Business Cycle Forecasting in Sweden: a Problem Analysis

Anders H Westlund and Sven Öhlén

SCB

R & D Report
Statistics Sweden
Research - Methods - Development
U/STM - 41

Från trycket December 1987
Producent Statistiska centralbyrån, Enheten för statistiska metoder
Ansvarig utgivare Staffan Wahlström
Förfrågningar Sven Öhlén, tel. 08 7835095

ISSN 0283-8680
Printed in Sweden
Garnisonstryckeriet, Stockholm 1987

INLEDNING

TILL

R & D report : research, methods, development, U/STM / Statistics Sweden. – Stockholm : Statistiska centralbyrån, 1987. – Nr 29-41.

Föregångare:

Promemorior från U/STM / Statistiska centralbyrån. – Stockholm : Statistiska centralbyrån, 1986. – Nr 25-28.

Efterföljare:

R & D report : research, methods, development / Statistics Sweden. – Stockholm : Statistiska centralbyrån, 1988-2004. – Nr. 1988:1-2004:2.

Research and development : methodology reports from Statistics Sweden. – Stockholm : Statistiska centralbyrån. – 2006-. – Nr 2006:1-.

R & D Report, U/STM 1987:41. Business cycle forecasting in Sweden: a problem analysis / Anders H. Westlund; Sven Öhlén.
Digitaliserad av Statistiska centralbyrån (SCB) 2016.

urn:nbn:se:scb-RnD-USTM-1987-41

Business Cycle Forecasting in Sweden; a Problem Analysis

by

Anders H. Westlund* and Sven Öhlén**

* Stockholm School of Economics

** Statistics Sweden

1. Introduction

Economists and decision makers will derive greatest benefit from business cycle analyses, if such analyses with a satisfactory reliability indicate changes in the business situation well in advance before such changes actually occur. The meaning of the concept "satisfactory reliability", of course varies between different situations with different requirements with respect to the size and ingredients of the forecast errors, the probability of incorrect signals pertaining to turning points of the business cycles, etc. Likewise, the concept "well in advance" is relative and affiliated with the requirements about time leads of each specific decision process. The economic policy in a country, of course, should be reconciled to the business cycle situation where serious effects caused by an extreme business cycle situation, should be partly counteracted. The efficiency of the economic policy is now a function of the preparedness to forthcoming changes. The earlier dependable signals of changes may be produced, the better the decisions will become. Early information about forthcoming business cycle changes is, of course, also essential to separate enterprises, which in this way may make, e.g., their investment decisions more efficient.

Thus, it is inherent that the debate of business cycle analysis recently has indicated a need for what is called an "Early Warning System", i.e., a system for analyses and forecasting that gives early signals with regard to forthcoming business cycle changes. Such an "Early Warning System" has been inquired also in Sweden by different business cycle analysts, and, thus, Statistics Sweden has initiated a research program with the purpose of developing such a system (from now called EWSIS, Early Warning System In Sweden).

In addition to producing reliable signals well in advance before the business cycle changes, the system should be relatively simple by construction. That means, e.g., that system limits are verified such that complex econometric structural models will not be specified. It should be observed that this, of course, in no way expels the claim that each model used within EWSIS should be essentially motivated by economic theory. The demand for simplicity is, however, vital for the way EWSIS will be constructed. On the other hand, smaller econometric models, and perhaps above all, different unirelational structural models will be indispensable within EWSIS. So called "leading indicators", i.e. variables with a certain lead to the basic reference series of the business cycle, have traditionally been very essential in quantitative business cycle analysis. That is the case also within EWSIS. The fact that a significant lead is a key prerequisite to each "Early Warning System" suggests that the interest here is focused on indicators with a lead, e.g., more than six months. The use of leading indicators in the model system, of course, implies requirements for methods to identify (specify) dynamic structures. As economic theory is not expected to essentially contribute to this dynamic specification process, the methodology of transfer function specification merges being applicable. On the other hand, however, the non-structural time series analysis is expected to be a less suitable approach to achieve the purposes characterizing EWSIS.

As stated above, essential parts of the now existing business cycle analysis is partly based on leading indicators. As an example, OECD has elaborated a forecasting system that is completely based on composite indices of leading indicators. In the case of Sweden, OECD, thus, utilizes twelve indicators that are weighed together into an index (see Table 2.1). It is natural to explore whether, and if so, to what extent EWSIS in some way should be related to the OECD system. At least it should be examined whether certain OECD indicators for Sweden also constitute a pertinent input to EWSIS. In particular the interest, of course, is focused on those indicators characterized by long leads. In some important respects, however, the construction of EWSIS will follow other tracks than those characterizing the OECD system. That is the case in weighing together indicators, where EWSIS will utilize more of structural analytic approaches (within the OECD system, the weights of the composite index are not estimated but specified a priori to be identical for every indicator). Furthermore, and this is perhaps the most essential difference, the construction of EWSIS originates in the fact that it is necessary to consider the variations in lead over time. For one thing there is a significant difference in lead between recession and economic upswing, and for another the variation in lead between different business cycles is too considerable just to be neglected. This is actually one aspect of the much more general problem of structural variability that complicates each structural analysis, and above all economic forecasting (see Westlund and Zackrisson, 1986 and Westlund, 1987). The EWSIS model is therefore expected to vary over time with respect to its functional form as well as in its parameters. In particular, the dynamic structure will change (varying leads), and the weights of the model are expected to change over time. Therefore, the construction of EWSIS presupposes methodology that will identify the existence of such structural variability, but also methodology to characterize the variability and to estimate models subject to the variability.

Similarly, of course, the forecasting process will also be affected by historical structural variations. But the forecasting process is further complicated by assumptions of future structural variations, e.g., with respect to degree of lead and relative weights for the different leading indicators. In spite of the claims for simplicity within EWSIS mentioned above, the premiss of EWSIS must be that the reliability of the system will be satisfactory only if the structural variability in some way is considered. As the OECD system for business cycle forecasting based on leading indicators actually will be one influential reference point for EWSIS, the OECD system will be more thoroughly presented in Ch. 2. Furthermore, that chapter will include some results from a partial evaluation of the system.

Good quality of data (reliability as well as validity) is, of course, an ultimate aspect of quantitative economic structural analysis and forecasting. Within the area of business cycle analysis data are unfortunately often just preliminary in the beginning and then impaired by significant errors. The data are therefore revised once or several times. These data problems discourage every aspiration to achieve an "Early Warning System". To reduce in these respects the negative consequences for EWSIS monthly data are concluded being more attractive than quarterly data. Furthermore, it will be analyzed whether the problems of preliminary data may be reduced by using certain recursive (and adaptive) data adjustment procedures based on Kalman filtering. How such a recursive data updating procedure may be entailed into EWSIS is further discussed in Ch. 3.

