expected profit depends on the expected gross proceeds of the investment project as well as on the opportunity cost of riskless alternatives such as government bonds. Instead of lending money for the risky investment at the interest rate r , the lender can buy riskless bonds paying the guaranteed return r^* , which is the lender's opportunity cost of lending at risk. The lender's expected profit, $\bar{\pi}$, is given by

$$\bar{\pi} = \int_{\theta^*}^K [B(1+r) - B(1+r^*)] dG(\theta) \quad (2.10)$$

$$+ \int_K^{\theta^*} [CF + (1+\theta)(B+E) - B(1-r^*)] dG(\theta)$$

where θ^* is the critical rate of return on investment, below which the firm is in default on its loan. The first RHS term in (2.10) describes the lender's expected profit in the event of full repayment plus interest and the second RHS term describes the expected profit in the event the borrower is bankrupt ($\theta < \theta^*$). In the case of default the lender receives the firm's cash flow, CF, plus the proceeds from the investment, $(1+\theta)(E+B)$, which means that both the new equity, E, and the firm's cash flow, CF, serve as collateral on the loan.⁵

It is more convenient to express equation (2.10) as

$$\bar{\pi} = B(r - r^*)(1 - G(\theta^*)) \quad (2.10a)$$

$$+ \int_K^{\theta^*} [CF + (1+\theta)(B+E) - B(1-r^*)] dG(\theta)$$

where $G(\theta^*)$ is the default risk. The critical value of θ , below which default becomes certain for given L and E, is derived by setting the second RHS term in equation (2.10a) equal to zero,

$$\theta^* = \frac{B(1+r^*) - CF}{(B+E)} - 1 \quad (2.11)$$

It is easy to see that the critical value of θ^* is a decreasing function of equity issues and the firm's cash flow, but an increasing function of debt issues, i.e., $\theta_{CF}^* < 0$ and $\theta_B^* > 0$.

Dividing both sides of the function (2.10a) by the amount of debt B gives the lender's expected profit rate $\bar{\pi}/B$,

$$\frac{\bar{\pi}}{B} = (r - r^*)(1 - G(\theta^*)) \quad (2.12)$$

$$+ \int_K^{\theta^*} [cf + (1+\theta)(1+\mu) - (1-r^*)] dG(\theta)$$

where $cf = CF/B$ and $\mu = E/B$. Finally, by setting the RHS of equation (2.11) equal to zero as the equilibrium condition, the expression for the expected rate of return is obtained

⁵ According to the limited liability principle the initial capital of the investing firm is assumed to be protected from lender claims in the case of default ($\theta < \theta^*$).

$$r = r^* + \Omega \quad (2.13)$$

where

$$\Omega = \frac{- \int_{\theta^*}^{\theta} [cf + (1 + \theta)(1 + \mu) - (1 + r^*)] dG(\theta)}{(1 - G(\theta^*))} > 0 \quad (2.14)$$

According to equation (2.13) the lending rate depends on the risk-free interest rate, r^* , and on the expected profit in the event the borrower defaults ($\theta < \theta^*$). There is no default risk in the case $G(\theta^*) = 0$, in which case equation (2.13) reduces to $r = r^*$. With perfect capital markets under certainty the lending rate is equal to the risk-free interest rate and, what is important, is independent of the balance sheet position of the borrower-investor. Under these circumstances the Modigliani-Miller proposition holds. With default risk, however, the balance sheet position becomes important as the lending rate depends on the firm's financial structure.

In order to find the partial derivatives of the default risk-adjusted interest rate r with respect to B , E , and CF , Ω is differentiated with respect to these variables. This gives first

$$\Omega_{\theta^*} = \frac{\Omega g(\theta^*)}{(1 - G(\theta^*))} > 0 \quad (2.15)$$

An increase in the critical rate of return raises the default risk-adjusted lending rate. The variables B , E , and CF affect r not only through the θ^* , but also directly through $\mu = E/B$ and $cf = CF/B$ in the Ω expression. Hence, we obtain

$$\begin{aligned} r_B &= \Omega_{\theta^*} \theta_B^* + \Omega_B > 0 \\ r_E &= \Omega_{\theta^*} \theta_E^* + \Omega_E < 0 \\ r_{CF} &= \Omega_{\theta^*} \theta_{CF}^* + \Omega_{CF} < 0 \end{aligned} \quad (2.16)$$

where $\theta_B^* > 0$, $\theta_E^* < 0$, $\theta_{CF}^* < 0$, $\Omega_{CF} < 0$, $\Omega_B > 0$, and $\Omega_E < 0$. With default risk, the lending rate is a decreasing function of equity financing, E , and the firm's cash flow, CF , and an increasing function of debt financing, B . Thus, we can write $r = r(B, E, CF)$.

