WORKING PAPER No. 30a-b
May 1993

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Quantitative production series compared with qualitative business survey series for five sectors of the Swedish manufacturing industry

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Abstract

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The relationship between industrial production measured as an ordinary quantitative series and the corresponding qualitative series from the Swedish Business Tendency Survey (BTS) is investigated for five sectors of the manufacturing industry. The explanatory value of other BTS series is also analyzed. Models are constructed using a systematic modelling strategy aiming at parsimonious models. Models of the Autoregressive-Distributed Lag (ADL) type are considered.

For all sectors models that include the ex post BTS production series are an improvement on purely autoregressive models. The explanatory power of the best ADL model is considerably smaller for the food industry than for other sectors of the industry. Other BTS variables than production contain little extra information regarding the development of the quantitative production series. The relationship between ex ante and ex post variables is analyzed as a first step in the construction of forecasting models based on the information set available at time-point "t-1". Inclusion of the ex ante BTS production series leads to an improvement of purely autoregressive models for at least three of the sectors. Inclusion of the ex post variable in lagged form leads to a further improvement in most cases.

1. Introduction.[1]

Business surveys have now been in use for considerable time in many countries. The variables used in these are typically qualitative with very few scale steps.The most common situation is a trichotomous variable which is constructed on the basis of a question with three possible alternatives of the type "increase", "no change" and "decrease". Questions with two alternatives of the type yes/no also occur frequently. As used in practice, the information from the trichotomous variables is often further condensed by the introduction of balances (net tendencies) which are computed as the difference between the "increase" and "decrease" or similar alternatives. In Sweden, The National Institute of Economic Research (NIER) has conducted the Business Tendency Survey (BTS) since the 1950s.

There are two basically different approaches, which can be used in the study of the relationship between barometer type series and ordinary quantitative series. One is based on very specific assumptions with regard to factors such as the distribution of production changes among firms and under which conditions firm report "no change" (see e. g. Theil 1966, Carlson & Parkin 1975). The other relates the quantitative production series to one or more barometer series using regression type models (see e. g. Teräsvirta 1985 and Öller 1990). A number of international studies have been performed and in several cases the strength of the relationship between the quantitative and the qualitative series has not been overly impressive. Large short-term fluctuations in the quantitative series that are not present in the qualitative series have been found (Klein 1983).

On Swedish data Lönnqvist (1959) is an important early study, while Knudsen & Norlin (1990), Bergström (1992a) and (1992b), Christoffersson et al (1992) and Rahiala & Teräsvirta (1992) are the most recent ones. The Christoffersson study uses a frequency domain type of analysis to investigate the relationship between quantitative and qualitative series in total manufacturing, while Rahiala & Teräsvirta develop a forecasting model for the engineering industry using Kalman type models. Bergström (1992a) models the relationship between the quantitative production series for total manufacturing and various BTS series using Autoregressive Distributed Lag (ADL) models, while Bergström (1992b) compares the information content in the full trichotomous scale with that in the balances.

[1]I am grateful to the NIER and particularly Roger Knudsen and Pekka Kääntä for putting data at my disposal. I also wish to thank Ann-Sofi Lönnquist and Anders Sundström for help with the collection of further data and preliminary analyses. The research reported in this paper has been supported by the NIER and the Economic Council of Sweden.

The purpose of the present paper is to study the connection between production in five sectors of the manufacturing industry and production and other series in the Business Tendency Survey. Models of the Autoregressive Distributed Lag (ADL) type will be used. In addition to ex post series we shall also look at ex ante series developing genuine forecasting models based on information available at time-point "t-1". This analysis includes a study of the connection between ex ante and ex post series. The volume series will be analyzed both in the form of quarter-to-quarter changes and as annual changes. We shall limit ourselves to the use of the BTS-series as balances in the present paper. As shown in Bergström (1992b) use of the full trichotomous scale in general does not lead to an improvement compared with use of balances only.

The remainder of the paper is organized as follows. Manufacturing production during the study period (1968-1990) is described in section 2, followed by a brief description of the Business Tendency Survey in section 3 and an outline of the modelling strategy used in section 4. Sections 5-7 deal with models for the annual and quarterly change in production, while section 8 compares the models selected with general ADL models, section 9 compares ex post and ex ante variables and in section 10, finally, genuine forecasting models are developed.

2. Manufacturing Production in Five Important Sectors

For the production volume, we have used the production index computed by Statistics, Sweden (Statistiska Centralbyrån, SCB) and regularly published in their Monthly Bulletin (MB), series I. We have used monthly index values adjusted for irregularities of the calendar as available in the databank at the NIER at the end of 1990. From the monthly index figures quarterly index figures have been computed by averaging the monthly figures. Data are available for the period 1968:1 -1990:3. Five different sectors of manufacturing are analyzed: manufacture of food, beverages and tobacco (SNI code 31) in the following "Food" (F), manufacture of wood and wood products (33), "Wood" (W), manufacture of pulp, paper and paper products (34), "Paper" (P), manufacture of chemicals, rubber and plastic products (35), "Chemical" (C) and manufacture of fabricated metal products, machinery and equipment excluding shipbuildning (38 excluding 3841) - the engineering industry - "Engineering" (E). These five sectors accounted for 10.5, 7.2, 16.3, 10.4 and 44.0% of the total production in manufacturing in 1989. Our choice includes one sector - Food- that is home-market oriented and in this respect differs from most of the other sectors considered.

Many of the important variables in the Business Tendency Survey are formulated in terms of changes. Consequently the development of production measured as (percentage) change is of considerable interest. Therefore we are going to use the variables $\Delta m = \log M - \log M_{-1}$ and $\Delta 4m = \log M - \log M_{-4}$ where M denotes production in a certain industrial sector, as our main variables. These variables are of course basically the quarterly and annual relative changes in production. The quarterly change is completely dominated by the seasonal variation and the series is more or less useless as an instrument for direct business cycle analysis. Quarterly changes based on seasonally adjusted series are easier to interpret, but the random variation is large. Such series reflect the cyclical variation rather less strongly than might perhaps have been expected. Fig. 1 shows the X-11 seasonally adjusted series compared with the corresponding series for "Total manufacturing".

The food industry is characterized by a fairly regular increase in production during the whole period. A linear trend can describe the development quite well. We do not see much evidence of a business cycle, although it is possible to discern the troughs in 1977 and 1981. Between 1970 and 1990 there is a production increase of 13%.

For the wood industry, we find a very rapid increase in production during the early part of the 1970s. A peak is reached in 1974:1, which is 25% above the level four years earlier. The decline from this peak is then rapid with troughs in 1977:4 and 1981:4 and an intermediate peak in 1979:4. In 1981:4 the level is 30% below that in 1975:4. The remaining part of the 1980s shows a rather steady increase, but the level in 1990 is still almost 15% lower than the peak level of 1974.

During the 1970s, the paper industry is characterized by a fairly slow growth. The two peaks in late 1973 and late 1979 are on about the same level, while the rather long drawn-out recession in between reaches troughs in 1975:3 and 1977:3 at levels about 15% below these peaks. The early 1980s trough occurs rather late in 1982:2 at a level not much higher than during the previous trough. After this there is a rapid increase until the end of 1984. The growth then continues but at a much slower rate and without much sign of the mini-recession in 1986. The highest production observed so far is reached in 1987:4, when the level is about 35% above that in 1970. After 1987 there is a steady decline in production so that the level at the end of the period is about 5% below the peak level observed.

Except for the last few years, the development of the chemical industry does not differ greatly from that of the paper industry. The expansion during the early 1970s is faster, however. Peaks occur in 1974:2 and 1980:1 with an intermediate recession. The early 1980s recession is very mild. As the mini-recession after the peak in 1985:1 is hardly noticeable, there is an almost uninterrupted increase in production during the whole decade. At the end of 1990, production is about 30% higher than ten years before and about 65% higher than twenty years previously.

The development of production in the engineering industry is similar to that of "Total manufacturing" with evidence of a cyclical behaviour. There is a rapid increase in production during the first half of the 1970s which peaks in 1975:1. It is possible to discern the troughs in 1977/78 and 1981/82 and the peak in-between which occurs during the first quarter of 1980. The mini-recession after the 1985 peak is hardly noticeable. The production increase between 1970 and 1990 is about 65%.

3. The Business Tendency Survey (BTS)

The Business Tendency Survey contains six different groups of questions according to the lay-out of the questionnaire. As shown in Table 1, the first 8 questions (B101-B108) refer to the situation during the present quarter as compared with that of the previous quarter. There is an instruction that seasonal effects shall be disregarded when the answer is given. All these questions have three alternatives of the type "larger than", "unchanged" and "smaller than". In the presentation of results so called "net tendencies" or "balances" are most commonly used. These are obtained as the difference between the first and the third alternative. Of specific interest among the questions of the first group is B101, which refers to the volume of production.

The second group of questions (B201-B213, B215-B218) has a heading of the type "The situation around Dec. 15". In most cases the questions refer to the situation at the time of answering, e.g. whether there is a shortage of skilled workers. Despite the heading there are exceptions to this, however. Thus some of the questions concern changes compared with the beginning of the quarter (B202, B204, B205, B210 and B212). They are really of the same type as the questions in the first group. Several of the questions have alternatives of the yes/no type and the proportion of yes answers is the most commonly used figure in these cases.

The third group of questions (B301-B308) concerns the expected situation one quarter ahead compared with the present quarter. They are ex ante questions exactly corresponding to the ex post questions in group one. The fourth group of four questions deals with the expected situation at the end of the following quarter compared with the present-day situation (April 1 compared with Dec. 15 in our example).

Finally there are two groups of questions described as "Other" and "Extra". In the present paper, we are going to use only variables from the first three groups of questions and use only the balances (or corresponding measures). We have used the data as given in the data bank at the NIER, which in some cases means minor differences compared with the published series. In some cases these differences are due to corrections due to changes in the sample of firms, in other cases the reason for small differences has not been possible to establish. For the engineering industry we have used BTS data for the period 1968:1-1990:3. For the remaining sectors data for the shorter period 1974:1-1990:3 have been available.