It has been stated above that EWSIS will be constructed with relatively high reliability. One way to elevate that is to apply at least two parallel systems for anlysis and forecasting. Therefore, some kind of so-called statistical surveillance of the business cycle process is suggested. That will support the econometrically and structurally related forecasting process suggested earlier. By statistical surveillance we mean statistical methodology with the purpose of quickly discovering essential changes in a certain process and separate them from accidental and random disturbances. What kind of statistical surveillance that actually will be included into EWSIS is still an open question. Within business cycle analysis statistical surveillance procedures have been suggested and evaluated by Zarnowitz and Moore (1982). A similar procedure may be positive to use. Certain rather essential modifications and reconciliations must be introduced before the procedure will be a suitable part of EWSIS. Statistical surveillance in general and the above procedure in particular will be further discussed in Ch. 4. Above all the necessary modifications of the procedure are introduced.

2. The OECD approach of Main Economic Indicators (MEI)

As was stated in the introduction, the OECD system of leading indicators will be considered as a reference point for EWSIS. In this chapter the OECD system of leading indicators will be introduced and some issues of main interest for the development of EWSIS will be pointed out. Some critique of the OECD system will be given. However, we should be aware of the need for compromises in the selection of methods. The reason for this is due to the fact that the selected methods done by OECD must cope with different restraints and limitations caused by differences between the member countries of OECD and the other countries analysed by the OECD system. The OECD approach could be further developed if it was used in a separate country. The chapter ends with showing some results from fitting simple auto-regressive regression models where the OECD composite leading index for Sweden is used as an explanatory variable of the Swedish industrial production.

2.1 The OECD approach

The following is based on "OECD Leading Indicators and Business Cycles in Member Countries 1960-1985" (1987), which describes the work done by the Economic Statistics and National Accounts Division of the Economics and Statistics Department of the OECD Secretariat during 1981-1983 in the field of cyclical analysis and leading indicators. The OECD's interest in leading indicators can be dated from the mid-1970's. The OECD's Working Party on Cyclical Analysis and Leading Indicators set up the OECD system during 1978-81. The output from it appeared for the first time in "OECD Economic Outlook" in July, 1981.

The OECD system of leading indicators is not a forecasting system by itself and should not replace properly specified econometric models. It is designed to assist OECD economists in foreasting and economic assessment.

> "Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occuring at about the same time in many economic activities, followed by similarly general recessions, contractions and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own."

This classical definition of business cycles made by Burns and Wesley (1946) is accepted by the Statistics Division in the cyclical analysis carried out at OECD. Some modifications of the definition are, however, made in order to take account of long term tendencies. Fluctuations of business activity according to the definition above are found in almost every time series such as in investment, production, employment, consumption, building and in many financial time series. Important economic activities of the society are selected and classified by the construction of "reference series". This makes it possible to establish the classification of economic series as leading, coincident or lagging with respect to some property of the reference series. The reference series are usually connected to industrial production, either as a single variable or an index of several variables. The approach of leading indicators is based on empirical observations of relatively stable time relationships between some reference series and related series usually called "indicators".

In these chains of events, leading indicators are specially important because they signal future changes of the reference series.

(a) Criteria for selection of leading indicators

The OECD leading indicator system is based on the growth cycle concept, by which is meant a cycle with a positive trend. The selection of a leading indicator is based on the properties of economic significance, length and consistency of the lead with respect to the reference cycle at turning points, the absence of extra or missing cycles, smoothness, freedom from excessive revisions, timeliness and availability of a long run of data of statistically satisfactory reliability with no breaks.

It is also desirable that the cyclical profile should not be too different from the reference series. A candidate leading indicator is selected by means of a peak-and-trough analysis and a cross-correlation analysis. Most attention is given to the mean lead at cyclical turning points and some measure of risk for deviation from the mean lead at peaks, troughs and at turning points. The second method is based on the cross correlation between a candidate leading indicator and the reference series.

According to these criteria the OECD Secretariat has chosen the leading indicators found in Table 2.1 below.

Table 2.1. Leading Indicators for Industrial Production in the OECD Leading Indicator System

INDICATOR	NUMBER OF COUNTRIES
Quantitative series	
Profits, flow of funds	1
Industrial production, branches	4
Orders	4 *
Stocks - materials	12
- finished goods	3
- imported products	1
Consumption	1
Construction approvals	3
Construction starts	6
Sales or registrations of motor vehicles	4
Retail sales	6
Ratio of new employment/employed	1 *
Layoffs/initial claims	2 *
Vacancies	2
Hours worked	3
Wages and salaries per unit of output	3 *
Price indices	4
Foreign exchange holdings	1
Deposits	1
Credit	5
Money supply	17 *
Interest rates	12 *
Stock prices	11 *
Company formation	1
Exports aggreg.	1
Exports components	1
Trade balance	1
Terms of trade	8
Foreign series	4
Business surveys	
General situation	6
Production	12
Orders inflow/new orders	12 *
Orderbooks/sales	9 *
Stocks of raw materials	3 *
Stocks of finished goods	9 *
Capacity utilization	1
Bottlenecks	2
Employment	3
Prices	1

* included in the Swedish composite leading index.

(b) Trend estimation

The OECD system of MEI is based on the concept of "growth cycles" series with a positive trend. Trend estimation is very important in the OECD system for revealing business cycle movements and identifying timing relationships between variables. The method of trend estimation used by OECD for cyclical analysis is called the "Phase Average Trend method" (PAT) developed by NBER (see Boschan and Ebanks, 1978). The PAT-method estimates the trend by splitting the series into cyclical phases by using a preliminary estimation of cyclical peak and trough dates. Then a sequence of points on the trend is defined in the following way:

1. Identify all cyclical phases,
2. calculate the averages M of the series for every phase,
3. calculate a three term moving average of M centered at the midpoints of the phases,
4. make adjustments to the correct level according to the original series and extrapolate to the ends of the series.

The choices of dates of peaks and troughs are crucial in the trend-estimation procedure because these choices define the cyclical phases. The routine by Bry and Boschan (1971) is used at OECD for the identification of peaks and troughs.

(c) Composite indices

The purpose of constructing a composite index is partly to determine a reference indicator for the whole economy and partly the reduction of false signals. By a false signal we mean an unexpected change of the reference series not signalled by an indicator.

Leading indicators with a different <u>periodicity</u> in comparison with the reference series are linearly interpolated so that the reference series and the leading indicator have the same periodicity. If the reference series is monthly and the leading indicator is quarterly, the interpolation uses 1/3 as weight for the separate months of the quarter. Other interpolation techniques as spline-functions could be used. The date of inclusion of a leading indicator is determined by the cross correlation between the reference series and the leading indicator. However, if the correlation for an early sub-period is low, the leading indicator is not selected. The components of the composite index are for that reason not fixed and stable. If a component looses its property of leading the reference series, it could be removed from the composite index. The purpose of smoothing is to reduce the impact of the error component of the leading indicator. This is carried through by means of a MCD moving average.[1]

Other suggested smoothing techniques are:

1. phase-shift filters developed by Statistics Canada (see Rhoades, 1979),
2. Henderson moving averages.[2]

The data lost from the ends of the series due to the moving average process are restored using sets of symmetric weights equivalent to extrapolating for the points lost in taking a k-term moving average by fitting a regression line over the last k points. Another

---

1 Month for Cyclical Dominance. MCD is defined as the shortest span of months for which the I/C ratio is less than unity. I and C are the average month-to-month changes (without regard to sign) of the irregular and cyclical components of the series, respectively. The OECD convention is that the maximum for MCD is 6 for monthly data and the corresponding MCD for quarterly data is 2. The I/C is used as a measure of the smoothness of the series.

