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A FLOW-OF-FUNDS MODEL FOR THE FIRM SECTOR IN FINLAND

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1. Introduction

The key role of the firm sector is to produce the bulk of the nation's output. Therefore, the most important of the firms' decisions are those related to production and use of productive inputs. The typical point of view of economic theory concerning the behaviour of the firm concentrates on aspects such as the volume and timing of increases in capital equipment, their financing and factor mixes to be used mainly because of the one good models mostly used in the analysis. In reality the firm has to make decisions e.g. on the product mix, on new products to be developed, and on marketing operations, as equally important as the decisions concerning the capital equipment, its expansion and modifications in it.

Our aim is here, however, to follow the traditional line and consider investment decisions in physical capital the most important ones for the firm, from which the firm sector model gets its starting point and leave the "soft" investments aside. For us from the point of view of building a flow-of-funds model of the integrated type where both real and financial portfolio decisions are considered, the most essential question is the one concerning the relationship between the investment decisions and the financial decisions of the firm. The link between these is basically made by the problem, how much to distribute of the profit as dividends and how much to use into investments, i.e. future dividends, and how to finance

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*) I thank professor Erkki Koskela for valuable comments.

the capital stock, whether by issuing new shares or by raising loan capital. The famous Modigliani-Miller theorem (1958) says in its basic form that the market value of the firm, the objective of the firm's decision making in the neoclassical analysis, is independent of its capital structure. It does not matter, what are the amounts of equity and debt in the balance sheet of the firm. As a consequence, financial decisions are irrelevant as to the market value of the firm, and therefore also irrelevant to investment decisions. This result is valid only in a specific model, and introduction of factors such as taxation and risk of bankruptcy, in general cause that there is a relationship between the financial structure and the market value of the firm, the overall cost of finance of the firm depending on its indebtedness.

Another aspect concerning the influence of financial factors on the investment decision is the role of the financial flow variables in the investment equation. Since the rise of the Jorgensonian neoclassical investment function into a dominating position in the investment theory in the 1960's, the "naive" liquidity, or profit theories of investment behaviour came under attack and were also tested to be empirically worse than the dominating model.[1)] The critique pointed out that financing of investments is just the mirror of the investment process and that profits are highly positively correlated with output and the rate of capacity utilization, see e.g. Feldstein and Flemming (1971) on this.

The experiences of the (late) 1970's have, however, quite substantially changed the investment situation and also attitudes in the research.

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1) See Jorgenson and Siebert (1968), Jorgenson (1971). The comparison of the performance of the investment equations in the mid-1970's recession by Clark (1979) sheds interesting light in this aspect.

The profit squeeze, stickiness of the real wage in a deteriorating terms-of-trade situation, the slowdown of productivity growth, the sharp decrease in company profitability and in productive investments have changed the attitudes towards a new assessment of the role of profits as a determinant of investments.

As noted briefly above, it is possible to integrate the role of past profits in the neoclassical model of the firm as a cost of funds factor, as Nickell (1978, p. 179) shows.[1] Profits also have an important role as an expectation variable. If past profits were the best predictor of future levels of profit, they would be the major or even only determinant of business investment.[2] In practice, however, the situation is not so simple, because as Nickell points out, there may be other even better variables doing this forecasting business, most notably the price of the firm's equity.

In the neoclassical framework of the firm an important aspect in the relationship between past profits and the firm's investment is the fact that this is typically considered to be of a short- run nature. We quote Nickell once more (p. 185): "Indeed, we can go further and argue that the main effect

1) "So we can conclude that high past profits, by increasing the funds available to the firm's owners, will have a tendency to lower the combined firm and owner level of debt and, since the debt must be procured from individuals who are more averse to risks of the firm than the owners, such a reduction will lower the effective cost of capital schedule and raise the optimal level of investment."

2) Nickell (1978, p. 183) states on this point: "The other, perhaps more forceful, argument is that a higher profit earned by the firm may actually influence prospects in the direction of optimism, thereby lowering the effective cost of capital. This could well be an extremely important effect and may possibly be the dominant reason why current profitability would influence the firms investment plans."

of current profits is on this rate of adjustment and not on the long-run equilibrium level of capital stock itself, for *in the long run* (italics by Nickell) the firm can generate enough wealth for its owners to finance its fixed equilibrium level of capital stock without recourse to expensive borrowing from less optimistic or more risk-averse economic agents".

This status of profits in the neoclassical analysis of the investment behaviour is due to the fact that in the long-run competition between various investment opportunities eliminates all differences in the rates of return and there are no pure profits in any investment object. So, it would be quite meaningless to operate independently with such a concept as the long-run profitability in a neoclassical framework.[1)] On the other hand, as is well-known, in the Keynesian growth literature the investment function is based on the notion of income distribution, and undistributed profits as well as distributed profits are the key factors in explaining the volume of investment in the economy.[2)]

2. The availability of finance and the investment process

In the standard framework the firm is supposed to be able to raise finance in loan markets which can be described to be of the well-functioning type.

1) Costrell (1983) presents a full equilibrium analysis on the relations between profits and investment where the competitive financial markets eliminate pure rents as a difference between profits and the rate of interest and thus disputes results of the partial analysis of Malinvaud (1982) where the interest rate is kept fixed. The latter is of course valid if rates of interest in the financial market are controlled by the public authority. Kouri (1982) presents a growth model where profits also have a role in the determination of growth and investment in the long-run growth equilibrium.

2) See e.g. Eltis (1973) on a survey of this.

In practice there are many features which violate this assumption, because typically in many countries there are various kinds of rigidities and rationing of credit in the financial markets.

One important consequence of this is the fact that there are quite strict limitations concerning the amount of external finance a firm can raise in one period for its investment projects, these being of the similar kind as the standard convex adjustment costs in the investment theoretical literature.[1] And secondly, the equity market is in many countries of a limited importance, and there is so little equity finance available that the bulk of the firm's own funds are usually made by the cumulated undistributed profits. This causes the fact that there are no great possibilities to perform portfolio type changes in the capital structure of the firm; own capital virtually rises pari passu with profits.[2]

In dynamic neoclassical models of the firm, however, the optimal capital accumulation path and the optimal financial structure are both solved in the optimization. This can be separated into two parts. First, in a static optimization problem a capital structure of the firm is found out which

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1) Schworm (1980) presents an analysis of optimal investment behaviour when the firm is under the financial constraint of not being able to raise new loans. This has the effect that the capital stock is never greater than the unconstrained capital stock and the shadow rental of capital services is never less than the unconstrained value. There are interesting differences with respect to the anticipatory effect of financial constraints on capital accumulation between the models of Schworm and Appelbaum and Harris (1978).

2) In Finland the investments of the firm sector have been on the average some 10 percent of GDP and the issues of new shares at the Helsinki Stock Exchange been of the order of only some 1-2 per mill of GDP and retained gross profits have been of the order of 6 per cent of GDP. However, lately there are many changes in the stock market and it may become in the sequel more important for the firms. One factor contributing to this is the deregulation in the financial markets and in the control of the interest rate setting of the banks obeyed by the central bank. As a consequence of this the capital structure of the firms evidently has a larger impact on the the costs of loan capital in the future.

minimizes the capital costs of the firm.[1] If there are (infinite) adjustment costs related to the capital structure just because of the small possibilities to achieve any major portfolio adjustments through the equity market, we get the interesting result of Steigum (1983) that in this first phase of the problem we in fact find out the optimal volume of the capital stock as a function of the equity capital, i.e. cumulated profits.

Steigum does not present this problem in the context of the working of the financial markets. Next we modify this model by retaining the standard linear, flat interest rate schedule, but taking the lender's point of view in the working of the bank loan market. We utilize the analysis of a bank's loan supply behaviour by Jaffee (1971). Let the total capital stock of the firm be K which can then be decomposed as

$qK = p_E E + L$, where $p_E E$ is the value of the firm's equity and L the debt capital and q the market price of a unit of capital. In the following we discard changes in the prices q and p_E and set them simply to unity.

Let y be the random return of the total investment. The value of the capital stock at the end of the period is $(s(K)y)K$, where $s(K)$ is a nonrandom function of total

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1) A common way to formalize the capital costs is to introduce a nonlinear interest rate function r where

$$r = r(e), \quad e = L/E,$$

$$r(e) = \begin{cases} r_0 & \text{for } -1 < e < \bar{e} \\ r_0 + a(e-\bar{e}) & \text{for } e > \bar{e} \end{cases}$$

where a is a function with properties

$$a(0)=0, \quad \lim_{e \to \bar{e}+} a\,(e-\bar{e})=0, \quad \lim_{e \to \infty} a\,(e-\bar{e})=\infty,$$

see Steigum (1983) and Koskenkylä (1983).

capital which adjusts the rate of return y for the scale of total assets. The density function of the random return y is given by $g(y)$ which is independent of the scale of the project. Thus, for $s(K) \equiv 1$ we would have a constant expected rate of return to scale and with $s'(K) < 0$ a decreasing expected rate of return, see more closely Jaffee (1971), page 58 for the properties of the function $s(K)$. Let R be the interest factor, $R = 1+r$.

