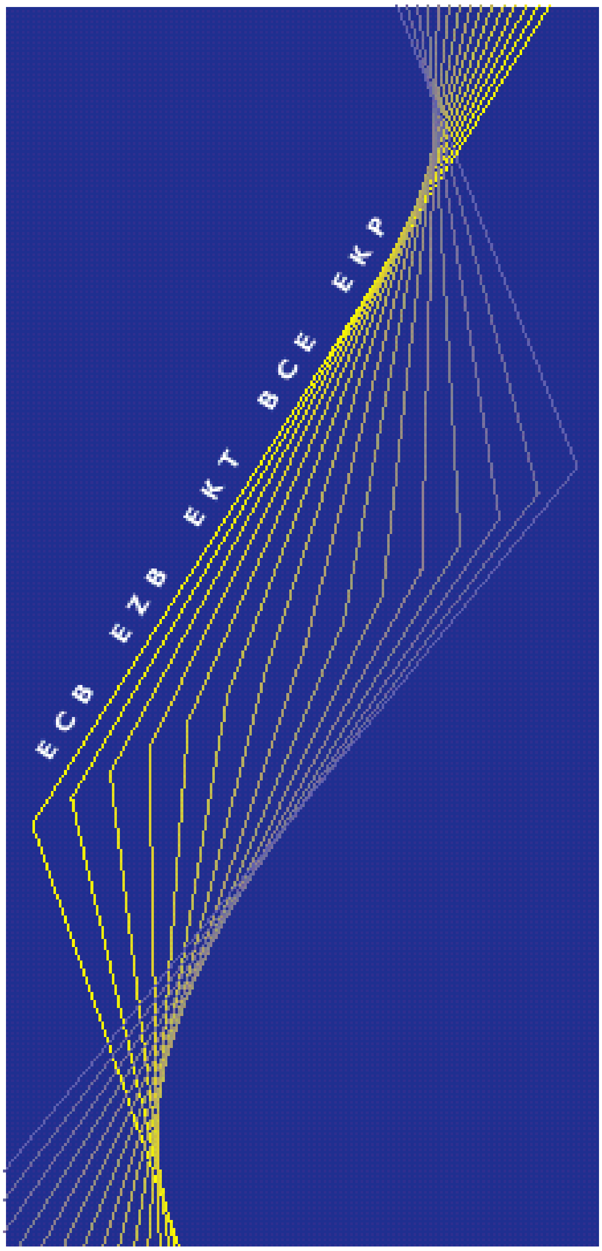
EUROPEAN CENTRAL BANK



SEASONAL ADJUSTMENT OF MONETARY AGGREGATES AND HICP FOR THE EURO AREA

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Address	Kaiserstrasse 29 D-60311 Frankfurt am Main Germany
Postal address	Postfach 16 03 19 D-60066 Frankfurt am Main Germany
Telephone	+49 69 1344 0
Internet	http://www.ecb.int
Fax	+49 69 1344 6000
Telex	411 144 ecb d

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EXECUTIVE SUMMARY

In 1999, the ECB set up a Task Force to consider technical aspects of seasonal adjustment, in particular as concerns euro area monetary aggregates and harmonised indices of consumer prices.

The Task Force's main tasks were: (a) to prepare proposals for the seasonal adjustment of euro area monetary aggregates and the Harmonised Index of Consumer Prices (HICP); (b) to assess other seasonally adjusted macroeconomic euro area statistics; (c) to examine the methods X-12-ARIMA and TRAMO/SEATS; and (d) to provide advice on the implementation of software at the ECB.

The main issues addressed in this report are summarised below.

A long-term approach for the adjustment of euro area monetary aggregates and loans is proposed. Seasonally adjusted results will be produced for the following aggregates and components: currency in circulation, overnight deposits, M1, other short-term deposits, M2, marketable instruments and M3. The same will apply for the counterpart series on loans.[1] All data mentioned will be available as seasonally adjusted stocks, seasonally adjusted transactions and seasonally adjusted indices of notional stocks. Where relevant, adjustment for trading day effects is carried out. M3 is derived through the aggregation of the seasonally adjusted components of M3. Seasonal factors are forecast for one year, but checked regularly against current re-estimations of those factors. It is recommended that experts from the NCBs and the ECB meet once a year for the purpose of reviewing and forecasting the seasonal factors. Standard quality reports will be produced at monthly frequency (short version) and annual frequency (complete version).

A similar solution for the adjustment of the HICP was found. Seasonally adjusted results will shortly be published for the euro area all-item index and its main components, except where seasonality is not significant (energy); the seasonally adjusted all-item index is derived by aggregating the seasonally adjusted components. No adjustment is made for effects other than the seasonal pattern. Forecasting factors will be used, but will continuously be compared with the results of the updated factors.

Both X-12-REGARIMA and TRAMO-SEATS are high-quality tools for seasonal adjustment. The theoretical framework of the model-based approach, which is partially implemented in X-12 REGARIMA and fully implemented in TRAMO/SEATS, is an important argument for their use. However, the technical development of TRAMO/SEATS has not been completed in full, so that it needs to be improved, especially in terms of its use of empirical measurements and the design of its input and output facilities. X-12-REGARIMA, which follows the model-based approach only in the pre-adjustment part (e.g. for trading-day adjustment), offers additional and useful non-model-based

1 These series are the only ones currently available which cover a long enough historical period to allow seasonal adjustment.

options in the seasonal adjustment part and also provides a significant set of important diagnostic tools.

From a *statistical* point of view, it was neither possible nor appropriate to exclude one of the two programs. Both programs are successfully used by different national central banks. There is no evidence for significant and systematic differences in the results when the programs are used in a consistent manner. <u>The combination of the two approaches in one seasonal adjustment tool is the most natural and promising way forward.</u> The ECB recommends promoting concrete actions to combine the two approaches in one unique product.

For other seasonally adjusted macroeconomic data, several desirable improvements are outlined. These concern the comparability of the seasonally adjusted national data as well as the compilation of seasonally adjusted euro area aggregates.

For seasonally adjusted data that is produced and published, the ECB recognises the importance of transparency and good documentation. The general principles of seasonal adjustment to be followed at the ECB have therefore been laid down in detail in this document. Further information on the revision policy, the method and the settings used will be published together with the results or will, where appropriate, be made available on request.

1 INTRODUCTION

The analysis of short and medium-term economic developments is an important element in the conduct of the two-pillar monetary policy strategy of the Eurosystem. In the context of the first pillar – the prominent role for money, as signalled by the announcement of a reference value for the growth of a broad monetary aggregate – the development of, in particular, M3 is crucial. The Harmonised Index of Consumer Prices (HICP) has been a key indicator for the monetary policy of the Eurosystem. Moreover, in the context of the second pillar ─ the broadly based assessment of the outlook for further price developments ─ a range of monthly and quarterly short-term economic statistics for the euro area is important.

A prerequisite for the monitoring of the short-term development of economic statistics is the availability of seasonally adjusted data. The compilation of seasonally adjusted data for the euro area entails a number of new challenges, which led to the creation of the ECB Task Force on Seasonal Adjustment. First, the concept of euro area data is relatively new. In particular, the common euro area banking statistics (compiled by the Eurosystem) and the HICP (compiled by Eurostat) are new statistics and have been available for an only short time period. Second, for the compilation of euro area aggregates, it has to be decided whether to aggregate seasonally adjusted country results or whether to derive them from seasonally adjusted raw euro area aggregates ("indirect" versus "direct" adjustment). Third, the discussion of seasonal adjustment of euro area data can benefit from the extensive experience not only of several national central banks, but also of the European Commission and the national statistical institutions (NSIs) in this field. However, this also implies that different methods and practices of seasonal adjustment have developed and raises the issue of the comparability of these methods and practices.

Following the discussion of selected methodological issues, the report explains the proposed approaches for the seasonal adjustment of monetary aggregates and the HICP. It then continues with a comparison of the two most prominent methods of seasonal adjustment (X-12-REGARIMA and TRAMO/SEATS). In the last chapter the focus turns to an overview and assessment of the seasonally adjusted data available with respect to other economic data which is produced by the European Commission.

The balance of payments statistics compiled for the euro area by the ECB are not discussed in this document. Implementation of seasonal adjustment methods for these statistics is foreseen in the course of the year 2000.

2 SELECTED METHODOLOGICAL ISSUES

2.1 Direct versus indirect seasonal adjustment

2.1.1 Possible approaches to aggregation

For the purposes of economic analysis, it is frequently necessary to compile time series through the aggregation of sub-components. While, at national level, economic statistics are mostly aggregated from national data broken down by sector/branch or product category, euro area series can be compiled either through "horizontal" (by country) aggregation and/or through "vertical" (by sector/branch/product) aggregation. The choice of the aggregation method has important implications for the seasonal adjustment of euro area data. In general, there are three options:

- seasonal adjustment of aggregated raw components (*direct approach*);
- aggregation of seasonally adjusted components (*indirect approach via country data and/or sub-components*);
- simultaneous derivation of seasonally adjusted series (*multivariate approach*).

The differences in the three approaches – and in the derived components – correspond to the differences in the information set, which is considered in the estimation process.[2] Only in the case of multivariate adjustment is a full set of information on a variable and other correlated variables taken into account.

However, in the cases of monetary aggregates and the HICP, using the multivariate method STAMP by Koopman, Harvey et al. (1995), Takala (1999) showed that "differences in the information set do not dominate the information received from major aggregates" or, in other words, that the differences between the multivariate and univariate approaches are relatively small. The differences are also small on comparison with other models, such as a choice between additive and multiplicative seasonal adjustment. In these comparisons the information set was limited to other monetary aggregates only.[3] In general, the main disadvantage of multivariate seasonal adjustment is that an unambiguous benchmark for an information set is lost and that the problem arises of choosing the proper set of explanatory factors for these aggregates. In addition to other monetary aggregates, interest rates should, for example, be added into the information set, etc.

Given the computational complexity of the multivariate approach and some limitations of existing software as well as the additional limitations discussed below, the adoption of univariate approaches (either direct or indirect) can be recommended.

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2 See Planas and Campolongo (1999) for a theoretical overview of this subject.

3 In addition, interest rates should be added to account for the seasonality arising from interest payments received in the end of the year.

The discussion can therefore be limited to direct versus indirect adjustment approaches. The empirical results show that the two methods produce equivalent results only under very restrictive assumptions, i.e. when no trading day or outlier correction is made, when the decomposition is additive and when no forecast is produced. In practice, such conditions are very rarely met and the differences in the series produced under the two rules can be significant depending on the series concerned.

2.1.2 Practical criteria

In spite of the lack of conclusive theoretical research, some criteria to discriminate between the direct and the indirect approaches have been put forward, namely:

1. *Smoothness of seasonally adjusted series*

   The choice between direct and indirect method is based on the comparison between the roughness measures, computed for the two series derived under the two different rules. This criterion was implemented in X-11-ARIMA.

2. *Minimisation of revision errors*

   This criterion is used in X-12-ARIMA, where a set of empirical measures of revisions, such as sliding spans and revision history diagnostics are derived for the two alternatives. In general, the preferred alternative is that producing a more stable seasonally adjusted series in terms of revisions. The set of measures on which the choice is based is descriptive (average absolute percentage of revisions, month-to-month percentage changes, etc.).

   A similar rule – which is, however, based on typical inference testing tools of the model-based approach – has been developed by Planas and Campolongo (1999). They suggest the minimisation of total revision errors as a criterion. Within the model-based approach, the distribution of the revision errors can be specified in analytical form, directly derived from the ARIMA model used for signal extraction, and inference on them is possible.

3. *Stability of seasonal component*

   Estimating the best possible seasonal component in order to obtain the most accurate estimate of the seasonally adjusted series is the general principle of this approach, proposed by Kaiser and Maravall (1999b). This implies the estimation of a seasonal component which is as regular and periodic as possible. In the model-based approach, every component of the series can be modelled via an ARIMA model, as can the seasonal component. The causes of irregularities in the components are the stochastic terms or, more precisely, their variances. Therefore, stable seasonal component means a low variance of the stochastic term. The decision on the rule to be adopted is then based on the minimisation of the variance of the noise of the seasonal component.

4. *Out-of-sample forecasting accuracy*

A further criterion is suggested by Kaiser and Maravall (1999b) and, in part, by Planas and Campolongo (1999) and refers to model-based methods, but could easily be applied to X-12-ARIMA as well. It is based on the accuracy of forecasts derived under the two rules. The decision is based on the comparison of mean-squared errors of out-of-sample forecasts. This criterion is relevant for both programs, as the forecasting quality is linked to the revisions. Both programs extend the time series with forecasts to estimate the concurrent seasonally adjusted series.[4]

Although there are some similarities between the four criteria and, in particular, between criteria 2, 3 and 4, they will not lead to the same decisions in all cases. Moreover, criterion 1 may be different from, in particular, criterion 3. A general preference should be given to criteria 2 to 4, compared with criterion 1. The smoothness of the seasonally adjusted series is linked to a more erratic seasonal component. For conceptual reasons, a general preference should be given to a smooth seasonal component, if there is no evidence of changes in the seasonal pattern.

