BANK OF FINLAND
DISCUSSION PAPERS

8/94

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22.4.1994

Manufacturing Investment and Taxation in the Nordic Countries

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ISBN 951-686-405-8
ISSN 0785-3572

Suomen Pankin monistuskeskus
Helsinki 1994

Abstract

This paper analyzes the accumulation of fixed productive capital in the manufacturing industries in Denmark, Finland, Norway, and Sweden over the years 1965–1990. Particular attention is given to the effect of taxes on this process. The following conclusions appear fairly robust across countries: Cointegrating long-run relationships can be found within the framework of the neo-classical model. The error-correction estimations indicate that investment is relatively sensitive to economic shocks. Taxes seem not to have had significant effects on long-run capital levels nor on the timing of investment behavior.

Tiivistelmä

Tutkimuksessa analysoidaan teollisuuden investointeja pohjoismaissa ajanjaksolla 1965–1990. Erityistä huomiota kiinnitetään yritysverotuksen merkitykseen investointien näkökulmasta. Tutkimuksessa selvitetään sekä lyhyellä että pitkällä ajalla investointeihin vaikuttavia tekijöitä. Kysyntä- ja kustannusmuuttujat ovat teollisuuden investointeihin vaikuttavat tärkeimmät tekijät pitkällä ajalla. Lyhyellä tähtäyksellä kysyntänäkymien merkitys on suuri. Verotustekijät vaikuttavat vain vähän teollisuuden investointeihin pohjoismaissa.

Contents

1 Introduction[1]

This paper analyzes the accumulation of fixed productive capital in the manufacturing industries in Denmark, Finland, Norway and Sweden over the years 1965–1990. Particular attention is given to the effect of taxes on this process.

Corporate firms in the Nordic countries have in general enjoyed extensive opportunities to defer taxes through various schemes of accelerated depreciation. The implications of this for investment incentives is far from self-evident, however. Nordic firms, including many tax paying firms, have to a large extent abstained from using all available tax allowances. In a recent study, Kanniainen and Södersten (1994) attribute this seemingly irrational behaviour to reporting conventions in the Nordic countries, requiring dividend payments to be made from after-tax taxable profits. The implication of this analysis is that the effective marginal corporate tax rate is zero. Despite their widespread use during the last decades as tools of policy making, changes in corporate tax rules may therefore have had little or no effects on the cost of capital. A similar hypothesis was suggested some time ago by Bergström and Södersten (1984), who argued that corporate tax changes in Sweden have had much less effect on investment incentives than conventionally believed.

A neo-classical benchmark model of optimal industry capital is developed and found to be robust with respect to different assumptions concerning industry competitiveness. The model partially captures the typical and important openness aspect of the Nordic economies by including a terms-of-trade variable that affects aggregate demand.

Optimal capital is defined in terms of linear combinations of variables that display stationarity over time, despite the fact that the individual series appear to be non-stationary. We find cointegrating variable combinations that support the neo-classical theoretical framework. As all components of the cointegrating vectors appear to possess unit roots, we examine the dynamics of investment using an error-correction framework.

To our knowledge, this study is the first comprehensive attempt to analyze comparative investment behaviour in the Nordic countries using cointegration techniques. To some extent our findings differ across the four countries, but the following conclusions appear to be fairly robust: First, cointegrating long-run relationships can be found in the neo-classical framework. Second, the error-correction estimations indicate that investment is relatively sensitive to economic shocks. Third, taxes seem not to have had significant effects on long-run capital levels nor on the timing of investment.

The paper is organized as follows: In section 2 we present an outline of the theory of optimal capital and investment. Taxes affect investment behaviour through a user-cost variable, which is presented and parameterized in section 3, where we also describe the Nordic tax systems of 1965–1990 and present our

[1] Acknowledgements: This paper has benefited considerably from comments by Torben Andersen, Villy Bergström, Erkki Koskela, Hanna-Leena Männistö, Juha Tarkka, Matti Virén and two anonymous referees. We also would like to thank Virpi Andersson and Anneli Majava for research assistance, Päivi Lindqvist for typing, Krister Andersson and Jörgen Söndergaard for supplying data.

estimates of corporate tax wedges. Section 4 contains the empirical results, and Section 5 contains some concluding remarks.[2]

2 Long Run Optimal Investment

We model the accumulation of productive capital as resulting from optimizing behavior. Optimal capital is a function of variables affecting the profitability of firms. Jorgenson (1963) was the first to empirically estimate a model which allowed for the effects of relative prices. His investment equations were critized, however, on the grounds that they were not reduced forms containing all relevant exogenous variables and no others (see Coen 1971, Gould 1969, Brechling 1975).

We assume that aggregate demand for industry production is of constant elasticity and exogenously affected by the countries terms-of-trade position (T). The nordic economies are open and the inclusion of a terms-of-trade variable (the real price of domestic goods in terms of importables) affecting aggregate demand is a way to capture this. We also include another shift parameter (Z) supposed to capture some general level of demand (see, e.g., Gould and Waud 1973). The demand curve is of the form

$$D(p) = A_0 p^{a_1} Z^{a_2} T^{a_3}, \tag{1}$$

where p is the price of output and A_0 and the a_i:s are constant parameters.