The five main barometer series B101 are shown in Fig 2 and compared with the annual rate of change of the corresponding production volume series. For the food industry there are large random fluctuations in both series. The closest correspondence between the series can be found during the latter part of the 1970s. For the wood industry there have been two periods of sharply falling production, 1975 and 1980/81. The behaviour of the barometer series during these periods as well as during the intermediate upturn is very similar to that of the annual production changes. For the period after 1985 the agreement between the two series is less striking.

For the paper industry, there is a reasonable agreement between the annual change in production and the series B101. Exceptions are the early part of the 1980s, when the balances are unusually small relative to the production changes and the last few years of the study period when the opposite is true. There is a considerable effect of the strike in 1980:2 in both series. For the chemical industry, the agreement is quite good until 1984 with exception for the years 1980-82, part of which may be due to the strike in 1980. During the period after 1984, the balance series in general has shown higher values than what has been realized in the production change series.

For the engineering industry the pattern observed in the barometer variable on the whole is similar to that of the production variable measured as annual changes. There are a couple of exceptions to this. Thus in 1981:2, there is a large production increase due to the strike in 1980:2. This change is not reflected in the barometer series which implies that those answering the barometer adjusted for the strike effect. During the strike quarter itself, the behaviour of both series is similar. A very extreme quarter is 1989:1, when the volume growth rate is much higher than both before and afterwards, while the opposite is true for the barometer series.

From the discussion above we conclude that the series in the form of annual changes is most suitable for business cycle analysis. Use of quarterly changes requires a correct modelling of the seasonal effects. However the barometer questions in general refer to quarterly changes and not annual changes, which is a strong argument for the consideration of quarterly changes as the dependent variable. In view of this we are going to analyze models with both the quarterly and the annual change as the dependent variable. It is obvious that the production series both in the form of quarterly and annual changes are stationary. Thus the assumption of stationarity should cause no difficulty in the cases when such an assumption is required.

4. General Modelling Strategy

Loosely speaking we are interested in the connection between the ordinary production volume series and different barometer series. In particular we want to see whether barometer series can explain the development of the volume series and if other barometer series than the basic production series provide additional information to this series or perhaps are superior to this series.

It is obvious that we have a large number of series to choose among. In addition we have to consider different lags, which means that the number of possible alternative models is very large indeed. Thus some sort of overall modelling strategy should be employed.

We want to see if models which include barometer data are an improvement on various naive and not so naive models. In particular we want to see whether we can improve on an autoprojective model that uses only the development of the dependent variable itself at earlier time points as explanatory variables.

The modelling will be performed within the general framework of the Autoregressive Distributed Lag (ADL) model, thus excluding for example transfer function models based on the Box-Jenkins methodology. The basic ADL model can be written

$$y_t = \beta_0 + \beta_1 y_{t-1} + .. + \beta_k y_{t-k} + \gamma_0 x_t + \gamma_1 x_{t-1} + \ldots + \gamma_r x_{t-r} + \varepsilon_t \qquad (4.1)$$

in the special case of just one explanatory variable. The residual is assumed to be white noise.

Given this general framework we first have to decide on the optimal lag length of the dependent and independent variables. As regards the dependent variable we are first going to estimate an optimal AR model fixing the maximum lag and possibly deleting unnecessary intermediate lags. The maximum lag considered is eight.

For the explanatory variable of main interest, B101, a model without lags of the dependent variables will also be obtained.

Using results from these preliminary modelling exercises we then estimate the full ADL model with B101 as the explanatory variable. We then consider the relationship between other barometer variables and production volume, finally testing whether these other barometer variables have additional explanatory value in the presence of B101.

In general we start with models with a very general lag structure and then test down towards more parsimonious models that incorporate the main features of the data. In the comparison of different models we employ the Schwarz information criterion (BIC) as a basic tool. The BIC criterion is defined as

$$\text{BIC} = \log \hat{\sigma}^2 + (k/T) \log T \qquad (4.2)$$

where $\hat{\sigma}^2$ is the ML estimate of the residual variance, k the number of estimated parameters and T the number of observations.

Like other information criteria the BIC criterion penalizes a model for the inclusion of extra parameters. Use of the criterion emphasizes parsimony and leads to more parsimonious models than e.g the maximum $\bar{R}^2$ criterion.

In order to get an additional test of the models, we use data up to the end of 1987 for estimation and save the 11 observations from 1988:1 to 1990:3 for predictive testing. Although this is a common strategy and the period is a reasonably long one compared with many other prediction periods used in the literature, it is obvious that the results of a predictive testing based on such a short period will be fairly uncertain.

If the test of parametric stability is insignificant, the properties of the model should be judged on the long estimation period and not on the few observations in the prediction period. There is one reason for this in addition to the uncertainty that is unavoidable in inference based on very few observations, namely that the most recent observation on the quantitative production series are preliminary, unreliable and can be changed very much in subsequent updating.

During the period under consideration a major labour market conflict occurred during the second quarter of 1980. Dummy variables denoted D802 etc are used to capture the effects of this conflict.

5. Modelling the Annual Change in Industrial Production ($\Delta 4m$)

5.1 The Engineering Industry

We report the modelling procedure in detail only for the engineering industry (Table 2). For the other sectors the results are summarized in Tables 3 and 4. The average annual growth rate for the engineering industry was 3.2% during the period 1969-87. The variability around this mean figure was large as shown by a standard deviation (SD) of 5.6 percentage points. In the analysis of pure AR models the BIC criterion is improved if lags 5-8 are deleted. Lag 4 on the other hand is essential but an exclusion of lag 3 somewhat improves the model. The industrial conflict in 1980 had a considerable effect on production in the Engineering industry and inclusion of dummies equal to one in 1980:2 and 1981:2 (D802 and D812) markedly improve the statistics of the model. The residual SD of the selected model is 3.51 percentage points. The estimated model is

$$\underset{}{\Delta 4e} = \underset{(0.005)}{0.011} + \underset{(0.100)}{0.521}\,\Delta 4e_{-1} + \underset{(0.114)}{0.501}\,\Delta 4e_{-2} \underset{(0.098)}{-0.372}\Delta 4e_{-4} - \underset{(0.036)}{0.119}\,D802 + \underset{(0.036)}{0.064}\,D812 \qquad (5.1)$$

A model with B101 in current form is about equal to the best AR model with a residual SD of 3.45 percentage points. This model can be improved if lagged values of B101 are included. There are several alternatives that are very similar. The lowest BIC value is obtained with lags 0, 3 and 4 but a model with lags 0 and 1 is not much inferior to this alternative. The estimated models are (the parameters of D802 and D812 not shown)

$$\Delta 4e = \underset{(0.0044)}{0.0020} + \underset{(0.00021)}{0.00168}\,B101 + \underset{(0.00034)}{0.00154}\,B101_{-3} - \underset{(0.00031)}{0.00079}\,B101_{-4} \qquad (5.2)$$

$$\Delta 4e = \underset{(0.0044)}{0.0016} + \underset{(0.00033)}{0.00115}\,B101 + \underset{(0.00032)}{0.00124}\,B101_{-1} \qquad (5.3)$$

Both these models have significant autocorrelation in the residuals. Otherwise they are superior to the best pure AR model.

The occurrence of lagged terms of the BTS variable can certainly be discussed. Both the dependent variable and the BTS variable refer to production in the same time period, which means that in principle lagged terms of the latter variable should not occur. One reason for the occurrence of lags could be termed purely artefactual and due just to the modelling of two time series which are both serially correlated. This is the principal reason why we are rather sceptical to the inclusion of lagged terms. In addition to this reason there are at least two other possibilities.

One would be that production as given in the volume series is registered with some delay. The other is that there are considerable random fluctuations in both series and use of, say, two BTS terms reduces the randomness in the BTS series. Whichever alternative is the true one, longer lags than one or two quarters hardly seem reasonable. Thus model (5.2) must considered highly doubtful. Model (5.3) on the other hand can be looked upon as a model with a moving average terms in the BTS variable as the basic explanatory variable. The almost equal parameter estimates are consistent with this. The exact interpretation of the model differs slightly depending on which of the two explanations given above, that is the true one.

An ADL model with a maximum lag length of four for both the dependent variable and B101 produces an R^2 of 0.8274, which implies a residual SD of 2.55 percentage points. Lags 2-4 of B101 can be eliminated without negative effects and a further deletion of lag 1 of the dependent variable produces a still lower BIC. The parameter estimates of the model are shown in Table 4 and the residual SD of 2.56 percentage points implies a considerable improvement compared with the pure AR model in terms of fit. There are no indications of serial correlation in the residuals.

The model passes the Chow-test (P=0.10), but there are indications of larger errors during the prediction period, as shown by a RMSE of 3.47 percentage points compared with the residual SD of 2.56 percentage points in the estimation period. However, such a comparison only tells part of the story. During the years 1988-89 the development of the volume series was very erratic as shown by the following annual percentage changes in the eight quarters: -0.8, 7.5, 0.7, 0.9, 12.5, 2.3, 4.1 and 3.6. It can certainly be questioned, if the true development really was quite so volatile. The remarkable quarter 1989:1 has no correspondence in the BTS series, where the figures for the same quarters are: -11, 21, 12, 25, -3, 25, 4 and 5. If we disregard the extreme quarter 1989:1, the RMSE is reduced to 2.39 percentage points, a figure that is well in accordance with the experiences from the sampling period.

5.2 Other Sectors

5.2.1 The Food Industry

As shown in Table 3, the variability in growth rate is markedly lower for the food industry than for the other four sectors considered. The best pure AR model contains only lag 4. The estimated parameter is -0.337 with a standard error of 0.147. The residual SD for this model is 2.40 percentage points. The model construction based on B101 results in a model with just B101 lagged two quarters. This model is about as poor as the best AR model, which is shown by a residual SD of 2.28 percentage points. The full ADL model includes exactly the variables selected in the partial modelling. There is hardly any reduction in residual SD for this model compared with the partial models. Thus we are unable to construct a model that has any appreciable explanatory power for the food industry.

5.2.2 The Wood Industry

The wood industry has the largest variation in growth rate of the sectors considered and the overall trend is negative. An AR model with 8 lags implies a reduction in residual SD from 6.90 to 4.65 percentage points. Deletion of the longest lags improves the BIC criterion considerably and the selected AR model includes lags 1, 2 and 4. The estimated parameters of these lags are 0.549, 0.306 and -0.386 with standard errors of the size 0.11 - 0.13. The residual SD is noticeably larger than with 8 lags.