2 See "The X-11 Variant of the Census Method II Seasonal Adjustment Program", US Dept. of Commerce, Bureau of the Census Technical Paper No. 15.

suggestion of restoring the ends is to use ARIMA models. Normalization is used to deal with different scale problems and units of measurements of the leading indicators. The relative contribution from the individual indicators to the composite indicator for a separate country is done by equal weights. For constructing composite indices of all OECD countries, the individual figures of the reference series are used as weights. Other suggested methods are principal component analysis, regression methods, expert opinions and methods using proportionality of the cross correlation with the reference series at selected lead. From a research point of view, this seems to be an important topic for examination.

All survey information is located to the month of the survey regardless of the "target point of time". For instance, investment plans measured in t-k for investment in t are located to time t-k. The composite index is then calculated by averaging the normalized indices prepared from the earlier stages. Some problem arises when the number of components of the composite index is varying in time. To fit the incomplete composite index to the "full" index, a linking method is used. An alternative method is the extrapolation backwards by ARIMA methods, exponential smoothing, etc.

At last the estimated trend for the reference series is restored to the composite indicator by multiplying the amplitude-adjusted composite indicator by the trend of the reference series (calculated earlier by the phase-average trend method). The idea is to provide an indicator from which the irregular component has been greatly diminished, and which has the same form of cyclical component and the same trend component as the reference series but for which the cyclical component leads that of the reference series.

2.2 Autoregressive models for the Swedish industrial production

The group of 12 leading indicators marked with "*" in Table 2.1 has been chosen for components of the composite leading index for Sweden. Five of these are quarterly series and the others are monthly series. The leading indicators have a median lead varying from two months (order books tendency) to approximately 19 months (interest rate of government bonds). The reference series for Sweden is a monthly industrial production index which is published by Statistics Sweden. These series of leading indicators and the reference series are processed by OECD according to the scheme which is outlined in Section 2.1. The output is smoothed, seasonally adjusted and normalized *series of a composite leading indicator* CLI_t and the reference series "production volume index" PVI_t. As has been pointed out in the proceeding chapter, the series have been cleaned for undesirable sources of variation, including random variation. The two series should in some sense be reflected images of each other. A change of the composite index at time t-k should for some k>0 signal a change in the reference series at time t. In developing the EWSIS system in Sweden, we have considered the use of the composite indicator in models which could be used for direct forecasting purposes.

If the OECD system has been successful, we should demand a simple structure of modeling PVI by CLI. Preliminary tests of the OECD approach have been carried through by use of the following models:

$$(2.1) \quad PVI_t = \gamma_1 + \beta_1 CLI_t + v_{1t}$$

$$(2.2) \quad \delta PVI_t = \beta_2 \delta CLI_t + v_{2t}$$

where

PVI_t = production volume index month t

CLI_t = composite leading index month t

γ_i, β_i = parameters

δ = monthly change in the variable

v_{it} = a stochastic variable.

We are investigating the following:

(i) What is the fit of the models (2.1) and (2.2) for the period 1960-1986?

(ii) Is it necessary to specify an autoregressive structure of the random variable of the models and if so, how much does the autoregressive structure contribute to the fit in comparison with the leading indicator?

(iii) Is there any indication of structural changes during 1960-1986?

In the introduction we stated that a successful development of the EWSIS system probably would require procedures capable of handling problems of structural change. In connection with this view, the time period 1960:1-1986:11 has been partitioned into

Per. 1: 1960:1-1973:12

Per. 2: 1974:1-1986:11

Per. 12: 1960:1-1986:11

and the models are compared for these periods. Per. 1 covers the period up till the first "oil crisis". Per. 2 is after the first "oil crisis" and Per. 12 corresponds to the whole period. Models (2.1-2) have been estimated for these periods with the use of SAS (Statistical Analysis System Rel. 5.16). The estimation method is "unconstrained least squares". This method minimizes the residual sum of squares simultaneously with respect to the regression parameters and the autoregressive structure. The order of the autoregressive structure is set to 12, which means that we expect the autoregressive structure to have a memory of one year.

The leading indicator CLI_t has been lagged by 8 months because the cross correlation between CLI_{t-k} and PVI_t reaches its peak value for k=8. The notation of the lagged composite indicator is CLAG8 below.

Results

a) Model (2.1) of the level of production volume index

Estimation by ordinary least squares produces residuals which are strongly serially correlated. For that reason the following autoregressive structure of v_t is adopted:

(2.3) $v_t = \epsilon_t - \alpha_1 v_{t-1} - \alpha_2 v_{t-2} - \dots \alpha_{12} v_{t-12};$

the autoregressive structure consists of 12 autoregressive parameters and a random variable with a "proper" behavior. The autoregressive models for the three periods are found in Tables 2.2-4 below.

Table 2.2. An Autoregressive Model for the Production Volume Index 1960:1 - 1973:12. Unconditional Least Squares.

VARIABLE	ESTIMATE	STD ERROR	T RATIO	APPROX PROB
INTERCEPT	54.551	6.060	9.002	0.0001
CLAG8	0.457	0.060	7.590	0.0001
α_1	-1.301	0.077	-16.966	0.0001
α_2	0.471	0.123	3.833	0.0002
α_3	-0.231	0.093	-2.486	0.0140
α_5	0.729	0.094	7.731	0.0001
α_6	-0.759	0.123	-6.147	0.0001
α_7	0.403	0.122	3.295	0.0012
α_8	-0.353	0.092	-3.836	0.0002
α_{10}	0.350	0.092	3.787	0.0002
α_{11}	-0.245	0.076	-3.209	0.0016

REG RSQ 0.282 TOTAL RSQ 0.9574

DURBIN-WATSON 1.9600

Table 2.3. An Autoregressive Model for the Production Volume Index 1974:1 - 1986:11. Unconditional Least Squares.

VARIABLE	ESTIMATE	STD ERROR	T RATIO	APPROX PROB
INTERCEPT	62.673	12.564	4.988	0.0001
CLAG8	0.407	0.108	3.752	0.0003
α_1	-0.991	0.015	-65.806	0.0001

REG RSQ 0.0899 TOTAL RSQ 0.9676

DURBIN-WATSON 1.8241

Table 2.4. An Autoregressive Model for the Production Volume Index 1960:1 - 1986:11. Unconditional Least Squares.

VARIABLE	ESTIMATE	STD ERROR	T RATIO	APPROX PROB
INTERCEPT	58.858	6.984	8.428	0.0001
CLAG8	0.423	0.067	6.332	0.0001
α_1	-1.078	0.024	-44.780	0.0001
α_5	0.473	0.061	7.806	0.0001
α_6	-0.378	0.054	-6.978	0.0001
	REG RSQ	0.1159	TOTAL RSQ	0.9685
	DURBIN-WATSON	1.8171		

REG RSQ = Multiple correlation coefficient due to the systematic part of the model

TOTAL RSQ = Total multiple correlation coefficient

DURBIN-WATSON = Durbin Watson test for positive autocorrelation

CLAG8 = Final composite index according to OECD lagged 8 months.