Consider an individual firm i. Depending on its market share, it may or may not believe that its output decisions affect market price. Let $p(Q_i)$ denote its conjectures in this respect, where Q_i denotes its quantity supplied. At time t the firm chooses investment (I_i) policy and labour (L_i) and energy (E_i) inputs efficiently to carry out the following optimization (time indices suppressed except on the lagged value of the capital stock):

$$\begin{aligned} &\max \sum_{s \geq t} (1+\rho)^{-(s-t)} [(1-\tau)(p(Q_i)F_i(K_i, L_i, E_i) - wL_i - fE_i) - p_K(1-A)I_i] \\ &\text{s.t. } K_i = I_i + (1-\delta)K_{i,t-1}, \end{aligned} \tag{2}$$

where F_i is a tri-factor production function, w the wage rate, f the price of energy, p_K the price of capital goods, ρ the discount factor, and δ the rate of depreciation, τ the corporate tax rate, A the present discounted value of tax saving from depreciation allowances, investment grants, etc. per unit of gross investment. We assume the firm perfectly observes f, w, p_K, ρ, δ, τ, A, and that

[2] See a more detailed version of this paper, available on request, which provides a review of existing studies on Nordic capital formation, descriptions of the development of the Nordic manufacturing sectors and Nordic corporate tax policies, reports on estimations involving cash flow variables, and data sources for this study (Dufwenberg, Bergström, Koskenkylä, Södersten, 1992).

it expects these values to prevail. We assume that the technology is Cobb-Douglas and that the firm keeps no inventory:

$$Q_i = F_i(K_i, L_i, E_i) = BK_i^{\alpha} L_i^{\beta} E_i^{\gamma} \tag{3}$$

The parameters B, α, β, γ, are assumed constant. We assume that aggregate industry supply equals aggregate demand for industry production so $\sum Q_i = D(p)$. Given these assumptions equilibrium aggregate industry steady state capital can be derived as[3]

$$K^* = \Omega Z^{\eta_Z} T^{\eta_T} c^{\eta_c} w^{\eta_w} f^{\eta_f} \tag{4}$$

Taxes directly affect investment through c, the user cost of capital, which is discussed in the next section. The η elasticities depend in a rather complicated way on the underlying production and demand parameters. For a wide range of values, Z and T affect K* positively, c has negative impact, the others can go either way (the more elastic is demand, the more likely are they negative).

In equilibrium it holds that $\delta K^* = I^*$ so that (4) also determines equilibrium investment and hence

$$I^* = \Omega \delta Z^{\eta_Z} T^{\eta_T} c^{\eta_c} w^{\eta_w} f^{\eta_f} \tag{5}$$

3 Taxation and the Cost of Capital[4]

3.1 The Basic Model

From the first order conditions of the maximization problem (2) it is straightforward to derive the real user cost of capital, denoted c in equation (4), as

[3] Solve for each firm assuming that it correctly anticipates its market share (which affects its marginal revenue). Then just aggregate across firms. The expression (4) then corresponds to a multi-firm Cournot-Nash equilibrium, and in this sense its qualitative form is robust with respect to assumptions regarding industry competitiveness. The more firms there are in the market, the higher will be Ω. See Gould and Waud (1973) or Koskenkylä (1985) on how to derive (4) with a monopolized or perfectly competitive industry and Dufwenberg (1993) for the extension to oligopoly. These authors work in continuous time; Dixit (1990, ch. 10) shows how to discretize.

[4] For detailed account of the theoretical model of capital cost and the empirical estimates, see Bergström and Södersten (1984).

$$cr = \frac{p_K}{p}\left(\frac{1-A}{1-\tau}\right)\left(\rho + \delta - \frac{\Delta p_K}{p_K}\right) \tag{6}$$

where δ is the rate of depreciation, and p_K and p are the prices of investment goods and output, respectively, τ is the corporate tax rate and A is the present discounted value of tax savings from depreciation allowances, investment grants etc. per unit of investment. The cost of capital depends on the forms of finance used by the company. We assume here that the marginal investment is financed by both debt and equity. This means that the firm's rate of discount ρ can be expressed as a weighted average of the after-tax cost of debt and the cost of equity funds, using the proportions of debt and equity as weights.