A model with just B101 in current form produces a residual SD of 4.52 percentage points. Inclusion of lags 1 and 2 further improves the model. The estimated parameters of the first three lags are 0.00166, 0.00100 and 0.00103 with standard errors 0.00043 - 0.00045. Among the full ADL models, the alternative selected is close to just a "sum" of the partial models. The chosen model includes lags 0-2 of B101 and lags 3 and 4 of the dependent variable. This model is a considerable improvement on the partial models as regards fit, which is shown by a residual SD of 3.55 percentage points. The residuals are white noise and the Chow-test is insignificant, although there is a tendency for somewhat larger errors in the prediction period as measured by the summary statistics. A considerable part of the forecast error is again due to the extreme quarter 1989:1, when the observed growth rate was 7.6%.

5.2.3 The Paper Industry

Selection of the best AR model for the paper industry is not straightforward. For the baseline model with eight lags included we obtain three parameters which are large in size and significant. These are those at lags 1, 4 and 8 with parameter values 0.62, -0.45 and -0.38. Successive elimination of the longest lags increases the BIC value to start with, a reflection of the significant lag 8, but then gradually reduces the BIC value again well below that obtained with all lags 1-8 included. The optimal model includes just lag 1, which has a parameter of 0.72. The residual SD of this model is larger than that of the baseline model, 3.93 percentage points compared with 3.67.

Employing a different selection principle can lead to the selection of other models. Thus if the variables (lags) that are "most insignificant" are eliminated, it is possible to decrease the baseline BIC value, without increasing the residual SD. In a model with lags 1, 4, 7 and 8 all parameters are almost significant at the 5% level, the parameters being (standard errors in parenthesis) 0.734 (0.091), -0.222 (0.100), 0.254 (0.135) and -0.355 (0.124). It is possible to reduce the BIC value even further by excluding lags 4 and 7. The resulting model has a BIC value that is marginally smaller than a model with just the first lag. All AR models perform extremely well in the prediction period. In general autocorrelation is not a problem.

With B101 as the only explanatory variable (in addition to the strike dummies) the optimal model includes lags 0-2, with estimated parameters of 0.00141, 0.00089 and 0.00080. They are all strongly significant and the residual SD is very much superior to that of the best AR model, 2.90 percentage points compared with 3.93 percentage points. Lags 1 and 2 are essential as a model with just B101 in current form has a much larger residual SD. While the selected model works very well in the estimation period, it fails completely in the period 1988-90. The reason is constant overprediction. This is not surprising in view of our earlier observation that the balances have not fallen to the same extent at all as production during the last few years.

If we formally rely on the BIC criterion, it is not possible to improve the model with B101 at lags 0, 1 and 2 just described if we include lags of the dependent variable. We denote this model A. However, there is a not very parsimonious ADL model, with AR lags 1, 5 and 8 and B101 lags 0, 1, 2 and 4 which has a lower residual SD than this model, although all parameters are not significant at the 5% level (but at the 10% level). A simplification of this model leads to a model, model B, which is of about the same quality as the model with B101 at lags 0-2 in the estimation period in terms of fit but includes serially correlated residuals. However, this model reflects the development during the period 1988-90 somewhat better. The model is

$$\underset{}{\Delta 4p} = \underset{(0.0041)}{0.0061} + \underset{(0.102)}{0.342}\,\Delta 4p_{-1} + \underset{(0.00027)}{0.00145}\,B101 + \underset{(0.00030)}{0.00081}\,B101_{-2} - \underset{(0.00025)}{0.00049}\,B101_{-4} \qquad (5.4)$$

5.2.4 The Chemical Industry

For the chemical industry, it is fairly straightforward to obtain an AR model. A model with lags 1, 2 and 4 performs well both in the estimation and the prediction period, although the errors in the estimation period are considerable as shown by a residual SD of 3.97 percentage points. The estimated parameters are 0.443, 0.344 and -0.412 with standard errors 0.11 - 0.13.

A model with B101 in current form as the only variable is inferior to the best pure AR model. B101 at lag 1 is slightly better than B101 in current form and is also slightly superior to a model with both lags 0 and 1 on the BIC criterion, although the latter has a smaller residual SD. The estimated parameter in the model with just B101 at lag 1 is 0.00218 (standard error 0.00044), while the parameters of the model with both lags 0 and 1 are 0.00112 and 0.00145. The standard errors are about 0.00060, which means that the current form variable is not quite significant.

The best ADL model includes the lags from the partial models. This model is better than the best pure AR model but the difference is not great.

6. The Explanatory Power of Other Ex Post Barometer Variables

The correlation between the current value of all the ex post BTS variables and the annual growth rate is very low for the food industry. For the period 1974:3-87:4, the correlation is 0.194 for B101 and only one of the other variables just marginally improves on this (the production capacity variable B102 with 0.211). If we allow lags of the variables, we know that the best alternative with B101 is at lag 2 when the correlation is 0.322. A consideration of all other variables again leads to just a marginal improvement, the correlation between B102 and the production growth rate being 0.338 at lag 1. These results mean that a more detailed modelling with other barometer variables than B101 is not worthwhile.

For the wood industry the situation is quite different. Several variables are highly correlated with the growth rate in production. In current form four variables in addition to B101 have a correlation that is higher in absolute value than 0.70, namely B107 (purchases of raw materials), B203 (as-of-now judgement of orderbooks), B204 (number of workers employed) and B213 (as-of-now judgement of stocks of finished goods). Several of these variables are significant improvements on an ADL model with AR lags 3 and 4 and B101 in current form only. The best alternative is that with B213 with a t-value of -3.13. We know however that the best ADL model based on just B101 also includes lags 1 and 2 of this variable. Addition of other BTS variables in current form to this model does not produce a significant improvement. For B213 the t-value of the estimated parameter is -1.17. It does not seem reasonable to expect other BTS variables in lagged form to include significant information, as the peak in the correlation structure is much more sharp at the current value for the other variables compared with B101.

For the paper industry there are just two current BTS variables in addition to B101 which have a correlation with the annual growth rate that is larger than 0.70. This is B105 and B107. With lags also allowed we find one further variable, B108 lagged one quarter. We obtained two possible ADL models in our earlier selection process, where the more parsimonious of the two models was slightly inferior in the estimation period and markedly inferior in the prediction period. Addition of each of the variables mentioned above to these two models gives as a result that a significant improvement is possible with the lagged B108 as the additional variable. B107 in current form is not quite significant at the 5% level. The parameter of $B108_{-1}$ is 0.00089 with a standard error of 0.00036 in the model which includes an AR term (model B), while the residual SD is 2.66 percentage points. In the alternative model the additional value of $B108_{-1}$ is slightly smaller.

For the chemical industry, the correlation between the annual growth rate and B101 is as low as 0.58. There are four current BTS variables which have a correlation with the growth rate that is higher than 0.55 in addition to B101 (B107, B108, B211 and B213). With lags also allowed and the same cut off-point used, we find two additional alternatives, $B108_{-1}$ and $B202_{-2}$. None of these variables have a higher correlation with the annual growth rate than B101.

Several of the variables mentioned above are significant when added to the selected ADL model. The best alternative is obtained with B213, which has an estimated parameter of -0.00161 (standard error 0.00057). The residual standard deviation of this model is 3.54 percentage points compared with 3.80 in the previously selected ADL model.

For the engineering industry only two BTS variables in current form have correlations with the annual growth rate that are higher than 0.7. These are the variables for the number of employed, B204 and B205. The correlations are clearly lower than that between B101 and the growth rate. If we consider lagged values, too, B107 (purchases of raw materials) should be noted. This variable has a higher correlation at lag 2 than in current form, which means that it is of interest in the case when models with large leads are aimed at. None of these alternatives implies a significant improvement on the previously selected ADL model. The best result is obtained for B205 in current form. The t-value of this variable is 1.41.

To summarize the results of this section, we have found that for two of the sectors it was possible to improve the ADL model based on B101 by inclusion of other BTS variables. The reduction in unexplained error was not great, although formally significant at the 5% level. However, it must me stressed that the "mass-significance" problem is considerable as we are studying five different sectors and considering a large number of BTS variables as well as a number of lags of these. In view of this, the additional value of other BTS variables than B101 must be considered doubtful.

7. Modelling the Quarterly Change in Industrial Production (Δm)

ADL models have been obtained for the quarterly change in industrial production (Δm) with the same methodology as that shown in some detail in Section 5. These models always include deterministic seasonal factors in the form of seasonal dummies. We are not going to present the results in detail. Some results can be found in Tables 5 and 6.

From the former table, it can be seen that the modelling of the food industry is again unsuccessful. For the remaining four sectors, we are able to reduce the residual SD of a baseline model with seasonal dummies by 37, 34, 19 and 36% respectively. For two of the sectors, the pure AR model is better than a model based on B101 only, while for the other two sectors the opposite is true. The full ADL model is a considerable improvement on these partial models in all four cases.

The structure of the models obtained is fairly similar. Three AR terms are included in all cases except for the chemical industry. The lags of B101 on the whole are shorter than in the Δ4m-modelling. In no case are more than two lags obtained. In one of these cases, the lagged term is in fact not quite significant, while in the other it is just significant at the 5% level. The seasonal factors are fairly similar for the paper, chemical and engineering industries. For the food industry the seasonal variation is smaller than for the other four sectors, and a much smaller decrease in the third quarter is particularly noticeable. The estimated parameters for the AR terms have a similar pattern in all the five sectors. The parameters of the B101 terms are remarkably similar to those obtained in the Δ4m-modelling.

Table 7 includes results that can form the basis for a comparison between the quality of the Δm and the Δ4m-models. The variability in the basic Δm series is obviously much larger. If, however, we eliminate the seasonal variability from this series, the variability is so much reduced that for all sectors except one, it is considerably smaller than the variability of the Δ4m-series. This means that there remains "more variance" to be explained in the modelling of the annual growth rates (with the food industry as an exception).

A comparison of the selected models shows that for the food and engineering industries, the ADL models obtained are almost equivalent. For the remaining three sectors the models based on Δm lead to a smaller residual standard deviation. In terms of reduction of the initial standard deviation (after adjustment for deterministic seasonal effects in the case of Δm), the Δ4m-modelling is more successful for all sectors except the food industry. To give just one example, the reductions for the engineering industry are 36 and 54% respectively.