However, criteria 2 to 4 should not be used as an exclusive tool to decide on the choice. For example, the theoretical criteria in 2 leads to problems as it does not give an indication of the level of disaggregation that should be used for seasonal adjustment. For indirect adjustment, it is moreover necessary to decide, first, on the breakdown (by country, by branch/product or by a combination of the two) and, second, on the level of detail to be considered in the adjustment exercise.

With regard to the latter point, two cases leading to opposite conclusions can be distinguished. In very detailed series the irregular component is often high and it may be difficult to detect seasonal signals. In that case, a relatively high residual seasonality in aggregated series due to the inaccurate adjustment of the component might be observed. In other cases, sub-components can combine in such a way that no seasonality can be detected in the resulting aggregate.

In the light of the problems encountered with all criteria, other aspects are often useful for the decision. The analysis of the correlation between the different seasonal or cyclical components, changes in the relative importance of the components within the aggregate and information concerning the sources of data (e.g. data coming from different surveys or surveys with the same survey error) give important insights in possible discrepancies between directly and indirectly seasonally adjusted results.

2.1.3 Conclusions

It appears impossible to set up a general, unambiguous statistical rule for the choice between direct and indirect adjustment. The decision has to be made case by case. However, some guidelines are possible.

4 Criteria 2, 3 and 4 are not yet available in the software TRAMO-SEATS. Professor Maravall explained that tests have almost been finalised and that they will be incorporated in one of the next versions of TRAMO/SEATS.

1. There is often a strong interest in preserving additive relationships between components. Direct adjustment series may differ from results of sub-components. This may affect the credibility of the results and may be not accepted by users. In that case, the indirect approach is the only solution to avoid inconsistencies in data. The level of detail is also defined on the same basis.

2. When sub-components do not have similar stochastic properties, the indirect approach is better in terms of both the final estimation error and revision errors.

3. It needs to be considered how the original data is compiled. When the aggregates are the sum of components derived from different statistical sources (e.g. with varying quality or different surveys), indirect adjustment is often preferable. When raw series are produced from one single source or are fully harmonised, the adjustment can be performed at a higher level of aggregation, since the decreasing sampling error leads to a lower variance at a higher aggregation level.

4. The choice can be influenced by practical considerations, such as the level of aggregation for which additional information is available (breaks, outliers, data source changes, trading day patterns, etc.).

5. When the correlation between the sub-series is very high, direct adjustment has an advantage. When the relative importance (in terms of weight) of the individual time series is changing very fast, indirect adjustment should be preferred.

6. In general, preference should be given to criteria 2 to 4. Given the examples shown above, it is clear, however, that statistical criteria, needs of economic analysis and common sense have to be used jointly for the decision on direct or indirect adjustment.

2.2 The use of model-based tools in the seasonal adjustment process

This section understands the model-based approach as an approach based on the REGARIMA model and distinguishes between model-based pre-adjustment and model-based decomposition. It is divided into three parts:

- forecast extension;
- inference; and
- framework for a wider analysis.

2.2.1 Forecast extension

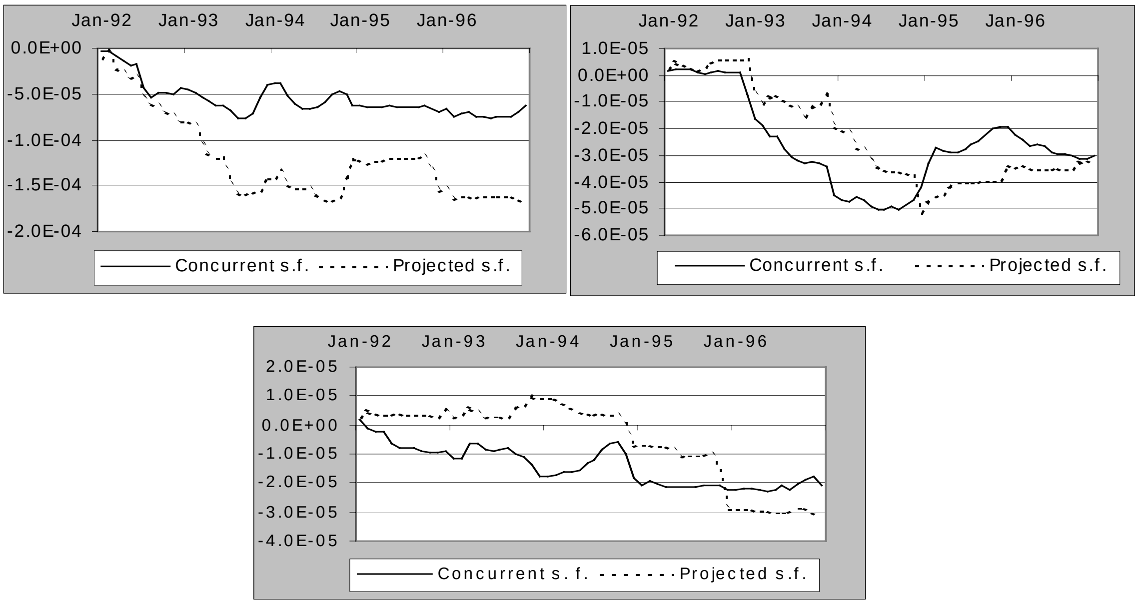
One of the main improvements in X-11-ARIMA, as compared with X-11, was motivated by the work of Dagum (1980). She showed that one can expect a reduction of the revision of the seasonal factors by forecasting the time series with ARIMA models, instead of using the asymmetric filters designed for X-11 at the current end. Pierce (1980) shows that this approach minimises the revisions under special conditions. In this respect, X-12-ARIMA shows another improvement to X-11-ARIMA as it allows the forecasts of REGARIMA models instead of ARIMA models. This means that past and current trading-day effects, special intervention effects and other special effects are taken into account in the forecast in a consistent way.

The aim of the example described below is to examine the advantages of the REGARIMA models, comparing their results with those obtained with X-11 and X-12-ARIMA.

Example:[5] M1, M2 less M1 and M3 were initially linearised with REGARIMA by removing the trading-day effect and outliers (Table B1 was therefore used as the input series for the experiment). This step was necessary to have a starting point, for which X-11 and X-12-ARIMA would have the same final estimator.

In a next step, the time series were seasonally adjusted sixty times, ending in the period between January 1992 and December 1996. The results for the concurrent runs were then compared with the "final" results when information on the series was available up to October 1999. Slight differences could be observed for the final seasonal factors; the results of X-11 were used as reference values (without any effects on the interpretation of the results).

Chart 2.2.1: ***Difference of the summed squared revisions between X-12-ARIMA and X-11 (M1, M2-M1, M3)***



The results are presented in Chart 2.2.1 above and shown as the difference between the summed squared revisions of the seasonal factors.[6] Negative values of the graphs indicate a better performance of the series extended with ARIMA forecasts, while positive values indicate an advantage of the classic X-11 procedure. In all the three time series a general advantage of the ARIMA forecast extended time series over the X-11 approach could be observed in terms of revisions. For M1, in particular, this advantage seems to be important. In that case, the advantage is even higher when forecasting the factors one-year ahead.

[5] The results of this example were also confirmed in a more comprehensive comparative study carried out by the Deutsche Bundesbank (1999).

[6] Revisions calculated as the relative difference from the final seasonal factor to the concurrent seasonal factor in relation to the final seasonal factor.

2.2.2 Inference on components

Limitations of empirical methods concerning inference

The possibility of inference on estimated components – e.g. computing confidence intervals for both parameter estimates and components – is one of the most appealing properties of the model-based approach.

Inference in ad-hoc-filtering procedures is often based on the estimated irregular component and not on the original series (e.g. inference on the significance of trading-day components). As shown by Maravall (1996), the main problem in this case is that the estimated irregular component for most of the model-based and ad-hoc filtering approaches (including SEATS, STAMP, X-11) shows a specific autocorrelation pattern different from the theoretical estimate that should be white noise (in the absence of outliers).[7]

Inference in ARIMA model-based framework

The full model-based approach allows the inference not only for the pre-adjustment, but also for the time series decomposition itself. The information gained from inference may be useful not only for the producer of seasonally adjusted results, but also for the economic analyst. Questions that may be addressed within the framework of model-based inference are, for example:

- What are the confidence intervals for the seasonal factors?
- What are the forecasts of the different components including their confidence intervals?
- How large is the total estimation error for the different components?
- What kind of revision pattern can be expected for the different components?
- Is it reasonable from a theoretical point of view to estimate the seasonal factors only once a year?
- How are the errors in the estimation process passed through to errors in growth rates?

However, the benefit of inference also depends on the quality of the raw data. High revisions of the raw data reduce the benefit of the information provided by model based inference, since their effects are not included in the information provided by these models.

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[7] This is caused by the fact that minimum mean squared error (MMSE) filtering of series showing a trend and an integrated seasonal component has the following properties. The complete spectral power around 0 is assigned to the trend-cycle, whereas the complete spectral power at the seasonal frequencies is assigned to the seasonal component. The estimator for the irregular component therefore displays dips at these frequencies. This behaviour leads to the fact that the estimator of the irregular contains a specific autocorrelation pattern (normally negative autocorrelation at lag of 1 and 12) different from the theoretical component (white noise). If inference (F-tests, t-tests) is based, under the null-hypothesis, on the assumption of no autocorrelation, the test statistics can be misleading. As the ad-hoc procedure does not provide any understanding of which autocorrelation structure the estimator shows, it is difficult to decide in which cases the tests are appropriate. The point estimate itself is less influenced by this distortion.

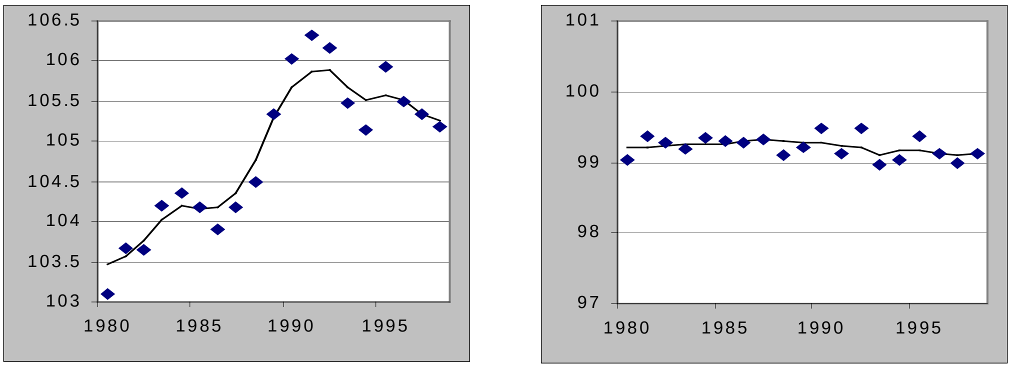
Given the positive experience of parsimonious ARIMA models (i.e. model using few parameters) in applied work (in particular, due to the experience with the programs X-11-ARIMA and X-12-ARIMA), the program TRAMO-SEATS is a natural extension of these approaches and uses the information of the REGARIMA model in a consistent framework, not only for pre-adjustment, but also for the time series decomposition.

However, some caution has to be exercised with regard to the assumptions that are inherent in the approach. This should be demonstrated on the example of the standard errors of the seasonal factors of M1.

Chart 2.2.2: *Seasonal factors (straight line) and seasonal times(irregular) for M1 (December to September)*

Different variances for M1 in different months

December *September*



The approach is based on the assumption that the same stochastic process creates the different months and that the variances for the seasonal factors are identical.

These assumptions, especially those relating to the variances, are sometimes incorrect and statistical inference can be misleading. Additional knowledge may indicate that differences can be expected. Whereas the seasonal factors of December evolved due to changing taxation rules and interest rates and were affected more by irregular effects, the seasonal factors for September show a very stable behaviour and a smaller variance of the irregular component. Other assumptions are, for example, the stability of the stochastic parameters over time. This assumption can be checked within the structural model-based approach.

2.2.3 Framework for a wider analysis

Besides the direct inference on the components, the model-based approach offers a wider range of possible additional uses. Recent work by Gomez and Maravall (1998a) and by Maravall and Kaiser (1999) indicates that it is possible to extend the programs to a large-scale data quality tool or to a tool for analysing the cyclical behaviour as well as long-term trends of time series. Another possible extension deals with the time disaggregation of time series that was presented in general lines by Gomez (Bundesbank seminar, October 1999).