Although the income from the firm is taxed twice, we ignore the shareholder's taxes. We assume that the market interest rate is exogenously given to the national economy and that domestic corporate shares may be traded freely in international capital markets. With these assumptions, changes in the personal taxation of debt and equity returns will have no effect on the firm's cost of capital.[5]

The tax rate τ differs from the statutory tax rate, τ_s in an important way. τ is the "effective" statutory corporate tax rate, which we define in a particular way to capture both the statutory tax rate τ_s and the option of allocating profits free of tax to so-called investment funds (IF), which was available in all the Nordic countries for at least part of the period under review.[6]

The effects of releases of funds from IF_s on the cost of capital, and hence on the incentive to invest, depended on whether or not firms were actually able to use IF releases to "finance" new investments. Data presented by Södersten (1989) for the Swedish manufacturing industry 1975–1982 indicate that new investments had to be written off using the regular rules of depreciation, despite the occurance of IF releases. Södersten (1983, 1989) also suggest a reinterpretation of the IF system, according to which the effects of the system are limited to reducing the "effective" corporate tax rate below the statutory rate. He derives an explicit expression for this "effective" statutory corporate tax rate τ as

$$\tau = \tau_s(1-s) + sA_d, \tag{7}$$

where s is the share of pre-tax profits that the firm may allocate free of tax to its IF, and 1–s is the share that is taxed at the statutory tax rate, τ_s. Though untaxed, the fund allocation does impose an implicit cost on the firm in that

[5] They will, however, affect the relative attractiveness to domestic shareholders of investing in domestic shares or debt instruments. A cut in personal taxes on interest income, for example, will reduce demand for domestic shares. The depressed share prices will in turn attract foreign portfolio investors and hence change the ownership structure of the domestic capital stock. From the firm's point of view the incentive to invest in real assets is left unchanged.

[6] For Norway we include the taxfree allocations to so called consolidation funds (konsolideringsfonder) in the derivation of τ.

intramarginal investment projects financed through the IF system are considered to be fully written off for tax purposes. The present discounted value of the increased tax payments, due to the loss of these regular depreciation allowances, is denoted as A_d.[7] The "effective" corporate tax rate, τ, is thus a weighted average of the statutory tax rate τ_s and the implicit cost of IF allocations, A_d. Following Berg (1986), we use this method of capturing the effects of the IF systems for all the Nordic countries.

The theoretical analysis by Kanniainen and Södersten (1994) suggests that corporate taxation in the Nordic countries has effectively been neutral in its impact on the cost of capital. The key to their conclusion is the legally required, close connection between taxable and reported book profits, which in turn may force dividend paying firms to abstain from maximizing the use of tax allowances. With unclaimed tax allowances, the effective marginal corporate tax rate is zero. For the purpose of this study, the Kanniainen-Södersten view is the special case of equation (5) above with $A = \tau = 0$. We denote the associated cost of capital as cnot (see also footnote 12).

3.2 Empirical Estimates of Capital Costs

The after-tax nominal discount rate ρ is computed using actual market interest rates and, for each country, we use the actual rates of price inflation for machinery and buildings. For lack of suitable alternatives, the after-tax cost of equity is assumed to be 1.5 times the nominal market interest rate.[8]

The cost of capital and its variation over time depends in a complicated way on the tax rules, the rate of inflation and the real interest rate.[9] The most important determinant of the variation over time in the cost of capital is found here to be the cost of capital in the absence of taxation. During 1965–1989, the coefficients of correlation between the costs of capital with and without taxation were actually as high as 0.973, 0.972, 0.978 and 0.952, for Sweden, Norway, Denmark and Finland, respectively. We also find that for Sweden, and during most of the period for Finland also, the corporate tax contributed very little to raising the average cost of capital. For 1965–1990, the corporate tax wedge, measured as the difference between the costs of capital with and without tax, was on the average as low as 0.1 percentage point in Sweden, and 1.5 percentage points in Finland. Both countries exhibit negative tax wedges for several years, which means that the range of tax concessions given to

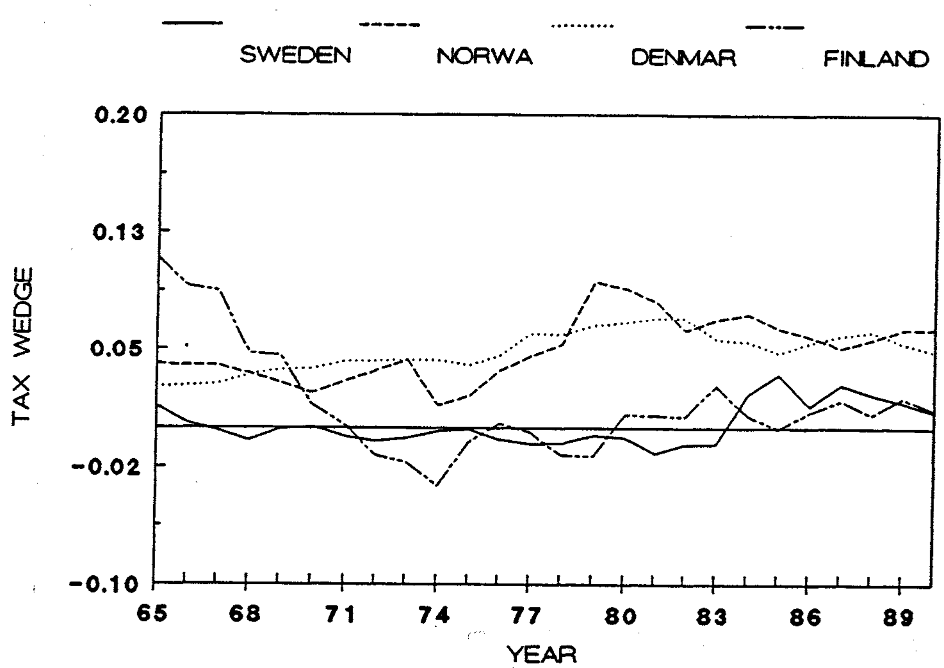
[7] In the case of Norway, firms had the option of claiming regular depreciation allowances also on assets financed through the IF system.