8. The Selected Models as Restrictions of a General ADL Model

The models selected by the procedure used in the previous sections can be looked upon as special cases of a very general model. If we formulate this model in terms of the undifferenced variable (the natural logarithm of the production series denoted y below), it will also be possible to judge the appropriateness of the annual and quarterly differencing procedures employed. The general model, that incorporates all estimated models as special cases can be written (except for strike dummies)

$$y_t = \beta_0 + \sum_{i=1}^{8} \beta_i y_{t-i} + \sum_{i=0}^{4} \gamma_i B101_{t-i} + \delta_1 Q_{1t} + \delta_2 Q_{2t} + \delta_3 Q_{3t} + \varepsilon_t \tag{8.1}$$

In the Δ4m-models the seasonal dummies are always excluded. In addition exclusion restrictions of the type $\beta_i = 0$ and restrictions between parameters lead to the Δm- and Δ4m-models from the general model.

The models for the food industry are parsimonious and can serve as examples of the principles used (although the actual modelling was unsuccessful for this sector). The Δ4m-model for this sector can be written

$$y_t - y_{t-4} = \beta_0^* + \beta_4^*(y_{t-4} - y_{t-8}) + \gamma_2^* B101_{t-2} + \varepsilon_t \tag{8.2}$$

which is equivalent to

$$y_t = \beta_0^* + (1+\beta_4^*)y_{t-4} - \beta_4^* y_{t-8} + \gamma_2^* B101_{t-2} + \varepsilon_t \tag{8.3}$$

We obtain (8.3) from (8.1) by imposing the exclusion restrictions $\beta_i = 0$ for $i \neq 4$, 8, $\gamma_i = 0$ for $i \neq 2$ and $\delta_i = 0$, as well as requiring that the sum of the parameters of y_{t-4} and y_{t-8} is equal to 1.

The Δm-model for the food industry is

$$\begin{aligned} y_t - y_{t-1} = {} & \beta_0^{**} + \beta_1^{**}(y_{t-1} - y_{t-2}) + \beta_2^{**}(y_{t-2} - y_{t-3}) + \beta_3^{**}(y_{t-3} - y_{t-4}) + \\ & + \gamma_0 B101_t + \varepsilon_t \end{aligned} \tag{8.4}$$

This is equivalent to

$$\begin{aligned} y_t = {} & \beta_0^{**} + (1+\beta_1^{**})y_{t-1} + (\beta_2^{**} - \beta_1^{**})y_{t-2} + (\beta_3^{**} - \beta_2^{**})y_{t-3} - \beta_3^{**} y_{t-4} + \\ & + \gamma_0 B101_t + \varepsilon_t \end{aligned} \tag{8.5}$$

In addition to the exclusion criteria $\beta_i = 0$ for $i \geq 5$ and $\gamma_i = 0$ for $i \geq 1$, we here require that the sum of the parameters of y_{t-1}, y_{t-2}, y_{t-3} and y_{t-4} is equal to 1.

Tables 8-10 show the results. The significance of the seasonal dummies in the unrestricted model can be tested by a simple F-test. The critical values at the 5% level are 2.8 - 2.9, which means that the seasonal dummies are significant for three of the sectors. This is also shown by the estimated residual standard deviations. For the food and engineering industries, there is not much difference between the models with and without deterministic dummies.

The exclusion restrictions can be tested by other F-tests. We do not present the detailed results, but all these tests are insignificant. This is also indicated by the small changes observed in the estimated residual standard deviations. In general imposition of the restrictions reduces the residual SD, which implies that the increase in unexplained variance has been more than offset by the increase in degrees of freedom. A final imposition of the restrictions between the non-zero parameters is never rejected. Here, too, we find many cases of reductions in residual SD, which implies that the restrictions are well supported by the data. Obviously the formal F-tests are insignificant.

Tables 9 and 10 confirm the results of the testing procedure. Thus we can for example see that the linear restrictions imposed between the non-zero parameters are remarkably well satisfied already in the general model when seasonal dummies are not included, while there is a somewhat larger discrepancy for the models with seasonals. In general the imposition of the linear restrictions on models that have been simplified by application of the exclusion restrictions produces very small changes in the estimated parameters.

9. Ex Ante and Ex Post Variables

The models obtained can be used as forecasting models in the sense that observations are available earlier for the barometer variables than for the quantitative variables. The ex post business survey variables describe the situation when most of a given quarter has already expired. To obtain truly forecasting models we have to use ex ante variables (or ex post variables in lagged form). Before obtaining models based on such variables, we look at the connection between the ex post variable B101 and the corresponding ex ante variable B301. It should be noted that the time index of the ex ante variables denotes the time-period which the "forecast" refers to and not when it was made. Tables 11 and 12 give some results. For all sectors the forecasts are on average higher than the outcomes. With the exception of the food industry the SDs of the forecasts are smaller, for three of the sectors considerably smaller, than those of the outcomes. This confirms the tendency towards caution in forecasts noticed e.g. in Bergström (1988) and Bergström (1992a).

The correlation between the ex post and the ex ante series is high for the engineering industry, but markedly lower for three of the other sectors. For all sectors a regression of B301 on B101 produces a positive constant term and a slope that is smaller than one. This is sometimes called "the flat slope syndrome". This need not reflect a systematic behaviour, as it may be the result of a low correlation between two variables that "measure the same thing" imperfectly (the "regression fallacy" situation). However, for the three sectors W, P and C where the SD of the ex ante series is considerably smaller than that of the ex post series an interpretation of systematic behaviour seems reasonable. The results of the reverse regression confirm this interpretation.

In the analysis of "Total manufacturing" Bergström (1992a) found that lagged values of ex post variables influenced the ex ante variables. For several of the eight variables considered more than one lag was significant. These results are confirmed in Table 12. With one exception $B101_{-1}$ has a significant effect on B301. The parameters are always positive but smaller in size than the parameter of B101. For all sectors there is a fairly large negative first quarter effect, which means that respondents are more pessimistic in their forecasts relative to outcome during the fourth quarter, when the forecasts for the first quarter are made, than otherwise.

A detailed analysis of seasonal effects will not be performed here, but it can be pointed out that the relative seasonal effects to some extent are dependent on the model used. Thus a direct comparison of the mean values of B101 and B301 reveals a significant first-quarter effect (relative to the fourth quarter) only for the paper industry. If instead we use a model with B101 as the only explanatory variable in addition to the seasonal dummies numerically larger first-quarter effects for all sectors except the paper industry are obtained. The effects are significant for the wood and chemical industries. Addition of B101 in lagged form gives the results shown in Table 12. The negative first-quarter effects are now further increased in absolute value except for the paper industry and the effects are significant for all sectors except the food industry.

10. Forecasting Models for $\Delta 4m$

Forecasting models have been obtained by the same general methodology as that used earlier except that the ex ante variable B301 has been used instead of the ex post variable B101. The selected models are shown in Table 13. Results are not given for the food industry, where not even use of ex post variables led to an acceptable model.

In terms of residual behaviour in the estimation period and forecasting properties in the period 1988-90, the models are acceptable as judged by the LM-test for serial correlation and the Chow test. A comparison with the results in Table 4 shows a markedly increased residual standard deviation for the wood and paper industries.

For the remaining two sectors use of B301 instead of B101 causes only a limited increase in unexplained variance.

The estimated parameters of the B301 variable are of the same size as those of B101. For three sectors addition of B301 to a pure AR model leads to a significant improvement of the model. For the chemical industry, this is not so, which can be seen from the not quite significant parameter of B301 in Table 13.

Having established forecasting models based on the variable B301, it is natural to ask whether better models can be obtained if other ex ante variables are also included. To test this, each of the variables B302-B308 has been added to the model selected on the basis of B301. For three of the sectors not a single significant effect is obtained. The exception is the chemical industry, where addition of the variable B308 leads to a significant improvement of the model. For this sector two other variables, too, are close to being significant at the 5% level (B304 and B306).

If we want to construct a forecasting model on the basis of the data available at time-point "t-1", using ex ante variables is not the only alternative. We could also use ex post variables in lagged form. We know from the previous analyses that the ex post variable is most important in current form, which means that the models obtained will be less good than the optimal models based on the information set at time-point "t" with regard to barometer variables. However, it is still possible that the models may be superior to the models based on ex ante variables.

The starting point for the analysis has again been the model obtained on the basis of B301. To this model has been added B101 in lagged form. Up to three lags have been considered. Results are shown in Table 14. In general use of B101 lagged two or three quarters does not improve a model that includes B101 lagged one quarter. An exception is the paper industry where the first two lags are both significant. For this sector the inclusion of the lagged B101 variables reduces the parameter of B301 to such an extent that is not quite significant at the 5% level.

The lagged B101 variable is strongly significant for the wood and engineering industries, while this is not so for the chemical industry. In the latter case B301 which was not quite significant earlier, is now further reduced in importance. The residual standard deviation is appreciably reduced for the wood and paper industries, while there is not much change for the other two sectors. For these sectors, the forecasting models are not much inferior to the ADL models based on

B101 as shown in Table 4.

11. Conclusions

There is a reasonably good connection between the production volume in the form of annual changes and the BTS production series for four of the sectors considered. The exception is the food industry. Quarter-to-quarter changes in production are completely dominated by the seasonal variability and trend and cyclical developments are not easy to discern in this series.

In the modelling of quantitative production the explanatory power of the ex post BTS production series is considerable for all sectors again with the exception of the food industry. This is true both with the dependent variable in the form of quarter-to-quarter and annual changes. The accuracy obtained measured as the residual standard deviation is greater in the former case for three of the sectors. Other BTS variables than production have only a marginal additional information content with regard to the development of industrial production in volume terms.

A comparison of the ex post and ex ante production series reveals systematic differences of the "flat slope" type for three of the sectors. For four of the sectors lagged values of the ex post series have a significant effect on the ex ante series. For all sectors there is a similar systematic seasonal variability in the ex ante series relative to the ex post series.

In a construction of forecasting models based on the ex ante BTS production variable it is found that this variable leads to a significant improvement of purely autoregressive models for at least three of the sectors, although the models for the wood and paper industry are markedly inferior to the corresponding models with the ex post variable. Addition of the lagged ex post variable further improves the forecasting models based on the ex ante variable in several cases.