If the value of the project at the end of the period is less than RL, the bank gets the value of the project; if the value is higher than RL the bank gets the loan capital and the interest payment in the normal way. Let further 1+i be the interest factor related to the opportunity cost of the bank. So, we have as the decision-making problem of a risk neutral bank: maximize with respect to L the expected net revenue P from lending to the customer in question where P is

$$(3) \qquad P = K \int_{-\infty}^{RL/sK} y g(y) dy + RL \int_{RL/sK}^{\infty} g(y) dy - (1+i)L.$$

Manipulating first this expression and derivativing it then with respect to L we get as the necessary condition for the bank loan optimum

$$(4) \qquad \frac{dP}{dL} = R - \int_{-\infty}^{RL/sK} G(y) dy - \frac{RE}{K} G(RL/sK) - (1+i) = 0,$$

where G is the distribution function of y.

By total differentiation of this expression with respect to L and E we can derive the relationship between the optimal loan supply of the bank and the own funds of the firm. In this case it is especially simple and we get the result

(5) $$\frac{dL}{L} = \frac{dE}{E}.$$

So, we find that the bank obeys in its lending policy the criterium of a fixed capital structure. The firm can acquire new loans strictly complementary with its accumulation of (retained) profits (in a ratio specific to it which depends on the properties of the distribution g).

The above analysis is a very simple one disregarding all the many relevant aspects in the bank's behaviour, such as non-constant opportunity costs i to the bank for loanable funds and possible costs attendant with collecting the available proceeds in case of the firm's bankruptcy, considered in detail by Jaffee (1971), chapter 2.7. Nor have we considered the position of the bank in the bank loan market, but simply have derived its loan offer (curve) with a fixed interest rate and taken it to be the market solution.[1] The empirical justification for this is the fact that in the Finnish conditions the interest rates have to a large degree been set administratively by the central bank.

Anyway, the above model gives us the result that

(6) $$K = \frac{1}{1+e_0} E,$$

where e_0 is a firm specific constant depending on the properties of the density function g, and on R and i. One very simple consequence of this analysis is the following relationship between the rate of investment and the flow of profits

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1) Koskela (1983) presents an analysis of the competitive bank loan market where the own funds-loan ratio is a non-price loan term and the equilibrium in the market implies rationing of the customers with this property of the required capital structure.

(7) $\dot{K} = I - dK = \frac{1}{1+e_0} \dot{E}$.

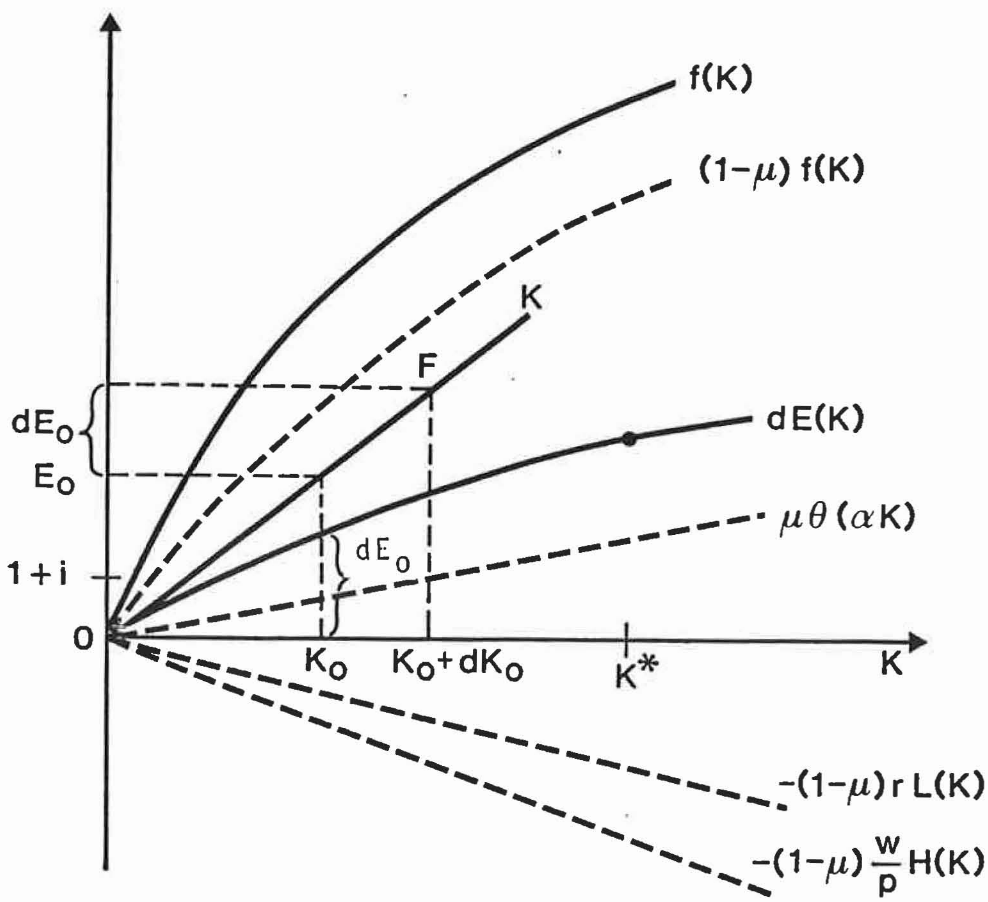
In a time series context we have to allow the variability of the coefficient e_0 as a result of variations in the distribution function g and in the bank's opportunity costs i. Clearly, this is not a final relationship because it does not explain the determination of retained profits. We should then make a dynamic optimization from the owners' point of view concerning the allocation of the firm's profits into dividends and into retained earnings which are then used to finance capital investment.

In the above model (7) the capital structure of the firm is determined by the rationing lender bank and the firm is implicitly assumed to be willing to take as much loan finance as is available because it has a reservoir of capital investment opportunities which are in an after-tax sense profitable enough in comparison to the safe interest rate i.

Let us consider more closely the investment process and illustrate it with the following diagram. The retained earnings function of the firm in the case of no dividends is the following

(8) $dE = pf(K)-wH-rL-u(pf(K)-wH-rL-\theta\alpha K)$,

where f(K) is the production function, p the price of output, w the wage rate, H the labour input, r the rate of interest, L the stock of debt, u the income tax rate in firm taxation, θ the rate of depreciation in the firm taxation, and α the ratio of the physical capital stock to the capital stock used as a basis for depreciation allowances in taxation (usually clearly less than one, perhaps in the Finnish conditions α is of the order one fourth or one third, see Alho (1980), page 79). Assuming the production function to exhibit decreasing marginal products and that there is simply a fixed relationship between the capital and labour inputs, we can draw the curve for the retained earnings dE as a function of the capital input K by summing the respective parts of the retained earnings included in (8), see the figure.



Starting from an initial position K_0 and E_0 where E_0 is marked on the vertical axis, we can first find out the retained profits related to the capital stock K_0, which we then add to the initial own funds E_0 to get their new level E_0+dE_0. These then "entitle" the firm to get total finance of the amount K_0+dK_0 according to the availability of funds line marked OFK. In making the investment decision on the basis of the profit function dE(K) the firm also has to take care that the new investment is profitable enough compared to the risk free interest rate i. So the slope of the dE(K) curve has to be steeper than i in order that the capital accumulation process would continue. The firm aims to reach a point denoted by K* where this equilibrium condition is reached, and K* is then the optimal capital stock.

This desired capital stock does not depend on profits (with a fixed r) but the speed of adjustment towards it depends on the flow of internal and external funds in the case of a credit rationed firm. There are situations where only the tightness of credit and the profitability of the firm determine the actual volume of investment. On the other hand, we may find situations where the firm is not credit constrained because of slack capacity.[1)]

1) We may add to the production function a shift parameter γ representing conditions in the output market, $f = \gamma f(K)$. A lowering of γ, i.e. slack capacity, may cause such a big downward shift in the production function f and also in the profit function dE(K) that there is less willingness to invest than are available funds.