In the previous section it was shown that under imperfect competition in the product market⁶, investment depends on the demand shift parameter, A , as well as on the interest rate, r , so that $I = I(r, A)$, with $I_r < 0$ and $I_A > 0$.

If the actual lending rate, r_a , fully reflects the default risk, then it could be used as the interest rate variable in the empirical investment function. But if this is not the case, the financial factors E , B , and CF should be included along with r_a as explanatory variables. This yields the investment function to be estimated:

⁶ See Precious (1987) for an analysis of these issues.

$$I = I(r_a, B, E, CF, A) \quad (2.17)$$

where $I_{r_a} < 0$, $I_B < 0$, $I_E > 0$, $I_{CF} > 0$, and $I_A > 0$. According to (2.17) investment is a decreasing function of the actual lending rate and debt financing, but an increasing function of equity financing, cash flow and the demand shift parameter. As the level of borrowing increases, the lending rate rises, which in turn has a negative effect on investment. An increase in equity financing will reduce the loan rate by providing more collateral and funds for the investment project on behalf of the investing firm, which has a positive effect on investment. The effect of cash flow on investment is qualitatively similar to that of equity financing. Increased cash flow decreases the lending rate and thereby increases investment. In summary, when the outcome of the investment is uncertain for the lender at the time the loan decision is made and when the actual lending rate is not a sufficient statistic for the default risk-adjusted lending rate, the firm's balance sheet position affects investment. More specifically, in this situation investment becomes a decreasing function of the debt and an increasing function of equity financing and cash flow.

3 Data sample and summary statistics

The empirical study uses a data base which contains adjusted annual data on the balance sheets and income statements of the largest 500 or so nonfinancial corporations in Finland.⁷ Of these firms, all those with complete panel data covering at least 6 subsequent years during 1985–92 were selected for the data set. After eliminating unreliable observations⁸ and dropping the first observation per firm in order to create lagged variables, the final unbalanced data sample contains 1579 observations on 280 firms.

In order to evaluate whether the actual lending rate is a sufficient statistic for the role of financial factor in explaining corporate investment, additional variables suggested by the theoretical model in section 2.2 are taken into account in the estimations. If the default risk is fully captured by the interest rate variable alone, the explanatory power of additional variables representing financial factors should be statistically insignificant. The variables used in the estimations are presented in table 1.

All additional variables except new equity issues are lagged by one year. The motivation for this is based on the sequence of the financing and investment decisions made by investing firms and lenders. First, before the firm can carry out on investment plan, it must be able to finance it. If the firm decides to finance the investment by issuing new equity, investment is undertaken when the firm finds the terms of sale favourable. Consequently, investment and equity issues are realized during the same period. However, if the firm decides to use debt financing, investment depends on the previous period's debt level and cash flow, as the balance sheet information on which the lenders' loan decisions are based is available only for the preceding accounting year.

Table 1. Measurement of variables

I_t	gross investment in plant and equipment during year t
CF_{t-1}	cash flow before depreciation, dividends and taxes during year $t-1$
E_t	new equity issues during year t
D_{t-1}	long-term liabilities at the end of year $t-1$
r_t	average interest rate on debt during year t , measured by the ratio of interest expenses plus other expenses on liabilities to liabilities subject to interest at the end of year t deflated by the investment goods price index
S_{t-1}	annual sales
dS_t	percentage sales growth $((S_t - S_{t-1})/S_{t-1})$

⁷ Large-firm data bank of Etlatieto Ltd. The data is collected by Talouselämä journal and comprises 500 or so of the biggest Finnish trade and industrial companies' adjusted financial statements. The adjustments to official financial statements are made according to the recommendations of the Finnish Committee for Corporate Analysis (YTN).

