KM 25(1987)
pag 39 - 56

Investment Behaviour in the Dutch Manufacturing Sector

J.J. van Dijk *

Abstract

In studies on investment behaviour dynamics are very important. A theoretical justification of a dynamic investment equation can be obtained by introducing adjustment costs for the production factors. The present paper discusses three studies in this field and selects a model that arrives at interrelated factor demand.
The empirical relevance of interrelated factor demand is illustrated by estimating an investment equation with data from eleven industries of the Dutch manufacturing sector. Furthermore, tests are performed on the dynamic structure of the investment equation. A general conclusion is that elaborate lag structures can be avoided.

* Vakgroep Micro-economie en Economische Orden
Erasmus Universiteit Rotterdam
Postbus 1738
3000 DR Rotterdam
Tel: 010-4081497

1. Introduction.

In a historical perspective the year 1963 appears to be very important for the understanding of investment behaviour of firms. In this particular year the studies of Jorgenson and of Eisner and Strotz were published and their importance for investment theory can hardly be exaggerated. Introduced by Jorgenson, dynamic optimization in investment theory and the user costs of capital are common elements to most studies in this field. Furthermore the notion of costs of adjustment for production factors from Eisner and Strotz is by far the most popular way to account for lag structures.

In the second section, the present paper discusses both studies and points out the difficulties met by these models. Essentially, the problem is the instantaneous adjustment of at least one production factor. To avoid this drawback a third model is discussed which results in interrelated factor demand.

The empirical part of this study in section 3 tests on an investment equation with data from eleven industries of the Dutch manufacturing sector. These tests concern the empirical relevance of interrelated factor demand and their lag structures.

To stress theoretical aspects of the models and to improve the readability, mathematical detail is left out. Full proofs of the existence of unique and stable solutions will not be given as they can be found in the references. The general conclusions are summarized in a final section and an appendix describes the data.

2. Costs of Adjustment.

Ever since the work of Eisner and Strotz [1963] costs of adjustment have played an important role in theories of investment behaviour. This is so because the concept of costs of adjustment provides a rationale for lag structures in the demand for capital goods. To put the theoretical importance of costs of adjustment in perspective, the original model of Jorgenson [1963] is discussed first, showing the difficulties encountered by models without costs of adjustment. Next, changes in the capital stock are no longer assumed to be costless as suggested by Eisner and Strotz [1963]. The third model is based on the work of Lucas [1967] and now costs of adjustment are generated by changes in both production factors, capital and labour. Finally the lag structure resulting from this model is discussed.

The basic assumption in Jorgenson's model is that the firm determines the quantities of the inputs such that the present value of the future net cash flows is maximized. The net cash flow is defined as the value of output minus labour costs and investment outlays. Omitting time indices the net cash flow is:

$$NCF_1 = p.Q\ (K,L) - w.L - q.I \tag{1}$$

where: NCF_1 = net cash flow without adjustment costs
p = price of output
Q = output
K = capital input = capital stock
L = labour input
w = wage rate
q = price of investments
I = gross-investments

The present value of future net cash flows is then maximised subject to an equation which links net- and gross-investments: *

$$\underset{\{K,L,I\}}{\text{Max}}\ Z_1 = \int_0^\infty e^{-rt}\ \left[NCF_1\right]_t dt \tag{2}$$

$$\text{s.t. } \dot{K} = I - \delta K \tag{3}$$

where: Z_1 = present value of the net cash flows
r = interest rate
$\dot{K}$ = net investment
δ = rate of deterioration

The Euler conditions for this problem result in two equations:

$$p\ Q_K - q(r+\delta-\dot{q}/q) = 0 \tag{4}$$

$$p\ Q_L - w = 0 \tag{5}$$

---

* a dot over a variable indicates the time derivative.

where: Q_K = marginal productivity of capital

Q_L = marginal productivity of labour

The equations (4) and (5) have a clear interpretation. The optimal amount of each input is reached if the value of its marginal product equals its price. This outcome is identical to the one obtained in a static profit maximisation model. Despite the dynamic framework the result is static which is explained by the absence of a mechanism that creates a dependency between the successive periods. According to the equations (4) and (5) the amount of each input is adjusted instantaneously and this static result is the essence of the theoretical objections to Jorgenson's model. An escape from the clearly unrealistic solution by introducing delivery lags is not a valid one as these lags are known by firms and have to be incorporated in the maximisation procedure as constraints. Nevertheless Jorgenson's model is a major contribution relating the demand of investment goods to a profit motive and deriving a meaningful price of capital services, the user costs of capital, which are contained in equation (4). The user costs of capital for a monetary unit consist of interest and depreciation minus the relative price change of investment goods.