3. The investment equation

In practice we may so find firms in different states, and the aggregate investment function has to be based on all these different aspects. Let us consider more closely this aggregation. On the basis of the previous discussion there are essentially three categories of firms,

(9) category 1 : $I_1 = dE_1 + dL_1$; liquidity constrained firms

category 2 : $I_2 = I_2(\frac{w}{p}, \frac{c}{p}, K_{2_{-1}})$; supply constrained neoclassical firms, where c = cost of capital per unit,

p = price of output,

w = labour cost

category 3 : $I_3 = I_3(Q_3, \frac{w}{c}, K_{3_{-1}})$; demand constrained keynesian firms

The total investments are made by the sum of these subcategories. This aggregation is not a simple one, because typically each firm can be in any of these categories depending on the conditions in the loan market and in the output market. So we can infer that the relation between total investment and each of the variables appearing in (9) is fairly complex and nonlinear. The weights of the three categories depend on the mutual relations between the explanatory variables on the macro level. For instance, we find out that the marginal impact of a rise in the retained profits has the larger influence on investment, ceteris paribus, the lower is the level of the profits, the tighter is the situation in the credit market and the higher is the (expected) demand in the goods market in relation to the existing capacity of the firm.

The econometric model which the analysis would produce might be of the type of a switching regression model considered e.g. by Goldfeld and

Quandt (1973). The basic idea is that the aggregative solution is made by a weighted sum of two micro relationships with weights to be further estimated. In our problem here this idea might be very difficult to follow because, as can be seen from (9), there are basically three variables which cause shifts in the relationship. With our scant data this sort of model may be quite awkward or even impossible to handle, and therefore we decide to formulate the model more in the line of a traditional econometric model.

Above we have operated with the flow of credit as a quantitative constraint on fixed investment. In fact, we naturally have to consider its impact also on all other real and financial uses of funds variables considered in the flow-of-funds model as endogenous variables.

A theoretical approach to the existence of quantitative constraint which constrain the agent's behaviour is to describe its influence analogously as a price variable which is a new parameter in the agent's economic environment, see Neary and Roberts (1980). They present an enlargenment of the standard demand analysis to the situation where the consumer is under quantitative rationing of some good. Rationing has two effects on behaviour. First, it has a normal substitution effect through increase in the (shadow) price of the rationed good which decreases the demand for the rationed good and increases that for other goods. It also has an income effect, because the rationed amount of the good in question can be bought at a cheaper (rationed) price than the "true" (shadow) price.

In the bank loan market we must notice that the borrowers gain from credit rationing in the sense that they get credit a lower rate of interest than the equilibrium rate but that, on the other hand, the lenders lose an equivalent amount through deposit rates of interest which are lower than equilibrium. We could make some speculations about the differences in propensity to demand for new loans among those who are at present borrowers and those who are depositors. On the aggregative level we, however, suppose that this effect can more or less be netted out, even though we could on good grounds think that the borrowers are more inclined to stay quite permanently on the borrower side than the depositors to change sides.

When we substitute the shadow price in the standard demand equation for the rationed good we get as a result the rationed amount itself. So, in the case of bank loan markets we get the rationed loan demand function which gives as a result the amount of credit which the banks are willing to supply.

Our flow-of-funds model has five endogeneous variables: fixed investment of the firm sector, denoted by I, change in inventories, I_{inv}, net foreign borrowing ΔL_{for}, demand deposits in domestic banks ΔDD, and borrowing from domestic banks in domestic currency ΔL_{bf}. Let us denote simply by X all the other relevant explanatory variables than rat which is the shadow price of rationing. Now we have as our equation system

(10) $I = f_1(X,rat)$

(11) $I_{inv} = f_2(X,rat)$

(12) $-\Delta L_{for} = f_3(X,rat)$

(13) $\Delta DD = f_4(x,rat)$

(14) $-\Delta L_{bf} = f_5(X,rat) = -\Delta L^s_{bf}$ (credit supply)

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sum $= 0 \cdot X + 0 \cdot rat = 0$

From equation (14) we see that price of rationing is an endogenous variable which can rarely be adequately described with a single variable. By solving rat from equation (14) with respect to ΔL_{bf} and X, we have

$$(14)' \quad rat = g(X, \Delta L_{bf}).$$

By inserting this into equations (10) to (13) we get

$$(10)' \quad I = f_1'(X, \Delta L_{bf})$$
$$(11)' \quad I_{inv} = f_2'(X, \Delta L_{bf})$$
$$(12)' \quad -\Delta L_{for} = f_3'(X, \Delta L_{bf})$$
$$(13)' \quad \Delta DD = f_4'(X, \Delta L_{bf})$$
$$(14) \quad -\Delta L_{bf} = -\Delta L_{bf}^{s}$$

Let us now consider the determination of the desired capital stock in a stock adjustment process, i.e. more closely or equation (10) without rationing effect:

$$(15) \qquad \frac{I}{K_{-1}} = \frac{\sum_i a_i(X_i^* - X_{-1})}{K_{-1}} + a_1\left(\frac{I^*}{K_{-1}} - d\right) + d, \quad i = 2,\ldots,m,$$

where the X_is are the items in the balance sheet of the firm, $X_1 = K$, the X_i^*s are their desired levels and I^* is the desired level of gross investment, $I^* = K^* - K_{-1} + dK_{-1}$, d is the rate of depreciation of capital.

Let us now suppose that the desired stock demand functions of other items than physical capital are of the standard type and homogenous with respect to the physical capital,

$$(16) \qquad X_i^* = K_{-1}b_i, \quad b_i = b_{i0} + b_{i1}Y + \sum_{j=1}^{m} b_{ij}r_j, \quad Y = \text{firms' gross income}, \; r_j = \text{yield on asset } j.$$

We next want to introduce the effect of the loan flow constraint on the speed of adjustment towards the optimum. Let us first describe what the above analysis tells us about the partial effect of the loan flow constraints on investment. Let $\dot{L}$ be the real loan flow from the banks to the firm sector and $\bar{\dot{L}}$ the average level of this loan flow. The influence of a marginal credit flow from the bank to the firm will the less influence the firm's investment behaviour the higher the loan flow is, naturally not in the sense that more loan finance would not be needed to finance the investment projects, but because it is less probable that the firm is under credit rationing and that its investments would be governed by the loan flow constraint. With the average loan flow we should have quite a small marginal effect from extra credit supply because we can on good grounds imagine that in the long-run monetary policy cannot essentially influence the volume of investment.

Let us now write an adjustment equation for investments of the following type[1)]

$$(17) \qquad \frac{I}{K_{-1}} = \left(\frac{I}{K}\right)_n \left(1 - \beta_0 e^{-\beta_1 \dot{E}/\bar{\dot{E}} - \beta_2 \dot{L}/\bar{\dot{L}}}\right)$$

where $(I/K)_n$ is a short symbol for the expression (15).

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1) This relation has similarities with the investment model by Coen (1971) who presented cash flow as a variable having an effect on the speed of adjustment towards desired capital stock. In his model the financial flow variable is included as a ratio to the desired investment flow which may be in some sense a sounder solution than our procedure of taking it in relation to the mean flow. In Coen's model, however, no guarantee is given that the adjustment coefficient is really constrained to the interval (0,1) and the nonlinear effects dominating the formulation (12) are not present in that kind of a model. See also Nickell (1978) p. 264 where these characteristics of Coen's model are critisized.

We see that (17) has positive but diminishing marginal effects from the financial flow variables on investment. It also has a substitution property between the two financial sources because we have $\partial I/\partial \dot{E}\partial \dot{L} < 0$. There is also the interaction effect discussed above between the financial flows and the "normal" determinants of investment behaviour, because the "cutting" effect of lack of adequate finance becomes greater the higher the "pure" investment demand is.