[8] For Finland and Sweden the cost of equity could alternatively be measured from earnings price data. Earlier studies Bergström and Södersten (1984), Koskenkylä (1985) indicate that so measured the cost of equity exceeded the interest rate by an average of fifty per cent. Our choice of proxy makes little difference to the results.

[9] Our main source of information for the empirical estimates is the Nordic Economic Research Council study by Sigbjörn Atle Berg (1986), which covers the period 1967–1984. Additional information was obtained from Bark and Forsgren (1991), Södersten (1991) and Sörensen (1994).

investment was sufficiently great that taken together they more that offset the effects of the tax. In Denmark and Norway the tax wedges were strictly positive and considerably higher, as shown in Figure 1.

Figure 1. **Corporate tax wedges in the Nordic countries 1965–1989**



4 Empirical Results

4.1 The Econometric Approach

The theoretical prediction on industry investment is I* as given by equation (5). If this prediction has some validity, then over time actual investment I should tend to move together with I*. Our theory is silent on what disequilibrium forces might cause such attraction between the two series, but if such exist then the difference I–I* should be stationary over time. To check this, we look for cointegration of the form[10]

$$\ln I = \ln I^{*} + u \tag{8}$$

or

[10] The decision to look for cointegration involving investment rather than capital is unorthodox. It is motivated by the fact that we find stronger support for cointegration in (8) than in lnK=lnK*+u which we tested too. Perhaps this is because our capital stock estimates are subject to measurement error.

$$\ln I = \ln \delta\Omega + \eta_z \ln Z + \eta_c \ln c + \eta_w \ln w + \eta_f \ln f + \eta_T \ln T + u \qquad (8')$$

where u is an equilibrium error. If u passes a test for being an I(0) process this provides evidence of cointegration between actual and theoretically predicted investment.

The price of oil (our proxy for energy price) and terms-of-trade are highly correlated.[11] In order to avoid multicollinearity problems we never include more than one of these variables at a time in our estimations. Hence we estimate

$$\ln I = \ln \delta\Omega + \eta_z \ln Z + \eta_c \ln c + \eta_w \ln w + \eta_m \ln m + u \qquad (9)$$

where m is either the oil price (f) or terms-of-trade (T). All components in (9) turn out to possess unit roots and indeed the error appears to be stationary. Thus it is fitting to employ the Granger-Engle two-step procedure. The parameter estimates in (9) are unbiased but inefficient. We cautiously interpret them as long-run elasticities of investment, or optimal capital, with respect to changes in the right-hand-side variables.

Re-writing the selected version of (9) in an error-correction form, we then estimate

$$\Delta \ln I = a_0 + a_1 \Delta \ln Z + a_2 \Delta \ln c + a_3 \Delta \ln w + a_4 \Delta \ln m + a_5 u_{-1} + v \qquad (10)$$

where Δ is the first difference operator, i.e. $\Delta \ln I = \ln I_t - \ln I_{t-1}$ etc.

Note that u_{-1} is stationary by cointegration, the other variables are stationary by differencing and v should be white noise. Degree-of-freedom constraints forbid extensive elaboration on the use of lags. In practice, we try two possibilities: current values or one-period lags for independent variables. To select between these options we use a goodness-of-fit criterion. The empirical evidence suggests that the selected equations (9) represent cointegrating relationships with all variables being I(1) and the error I(0). The validity of (10) is then a logical necessity by the Granger Representation Theorem (see Engle and Granger 1987).[12]

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[11] The correlations are −0.91, −0.67, 0.91, −0.75 for Denmark, Finland, Norway, and Sweden respectively. Notice the shift of sign in the Norwegian case. The variable Z captures the position of the aggregate demand curve facing the industry. We have tried three proxies for Z, namely

Q = real output of the manufacturing sector

GNP = real gross national product

OECD = real total gross domestic product of the OECD countries

There may be simultaneity bias between aggregate demand and investment. This problem should be most severe for "Q" and least for "OECD".

[12] Alternatively, the Euler equation could be used instead of this more structural approach. We did not choose this alternative because we wanted to preserve the comparability of our results to previous country results of investment behaviour and because we found the cointegration error correction model very useful in our application (see, e.g., Pindyck and Rotemberg, 1983 for the Euler equation approach).

4.2 Cointegration (stationarity) Tests of the Variables

We apply the Augmented Dickey–Fuller (ADF) test procedure to all the variables involved in our analysis. For a variable X, the test equation takes the form:

$$\Delta X = c_0 + c_1 X_{-1} + c_2 \Delta X_{-1} + \varepsilon, \tag{11}$$

where the X variables are I, Q, Z, w, c etc., c_i:s are the coefficients and ε is the ADF equation residual.