2.2.4 Conclusions

- The model-based approach X-12-ARIMA, as an extension of X-11, and the full model-based approach, as in TRAMO-SEATS, offer several advantages compared with an ad hoc procedure like X-11.
- The ARIMA forecast extension implemented in X-12-ARIMA generally leads to smaller revisions.
- The REGARIMA method offers a consistent framework for performing statistical inference that is not possible in ad hoc methods and improves transparency in the process of outlier adjustment, trading-day adjustment and (in the case of TRAMO-SEATS) seasonal adjustment.
- The full model-based approach TRAMO-SEATS offers additional functions to those offered by the REGARIMA part of X-12-ARIMA. Consistent forecasts of the components are produced, the revision error and the growth rates can be analysed, etc., and components can be classified according to their stochastic behaviour. The consistent statistical framework can improve the transparency of the adjustment procedure and reduce the role of judgmental decisions.
- The model-based approach TRAMO-SEATS is parsimonious in the number of parameters, and the structure of the model is relatively simple (linear). As shown in part 3 of the final report, it is possible with REGARIMA models to estimate appropriately most of the monetary series and the series of the HICP.

However, despite the progress that has been made, especially for TRAMO-SEATS, to adapt a model-based procedure to practical needs, the following reservations have to be made:

- Model-based methods should offer empirical and other tools to give the user the possibility of adequately checking the assumptions of the model. Only a combination of both tools can provide a satisfactory analysis in practice, since the appropriateness of the model assumptions decide on the quality of the adjustment.
- Since experience with model-based tools is limited in practice and since their use requires a high degree of statistical knowledge, it is preferable to use these tools in parallel with empirical tools (revision errors, etc). The monitoring of the robustness of these tools in practice will be an additional important test. In addition to the comparison with empirical tools, controls via the structural model-based approach might be considered to monitor the inference.

2.3 Projected seasonal factors versus concurrent adjustment

Seasonally adjusted figures should measure the developments in the economy as accurately as possible and should not, by definition alone, contain a systematic bias. Avoiding systematic phase shifts requires the use of symmetric filters. All seasonal adjustment methods that are used in the ESCB use symmetric filters to estimate the seasonal components. This implies that, at the current end of the time series (as well as at the beginning, replace future with past), the future has to be either forecast or the filters have to be more and more asymmetric when reaching the current end. In both cases, this leads to a constant revision of the seasonally adjusted data, irrespective of revisions of the original data. The revision of the seasonal estimation can be carried out either as soon as a new observation becomes available ("concurrent adjustment") or at predetermined, longer intervals. This practice requires the use of forecasting factors.

From a purely theoretical point of view and excluding the existence of outliers, the use of concurrent adjustment is preferable. New data always contribute new information and should therefore be used. The problem with this argument is that recent data are often not as reliable as historical data as they will undergo a specific revision process. Moreover, the identification of the components at the series end is less reliable than it is for historical periods so that the benefit of concurrent adjustment may be reduced.

Furthermore, revisions caused by the frequent update of the seasonal estimation are disturbing and may confuse users. However, new information cannot be taken into account appropriately if revisions are not provided for.

From a practical point of view, the uncertainty about the quality of the most recent euro area observations and their possible revision is an important argument. Euro area monetary aggregates are an example of this.

Example. When data on monetary aggregates are published for a new month, about five percent of the information (referring to small credit institutions) is not available and a grossing-up procedure is normally applied by, in general, simply carrying the data of the previous month forward. For this and other reasons, the published figures are therefore preliminary and are revised when data for the next month becomes available. Moreover, some other series (e.g. deposits of other general government) are sometimes only available in a quarterly reporting scheme and are estimated within the quarter. This leads to revisions of the original monthly time series when quarterly data become available.

The table shows the flows of M3 for the reporting periods from January 1999 to October 1999, as available in the months from April to November and their successive revisions.

It is clear, that especially the last observations have to be handled with care. Given the fact that the seasonal component in monetary aggregates can be considered to be rather stable and given the observations above, it is clear that a more conservative behaviour when dealing with the seasonal component might be appropriate, together with close co-operation with economists, to detect possible changes in the seasonal behaviour in time.

Flows for M3 in Mio Euro reported in month

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Jan-99	25659	34352	34311	34322	34105	34062	34062	38841
Feb-99	-6950	-16291	-14248	-14221	-13861	-13952	-13949	-12944
Mar-99	8092	13778	11390	11407	27354	27375	27374	23066
Apr-99		25566	33702	33715	31072	31020	31021	30690
May-99			36366	30701	27313	27339	27348	32264
Jun-99				9784	20182	20156	20150	19273
Jul-99					12875	16387	16437	14410
Aug-99						-20185	-19327	-18836
Sep-99							15178	17739
Oct-99								20416

columns in grey indicate availability of quarterly data

2.3.1 National practice

Although a concurrent adjustment is always preferable at a theoretical level, for practical reasons, which will be discussed in the next section, the use of forecasting factors is often preferred, especially when revisions are regarded as potentially problematical. This holds especially true of monetary aggregates, for which the heterogeneity of methodologies in use in the national central banks of EU countries reflects the existing trade-off in either decision. The methods can be summarised as follows:

- concurrent adjustment and publication of revised seasonally adjusted figures (Finland; United Kingdom, with some exceptions);
- concurrent adjustment, but no revision of historical seasonally adjusted data within the calendar year (Belgium);
- case-by-case decisions (Italy);
- forecasts once a year, but possibility of updating the factors when necessary (Germany);
- forecasts of seasonal factors once a year and no revisions during the year (Spain).

In making a decision on the method to be used, two main types of user groups could be identified:

1. <u>Users directly linked to the economic analysis of the seasonally adjusted data</u>

   This kind of user group prefers practically no revisions of the seasonally adjusted data in the course of the year, as they fear that revisions may confuse the public and could reverse the recent analysis presented in press releases and other publications. On the other hand, accuracy of the recent data is requested as well.

2. <u>Users performing forecasts of future developments or other economic research</u>

   Users who are responsible for forecasts are interested in the best possible seasonal factors that can be used to forecast economic developments. Revisions are accepted as their effects are generally seen as quality improvements.

2.3.2 Conclusions

The choice between concurrent and forecast adjustment depends on the following criteria:

- The stability of the seasonal component: the higher the stability of the seasonal component, the more appropriate are forecasting factors, since the expected forecast error is small (and vice versa).
- The size of the irregular component: a high irregular component may make the use of concurrent adjustment difficult, since the estimation is particularly difficult and affected by irregular effects.

- Knowledge of "outside information" on changing seasonal patterns. If available, more frequent updates of estimations may be more appropriate in order to consider this information.
- The main use of the data (internal purposes, publication, analysis, forecasting).
- The revision pattern of the raw data (no revision, revision of the last observation, quarterly and annual revisions, etc.).

A model-based tool to test whether a time series can be seasonally adjusted by using the forecast of the seasonal factors is made available via SEATS with the average percentage reduction in mean square error when using concurrent adjustment compared to the projection of the seasonal factors. A more empirical tool is made available in X-12-ARIMA with the revisions of the seasonal factors.

For the HICP and monetary aggregates, the conclusion is that seasonal factors will be forecast for a period of one year (for more details, also see Section 3). For the HICP and the monetary aggregates, the average percentage reduction of the residual mean squared error when performing concurrent seasonal adjustment compared to projecting seasonal factors is quite low and the difference of the empirical revisions from using the projected seasonal factors and the concurrent run is not significant. The HICP and the monetary aggregates show a stable seasonal component. It is therefore generally possible to use factors that are projected once or twice a year.

However, there is one problem for monetary aggregates in the short run. Data of good quality for marketable instruments is only available since July 1998. It is therefore not possible to construct reliable forecasts of seasonal factors that are not yet observed more than one time. Another argument for waiting with the official announcement of seasonal factors in the beginning of the year is the need for good interest rate statistics to allow an improvement in the forecast of the short-term deposits.

2.4 Outlier treatment

2.4.1 Introduction

An important aspect in the seasonal adjustment of time series is the fact that time series are affected by deterministic effects such as trading-day effects and outliers. These effects can distort the analysis of current figures and the estimation of a seasonally adjusted series. Especially at the current end, the possible effect of an atypical observation cannot be treated in a mechanical way. The question as to whether such an effect is caused by a changing seasonal pattern, a one-off event or a permanent effect on the level of the series or cannot be answered with mathematical tools. In addition, even for historical observations, there is no clear concept of the term outlier. Whether an effect is called an *outlier*, and deserves special treatment, or whether it will not be considered to be an *outlier* cannot be answered in an objective way. The definition of an outlier depends, in addition, on the implicit or explicit model assumptions that are made when performing the seasonal adjustment.

For these problems, a close collaboration between the seasonal adjuster and the economic analyst is helpful. A detailed documentation of outliers, a careful check and, in general, the specific treatment of outliers not fully dependent on automatic methods are important steps in the seasonal adjustment process. The treatment of outliers is based on assumptions that have to be compared with the statistical and economic factors causing them.

The following paragraphs describe the possible treatment of outliers in the case of REGARIMA models and in the case of X-11.

2.4.2 REGARIMA models

REGARIMA models are the widely used approach in current procedures for seasonal adjustment**.** The procedure for outlier treatment implemented in both TRAMO and in the REGARIMA part of X-12-ARIMA is based on the intervention analysis originally proposed by Box and Tiao (1975).

Especially in the model-based approach the bias possibly deriving from outliers is decisive for the quality of final adjustment, since seasonal filters are directly derived from the ARIMA model, which can be negatively affected both in identification and estimation. The general idea behind this approach is that each series can be modelled using an ARIMA model. When a single observation or a sequence of observations cannot be fitted, it is defined as *outlier* and treated separately, introducing special variables in the ARIMA model.

Outliers are classified and modelled with regression polynomials, expressed as functions of the lag operator B and depending on the specific type of outlier to the model. Therefore, if y_t denotes the original series, it can be decomposed in the following way:

$$y_t = y_t^* + \Sigma_I \omega_i \nu_i (B) I_t(t_i),$$

where y_t^* is a pure ARIMA process, $\nu_i(B)$ the polynomial characterising the outlier occurring at the time t_i, ω_i its impact on the series and $I_t(T)$ is an indicator function with the value of 1 at t_i and of 0 elsewhere (occurrence time of outliers).

There are three main types of outliers – handled by both programs – namely:

1. <u>additive outliers</u> (AO), which correspond to sudden jumps occurring at certain points in time t_0 and not affecting the future values of series. In term of regression polynomials, this type can be modelled by setting $\nu_i(B) = 1$;

2. <u>transient changes</u> (TC), which are outliers that have a temporary effect on the values of series. Their speeds of decay depend on the parameter δ in the polynomial $\nu_i(B) = 1/(1 - \delta B)$. This

parameter can take values strictly greater than 0 (fast decaying effect) and less than 1 (slowly decaying effect);[8] and

3. level shifts (LS), which are outliers permanently affecting the level of series after a point in time t_0. In this case the polynomial $\nu_i(B) = 1/(1 - B)$.

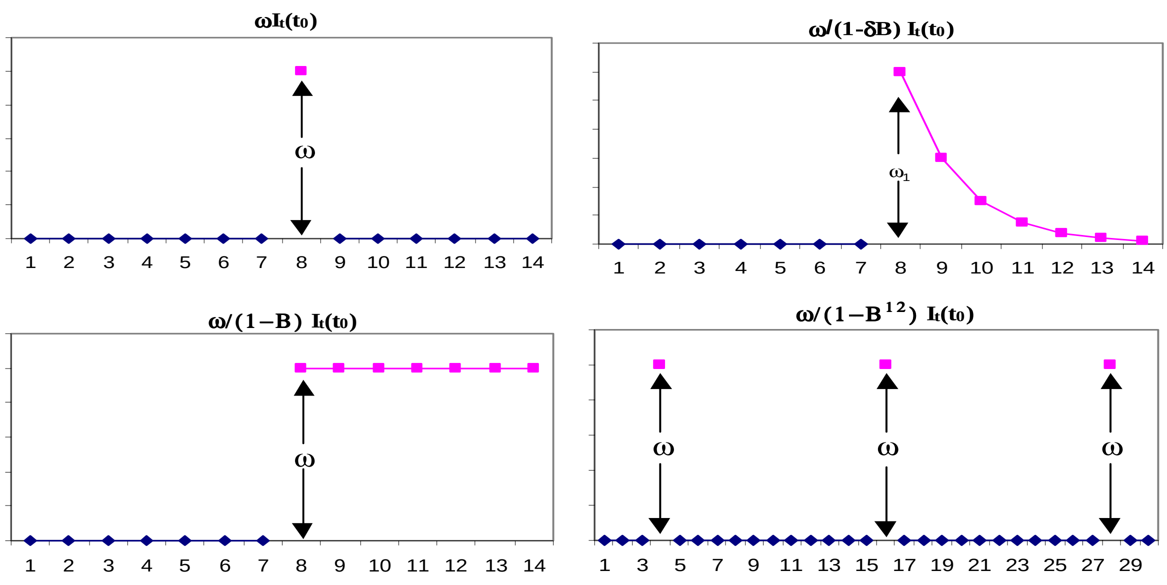
Recently, Kaiser and Maravall (1999a) have introduced a fourth type of outlier within the same theoretical framework. It is defined as follows:

4. seasonal outliers (SO), which are characterised by a polynomial $\nu_i(B) = (1 - \alpha B)/(1 - B^s)$, where $s = 12$ in monthly series and $s = 4$ in quarterly, and thus affecting only observations at time t_0, $t_0 + s$, $t_0 + 2s$, … .

