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FORMATION OF FIRMS' PRODUCTION PLANS IN FINNISH MANUFACTURING INDUSTRIES†

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Abstract. Business survey data have recently been used in several studies to shed light on the formation of firms' plans and expectations. The main tool for analysis has been the multivariate conditional loglinear model. In this work, the emphasis is on the production plan formation of Finnish firms. The trichotomous answers in a typical business survey have an ordering. Based on this ordering, ordered variables for production surprises and revisions of production plans can be constructed. These surprises and revisions are investigated by specifying so-called continuation ratio models which make use of the ordering, to pinpoint factors affecting the production plans of the firms. The parameters of the models may be estimated by GLIM. For the application of these models, the manufacturing industries are divided into three groups and the results indicate that there are differences in plan formation between different industries. Demand expectations which are not observed directly in the Finnish business survey seem to be the single most important factor overall. However, its most useful proxy varies by industry and sometimes also by the phase of the business cycle. Contrary to some theoretical considerations, no relation is found between inventories of finished products and production plans except in forest industries during recession. The Finnish data also support the notion of inertia in the production changes as the production plans seem to have extrapolative features.

Key words. Business survey data, continuation ratio model, gamma coefficient, ordinal categorical data, unanticipated demand

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1. INTRODUCTION

Business survey data have recently been used in several studies to shed light on the formation of firms' plans and expectations. They have also been applied to testing hypotheses concerning the behaviour of the firms. The main reason for this is that the survey questionnaires contain questions about plans and expectations which thus can be observed directly. The answers to a typical business survey question are trichotomous; the usual alternatives are "increases"/ "stays the same"/"decreases". A common feature to all the previous studies is that the main tool of the analysis has been the multivariate conditional loglinear model. A drawback of this model is that it does not take any ordering in the variables into account. On the other hand, the values of the business survey variables are ordered: "increases"> "stays the same">"decreases". However, the previous studies have not completely ignored this ordering. Kawasaki et al. (1982,1983) and König et al. (1979,1981) have in fact analyzed and summarized the results of the estimated loglinear models using so-called component gamma coefficients which assume an ordering in the values of variables.

In this paper, we suggest instead that business survey data be analyzed using so-called continuation ratio models (Agresti, 1984, pp. 114-117). They have the property that the ordering of alternative answers can be taken into account without making any assumptions about "distances" between different answers. This is an advantage, because information contained in the data can now be utilized in a more straightforward fashion than in previous studies. The focus is on the analysis of the formation of the production plans of the Finnish firms by industry.

The Finnish business survey has contained questions about prices for such a short time that the number of observations is as yet too small for considering the pricing behaviour of the firms by our techniques.

The formation of production plans is in this paper investigated by studying surprises in production of the firms and relating them to unanticipated demand, inventory behaviour, order backlogs and previous production. Revision of production plans from one quarter to the next has formed another starting-point. These revisions are related to revisions of other expectations and inventory behaviour as suggested by a model of König and Nerlove (1985). The results of both approaches indicate that demand expectations are a crucial factor in the production plan formation of the firms. This is in accord with the findings of König et al. (1979). Demand expectations are not explicitly inquired in the Finnish business survey, but expectations about exports and incoming new orders can be used as proxy variables. However, their rôle seems to vary not only by the phase of the business cycle but also by the industrial branch.

The importance of the order stock in the adjustment of production to exogenous demand shocks seems well established, but influence of inventories on production plans cannot be detected except in forest industries during recession. The results also suggest that the production plans of the Finnish firms contain extrapolative features.

The plan of the paper is as follows. In the next section we shall mention previous microeconometric studies using business survey data, briefly describe the business survey of the Confederation of Finnish Industries and present the theoretical background of this paper.

Statistical methods and estimation techniques will be considered in section 3. The empirical results of models explaining the production plan surprises are contained in section 4 and the results concerning the revision of production plans in section 5. Finally, some comments and conclusions will be offered.

2. PRELIMINARIES

2.1. Previous studies with business survey data

As already mentioned above, the previous studies with micro data from business surveys have mostly applied the conditional loglinear probability model or, equivalently, the conditional multinomial logit model. Most of the studies have been based on the French and German surveys, conducted by INSEE and Ifo-Institut für Wirtschaftsforschung, respectively. König et al. (1979) investigated the formation of production plans of French and German firms. The same authors also considered price expectations of these firms (König et al., 1981). Nerlove (1983) considered these two things together, but his paper also studied the extrapolative nature of expectation formation. Kawasaki et al. (1982) studied the problem of firms' responses to disequilibrium and the corresponding relative flexibility of prices and quantities. In another paper (Kawasaki et al., 1983), they also included the inventories and unfilled orders in their considerations; the conclusion was that while quantities adjust to both transitory and permanent demand changes, prices only respond to the latter.

Ottenwaelter and Vuong (1984) also analyzed unfilled orders, inventories, production and prices of the firms. Kawasaki et al. (1982,

1983) studied firms' responses to observed demand shocks while Ottenwaelter and Vuong were interested in adjustments to unanticipated demand shocks. Consequently, the demand expectations of the firms played a central rôle in their considerations. Business survey data have also been used in research on causes of French unemployment (Bouissou et al., 1984, 1986). Recently, Zimmermann (1986) has tested the rationality of the business climate expectations in German firms with data from the survey of the Ifo-Institut.

2.2. Modelling production plans and price expectations

König and Nerlove (1985) recently formed a recursive model to describe how demand shocks are reflected in prices and production through the adjustment of inventories and order backlogs. Their analysis was based on a theoretical model of the firm, proposed by Blinder and Fischer (1981); in this model the role of inventories and unfilled orders was again emphasized. The main premise was that firms are trying to maximize their expected discounted profits, when production costs and costs of holding inventories are taken into account. The most important assumptions of the model were as follows:

- The demand curve is downward sloping and exogenous demand shocks can shift it.
- Costs of holding inventories are a convex function of the size of the inventories.
- Prices can be adjusted without costs, and marginal production costs are rising.
- Firms' choice of technologies remain the same throughout the observation period.

These assumptions led to a recursive simultaneous model where plans concerning prices and production were formed on the basis of demand expectations, backlog of orders and level of inventories. Because the system was recursive, it was possible to estimate each loglinear "equation" separately. This was done both with German and with French business survey data.

In this paper, we shall concentrate only on the formation of production plans and leave the prices aside. We do not as yet have enough data on firms' prices and price expectations to investigate the formation of the latter. This does not, however, totally prevent us from using the theory of König and Nerlove (1985) in our analysis. In their model, quantities and prices are jointly endogenous. This means that if the prices are omitted the formation of production plans can still be studied in the same framework. The focus will be on checking the feasibility of the assumption that the demand expectations, backlog of orders and level of inventories form the basis for the production plans of the firms. Since we cannot a priori exclude the possibility that the plan formation mechanism is not the same across industries we have divided the manufacturing into three categories: metal and engineering (ISIC codes 37 and 38), forest (ISIC codes 33 and 34) and "other" industries. The two first sectors are very important ones in Finland whereas the last one is as such a rather heterogeneous group of industries. A further breakdown of this group for the purposes of this study would be difficult because of scarcity of observations.