In the discussion above instantaneous adjustment as well as exogenous delivery lags have been rejected so the search has to be directed towards endogenously generated lag structures. An endogenous lag structure can only result from an intertemporal dependency, i.e. today's decisions of the firm influence future decisions. One way of achieving this is the introduction of costs of adjustments for production factors. The first study in this field by Eisner and Strotz [1963] assumes that investments entail costs of adjustment. They choose the functional form to be quadratic in $\dot{K}$:

$$C = a.(\dot{K})^2 \qquad (a>0) \tag{6}$$

where C = costs of adjustment

Redefining the net cash flow using equation (6) leads to:

$$NCF_2 = p.Q(K,L) - wL - qI - a.(\dot{K})^2 \tag{7}$$

NCF_2 = net cash flow with adjustment costs on investments

The objective function now becomes:

$$\underset{\{K,L,I\}}{\text{Max}} \quad Z_2 = \int_0^\infty e^{-rt} \, [NCF_2]_t \, dt \qquad (8)$$

$$\text{s.t. } \dot{K} = I - \delta K \qquad (9)$$

where: Z_2 = present value of the net cash flows

Despite the similarity of this model with the previous one the Euler condition for capital input is quite different:

$$p\, Q_K - q(r+\delta-\dot{q}/q) - 2\, a\, r\, \dot{K} + 2\, a\, \ddot{K} = 0 \qquad (10)^*$$

$$p\, Q_L - w = 0 \qquad (11)$$

The Euler equation for the capital input is now a second order differential equation. In a stationary state, i.e. all variables no longer change, all time derivatives become zero and equation (10) is then identical to equation (4), so this part of the equation can be said to contain a target value: the desired capital stock. Starting from a stationary state a sudden increase in the desired capital stock will no longer be adjusted instantaneously. The time derivatives $\dot{K}$ and $\ddot{K}$ would be equal (the change in $\dot{K}$ then is $\dot{K}$ itself) and since the former is multiplied by the interest rate r there is still a gap between the value of the marginal product of capital and its (implicit) price.

In studies on investment behaviour quadratic costs of adjustment are often used as a theoretical justification of the partial adjustment (PA) hypothesis:

$$\dot{K} = \gamma.[K^*-K] \qquad (0 < \gamma < 1) \qquad (12)$$

where: K^* = desired capital stock

However, the dynamic structure in the PA model is not identical to the one described in equation (10). The PA model implies a fixed ratio of $\ddot{K}$ and $\dot{K}$

---

* $\ddot{K}$ is the time derivative of $\dot{K}$

which is not a general solution to equation (10). Only a linear Taylor approximation of equation (10) around K* will produce the PA model. Because of this the parameter γ in equation (12) will be a function of the interest rate r and the desired capital stock K*. So the derivation of the PA model with a fixed γ requires the additional assumption of static expectations, i.e. all exogenous variables are taken to remain at their present level (see Gould [1968]).

The inclusion of adjustment costs for the capital input has no direct influence on the adjustment of the second production factor, labour. According to equation (11) labour is still adjusted instantaneously: the value of its marginal product will always equal its price. Any interaction between the adjustments of the two production factors must come from the marginal productivities. It is important to note that Q_L depends on K and Q_K on L. In this sense the interaction is fully static. To create dynamic interaction, models have been developed in which the costs of adjustment depend on changes in more than one production factor.
An early model in this field was presented by Lucas [1967]. Adapting his model for the present purpose Lucas defines the net cash flow, NCF_3, as follows:

$$NCF_3 = p.Q(K,L) - wL - qI - C_1(\dot{L}) - C_2(\dot{K}) \tag{13}$$

In equation (13) C_1 and C_2 are non-negative functions of $\dot{L}$ and $\dot{K}$. Furthermore, the first and second order derivatives of C_1 and C_2 are assumed to be positive. The objective function is:

$$\underset{\{K,L,I\}}{\text{Max}} \; Z_3 = \int_0^\infty e^{-rt} \, [NCF_3] \, dt \tag{14}$$

$$\text{s.t. } \dot{K} = I - \delta K \tag{15}$$

where: Z_3 = present value of the net cash flows

The resulting Euler conditions for the two production factors K and L are:

$$p\,Q_K - q(r+\delta-\dot{q}/q) - r\frac{\partial C_2}{\partial \dot{K}}\dot{K} + \frac{\partial^2 C_2}{\partial \dot{K}^2}\ddot{K} = 0 \tag{16}$$

$$p\,Q_L - w \qquad\qquad - r\frac{\partial C_1}{\partial \dot{L}}\dot{L} + \frac{\partial^2 C_1}{\partial \dot{L}^2}\ddot{L} = 0 \tag{17}$$

Using a linear Taylor expansion of the equations (16) and (17) around K^* and L^* Lucas proves the existence of a unique and stable solution. His results require the additional assumptions of static expectations and a strictly concave production function. In the derived lag structure the change in each input is a linear function of the gaps between desired and actual amount of all production factors. This is called the generalized PA model.

From the discussion above it is clear that interrelated factor demand can be given a theoretical justification by using convenient adjustment costs functions. However, before using this result to estimate an interrelated investment equation two modifications are made. Firstly, all variables will be replaced by their logarithms. To illustrate this point a discrete version of equation (12) serves as an example:

$$K_t - K_{t-1} = \gamma \, [K^*_{t-1} - K_{t-1}] \tag{18}$$

By dividing both sides by K_{t-1} one obtains:

$$\left(\frac{K_t}{K_{t-1}} - 1\right) = \gamma \left(\frac{K^*_{t-1}}{K_{t-1}} - 1\right) \tag{19}$$

In equation (19) the terms between brackets can be approximated by log-linear functions:

$$\ell n\, K_t - \ell n\, K_{t-1} = \gamma(\ell n\, K^*_{t-1} - \ell n\, K_{t-1}) \tag{20}$$

The step from equation (19) to equation (20) is easily verified by a linear Taylor expansion of the latter equation. A log-linear specification can also be obtained by assuming adjustment costs or relative changes of the inputs (see Broer [1987]). The main purpose of a transformation to logarithms is to avoid heteroskedasticity in the estimation. In the remainder 'PA' refers to logarithms.

The second modification of the generalized PA model is based on the dependency of the adjustment coefficients on K^* and L^*. An empirical investigation of the PA model with fixed coefficients can not be justified on theoretical considerations as K^* and L^* will surely vary over time. To overcome this problem a more general lag structure serves as a starting point:

$$\ell nK_t = \alpha_0 \ell nK_{t-1} + \alpha_1 \ell nK^*_t + \alpha_2 \ell nK^*_{t-1} + \beta_0 \ell nL_{t-1} + \beta_1 \ell nL^*_t + \beta_2 \ell nL^*_{t-1} \tag{21}$$

However, this specification has the drawback that in a stationary state the actual capital stock is not necessarily equal to the desired capital stock. To ensure this the following restrictions should hold:

$$\alpha_0 + \alpha_1 + \alpha_2 = 1 \tag{22}$$

$$\beta_0 + \beta_1 + \beta_2 = 0 \tag{23}$$

These restrictions have an interesting implication. The long-run elasticity of the actual capital stock with respect to the desired capital stock equals unity and the one relating to the desired labour input is zero. In this way non-stationary deviations can be captured without undesirable implications for the long-run. Substitution of the two restrictions in equation (21) and a rearranging of terms gives:

$$\begin{aligned} \ell nK_t - \ell nK_{t-1} &= \alpha_1 [\ell nK^*_t - \ell nK^*_{t-1}] + [1-\alpha_0] [\ell nK^*_{t-1} - \ell nK_{t-1}] \\ &+ \beta_1 [\ell nL^*_t - \ell n L^*_{t-1}] + \beta_0 [\ell nL_{t-1} - \ell nL^*_{t-1}] \end{aligned} \tag{24}$$

In equation (24) the generalized PA model is present (with coefficients $[1-\alpha_0]$ and β_0) along with the two terms to account for changes in the desired levels K* and L* (with coefficients α_1 and β_1). If the estimates of α_1 and β_1 appear to be insignificant from zero the use of the generalized PA model with fixed coefficients is empirically acceptable despite the theoretical dependency of α_0 and β_0 on K* and L*.