⁸ Observations in which the ratio of fixed assets to sales was fivefold or more or the value of new equity issues exceeded annual sales or the real effective rate of interest on debt was over 40 %.

As investments generate income gradually over a longer time period, the use of long-term liabilities as a proxy for debt financing seems to be the most appropriate item to focus on in the context of investment financing. Short-term corporate debt consists mainly of trade credit, advances received and short-term financial debt used to smooth temporary cash flow fluctuations. Although economic theory indicates that one should rely on market rather than book values of debt, the book value of long-term liabilities is used due to the lack of data.⁹ The use of total liabilities instead of long-term liabilities as a proxy for the debt financing did not change the results very much. The following section gives the results using long-term liabilities.

Cash flow may play at least two different roles in the determination of investments. Strong cash flow can be taken as an indicator of the availability of internal financing or, alternatively, as collateral for debt issues, by decreasing the critical rate of return. In both cases its expected impact on investment is positive. For high leverage firms, the importance of cash flow either as a source of financing or as collateral might be greater than for low leverage firms. In the case of low leverage firms, cash flow is totally irrelevant if $G(\theta^*) = 0$.

As the sale of new equity broadens the financial opportunities of investing firms, its effect on investment is expected to be positive. As in the case of cash flow, the impact of equity issues might be stronger for high leverage firms than for low leverage firms, for the same reason.

Sales growth as a demand proxy is expected to affect positively the decision to invest as a high growth rate is likely to be considered as an indicator of sustained demand growth also in the future, which paves the way for capacity expansion.

Earlier it has been argued that the leverage of the firm may affect the significance of other explanatory variables. A crude way of trying to determine whether the relationship between financial factors and investment varies with the degree of the firm's indebtedness is to split the sample into two groups according to the firm's leverage ratio and to run separate regressions on these subsamples. In dividing the sample into two subsamples, all firm's whose total liabilities to sales ratio at least 100 per cent were classified as high leverage firms; the others were classified as low leverage firms.

In the econometric analysis both the dependent variable (I) and explanatory variables are normalized by the level of sales (S) to reduce potential heteroscedasticity due to firm size.¹⁰

Summary statistics of the variables are given in table 2.¹¹ According to table 2 the average rate of investment of the high leverage firms was more than two times higher than that of the low leverage firms during 1986–92. Further, the

⁹ In the absence of secondary markets for loans, the general procedure for computing the market value of debt would require data on maturity and maturity distribution of firms' long term debt. See Brainard, Shoven and Weiss (1980).

¹⁰ In most studies the scaling factor has been the level of capital stock or assets. Because the data set includes only the accounting values of these variables, which differ significantly from market values and to a varying degree across firms, it was considered better to use the level of sales instead. Consequently, all the variables except the real rate of interest are expressed as a per cent of sales in the estimations.

¹¹ Year-by-year sample summary statistics are reported in Appendix 3 for the period 1987–92.

financial positions differed considerably between the two subsamples. The ratio of long-term liabilities to sales as well as the ratio of new equity issues to sales were roughly three times higher in the sample of high leverage firms than in the sample of low leverage firms. In the light of the earlier discussion in section 2.2, it is important to note that the significant difference in the average indebtedness of the two groups was not reflected in the average real rates of interest.

Table 2. **Sample summary statistics, 1985–92:**
means of variables, %

	Total Sample	High Leverage Firms	Low Leverage Firms
$(I/S)_t$	9.4	22.8	8.0
$(CF/S)_{t-1}$	6.9	9.0	6.7
$(E/S)_t$	1.0	3.4	0.8
$(D/S)_{t-1}$	35.9	92.0	30.3
r_t	5.3	5.3	5.3
dS_t	7.5	4.0	7.9
Obs.	1579	145	1434