   This latter type has not been implemented yet in the automatic detection and replacement procedure, but some applications show that it may be useful in series characterised by seasonality with a sudden change in the pattern.

In Chart 2.4.1 below the four different types of outliers are shown.

Chart 2.4.1: *Polynomials for additive outlier, transient change, level shift and seasonal outlier.*



These basic types of intervention polynomials can be combined to increase the possibilities of modelling complex effects. Using these variables, it is possible to extend the use of ARIMA models to series characterised by discontinuities or irregularities, for which a linear model would be inappropriate. Moreover, intervention variables can be easily processed in the framework of regression analysis and classic inferential tools to test the significance of candidate outliers (e.g. t-test, F-test).

8 Another possibility – not implemented in TRAMO – is that of extending the possible values of δ to the interval (-1, 0). In that case, the temporary change would have a decaying oscillating behaviour.

One of the most important advantages in intervention analysis is the possibility of translating available economic information on possible disturbing effects into appropriate mathematical effects. When this information is not available or cannot be used efficiently because of the large amount of series to be processed, it is important to have the possibility of using automatic procedures to identify and estimate outliers in time series, in order to limit the possible biases in parameter values. Both TRAMO and X-12-ARIMA provide these facilities, based on a similar iterative procedure.[9]

Automatic procedure for outlier detection in REGARIMA models

The main steps involved in the automatic procedure for outlier detection are described below:

0. *Initialisation*

- Estimation of all model parameters, including fixed regression effects (fixed outliers, other regressors). The ARIMA model is supposed to be identified.

1. *Forward addition*

- Residuals are computed from the model, along with a robust estimate of their standard error, i.e. σ^R=1.43 median$_t$ $|r_t|$.
- T-statistics T_t are computed for each parameter ω, estimated for all type of outliers (i.e. using the different types of polynomial ν(B)) and for all time periods. This procedure is limited to the outliers not already included in the model.
- Given a fixed time t, the type of outlier is decided on the basis of the maximum value of the t-statistics, $T^* = max_{i\in\{AO,TC,LS\}} |T_t^i|$.
- If T^* exceeds a fixed critical value γ, then a suitable regression variable is included into the model (ν(B) is specified according to the type of outliers identified).

2. *Backward deletion*

- All model parameters are globally re-estimated (via maximum likelihood), including the new regression variables from the previous stage.
- Limited to outliers identified in stage 1, t-statistics T_t are computed and the one having min $|T_t|$ is compared with a critical value γ,
- If min $|T_t| < \gamma$, the outlier is deleted and a new ML estimate is performed.

In the model-based approach, the classification of outliers has a straightforward effect on the outcome of seasonal adjustment. Additive outliers and transient changes are assigned to the irregular component, level shifts to the trend cycle and seasonal outliers to the seasonal component. Inaccurate or wrong classifications have a direct effect on the quality of decomposition.

However, the REGARIMA approach depends on several parameters that must be carefully checked. First, outliers depend on the model specifications (type of ARIMA model, transformation chosen, adequacy of model, etc.). Second, the automatic procedure only handles a very small part of intervention effects. Third, the detection of outliers is based on the assumption of a constant variance of series, but this may not be appropriate for some series.

9 An iterative procedure for detection and estimation of outliers was originally proposed by Tsay (1989) and subsequently refined by Chen and Liu (1993). At present, iterative procedures do not take into account seasonal outliers, on which research is still in progress. Therefore, a pure intervention analysis approach is the only one possible at the moment.

Example. In the table below, the outliers detected in the consumer price index in Greece are shown. Outliers have been computed on the basis of Airline models (automatically identified), but with log- and no transformations. In the two columns, types and dates of occurrence are shown for two different critical values. In all cases, all models are statistically acceptable.

Model settings	**VA = 3.5**	**VA = 3.0**
Airline model Log-transformation	*Additive Outliers*: May 83, September 87, March 93 *Transient Change*: none *Level Shifts*: May 90	*Additive Outliers*: May 83, January 86, September 87, March 91, July 92 *Transient Change*: none *Level Shifts*: May 90
Airline model No transformation	*Additive Outliers*: July 92 *Transient Change*: March 93 *Level Shifts*: May 90, April 94, July 94	*Additive Outliers*: July 92, October 92, September 93, October 96 *Transient Change*: March 93, September 97 *Level Shifts*: October 92, September 93, July 92, October 96

The results of a fully automatic detection of outliers are strongly dependent on the model assumptions and parameters used for a specific series. The instability in outlier detection can also be linked to an inadequate treatment of heteroscedasticity in the series. However, a careful check of economic plausibility of all outliers is always desirable.

2.4.3 Outlier adjustment in X-12-ARIMA (X-11 part)

In addition to the possibility of outlier adjustment in REGARIMA, X-12-ARIMA offers the possibility of detecting and correcting outliers in the X-11 part.

It is possible to distinguish two types of outliers: *major* and *minor* outliers. Whereas the regression approach only allows an observation to be an outlier or not, X-11 discriminates between major outliers – for which no information is taken into account in the replacement – and minor outliers – for which the information is partially taken into account, with linear, gradually decreasing weights. Consequently, X-11 allows two critical values to be defined for the detection of outliers, one lower bound (l_l), at which the definition of minor outlier starts, and a second boundary (u_l), at which the definition of major outlier starts.

In general, two options are available in X-11: outliers can be detected either on the basis of a variance calculated within a moving interval on the irregular component of a window length of five years or on the basis of variances calculated specifically for individual months of the irregular component.

The motivation of the second option, which was developed for X-11 by the Deutsche Bundesbank, is the observation that, in several series, the variance of the irregular is dependent on the individual month's series (e.g. production index of the construction sector). In its X-11 part, X-12-ARIMA therefore allows outliers to be detected by using month-specific variances or variances dependent on user-defined groupings of months.

Procedure for outlier detection in X-11

In detail, the X-11 outlier procedure works as follows (only the five-year moving interval is described, the detection for outliers dependent on the variance of individual months works similar): let I_t be the irregular value at time t, SI_t the seasonal-irregular factors at time t and Y_t the original series. Then the calculation is performed in the following steps (the multiplicative model is always assumed):

- compute a moving five-year standard deviation of the estimates of the irregular component and test $|I_t-1|$ in the central year of the five-year period against the upper limit (ul)* standard deviation σ;
- remove values of $|I_t-1|$ beyond (u_l *σ) as extremes and re-compute the moving five years;
- assign a zero weight to irregulars for which $|I_t-1|$ lies beyond (ul *σ) and a weight of 1 to irregulars for which $|I_t-1|$ is below the lower limit multiplied by the calculated standard deviation (l_l *σ). Assign a linearly graduated weight between 1 and 0 if $|I_t-1|$ lies between the lower and the upper sigma limit, i.e.:
- replace the value of an extreme SI_t, an example is shown when $W_{t+-12}+W_{t+-24}=1$

$$W_t = \begin{cases} 1 & \text{if} \quad |I_t - 1| < l_l{}^* \sigma \\ \dfrac{u_l{}^*\sigma - |I_t - 1|}{u_l{}^*\sigma - l_l{}^*\sigma} & \text{if} \quad u_l{}^*\sigma < |I_t - 1| \le l_l{}^*\sigma \\ 0 & \text{if} \quad |I_t - 1| \ge u_l{}^*\sigma \end{cases}$$

$$SI_{trep} = \frac{1}{4 + W_t}\left[SI_{t-24} + SI_{t-12} + W_t SI_t + SI_{t+12} + SI_{t+24}\right]$$

- produce an extreme value adjusted original series for the next iteration run.

If $W_t < 1$ define $X_t = \dfrac{I_t}{1 + W_t(I_t - 1)}$, the adjusted series is then $Y_t^{\text{corrected}} = \begin{cases} Y_t, & \text{if } W_t = 1 \\ Y_t / X_t & \text{if } W_t < 1 \end{cases}$

The main disadvantage of this method, compared with REGARIMA, is that no specific treatment for outliers affecting the trend (corresponding to level shifts in the regression approach) is available. Moreover, due to the empirical nature of the method, inference is not possible.

2.4.4 Conclusions

The use of outlier adjustment in REGARIMA models is more adequate than in the traditional X-11 approach, especially in cases where outliers affect the trend level.

The environment of a central bank is characterised by the fact that the main users of seasonally adjusted figures and the producers of seasonally adjusted figures can work closely together. Additional information obtained from the main users can be considered by the producers of seasonally adjusted figures. For this specific situation, the model-based approach offers the advantage of transparency due both to the possibility of making inference and to its flexibility.

The use of the X-11 outlier detection method should be reduced to a minimum and major outliers should be treated in the REGARIMA part. Therefore, the σ limits for outlier detection in X-11 should be set higher than the default values in the program.

In addition, it seems desirable that tools are developed that deal with the robustness of the outlier detection, giving the user a rough indication of the sensitivity of a detected effect. This covers the possibility that outliers are detected with a chosen sensitivity. Outliers around this lower sensitivity bound may change from outliers to non-outliers in the course of a year as they can fall slightly below this bound.

Checking the robustness of the detected outliers, documenting outliers very carefully and fixing the historical outliers via regression effects during the annual check should always be recommended. In addition, it would be desirable, wherever possible, to flag outliers in publications.

2.5 Standard Quality Report

Quality control is an important step in the construction of a reliable seasonal adjustment procedure. The quality of the adjustment depends on the timely collection of information on statistical and economic factors that might influence the data. This information must be linked to the statistical analysis of the data. Two different kinds of situations can be distinguished for a quality check:

- annual review of the options in use; and
- monthly quality control.

The following sections present a proposal for the use of different criteria for these two situations.

2.5.1 Annual quality checks

The annual quality checks should provide answers to the following questions:

- *Does the REGARIMA model still fit the original series in an adequate way?*

  This question can be answered through an analysis of the residuals based on the Ljung-Box test and the Box-Pierce test, checking whether the residuals are uncorrelated at regular and seasonal lags. The analysis of the skewness and the kurtosis indicates whether residuals are normally distributed and the Ljung-Box test for the squared residuals helps analyse whether non-linearity affects residuals.[10]

  In addition to the analysis of the model residuals, spectrum estimates for the different kind of components and their stationary transformations help to find out underadjustments or inadequate trading-day adjustments.

  Another important issue is the analysis of prediction errors for different sources and horizons of the original series. Improving the forecast quality and understanding the structure of the error

[10] Some non-linearities have no effect on seasonally adjusted series, as shown in Planas (1998)

helps to improve the forecast quality of the trend and the seasonal component. Especially within the model-based approach, the analysis of the prediction error is important, as information is obtained on the contribution to the unpredictability of the original series of the various non-observable components.

- *How robust are the options compared with competing options?*

  This can be determined by analysing the changes in the parameter values within a calendar year and by analysing the history of the following criteria for the chosen model and for competing models:

  → AIC history;

  → comparison and analysis of out-of-sample forecast errors;

  → comparison of revision patterns.

  This check helps to improve the current settings of both the REGARIMA model and the seasonal adjustment part. Competing models can be different transformations, different types of ARIMA models or even the same model considering a different starting date for the modelling task.

- *Overview on the revisions of the published seasonally adjusted data and of the original data*

  Reasons for revisions in the last year should be checked. This check enables the user to find out whether important revisions of the original data or wrong settings for the seasonal adjustment caused important revisions. It helps ascertain whether the frequency used to update the seasonal factors is adequate.

- *Are detected outliers plausible?*

  The first check of the data concerns possible changes to definitions, which may have affected the classification, quality, method of estimation, etc. of the raw data. Checks on the outliers identified should answer the following questions: are the outliers plausible and are the outliers accounting for all the factors that are likely to have affected the data-set? Particular attention should be paid to the possibility of seasonal breaks. When problems from “statistical sources” can be excluded, the occurrence of detected outliers and their effects should be discussed with economic experts, in order to identify possible economic reasons for outliers in the current or forthcoming years affecting seasonal patterns.

- *Are different constraints fulfilled?*

  Different constraints can concern the annual sum of the seasonally adjusted data in comparison with the original data. As far as stock data are concerned, this constraint should roughly hold, whereas this is not true of flow data. It is important to analyse the reasons for discrepancies, for example as fast-moving seasonal components.

Another constraint concerns the additivity of the components to their aggregates. In the indirect approach, this is automatically achieved. But since the direct adjustment is used as the control variable, differences should be studied and options should be changed to reach smaller differences. At this point, an analysis should be performed comparing the seasonal patterns of the current year with the average seasonal pattern of recent years.

2.5.2 Monthly quality report

For the use of both concurrent and forecasting factors, the monthly monitoring of the seasonal adjustment is necessary, although the intensity and level of detail of this check depends on the importance of the series, their time series characteristics and the time available for carrying out regular checks. Taking into account the complex nature of X-12-ARIMA and TRAMO-SEATS, and the extensive amount of information provided for the numerous steps of adjustment by these programs, it is important that the core information included in the output of the programs is made available to the producer of seasonally adjusted results in a user-friendly and efficient manner.