The dynamic specification of the investment equation above, or more precisely the growth rate of the actual capital stock, is of the error correction mechanism (ECM) type (see Davidson et al [1978], Hendry and Ungern-Sternberg [1979]), generalized to account for the adjustment process of the labour input. For each production factor the change in desired level is present and also the lagged gap, or 'error', between desired and actual level. Estimation of equation (24) is turned to in the next section.

3. Interrelated Factor Demand.

In this section the results of the theoretical discussion above will be used by estimating an investment equation which explicitly accounts for the adjustment process of the labour input. Clearly empirical investigation requires additional assumptions.

Firstly, there is the choice of a specific production function and related to that the formulation of the desired levels of the inputs. In a stationary state the value of the marginal product will equal the price of each input and from this fact the targets or desired levels for the inputs can be determined. There has been much debate on the elasticity of substitution of the production function which is used (e.g. Eisner and Nadiri [1968], Bischoff [1969]) but tests on data of the Dutch manufacturing sector reveal the Cobb-Douglas function to be acceptable (van Dijk [1983]). This function implies a unitary elasticity of substitution. The choice of the Cobb-Douglas production function does not solve the problem of the reduced form equations for the desired levels. Jorgenson's formulation still contains the possibly endogenous value of output. This point has been investigated by Gould [1969] and he provides reduced forms in which the desired levels depend only on the input prices. Despite the theoretical elegancy of his model the empirical relevance for the Dutch manufacturing sector is very limited and provides no improvements over Jorgenson's model (see van Dijk [1983]). The bottom line is that the following Cobb-Douglas production function will be used:

$$Q_t = A.K_t^{\gamma_0}.L_t^{\gamma_1} \tag{25}$$

The parameters A, γ_0 and γ_1 are all positive and fixed. The implied desired levels of the inputs then become:

$$K_t^* = \gamma_0 \cdot \frac{P_t Q_t}{uc_t} \tag{26}$$

$$L_t^* = \gamma_1 \cdot \frac{P_t Q_t}{w_t} \tag{27}$$

where: uc_t = user costs of capital

Substitution of the equations (26) and (27) in equation (24) gives the following expression:

$$\ln K_t - \ln K_{t-1} = [(1-\alpha_0)\ln \gamma_0 - \beta_0 \ln \gamma_1] + \alpha_1 \left[\ln \frac{P_t Q_t}{uc_t} - \ln \frac{P_{t-1}Q_{t-1}}{uc_{t-1}}\right]$$

$$+ (1-\alpha_0). \left[\ln \frac{P_{t-1}Q_{t-1}}{uc_{t-1}} - \ln K_{t-1}\right] + \beta_1 \left[\ln \frac{P_t Q_t}{w_t} - \ln \frac{P_{t-1}Q_{t-1}}{w_{t-1}}\right]$$

$$+ \beta_0 \left[\ln L_{t-1} - \ln \frac{P_{t-1}Q_{t-1}}{w_{t-1}}\right]. \qquad (28)$$

Equation (28) is estimated by means of ordinary least squares over the period 1960-1976 for eleven industries of the Dutch manufacturing sector. The results are presented in Table 1.
The estimation results reveal not all parameters to be different from zero at a 95% significance level. Furthermore, the DW-statistic is biased towards two because of lagged endogenous variables. The estimates for the chemical industry (SBI 28-31) and the metal industry (SBI 33-35) are obtained by applying a correction method for autocorrelated errors. Despite this correction the DW-statistics are rather low.