Let us now return to the main investment equation (15). In deriving the desired increase in the net capital stock two procedures available are the profit maximization and the cost minimization frameworks. Under constant returns to scale, perfect competition and stationary expectations the outcome of these two procedures yields with Cobb-Douglas technology identical results, see Helliwell (1976).[1] However, a formulation consistent with both price-making and price-taking behaviour in the goods market is to derive the optimal labour input as a function of the capital stock from the relative marginal products and then insert this into the production function and solve the optimal capital stock as a function of the level of production Q^e. If w is the wage rate and c is the capital cost per unit, and γ the elasticity of output with respect to capital, we have in this case

$$(18) \qquad \frac{I^*}{K_{-1}} - d\sim\log\frac{K^*}{K_{-1}} = A + \log(Q^e/K_{-1}) + \gamma(\log w - \log c)$$

Feldstein and Flemming (1971) in their investment equation study take the expected output to be a weighted product of the past growth rates,

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1) Keeping the volume of output as fixed.

$$(19) \qquad Q^e = Q_{-1}\prod_{i=1}^{\ell}(1+g_{-i})^{h_i}\ .$$

By combining the above expression with the other stock adjustment parts of the investment model we get as the relation (10) for the investment expenditures (which does not take into account the lack of finance factor which may slower this adjustment process in the way discussed above),

$$(20) \qquad \left(\frac{I}{K_{-1}}\right)_n = d+A+\sum_i a_i b_i - \sum_{i=2}^{m} a_i \frac{X_{i,-1}}{K_{-1}} + a_1 \log(Q/K)_{-1}$$

$$+ \sum_i h_i g_{-i} + a_1\gamma(\log w - \log c),\ b_i \text{ is as in } (11) = X_i^*/K_{-1}.$$

4. The whole firm sector model

The whole model of the firm sector operates with the following balance sheet

assets	K_{fix}	stock of	fixed capital
	K_{inv}	"	inventories
	DDep	"	demand deposits at banks
	Dep_{BoF}	"	deposits of firms at the central bank
liabilities	E	"	own capital
	L_{bf}	"	bank loans
	L_{for}	"	foreign net debt
	L_{BoF}	"	loans from the central bank
	L_{odom}	"	other domestic debts
	Res	"	residual item, net

The own capital accumulates on its own because we disregard here decisions concerning the volume of dividend payments. Bank loans are derived from their supply equation, other domestic loans are an exogeneous variable, as is also the residual item. Deposits at and credit granted by the central bank are an instrument of monetary policy.

So we are left with decision-making between fixed capital, holding goods in inventories, holding domestic money or acquiring foreign assets, or in our notation, reducing foreign net liabilities. For these items we build a flow-of-funds model taking the other items in the balance sheet as predetermined. Let us denote by W the sum of these items under consideration. So we have for these items as a final relationship

$$(21)\qquad \frac{\Delta X_i}{K_{-1}} = \sum_j a_{ij} \frac{(X_i^* - X_{i,-1})}{K_{-1}} + b_i \frac{\Delta W}{K_{-1}} = \sum_j a_{ij} b_j - \sum_i a_{ij} \frac{X_{i,-1}}{K_{-1}} + b_i \frac{\Delta W}{K_{-1}},$$

where $b_i = X_i^*/K_{-i}$.

In the empirical model we separate variables determining the flow budget ΔW into individual variables in order to be able to discern the possible differences in their impacts on the allocations in (21).[1)]

In figures 1 and 2 we present the uses and sources of finance considered as either endogenous or exogenous in the firm sector model. Figure 1 presents the uses of funds, of which fixed investment is naturally the most dominating one. We have estimated equations only for investments of the narrow firm sector excluding those of financial institutions which,

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1) Our derivation of the flow-of-funds model is here quite straightforward without any explication of the various cost of adjustment factors. See Sarantis (1980) for an explicit derivation of a firm sector flow-of-funds model.

Figure 1. The uses of funds of the firm sector in Finland, in ratio to GDP.

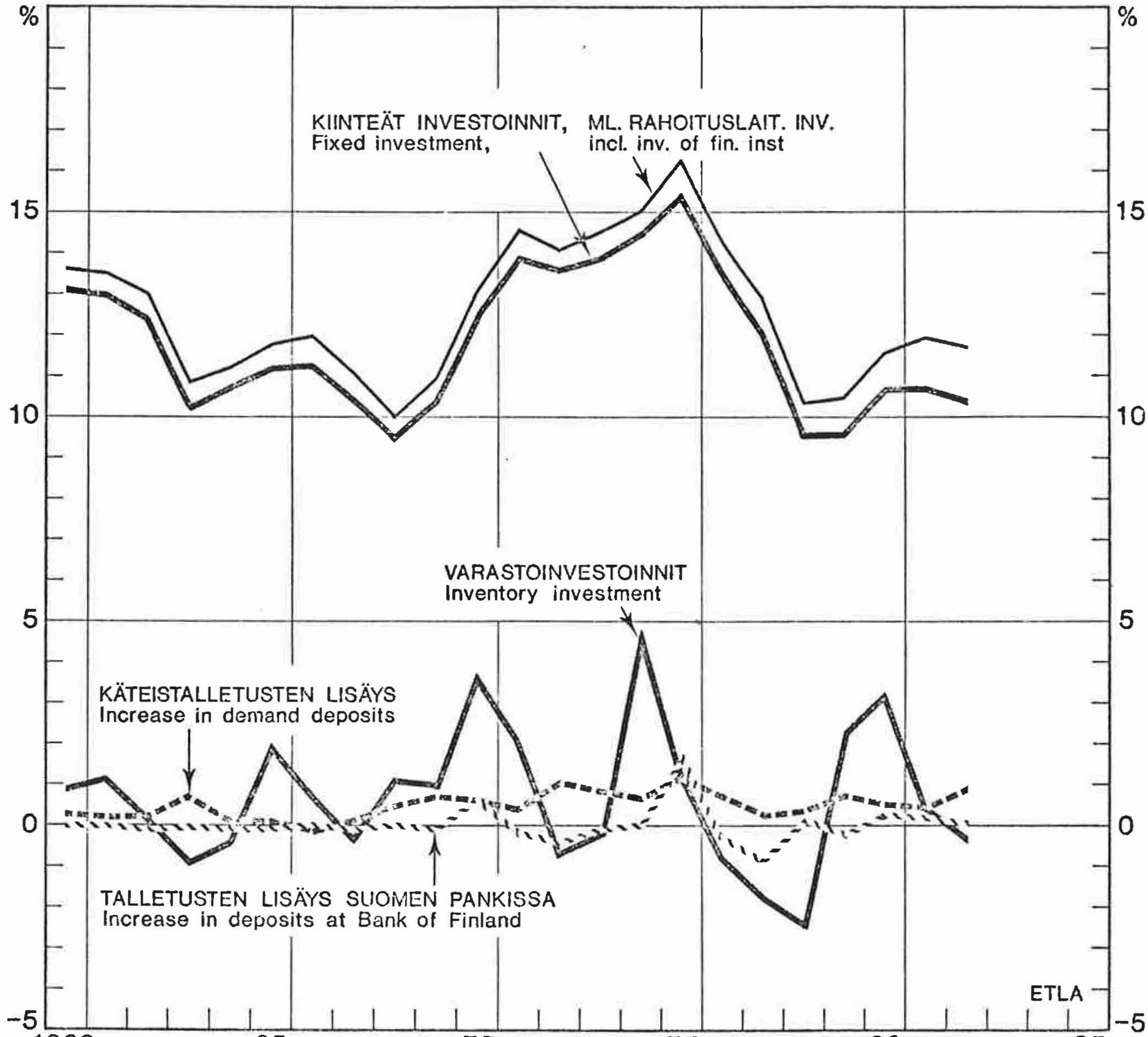
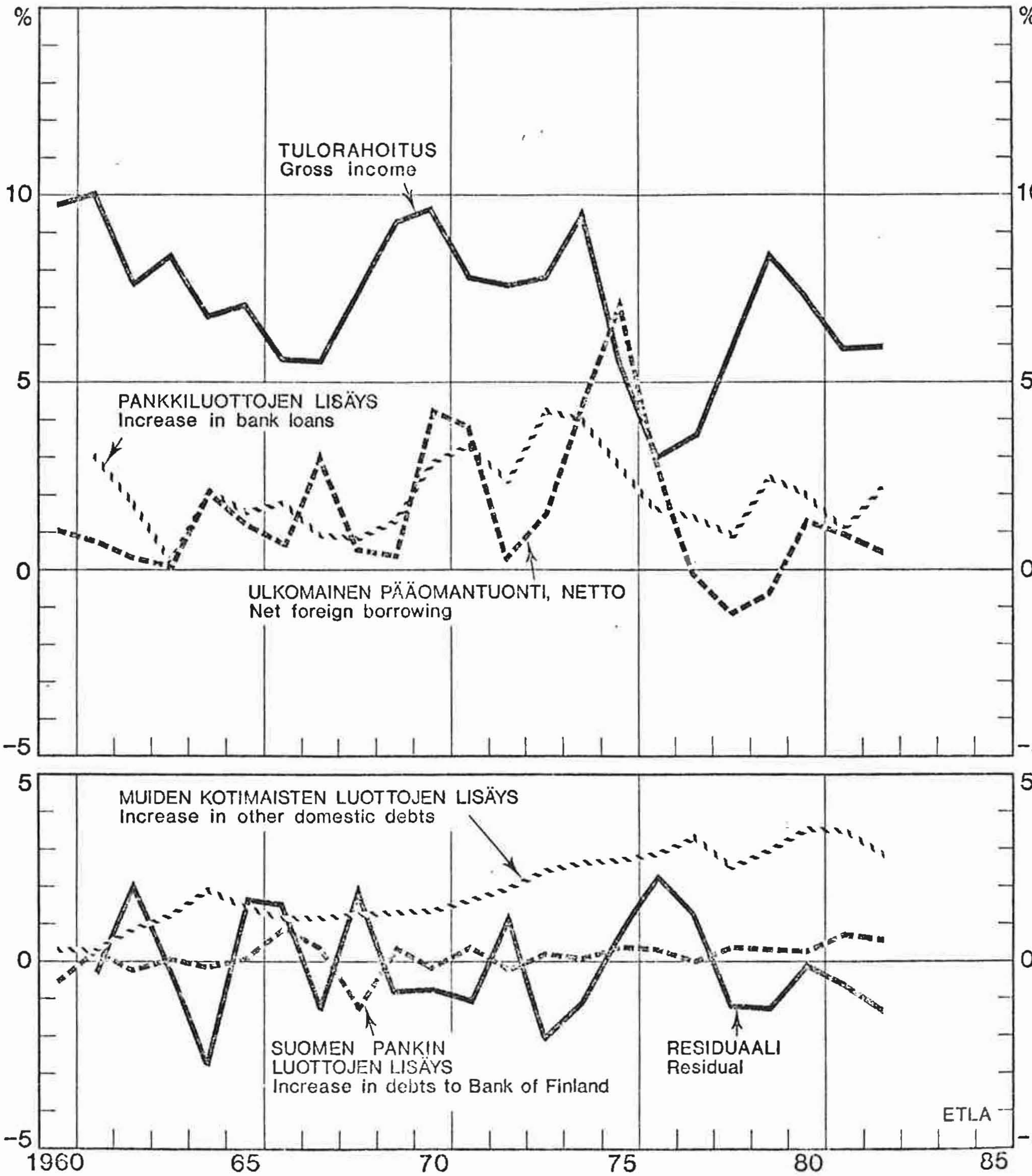