2.3. The Finnish business survey

In order to discuss the formation of production plans in the Finnish context it is necessary to characterize the Finnish business survey in view of the possibilities the questionnaire offers for a quantitative analysis and of the limitations it sets. The Confederation of Finnish Industries have conducted a quarterly business survey since 1966. The participating firms are asked to return the questionnaire by March, June, September and December 15, respectively. These firms have been chosen selectively, and the sample of firms has been gradually enlarged. At the moment it contains about 500 enterprises. In this paper, we shall concentrate on manufacturing industries which means that the number of returned questionnaires usually stays just below 480. The data set to be used in the analysis comprises the years 1977-1985.

The number of questions in the questionnaire has also been increased gradually and the questions relevant for this study are listed in Appendix 1. Most of them have three response alternatives; "increases", "stays the same" and "decreases". The tolerance limits indicated in the questionnaire for the alternative "stays the same" are ± 2 % for all questions. Firms are asked to give "seasonally adjusted" answers. The answers have not previously been subjected to any micro analysis, but their aggregates have been used e.g. in forecasting; for discussion see Teräsvirta (1986).

The study of the formation of plans in the Finnish case deserves particular care because no information on demand for or demand expectations of the manufactured products of the firms is explicitly available from the survey. The question about future business prospects in general is often cf. König et al. (1979, 1981), interpreted as demand expectations, but in the Finnish survey it lacks a counterpart concerning the observed demand. We have tried to use questions concerning the amount of new orders and the volume of exports as proxies for demand. Because Finland is a small open economy and as such very dependent on foreign trade, we might argue that export expectations (question E_t^*) at least to some extent reflect demand expectations in general as well. The usefulness of the question concerning incoming orders is in theory somewhat diminished by the fact that in mid-1983, the formulation of the question was changed. However, mainly because we have been unable to notice any conspicuous change in the response pattern at that time, we have in fact ignored the reformulation of the question.

In addition to the variables stipulated by the model we are considering, production plans are of course also dependent on whether the firm has idle production capacity or not, whether it anticipates bottlenecks in the production, etc. Because there is information about these things in the Finnish survey we also include them in the list of potential explanatory factors for the production plans of the firms.

Furthermore, König and Nerlove (1985) assume that changing the rate of production incurs extra costs to the firm. It may thus be argued that firms have a certain aversion against abrupt changes in the volume of production. If this is the case, the formation mechanism of the production plans should also be "extrapolative"; i.e., the past development of the production affects the plans for the next quarter. This implies that SQ_t be influenced by the previous production. We shall assume that the production of the four previous quarters (question ΔQ_t) will actually affect SQ_t.

2.4. Surprises and revisions

An important problem in the analysis is how to form quantitative variables which would help us to perceive the connections between production plans and factors affecting them. Suppose now that the production plans of a firm for period t+1 made at period t, Q^*_{t+1}, are formed on the basis of its demand expectations D^*_{t+1}, inventory level L^a_t, order backlog S^a_t and the firm's perception about its idle production capacity C^*_{t+1}. This would suggest that the discrepancy or surprise $SQ_t = Q_t - Q^*_t$ between observed (Q_t) and planned production (Q^*_t) would be affected by SD_t, SC_t and possibly S^a_t, S^a_{t-1}, L^a_t and L^a_{t-1}. The actual construction of quantitative "differences" SQ_t, SD_t and SC_t will be discussed in section 3.2.

Using SQ_t is not the only conceivable way of studying the production plan formation mechanism. Another possibility opens up through observing what makes firms change their production plans from one quarter to the next one. Such changes are certainly not arbitrary and the model discussed above implies that a revision of a production plan $DQ^*_t = Q^*_{t+1} - Q^*_t$ depends on DD^*_t, DC^*_t, DL^a_t and DS^a_t. Estimation results illuminating the truthfulness of this proposition are contained in section 5. In order to test the "extrapolative" nature of the production plan formation mechanism, we shall also investigate the connection between DQ^*_t and Q_t.

3. STATISTICAL METHODS

3.1. Conditional distribution of production

There are at least two possible ways to analyze the discrepancy between production plans and the corresponding actual production. First, one can examine how different factors affect the conditional distribution of the actual production given the previous production plans. Second, it is possible to construct a variable to measure the difference between production plans and actual production and to examine the influence of the explanatory factors on this variable. We start out by taking a closer look at the first possibility.

Imagine the volume of the production of firm i at time t as a continuous variable $T_t^{(i)}$. The corresponding production plan for time t, made at the previous quarter is denoted by $T_t^{(i)*}$. The answers to questions Q_t and Q_{t+1}^* of the survey are then actually categorized observations from variables

$$z_t^{(i)} = T_t^{(i)}/T_{t-1}^{(i)} \text{ and } z_{t+1}^{(i)*} = T_{t+1}^{(i)*}/T_t^{(i)}$$

classified into categories $C_j = [c_{j-1}, c_j)$, $j = 1,2,3$, where $c_0 = 0$, $c_1 = 0.98$, $c_2 = 1.02$ and $c_3 = \infty$.

Consider now the conditional distribution of $z_t^{(i)}$, conditioned by $z_t^{(i)*}$ and $X_t^{(i)}$, where the vector $X_t^{(i)}$ includes all factors that are believed to affect the volume of the actual production, once the production plans have been made at the previous quarter. Next, suppose that there is a common conditional distribution for all variables $z_t^{(i)}$ within each industrial sector. For brevity, let

$$\pi_j = P(z_t \in C_j | z_t^*, X_t) \ , \ j = 1,2,3.$$

Because z_t is a nonnegative variable, its (conditional) distribution can be characterized by the so-called hazard function

$$h_z(s) = \frac{f_z(s)}{1-F_z(s)} \ , \ s > 0$$

where f_z is the (conditional) probability density function of z_t and F_z the corresponding cumulative distribution function. Suppose that the explanatory factors X_t affect the hazard multiplicatively, i.e.,

$$(1) \qquad h_z(s) = h_0(s|z_t^*)e^{\beta' X_t}$$

where $h_0(s|z_t^*)$ stands for the distribution of z, conditioned on the production plans.