As could be seen from these tables, the total fit is quite high for every period. However, the autoregressive part of the model is dominant and quite complex, especially for the early part up to the first oil crisis. The composite leading indicator is statistically significant but its contribution to the fit is outperformed by the autoregressive structure. Although there does not seem to be any sign of a structural change of the composite leading index, its contribution to the fit has been substantially reduced during 1974-1986. The complex autoregressive structure has changed considerably to an AR(1) model, where the autoregressive parameter is dominant. It is most likely that not much is lost if PVI is modeled by a pure univariate time series AR(1) model.

We cannot at this moment explain the autoregressive structure, but it might be that the OECD technique in fact causes this autoregressive structure. Other sources of explanation of the autoregressive structure could be connected with different and changing properties of lead among the indicators.

b) Model (2.2) of changes of the production volume index

The corresponding models for changes of PVI are shown below in Tables 2.5-7.

Table 2.5. An Autoregressive Model for Monthly Changes of the Production Volume Index 1960:1 - 1973:12. Unconditional Least Squares.

VARIABLE	ESTIMATE	STD ERROR	T RATIO	APPROX PROB
LAGCIDIF	0.402	0.063	6.349	0.0001
α_1	-0.268	0.059	-4.540	0.0001
α_5	0.541	0.076	7.133	0.0001
α_{10}	0.258	0.072	3.567	0.0005
α_{12}	-0.216	0.065	-3.341	0.0010
	REG RSQ	0.2111	TOTAL RSQ	0.4284
	DURBIN-WATSON	1.8163		

LAGCIDIF = Monthly change of the composite leading index lagged 8 months

Table 2.6. An Autoregressive Model for Monthly Changes of the Production Volume Index 1974:1 - 1986:11. Unconditional Least Squares.

VARIABLE	ESTIMATE	STD ERROR	T RATIO	APPROX PROB
LAGCIDIF	0.444	0.088	5.020	0.0001
α_5	0.312	0.081	3.856	0.0002
	REG RSQ	0.1497	TOTAL RSQ	0.1740
	DURBIN-WATSON	1.7013		

Table 2.7. An Autoregressive Model for Monthly Changes of the Production Volume Index 1960:1 - 1986:11. Unconditional Least Squares.

VARIABLE	ESTIMATE	STD ERROR	T RATIO	APPROX PROB
LAGCIDIF	0.432	0.061	7.064	0.0001
α_1	-0.188	0.050	-3.732	0.0002
α_3	-0.131	0.051	-2.561	0.0109
α_5	0.425	0.055	7.706	0.0001
α_{10}	0.144	0.055	2.605	0.0096
α_{12}	-0.116	0.052	-2.253	0.0249
	REG RSQ	0.1427	TOTAL RSQ	0.2736
	DURBIN-WATSON	1.9783		

As would be expected, monthly differencing reduces the autoregressive structure in favour of the composite index. The autoregressive structure is still quite strong for the period up till the first oil crisis. The composite leading index "dominates" the autoregressive part for the period after the first oil crisis. However, the model according to Table 2.6 could only explain about 17 percent of the monthly changes in PVI.

2.3 Summary

The estimated models of the production volume index for Sweden show that there are considerable problems in using OECD's composite leading index in simple regression models. At least for the early part of the series, it is necessary to specify a relatively complex autoregressive structure of the residuals in order to meet necessary statistical requirements. The autoregressive structure has changed from a quite complex one to a simpler. This indicates that it would be wise to look carefully upon the selection of times for the estimation of models of PVI. A result of the utmost importance is that the autoregressive structure is the most prominent part of the models (at least for models of levels) while the leading index insignificantly contributes to the fit. As a general conclusion, we must state that it is very much in doubt if the composite leading index for Sweden produced by OECD could be used as a starting point for a model of the production volume. That does not mean that we state that the OECD system of leading indicators is of no value for the analysis of Swedish business cycles. The OECD system is designed to shed light on the regions of "changes of the business cycles". The extraction of these points would however reduce the data up to a limit where we could not estimate with reasonable statistical qualities. Another use of the OECD system would be to adopt a statistical surveillance system according to Zarnowitz and Moore. This discussion will be brought further in Chapter 4

3. On a strategy for possible reduction of preliminary data problems

The reliability of EWSIS will, of course, be highly dependent on the quality of input data. The leading indicators constituting the input data are, however, mostly preliminary and characterized by significant errors. Thus, the monthly indicators are revised several times as a rule. The first revision is determined within a few months. Although the time lag between first publishing the preliminary data and the first revision is relatively short, this extra delay is judged being vital for the attempts to design an "Early Warning System" for business cycle analysis. Thus, EWSIS either has to rely on incorrect preliminary indicator data, or to include some strategy for preliminary revising preliminary data. In the present chapter such a strategy for data revision is outlined, a strategy that is expected to improve the EWSIS procedure compared to the case of using just unrevised data.

The data generation procedure is expected to create indicator data with errors that are correlated over time. For example, the errors of a certain indicator will involve bias properties. Therefore, the revisions of preliminary data will also be correlated over time, which means that a knowledge of earlier revisions will give a possibility to forecast the actual revision. On the other hand, it is, of course, possible to forecast the actual indicator series, i.e. after necessary revisions, by, e.g., a time series analysis on the revised indicator series. Our present strategy for preliminary data revision will be based on a combination of such a general forecast of indicator values and the more explicit consideration of earlier data revisions. The question is now, how such a combination is to be determined. One way is to follow the principles of Kalman filtering (see, e.g., Kalman, 1960).

Now, let us consider the following forecast relation:

(3.1) $L_t^i = \bar{L}_t^{f\,i} + v_t^i$; $i = 1, \ldots, I;\quad t = 1, \ldots, T$

where L_t^i denotes a leading indicator, and $\bar{L}_t^{f\,i}$ denotes the expected value of the forecast of L_t^i. Furthermore, the error term is characterized by

(3.2) $v_t^i \sim N(0, C_t^{iL})$.

The variance C_t^{iL} is estimated by considering the previously observed forecast errors.

Data revising is introduced into the strategy within the following measurement error relation:

(3.3) $L_t^{ip} = G_t^i L_t^i + w_t^i$; $i = 1, \ldots, I;\quad t = 1, \ldots, T$

where L_t^{ip} is the time series containing preliminary data of L_t^i, G_t^i denotes transitions, and the disturbance term w_t^i is described by

(3.4) $w_t^i \sim N(0, C_t^{ip})$.

Here, the variance C_t^{ip} is determined by observing earlier data revisions.

(3.1-4) now correspond to measurement and state relations of

Kalman filtering, i.e., we are able to conditionally estimate the preliminary value of the leading indicator L_t^i, and, also to estimate conditionally the corresponding covariance matrix:

$$(3.5)\quad \hat{L}^i_{t/L_t^{ip}} = \bar{L}_t^{if} + G_t^{*i}(L_t^{ip} - G_t^i \bar{L}_t^{if})$$

where

$$(3.6)\quad G_t^{*i} = C_t^{iL} G_t^{i'} (G_t^i C_t^{iL} G_t^{i'} + C_t^{ip})^{-1}$$

denotes the so-called "gain" matrix.