This equation includes only one lagged difference because we use annual data (1966–1990). The test is based on the t-statistics of the coefficient c_1. H_0 is the hypothesis that the series under consideration is not stationary. H_0 is rejected if the t-statistic exceeds the critical value of the ADF test. If H_0 is rejected, then X follows a I(0) process. If H_0 cannot be rejected, we proceed to the I(1) tests, i.e. tests of the log-differences. The test is applied to the logs of the variables.

The results of these ADF tests are shown in tables one and two below. The critical values are 1 %/3.58 and 5 %/2.93, (see Engle and Yoo (1987), Fuller (1976)).

The unit root tests in table 1 show that most variables are not stationary in the original log-level form.

Table 1 **The unit root (ADF) tests of the variables (the t-value of the c_1 coefficient, eqn. 11)**

	Denmark	Finland	Norway	Sweden	Aggregate
I	1.67	2.69	1.99	1.46	1.65
Q	2.42	2.04	3.03*	1.67	2.34
GNP	1.82	1.47	1.38	1.84	1.65
w	3.42*	0.62	2.62	1.69	2.32
cr	2.22	3.01*	2.16	0.67	1.15
cnot	2.68	3.20*	2.62	1.24	1.77
f	1.62	1.51	1.44	1.69	1.50
TOT	1.75	0.90	2.14	1.60	2.06
OECD					1.10

* indicates that the test statistic exceeds the critical value at the 5 % significance level and ** at the 1 % level.

Table 2 shows the results of the I(1) tests, i.e. tests applied to the log-differences of the original variables.

Table 2 **The ADF tests of the log differences of the variables**

	Denmark	Finland	Norway	Sweden	Aggregate
I	4.15**	4.11**	5.59**	3.49*	3.79**
Q	3.60**	3.22*	2.72	3.58**	3.13*
GNP	3.77**	3.76**	2.99*	3.35*	2.67
w	2.98*	4.54**	3.15*	2.97*	2.96*
cr	3.89**	3.81**	3.69**	5.66**	4.63**
cnot	4.68**	4.69**	4.78**	5.51**	5.08**
f	2.84	2.96*	2.75	2.67	2.99*
TOT	4.81**	1.97	3.19*	4.25**	5.70**
OECD					3.71**

See also table 1.

The results of table 2 show that, after differencing, most variables get stationary values. In tables 1 and 2 the variable cnot refers to the real user cost excluding taxes (see footnote 11). The aggregate refers to the weighted average of individual country data, the weights being the 1978 US dollar value GDP weights.

We also added a trend variable as an additional regressor in equation (11), but it turned out to be insignificant. The conclusion is that we can safely use the two-stage Granger-Engle ECM estimation procedure in our empirical investigation of investment behaviour.

4.3 Equilibrium Equations of Investment and Cointegration Tests of Residuals

The equilibrium equation for investment to be estimated is (9). The estimation results are shown in table 3 for the aggregate Nordic data and for the countries separately. In table 3 we present only the "best" estimation result which was selected on the basis of the goodness-of-fit. We experimented with all three proxies for the demand (Z) variable and also interchanged the price of oil (f) and the terms of trade (T) variables.

On average, the GNP variable turned out to be the best proxy for demand, and the terms of trade (T) performed better than the price of oil (f). The residuals of the equations are I(0) by the ADF and cointegration D–W test.

The equilibrium investment equations perform quite well except in the case of Norway. In the cointegration analysis the t-statistics of the coefficients are usually not shown nor analyzed since the residual of this equilibrium relationship is what matters with respect to the ECM investment model. However, since these equations give the long-run investment and capital stock elasticities with respect to the explanatory variables, we have included in table 3 the t-statistics for all coefficients.

The coefficients of the variables are of reasonable magnitude. Notice that the coefficients are the long-run elasticities of investment and capital stock with respect to all the variables. For example, the user cost elasticity (eq. 1, –0.31) means that if the real user cost increases by 10 % then investment and capital stock will decrease in the long-run by 3.1 %. On the other hand, if the real rate of interest increases permanently by one percentage point (e.g. from 10 % to 11 %), then investment decreases by about 3 % (at average values of the data).

The underlying structural parameters are not discussed further here because we do not have reliable information on the elasticities of the underlying demand function for the firms' products (see Gould and Waud, 1973).

4.4 The Long-Run Effect of Corporate Taxation on Investment

The central issue in this study is the impact of tax factors on manufacturing investment decisions. The possible effects can come through the user cost variable and indirectly through general economic conditions. The latter channel would require the use of a total macroeconomic model. Here, we attempt to sort out the direct effects on investment via the user cost variable.

Two methods are used to clear up the role of corporate tax parameters. First, we estimate the equilibrium investment equations by replacing the normal user cost variable, cr, with the cnot-variable.[13] Second, we apply the encompassing test procedure to a non-nested situation, i.e. to the choice between cr and cnot.[14]

Table 4 gives the results of the cr and cnot estimations in the best performing equations of the preceding equilibrium analysis. The results show that the estimated equations are practically unchanged by the change in the c. This points to the conclusion that taxes have no effect on investment in the long-run, i.e. the corporate tax system in the Nordic countries has been effectively neutral.