Now define the ratios

$$(2) \qquad \delta_j = \frac{\pi_j}{\pi_j+\ldots+\pi_k} \ , \ j = 1,\ldots,k \ ; \ \delta_1 = \pi_1, \ \delta_k = 1 \ .$$

Because

$$\pi_j = e^{-\int_0^{c_{j-1}} h_z(s)ds} - e^{-\int_0^{c_j} h_z(s)ds}$$

it follows that

$$1 - \delta_j = \frac{\pi_{j+1}+\ldots+\pi_k}{\pi_j+\ldots+\pi_k} = e^{-\int_{c_{j-1}}^{c_j} h_z(s)ds} \ .$$

Using (1) and taking logarithms one obtains

$$\log(1-\delta_j) = - e^{\beta' X_t} \int_{c_{j-1}}^{c_j} h_0(s|z_t^*)ds$$

and

(3) $$\log[-\log(1-\delta_j)] = \beta' X_t + \mu_j(z_t^*)$$

where

$$\mu_j(z_t^*) = \log \int_{c_{j-1}}^{c_j} h_0(s|z_t^*)ds, \; j = 1,\ldots,k-1 \; .$$

The assumption (1) about the multiplicative effects of X_t on the conditional distribution of z_t thus definitely implies model (3). This model is a special case of the so-called continuation ratio models; cf. Agresti (1984, p. 114) or Fienberg (1980, pp. 114-116).

Assumption (1) states that the volume of production is primarily determined by the previous production plans and the corresponding basic hazard $h_0(s|z_t^*)$. Deviations from the expected development that the production plans were based on can then alter the distribution of z_t as postulated in (1).

Model (3) is actually equivalent to the following model by McCullagh (1980):

(4) $$\log[-\log(1-\gamma_j)] = \mu_j+\beta' X_t$$
$$\gamma_j = \pi_1+\ldots+\pi_j, \quad j = 1,\ldots,k-1 \; .$$

The equivalence of models (3) and (4) has been shown by Läärä and Matthews (1985). It is easy to see that the form of model (4) remains unchanged if some of the categories are pooled, cf. McCullagh (1980). This implies that model (3) has the same property.

3.2. Estimation

The parameters of model (3) can be easily estimated using the GLIM-programme, cf. Baker and Nelder (1978). According to (2),

$$\pi_1 = \delta_1$$

and

$$\pi_j = (1-\delta_1) \ \dots \ (1-\delta_{j-1})\delta_j, \quad j = 2,\dots,k \ .$$

Let n_j be the observed frequency of firms in the response category C_j, $j = 1,\dots,k$, given the values of the explanatory variables X_t. The corresponding likelihood-function will be of the form

$$L \simeq \prod_{j=1}^{k} \pi_j^{n_j} = \prod_{j=1}^{k} [(1 - \delta_1) \ \dots \ (1 - \delta_{j-1})\delta_j]^{n_j}$$

$$= \prod_{j=1}^{k-1} \delta_j^{n_j}(1 - \delta_j)^{n_{j+1} + \dots + n_k}$$

$$= \prod_{j=1}^{k-1} \delta_j^{n_j} (1 - \delta_j)^{[n_j + \dots + n_k] - n_j} \ . \tag{5}$$

There is a formal resemblance between (5) and a likelihood defined by (k-1) mutually independent binomial observations. The logarithm of (5) will thus consist of terms that are technically of the following form, considered by Nelder and Wedderburn (1972):

$$\log L = \text{constant} + \sum_{j=1}^{k-1} n_j\theta_j + g_j(\theta_j) \; ,$$

where $\theta_j = \log \delta_j$ and $g_j(\theta_j) = (n_{j+1} + \ldots + n_k)\log(1 - e^{\theta_j})$. Consequently, the values of the likelihood function corresponding to model (3) can be calculated and optimized with the standard options ERROR B, LINK C, in GLIM.

Note, however, that the functions $g_j(\theta_j)$ involve stochastic factors which are not mutually independent. Consequently, the presumptions of Nelder and Wedderburn (1972) for calculating the information matrix for β are not valid and the standard deviations of the parameter estimates, computed by GLIM, are erroneous. Better estimates for the standard deviations could be obtained using the inverse of the Hessian of the observed likelihood function. The estimated standard errors are not reported at all, because the importance of different explanatory factors in X_t can be better evaluated by likelihood ratio tests with the help of the deviance measures produced by GLIM.

Because z_t^* in formula (3) is only observed in a categorized form, it is necessary to include separate basic hazard parameters $\mu_j(i)$, $j = 1,2$, for each level C_i, $i = 1,2,3$, of z_t^*. This makes six such parameters altogether. The importance of different explanatory factors in X_t can be evaluated by likelihood ratio tests with the help of the deviance measures produced by GLIM, cf. Baker and Nelder (1978). Note that model (3) takes the ordering of the response alternatives into account without making any assumptions about the distances between the response categories.

3.3. Construction of the surprise variables

Before proceeding any further, we have to quantify the surprises, SQ_t, or changes in plans, DQ_t^*. What is needed is first of all a coding technique for trichotomous questions. As an example, consider a "variable" measuring unanticipated demand shocks or surprises $SD_t = D_t - D_t^*$. It can be constructed according to the following scheme:

(6)

		D_t^*: 1 +	2 =	3 −
D_t	1 +	3	2	1
	2 =	4	3	2
	3 −	5	4	3

For instance, $SD_t = 5$ means that the firm has badly overestimated the demand for its products. On the other hand, $SD_t = 3$ implies that the firm has anticipated the direction of the demand development without error. The constructed scale is strictly ordinal and does not imply that the "distances" between consecutive values of SD_t be equal. Corresponding "surprise" variables can be constructed for other questions as well. For the dichotomous question about idle production capacity the values of the surprise variable $SC_t = C_t - C_t^*$ are

		C_t^*: 1 YES	3 NO
C_t	1 YES	2	1
	3 NO	3	2

The above coding technique (6) is very similar to that of König et al. (1981) and Nerlove (1983). However, instead of their three surprise categories we have defined five.

3.4. Modelling the production surprises

There is now another possibility of studying factors which influence the realization of the production plans. The idea is to construct a surprise variable $SQ_t = Q_t - Q_t^*$ as above and inspect how the (unconditional) distribution of SQ_t varies with X_t. Because SQ_t is ordinal, we can use continuation ratio models to characterize the dependence between X_t and the distribution of SQ_t:

$$\pi_j^0 = \Pr(SQ_t = 6 - j \mid X_t),\ j = 1,\dots,5$$

$$(7)\qquad \delta_j^0 = \frac{\pi_j^0}{\pi_j^0 + \dots + \pi_k^0}$$

$$\log[-\log(1 - \delta_j^0)] = \mu_j^0 + \beta^{0'} X_t,\ j = 1,\dots,k-1.$$

This model does not have a natural hazard function interpretation which would correspond to (1), because SQ_t is not a categorized version of any latent continuous variable. On the other hand, its parameters are easier to interpret than those of model (3), if one wants to investigate the difference between production plans and actual production.

If (7) is to be applied, it has to be noticed that firms have a tendency of giving a "stays the same" answer too often, especially to questions concerning expectations; for discussion see for example Batchelor (1982) and Nerlove (1983). This tendency is also obvious in the Finnish business survey, cf. Teräsvirta (1985,1986). Therefore, it is necessary to include special level parameters α_2, α_3 and α_4 for the cases where $Q_t^* = 2$ and $SQ_t = 2,3$ or 4, respectively, in model (7). These are added to the model by including corresponding indicator variables in the explanatory vector X_t.