Given these results it is necessary to estimate alternative specifications of the model. Since some parameters tend to be insignificant simplified versions of the general model have to be tested. This is done by PA lags (instead of the ECM) and by neglecting the interrelationship between labour and capital. Because of the possible correlations between the regressors the tests are performed on the log of the likelihood and not on the partial t-tests. In table 2 the log of likelihood is given for six versions of the model, all estimated for each industrial sector. The chi-square statistic (χ^2) can easily be calculated by doubling the difference in log of likelihood where the number of restrictions identifies the degrees of freedom for the chi-square statistic. Now that particular version of the model is chosen which is the simplest formulation without a significant loss in likelihood as measured by the chi-square statistic at a 5% level ($\chi_1^2 = 3.84$, $\chi_2^2 = 5.99$ etc.). The final column of table 2 provides the selected version for each industrial sector. Note that PA lags imply that the coefficients α_1 and/or β_1 are restricted to zero. So going from column (1) to column (2) is one restriction, from column (1) to column (4) are two restrictions etc.. The columns (5) and (6) refer to a situation with no interaction from the labour input, i.e. $\beta_1=\beta_0=0$.

Table 1. Estimation results for the growth rate of the capital stock, 1960-1976. *

SBI-code	$(1-\alpha_o)\ell n\ \gamma_o - \beta_o \ell n\ \gamma_1$	α_1	$1-\alpha_o$	β_1	β_o	D.W.	s.e. (s.d.)
20-21	0.063 (0.008)	0.072 (0.049)	0.226 (0.072)	-0.079 (0.056)	0.219 (0.065)	1.72	0.008 (0.011)
22	0.032 (0.009)	0.041 (0.083)	0.212 (0.067)	-0.041 (0.066)	0.189 (0.107)	1.84	0.011 (0.019)
23	0.060 (0.004)	-0.014 (0.054)	0.151 (0.033)	0.003 (0.047)	0.171 (0.076)	1.94	0.009 (0.028)
24	0.046 (0.004)	0.008 (0.051)	0.099 (0.045)	-0.064 (0.046)	-0.024 (0.070)	1.80	0.008 (0.031)
25	0.070 (0.017)	0.014 (0.099)	0.190 (0.102)	-0.150 (0.065)	0.124 (0.146)	1.40	0.014 (0.025)
26	0.031 (0.020)	0.346 (0.211)	0.480 (0.203)	-0.155 (0.175)	0.126 (0.075)	1.75	0.028 (0.037)
27	0.050 (0.009)	0.398 (0.193)	0.752 (0.295)	-0.089 (0.078)	0.281 (0.137)	2.17	0.014 (0.017)
28-31	0.119 (0.027)	-0.216 (0.116)	-0.136 (0.105)	-0.050 (0.065)	0.289 (0.093)	1.11	0.014 (0.040)
32	0.081 (0.017)	0.074 (0.123)	0.321 (0.113)	-0.104 (0.126)	0.413 (0.227)	2.04	0.020 (0.029)
33-35	0.050 (0.013)	0.116 (0.143)	0.426 (0.139)	0.023 (0.076)	0.071 (0.085)	1.37	0.017 (0.026)
36	0.085 (0.012)	0.101 (0.153)	0.351 (0.121)	-0.108 (0.121)	0.311 (0.157)	1.97	0.021 (0.031)

* The appendix contains a description of the data
Standard errors between parentheses
D.W. = Durbin-Watson statistic
s.e. = standard error
s.d. = standard deviation of the dependent variable

Table 2. Log of likelihood depending on the lag structures.

	(1)	(2)	(3)	(4)	(5)	(6)	
	K: ECM	K: ECM	K: PA	K: PA	K: ECM	K: PA	selection
SBI-code	L: ECM	L: PA	L: ECM	L: PA	L: -	L: -	
20-21	60.1	58.8	58.8	58.7	54.5	54.4	(4)
22	54.5	54.2	54.3	54.2	52.7	52.2	(4)
23	57.9	57.9	57.9	57.8	55.6	55.4	(4)
24	61.6	60.4	61.6	59.1	59.1	58.6	(3)
25	50.0	47.0	50.0	45.8	47.0	45.6	(3)
26	39.0	38.6	37.5	36.8	36.8	36.3	(6)
27	50.7	49.9	48.3	48.3	48.1	48.0	(6)
28-31	50.5	50.1	48.4	42.8	45.4	41.3	(2)
32	44.8	44.4	44.6	44.4	42.9	42.4	(4)
33-35	48.2	48.1	47.8	47.1	47.3	46.6	(6)
36	44.3	44.0	44.1	43.9	42.4	41.9	(4)

The choice being made, table 3 provides the estimation results for the selected lag structures.