The corresponding covariance matrix of $\hat{L}^i_{t/L_t^{ip}}$ is

$$(3.7)\quad C^{L^i}_{t/L_t^{ip}} = (I - G_t^{*i} G_t^i) C_t^{iL}.$$

The preliminary estimate of L_t^i according to (3.5) is a weighted average of preliminary reported data and forecast data with weights being determined according to the relative precision of the two sources of information for the state of the economy. That procedure will be introduced and evaluated within EWSIS.

4. A sequential procedure for statistical surveillance of business cycles

4.1. Background

Ordinary extrapolative forecasting of business cycles is complicated, basically because of the existence of significant structural variabilities in business cycle processes and in related economic structures. The reliability of forecasting generally decreases quickly with increasing forecasting horizons. In principle the applicability of forecasting strategies is restricted to short term forecasting. It is obvious that an "Early Warning System" for analysis and forecasting of business cycles requires efficient forecasting procedures but, if possible, also some supporting statistical surveillance approach. Statistical surveillance, i.e. statistical methodology for continuously observing processes in order to indicate when changes occur, is of basic interest in the analysis of medical processes as well as within quality control of industrial production, etc. In economics, it is often important to discover that a positive trend in an economic series has switched before the recession develops too far. In particular, it is extremely important to discover without unnecessary delays, recessions and recoveries in business cycle reference series. In general, this problem is complicated by the existence of more or less random changes. By statistical analysis (such as statistical surveillance) it is sometimes possible to separate essential and permanent changes from the occasional irregularities. Statistical surveillance procedures are often sequential in nature, and should be designed to fulfil postulated requirements on reliability and precision, as well as with respect to the time delay between actual changes and indications of these changes. In this chapter a procedure for business cycle forecasting and surveillance is described.

4.2. A sequential procedure

The main purpose here is to briefly describe a sequential procedure[3] for indicating business cycle recessions and recoveries (and business cycle peaks and troughs). The basic reason for introducing the procedure is its promising ability (at least within the U.S.) as an instrument for statistical surveillance and forecasting of business cycles. Statistics Sweden has now initiated an evaluation of the procedure within the framework of EWSIS. As a result of that evaluation process, it will, hopefully, be possible to revise and adapt the procedure in such directions that it will constitute one possible part of an EWSIS.

The procedure is designed to produce early and then sequentially confirming signals of business cycle peaks and troughs. This is obtained by monitoring smoothed rates of change in leading and coincidental indicators, and by relating these changes to certain a priori determined critical limits of change.

The reference series of main interest will here be an index of industrial production (PVI_t); total, or related to specific trades. Alternatively, the business cycle process is represented by a composite index of a number of coincident indicators of various parts of the economy. Furthermore, a composite index L_t of leading indicators

---

3 The procedure is suggested and evaluated within the U.S. business cycle analysis in Zarnowitz and Moore (1982) (see also Ch. 4 in Moore, 1983).

L_t^i related to, e.g., PVI_t is verified; where

$$(4.1) \quad L_t = f_t^L\left[L_t^i,\ W_t^L\right];\ i = 1,\ \dots,\ I\ ;\ t = 1,\ \dots,\ T,$$

where W_t^L denotes a weight vector, and f_t^L a weight function.

It is necessary to determine the set of criteria to be used for selecting leading indicators. One criterion, of course, deals with the question of the suitable size of the lead. It is also urgent to identify some criterion according to which the number of indicators involved (i.e. I) will be settled.

Usually, f_t^L, as well as W_t^L, will be constant over time. Due to lead variability and variations with respect to the relative importance of various leading indicators, the index construction itself, as well as the weighing of individual indicators, sometimes will have to change over time. One important aspect of the evaluation process will be to check for the existence of and the need for such possible variabilities in the index construction.

Most of what is said about L_t is also of relevance in verifying the composite index of coincident indicators:

$$(4.2) \quad C_t = f_t^c\left[C_t^j,\ W_t^c\right];\ j = 1,\ \dots,\ J;\ t = 1,\ \dots,\ T.$$

The construction of C_t involves the choice of J as well as of individual C_t^j. Furthermore, a potential variability in f_t^c and W_t^c over time must be identified and characterized.

It might be possible to replace C_t by PVI_t, i.e. instead of using the coincident indicator index, the following analysis might be based on a statistical surveillance of PVI_t itself. The two alternative strategies should be compared.

The two weight vectors (W_t^{ℓ}, ℓ = L, C) depend on the overall performance scores of individual indicators (as the result of a scoring procedure with respect to the criteria chosen). Furthermore, the indicators are standardized as well as trend adjusted before including them into the composite indices. Instead of analysing the composite indices directly, the procedure involves the monitoring of rates of change in the composite indices, i.e. ΔL_t and ΔC_t, where, e.g.,

$$(4.3)\quad \Delta L_t = \left[L_t / \frac{1}{12} \sum_{t'=t-12}^{t-1} L_{t'} \right]^{12/6.5}$$

(ΔC_t is determined accordingly)

(4.3) corresponds to a smoothed six-month change in the index series, with the influence from erratic fluctuations in the index reduced by the use of the twelve-month centered moving average in the denominator.

The ΔL_t and ΔC_t trajectories over time are now compared with two limits, viz. with Δ_t^* and 0, where Δ_t^* is a measure of the long-run trend rate of the growth in the economy as a whole for t=1 to t=T. As a special case, we may assume that $\Delta_t^* = \Delta^*$, i.e. one single trend rate over the period is used. It might, however, be worthwhile to consider a number of trend shifts over the period of analysis.

It should be remembered that the present analysis focuses on the verification of changes in growth cycles (i.e. cycles in the deviations from a trend), and only indirectly on business cycle recessions and recoveries. A business cycle will involve at least one growth cycle but it might also include two or more growth cycles. That will happen, e.g., when the changes in business cycle reference series decrease below the long-run trend, but still are non-negative. In a growing economy it is also obvious that growth cycle peaks will lead the business cycle peaks. As for the growth and business cycle troughs, these will in general occur more or less at the same time.

In order to design and evaluate the present procedure for statistical surveillance and forecasting of business cycles there must be a chronology for business cycle peaks and troughs. Of course, a corresponding chronology for growth cycles might be used, but conclusions drawn from that frame of reference will not directly be applicable for business cycle analysis.

One very simple version of the sequential procedure for business cycle surveillance works as schematically illustrated by Fig. 4.1.