The encompassing tests are also given in table 4. H_0: c = cr is rejected in the aggregate and for Finland. For other countries H_0 cannot be rejected. When the test is reversed, i.e. H_0: c = cnot, H_0 is not rejected in any case.

In summary, the test results clearly indicate that the prevailing corporate tax systems have been neutral in the Nordic countries. This result is not surprising since tax allowances have been very generous in the Nordic countries and the effective tax rates low, especially in Finland and Sweden. In the case of Denmark this neutrality result is perhaps more surprising because the effective tax rate has been higher and more variable than in the other countries.

4.5 Error Correction Models of Investment

The dynamic part of investment behaviour is analyzed through the ECM equations. The basic equation is (10), where u_{-1} is the lagged residual of the corresponding equilibrium equation and a_5 is the speed of adjustment.

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[13] cnot = $(p_K/p)(\rho + \delta - \Delta p_K/p_K)$, i.e. no tax factors enter this user cost.

[14] The test used here is of the Davidson–MacKinnon type (see Davidson and MacKinnon (1982)).

Also with this model, we experiment with both the price of oil and the terms of trade. However, the analysis shown here is based on the best selected equilibrium investment equations, which were given in table 3. We use both the current and previous period values for the explanatory variables. The estimation results are given in table 5. Case A always uses current period values and case B lagged values for the independent variables.

The accelerator variable (demand) affects investment in all the countries except Norway. The user cost is significant except in Finland. The wage rate is significant only in Sweden. Terms of trade is significant in Finland and Sweden. The best performing equations were of type A, with no lags in the variables, except for Finland.

The coefficient of the lagged residual, u_{-1}, is always significant and gets values between 0.5 and 1, implying rapid adjustment of investment to the equilibrium level. The respective t-ratios are rather high indicating that our cointegration assumptions may indeed be valid (see Kremers, Ericsson and Dolado (1992)).

In sum, the short-run investment behaviour of manufacturing in the Nordic countries seems to depend on demand, cost of capital and terms of trade factors. Wage costs, price of oil and cash flow factors are not important determinants in this respect.

4.6 The Effect of Taxes on Investment in the Short-Run

As with the equilibrium investment equations, we now use the two methods to discover the effect of tax factors. Table 6 gives the estimation results using both cr and cnot. The best equations were selected from table 5. It can be seen from table 6 that the estimation results are again practically unchanged when cr is substituted for cnot. Corporate taxes do not seem to affect short-run investment decisions in the Nordic countries.

The encompassing tests are also given in table 6. H_0: c = cr is rejected in the aggregate. H_0: c = cnot is rejected only in the Danish case. Hence, the test results are fairly clear. Only in Denmark have the corporate tax factors affected investment behaviour in the short-run. In all other cases the tax system is neutral also in the short run. In light of table 6 (eqs. 2A and cnot) this effect may also be quite small in the case of Denmark.

It should be emphasized that although the tax factors seem not to be relevant, the user cost variables are, however, generally significant. This means that the real rate of interest has a significant impact on investment both in the short and long run.

5 Concluding Remarks

Overall, the results of the analysis of manufacturing investment decisions in the Nordic countries over the period 1966–1990 seem to indicate that the neoclassical model applied in the ECM framework is quite capable of explaining the main features of investment. Also for the aggregate data (an average Nordic investment model), the results are very promising.

The chief determinants of investment are the demand variable (output), the real prices of inputs (wages, user cost and oil price) and the terms of trade. The cash flow variables do not affect investment behaviour.

Our main purpose was to test for the effect of corporate taxation on fixed investment decisions in the Nordic manufacturing sector. The cost of capital per se is a highly significant determinant of investment both in the short and long run. This would imply that both the expected real rate of interest and other cost of capital factors are important determinants of investment. However, when the equations are tested with and without tax factors in the user cost, it turns out that there is practically no difference in the results. Hence it can be concluded that corporate tax systems have been effectively neutral in the Nordic countries. Only in the case of Denmark tax factors have had a small impact in the short run.

This result, i.e. the neutrality of the corporation tax with respect to investment demand, is in accordance with the Kanniainen-Södersten view that Nordic firms to a large extent have been constrained in their use of tax allowances. With unused tax allowances, the effective corporate tax rate is zero. It should be pointed out, however, that this neutrality result is valid only in the aggregate data for each country. It is possible that there are important differences between subsectors and individual firms, some being tax-neutral and some not.

The new corporate tax systems adopted in Finland, Norway and Sweden in 1991–1992 may have changed the role of tax factors. The corporate profit tax rates have been lowered (to 25–30 %) and the range of tax allowances has been considerably reduced. A possible result of this is that fewer firms now are constrained in their use of tax allowances, possible restoring the potential of corporate taxation as a tool of affecting investment behaviour.