Table 3. Estimation results for the selected lag structures.

SBI-code	lags	$(1-\alpha_o)\ell n\ \gamma_o - \beta_o \ell n\ \gamma_1$	α_1	$1-\alpha_o$	β_1	β_0	s.e.	D.W.
20-21	K: PA L: PA	0.065 (0.007)	-	0.175 (0.061)	-	0.171 (0.056)	0.008	1.85
22	K: PA L: PA	0.033 (0.008)	-	0.199 (0.057)	-	0.164 (0.088)	0.011	1.76
23	K: PA L: PA	0.059 (0.004)	-	0.153 (0.029)	-	0.179 (0.067)	0.009	1.97
24	K: PA L: ECM	0.046 (0.003)	-	0.094 (0.035)	-0.056 (0.027)	-0.031 (0.053)	0.008	1.86
25	K: PA L: ECM	0.070 (0.017)	-	0.183 (0.087)	-0.145 (0.049)	0.115 (0.127)	0.014	1.39
26	K: PA L: -	0.049 (0.012)	-	0.257 (0.107)	-	-	0.030	1.72
27	K: PA L: -	0.065 (0.004)	-	0.173 (0.076)	-	-	0.015	1.88
28-31	K: ECM L: PA	0.121 (0.019)	-0.286 (0.068)	-0.176 (0.089)	-	0.268 (0.087)	0.014	1.20
32	K: PA L: PA	0.087 (0.013)	-	0.298 (0.098)	-	0.347 (0.198)	0.020	2.07
33-35	K: PA L: -	0.054 (0.011)	-	0.258 (0.082)	-	-	0.017	1.33
36	K: PA L: PA	0.091 (0.007)	-	0.298 (0.096)	-	0.235 (0.122)	0.021	1.85

Starting a discussion of these results with the chemical industry (SBI 28-31). The parameter α_1 is significant but with the wrong sign. An increase in the desired capital stock should not decrease investments so for the chemical industry the model has to be rejected. The performance of the model for the metal industries (SBI 33-35) also raises serious doubts since the DW-statistic is rather low. From the nine remaining sectors there is no interaction ($\beta_0=\beta_1=0$) in factor demand in the paper- (SBI 26) and the publishing industry (SBI 27). An explanation is the constancy of actual and desired labour input in the latter industry. Note that changes in the desired levels of the inputs can be observed by using the equations (26) and (27). Furthermore the paper industry posesses the highest capital-labour ratio of the nine remaining sectors, so a dominance of capital requirement can be suspected.

Quite the opposite is the case with the leather- (SBI 24) and wood industry (SBI 25). Here the ECM lag structure for the labour terms ($\beta_1 \neq 0$) is maintained. This fact is readily explained by a very sharp decrease in the desired labour input for both sectors. It is remarkable that in these sectors the PA coefficients β_0 become insignificant so the theoretical underpinning with costs of adjustment is lost. Finally, the five remaining sectors (SBI 20-21, 22, 23, 32, 36) show simple PA lags on both K and L.

Restricting the discussion to the nine sectors on which the model performed well two important conclusions emerge. Firstly, interrelated factor demand in an investment equation is highly relevant and secondly, elaborate lag structures can be avoided. Exceptions to these rules are easily detected and can be explained on a priori grounds e.g. a highly non-stationary target.

4. Conclusions.

The development of theories of investment behaviour has greatly benefitted from the concepts of dynamic optimization and of costs of adjustment. Along these lines a model is presented leading to an interrelated demand for production factors.