Signal 1 (s_1) of a possible forth-coming recession is given when

$$\Delta L_t < \Delta_t^* \qquad (4.4)$$

$$(\text{and } \Delta C_t > 0; \text{ often } > \Delta_t^*)$$

Signal 2 (s_2), confirming s_1, is given when

$$\Delta L_t < 0 \qquad (4.5)$$

and

$$\Delta C_t < \Delta_t^*$$

Finally, signal 3 (s_3) further confirming s_1 and s_2, when

$$\Delta L_t < 0 \qquad (4.6)$$

and

$$\Delta C_t < 0$$

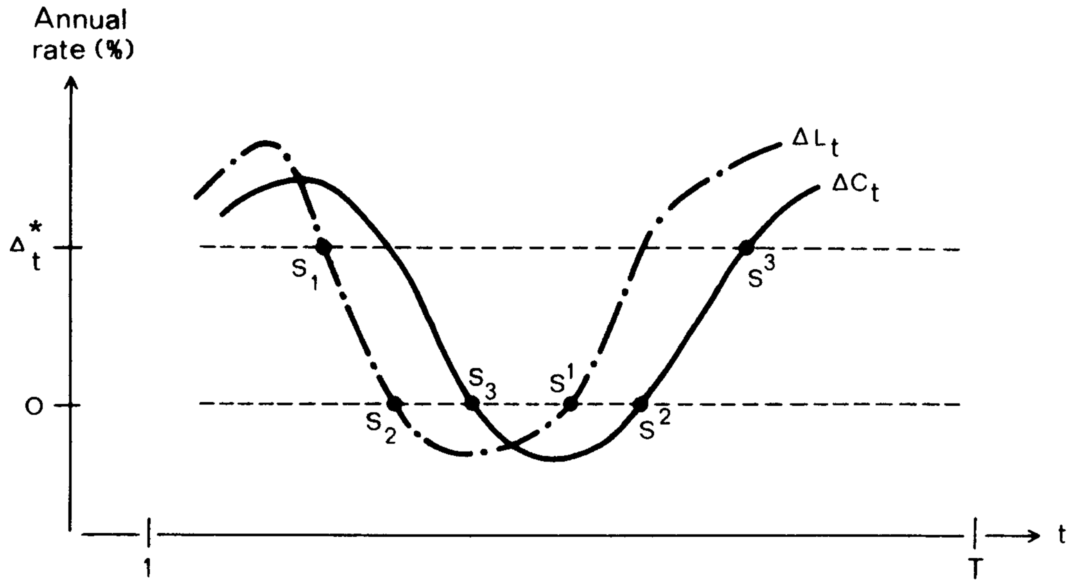

Fig. 4.1 Sequential signals of business cycle recession and recovery.

The business cycle peak is expected to occur close to the third signal s_3 (in general some short time before s_3).

In the U.S. evaluation mentioned above this procedure was found to identify each business cycle peak (BCP) in the period from 1953 to 1980. It was also found that

$$\text{mean } (t_{s_1} - t_{BCP}) = -10$$

$$\text{mean } (t_{s_2} - t_{BCP}) = -2$$

$$\text{mean } (t_{s_3} - t_{BCP}) = 1 \text{ (a mean lag).}$$

However, the observed lead variations were considerable, in particular in the case of s_1:

$$\max (t_{s_1} - t_{BCP}) - \min (t_{s_1} - t_{BCP}) = 19$$

$$\max (t_{s_2} - t_{BCP}) - \min (t_{s_2} - t_{BCP}) = 8$$

$$\max (t_{s_3} - t_{BCP}) - \min(t_{s_3} - t_{BCP}) = 7.$$

The expected sequence of the signals is maintained all over the period analysed.

The signal s_1 and sometimes also s_2 but never s_3 identified the situations when growth cycle but not business cycle recessions occurred. The procedure also implied some false signals which, however, with a few exceptions related to periods with strikes, were ruled out by s_3.

As for business cycle troughs the procedure works as follows. The first signal (s^1) is given when

$$\Delta L_t > 0 \quad (4.7)$$

$$(\text{and } \Delta C_t < 0)$$

Thus, $t_{s^1} > t_{s_3}$. The first confirming signal (s^2) requires that

$$\Delta L_t > \Delta_t^* \quad (4.8)$$

$$\text{and}$$

$$\Delta C_t > 0$$

The third signal (s^3) is obtained when

$$\Delta L_t > \Delta_t^* \quad (4.9)$$

$$\text{and}$$

$$\Delta C_t > \Delta_t^*$$

(see Fig. 4.1). These three signals together identified all recoveries between 1949 and 1975 in the U.S. evaluation. However, certain lags related to the time for business cycle troughs were observed:

$$\text{mean } (t_{s^1} - t_{BCT}) = 1$$

$$\text{mean } (t_{s^2} - t_{BCT}) = 5$$

$$\text{mean } (t_{s^3} - t_{BCT}) = 7.$$

The corresponding lag variability over time was very small compared to the observed lead variability related to t_{BCP} (as indicated above). Furthermore, no false signals of recovery were observed in the

U.S. evaluation.

The sequential procedure has also been evaluated for other countries (Canada, U.K., West Germany, France, Italy, and Japan), and with results that correspond very well with those obtained in the U.S. evaluation. These evaluations are related to the analysis of growth cycles which implies some extra lag in the identification of peaks.

4.3 An alternative sequential procedure

One argument against the procedures outlined above might be that the procedures do not directly involve level changes in the composite indices. The information related to changes in lagged indicators might also be of some value to a statistical surveillance procedure for business cycle analysis. Niemira (1983) suggests the following sequential procedure for, at least partially, reducing these drawbacks. If ∇L_t, ∇C_t and ∇G_t represent level changes in leading, composite, and lagged composite indices, respectively (i.e. no smoothing mechanism, such as in (4.3)) is introduced (ΔG_t defined in line with (4.3) above), the sequential signals of recessions are suggested to be as follows:

The first signal requires

(4.10)
$$\nabla L_t < 0$$
and
$$\Delta G_t \geq \Delta_t^{**}$$

where Δ_t^{**} differs from

$$\Delta_t^{*}.$$

The second signal is defined by

(4.11)
$$\nabla C_t < 0$$
and
$$\Delta L_t < -\Delta_t^*$$

and signal 3 is given when

(4.12)
$$\Delta L_t < -\Delta_t^*$$
and
$$\Delta C_t < 0.$$

The first signal is suggested to be reversed if

(4.13)
$$\Delta L_t \geq \Delta_t^*$$
and
$$\Delta C_t \geq \Delta_t^*$$

and the second, as well as the first, signal is reversed when

(4.14)
$$\Delta G_t < 0$$
(together with (4.13)).

The corresponding signals for recoveries are suggested as follows: Signal 1 will be

(4.15)
$$\nabla L_t > 0$$
$$\Delta L_t < 0$$
$$\Delta C_t < 0,$$

followed by signal 2, i.e.

(4.16)
$$\nabla C_t > 0$$
$$\Delta L_t > \Delta_t^*.$$

The sequential procedure is terminated by signal 3, i.e.

$$\Delta L_t > \Delta_t^{*} \qquad (4.17)$$

$$\Delta C_t > 0$$

and

$$\nabla G_t > 0,$$

or even with an extra (optional) signal 4:

$$\Delta L_t > \Delta_t^{*} \qquad (4.18)$$

$$\Delta C_t > \Delta_t^{*}$$

$$\Delta G_t > 0.$$

This modification is evaluated on U.S. business cycle data and results obtained are, so far, promising. At least the introduction of ∇L_t (and ∇C_t) will be tested on Swedish business cycle data. Whether also lagged indices are to be used is still an open question. The modification described in the next section is, however, of a particular interest to EWSIS.

4.4 A strategy to reduce the frequency of false signals

It is important to notice that what is said so far referring to the historical U.S. evaluation of the sequential surveillance procedure presupposes revised and accurate data on the indicators and reference series. The actual business cycle analysis and forecasting is, however, based on current data. It is difficult (or impossible) to wait for the revisions to be completed (see, however, Ch. 3 above). In order to avoid the need for large revisions on index series, one important criterion in choosing indicators for index construction will be the current availability of indicators (avoiding those with publication delays).