4 Estimation results

4.1 Specification of the empirical model

The empirical estimation utilizes the techniques developed for panel data analyses, which provide several benefits for econometric estimation not captured by time-series or cross-sectional data (Hsiao 1985; Judge et al. 1990). Specifically, firm-specific panel data contain information with regard to interfirm as well as intra-firm differences in investment behaviour. The general structure of the estimated model can be written as

$$I_{it} = \alpha_0 + \alpha_i + \gamma_t + \beta'X_{it} + \varepsilon_{it} \quad (4.1)$$

$$t = 1, \dots, T_i \text{ and } i = 1, \dots, N$$

where I_{it} denotes gross investment of firm i at time t , X_{it} is a vector of variables including the interest rate as well as the financial factors for firm i at time t , and ε_{it} is a classical disturbance term with the conventional properties: $E[\varepsilon_{it}] = 0$, $\text{Var}[\varepsilon_{it}] = \sigma^2$ and $E[\varepsilon_{it}\varepsilon_{js}] = 0$ for all t and s , $i \neq j$.

In equation (4.1) the parameter $\alpha_{1i} = \alpha_0 + \alpha_i$ is the intercept of the i^{th} firm, where α_0 is the 'mean' intercept, and α_i represents the unobservable firm-specific effect calculated as the difference from the mean for the i^{th} firm. Parameter γ_t represents the time effect of the period t . The problem of multicollinearity is avoided by imposing the restriction $\sum_i \alpha_i = \sum_t \gamma_t = 0$.

4.2 Results

Table 3 presents the results of estimating equation (4.1) on the total sample and on the samples of high and low leverage firms (the firm and time dummies are not reported).¹²

Turning to specific results, the following comments merit attention: First, the signs of all the explanatory variables conform to the predictions of the theoretical model presented in Section 2. Most of the coefficient estimates are statistically significant at standard significance levels. These results clearly suggest that financial factors matter and that corporate investment and financing conditions are interrelated.¹³ Furthermore, the hypothesis that the parameters are the same for the high and low leverage firms is clearly rejected by the likelihood-ratio test, suggesting the importance of separate estimation.

¹² With panel data, the standard practice has been to report 'fixed-effects' or 'within-groups' estimators. This paper follows this practice although, according to the Hausman (1978) test statistics, a random-effects model performed slightly better for the sample of high leverage firms. The results, however, were very similar to those reported in table 3. Moreover, the significance of the differences in the parameters can be directly tested for by following this practice.

¹³ In Finland, investment behaviour has been empirically studied mostly using aggregate time-series data (see Koskenkylä (1985); Pyyhtiä (1990); and Holm, Honkapohja and Koskela (1993, 1994)). Perhaps due to a lack of data, financial factors have not been emphasized in these studies. See, however, Koskenkylä (1985) for the role of the cash flow variable.

Table 3.

Fixed-effects estimates for the total sample and for the samples of high and low leverage firms, 1985–92

Independent Variables	Dependent Variable = $(I/S)_t$					
	Total Sample N = 1579		High Leverage Firms N = 145		Low Leverage Firms N = 1434	
Constant	13.385	(12.65)	32.889	(2.96)	10.496	(14.13)
$(CF/S)_{t-1}$	0.256	(4.49)	0.538	(1.43)	0.146	(3.46)
$(E/S)_t$	0.705	(13.85)	0.831	(4.25)	0.354	(7.12)
$(D/S)_{t-1}$	-0.184	(-6.21)	-0.226	(-1.92)	-0.130	(-4.90)
r_t	-0.379	(-5.55)	-0.419	(-0.60)	-0.225	(-5.02)
dS_t	0.040	(3.06)	0.150	(1.68)	0.032	(3.42)
Diagnostics						
R^2	0.507		0.618		0.580	
L.M. [d.f.]	437.366	[280]	43.486	[52]	607.284	[270]
Hausman statistic	81.286	[5]	1.894	[5]	83.003	[5]

t-statistics in parentheses

Second, as for individual variables, the estimated cash flow coefficient for investment is highly significant for the total sample as well as for the two subsamples, but the magnitude of the coefficient differs considerably between the two subsamples. It is considerably higher for the high leverage firms, which indicates that firms' investment becomes increasingly dependent on cash flow as leverage increases. A similar conclusion also obtains with respect to equity financing; its coefficient estimate for high leverage firms is much higher than that for low leverage firms. Third, the coefficient estimate for the sales growth is quite significant, and also higher for the high leverage firms.