Finally, note that model (7) can also be used to describe the behaviour of "differences" $DQ_t^* = Q_{t+1}^* - Q_t^*$ when DQ_t^* is constructed by the coding technique (6).

4. REALIZATION OF PRODUCTION PLANS

4.1. Preliminary considerations

In order to apply models discussed in section 3, the frequencies of firms for each response combination of SQ_t and X_t are needed. Firms that have left at least one of the questions in SQ_t or X_t unanswered must be omitted from the consideration. The number of available answers from a single survey has usually been about 130 in metal and engineering, 80 in forest and 180 in other industries. These figures are small but as was previously mentioned, the three categories have to be modelled separately. Other industries are of course still a heterogeneous group of firms, but its size makes further subdivision difficult. Because of fairly small sample sizes we have been obliged to aggregate answers from several periods in order to have enough observations for making inferences. In doing this, we have also accounted for the possibility that the firms' behaviour is affected by the state of the economy in general. Therefore, the quarters to be aggregated have been chosen from the same phase of the business cycle.[1)] Because we have not been fully convinced about the firms' ability to take the summer holiday season correctly into account in the "seasonal adjustment" of their answers, we have avoided the third and fourth quarters of the year. The following periods then represent the recession and recovery, respectively:

Recession:

Metal and engineering industries:	1977/1,	1978/1,	1983/1	
Forest industries:	1981/1,	1981/2,	1982/1,	1982/2
Other industries:	1977/1,	1977/2,	1982/1,	1982/2

Recovery:

Metal and engineering industries:	1979/2,	1980/2,	1984/2,	1985/2
Forest industries:	1979/1,	1983/2,	1984/1,	1984/2
Other industries:	1979/1,	1979/2,	1984/1,	1984/2

4.2. Inspection of two-dimensional marginal tables

Because it is virtually impossible to perceive the information contained in multidimensional contingency tables with a bare eye, we calculated all possible two-dimensional marginal frequency tables from each contingency table considered. The idea was to prevent false interpretations of the observed frequency distributions. At the same time, we calculated the Goodman-Kruskal γ-coefficients and their approximate standard deviations (cf. Agresti, 1984, pp. 159-165) from each two-dimensional marginal table.

The marginal tables of the aggregated periods imply that some of the factors we originally assumed to affect SQ_t are actually not associated with SQ_t at all. The association of the future business prospects variable B^*_{t+1}, as well as that of B^*_t with SQ_t seems so vague that the variables have been excluded from any further analysis. (Note that it is not possible to construct SB^*_{t+1} because there is no current prospects question in the Finnish survey.) The same is true for a change in inventories, L_{t-1}, and the lagged order backlog S^a_{t-1}. Furthermore, in the Finnish survey there is no question concerning actual levels of inventories so that L^a_t and L^a_{t-1} cannot be considered at all.

Another problem related to the model of König and Nerlove (1985) is that there are no questions on either demand or demand expectations in the Finnish business survey. The same problem appears when working with German data: König et al. (1979,1981) have interpreted the German equivalent of B^*_{t+1} to represent demand expectations. On the other hand, we have just indicated that neither B^*_{t+1} nor B^*_t is an informative question in connection with SQ_{t+1}. Therefore, other proxies must be found for both the expected and observed demand. We shall substitute the volume of exports E_t and the incoming new orders S_t for demand D_t [2)] and, by the same token, E^*_{t+1} and S^*_{t+1} for D^*_{t+1}.

4.3. Comparing production surprise models

After defining the demand proxies but before actually starting the model fitting we still wanted to check the assumption that the association between SQ_t and these proxies varied from recession to recovery. For this purpose, we calculated the γ's between SQ_t and SS_t, SE_t and SC_t for each quarter between 1976/3-1985/2. The smoothed graphs of the γ-series are shown in Figures 1, 2 and 3. The smoothing operator is a centred annual moving average and graphs of the annual logarithmic changes in the volume of production are attached below each figure. The variations in the strength of the association seem by and large to follow the business cycle. The choice of the periods to be aggregated seems relatively sensible in the light of this information. The γ-coefficients between SQ_t and the remaining potential explanatory variables computed for the aggregated periods are shown in Table 1.

As to the model fitting, note that we now have two models, (3) and (7) to choose among. It is thus interesting to find out which model is more useful of the two by comparing their performance. To this end, we first study the simultaneous influence of SS_t and SE_t on SQ_t and on the conditional distribution of Q_t given Q_t^*. As an example to illustrate the point, take "other industries" during recession. The parameter estimates and likelihood ratio test statistics are given in Table 2. The basic hazard parameters are denoted by $\mu_j(i)$, $j = 1,2$; $i = 1,2,3$, as in section 3, and α_2, α_3 and α_4 are the coefficients of the indicator variables for the cases $Q_t^* = 2$ and $SQ_t = 2,3,4$, respectively. The variables in X_t are treated as qualitative factors with one parameter for each contrast to the level 1 for each factor. Contrasts corresponding to the same variable should either decrease or increase with increasing level of the variable if its effect on SQ_t is believed to be monotonic. We have not actually taken this order restriction explicitly into account in the estimation, because it is already satisfied by almost all of our unconstrained parameter estimates.

It can be seen from Table 2 that the estimation results resemble each other quite closely, but model (3) fails to detect the explanatory power of SE_t. Furthermore, the estimates of the contrasts of SS_t do not satisfy the order restriction mentioned above. This speaks in favour of model (7), and because its parameters are also very easy to interpret, it is our final choice.

It is worth pointing out that in most cases the contrasts between the factor levels 1 and 2, and 4 and 5, respectively, turn out to be significant. The use of the three level coding system of König et al. (1979,1981) would therefore mean a certain loss of information.

4.4. Finding factors influencing production plans

After settling for model (7), we can concentrate on pinpointing the factors influencing the production plans in Finnish industries. The technique is to estimate these models and perform likelihood ratio tests to test the hypothesis that a potential explanatory variable does not affect the production plan. The explanatory variables of interest are those suggested by the theory and availability of data as well as the inspection of the two-dimensional marginal tables in section 4.1. Unfortunately, all possible regressors could not be included in the model at the same time because of the scarcity of data and certain computer memory restrictions. The results in Table 3 are actually from three different models M1-M3, because we have only been able to handle six-dimensional contingency tables. The regressors have been removed from the models in the same order as they are listed in Table 3.

The choice of the proxy for SD_t is relatively easy in the forest sector, because SE_t is a much more important regressor than SS_t during all phases of the business cycle. A short turnover time of the order stock in many branches of this industry compared to the time unit (one quarter) may be a factor here. Also, these industries lean heavily on exports. In metal and engineering industries, SS_t is clearly an important explanatory factor for SQ_t during recession, whereas SE_t has no significant explanatory power at all. During recovery SE_t and SS_t change rôles. This may be due to the export behaviour of the metal and engineering industries. During the recovery, exports to the Western markets tend to increase and, as a result, unanticipated exports amount to unplanned production. The exports to these competitive markets slow down during the recession and the unanticipated demand is then perhaps more often domestic and more clearly visible through the order books.