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Table 3 **OLS estimates of equilibrium investment equations for the Nordic countries**

Eq. No.	constant	Z/Q	Z/GNP	cr	w	f	T	R^2	SEE	ADF
1/A	−11.53		2.73	−0.31	−1.02		1.67	0.852	0.075	4.62**
	(3.26)		(5.32)	(3.96)	(2.96)		(1.96)			
2/D	-3.48		2.24	−0.30	−0.46	−0.02		0.790	0.089	4.36**
	(1.62)		(4.79)	(2.63)	(1.45)	(0.31)				
3/F	−4.18	0.73		−0.11	−0.04		1.19	0.784	0.120	5.69***
	(0.75)	(1.70)		(1.71)	(0.62)		(2.36)			
4/N	4.37		0.30	−0.05	0.92		−0.25	0.653	0.159	5.60***
	(1.03)		(0.40)	(0.72)	(1.90)		(0.60)			
5/S	−16.0		2.56	−0.30	-1.02		2.85	0.862	0.078	4.23*
	(6.41)		(5.77)	(3.06)	(3.67)		(7.12)			

Eqn. No. 1: Aggregate Nordic data, Eqn. No. 2: Denmark, Eqn. No. 3: Finland, Eqn. No. 4: Norway and Eqn. No. 5: Sweden. The variables are Q = industrial value-added, GNP = gross national product, c = real user cost, w = real wage rate, f = real price of oil and T = terms of trade; ADF = augmented Dickey-Fuller test, t-values of coefficients are shown in brackets.

*** the ADF-test is significant at 1 %-level

** the ADF-test is significant at 5 %-level

* the ADF-test is significant at 10 %-level

Significant implies that the ADF value exceeds the critical level of the test so that (H_0: no cointegration) is rejected.

Table 4 **OLS estimates of investment equations with and without tax factors in the user cost variable and the encompassing tests of tax effects**

Eqn. No.		constant	Q	GNP	cr	cnot	w	f	T	R^2	SEE	DW	ADF	H_0: c=cr	H_0: c=cnot
1	(table 3,	−11.53		2.73	−0.31		−1.02		1.67	0.852	0.075	1.47	4.62		1.49
	eqn. 1)	(3.26)		(5.32)	(3.96)		(2.96)		(1.96)						
2	cnot	−12.41		2.75		−0.30	−1.08		1.88	0.864	0.073	1.41	3.53	2.08	
		(3.65)		(5.63)		(4.38)	(3.28)		(2.17)						
3	(table 3,	−3.48		2.24	−0.31		−0.46	−0.02		0.790	0.089	1.71	4.36		0.37
	eqn. 2)	(1.62)		(4.79)	(2.63)		(1.45)	(0.31)							
4	cnot	−4.05		2.41		−0.27	−0.61	−0.01		0.795	0.088	1.70	3.67	0.78	
		(1.85)		(5.15)		(2.75)	(2.01)	(0.16)							
5	(table 3,	−4.18	0.73		−0.11		−0.04		1.19	0.784	0.120	1.22	5.69		1.31
	eqn. 3)	(0.75)	(1.69)		(1.68)		(0.62)		(2.36)						
6	cnot	−2.81	0.54			−0.19	0.18		1.13	0.805	0.116	1.27	5.20	2.03	
		(0.56)	(1.06)			(2.19)	(0.33)		(2.40)						
7	(table 3,	4.37		0.30	−0.05		0.92		−0.25	0.654	0.159	1.07	5.60		0.32
	eqn. 4)	(1.03)		(0.40)	(0.72)		(1.88)		(0.60)						
8	cnot	4.35		0.32		−0.04	0.90		−0.25	0.656	0.158	1.06	5.07	0.52	
		(1.03)		(0.42)		(0.82)	(1.87)		(0.61)						
9	(table 3,	−16.0		2.56	−0.30		−1.02		2.85	0.862	0.078	2.29	3.23		0.84
	eqn. 5)	(6.41)		(5.77)	(3.06)		(3.67)		(7.92)						
10	cnot	−14.75		2.38		−0.29	−1.01		2.82	0.878	0.073	2.33	3.18	1.90	
		(7.14)		(6.45)		(3.62)	(3.94)		(8.30)						

Equations 1&2: aggregate Nordic data, Equations 3&4: Denmark, Equations 5&6: Finland, Equations 7&8: Norway, Equations 9&10: Sweden
H_0: c=cr and H_0: c=cnot refer to the Davidson–MacKinnon encompassing test, the H_0: c=cr column gives the t-statistic of cnot and the H_0: c=cnot column gives the t-statistic of cr.