Fourth, as for the effects of accumulated debt and the real rate of interest, it appears that for the total sample as well as for the low leverage firms both factors have a negative and statistically significant impact on investment.

To sum up, the results suggest that firms' financial and investment decisions cannot be separated and that investment becomes increasingly dependent on cash flow and equity financing as well as on positive growth expectations as the leverage of the firm increases.

Panel data estimations were also carried out for two additional subsamples: industrial firms (traded goods sector) and service sector firms, including construction (non-traded goods sector). These additional estimations were performed in order to test whether the relationship between financing and investment vary across different production sectors. The estimations were based on the same specification as above. The estimation results are presented in table 4.

According to the likelihood-ratio test, the coefficient estimates differ significantly between the industrial and service sector firms. Specifically, the estimation results do not differ significantly with respect to cash flow but do differ with respect to equity financing and leverage. It appears that corporate investment in the service sector depends more heavily on the possibility to issue new equity as well as on the leverage ratio than is the case for the industrial sector. This finding does not contradict the hypothesis that service sector firms have more

limited access to the credit market and are thereby obliged to resort to equity issues to finance their investments 'more often' than industrial firms.

Table 4. **Fixed-effects estimates for industrial and service sector firms, 1985-92**

Independent Variables	Manufacturing Industries N = 785		Services N = 794	
	Constant	13.545	(9.11)	12.706
$(CF/S)_{t-1}$	0.234	(3.61)	0.225	(2.35)
$(E/S)_t$	0.362	(6.47)	1.181	(13.32)
$(D/S)_{t-1}$	-0.111	(-2.98)	-0.231	(-5.13)
r_t	-0.399	(-4.09)	-0.374	(-4.02)
dS_t	0.045	(2.48)	0.030	(1.65)
Diagnostics				
R^2	0.545		0.559	
L.M. [d.f]	246.564	[137]	207.589	[143]
Hausman statistic	38.225	[5]	46.554	[5]

t-statistics in parentheses

5 Conclusions

This paper presented a simple intertemporal model for the determination of corporate investment in the case, where the required rate on debt financing depends on the financial risk involved. It was shown that if the actual lending rate fully reflects the financial risk involved, investment is a decreasing function of the lending rate and an increasing function of demand. However, in a situation where the actual lending rate fails to fully reflect the financial risk, the balance sheet position of firms also affects investment, as do the lending rate and demand. Specifically, in this case investment becomes a decreasing function of corporate debt and an increasing function of new equity financing and cash flow.

Empirical results using Finnish panel data over the period 1985–92 were in conformity with the above predictions. This finding suggests not only that corporate investment and financial factors cannot be separated, but also that investments become increasingly dependent on the balance sheet positions as the leverage of the firm increases.

Appendix 1.

