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RELATIVE RATES OF RETURN IN NORWEGIAN MANUFACTURING INDUSTRY 1962-1981

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CONTENTS

ABSTRACT

This note updates the estimates of the relative rates of return among manufacturing production sectors in the MSG model, and reviews the tests of some common hypotheses about producer behavior.

1. INTRODUCTION

A basic (and persistent) feature of the MSG model is the assumption of a stable structure for the rates of return on capital in the production sectors of the model. It was introduced with the first MSG model by Johansen (1974). The hypothesis that the relative rate follows a partial adjustment mechanism was introduced by Strøm (1967) [1], and it has been used to estimate the relative rates of return [see Strøm (1967), Olsen (1982), and Longva and Olsen (1983)]. The current MSG model contains the assumption of fixed relative rates of return. [2]

Several explanations have been given to justify this persistent difference in the rates of return across sectors. Its partial inconsistency within a long run general equilibrium model has been recognized, and some attempts have been made to determine whether there is any tendency for these rate differentials to narrow over time.

The purpose of this note is primarily to reestimate the relative rates of return in order to update the coefficient estimates for the MSG model. The updated estimates are reported in Bye and Frenger (1985). We have at the same time reestimated some of the earlier tests and used some new estimation procedures.

In section 2 we briefly review the data used for the estimation and the definition of the rate of return. One of our models postulates a very long lag for the rate of return for industry as a whole, and this necessitates some special data construction for the years 1958-1961 for this variable. The sample period was 1963 to 1981. In section 3 we estimate the basic model which is presently used in MSG, and give the updated coefficient estimates. Alternative hypotheses for the structure of the rate of return, specifying a trend factor, are given in section 4. In this section we also compare results using both single equation methods from section 3 and Zellner's procedure. Section 5 then compares the more traditional version of the user cost of capital, using a rate of interest, with the residually determined procedure used in MSG.

We had also intended to consider the effect of capacity utilization on the rate of return, but this has not been done. In fact, our ambition at the start was to conduct a somewhat more detailed analysis of the structure and development of the rate of return in the various manufacturing sectors than what we have accomplished.

2. THE DATA

All the data used in this paper have been obtained from the national accounts database (AARNR).[1] The estimations have been performed on data for the period 1963-1981, the figures for 1981 beeing preliminary. All constant price series are normalized to 1975 prices. The estimation includes all mining and manufacturing industries in the MSG-4 model except sector 40 "Refinery of oil products" for which the time series are too short. To calculate the rate of return for capital in a sector, or for the mining and manufacturing industry as a whole, the following expressions are used (sector indices excluded)

$$qy = \sum_i p_i x_i + p_{L1} L_1 + p_{L2} L_2 + p_K K + T, \tag{2.1}$$

$$p_K K = p_J (r + \delta) K, \tag{2.2}$$

$$V = qy - \sum_i p_i x_i, \tag{2.3}$$

where

- y - gross output,
- q - output price,
- $\Sigma p_i x_i$ - value of material inputs,
- L_1 - workers, man-years,
- L_2 - owners, man-years,
- p_{L1} - wage costs per man-year, workers,
- p_{L2} - imputed "wage costs" per man-year, owners,
- K - real capital at the end of the year, constant prices,
- p_K - price index, real capital,
- p_J - price index, new investment,
- r - rate of return on real capital,
- δ - depreciation rate,
- V - gross product (value added) in value terms,
- T - indirect taxes minus subsidies.

When calculating r we assume that $p_{L2} = p_{L1} = p_L$, i.e. we assume the same wage rate per man-year for both workers and owners: These assumptions will lead to the following expression for the return to capital

$$R_E = V - P_L(L_1 + L_2) - p_J\delta K - T . \tag{2.4}$$

r is then calculated by [2]

$$r = \frac{V - p_L(L_1 + L_2) - p_J\delta K - T}{p_J K} . \tag{2.5}$$

In the national accounts databank operating surplus includes salaries to owners and is defined by

$$R_E^{*} = V - p_L L_1 - p_J \delta K - T , \tag{2.6}$$

which implies that

$$R_E = R_E^{*} - p_L L_2 . \tag{2.7}$$

In some of the estimated equations we use a five year moving average for the rate of return of capital for total mining and manufacturing industry.[3] The moving average is defined as

$$\bar{r}_t = \frac{1}{5}\sum_{\tau=0}^{4} r_{t-\tau} . \tag{2.8}$$

Calculation of $\bar{r}_t$ requires data for the period 1958-1961 for mining and total manufacturing industry. Figures for real capital are calculated on the basis of data from the national accounts for 1962 and data for gross investment and depreciation from the national accounts for 1959-1962.[4]

Table 2.1. Caculation of real capital in value terms for the years 1958-1961. Total mining[1] and manufacturing industry, refinery excluded

year	Gross Investm. J	Depreciation D	Real capital
1958			14962
1959	1167	677	15452
1960	1483	709	16226
1961	1809	776	17259
1962	2004	874	18389 [2]

1 We have ignored the fact that investment and depreciation figures include the refinery sector.

2 Figure from the national accounts database AARNR.

The capital stock figures for 1961-1958 are calculated using

$$K_{t-1} = K_t + D_t - J_t , \tag{2.9}$$

and are presented in table 2.1.

Table 2.2 shows the national account figures for total wage costs (1), workers man-years (2) in 1962, owners man-years (3) in 1962, total man-years (2+3) in the period 1958-1961, and operating surplus (5) computed according to (2.6), in mining and manufacturing industry exclusive of refineries. When calculating these figures we assume for lack of data that the refinery sector remained of the same size during the years 1958-1962. When calculating the wage costs for owners we assume that the owners wage costs represent a constant share of the total wage costs at the sector level. The share in the years 1958-1961 is assumed to be equal to the share in 1962. The corrected profit (2.7) is given by column (6), capital stock in column (7) and the rate of return on capital (2.5) is presented in column (8).

Table 2.3 shows the calculated rate of return on capital for the twelve industries in our study. In sector 17, manufacturing of beverages and tobacco, the rate of return is mostly negative. This is due to the subsidies on milk products, which in the accounts are allocated to the dairy sector. In total manufacturing industry both annual data and five year moving average are given. The five year moving average is defined according to (2.8), i.e. as the average of the "observation" year and the four previous years.

Figure 2.1 shows the development of the rate of return on capital in total manufacturing industry, both annual and five year moving average data.