The empirical relevance of interrelated factor demand in an investment equation has been clearly demonstrated. From the nine industrial sectors on which the model performed well only two show no interrelationship in the investment equation. These two exceptions can be explained by a close inspection of the industries concerned. Tests of the lag structures on the nine remaining sectors reveal the partial adjustment model with fixed coefficients to be acceptable. Only in two cases the error correction mechanism is selected instead of the partial adjustment model. These two exceptions can be understood by looking at the highly non-stationary targets for the industries concerned.

From a theoretical point of view the empirical analysis is partial. Only the growth rate of the capital stock is explained and a suggestion for further research would be to estimate a simultaneous model of factor demand with the production function acting as a constraint.

Appendix

The definitions and sources of the data will be given in this section. In the actual estimation all levels have been transformed to indexnumbers.

pQ :	nominal gross value-added at market prices	(2)
L :	employment multiplied by the average working-hours per week	(1)
w :	nominal total labour costs divided by L	(2)
I :	nominal gross-investments in equipment	(1)
p_I :	price indexnumber for I	(3)
K :	capital stock at constant prices, constructed from a benchmark for 1952 with a scrapping rate of 0.06	
uc :	user costs of capital without capital gains but corrected for tax regimes	(3)

Sources:

(1) Brinkers and Goudswaard [1979]

(2) van Dijk [1985]

(3) Magnus [1978]

Classification according to the SBI:

SBI-code	Industry group
20-21	Food, beverages and tobacco products
22	Textiles
23	Clothing
24	Leather and leather products
25	Wood products
26	Paper and paper products
27	Printing and publishing
28-31	Chemical industry
32	Building materials
33-35	Basic metal-industries and metal products
36	Electrical engineering

References

Bischoff, C.W.,
'Hypothesis testing and the demand for capital goods',
The Review of Economics and Statistics, 1969.

Brinkers, H.W. and D.M. Goudswaard,
'Nominale investeringsreeksen en arbeidsbestandcijfers voor Nederlandse bedrijfsklassen in de nijverheid 1951-1977,
Institute for Economic Research, Discussion Paper 7906/G, 1979.

Broer, D.P.,
'Neoclassical Theory and Empirical Models of Aggregate Firm Behaviour',
Amsterdam, 1987.

Coen, R.M.,
'The effect of cash flow on the speed of adjustment',
in: G. Fromm (ed.),
Tax Incentives and Capital Spending,
Amsterdam 1971.

Davidson, J.E.H., D.F. Hendry, F. Srba and S. Yeo,
'Econometric modelling of the aggregate time-series relationship between consumers' expenditure and income in the United Kingdom',
The Economic Journal, 1978.

Dijk, J.J. van,
'Investment behaviour of sectors of industry in the Netherlands',
Institute for Economic Research, Discussion Paper 8309/G, 1983.

Dijk, J.J. van,
'Consistente tijdreeksen voor bedrijfsklassen van de Nederlandse industrie',
Institute for Economic Research, Discussion Paper 8515/G, 1985.

Eisner, R. and M.I. Nadiri,
'Investment behavior and neo-classical theory',
The Review of Economics and Statistics, 1968.

Eisner, R. and R.H. Strotz,
'Determinants of business investment',
in: Commission on Money and Credit,
Impacts of Monetary Policy,
Englewood Cliffs, 1963.

Gould, J.P.,
'Adjustment costs in the theory of investment of the firm',
The Review of Economic Studies, 1968.

Gould, J.P.
'The use of endogenous variables in dynamic models of investment',
Quarterly Journal of Economics, 1969.

Hendry, D.F. and T. von Ungern Sternberg,
'Liquidity and inflation effects on consumers' behaviour',
in: A.S. Deaton (ed.),
Essays in the Theory and Measurement of Consumers' Behaviour, Cambridge, 1979.

Jorgenson, D.W.,
'Capital theory and investment behavior',
The American Economic Review, 1963.

Magnus, J.,
'De constructie van prijs- en hoeveelheidsindices voor de produktie en de inputs van arbeid, energie en kapitaal in Nederlandse bedrijven',
Report AE 9/78, 1978.

Lucas, R.E.,
'Optimal investment policy and the flexible accelerator',
International Economic Review, 1967.

Ontvangen: 17-06-86
Geaccepteerd: 10-04-1987