Figure 1. Equity issues, at 1985 prices, bill. FIM

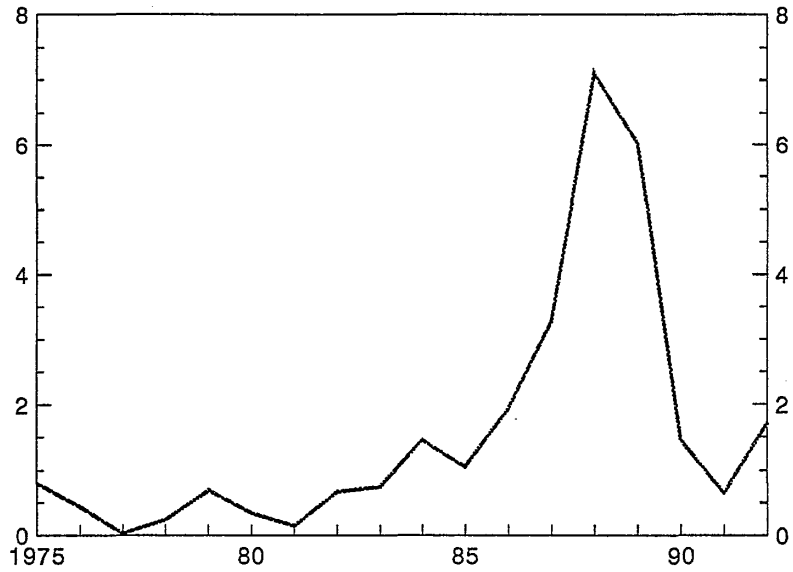
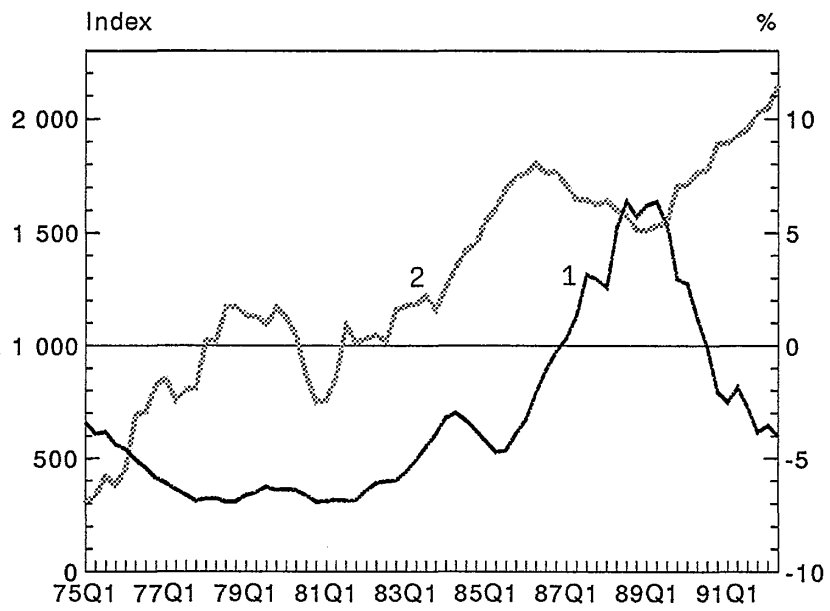


Figure 2. Real stock prices and real lending rate on new loans



1 Real stock prices HEX index, 1985 = 1000, left scale
2 Lending rate on new loans, %, right scale

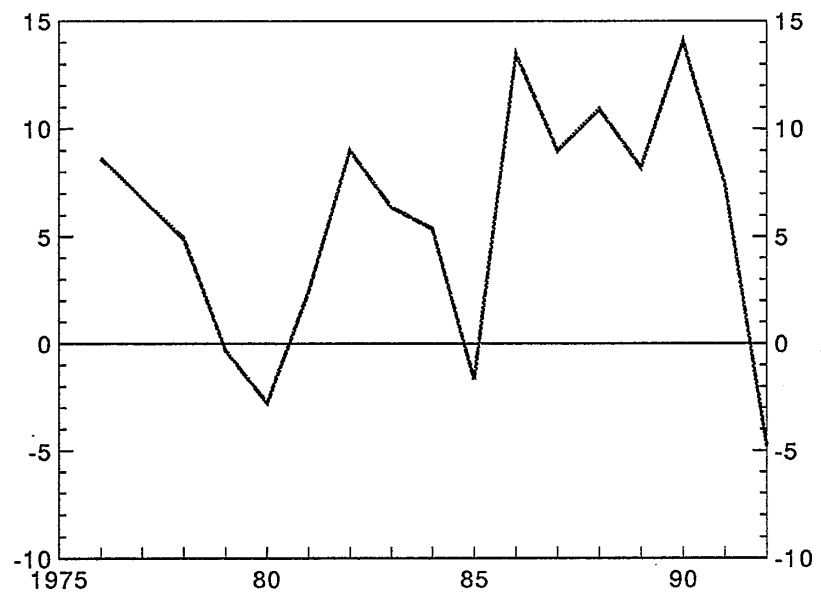
Figure 3.

Private fixed investment, at 1985 prices
Change over previous year, %



Figure 4.