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TABLE 1

Definition of variables in the Business Tendency Survey (BTS).

L=larger, H=higher, U= unchanged, S= smaller, LO= longer, SH= shorter, Y=yes, N= no, LOW= lower, CL= comparatively large, A= adequate, TS= too small, TL= too large

Ex Post Questions

A. Present Quarter Compared with Previous Quarter Alternatives

101	Volume of production	L	U	S
102	Production capacity	L	U	S
103	Prices (domestic)	H	U	LOW
104	Prices (export)	H	U	LOW
105	Orders received (domestic market)	L	U	S
106	Orders received (export market)	L	U	S
107	Purchases of raw materials	L	U	S
108	Time of deliveries	LO	U	SH

B. Situation 15 days Before the End of the Quarter

201	Present level of production induce full utilization of capacity	Y	N	
202	If not: Rate of not used capacity - compared to the corresponding date of the previous quarter.	L	U	S
203	As-of-now judgement of orderbooks	CL	A	TS
204	Number of workers employed[1]	L	U	S
205	Number of employees[1]	L	U	S
206	Shortage of: Skilled workers	Y	N	
207	Shortage of: Other workers	Y	N	
208	Shortage of: Technical employees	Y	N	
209	Shortage of: Other employees	Y	N	
210	Stocks of raw materials[1]	L	U	S
211	As-of-now judgement of stocks of raw materials	TL	A	TS
212	Stocks of finished goods[1]	L	U	S
213	As-of-now judgement of stocks of finished goods	TL	A	TS
215	Bottleneck (primary and secondary) in demand	Y	N	

[1]Compared with the beginning of the quarter

216	Bottleneck (primary and secondary) in plant capacity	Y	N	
217	Bottleneck (primary and secondary) in labour supply	Y	N	
218	Bottleneck (primary and secondary) in other factors	Y	N	

Ex Ante Questions

C. Next Quarter Compared with Present Quarter

301	Volume of production	L	U	S
302	Production capacity	L	U	S
303	Prices (domestic)	H	U	LOW
304	Prices (export)	H	U	LOW
305	Orders received (domestic market)	L	U	S
306	Orders received (export market)	L	U	S
307	Purchases of raw materials	L	U	S
308	Time of deliveries	LO	U	SH

Table 2 Model Selection for the Engineering Industry. The Models Include the Strike Dummies D802 and D812. Dependent Variable: Δ4m.

(1) Autoprojective models
Estimation period: 1972:1 - 87:4.

Lags included	R^2	$\hat{\sigma}_\varepsilon$	BIC	LM-test $\chi^2(5)$	P	Chow-test F	P
1-8	0.7019	0.0344	-6.2137	3.18	0.50	1.10	0.38
1-6	0.6722	0.0354	-6.2486	6.57	0.35	1.42	0.19
1-4	0.6687	0.0350	-6.3681	3.19	0.74	1.46	0.17
1-3	0.5774	0.0391	-6.1897	16.68	0.01	1.72	0.09
1, 2, 4	0.6607	0.0351	-6.4091	3.98	0.62	1.83	0.07

(2) B101 only
Estimation period: 1969:2 - 87:4

Lags included	R^2	$\hat{\sigma}_\varepsilon$	BIC	LM-test $\chi^2(5)$	P	Chow-test F	P
0-5	0.7468	0.0299	-6.6320	18.19	0.004	1.54	0.14
0-4	0.7414	0.0300	-6.6683	18.36	0.003	1.48	0.16
0, 3, 4	0.7296	0.0302	-6.7390	17.72	0.003	1.60	0.12
0, 1	0.7002	0.0316	-6.6934	17.60	0.003	1.65	0.10
0	0.6358	0.0345	-6.5563	15.35	0.009	1.78	0.07

(3) ADL models
Estimation period: 1970:1 - 87:4

Lags included Δ4e	B101	R^2	$\hat{\sigma}_\varepsilon$	BIC	LM-test $\chi^2(5)$	P	Chow-test F	P
1-4	0-4	0.8274	0.0255	-6.8058	8.55	0.21	1.37	0.21
1-4	0-1	0.8180	0.0256	-6.9306	3.67	0.68	1.73	0.09
2, 3, 4	0-1	0.8153	0.0256	-6.9754	5.25	0.47	1.68	0.10

Table 3 Characteristics of the Selected Models. Dependent Variable: Δ4m. For the Paper Industry Two ADL Models are Shown.

		F	W		P	C	E
Mean of dep variable [1]		0.0068	-0.0112		0.0122	0.0206	0.0316
SD of dep variable [1]		0.0250	0.0690		0.0566	0.0533	0.0565
AR model[2]	R^2	0.0889	0.5225		0.5439	0.4751	0.6687
	$\hat{\sigma}_\varepsilon$	0.0240	0.0490		0.0393	0.0397	0.0350
	LM-$\chi^2(5)$	7.82	8.54		7.45	6.44	3.19
	Chow F	0.70	0.98		0.26	0.33	1.46
B101 - only model[3]	R^2	0.1045	0.6879		0.7791	0.3395	0.7296
	$\hat{\sigma}_\varepsilon$	0.0228	0.0389		0.0290	0.0438	0.0302
	LM-$\chi^2(5)$	11.34	8.30		7.03	7.71	17.72
	Chow F	0.78	1.32		3.78	0.85	1.60
ADL model[4]	R^2	0.1954	0.7556	A	0.7807	0.5407	0.8153
				B	0.7962		
	$\hat{\sigma}_\varepsilon$	0.0225	0.0355	A	0.0288	0.0380	0.0256
				B	0.0281		
	LM-$\chi^2(5)$	6.25	4.62	A	6.37	4.02	5.25
				B	14.52		
	Chow F	0.71	1.56	A	3.83	0.32	1.68
				B	1.36		

[1] Sample period 74:1-87:4. (69:1-87:4 for E)
[2] Sample period 74:1-87:4. (72:1-87:4 for E)
[3] Sample period 75:2-87:4. (69:2-87:4 for E)
[4] Sample period 75:1-87:4. (70:1-87:4 for E)

Table 4 The Selected ADL Models with Δ4m as the Dependent Variable. Parameter Estimates of D802 and D812 Not Shown When Included. $\hat{\sigma}_F$ in This and Other Tables Denotes the RMSE in the Prediction Period 1988:1-1990:3.

	F	W	P	C	E
Const	0.005 (0.004)	-0.017 (0.005)	0.008 (0.004)	0.006 (0.006)	0.002 (0.004)
$\Delta 4m_{-1}$				0.319 (0.127)	
$\Delta 4m_{-2}$				0.279 (0.132)	0.295 (0.084)
$\Delta 4m_{-3}$		0.273 (0.100)			0.177 (0.083)
$\Delta 4m_{-4}$	-0.349 (0.138)	-0.286 (0.094)		-0.350 (0.115)	-0.295 (0.076)
B101		0.00148 (0.00042)	0.00141 (0.00029)	0.00108 (0.00044)	0.00128 (0.00028)
$B101_{-1}$		0.00091 (0.00040)	0.00089 (0.00031)		0.00089 (0.00029)
$B101_{-2}$	0.00067 (0.00029)	0.00095 (0.00043)	0.00080 (0.00027)		
R^2	0.1954	0.7558	0.7807	0.5407	0.8153
$\hat{\sigma}_\varepsilon$	0.0225	0.0355	0.0288	0.0380	0.0256
$\hat{\sigma}_F$	0.0192	0.0470	0.0642	0.0218	0.0347

Table 5 Characteristics of the Selected Δm-Models.

	F	W	P	C	E
Mean of dep variable [1]	0.0017	-0.0019	0.0033	0.0048	0.0070
SD of dep variable [1]	0.1464	0.2739	0.1264	0.1652	0.2290
SD of dep variable adj for seasonals[1]	0.0321	0.0485	0.0359	0.0397	0.0398
AR model[2] R^2	0.9789	0.9728	0.9397	0.9540	0.9825
$\hat{\sigma}_\varepsilon$	0.0225	0.0470	0.0329	0.0368	0.0324
LM-$\chi^2(5)$	3.17	6.40	4.39	1.19	7.67
Chow F	0.63	1.11	0.35	0.19	1.17
B101 - only model[3] R^2	0.9569	0.9808	0.9599	0.9518	0.9788
$\hat{\sigma}_\varepsilon$	0.0321	0.0403	0.0280	0.0380	0.0359
LM-$\chi^2(5)$	26.35	17.82	10.96	15.99	34.41
Chow F	0.31	1.54	0.90	0.26	1.04
ADL model[4] R^2	0.9805	0.9895	0.9718	0.9656	0.9899
$\hat{\sigma}_\varepsilon$	0.0221	0.0308	0.0238	0.0322	0.0253
LM-$\chi^2(5)$	6.45	3.82	6.25	3.29	3.12
Chow F	0.62	1.58	1.71	0.36	1.14

[1] Sample period 74:1-87:4. (72:1-87:4 for E)
[2] Sample period 74:1-87:4. (72:1-87:4 for E)
[3] Sample period 75:2-87:4. (69:2-87:4 for E)
[4] Sample period 75:1-87:4. (70:1-87:4 for E)

Table 6 The Selected ADL Models With the Dependent Variable as a First Difference. Strike Dummies not Shown When Included.

Variable	F	W	P	C	E
Const	0.056 (0.021)	0.029 (0.048)	0.091 (0.019)	0.093 (0.029)	0.070 (0.031)
$\Delta 4m_{-1}$	-0.895 (0.124)	-0.859 (0.134)	-0.523 (0.107)	-0.523 (0.122)	-0.849 (0.107)
$\Delta 4m_{-2}$	-0.701 (0.146)	-0.644 (0.141)	-0.306 (0.115)		-0.609 (0.116)
$\Delta 4m_{-3}$	-0.503 (0.124)	-0.279 (0.121)	-0.303 (0.114)		-0.465 (0.099)
B101	0.00060 (0.00031)	0.00157 (0.00042)	0.00148 (0.00022)	0.00096 (0.00034)	0.00127 (0.00032)
$B101_{-1}$		0.00090 (0.00049)			0.00075 (0.00036)
Q1	-0.067 (0.040)	-0.031 (0.080)	-0.054 (0.035)	-0.032 (0.055)	-0.038 (0.053)
Q2	-0.029 (0.019)	0.142 (0.059)	-0.076 (0.032)	-0.056 (0.025)	-0.023 (0.042)
Q3	-0.121 (0.040)	-0.272 (0.084)	-0.210 (0.029)	-0.281 (0.037)	-0.216 (0.053)
R^2	0.9805	0.9895	0.9718	0.9656	0.9899
$\hat{\sigma}_\varepsilon$	0.0221	0.0308	0.0238	0.0322	0.0253

Table 7 A Comparison of Models Based on Δm and $\Delta 4m$.