Figure 2. The sources of funds of the firm sector in Finland, in ratio to GDP.



however, according to the figure would not much change the model. On the other hand, during the years of the early 1980's the leasing investments, which are in fact investments of the firms but which in national accounts are included in the financial institutions' investments, have increased quite rapidly. This somewhat changes the overall development. The inventory investments have fluctuated quite much depending on the cyclical situation. Increase in domestic bank deposits has been quite a smooth variable in this comparison.

Of the sources of finance in figure 2 gross income (net profit + depreciation allowances according to national accounts) is the dominating one. We can see a sharp decrease in the profits of the firms in the mid-1970's and a rapid upturn thereafter as a consequence of devaluations and economic policy measures in those years. Foreign borrowing has also been an important source of finance especially in the mid-1970's when there was a very big disprepancy between domestic saving and investment, i.e. a big current account deficit. The increase in bank loans[1)] has also been quite fluctuating and has diminished to a lower level during the recent years as has also been the case with the foreign borrowing. Increase in other domestic debts is here simply taken to be the net financial surplus of the financial institutions. It has steadily increased to some 4 per cent of GDP. This development is to a large degree a result of the increase in pension funds, the working pension system being in Finland taken care by the private pension institutions. Increases and decreases in special lending of Bank of Finland to firms (also financial institutions are included here) have in some phases been of some magnitude.

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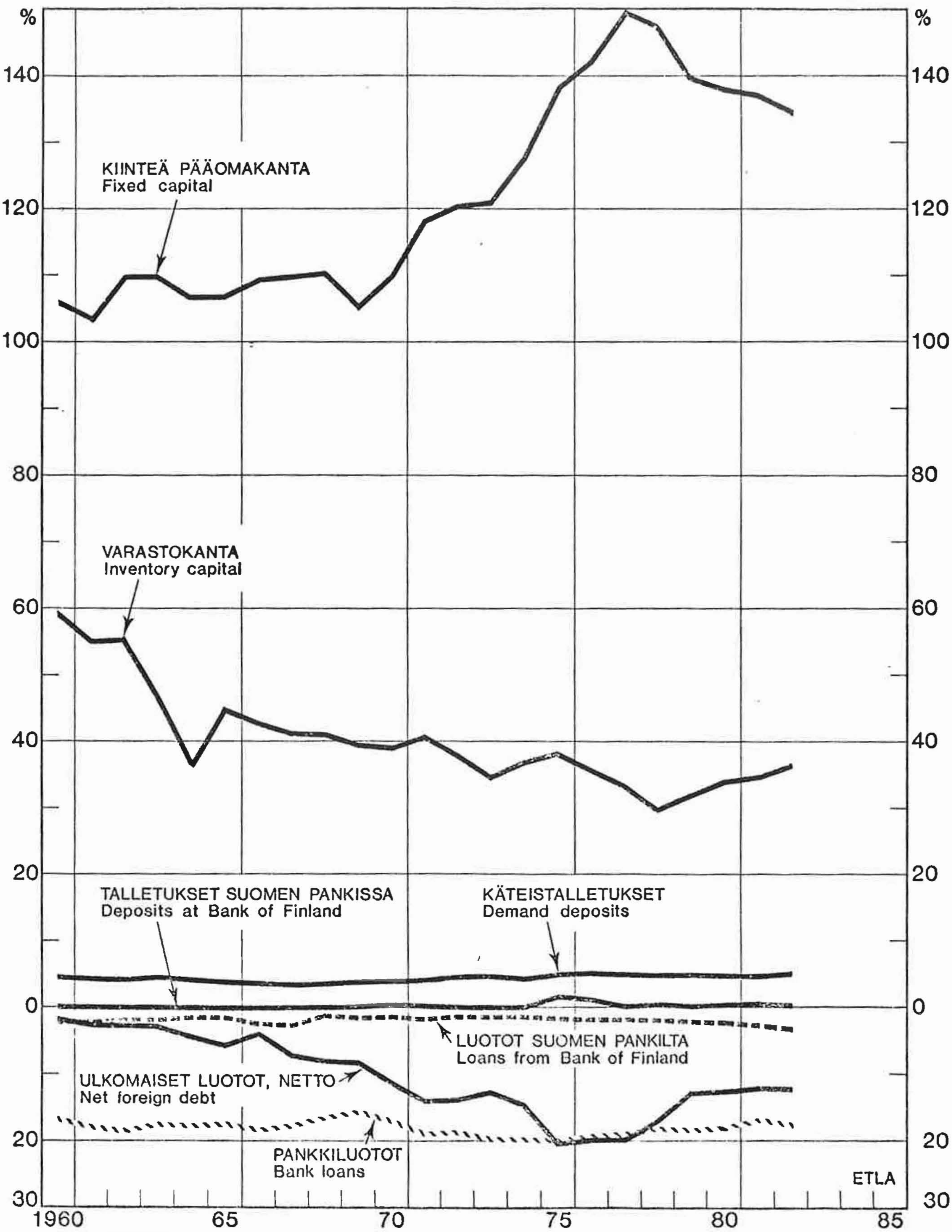
1) Bank loans cover here all lending of banks to firms (including financial institutions) in domestic currency. The loans denominated in foreign currency in the balance sheets of the banks are included in foreign borrowing of the firms.

Figure 3. The stocks of assets and liabilities of the firm sector in Finland, in ratio to GDP.



In figure 3 the corresponding stocks are presented in ratio to GDP. The fixed capital stock increased quite rapidly in the first half of the 1970's (partly as a result of fast increase in the prices of the investment goods) but has thereafter shown a decreasing relative trend as a consequence of diminished investment activity. The inventory capital has on the other hand been falling in ratio to GDP. Demand deposits are quite a small item in this comparison. Net foreign debt of the firm sector was at a very low level in the early 1960's but rose rapidly to 20 per cent of GDP in the mid-1970's. Thereafter foreign indebtedness has been diminishing reflecting the improved balance between domestic saving and investment. On the contrary, the bank loans to firms have been quite steadily at the level of almost 20 per cent of GDP all through the period.