Total lending to corporate sector, at 1985 prices
Change over previous year, %



Appendix 2. Investment function in the infinite-horizon case

The two-period model can be generalized as follows. If one assumes, for simplicity, perfect competition in the product market, then the firm's profit function in period t can be written as

$$P_t = F(K_t) - I_t - K_t \phi(I_t(K_t)) \quad (25)$$

Allowing for imperfect competition would only affect the revenue function $F(K_t)$. Capital stock K accumulates according to equation (2),

$$K_{t+1} - K_t = I_t - \delta K_t \quad (26)$$

so that $K_{t+1} = (1-\delta)K_t + I_t$ where δ is the rate of capital depreciation. From period t onwards the firm chooses its planned investment so as to maximize the present

value of profits $V_t = \sum_{i=1}^{\infty} P_{t+i}/(1+r)^i$. The corresponding Lagrangian is

$$L_t = \sum_{i=0}^{\infty} P_{t+i}(1+r)^{-i} - \sum_{i=0}^{\infty} q_{t+i}(1+r)^{-i} [K_{t+i+1} - (1-\delta)K_{t+i} + I_{t+i}] \quad (28)$$

where q_t is the Lagrange multiplier in period t associated with the capital accumulation equation (2). The first-order condition for the maximization of V_t in terms of I_{t+i} is

$$\frac{\partial L_t}{\partial I_{t+i}} = (1+r)^{-i} \left[-1 - \phi' \left(\frac{I_{t+i}}{K_{t+i}} \right) + q_{t+i} \right] = 0 \quad (29)$$

which is identical to equation (2.4) in section 2.1. In order to get the expression for q_{t+i} , write the first-order condition in terms of K_{t+i}

$$\frac{\partial L_t}{\partial K_{t+i}} = (1+r)^{-i} [P'_{t+i} + q_{t+i}] - (1+r)^{i-1} q_{t+i-1} = 0 \quad (30)$$

where $P' = \partial P/\partial K$ is the marginal productivity of investment and where it has been assumed that $\delta = 0$ for simplicity. Now (30) can be used recursively to give

$$q_t = q_{t+n}(1+r)^{-n} + \sum_{i=0}^n P'_{t+i}(1+r)^{-i} \quad (31)$$

If it is assumed that the so called transversality condition

$$\lim_{n \rightarrow \infty} q_{t+n} (1+r)^{-n} = 0 \quad (32)$$

holds, then we obtain

$$q_t = \sum_{i=0}^{\infty} P_{t+i}' (1+r)^{-i} \quad (33)$$

This is Tobin's q ; the present value of current and future marginal productivity of investment is equal to the marginal cost of investment, $1 + \phi'(I_t/K_t)$. Condition (7) means that q cannot grow faster than the interest rate. Otherwise investment, I , would be infinite. In the case $\delta > 0$, formula (8) is slightly more complicated in the sense that the future marginal productivities are now discounted more heavily to reflect depreciation.

Appendix 3.

Sample summary statistics 1987–92: Means of variables (as a per cent of sales).

Total Sample	1987	1988	1989	1990	1991	1992
Investment	8.6	11.4	10.3	10.1	10.1	8.3
Total Debt	53.2	51.4	50.4	50.4	53.7	61.3
Long-Term Debt	25.5	24.7	24.7	24.0	25.6	32.1
Cash Flow	7.9	10.2	7.8	7.7	5.4	3.5
Equity Issues	1.7	2.3	0.8	0.9	0.4	0.7
High Leverage Firms	1987	1988	1989	1990	1991	1992
Investment	21.1	34.3	20.1	25.9	14.9	22.8
Total Debt	140.3	141.2	147.3	146.9	136.2	137.4
Long-Term Debt	86.7	91.6	83.8	85.1	81.5	85.7
Cash Flow	14.5	15.5	10.9	8.7	-2.4	0.7
Equity Issues	8.8	5.4	0.9	1.5	0.7	3.8
Low Leverage Firms	1987	1988	1989	1990	1991	1992
Investment	7.4	9.6	9.4	8.9	6.0	5.9
Total Debt	44.6	44.2	45.6	47.5	47.8	50.4
Long-Term Debt	21.4	20.3	21.2	22.0	23.1	24.5
Cash Flow	7.2	9.9	7.5	5.2	3.8	3.9
Equity Issues	1.0	2.0	0.9	0.3	0.2	0.3