Table 2.2. Calculation of rate of return of capital for earlier years than 1962 in the national accounts. (Mining and manufacturing industry, exclusive of refineries)

Source:	year	Wage cost workers 1 mill.kr	Workers 2 1000 man-year	Owners 3	Wage cost owners[1] 4
	1958	4106	337		238
National accounts	1959	4412	337		256
1949-1962	1960	4734	341		275
revised edition	1961	5207	348		302
	1962	5755	352		334
AARNA	1962	5755	331	20	334
MSG-sector 40	1962	29	1	-	-

[1] It is assumed that owners and workers wage rate are equal.

Table 2.2. (Cont.)

Source:	year	Operating surplus 5	Profit corect. 6	Capital stock 7	Rate of return 8
	1958	1156	918	14962	0.0614
National accounts	1959	1085	829	15452	0.0537
1949-1962	1960	1397	1122	16226	0.0692
revised edition	1961	1418	1116	17259	0.0647
	1962	1307	973	18389	0.0529
AARNA	1962	1307	973	18389	0.053
MSG-sektor 40	1962	-0.2	-	-	-

Table 2.3 Rate of return on capital. MSG - manufacturing sectors. Total manufacturing[1] industry: annual data and five year moving average.

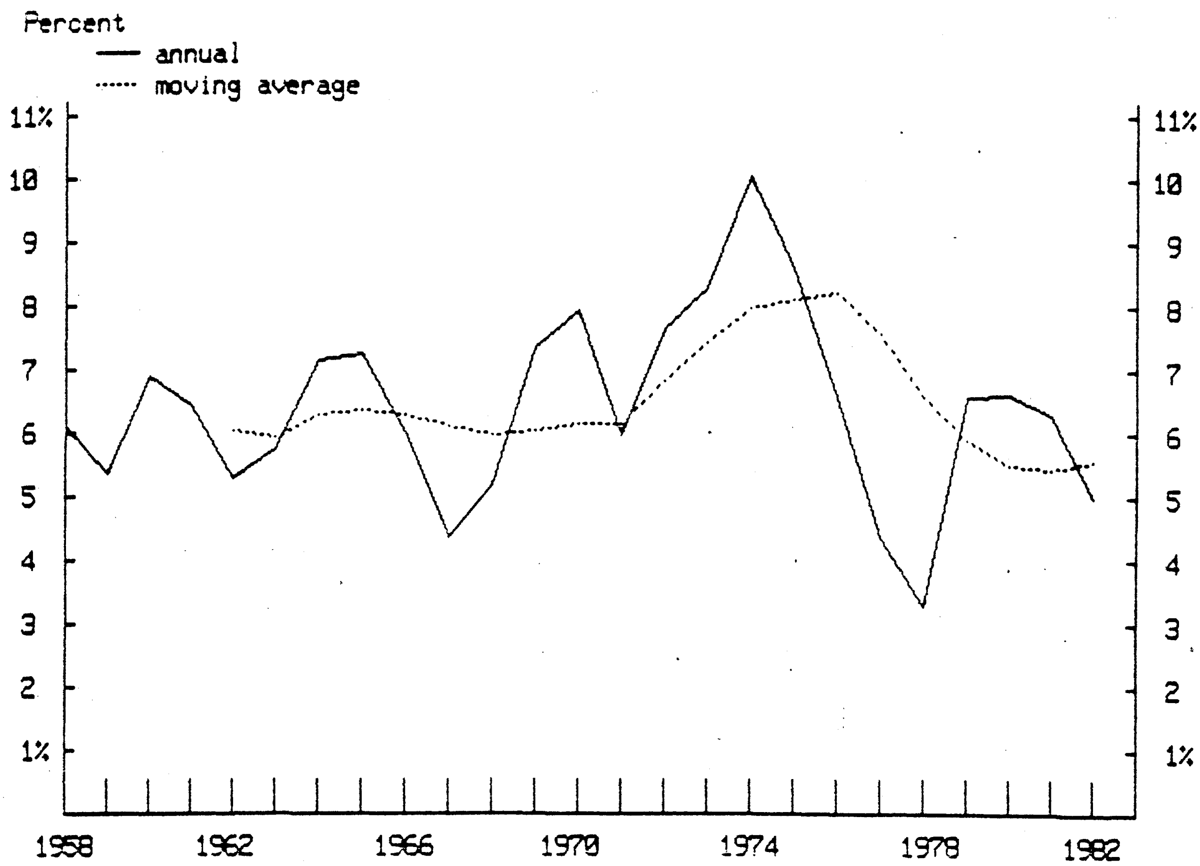
	MSG-Sector						
	16	17	18	26	27	28	31
1962	0.051	0.051	0.250	0.130	0.056	0.074	0.074
1963	0.068	0.059	0.180	0.146	0.056	0.164	0.067
1964	0.062	0.011	0.245	0.220	0.093	0.165	0.063
1965	0.079	-0.004	0.252	0.246	0.054	0.142	0.084
1966	0.091	-0.006	0.202	0.195	0.039	0.144	0.075
1967	0.076	-0.012	0.163	0.163	0.027	0.144	0.081
1968	0.087	0.003	0.165	0.183	0.040	0.166	0.078
1969	0.106	0.013	0.210	0.229	0.041	0.163	0.105
1970	0.068	0.035	0.188	0.243	0.055	0.111	0.053
1971	0.067	-0.030	0.171	0.178	0.068	0.122	0.037
1972	0.079	-0.054	0.133	0.210	0.107	0.139	0.040
1973	0.053	-0.024	0.115	0.192	0.068	0.056	0.040
1974	0.080	-0.072	0.077	0.174	0.078	0.060	0.036
1975	0.066	-0.000	0.052	0.170	0.080	0.106	0.016
1976	0.079	-0.022	0.058	0.155	0.076	0.059	0.002
1977	0.079	-0.036	0.056	0.103	0.050	0.094	0.007
1978	0.050	0.022	0.051	0.056	0.041	0.066	0.000
1979	0.050	-0.033	0.073	0.085	0.035	0.069	0.007
1980	0.071	-0.039	0.074	0.114	0.055	0.051	-0.004
1981	0.054	0.013	0.071	0.089	0.057	0.092	0.037
1982	0.049	0.039	0.044	0.067	0.047	0.121	0.025

Table 2.3. (cont.)