The allocation of the financial flows depends also on the rate of returns and costs on the various assets and liabilities. Of these the most controversial is how to measure the cost of fixed capital services. Our procedure here is the following. By calculating the present value of all the expected benefits and costs attached to the investment project the firm compares these with the value of the investment outlay. This comparison is the following [1)]

(22) $$p_0 MP_0 (d+r-\dot{p}_e)(1-u)+uq_0 B+urq_0 \tilde{L}-u_k q_0 Y_{k-v}(d+r-\dot{p}_e)-vq_0 H \geqq q_0$$

where MP_0 = marginal productivity of capital initially = the required before tax rate of return on new investment

p_0 = price of output in period 1

d = rate of depreciation

r = rate of interest, actual = expected

$\dot{p}_e$ = expected rate of inflation

1) See more closely the appendix on page 37.

u = tax rate in company income taxation

q_0 = price of unit of capital in period 0

B = present value of future depreciation allowances in company taxation

$\tilde{L}$ = present value of future interest payments per unit of capital

u_k = tax rate in company taxation on the local level

Y_{k-v} = excess of taxable income in local taxation to that in state taxation per unit of capital

v = rate of wealth tax

H = present value of unit of capital in wealth taxation

All nominal entities are expected to rise together with inflation, but the rate of interest is taken to be fixed because of the small changes in nominal rate interest and large variations in the real interest rate in Finland, see e.g. Alho (1983a). In interpreting the above formula it is to be noted that the present value of the stream $\sum_t (1+r)^{-t}(1-d)^t(1+\dot{p}_e)^t$ is very closely equal to $(d+r-\dot{p}_e)^{-1}$.

In figure 4 we present some of the components of our cost of capital variable. Above we transformed the cost of capital p_0MP_0 into logarithmic form in (18) and (20):

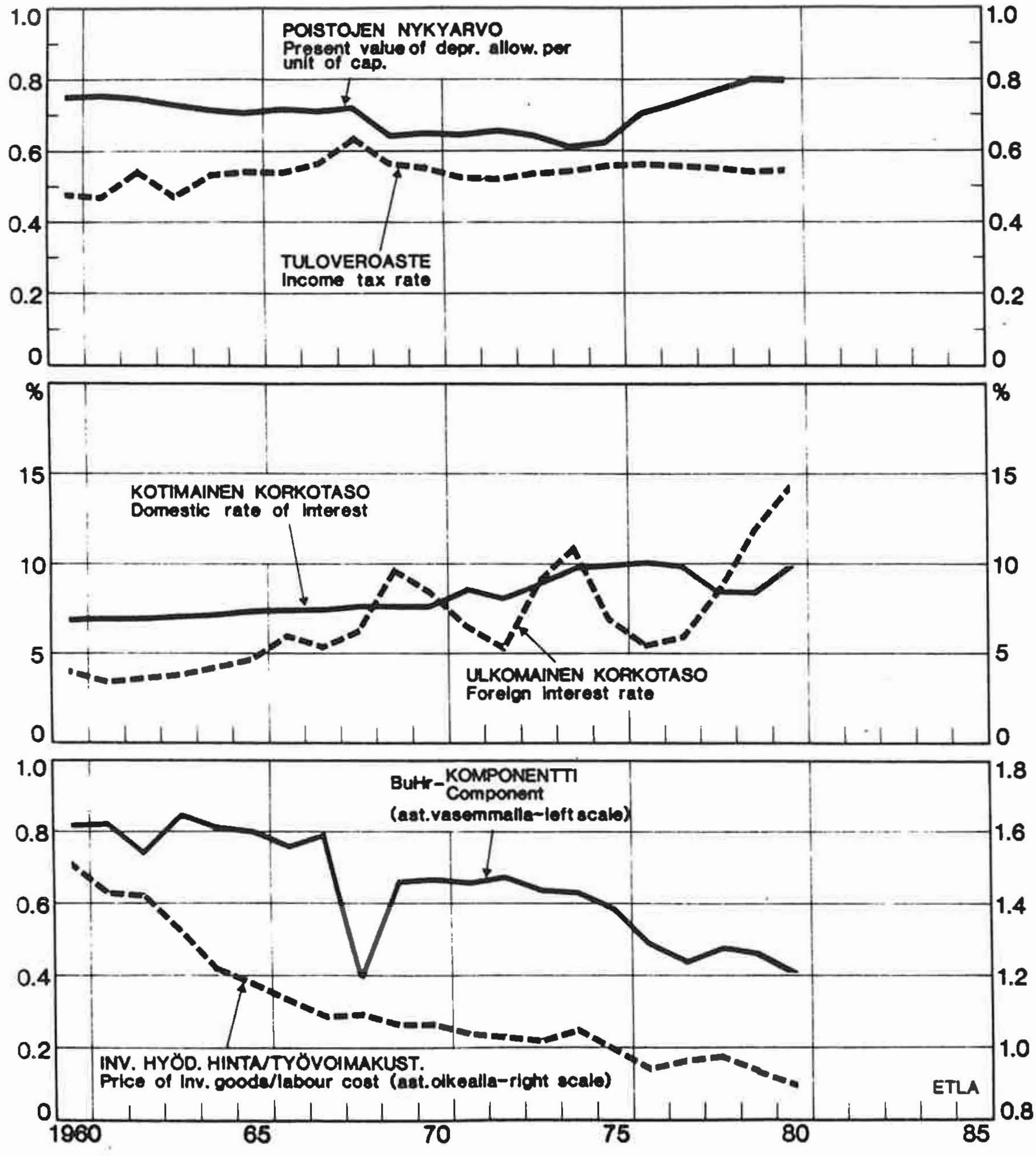
$$\text{(23)} \qquad \log c = \log p_0MP_0 \sim \log q_0 + \log(r-\dot{p}_e+d) + \log f(B,u,H,r)$$

$$+ u_kY_{k-v}(1-u)^{-1}f(B,u,H,r)^{-1}(r-\dot{p}_e+d)^{-1}$$

$$\sim \log q_0 + \log d + \frac{1}{d}(r-\dot{p}_e) + \log f(B,u,H,r) + A$$

where $f(B,u,H,r)$ is the component $(1-u(B+r\tilde{L})+vH)(1-u)^{-1}$ and A is the last term in the first approximation. Below we have not taken this term into account but simply operate with the three first terms, see Alho (1981) for more details on this cost of capital variable.

Figure 4. Components of the cost of capital variables.



5. Empirical estimation of the model

5.1. The fixed investment equation

The basis of the investment equation is the nonlinear speed of adjustment equation (17) and its more elaborated version (20). The equation has in this form far too many parameters to be really estimated from our scant annual data covering in the estimations the years 1961-1980. In the preliminary estimations we could discern some quite uniform features in the model and transform it more parsimonous. First, the lagged rate of growth of output does not have any explanatory power in the model, but only the rate of capacity utilization variable is enough and is a very powerful explanatory variable. Of the two financial flows the profit variable loses much of its explanatory power when the rate of capacity utilization is added to the model. The flow of bank credits is also a very powerful variable in the model. With these variables we can explain nearly 85 per cent of the total variation, but the residual is, however, quite clearly positively autocorrelated. Adding the cost of capital variables increases the explanatory power of the model to some degree and now the residual is hardly at all autocorrelated. Adding still the flow of gross profits variable does not much raise the explanatory power of the model but, on the other hand, makes the residual negatively autocorrelated (the Durbin-Watson statistic gets the value 2.7).

Let us first report the nonlinear investment equation. We got the following result[1)]

---

1) All the variables in the equation are in fact multiplied by 100 before estimation. A list of symbols is presented on page 38.

$$(24) \qquad \frac{I}{K_{-1}} = (24.426 + 0.343 \log(\frac{Q}{K})_{-1} - 0.337rf + 0.113\dot{p}y_{-1} - 0.044 \log(\frac{q}{w})_{-1}$$
$$\qquad (8.058) \quad (.113) \qquad\qquad (.145) \quad (.052) \qquad (.022)$$

$$- \underset{(.014)}{0.028} \log(BuHr)_{-1})(1 - \underset{(.171)}{0.439}e^{-\underset{(.392)}{0.360}(\Delta L_{bf}/\overline{\Delta L}_{bf})}),$$

$s_e^2 = .148$, $R_c^2 = 0.961$.

From this we can see that all other variables are quite significant, but only the parameter in the exponent of the nonlinear part of the model is not. According to this quite weak evidence, with no flow of credit from the banks to the firms, investments would be over forty per cent (43.9 %) smaller than desired. With a flow equal to the historical average, this cutting effect would be still 30 percent which is quite much indeed and with a double flow compared to the average we would have a 20 per cent cut in investments. This would indicate quite a strong effect of credit rationing under which the firm sector would have been nearly all the time in the 1960's and 1970's. The result is, however, not robust and with other specifications we could get smaller effect from credit rationing than above but these models were in other respects not satisfactory, there was quite strong positive autocorrelation in the residual.