A monthly output has been designed at the ECB to monitor the quality of seasonal adjustment, based on the adjustment in a FAME database environment. This “quality report” summarises the chosen program options, the main time series components, the results of test statistics and the revisions of previous results in the form of charts and tables. The complete version of the proposed quality report is presented in the Annex and explained in further detail below. The example refers to a quality report for X-12-ARIMA, but a very similar report can be produced and used for TRAMO-SEATS (the only difference are the model-based quality criteria for the seasonal adjustment). The proposed output may be further developed by distinguishing between regular and optional parts, depending on the series concerned, and the required degree of quality checking. It is clear that this report can be only used in combination with a table containing all additional information that has been collected on “statistical” problems in the data and economic factors that might have distorting effects on the analysis.

2.5.3 Short description of the data base environment and the monthly output

Seasonal adjustment in the FAME database is organised as follows: only the seasonal factors and the trading-day factors are stored as time series. The seasonally adjusted stocks, flows and indices as well as all growth rates are formulae in FAME that are calculated when the series is requested from the user in the working environment. The official factors that are used have the extension “final”. Whenever a seasonal adjustment is run, the seasonal factors and the trading-day factors of this current run as well as additional pre-adjustment factors are stored as series with the extension “concurrent”. All series can then be checked and compared on the basis of the current run and the official run. If an update of the official factor is desired, the seasonal and trading-day factors are simply copied from the extension “concurrent” to the extension “final”. In addition to the seasonal factors, the specification file containing the input options for X-12-ARIMA or SEATS are stored in case series associated with the seasonal factors. The output parameters are stored in two case series: one case series of type-precision contains the parameters of the REGARIMA model, the associated standard errors and the quality criteria, while another series, a string series, contains the description of the parameters. As this information is linked to the time series, one can easily access information on the input and output parameters.

Whenever a seasonal adjustment is run for the monetary aggregates and the HICP, the quality report will be produced in a postscript format that can be easily printed out or checked on screen. An example of monetary aggregates and a detailed explanation of the content can be found in the Annex A2. It contains the following information:

1. revisions of raw series;
2. specifications used to perform seasonal adjustment;
3. chart of the components;
4. values of estimated parameters for the stochastic and the deterministic parameters of the REGARIMA model;
5. parameter significance, plausibility, and stability in time compared with previous estimations;
6. standard quality criteria for the adjustment;
7. forecast error for the original series (to detect special revision patterns);
8. indications of seasonal breaks and/or special effects; and
9. validity of the projected seasonal factors in use, compared with concurrent adjustment.

Linked to information on special events from statistical as well as economic sources, this report forms an important part in helping to assess the quality of the seasonal adjustment.

3 PRACTICAL IMPLEMENTATION AT THE ECB

3.1 Monetary aggregates

3.1.1 Introduction

The Governing Council of the ECB has assigned a "prominent role" to money in the assessment of its monetary policy strategy and, for this purpose, it has announced a quantitative reference value for the growth rate of the broad monetary aggregate M3. It was decided to use the three-month moving average of the annual growth rate, calculated by using flows, as the tool to analyse the current growth rate with respect to the reference value. However, this tool cannot be used to compare the monthly variations of the monetary aggregates directly and to assess the most recent developments, since seasonal, calendar and irregular variations distort the signal of interest. In addition, disturbances due to base effects can complicate the interpretation. Seasonal adjustment is therefore essential for the purposes of the short-term analysis, since it allows the removal of those variations in the time series that are repeated, more or less regularly, every year.

In addition to the short-term monitoring of seasonally adjusted results, a central bank might be interested in detecting certain seasonal regularities associated with systematic behaviour of the general public in its demand for liquidity (impact of extraordinary payments, use of automated teller machines, interest rates payments, etc.).

The consolidated balance sheet of the euro area Monetary Financial Institutions sector is the basis on which euro area monetary aggregates are calculated. The data is complete from September 1997 onwards, a time span that is far too short to perform seasonal adjustment. However, the NCBs have carried out a backward estimation of the series currency in circulation, overnight deposits, M1, M2 and M3 back to 1980, thus long enough to allow the use of seasonal adjustment methods.

3.1.2 Seasonality in the monetary aggregates

The sources of seasonality in monetary aggregates time series are various. For currency in circulation and overnight deposits, the holiday period in summer, the 13th month salary and the payment of value-added and income tax play an important role as well as interaction with marketable instruments at the end of the year (window dressing and tax reasons). The strongest seasonal pattern can be observed in December: on average (between 1980 and 1999), this month shows, for overnight deposits, a seasonal effect of more than 5% above average.

Seasonality in other short-term deposits is dominated by the interest rate payments at the end of the year, leading to average seasonal effects of around 1% for December and January between 1980 and 1999.

Seasonality of marketable instruments is dominated by the strong negative seasonal effect due to tax reasons in December.

An important feature of the seasonality in monetary aggregates is its slowly moving character (moving interest rates, changes in the gratification, etc.).

In order to provide an overview of the importance of seasonality in monetary series, the chart below shows the seasonal factors (multiplied by 100) of some of the components of M3 for individual months in the period from 1980 to 1999, together with their long term averages.

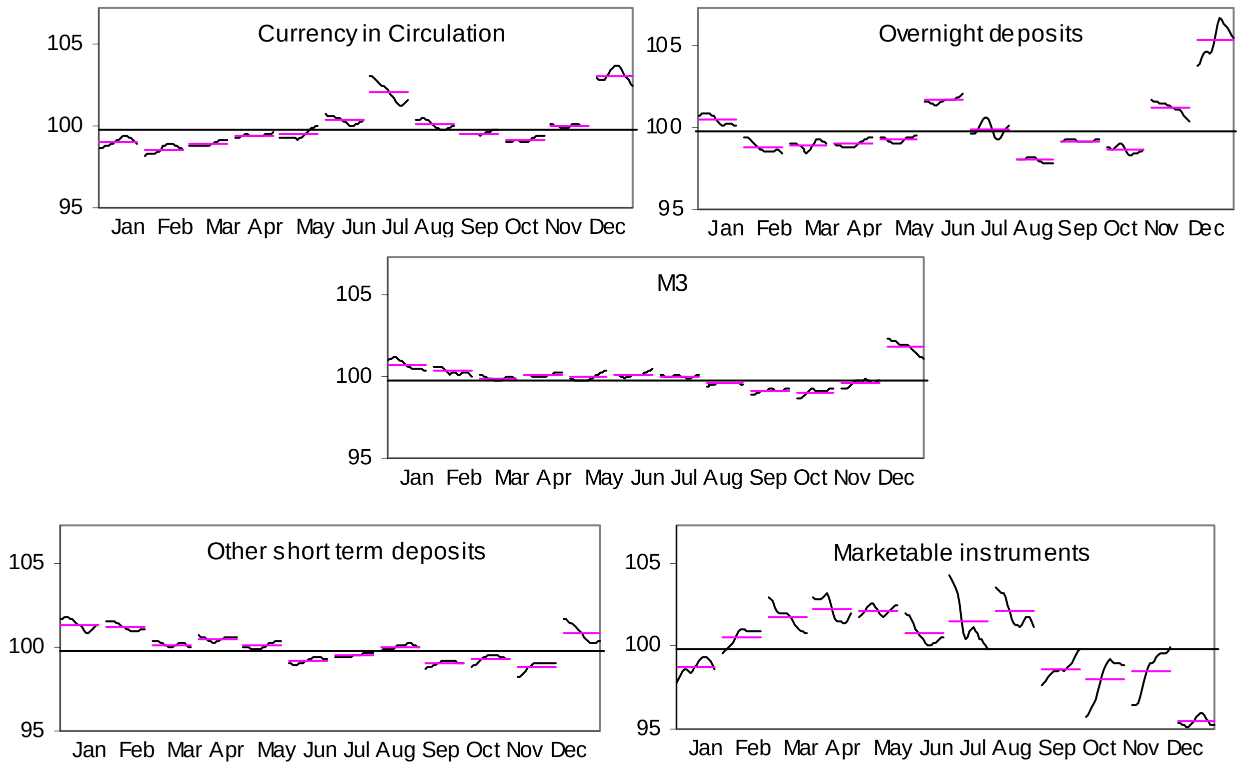


Chart 3.1.1: *Seasonal factors (multiplied by 100) for the components of euro area M3*

3.1.3 Practical recommendations

After analysing several possibilities for the seasonal adjustment of the monetary aggregates, the ECB has come to the following recommendations:

1. <u>*Indirect versus direct adjustment*</u>

   Several criteria have been considered to decide on the choice of direct versus indirect seasonal adjustment of M3. No mechanical criteria that can be fully decisive. In the case of monetary aggregates, no clear "winner" could be found. It was finally decided to use an indirect method.

Among other things, this was based on the practical consideration that this approach ensures the additivity of the seasonally adjusted components to the seasonally adjusted aggregate.[11]

Empirical work by Takala (1999), checking the difference between the indirect seasonal adjustment approach for M3 via M1, other short term deposits and marketable instruments and the multivariate approach, and the empirical work by Cabrero (1999), comparing direct and indirect adjustment for the Spanish contribution to M3, confirmed that this approach cannot be characterised as inferior to a multivariate approach or the direct adjustment.

The seasonal adjustment of M3 will therefore be done indirectly on the components M1, M2 minus M1 (other short-term deposits) and M3 minus M2 (marketable instruments). In addition, currency in circulation will be seasonally adjusted. Overnight deposits will be seasonally adjusted indirectly as a residual item from M1 and currency in circulation.

Support for choosing the indirect method was given by the fact that the seasonal components for the above mentioned time series showed a low correlation, an exception being the negative correlation in the seasonal and cyclical components between overnight deposits and marketable instruments. However, even for these two components, taking into account the fact that the reliability of overnight deposits at the current end is rather high, whereas marketable instruments are characterised by high revisions, a separation of both seems to be recommendable. The choice of directly seasonally adjusting M1 was based on the revision history comparison and the high correlation of the seasonal component between currency in circulation and overnight deposits.

The time series will be adjusted, starting in 1980, as no evidence could be found that the use of shorter periods proved to be superior.[12]

Due to the importance of studying the differences of directly and indirectly seasonally adjusted results, direct adjustment will be run in parallel to indirect adjustment as a control and quality tool.

2. *The use of the index of notional stocks*

To ensure consistency between the seasonally adjusted results of stocks and flows and based on statistical criteria,[13] it was decided to perform the seasonal adjustment on the index of notional

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11 The additivity of the components in the monetary analysis normally has two dimensions: the additivity of the components of M3 to its total, with the requirement, however, that the results for the monetary aggregates must match the results of their counterparts. This makes the additivity issue far more complex. However, data for the counterparts are only available from September 1997 onwards (except for loans to other euro area residents which have been estimated backwards to January 1982). This kind of additivity requirement for seasonally adjusted data will therefore only occur in around three years when the time series will be long enough for seasonal adjustment. The problem has therefore not been addressed in this report.

12 Based on the forecast error of the REGARIMA model between September 1997 and October 1999.

13 The adjustment of flows causes problems: as the variation of flows is dependent on the level, the adjustment of the stocks can be problematical at the current end since reclassifications, revaluations and other changes in stocks that are not caused by true transactions can distort the signal of interest. An empirical investigation showed the advantages with respect to the stability of the seasonal factors if the index of notional stocks is used instead of the stocks.

stocks. The stocks and the flows should be seasonally adjusted by applying the seasonal factors from the index of notional stocks to the stocks and to the differences in stocks that are caused by events other than true transactions. The seasonally adjusted index of notional stocks for the aggregates M3 and M2 will be calculated from the seasonal factors of the indirectly seasonally adjusted stocks for these aggregates.

3. *Trading-day adjustment*

Currency in circulation and some deposits are affected by trading-day effects. These effects are caused by the day of the week on which the month ends, as monetary aggregates are collected as end-of-month-stocks. Different needs for cash close to the weekend, compared with the needs on weekdays, as well as rules on the payments of pensions are the main causes of this effect. This stock trading-day effect is estimated by taking into account special national holidays in euro area countries at the end or at the beginning of the month.

4. *The use of projected seasonal factors*

The seasonal component of nearly all components of the monetary aggregates is rather stable and the importance of the irregular component is rather low. Statistical criteria indicated that the loss in accuracy for projected factors against concurrent adjustment for the monetary series is low.[14] These characteristics allow the use of projected seasonal factors that are preferred mainly on account of presentational advantages. Another reason for this choice were the high revisions of the data in the course of 1999. However, a general decision for a policy to forecast the seasonal factors only once a year had not been taken in view of, especially, the instability of the seasonal factors of marketable instruments. This instability is caused by the fact that reliable information on this issue is rather scarce for important members of the euro area, due to high innovations in this market and due to the minimum reserve requirements that have led to a change in the importance of some instruments.