In other industries both SE_t and SS_t are clearly associated to SQ_t, but the influence of SS_t seems stronger throughout the business cycle. In metal and engineering as well as in other industries we obviously have to accept both SS_t and SE_t as proxies for SD_t.

The only detected connection between the change of inventories L_t and SQ_t appears in forest industries during recession. Firms that have then increased their inventories have also often overestimated their production. The association is thus negative, which is what can be expected but what is not often found in empirical studies. The backlog of orders S_t^a turns out to be an important regressor in other than forest industries, whereas S_{t-1}^a, S_t and S_{t-1} do not have any significant impact on SQ_t. The anticipated connection between the capacity surprise SC_t and SQ_t is traceable only in metal and engineering and other industries during recession. The connection is based on the fact that firms reaching full production capacity unexpectedly (SC_t=3) often at the same time underestimate their production.

As a whole, the model used by König and Nerlove (1985) for French and German firms is not fully supported by the Finnish data. The inventories do not play their assumed rôle except in forest industries during recession. In the other two sectors, S_t^a does seem to be a factor as stipulated by the model, but no connection between inventories and production can be verified. Finally, the question ΔQ_t is an important explanatory factor throughout. This does give indirect support to the idea that the production plan formation mechanism could have extrapolative features.

5. REVISION OF PRODUCTION PLANS

5.1. Preliminary results

In order to gain more information on the plan formation we shall look at the business survey data from another angle. We shall relate the changes in production plans $DQ_t^* = Q_{t+1}^* - Q_t^*$ to changes in demand expectations, business prospects and the development of inventories and order backlogs to detect possible covariation. The power of Q_t in explaining DQ_t^* is also investigated to test the extrapolative nature of the production plan formation mechanism. Three possible proxies can be constructed for the change of demand expectations DD_t^*. They are DS_t^*, DE_t^* and the change in business prospects, DB_t^*. However, the previous analysis has indicated that S_t^a rather than S_{t+1}^* is the order stock variable which may affect Q_{t+1}^*. Because S_{t+1}^* corresponds to the expected change in S_t^a we may conclude that S_{t+1}^*, not SD_t^*, should be related to DQ_t^*.
A preliminary scrutiny of the two-dimensional marginal frequency tables shows in fact that the association between S_{t+1}^* and DQ_t^* is stronger than that between DS_t^* and DQ_t^*.

An additional feature in this analysis is to partition the firms in two categories according to the number of employees. This is done because preliminary investigation of the data shows that large and small firms might not revise their production plans according to the same pattern. The somewhat arbitrary division of firms into "large" and "small" has been done by the number of employees and the borderline is set at 350 persons. This number is not very far from the median size of the firms in the survey and is as such feasible, as both categories have to contain a sufficient number of firms.

5.2. Main results

We have again tested the significance of different explanatory factors using likelihood ratio tests within model (7). The results appear in Table 4. We are not able to find any association whatsoever between changes of inventory levels and changes in production plans. This result is coherent with the results of the previous section and leads us to conclude that the level of inventories is not a key factor in the formation of quarterly production plans. On the other hand, the order backlog S_t^a passes both of our tests, and its importance in the production plan formation seems well established. The most important factor, however, is undoubtedly the anticipated demand D_{t+1}^*. In the Finnish survey, export expectations E_{t+1}^* seem to be the best proxy for D_{t+1}^* judged by the ability of DE_t^* to explain the variations in DQ_t^*. For large firms in metal and engineering industries, no connection at all is found between changes in production plans and the other possible proxy, expectations on new orders during recession.

As mentioned above, B_{t+1}^* has no counterpart indicating prevailing business climate and in section 4.2, no connection was found between unanticipated production and the business climate. Now that DQ_{t+1}^* is compared with DB_{t+1}^* a connection appears, although its strength varies by industry and by the size of the firm. It is strong for large forest industry enterprises who are major exporters to Western markets. Obviously, B_{t+1}^* and E_{t+1}^* are closely related for these firms. At the other extreme, no connection between DQ_{t+1}^* and DB_{t+1}^* is found for large firms in metal and engineering industries who export more to the Eastern European non-market economies than the forest industry firms. For the former, the future business climate reflecting expected market conditions is a much less reliable demand indicator than the exports.

The production development during the last quarter Q_t is also a good explanatory factor for DQ_t^* in forest as well as in other industries. The differences between large and small firms are most conspicuous in metal and engineering industries. Revisions of production plans in large firms seem to be associated merely with revisions of export expectations. In small firms, anticipations on new orders also seem to affect production plans and for them, B_{t+1}^* might also be interpreted as a proxy for demand expectations. Furthermore, the production plans of the small firms seem to be more of extrapolative character than those of the large firms.

As a whole, the analysis of the plan revisions DQ_t^* gives support to the idea that the production plans Q_{t+1}^* are formed on the basis of demand expectations D_{t+1}^* and order backlog S_t^a. Export expectations of the firms seem to be the best overall proxy for anticipated demand. On the other hand, no effects of the changes in L_t or DC_t^* on DQ_t^* can be traced. Finally, the explanatory power of Q_t supports the perception of the extrapolative nature of the production plan formation. These results are reasonably well in line with the findings of section 4.

6. CONCLUSIONS

The results of this paper clearly show that continuation ratio models are well suited for the analysis of business survey data. The estimation of the models can be handled using existing methods and techniques. Although the number of observations in this study is not large, the division of manufacturing into subcategories undisputedly pays off. The formation of production plans does not seem to be identical in all branches of manufacturing. Demand expectations are crucial in every industry but useful demand proxies are not necessarily the same. The rôle of inventories also seems to vary between branches. Further, this study casts some doubt on the significance of inventories as buffers in the adjustment of production to exogenous demand shocks. Support for the theoretical model is only found in forest industries during recession where there is a negative association between production plans and inventories. In forest industries, a firm may produce large quantities of homogeneous bulk products like pulp or newsprint. On the other hand, for example in metal and engineering industries, the products tend to be more diverse and, as a result, the quantities produced smaller. This obviously diminishes the significance of inventories in the production strategy of the firm. Finally, the evidence from data also clearly supports the notion of inertia in the production changes as the production plans seem to have extrapolative features.

Footnotes:

1) The choice has been made on the basis of the annual logarithmic change of the volume of production within each industry.

2) We shall use the slightly misleading notation S_t for incoming new orders, because before 1983/2 the question was phrased "Do you estimate your backlog of orders to be at the moment greater/the same/smaller than three months ago".