Table 5 **OLS estimates of the error correction equations of investment, eqn. (10)**

Eqn. No.		constant	Q	GNP	cr	w	f	T	u_{-1}	R^2	SEE	DW	Dm
1A⁺	(table 3,	0.01		0.93	−0.29	−0.17		0.80	−0.81	0.604	0.060	1.56	1.60
	eqn. 1)	(0.43)		(2.11)	(3.35)	(0.37)		(1.47)	(4.38)				
1B		−0.02		2.66	0.04	−1.09		0.21	−0.49	0.476	0.069	1.85	0.65
		(0.11)		(2.43)	(0.46)	(1.87)		(0.32)	(1.91)				
2A⁺	(table 3,	−0.02		2.72	−0.30	−0.37	0.04		−0.78	0.528	0.091	1.76	1.52
	eqn. 2)	(0.51)		(1.72)	(2.20)	(0.57)	(0.73)		(2.11)				
2B		−0.01		1.92	0.02	−0.36	−0.01		−1.07	0.509	0.093	2.29	1.44
		(0.21)		(1.82)	(0.18)	(0.61)	(0.05)		(4.43)				
3A	(table 3,	−0.06	1.07		−0.08	1.14		1.61	−0.85	0.477	0.102	1.79	1.20
	eqn. 3)	(1.50)	(1.56)		(1.19)	(1.85)		(2.27)	(3.83)				
3B⁺		−0.05	1.67		−0.05	0.06		1.40	−0.66	0.510	0.019	2.02	1.16
		(1.09)	(2.47)		(0.71)	(0.10)		(2.04)	(2.71)				
4A⁺	(table 3,	−0.01		−0.29	−0.13	1.17		−0.74	−0.62	0.344	0.135	1.72	1.48
	eqn. 4)	(0.22)		(0.42)	(1.90)	(1.40)		(1.75)	(2.88)				
4B		0.02		0.52	−0.04	−0.19		−0.16	−0.57	0.144	0.163	1.57	1.22
		(0.37)		(0.72)	(0.44)	(0.18)		(0.32)	(2.23)				
5A⁺	(table 3,	0.01		2.07	−0.28	−0.88		1.99	−0.99	0.607	0.074	1.80	0.92
	eqn. 5)	(0.29)		(2.47)	(3.04)	(2.16)		(3.67)	(4.37)				
5B		−0.04		3.58	−0.18	−0.77		0.13	−0.54	0.481	0.085	2.11	1.73
		(1.28)		(3.60)	(1.93)	(1.68)		(0.22)	(2.02)				

The equations selected for further analysis are marked by ⁺.
A refers to the current period values and B to lagged values
Aggregate Nordic data: 1A&1B, Denmark: 2A&2B, Finland: 3A&3B, Norway: 4A&4B, Sweden: 5A&5B, Dm is Durbin's m-statistic for testing autocorrelation in the presence of a lagged dependent variable (see Durbin (1970)).

Table 6 **OLS estimates of the error correction equations with and without tax factors in the user cost variable and the encompassing tests of tax effects**

Eqn. No.		constant	Q	GNP	cr	cnot	w	f	T	u_{-1}	R^2	SEE	DW	Dm	H_0=c	H_0=cnot
1A	**(table 5)**	0.01		0.93	−0.29		−0.17		0.80	−0.81	0.604	0.060	1.56	1.60		1.60
		(0.43)		(2.11)	(3.35)		(0.37)		(1.47)	(4.38)						
1	**cnot**	0.01		1.06		−0.28	−0.18		0.88	−0.81	0.654	0.057	1.55	1.57	3.37	
		(0.32)		(1.78)		(3.94)	(0.42)		(1.73)	(4.54)						
2A	**(table 5)**	−0.02		2.72	−0.30		−0.37	0.04		−0.78	0.528	0.091	1.76	1.52		2.21
		(0.51)		(1.72)	(2.20)		(0.57)	(0.43)		(2.11)						
2	**cnot**	−0.03		3.39		−0.29	−0.63	0.06		−0.70	0.548	0.089	1.81	1.02	1.32	
		(0.74)		(2.33)		(2.70)	(0.99)	(0.76)		(2.04)						
3B	**(table 5)**	−0.05	1.67		−0.05		0.06		1.40	−0.66	0.510	0.099	2.02	1.16		0.44
		(1.09)	(2.47)		(0.71)		(0.10)		(2.04)	(2.71)						
3	**cnot**	−0.06	1.91			−0.03	0.16		1.39	−0.75	0.527	0.098	2.06	1.09	0.62	
		(1.37)	(2.96)			(0.35)	(0.22)		(2.06)	(2.88)						
4A	**(table 5)**	−0.01		−0.29	−0.13		1.17		−0.74	−0.62	0.344	0.135	1.72	1.48		0.38
		(0.22)		(0.42)	(1.90)		(1.40)		(1.75)	(2.88)						
4	**cnot**	−0.01		−0.27		−0.09	1.21		−0.77	−0.61	0.362	0.133	1.71	1.67	0.79	
		(0.28)		(0.40)		(2.04)	(1.48)		(1.84)	(2.90)						
5A	**(table 5)**	0.01		2.07	−0.28		−0.88		1.99	−0.99	0.607	0.074	1.80	0.92		0.31
		(0.59)		(2.47)	(3.04)		(2.16)		(3.67)	(4.37)						
5	**cnot**	0.01		1.68		−0.28	−0.95		2.08	−1.02	0.665	0.069	1.71	1.25	0.76	
		(0.59)		(2.13)		(3.16)	(2.47)		(4.15)	(4.82)						

Eqn. 1 for aggregate Nordic data, eqn. 2 for Denmark, eqn. 3 for Finland, eqn. 4 for Norway, eqn. 5 for Sweden.

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