The pragmatic solution that has therefore been proposed is the general use of projected seasonal and trading-day factors. The accuracy of these factors will be monitored monthly, by comparing them with the seasonal factors of the concurrent run. If the criteria described in the monthly quality report or empirical evidence from additional information indicate that an update of these seasonal and trading-day factors is necessary, this update will be performed.

In order to gain more experience in the field of projecting seasonal factors one year ahead and to benefit of the experience of national seasonal adjustment experts with respect to the national sources of seasonality, in the course of of the year 2000 a meeting of interested NCBs and the ECB will be held to perform a pilot exercise for forecasting the seasonal factors one year ahead. At a meeting in 2001, the results and further possible steps will be discussed.

[14] The reduction in the residual mean square error when using the concurrent adjustment, compared with the use of projected factors, was studied and found to be rather low.

5. *The use of additional growth rates*

To aid comparison with the twelve-month growth rates of the original series and the month-on-month growth rate of the seasonally adjusted series, the annualised three and six-month growth rates based on the seasonally adjusted figures can be of additional interest as they give an important insight in recent evolutions. However, these figures have to be analysed with care as they can give a misleading interpretation if the three or six months used for the annualisation process contain erratic observations. Alternatively calculated annualised growth rates for other periods can help in understanding these effects.

6. *The use of X-12-ARIMA and TRAMO-SEATS for seasonally adjusting the monetary aggregates*

Empirical investigations have indicated that the advantages of the use of REGARIMA models apply to the monetary aggregates. The time series under consideration can be fitted with an acceptable quality by parsimonious REGARIMA models. TRAMO-SEATS therefore offers the possibility of statistical inference due to its definition, whereas some modelling possibilities of X-12-ARIMA (different seasonal filter for different months and month-dependent outlier detection) and the strong part in X-12-ARIMA concerning the empirical quality checks have motivated the use of X-12-ARIMA.

7. *Stylised facts*

The main characteristics of the monetary aggregates with respect to their models can be described as follows:

All time series could be modelled adequately with parsimonious REGARIMA models using a reasonable amount of outliers.[15] All time series considered for the euro area contain a highly stochastic trend and a medium stable seasonal component.

The reliability of the estimation of the seasonal component is high for M1, other short-term deposits and the aggregate M3, but far less reliable for the marketable instruments (M3 minus M2).[16] In addition, the original series for marketable instruments in 1999 was characterised by a high number of revisions at the current end. When considering the national contributions for M3, a very stable seasonal component could be detected in the German and Spanish contributions, whereas the Italian contribution and, especially, the contribution of several small members of the euro area showed a rather stochastic behaviour.

8. *Agreed criteria for a quality control*

The standard quality report will be produce to monitor the seasonal adjustment on a monthly basis that is independent of the question as to whether X-12-ARIMA or TRAMO-SEATS is used. The software for the monthly report has been installed in the FAME database

[15] Adequacy was checked via the residual analysis (test for autocorrelations of the residuals, independence test for residuals, normality test for residual). The exact specifications can be found in the annex of the final report.

[16] Reliability was tested using the confidence interval from SEATS as well as empirical revision criteria.

environment. However, mechanical criteria can never replace a reliable information flow on special effects that might distort the figures from the NCBs to the ECB.

9. *Time series to be presented in seasonally adjusted form*

The following time series of the monetary aggregates are presented in seasonally adjusted form:

Currency in circulation, overnight deposits, M1, other short-term deposits (M2 minus M1), M2, marketable instruments (M3 minus M2), M3.

All the time series mentioned will be published as seasonally adjusted stocks, as seasonally adjusted flows and as seasonally adjusted indices of notional stock.

3.2 HICP

3.2.1 Introduction

The HICPs were developed for the purpose of measuring convergence on a comparable basis. Since the start of the single monetary policy in the euro area, the HICP has been a key indicator for the monetary policy strategy of the Eurosystem.

The national HICPs have a common product coverage, but index baskets and weights reflect national consumption patterns. HICPs are available from 1995. Before that date, series were extended using national CPIs adjusted to the coverage of HICPs. Pre-1995 backdata are available for ten euro area countries (excluding Luxembourg) and for an only small sub-set of sub-indices. Meaningful euro area aggregates can be compiled back to 1992.

From end-1999, the coverage of HICPs has been enlarged to include social services (health and education) and some other fields (insurance and geographic coverage). Moreover, a revised sub-index classification has been applied as from 2000. The European Commission (Eurostat) publishes series on the basis of the new classification back to January 1995. A review of the settings used to produce the seasonally adjusted series will be necessary as soon as the new HICPs become available.

3.2.2 Seasonality in the HICP

Seasonal price movements may be defined as intra-year changes occurring to a similar extent in successive years. Baxter (1999) outlined some of the reasons for seasonality in CPIs:

(i) food prices varying during the year;

(ii) sales prices affecting, in particular, clothing or consumer durables;

(iii) tax changes at same dates each year; and

(iv) price increases at fixed intervals, as in the case of railway tickets or mail-order catalogue goods.

In general, seasonal price variations may occur in many sub-indices, but affect these to very different degrees. They are usually strong in categories such as vegetables and fruits, but very small or non-existent in item groups such as certain durable consumer goods or services. They may also show a highly different pattern in different euro area countries. Seasonality can differ significantly from one country to another. One reason is represented by different weights of the items, which typically show considerable seasonal price fluctuations. The table below reports weights of the 11 euro area countries for unprocessed food (containing fish, fruits, vegetables and meat) and clothing. The weight shares differ between countries by a factor higher than 2 (see Table 4.2.1).

Table 3.2.1: *Weights in HICP (1999, in %)*

	euro	BE	DE	ES	FR	IE	IT	LU	NL	AT	PT	FI
Unprocessed food	9.0	10.2	6.6	16.2	9.7	9.6	9.2	7.9	7.2	6.3	14.7	7.2
Clothing	8.5	8.7	8.0	11.4	6.4	6.3	10.7	9.1	7.6	8.1	8.0	5.6

Another reason for differences in the seasonal pattern between countries is the lack of harmonisation in the treatment of seasonal items, i.e. items only available in some months and items which have seasonal price movements (as shown in the chart below for package holidays).

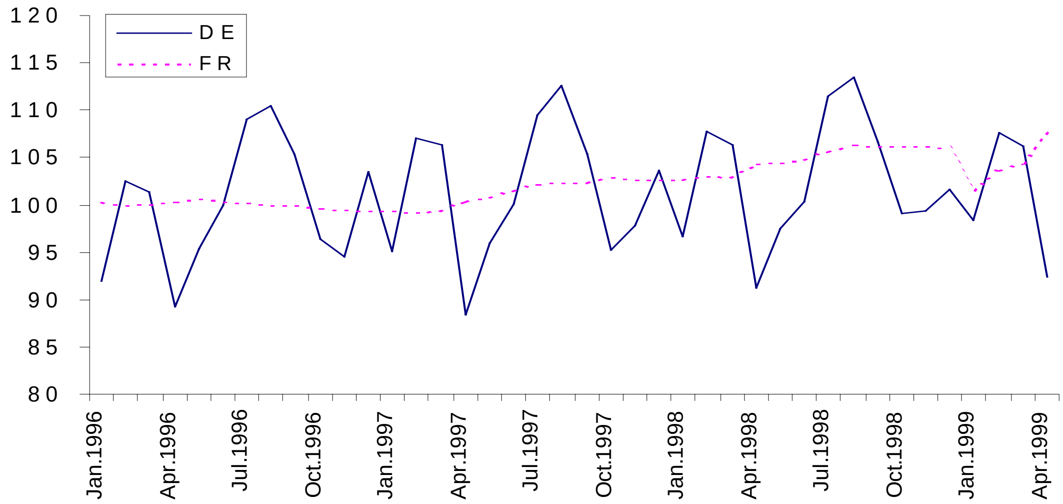


Chart 3.2.1: *Price index for package holidays (France and Germany)*

In general, seasonal variations in prices are stronger in national series than in euro area aggregates. This is due to the different (often, contrasting) behaviour of seasonal patterns in national components. Moreover, as expected, most euro area sub-indices show stronger seasonality than the overall index. Compared with the seasonality of monetary aggregates, the seasonality in the HICPs is small. However, they explain about 0.5 percentage points of the intra-annual development of the HICP.

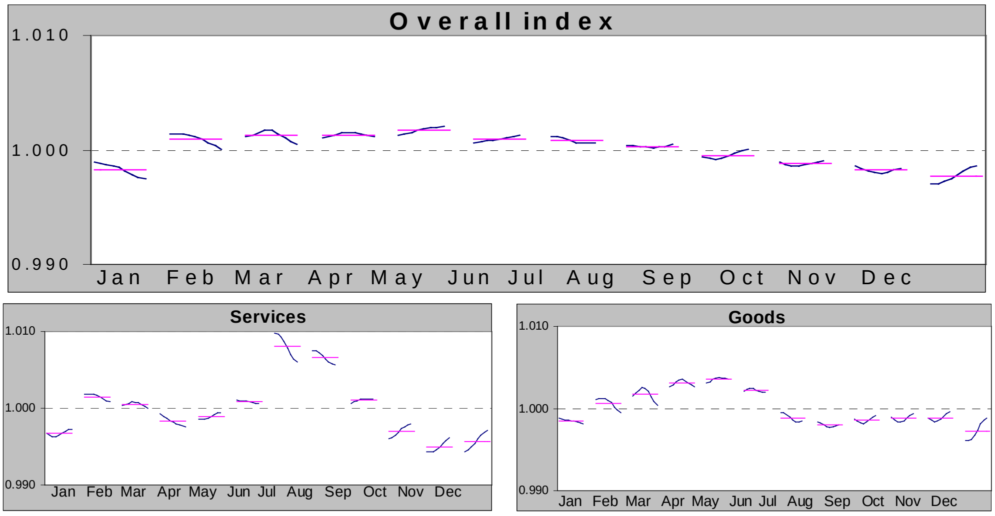


Chart 3.2.2: *Seasonal factors for euro area overall HICP and breakdowns (services and goods).*

Statistical tests signal a significant presence of seasonality in most euro area series, with the only exception of the energy series and industrial goods, the former of which is one of the two sub-components. Tests available in X-12-ARIMA for euro area main aggregates are reported below.

Table 3.2.2: *X-12-ARIMA seasonality tests – item groups*

Series	TESTS FOR SEASONALITY (INCL. BACKDATA)			Combined test for identifiable season.
	Stable seasonality	**Kruskal-Wallis test**	**Moving seasonality**	
All items	Present at 0.1% level	Present at 1% level	Present at 5% level	PRESENT
GOODS	Present at 0.1% level	Present at 1% level	Present at 5% level	PRESENT
FOOD	Present at 0.1% level	Present at 1% level	No evidence at 5%	PRESENT
Processed food	Present at 0.1% level	Present at 1% level	Present at 1% level	PRESENT
Unprocessed food	Present at 0.1% level	Present at 1% level	Present at 5% level	PRESENT
INDUSTRIAL GOODS	Present at 0.1% level	Present at 1% level	*No evidence at 5%*	*PROBABLY NOT PRESENT*
Excluding energy	Present at 0.1% level	Present at 1% level	*No evidence at 5%*	PRESENT
Energy	*No evidence at 0.1%*	*No evidence at 1%*	*No evidence at 5%*	NOT PRESENT
SERVICES	Present at 0.1% level	Present at 1% level	Present at 5% level	PRESENT

Similar results and further details are available in the recent study of Cristadoro-Sabbatini (1999).

3.2.3 Practical recommendations

1. <u>*Model choice*</u>

For both X-12 ARIMA and TRAMO-SEATS, the model choice is important for the results. For the HICP, the Airline model (multiplicative ARIMA (0,1,1)(0,1,1) model) generally proved satisfactory and is used, with the proviso that statistical evidence supports its use. In this case, models are chosen to fit problematic series in a statistically optimal way, according to some of the statistics of the quality report. Tests carried out on both the estimated parameter and the adequacy of Airline models signal a high stability of the price series.

2. *Series length and use of backdata*

HICPs start in January 1995 and are therefore relatively short for seasonal adjustment. The use of backdata for periods before 1995 is useful for seasonal adjustment, since, due to the longer series length, the use of asymmetric filters is reduced and also increases estimate accuracy. The use of backdata, when they are available, is therefore recommended to improve the quality of estimates.