(a) Characteristics of the Dependent Variable.

Sector	Mean of Δm	Mean of $\Delta 4m$	SD of Δm	SD of $\Delta 4m$	SD of error in model of Δm with seasonal dummies
Food	0.0017	0.0068	0.1464	0.0250	0.0321
Wood	-0.0019	-0.0112	0.2739	0.0690	0.0485
Paper	0.0033	0.0122	0.1264	0.0566	0.0359
Chemical	0.0048	0.0206	0.1652	0.0533	0.0397
Engineering	0.0070	0.0316	0.2290	0.0562	0.0398

(b) Estimated Models.

Sector		Selected AR model	B101 current	Selected B101 model	Selected ADL model
Food	Δm	0.0225	0.0321	0.0321	0.0222
	$\Delta 4m$	0.0240	0.0235	0.0228	0.0225
Wood	Δm	0.0470	0.0403	0.0403	0.0308
	$\Delta 4m$	0.0490	0.0452	0.0408	0.0355
Paper	Δm	0.0329	0.0304	0.0280	0.0238
	$\Delta 4m$	0.0367	0.0361	0.0290	0.0265
Chemical	Δm	0.0368	0.0380	0.0380	0.0322
	$\Delta 4m$	0.0397	0.0450	0.0428	0.0380
Engineering	Δm	0.0324	0.0369	0.0359	0.0253
	$\Delta 4m$	0.0351	0.0345	0.0302	0.0256

Table 8 Residual SD of Different Models of Type (8.1) and Restrictions of This Model. Estimation Period 1975:1 - 87:4 (70:1 - 87:4 for E).

Models without Q1 - Q3	F	W	P	C	E
(A) Unrestricted model	0.0241	0.0369	0.0295	0.0389	0.0263
(B) Exclusion restrictions imposed	0.0224	0.0351	0.0286	0.0383	0.0261
(C) All restrictions imposed	0.0225	0.0355	0.0281	0.0380	0.0256

Models with Q1 - Q3	F	W	P	C	E
(D) Unrestricted model	0.0232	0.0329	0.0253	0.0339	0.0252
(E) Exclusion restrictions imposed	0.0223	0.0309	0.0240	0.0323	0.0255
(F) All restrictions imposed	0.0221	0.0308	0.0238	0.0322	0.0253
F-test of (D) vs (A)	2.01	4.31	5.41	5.00	2.62

Table 9 Δ4m - and Δm - Models as Restrictions of General Models of Type (8.1) for the Wood Industry.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.396 (0.411)	0.086 (0.236)	-0.017 (0.005)	0.363 (0.370)	0.337 (0.330)	0.029 (0.048)
Lag of dep variable						
1	-0.027 (0.153)			0.079 (0.163)	0.110 (0.138)	0.141 (0.134)
2	-0.008 (0.147)			0.131 (0.157)	0.196 (0.119)	0.215 (0.117)
3	0.228 (0.139)	0.268 (0.102)	0.273 (0.100)	0.324 (0.156)	0.356 (0.122)	0.356 (0.121)
4	0.626 (0.129)	0.701 (0.094)	0.714 (0.094)	0.227 (0.166)	0.271 (0.122)	0.279 (0.121)
5	-0.008 (0.147)			0.033 (0.160)		
6	-0.013 (0.140)			0.023 (0.157)		
7	-0.200 (0.136)	-0.241 (0.101)	-0.273 (0.100)	0.009 (0.148)		
8	0.310 (0.124)	0.249 (0.096)	0.286 (0.094)	0.099 (0.126)		
Lag of B101						
0	0.00172 (0.00053)	0.00182 (0.00047)	0.00147 (0.00042)	0.00146 (0.00048)	0.00145 (0.00044)	0.00157 (0.00042)
1	0.00051 (0.00071)	0.00037 (0.00051)	0.00091 (0.00041)	0.00079 (0.00064)	0.00093 (0.00049)	0.00090 (0.00049)
2	0.00084 (0.00071)	0.00114 (0.00044)	0.00095 (0.00043)	0.00035 (0.00065)		
3	-0.00009 (0.00072)			-0.00017 (0.00066)		
4	0.00058 (0.00069)			0.00069 (0.00063)		
Q1				-0.033 (0.121)	-0.029 (0.080)	-0.031 (0.080)
Q2				0.128 (0.081)	0.148 (0.060)	0.142 (0.059)
Q3				-0.243 (0.121)	-0.265 (0.085)	-0.272 (0.084)
R^2	0.9644	0.9626	0.9614	0.9740	0.9725	0.9720
$\hat{\sigma}_\varepsilon$	0.0369	0.0351	0.0355	0.0329	0.0309	0.0308

Table 10 $\Delta 4m$ - and Δm - Models as Restrictions of General Models of Type (8.1) for the Engineering Industry. Strike Dummies Included but Not Shown.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.076 (0.119)	0.065 (0.105)	0.002 (0.004)	0.128 (0.118)	0.116 0.113)	0.070 (0.031)
Lag of dep variable						
1	0.122 (0.111)			0.193 (0.127)	0.147 (0.108)	0.151 (0.107)
2	0.255 (0.105)	0.288 (0.087)	0.295 (0.084)	0.329 (0.126)	0.238 (0.098)	0.240 (0.097)
3	0.167 (0.105)	0.179 (0.086)	0.177 (0.083)	0.175 (0.132)	0.142 (0.103)	0.144 (0.102)
4	0.795 (0.100)	0.703 (0.079)	0.705 (0.076)	0.543 (0.132)	0.463 (0.100)	0.465 (0.099)
5	-0.131 (0.113)			-0.069 (0.121)		
6	-0.254 (0.107)	-0.296 (0.087)	-0.295 (0.084)	-0.193 (0.115)		
7	-0.171 (0.106)	-0.179 (0.085)	-0.177 (0.083)	-0.096 (0.114)		
8	0.200 (0.102)	0.292 (0.079)	0.295 (0.076)	0.104 (0.106)		
Lag of B101						
0	0.00133 (0.00035)	0.00133 (0.00033)	0.00128 (0.00028)	0.00132 (0.00035)	0.00126 (0.00032)	0.00127 (0.00032)
1	0.00052 (0.00046)	0.00083 (0.00034)	0.00089 (0.00029)	0.00056 (0.00048)	0.00075 (0.00036)	0.00075 (0.00036)
2	-0.00002 (0.00050)			-0.00029 (0.00050)		
3	0.00053 (0.00048)			0.00038 (0.00047)		
4	-0.00068 (0.00044)			-0.00048 (0.00043)		
Q1				-0.043 (0.063)	-0.038 (0.053)	-0.038 (0.053)
Q2				-0.025 (0.052)	-0.022 (0.042)	-0.023 (0.042)
Q3				-0.155 (0.062)	-0.216 (0.052)	-0.216 (0.052)
R^2	0.9836	0.9825	0.9825	0.9857	0.9836	0.9835
$\hat{\sigma}_\varepsilon$	0.0263	0.0261	0.0256	0.0252	0.0255	0.0253

Table 11 B301 and B101 in Different Sectors. Period 1974:2 - 90:3 (E 1968:1-90:3).

Sector	Mean B101	Mean B301	SD B101	SD B301	Correlation B101/B301	Regression slope B301 vs B101	Regression slope B101 vs B301
F	6.5	7.2	11.9	12.4	0.62	0.645	0.594
W	3.3	5.6	17.9	14.6	0.78	0.637	0.950
P	2.9	5.2	18.2	12.3	0.61	0.414	0.903
C	8.7	12.1	13.5	9.5	0.67	0.471	0.945
E	11.5	14.0	19.5	19.0	0.89	0.871	0.910

Table 12 The Relationship Between B301 and B101. Estimation period: 1974:2 - 90:3 (E 1968:2 - 90:3).

	F	W	P	C	E
Const	3.45 (2.43)	3.06 (1.88)	8.61 (2.32)	9.72 (1.81)	3.60 (1.76)
B101	0.384 (0.124)	0.380 (0.084)	0.323 (0.082)	0.323 (0.082)	0.594 (0.071)
$B101_{-1}$	0.331 (0.122)	0.266 (0.083)	0.155 (0.083)	0.220 (0.082)	0.326 (0.072)
Q1	-6.60 (3.45)	-8.10 (2.70)	-9.98 (3.27)	-7.58 (2.42)	-6.63 (2.44)
Q2	5.04 (3.30)	9.40 (2.52)	-4.75 (3.20)	0.51 (2.37)	4.86 (2.35)
Q3	-2.46 (3.46)	-0.82 (2.96)	-4.80 (3.19)	-3.04 (2.27)	-0.02 (2.34)
R^2	0.4889	0.7766	0.5042	0.5846	0.8460

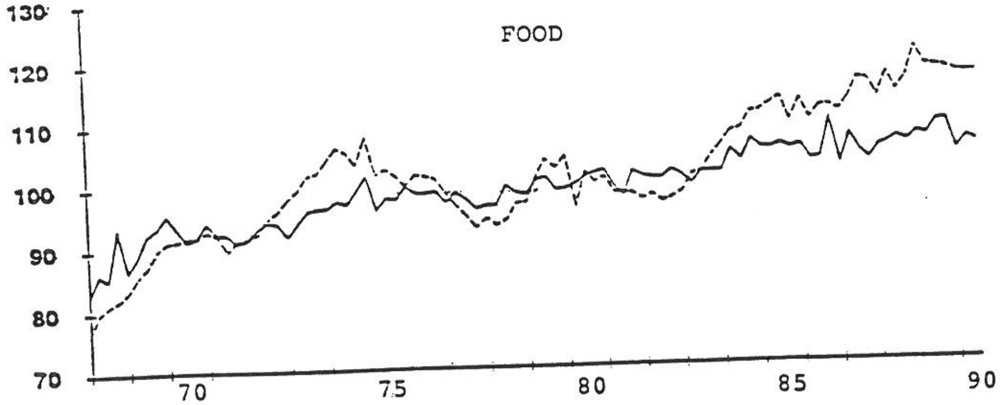
Table 13 Forecasting Models Based on B301.