	MSG-Sector						
						Industry	
	34	37	43	45	50	annual	mov.av.
1962	0.000	0.006	0.068	0.035	0.029	0.053	0.060
1963	0.003	0.009	0.048	0.062	0.038	0.058	0.060
1964	0.029	0.009	0.070	0.059	0.067	0.071	0.063
1965	0.007	0.029	0.088	0.047	0.072	0.073	0.064
1966	-0.017	0.017	0.078	0.045	0.021	0.060	0.063
1967	-0.018	-0.015	0.051	0.013	0.048	0.044	0.061
1968	0.027	-0.006	0.061	0.004	0.003	0.052	0.060
1969	0.039	0.018	0.080	0.037	0.040	0.074	0.060
1970	0.047	0.010	0.119	0.103	0.046	0.079	0.062
1971	0.009	0.014	0.052	0.091	0.011	0.060	0.062
1972	0.030	0.014	0.053	0.101	0.110	0.076	0.068
1973	0.074	0.043	0.099	0.110	0.156	0.083	0.074
1974	0.170	0.062	0.174	0.120	0.061	0.100	0.080
1975	0.059	0.035	0.120	0.086	0.193	0.086	0.081
1976	0.021	0.010	0.057	0.063	0.201	0.066	0.082
1977	-0.002	-0.017	0.014	0.049	0.135	0.044	0.076
1978	0.007	-0.027	0.030	0.061	0.053	0.033	0.066
1979	0.041	0.050	0.137	0.076	0.098	0.066	0.059
1980	0.002	0.028	0.140	0.076	0.105	0.066	0.055
1981	0.016	0.005	0.027	0.097	0.131	0.063	0.054
1982	0.002	-0.004	-0.011	0.080	0.143	0.050	0.056

1 The sector names are listed in table 3.1

Figure 2.1
Rate of return on capital. Total manufacturing industry:
annual data and five year moving average.



3. ESTIMATES OF RELATIVE RATES OF RETURN

Basic to the calculation of the return on capital in sector k for year t r_{kt} is the assumption that there exists a stable relationship between the expected rate of return on capital in sector k and the rate of return on capital for industry as a whole (i.e. mining and manufacturing) in the long run for each of the 12 sectors. This may be written

$$\frac{r^e_{kt}}{r^e_t} = \varrho_k , \qquad k = 1,\dots,n, \qquad (3.1)$$

where r_t is the rate of return for industry and the superscript e indicates expected value. This assumption was introduced by Johansen (1974, p. 47), and has been relaxed by Strøm (1967) who formulated the following partial adjustment model for the rate of return in sector k [1] (see also Longva and Olsen (1983))

$$\frac{r_{kt}}{r_t} - \frac{r_{k,t-1}}{r_{t-1}} = \gamma_k \left[\varrho_k - \frac{r_{k,t-1}}{r_{t-1}}\right] . \qquad (3.2)$$

It follows that $r_{kt}/r_k = \varrho_k$ at a stationary point, and thus that (3.2) tends towards (3.1). The model may be written as an autoregressive model of order one

$$(1 - \alpha_k L)\, z_{kt} = \gamma_k \varrho_k + \varepsilon_{kt} ,$$

where $\alpha_k = 1 - \gamma_k$, L is the lag operator, and ε_{kt} is a serially uncorrelated random variable. One gets an alternative stochastic interpretation of (3.2) by noting that (3.2) may be obtained from (3.1) by writing

$$z_{kt} = \frac{r_{kt}}{r_t} = \varrho_k + u_{kt} , \qquad (3.3)$$

and then postulate that the error terms are autocorrelated

$$u_{kt} = \sum_{\tau=0}^{\infty} \alpha_k^{\tau} \varepsilon_{k,t-\tau} = \alpha_k u_{k,t-1} + \varepsilon_{kt} .$$

Transforming (3.3) gives

$$z_{kt} - z_{k,t-1} = (1 - \alpha_k)(\varrho_k - z_{k,t-1}) + \varepsilon_{kt}, \qquad (3.4)$$

which is of course equivalent to (3.2) with $\gamma_k = 1 - \alpha_k$. Strøm (1967, pp. 128-30) discusses autocorrelated residuals, but does not mention the simple relationship between (3.2) and (3.3).

It is also stated in Longva and Olsen (1983), p.64 that (3.2) "reflects the hypothesis that there is a convergent development in the actual relative rates of return", an hypothesis for which they find empirical confirmation in the estimated value of the γ's. But there is nothing in (3.2) that suggest that the rates of return in the various sectors tend to converge towards a common value over time. This is an interesting, and elusive, proposition to which we will return below.

The model (3.2) has been used to estimate ϱ for the MSG model with r_t replaced by a moving average $\bar{r}$ [see (2.8)]

$$\bar{r}_t = \frac{1}{5} \sum_{t=0}^{4} r_{t-\tau},$$

and the results are reported in Olsen (1982) and Longva and Olsen (1983). This relationship between the annual data and the moving average seems somewhat artificial: it would probably be more reasonable to postulate a relationship between annual data and moving averages for both r and r_k. If producers have a concept of an expected or average rate for industry as a whole, then they probably also apply the same reasoning to their own rate of return. We have not, however, done any estimation using moving averages for sectoral rates of return.

It is shown below that it does not matter significantly whether current or moving average data are used for the estimation of ϱ. It will, however, matter for the computed (implied) cost of capital.

Tables 3.1-3.4 below presents estimates of the static model (3.1) and of the partial adjustment model (3.2) using both the current and the average rate of return for industry as a whole.

Looking first at the static model we see that the low values for the D.W., indicating autocorrelated residuals, tend to reject this formulation. There is very little difference between the estimates using the current and those using the average rate of return.

Tables 3.3 and 3.4 present the results for the partial adjustment model using current and average rate of return for industry as a whole. The model seems to fit better, judging by the D.W., and the parameters are relatively close to those of tables 3.1 and 3.2. The standard errors of the estimates increase substantially, as is to be expected since the standard errors in tables 3.1 and 3.2 are underestimated when rediduals are autocorrelated.[2]

Table 3.1 Estimation of the static model.[1] 1963 - 1981
(Industry to total industry)