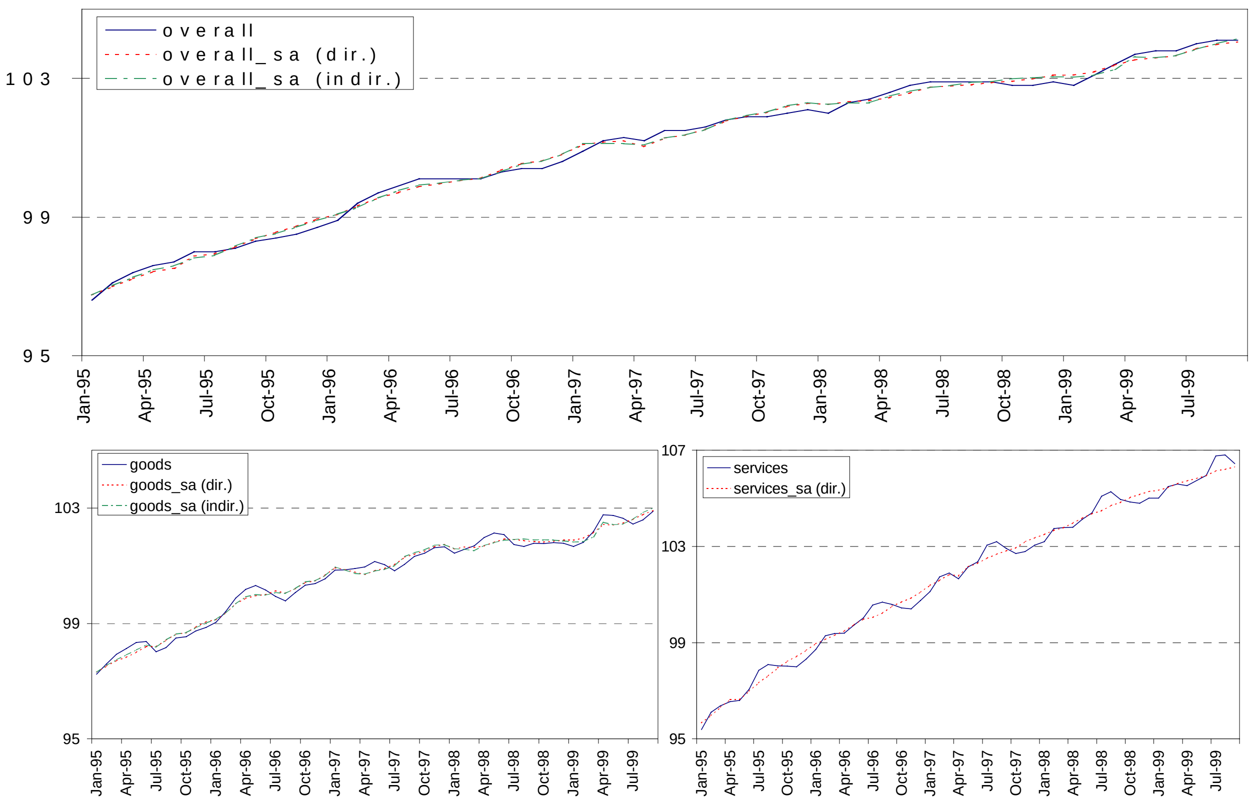
3. *Concurrent adjustment and forecasting factors*

The seasonal factors of the HICP are quite stable. Their behaviour over time has been simulated by extending progressively the last sample date of some important sub-components. For the same reference month, the seasonal factor variations are small in almost all cases and the changes did not affect the rounding margin of the HICP. However, a parallel concurrent adjustment will be performed for the key series in order regularly to check the adequacy of the forecasting factors.

4. *Direct and indirect adjustment*

There is no decisive *statistical* evidence supporting either direct or indirect adjustment. The differences in the results for the aggregates are very small due to the limited and, at the same time, stable seasonality of the series.

Chart 3.2.3: *Raw and seasonally adjusted series for the euro area overall index, goods and services.*



The table below shows figures for seasonally adjusted series derived on the basis of different rules.

Table 3.2.3: *Direct and indirect adjustment for all items of the euro area HICP*

	Direct	**Indirect via five sub-components**	*Difference*	**Indirect 11 countries**	*Difference*
Oct. 1998	102.91	102.95	*0.04*	102.94	*0.03*
Nov. 1998	102.99	103	*0.01*	102.98	*-0.01*
Dec. 1998	103.08	103.07	*-0.01*	103.08	*0.00*
Jan. 1999	103.07	103.04	*-0.03*	103.13	*0.06*
Feb. 1999	103.15	103.09	*-0.06*	103.22	*0.07*
Mar. 1999	103.35	103.27	*-0.08*	103.39	*0.04*
Apr. 1999	103.57	103.61	*0.04*	103.55	*-0.02*
May 1999	103.61	103.62	*0.01*	103.6	*-0.01*
June 1999	103.67	103.69	*0.02*	103.67	*0.00*
July 1999	103.87	103.87	*0.00*	103.81	*-0.06*
Aug. 1999	104.00	104	*0.00*	103.95	*-0.05*
Sep. 1999	104.06	104.12	*0.06*	104.09	*0.03*

Sometimes, however, small discrepancies in the growth rates computed on series derived on the basis of different rules can be observed. Users underlined the importance of consistent growth rates of euro area all-item and sub-index HICPs. Therefore, it is recommended that the compilation of the seasonally adjusted overall HICP is made as the sum of adjusted euro area sub-indices (ECB breakdown, indirect adjustment via five sub-components, namely processed food, unprocessed food, industrial goods excluding energy, services and energy which is added as a raw series).

5. *HICP corrected for tax effects*

HICPs measure the prices which are actually paid by consumers. They therefore include all indirect taxes on products, which are paid by the consumer. Moreover, so-called "administered" prices are generally covered by the HICP. For this reason, changes in indirect taxes, changes in subsidies or the reimbursement or changes in administered prices are reflected in the HICPs.

In particular, tax changes can have a noticeable effect on the quality of adjustment and the seasonally adjusted results, especially when these tax changes occur in the same months of two or more years which are covered by the seasonal filter. In that case, the tax change may be partially attributed to the seasonal component by the automatic program settings. In this case, the seasonally adjusted series does than not (fully) reflect the increase in prices due to tax increases. This is not desirable from an analytical point of view, since tax changes are usually not regarded as being of a seasonal nature.

The consideration of information on tax changes requires external information on the main tax changes at the *national* level. The most efficient way of collecting and incorporating this information was not discussed by the Task Force. It will be examined further by the ECB.

6. *Growth rates*

One of the main effects of the seasonal adjustment of price indices can be observed in the growth rates. In general, seasonally adjusted series have stabilising effects on growth rates computed from them. A reduction in the volatility of the short-term growth rates is evident in all series, regardless of the specific rule adopted to derive them. As a rough indicator, standard deviations have been computed for the month-to-month growth rates from January 1996 to September 1999. For the overall HICP, they drop from 0.136 in the non-adjusted series to 0.084 in the directly adjusted series and to 0.092 in the series indirectly adjusted via countries. A similar reduction is also observed in the growth rates computed for growth rates of three months with respect to the three preceding months: from 0.242 in the non-adjusted series to 0.150 and 0.164 in the series seasonally adjusted directly and indirectly respectively via ECB sub-components.

7. *Time series to be seasonally adjusted*

The following time series of the HICP are recommended for seasonal adjustment:

- Overall index, goods, food, processed and unprocessed food, industrial goods and non-energy industrial goods, services.

4 EMPIRICAL ASSESSMENT OF CENSUS X-12-ARIMA AND TRAMO-SEATS

4.1 Criteria for a comparison of methods and their limitations

This section presents the comparison of the two software tools X-12-ARIMA and TRAMO-SEATS. The comparison is based on three main sets of criteria, namely:

- theoretical criteria;
- empirical criteria; and
- environmental criteria.

Theoretical foundations represent the principal criterion in the selection of a seasonal adjustment method. From a user perspective, how theoretical features are implemented in practice has to be evaluated. For this purpose, the tools offered by X-12-ARIMA and TRAMO-SEATS will be reviewed and compared.

Second, criteria for a selection must also deal with the empirical performance of the methods to indicate to the economists and policy-makers the practical implications of using one particular software. However, empirical comparison is often not conclusive, since different criteria only highlight different aspects of the results that often even contradict one another.[17] In this respect, the following issues will be discussed: revisions of the seasonal factors, detection of turning points, idempotency.

Third, but not less important, the use of a seasonal adjustment method is based not only on the choice of the best idea, but also on the need to select the procedure that guarantees the best possible results in the given framework. The evaluation is based on the consideration of which learning facilities are currently available (courses, literature and specific documentation), but also on evidence concerning the performances of the two programs (accessibility to non-experts, flexibility of input/output, computing time, etc.).

All results produced in this section are based on the most up-to-date versions of the two software programs and documentation that are available or have become available between June 1999 and January 2000.

[17] There are many examples of contradicting criteria. For instance, revisions versus accuracy of the signal, fast detection of turning points versus small number of false alarms and small revisions versus fast convergence of the revision process.

4.2 Theoretical comparison of the methods

The main steps involved in a standard seasonal adjustment process are summarised in the chart below.

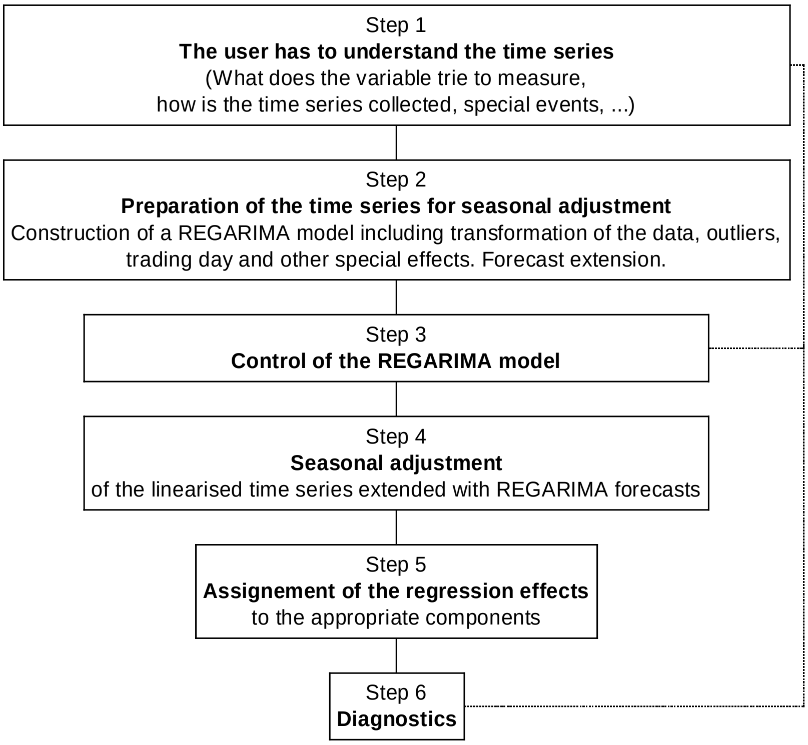


Chart 4.2.1: *Different steps in seasonally adjusting a time series*

Differences concerning the theoretical framework between the two sets of software in the first phase of the procedure (steps 2 and 3), i.e. the specification of an adequate model, do not exist. Some differences exist in the way in which they are implemented and in the way the output is presented to users.

The main difference between the programs lies in the actual seasonal adjustment process (step 4). Statistical theory does not provide generally applicable criteria for comparing the two methods that are not comparable by definition.

4.2.1 Comparison of the specifications of REGARIMA models

The theoretical framework on which the algorithms implemented in X-12-ARIMA and TRAMO are based is exactly the same. Differences only relate to the practical realisation of the general principles of this class of models.

Given an observed series y_t, the general model that is assumed is the following:

$$y_t = X\beta + y_t^*,$$

where X is a regressor matrix, containing deterministic variables such as, for instance, outliers and trading-day factors, and y_t^* is a seasonal ARIMA model of the order $(p,d,q) \times (P,D,Q)_s$, i.e.:

$$\phi_p(B)\,\Phi_P(B^s)\,\nabla^d\nabla^D\,(y_t{*}-\mu) = \theta_q(B)\,\Theta_Q(B^s)\,a_t$$

in which $\phi_p(B) = (1-\phi_1 B - \dots - \phi_p B^p)$, $\theta_q(B) = (1-\theta_1 B - \dots - \theta_q B^q)$ are the non-seasonal autoregressive and moving average polynomials respectively; $\Phi_P(B^s) = (1-\Phi_1 B^s - \dots - \Phi_P B^{Ps})$ and $\Theta_Q(B^s) = (1-\Theta_1 B^s - \dots - \Theta_Q B^{Qs})$ are the seasonal autoregressive and moving average polynomials (the quantity *s* correspond to the series frequency); $\nabla^d = (1-B)^d$ and $\nabla_s^D = (1-B^s)^D$ are two difference operators. The function *B* is defined as *lag* or *backshift operator*, i.e. $By_t = y_{t-1}$. Finally, the quantity a_t is supposed to be a white noise, i.e. a random term uncorrelated in time, having zero mean and constant variance σ_a^2. The parameter μ represents the mean of y_t*.

A seasonal ARIMA model is therefore a linear stochastic model that relates successive observations and observations at seasonal lags to each other. It is designed to model trend-cycle movements as well as seasonal fluctuations.