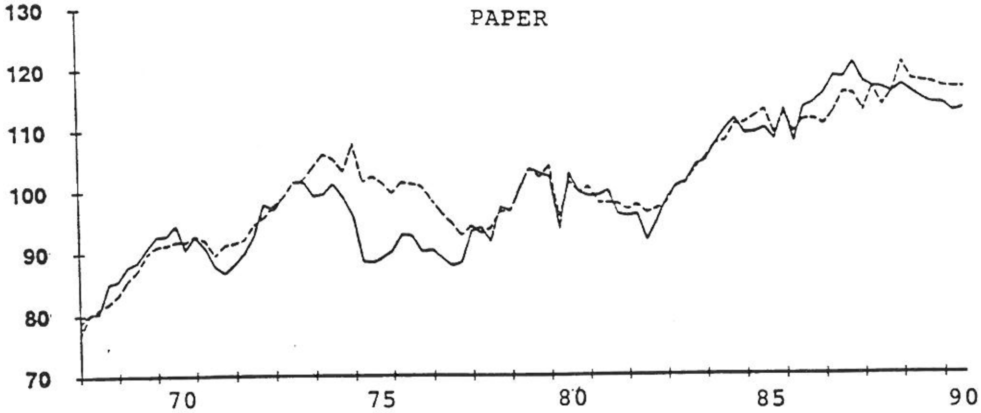
	W	P	C	E
Constant	-0.020 (0.007)	0.001 (0.006)	0.003 (0.009)	0.002 (0.004)
$\Delta 4m_{-1}$	0.443 (0.114)	0.553 (0.103)	0.368 (0.128)	0.233 (0.096)
$\Delta 4m_{-2}$			0.283 (0.137)	0.338 (0.095)
$\Delta 4m_{-3}$				0.160 (0.094)
$\Delta 4m_{-4}$	-0.371 (0.098)		-0.420 (0.115)	-0.346 (0.085)
B301	0.00125 (0.00049)	0.00146 (0.00046)	0.00112 (0.00066)	0.00145 (0.00025)
$B301_{-2}$	0.00128 (0.00050)			
R^2	0.5999	0.6273	0.5106	0.7682
$\hat{\sigma}_\varepsilon$	0.0449	0.0371	0.0392	0.0286
LM-$\chi^2(5)$	6.75	5.90	2.83	3.46
Chow-F	1.06	0.57	0.31	1.89

Table 14 Forecasting Models Based on the Information Set "t-1". Addition of Lagged Values of B101 to Models Based on B301.

	W	P	C	E
Constant	-0.024 (0.007)	0.005 (0.005)	0.002 (0.008)	0.003 (0.004)
$\Delta 4m_{-1}$	0.138 (0.147)	0.185 (0.144)	0.278 (0.133)	0.077 (0.108)
$\Delta 4m_{-2}$			0.241 (0.135)	0.317 (0.091)
$\Delta 4m_{-3}$				0.136 (0.090)
$\Delta 4m_{-4}$	-0.297 (0.094)		-0.386 (0.113)	-0.321 (0.081)
B301	0.00084 (0.00047)	0.00086 (0.00046)	0.00064 (0.00068)	0.00098 (0.00030)
$B301_{-2}$	0.00134 (0.00047)			
$B101_{-1}$	0.00163 (0.00055)	0.00107 (0.00043)	0.00098 (0.00051)	0.00099 (0.00036)
$B101_{-2}$		0.00074 (0.00035)		
$\hat{\sigma}_{\varepsilon}$	0.0416	0.0339	0.0381	0.0273
$\hat{\sigma}_{F}$	0.0474	0.0528	0.0267	0.0373

Figure 1 Seasonally adjusted production in different industrial sectors (———) compared with seasonally adjusted production in "Total manufacturing" (- - - - - - - -) 1968-1990. Index values with 1980 as base year.

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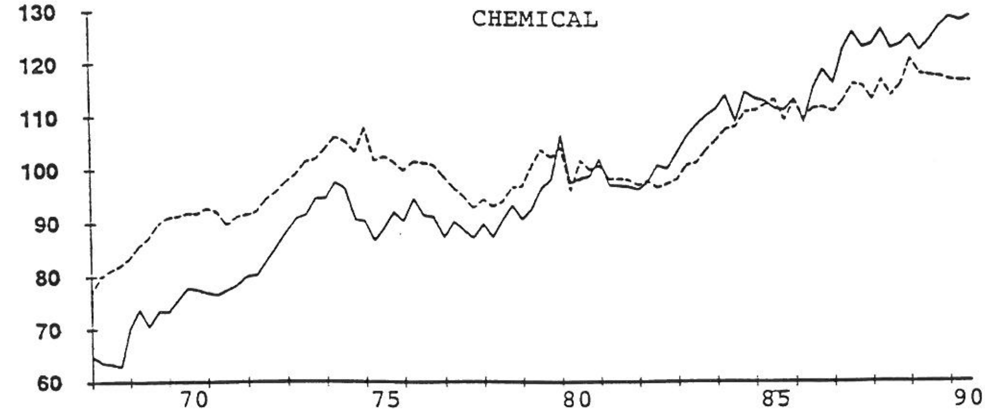
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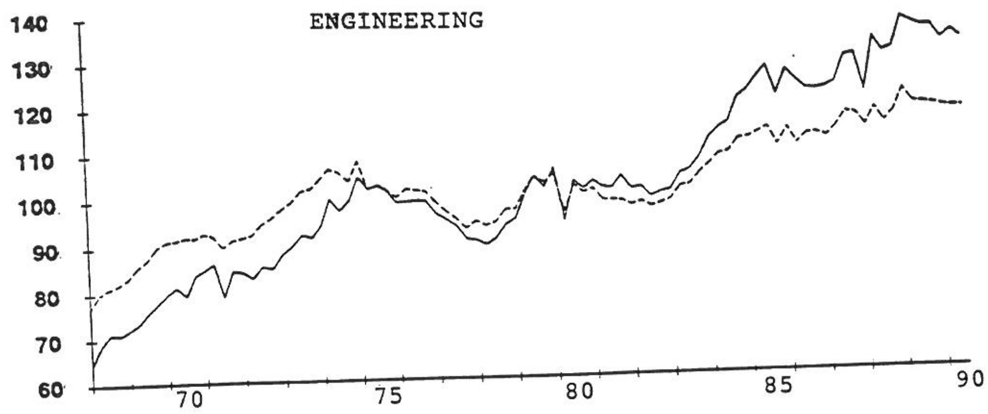
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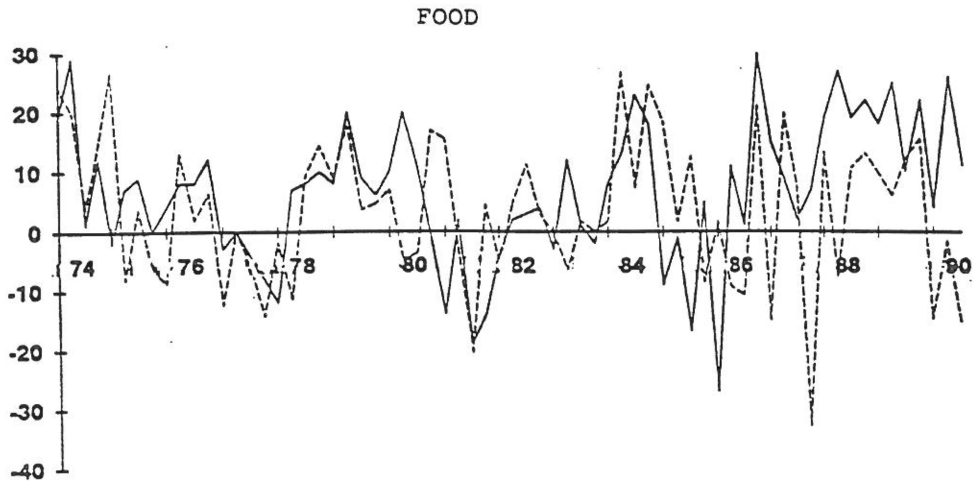
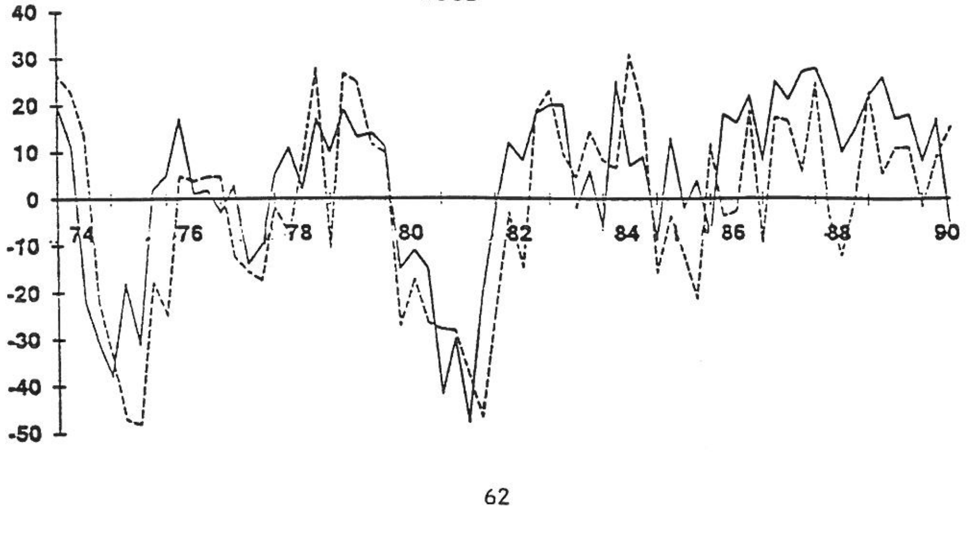
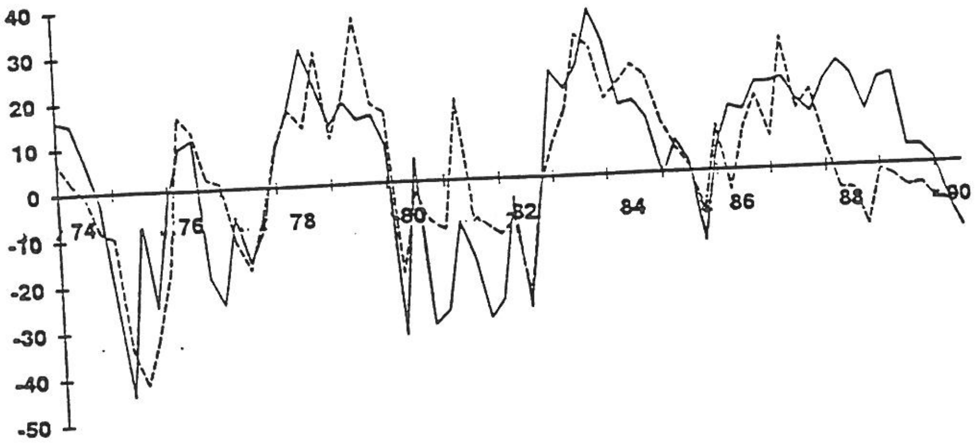
90

Figure 2 Balances for the BTS variable B101 (———) compared with the annual relative production change, Δ4m, (- - - - -) 1974-1990. The latter variable is scaled by different factors to produce a variability that is comparable to that of the balances. Scaling factors: FOOD 5, WOOD 3, PAPER 3, CHEMICAL 2 and ENGINEERING 3. Thus for ENGINEERING the value 30 on the vertical axis implies a growth rate of 10% in the volume series.