Industry	Rho	R^2	DW	SSR
31 Mining and quarrying	0.6773 (0.1313)	0.0000	0.3070	5.8928
16 Manuf. of food	1.1856 (0.0828)	0.0000	1.0662	2.3425
17 Manuf. of beverages and tobacco	-0.1093 (0.1138)	0.0000	1.7020	4.4324
18 Manuf.of textiles, wearing apparels etc	2.1002 (0.2502)	0.0000	0.1593	21.4065
26 Manuf. of wood and wood products	2.5352 (0.1719)	0.0000	0.2497	10.1079
34 Manuf. of paper and paper products	0.3550 (0.1062)	0.0000	1.1206	3.8574
37 Manuf. of industrial chemicals	0.1631 (0.0855)	0.0000	1.6287	2.5014
27 Manuf. of nonindustrial chemicals	0.9050 (0.0599)	0.0000	1.4932	1.2255
43 Manuf. of metals	1.1558 (0.1070)	0.0000	1.5436	3.9161
45 Manuf. of metal prod. mascinery and eq.	1.0412 (0.1038)	0.0000	0.7201	3.6844
50 Constr. of ships and oil platforms	1.2923 (0.2057)	0.0000	0.8200	14.4695
28 Printing and publishing	1.7522 (0.1996)	0.0000	0.5889	13.6226

Table 3.2 Estimation of the static model.[1] 1963 - 1981
(Industry to moving average of total industry)

Industry	Rho	R^2	DW	SSR
31 Mining and quarrying	0.6868 (0.1253)	0.0000	0.3602	5.3726
16 Manuf. of food	1.1434 (0.0667)	0.0000	1.0203	1.5221
17 Manuf. of beverages and tobacco	-0.1158 (0.1119)	0.0000	1.4313	4.2798
18 Manuf.of textiles, wearing apparels etc	2.1031 (0.2647)	0.0000	0.1631	23.9698
26 Manuf. of wood and wood products	2.5429 (0.2055)	0.0000	0.3970	14.4425
34 Manuf. of paper and paper products	0.4077 (0.1254)	0.0000	1.1696	5.3765
37 Manuf. of industrial chemicals	0.2296 (0.0755)	0.0000	1.5045	1.9483
27 Manuf. of nonindustrial chemicals	0.8931 (0.0658)	0.0000	1.2112	1.4788
43 Manuf. of metals	1.2150 (0.1479)	0.0000	1.5516	7.4779
45 Manuf. of metal prod. mascinery and eq.	1.0528 (0.1155)	0.0000	0.5844	4.5654
50 Constr. of ships and oil platforms	1.2385 (0.1803)	0.0000	1.0354	11.1230
28 Printing and publishing	1.6801 (0.1801)	0.0000	0.3679	11.0877

1) R^2 is the multiple correlation coefficient, D.W is the Durbin-Watson statistic, and SSR is the sum of squared residuals of the regression. The numbers in paranthesis is the standard errors of the coefficients.

Table 3.3 Estimation of the partial adjustment model. 1963 - 1981
(Industry to total industry)

Industry	Gam	Rho	R^2	DW	SSR
31 Mining and quarrying	0.1804 (0.1224)	0.4878 (0.4229)	0.7250	1.8398	1.6207
16 Man. of food	0.5423 (0.2174)	1.2076 (0.1412)	0.2067	1.5466	1.8582
17 Man. of beverages and tobacco	0.7857 (0.2133)	-0.1192 (0.1454)	0.0560	2.1865	4.1840
18 Man.of textiles, wearing apparels	0.1967 (0.0969)	1.3198 (0.7540)	0.8017	1.8643	4.2447
26 Man. of wood and wood products	0.0619 (0.1282)	1.6734 (2.3645)	0.7591	1.6074	2.4346
34 Man. of paper and paper products	0.5584 (0.2137)	0.3668 (0.1753)	0.2008	1.7695	3.0828
37 Man. of industrial chemicals	0.8144 (0.2382)	0.1638 (0.1062)	0.0345	1.8671	2.4150
27 Man. of nonindustrial chemicals	0.7444 (0.2321)	0.9024 (0.0800)	0.0666	1.8932	1.1439
43 Man. of metals	0.8253 (0.2509)	1.1477 (0.1323)	0.0277	1.5648	3.8076
45 Man. of metal prod. mascinery and eq.	0.3592 (0.2045)	1.1417 (0.2530)	0.3662	1.5601	2.3350
50 Building of ships and oil platforms	0.4032 (0.1984)	1.4197 (0.4369)	0.3474	2.0453	9.4430
28 Printing and publishing	0.3527 (0.2036)	1.6646 (0.4676)	0.3729	1.4707	8.5424

Table 3.4 Estimation of the partial adjustment model. 1963 - 1981
(Industry to moving average total industry)

Industry	Gam	Rho	R^2	DW	SSR
31 Mining and quarrying	0.1947 (0.1338)	0.5720 (0.3868)	0.6807	1.9942	1.7154
16 Man. of food	0.5348 (0.2379)	1.1820 (0.1217)	0.1337	1.7618	1.2425
17 Man. of beverages and tobacco	0.6856 (0.2111)	-0.1284 (0.1584)	0.1154	2.0680	3.7858
18 Man.of textiles, wearing apparels	0.1437 (0.0953)	1.2007 (1.0557)	0.8259	1.7279	4.1724
26 Man. of wood and wood products	0.1842 (0.1515)	2.4124 (0.7101)	0.6304	1.4965	5.3381
34 Man. of paper and paper products	0.5822 (0.2167)	0.4201 (0.2010)	0.1795	1.7956	4.4115
37 Man. of industrial chemicals	0.7507 (0.2338)	0.2313 (0.1002)	0.0627	1.7895	1.8262
27 Man. of nonindustrial chemicals	0.6073 (0.2255)	0.8975 (0.1027)	0.1514	1.8698	1.2549
43 Man. of metals	0.7949 (0.2429)	1.2085 (0.1878)	0.0402	1.6222	7.1770
45 Man. of metal prod. mascinery and eq.	0.2616 (0.1979)	1.2644 (0.4007)	0.4503	1.2015	2.5095
50 Building of ships and oil platforms	0.5101 (0.2287)	1.3418 (0.3364)	0.2125	2.0459	8.7593
28 Printing and publishing	0.2648 (0.1820)	1.5843 (0.5078)	0.4897	1.6107	5.6578

All our estimation procedures gave a negative relative rate of return for sector 17 "Manufacturing of beverages and tobacco" (in the ensuing estimation of the Generalized Leontief factor demand equations we utilized ϱ_{37} for ϱ_{17} because ϱ_{37}, i.e "Manufacturing of industrial chemicals", was the positive ϱ closest to zero).