Let us now turn to the corresponding linear model.

$$(25) \qquad \frac{I}{K_{-1}} = \underset{(.912)}{14.989} + \underset{(.027)}{0.227} \log(\frac{Q}{K})_{-1} - \underset{(.052)}{0.247}rf + \underset{(.022)}{0.076}\dot{p}y_{-1} - \underset{(.013)}{0.030} \log(\frac{q}{w})_{-1}$$

$$- \underset{(.007)}{0.020} \log(BuHr)_{-1} + \underset{(.127)}{0.931} (\frac{\Delta L_{fb}}{K_{-1}})$$

$s^2 = 0.141$, $R^2 = 0.963$, D-W = 2.038

According to this estimation on the margin almost all of bank credit expansion to the firms would be reflected in increased fixed capital formation. This would again indicate an effect of credit rationing. The capacity utilization variable has a very strong impact on investments as mentioned above. All the cost of capital variables are also quite significant in the model, and their inclusion transforms the residual as nonautocorrelated. Of the interest rates the foreign interest rate, the eurodollar rate, is more significant than the domestic bank loan rate, which gets a wrong, positive sign (this also happens when they both are included in the model).

The inflation variable is lagged by one year representing the inflation expectations. We do not in this paper discuss hypothesis of expectations formation any more closely. In models (24) - (27) we can think about that inflation expectations are made asymptotically rationally: $\dot{p}_e = a\dot{p}_{-1} + (1-a)\bar{\dot{p}}$ where $\bar{\dot{p}}$ is a long average inflation rate assumed constant. On the basis of the estimation results the coefficient a is roughly of the order of 0.3. When we test whether we should instead treat the interest rate as a real interest rate in the above equations, with a wide margin we disapprove this hypothesis. However, later on we have used the assumption $\dot{p}_e = \dot{p}_{-1}$ which gives static inflation expectations because of the difficulties of taking the nonlinear constraint into account which the asymptotically rational expectations would imply across the equations.

The relative prices of the investment goods and the labour costs (= wage rate added by the indirect labour costs), and the component of the capital cost variable representing depreciation allowances (B), firm income tax rate (u), property taxation (H) and deductibility of interest expenses (r) = BuHr-variable, are separated into distinct variables in the manner of Feldstein and Summers (1971).[1] From the coefficients we can infer that an extra 10 per cent increase in labour costs with respect to the prices of the investment goods raises through rationalization and factor substitution the growth of the capital stock by half a percentage point in a two years' horizon, and thus raises investment by 5 percentage points (the gross growth rate of the capital stock has been on the average 10 per cent per year). An increase of the BuHr-variable by the same amount would increase investments by two percent. This can be achieved e.g. by 5 per cent increase in the tax rate, by an increase of 0.07 units in the present value of the depreciation allowances per unit of capital and by a 5 percentage point increase in the bank loan rate.[2]

We can well think about that the effect from the bank lending is not reflected in investment contemporaneously but that there are some lagged effects on investments from loans. In fact, this can be found out, as the following model shows

$$(26) \qquad \frac{I}{K_{-1}} = \underset{(.926)}{15.234} + \underset{(.026)}{0.233} \log\left(\frac{Q}{K}\right)_{-1} - \underset{(.042)}{0.221} rf + \underset{(.020)}{0.062} \dot{p}y_{-1} - \underset{(.013)}{0.042} \log\left(\frac{q}{w}\right)_{-1}$$

$$- \underset{(.006)}{0.018} \log(BuHr)_{-1} + \underset{(.125)}{0.729}\left(\frac{\Delta L_{fb}}{K_{-1}}\right) + \underset{(.100)}{0.195}\left(\frac{\Delta L_{fb}}{K_{-1}}\right)_{-1} ,$$

$$s_e^2 = 0.087 \; , \; R_c^2 = 0.975 \; , \; D\text{-}W = 2.53 \; .$$

---

1) We can formally test whether the coefficients are the same, see formula (23) above. Clearly the coefficient of the interest rate variable deviates from the others. The equality of the coefficients of the relative price and the BuHr-variable can be accepted with a narrow margin in a F-test but the common coefficient is -0.022, i.e. only half of the coefficient of the relative price variable in equation (26). Therefore we have not reported these constrained equations here.

2) Without taking into account the decrease in the present value of the depreciation allowances caused by the increase in the discount rate.

One fifth ot the total effect of bank credit flow is lagged to the second year, but the equation already shows quite much negative autocorrelation in the residual.

Above we stated that the profit variables do not fit very well in the data and that they are a rival hypothesis to the capacity effect. Replacing the capacity variable with the gross profits variables we get the following equation

$$(27)\quad \underset{}{\frac{I}{K_{-1}}} = \underset{(1.851)}{7.060} + \underset{(.119)}{0.245}\,\frac{\pi}{K_{-1}} + \underset{(.140)}{0.337}\,\left(\frac{\pi}{K_{-1}}\right)_{-1} - \underset{(.087)}{0.342}rf + \underset{(.039)}{0.064}\dot{p}y_{-1}$$

$$- \underset{(.027)}{0.039}\log\left(\frac{q}{w}\right)_{-1} + \underset{(.249)}{0.804}\left(\frac{\Delta L_{fb}}{K_{-1}}\right) + \underset{(.197)}{0.330}\left(\frac{\Delta L_{fb}}{K_{-1}}\right)_{-1},$$

$$s_e^2 = .320\ ,\quad R_c^2 = 0.906\ ,\quad D\text{-}W = 1.963\ .$$

This equation has clearly less explanatory power than the above equations. This is especially true in the late 1970's when this equation overpredicts the actual investment quite much which the capacity equation does not. This is a result of the fact that the profits increased quite rigorously in those years but investments did not rise in the previous manner but stayed at a lower level because of the big decrease in the rate of capacity utilization, see figures 1 and 2.

5.2. The whole flow-of-funds model for the firm sector

Let us now turn to the estimation of the whole flow-of-funds model for the firm sector. The model has to be estimated with the budget constraint binding the sum of the equations. So, we know a priori that also the sum of the residuals in the four uses of finance equations have to sum to zero. This is a case of not using ordinary least squares in the estimation but instead using Zellner's seemingly unrelated regression method, programmed on a Wang 2200 desk computer in ETLA by Heikki Vajanne (1983). In table 1 we present an estimation result for the whole model including fixed investments. Here we have naturally used all the individual constraints arising from the budget constraint. In addition to this we have also constrained the interest rate variable to be a real interest rate variable in the expenditure equation, i.e. in the equations for fixed and inventory investment (in the latter it gets a coefficient with a wrong sign). On the other hand, in the equations for financial assets the inflation variable is constrained to be of the same value, i.e. inflation is neutral with respect to how the financial portfolio is allocated on various assets but only changes its total volume. As a whole the F-statistic for the constraints in the model is 1.96 with 16 and 56 degrees of freedom, which does not differ significantly from zero. One can also see that we are (only) using 6 degrees of freedom per equation in the estimation of the model.

Of the individual equations the equation for demand deposits is fairly poor measured by its R^2-statistic. This may quite easily be explained by the small variability of this variable in comparison to the other variables to be explained. We also find some difficulties in interpreting some of the coefficients in table 1. The bank loan flow variable has a negative coefficient in the equation for foreign net lending. This does not mean a "crowding-in" effect on domestic money as a consequence of bank lending through foreign capital inflow. This can be explained by the fact that there is quite a strong complementary relationship between fixed investments, bank loans and foreign borrowing. Accordingly, an increase in the bank lending to the firms has been linked to increased investment activity and also to more foreign borrowing to finance this. Below we

Table 1. A flow-of-funds model for the firm sector. (each equation is presented on two lines)

Equation	Constant	Capac. utiliz. $\log(Q/K)_{-1}$	Bank credits $\Delta L_{fb}/K_{-1}$	Gross profits π/K_{-1}	Other dom. cred. $\Delta L_{fo}/K_{-1}$	Relative prices $\log(q/w)_{-1}$	Cost of cap. comp. $\log(BuHr)_{-1}$	Foreign int. rate rf
Fixed investment	14.322	0.226	0.795			-0.017	-.008	-0.089
I/K_{-1}	(.322)	(.010)	(.043)			(.004)	(.002)	(.006)
Inventory investment	26.914	0.347	0.622	0.437	-.071	0.083	-.001	0.046
I_{inv}/K_{-1}	(1.476	(.023)	(.164)	(.055)	(.095)	(.011)	(.004)	(.016)
- Foreign net borrowing	-38.733	-0.573	-0.417	0.272	1.071	-.066	.009	0.171
$-\Delta L_{for}/K_{-1}$	(1.639)	(.003)	(.172)	(.051)	(.095)	(.012)	(.005)	(.022)
ΔDemand deposits	-2.503			0.291				-0.128
$\Delta DD/K_{-1}$	(.425)			(.026)				(.016)
Sum	0	0	1	1	1	0	0	0