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Appendix 1. Questions of the Finnish business survey relevant in this paper

Symbol	Question
Q_t	Is the production [volume] of your company this quarter larger than/the same as/smaller than last quarter?
ΔQ_t	Is the production [volume] of your company this quarter larger than/the same as/smaller than a year ago?
Q^*_{t+1}	Do you expect the production [volume] of your company next quarter to be larger than/the same as/smaller than this quarter?
L_t	Are your inventories of finished products this quarter larger than/the same as/smaller than last quarter?
S^a_t	Do you consider your present backlog of orders larger than normal/normal/smaller than normal?
S_t	Do you consider the amount of new orders received by your company during this quarter to be larger than/the same as/smaller than during the previous quarter?
S^*_{t+1}	Do you expect the amount of new orders your company will receive during the next quarter to be larger than/the same as/smaller than during this quarter?
E_t	If you export, do you consider the volume of exports of your company this quarter to be larger than/the same as/smaller than last quarter?
E^*_{t+1}	Do you expect the volume of your exports next quarter to be larger than/the same as/smaller than this quarter?

C_t Does your company have idle production capacity at the moment? (Yes/No).

C^*_{t+2} Do you expect your company to have idle production capacity six months from now? (Yes/No).

B^*_{t+1} On the basis of the answers you have given, how would you describe the business prospects of your company? Do you expect them to improve/stay the same/deteriorate in the near future?

Table 1. Goodman-Kruskal γ-coefficients between SQ_t and other variables calculated from two-dimensional marginal tables corresponding to aggregated periods. (The figures in parentheses depict the γ-coefficients divided by their estimated standard deviations.)

Variable	SS_t	SE_t	SC_t	S_t^a	L_t	ΔQ_t
Metal and engineering industries						
Recession	0.320	0.200	-0.459	0.311	0.233	0.436
	(4.0)	(2.0)	(-4.6)	(3.8)	(2.8)	(6.0)
Recovery	0.121	0.356	-0.178	0.131	-0.040	0.312
	(1.8)	(5.5)	(-2.1)	(1.8)	(-0.5)	(4.5)
Forest industries						
Recession	0.276	0.516	-0.228	0.113	-0.245	0.388
	(3.7)	(7.7)	(-2.0)	(1.2)	(-3.1)	(5.0)
Recovery	0.214	0.571	-0.304	0.094	0.062	0.396
	(2.5)	(8.1)	(-2.3)	(0.9)	(0.7)	(3.9)
Other industries						
Recession	0.346	0.219	-0.237	0.246	-0.074	0.318
	(6.6)	(3.7)	(-3.3)	(4.2)	(-0.8)	(6.2)
Recovery	0.305	0.187	-0.125	0.236	0.113	0.384
	(5.1)	(3.0)	(-1.5)	(3.8)	(1.3)	(6.6)

Table 2. Comparison of parameter estimates of models (3) and (7) when $X_t = (SS_t, SE_t)$ in "other industries" during recession.

"Regressand"	Q_t given Q_t^*		$SQ_t = Q_t - Q_t^*$	
Model	(3)		(7)	
Estimates				
Technical parameters:				
	$\mu_1(1)$	-2.787	μ_1^0	0.675
	$\mu_1(2)$	-2.343	μ_2^0	-1.080
	$\mu_1(3)$	-1.082	μ_3^0	-3.644
	$\mu_2(1)$	-1.833	μ_4^0	-4.269
	$\mu_2(2)$	-0.202	α_2	0.072
	$\mu_2(3)$	-0.205	α_3	0.510
			α_4	-9.516
SS_t:				
	$SS_t(2)$	0.307		0.470
	$SS_t(3)$	0.887		0.907
	$SS_t(4)$	1.758		1.601
	$SS_t(5)$	1.678		1.658
SE_t:				
	$SE_t(2)$	0.109		0.247
	$SE_t(3)$	0.286		0.341
	$SE_t(4)$	0.420		0.611
	$SE_t(5)$	0.875		1.484

Hypothesis:	LR	p	LR	p
$SS_t \notin X_t$	47.2	10^{-9}	38.8	$8 \cdot 10^{-8}$
$SE_t \notin X_t$	6.8	0.15	16.3	0.003

Table 3. Likelihood Ratio test statistics, the corresponding degrees of freedom (df) and p-values for null hypotheses of no explanatory power of various factors for SQ_t in model (7)

Model		M1		M2			M3
X_t		(SS_t, SE_t)		$(SC_t, S_t^a, \Delta Q_t)$			L_t
Hypothesis		$SS_t \notin X_t$	$SE_t \notin X_t$	$SC_t \notin X_t$	$S_t^a \notin X_t$	$\Delta Q_t \notin X_t$	$L_t \notin X_t$
Metal and engineering industries							
Recession	LR	15.1	7.0	18.5	9.5	23.2	-
	df	4	4	2	2	2	
	p	0.005	0.14	$9 \cdot 10^{-5}$	0.009	$9 \cdot 10^{-6}$	
Recovery	LR	8.6	15.8	5.7	9.2	27.9	-
	df	4	4	2	2	2	
	p	0.072	0.003	0.055	0.01	$8 \cdot 10^{-7}$	
Forest industries							
Recession	LR	6.8	47.4	4.2	1.2	25.6	9.5
	df	4	4	2	2	2	2
	p	0.15	10^{-9}	0.12	0.55	$3 \cdot 10^{-6}$	0.009
Recovery	LR	9.5	61.9	4.7	2.2	11.9	0.3
	df	4	4	2	2	2	2
	p	0.05	10^{-12}	0.09	0.33	0.003	0.86
Other industries							
Recession	LR	38.8	16.3	8.7	14.5	26.7	-
	df	4	4	2	2	2	
	p	$8 \cdot 10^{-8}$	0.003	0.013	$7 \cdot 10^{-4}$	10^{-6}	
Recovery	LR	32.2	13.5	2.5	11.7	31.5	-
	df	4	4	2	2	2	
	p	$2 \cdot 10^{-6}$	0.009	0.29	0.003	10^{-8}	

Table 4. Likelihood Ratio test statistics, the corresponding degrees of freedom (df) and p-values for null hypotheses of no explanatory power of various factors for DQ_t^* in model (7)

Hypothesis		$DE_t^* \notin X_t$	$S_{t+1}^* \notin X_t$	$Q_t \notin X_t$	$DB_t^* \notin X_t$
Metal and engineering industries					
Recession					
Small firms					
	LR	25.3	15.2	7.0	14.0
	df	4	2	2	4
	p	$4\cdot10^{-5}$	$5\cdot10^{-4}$	0.03	0.007
Large firms					
	LR	17.2	1.9	0.9	0.8
	df	4	2	2	4
	p	0.002	0.39	0.64	0.94
Recovery					
Small firms					
	LR	47.7	14.2	13.5	11.0
	df	4	2	2	4
	p	10^{-9}	$8\cdot10^{-4}$	0.001	0.027
Large firms					
	LR	35.0	14.9	5.6	5.9
	df	4	2	2	4
	p	$5\cdot10^{-7}$	$6\cdot10^{-4}$	0.06	0.21
Forest industries					
Recession					
Small firms					
	LR	14.1	3.0	21.5	7.9
	df	4	2	2	4
	p	0.007	0.22	$2\cdot10^{-5}$	0.09
Large firms					
	LR	32.8	4.1	27.3	20.8
	df	4	2	2	4
	p	10^{-6}	0.13	10^{-6}	$3\cdot10^{-4}$
Recovery					
Small firms					
	LR	49.4	3.3	17.0	4.5
	df	4	2	2	4
	p	10^{-10}	0.19	$2\cdot10^{-4}$	0.34
Large firms					
	LR	40.9	2.2	57.8	14.6
	df	4	2	2	4
	p	10^{-8}	0.33	$3\cdot10^{-12}$	0.006