Comparing the results given in table 3.4 with the corresponding estimates given in table 1 in Olsen (1982, p.13) and in Longva and Olsen (1983) p.83, which have been estimated on the period 1962-1978, we see that, while most estimates are relatively close, there are some significant differences in sectors 18 "Manufacturing of textiles, wearing apparels etc" and 26 "Manufacturing of wood and wood products". As in Longva and Olsen (1983) p.64, the standard deviation of the parameter estimates in these sectors are very high. Reestimating these sectors on a shorter sample (i.e 1962-1978), however, did not significantly alter our results. That is, we could not identify why the differencies occured.

4. ALTERNATIVE EXPLANATIONS

It has often been asked whether the ratios ϱ_k are constant or whether there is a tendency over time for ϱ_k to approach 1, i.e. for the rate of return of the sectors to approach the industry average.

As a preliminary[1] test of this hypothesis we have included a trend in the partial adjustment model (3.2)

$$z_{kt} - z_{k,t-1} = \gamma_k [\varrho_k + \tau_k(t-1) - z_{k,t-1}] + \varepsilon_{kt}, \qquad (4.1)$$

where t is a trend, and the error terms are assumed to be serially uncorrelated. The model (4.1) postulates that the "desired" relative rate of return at time t is given by $\varrho_k + \tau_k(t-1)$. We can rewrite the model in a linear in parameter form.

$$z_{kt} = a_{k0} + a_{k1} z_{k,t-1} + a_{k2} t \,, \qquad (4.2)$$

where

$$a_{k0} = \gamma_k (\varrho_k - \tau_k) \,,$$

$$a_{k1} = (1 - \gamma_k) \,,$$

$$a_{k2} = \gamma_k \tau_k \,.$$

The assumption of autoregressive residuals $u_t = \alpha u_{t-1} + \varepsilon_t$ in (4.2) gives the model

$$z_{kt} - z_{k,t-1} = (1 - \alpha_k) [\varrho_k + \tau_k(t-1) - z_{k,t-1}] + \tau_k, \quad (4.3)$$

which differs from (4.1) by the presence of the additive constant τ_k. Estimation of (4.1) and (4.3) would give the same estimate for $\gamma_k = 1 - \alpha_k$, but the estimates for ϱ_k and τ_k would differ.

We will use the partial adjustment model (4.1), and the estimation results are given in table 4.1.

Table 4.1 Estimation of the partial adjustment model with trend factor. 1963-1981 (Industry to total industry)

Industry	Gam	Rho	Thau	R^2	DW	SSR
31 Mining and quarrying	0.3929 (0.2423)	-0.0490 (0.3853)	-0.0662 (0.0363)	0.7416	1.6569	1.5224
16 Man. of food	0.5450 (0.2248)	1.1717 (0.2997)	-0.0036 (0.0262)	0.2076	1.5461	1.8561
17 Man. of beverages and tobacco	0.9549 (0.2565)	-0.4150 (0.2521)	-0.0304 (0.0226)	0.1295	2.0228	3.8585
18 Man.of textiles, wearing apparel	0.5065 (0.2105)	0.4436 (0.4511)	-0.1470 (0.0440)	0.8302	1.4651	3.6354
26 Man. of wood and wood products	0.4000 (0.1537)	1.0137 (0.4539)	-0.1436 (0.0386)	0.8466	1.8709	1.5501
34 Man. of paper and paper products	0.5860 (0.2295)	0.4984 (0.3576)	0.0133 (0.0315)	0.2090	1.7478	3.0513
37 Man. of industrial chemicals	0.8150 (0.2456)	0.1782 (0.2276)	0.0014 (0.0200)	0.0348	1.8669	2.4143
27 Man. of nonindustrial chemicals	0.7488 (0.2384)	0.9600 (0.1699)	0.0058 (0.0149)	0.0752	1.9043	1.1333
43 Man. of metals	0.8528 (0.2658)	1.2509 (0.2753)	0.0102 (0.0240)	0.0380	1.5831	3.7674
45 Man. of metal prod. mascinery and eq.	0.5761 (0.2313)	1.6055 (0.3025)	0.0523 (0.0259)	0.4646	1.5560	1.9725
50 Building of ships and oil platforms	0.6932 (0.2370)	2.3748 (0.4800)	0.1044 (0.0418)	0.4718	1.9090	7.6421
28 Printing and publishing	0.6815 (0.2107)	0.4949 (0.4472)	-0.1235 (0.0391)	0.5731	1.5431	5.8158

These may be compared with table 3.3 which gives the results without a trend. Since t(1981)= 0, the ϱ_k parameter gives the equilibrium value of ϱ_k in that year. We see that it differs frequently from the average value given in table 3.3.

There is no evidence that the difference in the rate of return tends to narrow over the period. A positive (negative) τ_k indicates that the rate of return in the sector tends to increase (decrease) over the period, when compared with the industry average.

Comparing the average ϱ_k as given in table 3.3 with the trend given in table 4.1 allows us to set up the following matrix which specifies the relationship between the magnitudes og ϱ and τ. The matrix should only have elements on the diagonal if a high relative rate of return was associated with a negative trend and vice versa.

Table 4.2 Number of sectors for which the rate of return diverge or converge to the average of the rate of return for total industry

	$\tau_k < 0$	$\tau_k > 0$
$\varrho_k < 1$	2	3
$\varrho_k > 1$	4(3)	3(2)

The number in parenthesis gives instances in which τ_k was significantly different from zero. In several cases ϱ_k passed from beeing greater (smaller) than 1 to less (greater) than 1 over the period. The table does not indicate any tendency for the rate of return to converge towards the industry average.

It is reasonable to assume that the residuals from the equations for the industrial sectors are correlated: business cycles, demand conditions, and other omitted variables probably tend to affect the profitability of the various sectors in similar ways. We have therefore reestimated the model (3.2) using Zellner's (1962) "seemingly unrelated regression" approach.

These new regressions are estimated on the sample period 1963-1982, with preliminary national accounts data for 1982 (i.e. in this estimations we have included observation for 1982, which is not included in the estimates of tables 3.1-3.4 and 4.1. However, the comparison of the results should not be very much disturbed by this fact).

The Zellner estimates do not affect the estimated coefficients to any great extent, but they reveal a substantial gain in efficiency. The standard errors for the γ_k parameters are reduced on the average by 49 percent, while those for the ϱ_k parameters are reduced by 19 percent.

Table 4.5 presents the correlation matrix for the residuals of the Zellner estimation.