The U.S. evaluation includes a comparative study of the sequential procedure based on either preliminary data, or on the first revised data. In particular, the occurrence of false signals for those two cases is verified. The use of preliminary data introduces a high frequency of false signals, in particular in the peak identification sequence (s_1, s_2, and s_3). Actually, the number of false signals is such that the applicability of the sequential procedure must be questioned. When first revised data are used, the frequency of false signals is drastically reduced (see the discussion above), but the price to be paid is of course a, sometimes unacceptable, delay in obtaining the signals.

In order to reduce the problem of false signals, without increasing the delay of signals too much, the sequential procedure is modified. The limits Λ_t^* and 0 introduced above are replaced by limit bands as follows:

(4.19)
$$\Lambda_t^* \pm \hat{\sigma}_{et}$$
and
$$0 \pm \hat{\sigma}_{et}$$

where $\hat{\sigma}_{et}$ denotes the estimated standard deviation of the irregular component of the leading index rate. Referring to fig. 4.2, the procedure will now to some extent allow for the irregularities of the composite indices.

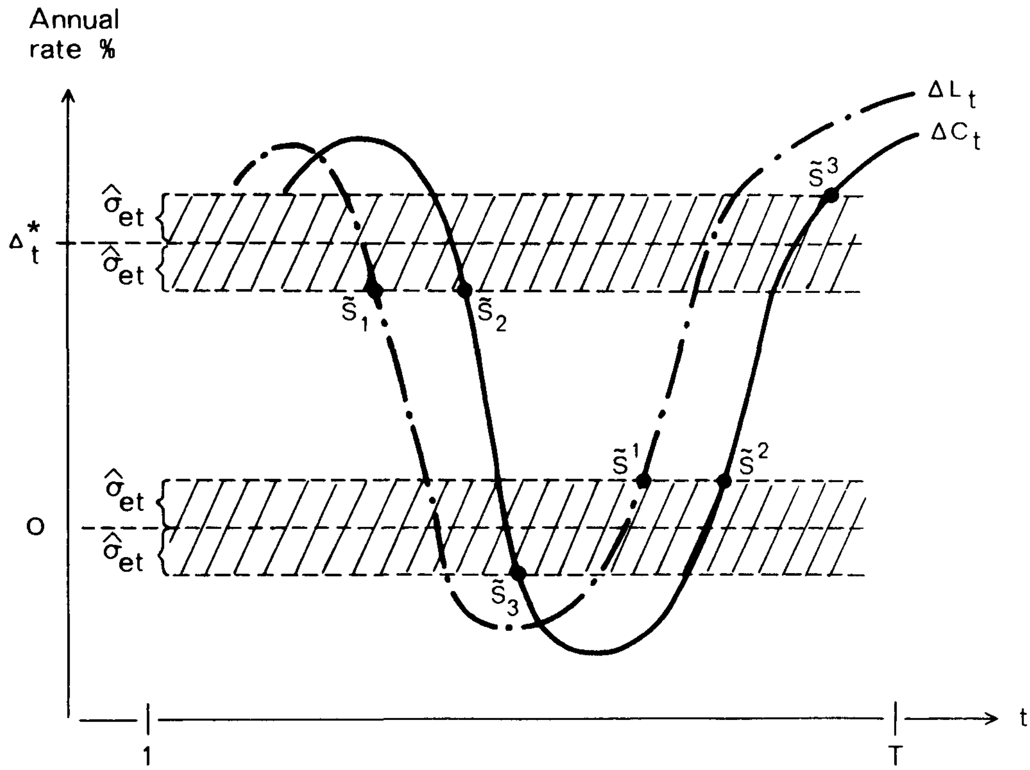

Fig. 4.2. Sequential signals of business cycle recession and recovery (reducing effects of temporary irregularities)

The first signal referring to forthcoming peak ($\tilde{s}_1$) is obtained when

(4.20) $$\Delta L_t < \Delta_t^* - \hat{\sigma}_{et}$$

and

$$(\Delta C_t > 0;\ \text{often} > \Delta_t^* + \hat{\sigma}_{et})$$

This signal is ruled out only if ΔL_t increases, such that $\Delta L_t > \Delta_t^* + \hat{\sigma}_{et}$. The first confirmatory signal $\tilde{s}_2$ happens if

(4.21) $$\Delta L_t < - \hat{\sigma}_{et}$$

and

$$\Delta C_t < \Delta_t^* - \hat{\sigma}_{et}$$

The third and final signal ($\tilde{s}_3$) indicating the start of a recession period is given by

(4.22)
$$\Delta L_t < 0$$
and
$$\Delta C_t < -\hat{\sigma}_{et}$$

The expected sequence of signals at business cycle troughs is now as follows. The first signal $\tilde{s}^1$ is given by

(4.23)
$$\Delta L_t > \hat{\sigma}_{et}$$
and
$$\Delta C_t < \hat{\sigma}_{et}$$

which means that $t_{\tilde{s}^1} > t_{\tilde{s}_3}$.

The two following confirmatory signals will require that (when $\tilde{s}^2$)

(4.24)
$$\Delta L_t > \Delta_t^* + \hat{\sigma}_{et}$$
and
$$\Delta C_t > \hat{\sigma}_{et}$$
and

(when $\tilde{s}^3$)

(4.25)
$$\Delta L_t > \Delta_t^* + \hat{\sigma}_{et}$$
and
$$\Delta C_t > \Delta_t^* + \hat{\sigma}_{et}$$

It should be stressed that false signals always require a following reverse crossing through the band.

The U.S. evaluation strongly supports the hypothesis that this modification of the sequential procedure will reduce the problem of existence of false signals. Actually, almost no false signals at all remain after modifying the procedure by introducing band criteria. The question is now what the price will be to obtain that significant improvement. In the U.S. case the bands are such that the proportion of observations on the composite indices falling within the bands are very moderate. It is found that ΔL_t is within $\Delta_t^* \pm \hat{\sigma}_{et}$ and within $0 \pm \hat{\sigma}_{et}$ 5 % and 7 %, respectively. As for ΔC_t, the corresponding figures are 12 % and 8 %, respectively, i.e. somewhat higher, but still low enough. The basic reason for rejecting a procedure based on revised data was the resulting delay in producing signals. The modification of the sequential procedure by using bands, of course, also is expected to imply some delay compared to the level procedure described in fig. 4.1. The modified procedure seems to differ very little with respect to leads and lags for signals and business cycle peaks and troughs, compared to the original procedure. As an example from the U.S. evaluation, it is seen that

$$\text{mean } (t_{\tilde{s}_1} - t_{BCP}) = -8 \quad \text{(months)}$$

$$\text{mean } (t_{\tilde{s}_2} - t_{BCP}) = -3$$

$$\text{mean } (t_{\tilde{s}_3} - t_{BCP}) = 3 \quad \text{(a mean lag).}$$

Thus, the overall impression is that the sequential band approach will have substantial advantages in relation to the procedure first described. Actually, the results of the U.S. evaluation are very promising. An adaptation to conditions and requirements of EWSIS is therefore recommended.