References

- Brainard, W.C., Shoven, J.B., and Weiss, L. (1980), **The Financial Valuation of the Return to Capital**. Brookings Papers on Economic Activity.
- Fazzari, S., Hubbard, R., and Petersen, B. (1988), **Financing Constraints and Corporate Investment**. Brookings Papers on Economic Activity.
- Gertler, M., and Hubbard, R. (1988), **Financial Market Volatility**. A Symposium Sponsored by The Federal Reserve Bank of Kansas City, August 17–19.
- Gilchrist, S., and Himmelberg, C. (1993), **Evidence on the Role of Cash Flow for Investment**. Finance and Economics Discussion Series, No. 93–7.
- Greenwald, B., Stiglitz, J., and Weiss, A. (1984), **Informational Imperfections in the Capital Market and Macroeconomic Fluctuations**. American Economic Review, Papers and Proceedings, Vol. 74, May.
- Hausman, J.A. (1978), **Specification Tests in Econometrics**. Econometrica, Vol. 46.
- Holm, P., Honkapohja, S., and Koskela, E. (1993), **Incidence Effects of Proposed Reforms for the Payroll Tax in Finnish Manufacturing**. Finnish Economic Papers, Vol. 6, No. 2.
- Holm, P., Honkapohja, S., and Koskela, E. (forthcoming in 1994), **A Monopoly-Union Model of Wage Determination with Capital and Taxes**. An Empirical Application to the Finnish Manufacturing. European Economic Review.
- Hsiao, C. (1985), **Benefits and Limitations of Panel Data**. Econometric Reviews.
- Hubbard, R., and Kashyap, A. (1992), **Internal Net Worth and the Investment Process: An Application to U.S. Agriculture**. Journal of Political Economy, Vol. 100.
- Hubbard, R., Kashyap, A., and Whited, T. (1993), **Internal Finance and Firm Investment**. NBER Working Paper No. 4392.
- Judge, G., Griffiths, W.E., Hill, R.C., Lütkepohl, H., and Tsoung-Chao Lee (1990), **The Theory and Practice of Econometrics**. John Wiley and Sons.
- Koskela, E. (1983), **Credit Rationing and Non-Price Loan Terms. A Re-Examination**. Journal of Banking and Finance, Vol. 7.
- Koskenkylä, H. (1985), **Investment Behaviour and Market Imperfections with an Application to the Finnish Corporate Sector**. Bank of Finland, B:36.
- Malinvaud, E. (1981), **Wages and Unemployment**. Economic Journal, Vol. 92.
- Modigliani, F., and Miller, M.H. (1958), **The Cost of Capital, Corporation Finance, and the Theory of Investment**. American Economic Review, Vol. 48, June.
- Myers, S., and Majluf, N. (1984), **Corporate Financing and Investment Decisions when Firms Have Information that Investors Do Not Have**. Journal of Financial Economics, Vol. 13.
- Oliner, S., and Rudebusch, G. (1992), **Sources of Financing Hierarchy for Business Investment**. Review of Economics and Statistics, Vol. LXXIV
- Precious, M. (1987), **Rational Expectations, Non-Market Clearing and Investment Theory**. Clarendon Press, Oxford.

Pyyhtiä, I. (1990), **The Revision and Realization of Investment Plans in the Finnish Manufacturing Industries in 1964–1986.** Bank of Finland.

Smith, V. (1972), **A Theory and Test of Credit Rationing: Some Generalizations.** American Economic Review, June.

Whited, T. (1992), **Debt, Liquidity Constraints, and Corporate Investment.** Journal of Finance, Vol. XLVII, No. 4.

BANK OF FINLAND DISCUSSION PAPERS

ISSN 0785-3572

- 1/94 Juha Tarkka **Implicit Interest as Price Discrimination in the Bank Deposit Market.** 1994. 28 p. ISBN 951-686-385-X. (TU)
- 2/94 Airi Heikkilä **Selvitys suorista sijoituksista Suomeen** (Foreign Direct Investment in Finland). 1994. 59 p. ISBN 951-686-386-8. (TU)
- 3/94 Erkki Koskela — Jouko Vilmunen **Tax Progression is Good for Employment in Popular Models of Trade Union Behaviour.** 1994. 22 p. ISBN 951-686-387-6. (TU)
- 4/94 Anne Brunila **Investment and Financing Considerations: Evidence from Finnish Panel Data.** 1994. 28 p. ISBN 951-686-398-1. (KT)