Table 4.3. Single equation estimation of the partial adjustment model. 1963-1982
(Industry to total industry)

Industry	Gam	Rho	R^2	DW	SSR
31 Mining and quarrying	0.1790 (0.1220)	0.4825 (0.4259)	0.7271	1.8458	1.6086
16 Man. of food	0.5195 (0.2157)	1.1493 (0.1449)	0.2259	1.6403	1.8291
17 Man. of beverages and tobacco	0.7785 (0.2115)	-0.1256 (0.1457)	0.0606	2.2081	4.1198
18 Man.of textiles, wearing apparel	0.1982 (0.0968)	1.3358 (0.7428)	0.8015	1.8590	4.2414
26 Man. of wood and wood products	0.0656 (0.1278)	1.7515 (2.1052)	0.7586	1.6001	2.4205
34 Man. of paper and paper products	0.5561 (0.2136)	0.3642 (0.1758)	0.2026	1.7652	3.0795
37 Man. of industrial chemicals	0.8241 (0.2389)	0.1580 (0.1052)	0.0309	1.8619	2.4297
27 Man. of nonindustrial chemicals	0.7447 (0.2322)	0.9018 (0.0800)	0.0664	1.8966	1.1434
43 Man. of metals	0.8625 (0.2584)	1.1409 (0.1306)	0.0164	1.5908	4.0355
45 Man. of metal prod. mascinery and eq.	0.3691 (0.1957)	1.1091 (0.2301)	0.3795	1.5974	2.1386
50 Building of ships and oil platforms	0.4053 (0.1971)	1.4063 (0.4302)	0.3488	2.0566	9.3193
28 Printing and publishing	0.4345 (0.1995)	1.8063 (0.3669)	0.3209	1.4905	8.2084

Table 4.4 Zellner estimation of the partial adjustment model. 1963-1982
(Industry to total industry)

Industry	Gam	Rho	R^2	DW	SSR
31 Mining and quarrying	0.2790 (0.0718)	0.5672 (0.2425)	0.7164	1.6288	1.6721
16 Man. of food	0.6611 (0.1098)	1.1515 (0.1077)	0.2063	1.4437	1.8755
17 Man. of beverages and tobacco	0.7640 (0.1160)	-0.1266 (0.1400)	0.0604	2.2396	4.1209
18 Man.of textiles, wearing apparel	0.2397 (0.0590)	1.5012 (0.4922)	0.7994	1.7410	4.2874
26 Man. of wood and wood products	0.0799 (0.0689)	1.3025 (1.1848)	0.7584	1.5771	2.4223
34 Man. of paper and paper products	0.5413 (0.0910)	0.3649 (0.1707)	0.2024	1.7864	3.0804
37 Man. of industrial chemicals	0.8546 (0.1149)	0.1580 (0.0960)	0.0300	1.8245	2.4320
27 Man. of nonindustrial chemicals	0.7837 (0.1258)	0.9024 (0.0718)	0.0649	1.8347	1.1453
43 Man. of metals	0.8515 (0.1129)	1.1402 (0.1244)	0.0163	1.5905	4.0359
45 Man. of metal prod. mascinery and eq.	0.4642 (0.0993)	1.0837 (0.1672)	0.3708	1.4510	2.1683
50 Building of ships and oil platforms	0.3736 (0.0960)	1.4233 (0.4337)	0.3478	2.1204	9.3336
28 Printing and publishing	0.5575 (0.0987)	1.8049 (0.2705)	0.3057	1.2941	8.3920

Table 4.5 The correlation matrix for the residuals of the Zellner estimation

Indu.	31	16	17	18	26	34	37	27	43	45	50	28
31	1.000	0.360	-0.030	0.415	0.169	-0.272	-0.131	-0.363	-0.305	-0.424	0.021	0.527
16	0.360	1.000	-0.060	0.422	0.278	-0.516	-0.619	0.129	-0.382	-0.206	-0.140	0.700
17	-0.030	-0.060	1.000	-0.081	-0.122	-0.031	-0.387	0.000	-0.196	0.408	-0.166	0.242
18	0.415	0.422	-0.081	1.000	0.475	-0.491	-0.403	0.050	-0.189	-0.185	-0.124	0.328
26	0.169	0.278	-0.122	0.475	1.000	-0.606	-0.097	0.167	-0.070	-0.462	0.357	0.326
34	-0.272	-0.516	-0.031	-0.491	-0.606	1.000	0.329	-0.131	0.263	0.006	-0.353	-0.455
37	-0.131	-0.619	-0.387	-0.403	-0.097	0.329	1.000	-0.471	0.569	-0.277	0.031	-0.570
27	-0.363	0.129	0.000	0.050	0.167	-0.131	-0.471	1.000	-0.552	0.360	0.207	0.166
43	-0.305	-0.382	-0.196	-0.189	-0.070	0.263	0.569	-0.552	1.000	-0.279	-0.309	-0.524
45	-0.424	-0.206	0.408	-0.185	-0.462	0.006	-0.277	0.360	-0.279	1.000	-0.080	-0.185
50	0.021	-0.140	-0.166	-0.124	0.357	-0.353	0.031	0.207	-0.309	-0.080	1.000	-0.147
28	0.527	0.700	0.242	0.328	0.326	-0.455	-0.570	0.166	-0.524	-0.185	-0.147	1.000

5. ALTERNATIVE MEASURES OF THE USER COST OF CAPITAL

The analysis above has used a residually determined (or what may be termed as an ex post) rate of return on capital. This is the rate which is used in the determination of the cost of capital services in the MSG model. A frequently used measure of the cost of capital is the user cost concept in which an appropriate rate of interest measures the opportunity cost of using capital as compared with investment in financial assets. To the extent that the financial markets reflect expectations about future developments of capital return then a user cost concept can be regarded as an ex ante price. The rate of interest is less influenced by a variety of other factors which contribute to the determination of the measured return on capital. Among such factors can be mentioned unanticipated cyclical fluctuations, different degrees of uncertainty among sectors, pure profits due to returns to scale, and, since the data are generally computed residually from the national accounts, all the errors which influence the measurement of this concept in the national accounts. The extensive use of internal financing may, however, make a market determined interest an inappropriate measure of the opportunity cost. Further these rates of return could be adjusted for the capital gain or loss component and thereby result in one nominal and one real rate of return on capital. Corrections could also be made for the level and changes in the tax structure, but this will not be discussed here. Which of these concepts one uses may have significant effects on the estimates, and the purpose of this section is briefly to compare the data for some of the alternatives.

Berndt (1976) used alternative proxies for the rate of return in the construction of the service price of capital, and found significant differences in the estimated elasticities of substitution between capital and labor in a two factor CES-function. Hazilla and Kopp (1984) tried to determine whether the different service prices systematically lead to complementarity or substitutability between capital and energy. They concluded that "statistically significant systematic effects are found between monotonicity and concavity properties of the cost functions and service price specification as well as between measures of substitution".