Table 4 (continued)

Hypothesis	$DE^*_t \not\in X_t$	$S^*_{t+1} \not\in X_t$	$Q_t \not\in X_t$	$DB^*_t \not\in X_t$
Other industries				
Recession				
Small firms				
LR	36.3	10.9	20.7	12.9
df	4	2	2	4
p	10^{-7}	0.004	$3 \cdot 10^{-5}$	0.012
Large firms				
LR	14..6	27.9	23.0	18.2
df	4	2	2	4
p	0.006	$9 \cdot 10^{-7}$	10^{-5}	0.001
Recovery				
Small firms				
LR	34.4	30.8	33.0	14.4
df	4	2	2	4
p	$6 \cdot 10^{-7}$	$2 \cdot 10^{-7}$	$7 \cdot 10^{-8}$	0.007
Large firms				
LR	7.8	11.8	38.2	3.1
df	4	2	2	4
p	0.1	0.003	$5 \cdot 10^{-8}$	0.54

Figure 1. Five-term moving averages of γ-coefficients of SQ_t and three other variables in metal and engineering industries, and logarithmic annual change of production volume in these industries in 1977-1984

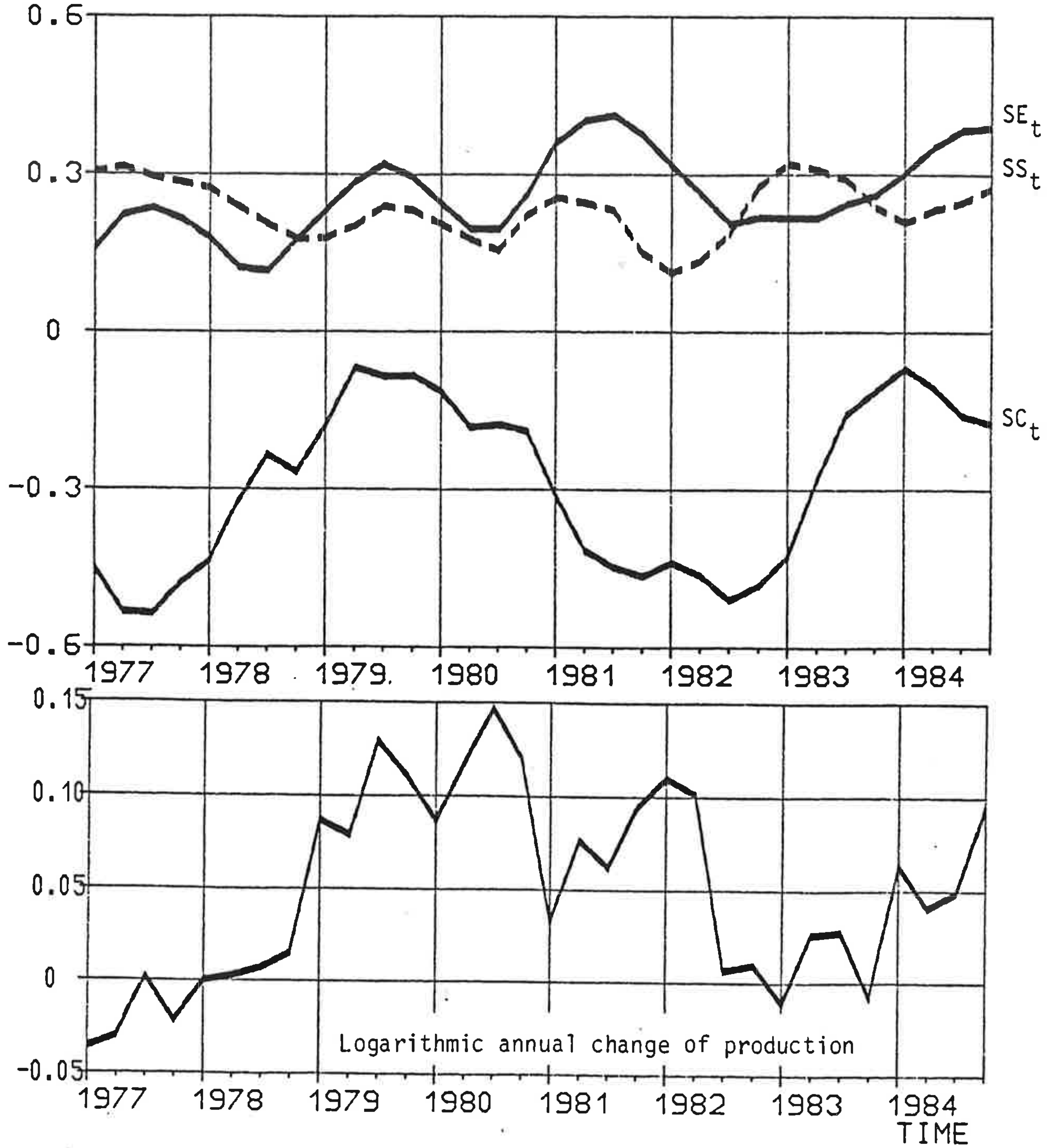
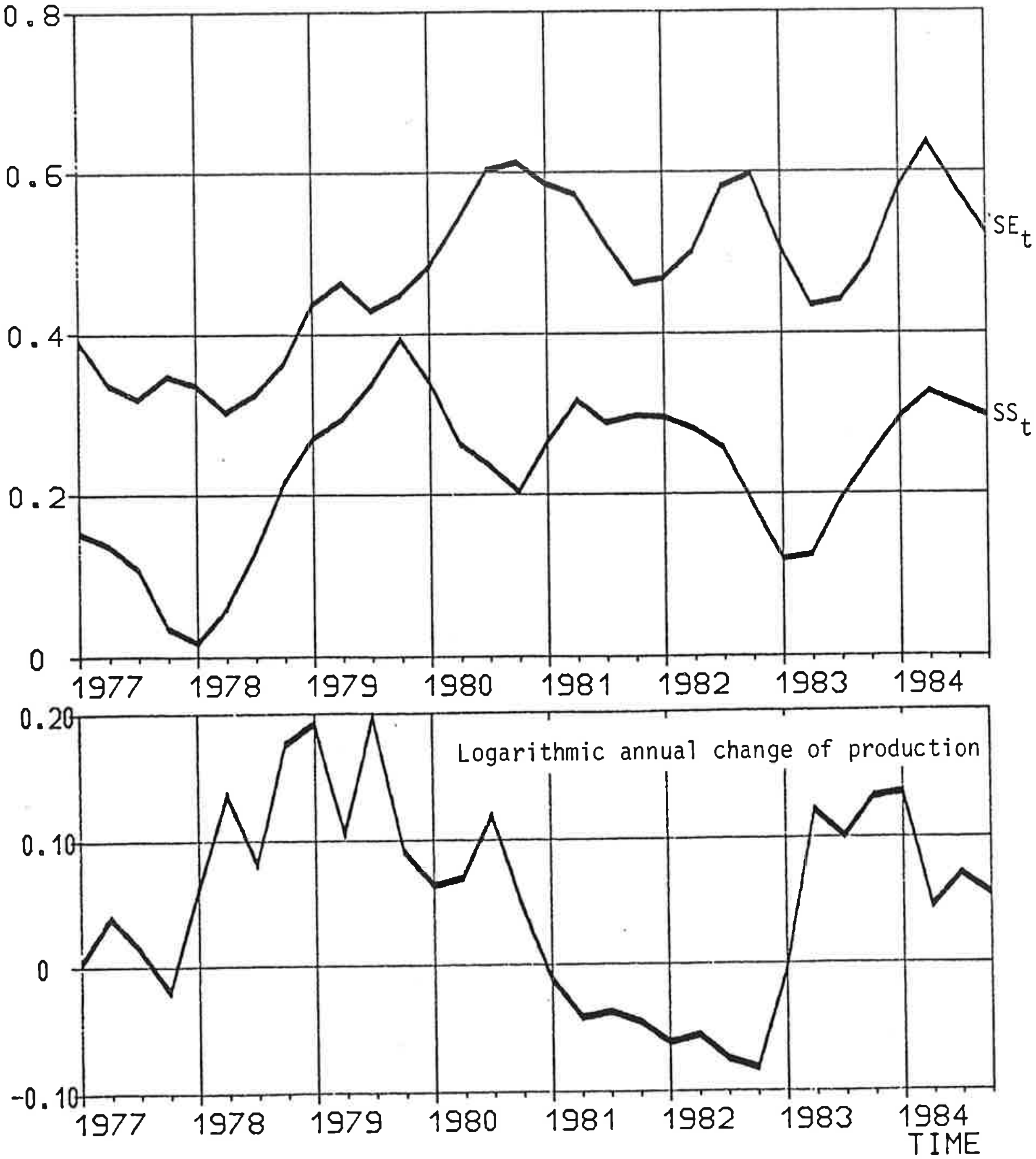
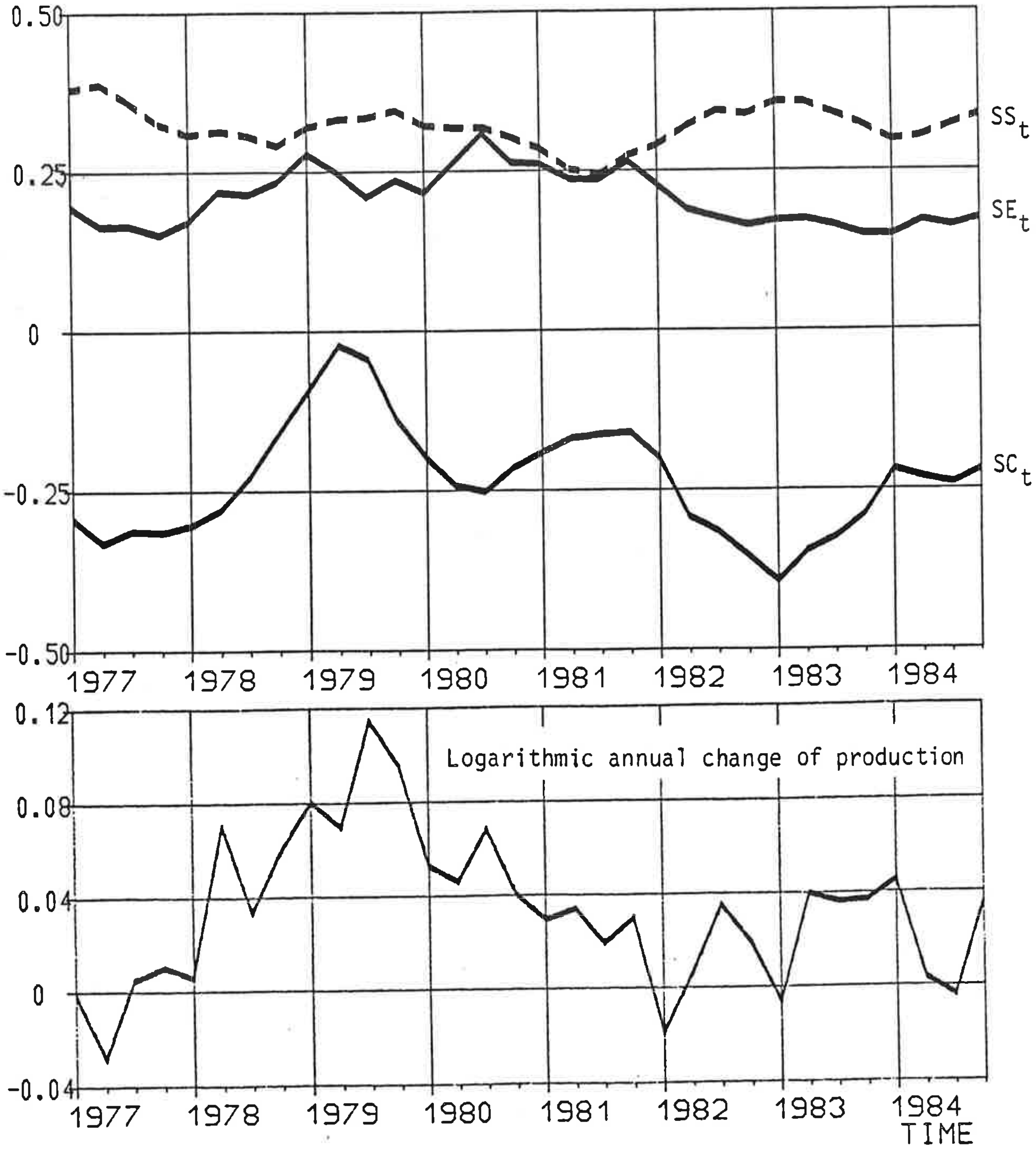


Figure 2. Five-term moving average of γ-coefficients of SQ_t, and SE_t and SS_t, respectively, in forest industries, and logarithmic annual change of production volume in these industries in 1977-1984



<u>Figure 3.</u> Five-term moving average of γ-coefficients of SQ_t and three other variables in other industries, and logarithmic annual change of production volume in these industries in 1977–1984



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