References

Boschan, C. and Ebanks, W. (1978), "The Phase-Average Trend, A New Way of Measuring Economic Growth", Proceedings of the Business and Economic Statistics Section, American Statistical Association.

Bry, G. and Boschan, C. (1971), "Programmed Turning Point Determination" in Cyclical Analysis of Time Series: Selected Procedures and Computer Programs, NBER.

Burns, A.F. and Wesley, C.M. (1946), Measuring Business Cycles, NBER, New York.

Kalman, R.A. (1960), "A New Approach to Linear Filtering and Prediction Problems", Journal of Basic Engineering, 82, 34-45.

Moore, G.H. (1983), Business Cycles, Inflation and Forecasting, Ballinger Publ. Company (Ch. 4).

Niemira, M.P. (1983), "Sequential Signals of Recession and Recovery: Revisited", Business Economics, 18, 51-53.

"OECD Leading Indicators and Business Cycles in Member Countries 1960-1985", OECD Department of Economics and Statistics, Main Economic Indicators, Sources and Methods, No. 39 (Jan., 1987).

Rhoades, D. (1979), "A Note on the Design and Application of Minimum Phase-Shift Noise Reducing Filters", Statistics Canada.

Westlund, A.H. (1987), "Partial Parameter Instability and Small Sample Prediction Bias", New Perspectives in Theoretical and Applied Statistics, Wiley, New York (383-395).

Westlund, A.H. and Zackrisson, U. (1986), "On the Prediction of Structurally Varying Systems", Technological Forecasting and Social Change, 30, 63-72.

Zarnowitz, V. and Moore, G.H. (1982), "Sequential Signals of Recession and Recovery", Journal of Business, 55, 57-85.

Tidigare nummer av Promemorior från U/STM:
NR

1 Bayesianska idéer vid planeringen av sample surveys. Lars Lyberg (1978-11-01)

2 Litteraturförteckning över artiklar om kontingenstabeller. Anders Andersson (1978-11-07)

3 En presentation av Box-Jenkins metod för analys och prognos av tidsserier. Åke Holmén (1979-12-20)

4 Handledning i AID-analys. Anders Norberg (1980-10-22)

5 Utredning angående statistisk analysverksamhet vid SCB: Slutrapport. P/STM, Analysprojektet (1980-10-31)

6 Metoder för evalvering av noggrannheten i SCBs statistik. En översikt. Jörgen Dalén (1981-03-02)

7 Effektiva strategier för estimation av förändringar och nivåer vid föränderlig population. Gösta Forsman och Tomas Garås (1982-11-01)

8 How large must the sample size be? Nominal confidence levels versus actual coverage probabilities in simple random sampling. Jörgen Dalén (1983-02-14)

9 Regression analysis and ratio analysis for domains. A randomization theory approach. Eva Elvers, Carl Erik Särndal, Jan Wretman och Göran Örnberg (1983-06-20)

10 Current survey research at Statistics Sweden. Lars Lyberg, Bengt Swensson och Jan Håkan Wretman (1983-09-01)

11 Utjämningsmetoder vid nivåkorrigering av tidsserier med tillämpning på nationalräkenskapsdata. Lars-Otto Sjöberg (1984-01-11)

12 Regressionsanalys för f d statistikstuderande. Harry Lütjohann (1984-02-01)

13 Estimating Gini and Entropy inequality parameters. Fredrik Nygård och Arne Sandström (1985-01-09)

14 Income inequality measures based on sample surveys. Fredrik Nygård och Arne Sandström (1985-05-20)

15 Granskning och evalvering av surveymodeller, tiden före 1960. Gösta Forsman (1985-05-30)

16 Variance estimators of the Gini coefficient - simple random sampling. Arne Sandström, Jan Wretman och Bertil Waldén (Memo, Februari 1985)

17 Variance estimators of the Gini coefficient - probability sampling. Arne Sandström, Jan Wretman och Bertil Waldén (1985-07-05)

18 Reconciling tables and margins using least-squares. Harry Lütjohann (1985-08-01)

19 Ersättningens och uppgiftslämnarbördans betydelse för kvaliteten i undersökningarna om hushållens utgifter. Håkan L. Lindström (1985-11-29)

20 A general view of estimation for two phases of selection. Carl-Erik Särndal och Bengt Swensson (1985-12-05)

21 On the use of automated coding at Statistics Sweden. Lars Lyberg (1986-01-16)

22 Quality Control of Coding Operations at Statistics Sweden. Lars Lyberg (1986-03-20)

23 A General View of Nonresponse Bias in Some Sample Surveys of the Swedish Population. Håkan L Lindström (1986-05-16)

24 Nonresponse rates in 1970 - 1985 in surveys of Individuals and Households. Håkan L. Lindström och Pat Dean (1986-06-06)

25 Two Evaluation Studies of Small Area Estimation Methods: The Case of Estimating Population Characteristics in Swedish Municipalities for the Intercensal Period. Sixten Lundström (1986-10-14)

26 A Survey Practitioner's Notion of Nonresponse. Richard Platek (1986-10-20)

27 Factors to be Considered in Developing a Reinterview Program and Interviewer Debriefings at SCB. Dawn D. Nelson (1986-10-24)

28 Utredning kring bortfallet i samband med den s k Metropolitdebatten. Sixten Lundström (1986-11-10)

29 Om HINK-undersökningens design- och allokeringsproblematik. Bengt Rosén (1986-10-06)

30 Om HINK-undersökningens estimationsförfarande. Bengt Rosén (1987-01-28)

31 Program för minskat bortfall i SCBs individ- och hushållsundersökningar - förslag från aktionsgruppen för uppgiftslämnarfrågor. Lars Lundgren (1987-02-20)

32 Practical estimators of a population total which reduce the impact of large observations. Jörgen Dalén (87-03-03)

33 A Multivariate Approach to Social Inequality. M Ribe (1987-05-05)

34 BORTFALLSBAROMETERN NR 2. Bortfall vid I-avdelningen, AKU och F-avdelningen t o m 1986. Håkan L. Lindström, Peter Lundquist och Tomas Garås (1987-08-01)

35 Use of Laboratory Methods and Cognitive Science for the Design and Testing of Questionnaires. Handbook of Methods. Judith T. Lessler (June 1987)

36 Some Optimal Problems When Estimating Household Data on the Basis of a "Primary", Stratified Sample of Individuals. Bengt Rosén (1987-08-10)

37 Early Survey Models and Their Impact on Survey Quality Work. Gösta Forsman (1987-09-17)

38 A Generalized Perks Formula for Old-Age Mortality. Sten Martinelle (1987-08-17)

39 Beskrivning av arbetstidens förklaringsgrad på arbetsinkomstens ojämnhet 1975-1984. Arne Sandström (1987-03-31)

40 Utveckling av estimator för skattning av antal förvärvsarbetande i olika arbetstidsklasser inom små redovisningsgrupper. Sixten Lundström (1987-10-01)

Kvarvarande exemplar av ovanstående promemorior kan rekvireras från Elseliv Lindfors, U/STM, SCB, 115 81 Stockholm, eller per telefon 08 7834178

GARNISONSTRYCKERIET ☆ STOCKHOLM ☆ 1987☆