Frenger (1983) uses an ex ante nominal rate of return [1] when estimating the "long run" GL-functions, while we in our paper Bye and Frenger (1985) use the ex post real rate of return described above in the estimation procedure.

In equation (2.2) we defined the user cost of capital as,

$$p_K = p_J (r + \delta) , \quad (5.1)$$

the ex post rate of return being measured in real terms since it was derived from national accounts which do not include capital gains as part of income. If we choose to use the interest rate we have the general form (differs slightly from the Fraumeni and Jorgenson version since we exclude the levels and the changes in the tax structure),

$$p_K = p_J \left[r^* + \delta - \frac{\dot{p}_J}{p_J} \right] , \quad (5.2)$$

where r^* is the nominal interest rate,

$$\dot{p}_J = \frac{p_{J,t+1} - p_{J,t}}{p_{J,t}} , \quad (5.3)$$

represent the rate of change of investment goods prices, and

$$r = r^* - \frac{\dot{p}_J}{p_J} \quad (5.4)$$

represent the real interest rate.

Thus to compare the rate of return derived above with the rate of return using the interest rate we have to adjust for the change in the rate of inflation (or rather the rate at which the price of investment goods changes).

In figure 5.1 we compare the ex post rate of return with the interest rate from Frenger (1983). In figure 5.2 the real interest rate r, and the nominal interest rate subtracted the rate of change of prices of new investments $r^* - \dot{p}_J$, is presented.

These figures clearly show that the rates of return ex ante and ex post differ. The development of the nominal ex ante rate differs from the real ex post rate, but significantly only in the six last years. The ex post rate shows, as expected, much greater variability even if we take into account that the ex post rate is a moving average. When comparing ex post and ex ante rates both measured in real terms, however, they differ markedly over the whole period. The ex post rate increases when the ex ante rate decreases, and vice versa.

There is reason to believe that this result imply that different ways of calculating the rate of return on capital would result in significant differences in the estimated elasticities of substitution. In a multiple factor cost function, on the background of figure 5.2, we would suspect that capital substitutability or complementarity against the other factors might depend on which rate of return were used. That is due to the opposite development of the two rates of return, and the fact that the rate of return have strong impact on the development of the capital service price. The service prices based on the ex ante real rate and the ex post real rate is shown in figure 5.3. As we expect from the discussion of the rate of return, the calculated prices of services also differ a lot. The service price based on the ex ante real rate of return is even negative at one point.

Figure 5.1
Rate of return on capital according to (2.5).
Nominal interest rate according to (5.2).

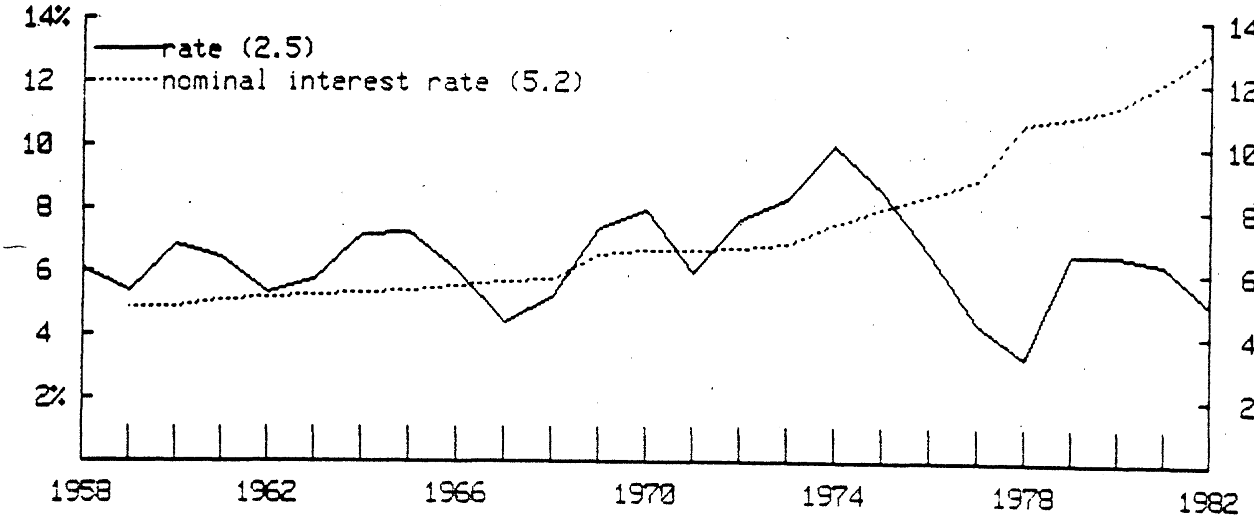


Figure 5.2
Rate of return on capital according to (2.5).
"Real" interest rate according to (5.4).