Equation	Dom. int. rate r	Inflation rate $\dot{p}y_{-1}$	Invent. capital $(K_{inv}/K)_{-1}$	-Foreign net debt $-(L_{for}/K)_{-1}$	Demand deposits $(DD/K)_{-1}$	Residual res	R^2, D-W
Fixed investment		0.089					0.956
I/K_{-1}		(.006)					1.630
Inventory investment		-0.046	-0.615	0.139		0.390	0.787
I_{inv}/K_{-1}		(.016)	(.030)	(.037)		(.038)	1.880
- Foreign net borrowing	-0.536	-0.022	0.615	-0.087	0.614	0.611	0.848
$-\Delta L_{for}/K_{-1}$	(.068)	(.008)	(.030)	(.033)	(.082)	(.038)	1.737
ΔDemand deposits	0.536	-0.022		0.052	-.614		0.187
$\Delta DD/K_{-1}$	(.068)	(.008)		(.015)	(.082)		1.874
Sum	0	0	0	0	0	1	

present in table 2 another model where this awkward feature is described in a more clearcut fashion and we can discern the total and partial effects of bank lending on foreign capital outflow when fixed investments are allowed to change simultaneously or kept the same,respectively.

Of the interest rate effects an increase of one percentage point in the eurodollar rate results in an outflow of some 600 mill.marks in the present situation where the value of the capital stock is some 400 bill. marks. The influence of the domestic bank rate is three times bigger than that of the foreign rate. On the other hand, the coefficient of the lagged foreign debt variable would indicate a very slow speed of adjustment which is not at all plausible. The speed of adjustment of inventory capital and demand deposits is much more rapid with the average lag being about one and a half year. The impact of current profits is concentrated on inventory investment, and here we can find out a real expenditure effect of changes in profitability.

In table 2 we present another flow-of-funds model which is made recursive by first solving fixed investment which is determined by predetermined variables and then treating it as fixed with respect to the allocation of the rest of the financial flows. We have combined bank loans and other domestic loans here into a single variable. The results would suggest that 80 per cent of domestic credit expansion would flow out as increased foreign asset acquisacion and 20 percent would be reflected in inventory investment (if we keep the fixed investment as fixed). Here the effect of profits is more strongly concentrated on inventories than in table 1. The speed of adjustment of foreign debt to its desired level is much more rapid than above and is now of a more plausible magnitude, the speeds of adjustment of the three assets in table 2 being of the same magnitude with each other.

Table 2. A flow-of-funds model for the firm sector having fixed investment as predetermined

Equation	Constant	Fixed inv. I/K_{-1}	Gross profit π/K_{-1}	Total dom. loans $\Delta L_{tot}/K_{-1}$	Foreign int. rate rf	Dom. int. rate r	Invent. capital $(K_{inv}/K)_{-1}$	Foreign net debt $(L_{for}/K)_{-1}$	Demand deposits $(DD/K)_{-1}$	Residual res	R2, D-W
Invent. invest.	8.648	0.781	0.618	0.240	-.099		-0.483	-0.466		0.416	0.839
$I/_{inv}/K_{-1}$	(1.714)	(.073)	(.072)	(.072)	(.066)		(.045)	(.044)		(.058)	2.705
- Foreign net borr.	-7.034	-1.781	0.153	0.760	0.153	-0.272	0.483	0.416	0.377	0.584	0.918
$-\Delta L_{for}/K_{-1}$	(1.760)	(.073)	(.070)	(.072)	(.065)	(.103)	(.044)	(.042)	(.119)	(.058)	2.594
Δ Demand deposits	-1.614		0.229		-0.054	0.272		0.050	-0.377		0.394
$\Delta DD/K_{-1}$	(.602)		(.035)		(.023)	(.103)		(.021)	(.119)		1.945
Sum	0	-1	1	1	0	0	0	0	0	1	

6. Concluding remarks

In this paper we have constructed a flow-of-funds model for the real and financial portfolio allocations of the firm sector in Finland in principle in the spirit of Brainard and Tobin (1968). In deriving the model we have put quite much emphasis on the equation for fixed investment, the most important and biggest of the uses of funds items of the firms. Accordingly, we tried to fomulate the flow-of-funds model flexible enough to be able to include in it a reasonable good investment equation on its own. In this sense our model differs from a strict flow-of-funds model.[1)]

The model presented above is to be regarded as a preliminary one and it has to be amended with equations for the bank loan supply before being able to simulate it properly in the context of a larger model and together with the household secot´s flow-of-funds model, see Alho (1983b).

Anyway we are inclined to consider the above model a reasonably good starting point because it should include the main theoretical elements and it of its fairly well. As presented above there are some competizing hypothesis in the model building which we have not yet made any final decision upon. So, there is still work to be done before the model can be considered good enough to be included in the Institute´s macroeconomic model. Anyway, the inclusion of many yield of asset variables and the stock adjustment mechanism is certainly an improvement to the present situation. One crucial point in the model is the treatment of the financial flow variable and the status of the bank loan flow as an explanatory variable. The

1) Kostiainen (1981) has constructed this kind of flow-of-funds model for Finnish manufacturing.

justification for this was the (tight) credit rationing in the Finnish financial markets. We should, however, consider this somewhat more and specify demand and supply determined loans and carry out empirical testing between these rival hypothesis. We postpone these considerations, however, to a later phase.

Appendix: The cost of capital variable

Using the symbols presented on pages 24 and 25 we can define the capital cost per unit of new capital equipment from the condition

$$(1-u)\sum_{t=0}^{\infty} p_0(1+\dot{p}_e)^t(1-d)^t(1+r)^{-t} + uq_0B + urq\tilde{L}$$

$$- u_K q_0 Y_{k-v} \sum_{t=0}^{\infty}(1+\dot{p}_e)^t(1-d)^t(1+r)^{-t} - vq_0H \geq q_0 \, .$$

The first term on the left hand is the present value of the net after tax income from a unit's investment, the second is the tax gain from depreciation allowances, the third the tax gain from the deductibility of the interest expenses, the fourth is the extra tax burden in the local taxation (its present value) and the last is the term representing the effect of the wealth taxation in force up to year 1967 (temporarily also in 1976).

Next we utilize the close approximation

$$\sum_{t=0}^{\infty}(1+\dot{p}_e)^t(1-d)^t(1+r)^{-t} \approx (r+d-\dot{p}_e)^{-1}$$

and transform the cost of capital c as

$$c = p_0MP_0 = q_0(r+d-\dot{p}_e)(1-u(B+r\tilde{L})+vH)(1-u)^{-1}$$

$$+ u_K q_0 Y_{k-v} \, .$$

We have first aggregated B and H over industry and buildings and machines respectively, and then calculated the components as in figure 4.

List of symbols

I	=	volume of firms' fixed investment
K	=	volume of firms' fixed capital stock
Q	=	volume of GDP
rf	=	3 months' annual average
$\dot{p}y$	=	rate of inflation measured by the implicit price index of GDP
q	=	implicit price index of firms' fixed investment
w	=	total labour costs in manufacturing = wage rate + indirect labour cost
$BuHr$	=	the depreciation, income and property taxation, and interest charge deductibility component of the cost of capital variable of the firms
ΔL_{bf}	=	change in the credits granted by the banks to the firm sector (including other financial institutions than the banks)
$\Delta\bar{L}_{bf}$	=	average of ΔL_{bf}
π	=	gross profit (= net profit + depreciation according to national accounts) of the firm-sector
ΔL_{fo}	=	change in other domestic credits = net financial surplus of the financial institutions + change in credits granted the Bank of Finland to firms and other financial institutions than the firms-change in deposits at the Bank of Finland by the firms and other financial institutions than the banks
I_{inv}	=	volume of firms' inventory investment
L_{for}	=	stock of net foreign debt of the firms and other financial institutions than the banks
ΔL_{for}	=	net foreign borrowing of the firms and other financial institutions than the banks

DD = demand deposits of the domestic banks

r = bank loan rate of interest, annual average

res = residual item in the flow-budget constraint of the firms, in ratio to the lagged fixed capital stock of the firms.

L_{tot} = total domestic credits of the firms (bank loans and other domestic debts)

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