PAPER



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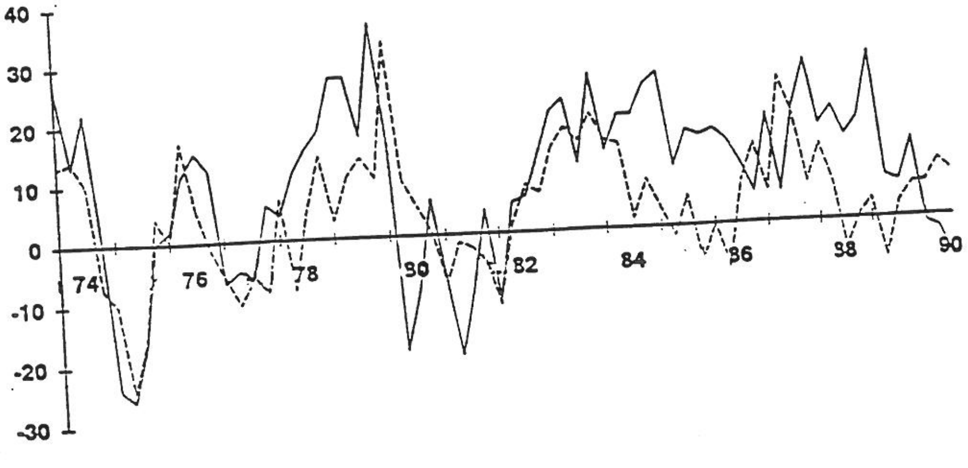

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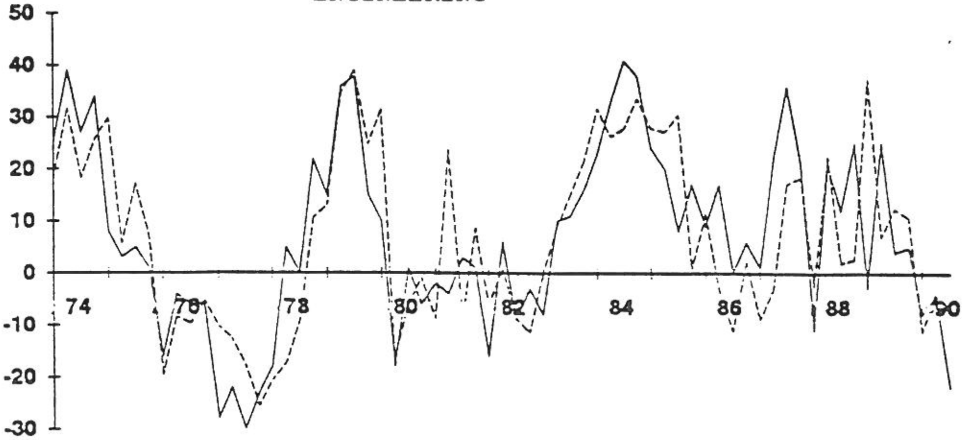

Sambandet mellan kvantitativa produktionsserier och barometerserier inom fem sektorer av tillverkningsindustrin

I ett tidigare arbete har sambandet mellan produktionen inom tillverkningsindustrin mätt som en traditionell volymserie och olika serier i Konjunkturbarometern analyserats. I nu föreliggande arbete utsträcks denna analys till att omfatta fem sektorer av tillverkningsindustrin. De sektorer som behandlas är livsmedel (SNI kod 31), trävaru(33), papper (34), kemisk (35) och verkstadsindustri exklusive varv (38 exklusive 3841).Mera exakt studeras hur mycket av variationen i respektive volymserie som kan förklaras med hjälp av barometerserier och då speciellt serierna B101 (produktionen detta kvartal jämfört med föregående) och B301 (beräknad produktion nästa kvartal jämfört med innevarande). Barometerserierna behandlas enbart i form av nettotal.

Barometerserierna är i allmänhet formulerade i termer av förändringar. En jämförelse med volymserien kräver därför att den uttrycks som förändringar. Två olika alternativ används, nämligen procentuella förändringen jämfört med föregående kvartal och procentuella förändringen jämfört med samma kvartal föregående år. De kvartalsvisa förändringarna domineras helt av de säsongsmässiga variationerna och denna serie lämpar sig inte för direkt analys av konjunkturförlopp i motsats till serien över årliga förändringar där konjunkturmönstret framträder mycket väl.

Ett mycket viktigt inledande resultat är att en jämförelse mellan ex ante serien B101 och den årliga förändringstakten visar på en mycket god samvariation mellan serierna speciellt under tiden fram till 1985 för de flesta av de studerade sektorerna. Detta bekräftar de tidigare resultaten för hela tillverkningsindustrin. En tolkning av detta är att uppgiftslämnarna till Konjunkturbarometern primärt tenderar att göra jämförelser med motsvarande kvartal föregående år när de besvarar enkäten, snarare än att göra jämförelser med föregående kvartal. Huvuddelen av modelleringsarbetet sker därför med volymserien i form av årlig förändringstakt som beroende variabel.

Den grundläggande modell som används vid analyserna är den s k ADL modellen, som relaterar den årliga förändringstakten i volymserien till laggade värden på den beroende variabeln och barometerserier. Även barometerserierna kan förekomma i laggad form.Som standard används en s k autoregressiv modell, där enbart laggade termer av serien själv ingår. Sedan analyseras i vilken utsträckning barometerserier kan förklara den återsående variabiliteten.

Det visar sig att barometerserien B101 leder till en förbättring av den bästa autoregressiva modellen för samtliga fem behandlade sektorer. För livsmedelsindustrin är förklaringsvärdet både hos den grundläggande autoregressiva modellen och det ytterligare förklaringsvärdet hos variabeln B101 så litet att modelleringen måste anses som misslyckad. Bland övriga sektorer ger serien B101 relativt sett minst ytterligare förklaringsvärde inom den kemiska industrin. Den ger dock även här ett klart signifikant ytterligare bidrag till en rent autoregressiv modell. En undersökning av om andra barometerserier än B101 kan förbättra modellerna ytterligare visar att så är fallet för två av sektorerna. Ökningen av förklaringsvärdet är dock blygsam och med hänsyn till det stora antal variabler som undersöks måste det anses tveksamt om andra variabler än B101 verkligen har betydelse.

Modeller baserade på kvartalsvisa förändringar analyseras också med samma grundläggande metodik. Det visar sig då att resultaten i viss mening blir likartade med de som erhölls vid analysen baserad på årliga förändringar, trots att serierna ser så olika ut rent deskriptivt. Även i detta fall visar sig serien B101 ha ett stort förklaringsvärde beträffande utvecklingen av industriproduktionen. Både modellerna baserade på årliga och kvartalsdifferenser kan ses som specialfall av en mera generell modell. De restriktioner på den generella modellen som leder till specialfallen testas och visar sig på det hela taget väl vara förenliga med data.

De hittills behandlade modellerna är inte genuina prognosmodeller, eftersom de baseras på barometerserier från samma kvartal. Eftersom barometerdata föreligger tidigare än volymdata och speciellt tidigare än volymdata i reviderad form kan dock även modellerna baserade på ex post serier sägas vara en form av prognosmodeller. Modeller som utnyttjar ex ante serier är dock genuina prognosmodeller i den meningen att de baseras på information som är tillgänglig vid tidpunkten "t-1". Som en förberedelse till konstruktionen av prognosmodeller analyseras sambandet mellan ex ante och ex post variablerna. Det visar sig då att samvariationen mellan prognosen i ex ante variabeln och utfallet i ex post variabeln mätt som en enkel korrelationskoefficient varierar mellan drygt 0.60 för livsmedels och pappersindustrin och 0.89 för verkstadsindustrin. Ex ante variablerna tenderar dock att "släpa efter", vilket visar sig genom att inte bara ex post variabeln vid samma tidpunkt påverkar ex ante variabeln utan också laggade värden av ex post variabeln har betydelse. Det tycks också finnas vissa systematiska säsongeffekter i ex ante variablerna relativt ex post variablerna.

För fyra av sektorerna har prognosmodeller konstruerats genom att vid ADL modellering använda variabeln B301 i stället för B101. Det visar sig då att även B301 har ett stort förklaringsvärde. Förklaringsvärdet är dock alltid lägre än om B101 används och för den kemiska industrin är B301 inte signifikant. Denna sektor är också det enda fall där andra ex ante variabler signifikant förbättrar modeller med B301. I den informationsmängd som är tillgänglig vid tidpunkten "t-1" ingår också laggade värden av ex post variabler, främst B101. Effekten av att addera denna variabel i laggad form till prognosmodellerna baserade på B301 har analyserats. Återigen med den kemiska industrin som undantag är B101 i laggad form signifikant. I allmänhet reduceras effekten av B301 i dessa modeller, i vissa fall så att den inte längre är signifikant.

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