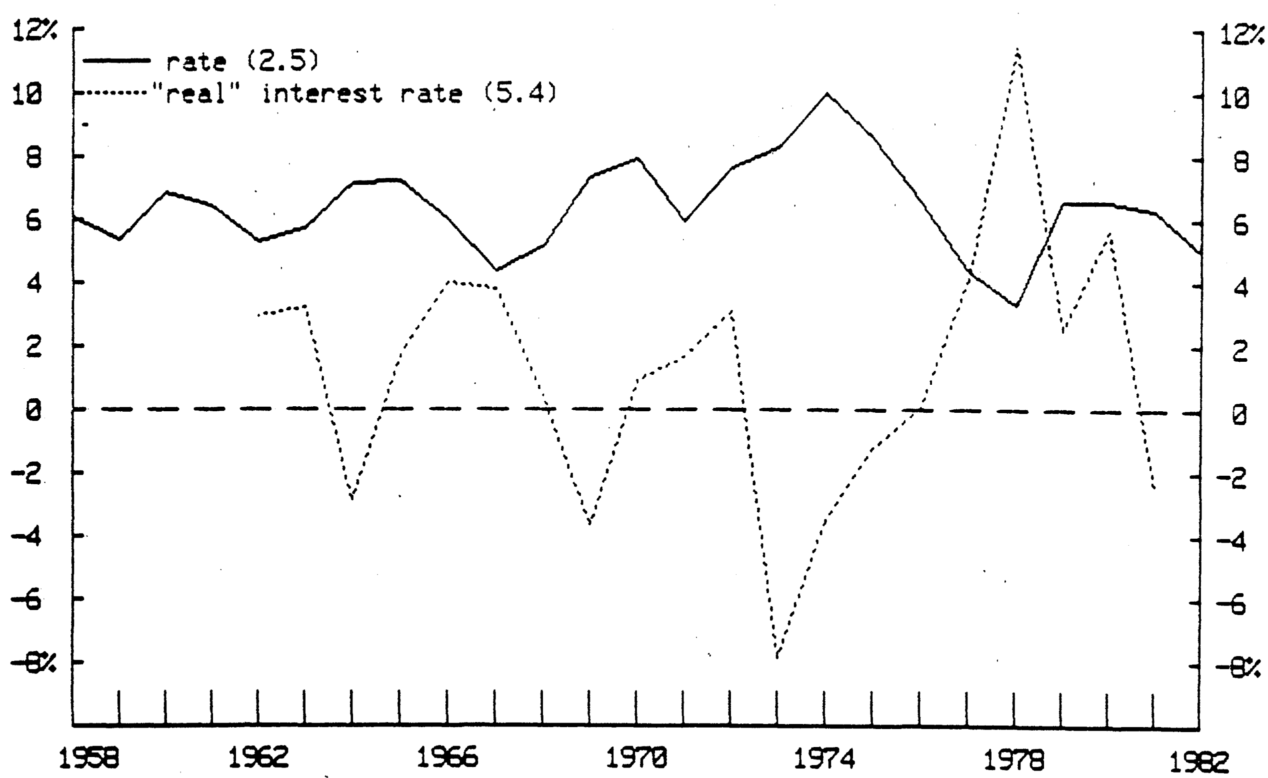
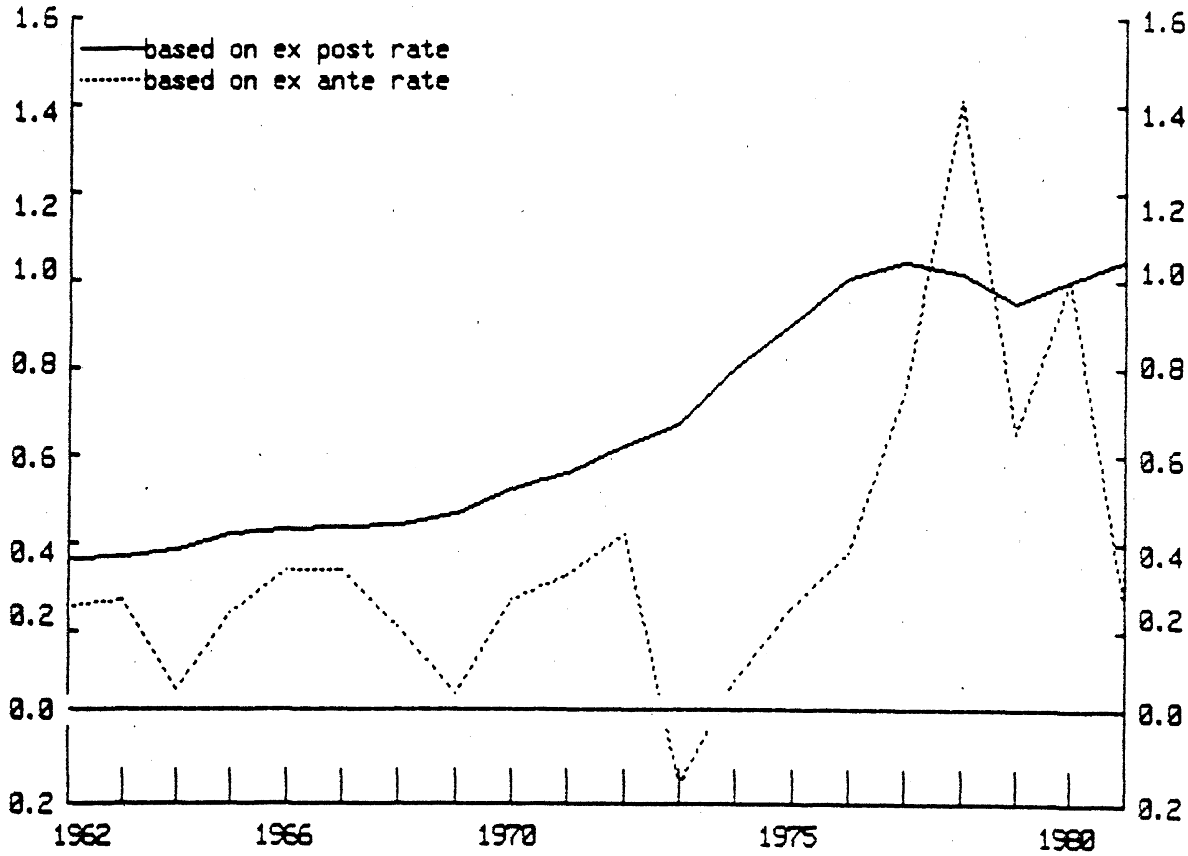


Figure 5.3
Capital service prices. Based on ex ante or ex post rate of return.
Both prices are normalized to unity in base year i.e volumes are different.



FOOTNOTES:

SECTION 1

1) See also Johansen (1974), pp. 259-67.

2) See Longva, Lorentsen and Olsen (1981), and Longva and Olsen (1983).

SECTION 2

1) Wenche Orzwi and Morten Reymert (1984)

2) This method was also used in Johansen (1974), see page 71-80.

3) Olsen, Ø. (1981).

4) Nasjonalregnskap 1949-1962. Revised edition.
NOS B239 - ISBN 82-537-1625-7.

SECTION 3

1) See Strøm (1967), particularly pp. 107-8 and p. 111. Equation (3.2) represents his model II, since we do not assume that $\varrho_k = 1$.

2) The increase is probably even larger than expected, but this may be due to the joint estimation of the parameters and the autocorrelation coefficient.

SECTION 4

1) Preliminary in the sense that the formulation does not allow for any convergence (the trend being linear). Alternative ways for introducing the trend, such as $\varrho\,(1 + \tau t)$ and $\varrho e^{\tau t}$, could have been used instead.

SECTION 5

1) Interest rates on new loans in Norwegian commercial banks, annual rate. Norwegian Central Bank, Quarterly Journal "Penger og Kreditt". Table 29, second to last column, average of highest and lowest rate. RAPP 80/3, section 3.3, Central Bureau of Statistics, Oslo, Norway.

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