The typical steps necessary to fit a particular REGARIMA model to a series are the following:

1. Pre-adjustment of the series for deterministic effects such as outliers, calendar effects, etc., i.e. specification of an appropriate matrix *X*.
2. Identification and estimation of ARIMA model, i.e.
    (a) specification of the number of seasonal/non-seasonal differences, *d* and *D*, necessary to make the series stationary;
    (b) specification of the order of the stationary seasonal ARMA model (i.e. *p* and *q* for the non-seasonal polynomial, and *P* and *Q* for the seasonal one; the quantity *s* is derived directly from series frequency);
    (c) estimation of the parameters of the REGARIMA model, namely β for the regression model, ϕ_i and Φ_i in the autoregressive polynomials, θ_i and Θ_i in the moving average polynomials, and the so-called innovation variance σ_a^2.

A summary description of these steps, which are implemented in X-12-ARIMA and TRAMO, indicating, when necessary, differences and additional features offered to users, are summarised in Table 4.2.1.

Table 4.2.1: *Comparison of X-12-REGARIMA and TRAMO – series pre-adjustment*

<table>
<tr><th></th><th>X-12-ARIMA</th><th>TRAMO</th></tr>
<tr><td>Transformation choice</td><td>The choice is based on the comparison of the AICC criteria computed on ARIMA models on original and log-transformed series. Log transformation is always preferred unless:
$AICC_{nolog} - AICC_{log} < \Delta_{AICC}$,
Where Δ_{AICC} is a value which can be decided by users (by default, it is set equal to -2).
In general, a large set of Cox-Box transformation is possible. The test is fitted to the particular chosen transformation.</td><td>The choice is based on two tests:
1. A trimmed range-mean regression is computed after splitting the sample into n sub-samples, i.e. the model $r_i = \alpha+\beta\ m_i + u_i$ is estimated, where r_i and m_i are the range and mean respectively in the i-th sub-sample (excluding min. and max.). If the slope β is greater than a specified value, then data are log-transformed.
2. Comparison of BIC with and without data transformation.
The second test is considered when the first does not give clear indication.</td></tr>
<tr><td colspan="3">Regression variables</td></tr>
<tr><td rowspan="2">Outliers</td><td colspan="2">The two programs do not contain any relevant difference both in the type of outliers that can be modelled, namely AO, TC and LS. Also the algorithms for their detection and correction are basically the same. A summary description of the algorithm for the automatic detection and correction of outliers has been given in section 3.4.1 of this document.</td></tr>
<tr><td>Temporary ramp is an additional outlier available. It corresponds to a LS with an increasing linear effect within a time interval $[t_0, t_1]$.</td><td>In TRAMO, any outlier described by a polynomial $1/(1-\delta B)$, $1/(1-\delta B^s)$ or combinations of both can be processed.
In a future version, the automatic detection and correction will be extended also to seasonal outliers.</td></tr>
<tr><td>Calendar components</td><td colspan="2">As far as <u>flow trading day</u> is concerned, no major differences are observed in the two softwares. They allow the same type of predefined regressors, namely:
• one variable
<code>[#(working days) - 5/2 #(non-working days)];</code>
• six variables
<code>[#Mon.-#Sun.,#Tues.-#Sun.,#Wed.- #Sun.,#Th.-#Sun.,#Fr.-#Sun.].</code>
<u>Stock trading-day</u> effect is only allowed in X-12-ARIMA and not in the version of TRAMO currently available. In a forthcoming version of the latter software, this feature will be available.
Regarding the <u>Easter effect</u>, there are no differences. In both X-12-ARIMA and TRAMO, the length of the Easter effect can vary.
In general, both programs allow <u>user-defined regressors</u> to be introduced, thus enabling users to model special effects which are not available as standard features in the software.
Moreover, tests on the significance of calendar components (or, more generally, on regression variables) are available in both programs.</td></tr>
<tr><td>Special effects</td><td colspan="2">Length-of-month (i.e. difference between the numbers of days in a month and the average number of days) and leap-year variables are available in both programs.
In X-12-ARIMA, additional moving holidays (Labor Day and Thanksgiving) are also available.</td></tr>
<tr><td>Significance of regressors</td><td>The test is performed when the ARIMA model has been identified and a global estimation of REGARIMA part is done.
Given several competing models that include or exclude regressors, that with the minimum AIC value is chosen.</td><td>The significance of the individual regressors is tested with a standard t-test; a group of regressors is not tested globally.</td></tr>
<tr><td colspan="3">ARIMA models</td></tr>
<tr><td>Model structure</td><td>ARIMA models can be specified with the following limitations:
• <u>autoregressive coefficients</u>: $p+P = 24$
• <u>moving average coefficients</u>: $q+Q = 24$
• <u>differences</u>: $d+D = 24$
In total, $(p+P)+(q+Q)+(d+D)<25$.
Users can also specify missing lags in the ARIMA model.</td><td>The ARIMA model with maximum order that may be considered is:
• <u>non-seasonal polynomial</u>: $p=3$, $d=2$, $q=2$
• <u>seasonal polynomial</u>: $P=1$, $D=1$, $Q=1$
Users can specify missing lags in the ARIMA model by setting parameter values to 0.</td></tr>
</table>

Automatic model identification	X-12-ARIMA only has a semi-automatic model selection procedure. Users are allowed to limit the choice only to models specified in a particular file. Each model is first checked by considering both the estimated mean absolute percentage error forecast error statistics and Box-Ljung portmanteau statistics and signs for over-differencing.	First, the differencing order is looked for, testing the number of autoregressive unit roots. Identification of the ARMA model orders is performed on the basis of the minimum BIC value. The candidate model is accepted/rejected according to the value of the Ljung-Box test. Emphasis is generally placed on low order and balanced models.
Estimation	Maximum likelihood method (via Iterative Generalised Least Squares regression). Differences are only in the numerical algorithms implemented in the two programs.	

Most macroeconomic time series can be modelled with ARIMA models containing a low number of parameters. In TRAMO-SEATS, the preference for parsimonious models is also directly linked to the capacity of the programs to compute non-approximate filters. Moreover, when the model structure is complex, deriving properties and checking basic properties such as stationarity or invertibility become quite difficult.

The automatic ARIMA modelling procedure implemented in TRAMO is accepted to be superior to the semi-automatic modelling selection procedure in X-12-ARIMA which is based on the criteria developed in X-11-ARIMA. Professor Findley, the scientist responsible of X-12-ARIMA, therefore expressed his plans to incorporate the automatic ARIMA modelling procedure of TRAMO in X-12-REGARIMA, replacing the present algorithm.

4.2.2 Comparison of the diagnostics of REGARIMA models

The table below summarises the main tools available in both programs.

Table 4.2.2: *Comparison of X-12-REGARIMA and TRAMO – diagnostics of REGARIMA models*

	X-12-ARIMA	***TRAMO***
	Model specification	
Transformation	A message informs of the chosen transformation, based on the AICCs comparison, that is the F-adjusted AIC allowing the likelihood for different transformations to be compared.	Only the estimates of the regression parameter α and β are reported, but neither s.e. nor t-test are reported. A message informs whether data are log-transformed or not, but without any detail on the criterion eventually considered.
Regression variables	The complete list of parameters (trading-day regressors, Easter-effect variable or other special holidays and – only in X-12-ARIMA – outliers) is reported with estimates, standard errors and t-tests.	
	Types and dates of occurrence are specified for outliers.	
Automatic model choice	Model structure and statistics on average percentage error in within-sample and out-of-sample forecasts; Box-Pierce statistics are only reported when significant at a given level.	Model structure and BIC can be extensively reported. In the default option only chosen model is reported.
	Estimation	
Regression variables	The complete list of parameters (trading-day regressors, Easter-effect variable, other special holidays and – only in X-12-ARIMA – outliers) is reported with estimates, standard errors and t-tests. Type and date of occurrence is specified for outliers.	

Parameter estimates	Estimates and standard errors are reported. Some likelihood statistics for the global REGARIMA model (log-likelihood value, AIC, AICC, Hannan-Quinn criterion, BIC) are also reported. Complex roots (and period) are also computed and reported to give an indication about the dynamic behaviour implied by the model.	Estimates and standard errors are reported. Complex roots (and period) are also computed and reported to give an indication of the dynamic behaviour implied by the model.
	Checking	
Residual analysis	Normality test, skewness and kurtosis are reported. Histograms and descriptive statistics on distribution (median, quartiles) are also reported. Autocorrelation and partial autocorrelation values and standard errors are reported. Ljung-Box on residual correlation is reported (critical values are also reported). Autocorrelations and Ljung-Box test are also computed on squared residuals to test possible non-linearities.	Normality test, skewness and kurtosis are reported. Autocorrelations and partial autocorrelation values and standard errors are reported. Ljung-Box on residual correlation is reported (only its distribution is declared, but critical values are not reported). Non-parametric tests of independence (test on runs) are computed on residuals and their autocorrelations. Autocorrelations and Ljung-Box test are also computed on squared residuals to test possible non-linearities.
Additional diagnostics	Out-of-sample forecast errors. History of information criteria and forecast error of competing models.	Out-of-sample forecast errors.

Both programs offer further graphic tools for model checking. TRAMO has built-in MS-DOS software, whereas X-12-ARIMA offers graphic facilities via the SAS Graph module X-12-Graph (see Hood, 1999a and 1999b, for details). The input for both programs (ASCII text files) can be read by all other programs as well as for further analysis.

4.2.3 Comparison of the seasonal adjustment: X-12-ARIMA (X-11) versus SEATS

General classifications

X-11 was developed by Shiskin, Young and Musgrave (1967) and falls in the class of empirical methods. It is empirical in the sense that it is a complex combination of different calculation steps without an underlying model. The seasonal adjustment module in X-12-ARIMA is still called X-11, although it offers some additional options compared with the previous versions of X-11 and X-11 ARIMA. In many cases, these improvements were developed by users of X-11 and X-11-ARIMA and were integrated in X-12-ARIMA by the US Bureau of the Census.

SEATS was developed by Maravall and Gomez (for details, see Maravall and Gomez, 1997) and falls in the class of ARIMA model-based approaches. It decomposes the spectrum of the estimated ARIMA model into the orthogonal components, trend-cycle, seasonal and irregular components, using the constraint of maximising the variance of the irregular.

From a purely theoretical point of view, a model-based approach is preferable, as the assumptions of the method are known and proper inference is possible. To date, however, the empirical method X-11 is the most widely used seasonal adjustment program.

Comparison on the basis of the squared gain of the symmetric filter

X-11 module within X-12-ARIMA (X-11)

A seasonal adjustment program can be seen as a linear filter; in our case, it filters out the seasonal component of the original time series. A straightforward presentation of a filter is the frequency domain of the filter; in this case, the squared gain of a filter and a phase shift.

The squared gain shows for the frequency range between 0 and 0.5 cycles per month, if a special frequency λ^* is smoothed, amplified or fully eliminated by the linear filter. The phase shows how much a signal of a given frequency is shifted in time by the filter. As the middle filters of X-11 are symmetric, the phase shift is always zero.

X-11, as well as SEATS, can be seen as a linear filter operation in the additive version. Whereas the model-based approach SEATS offers direct access to the squared gain of the filters, this is more complicated for X-11. In X-11 the linear filter is produced by the successive use of many simple seasonal and non-seasonal linear filters, moving averages and moving Henderson filters.[18] The squared gain was calculated following Bell and Monsell (1992). The squared gain was calculated by linking all linear filters of X-11 and then calculating the squared gain of the overall filter in the frequency domain.[19] The results of the 13-term Henderson filter for trend and different seasonal filter lengths are shown in the charts below.

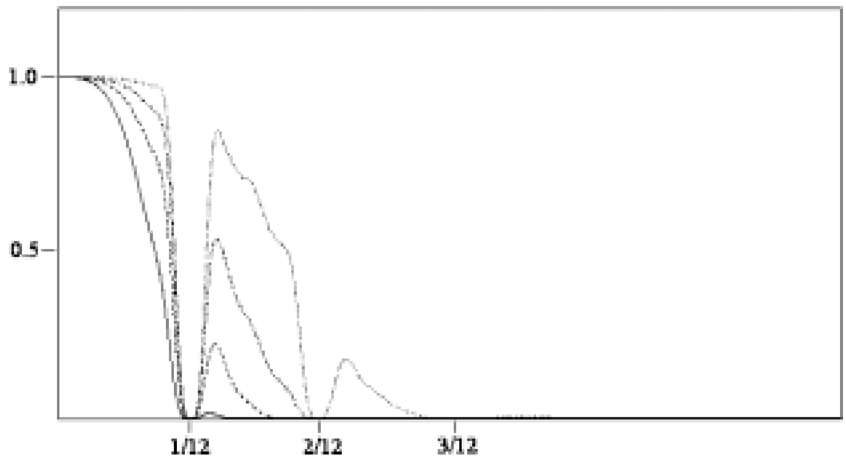


Chart 4.2.1: *Squared gain of different Henderson trend filters in X-11 (from the left to the right, 23-term, 17-term,13-term and 9-term Henderson filters)*

[18] This describes the exact procedure of the additive version, but holds approximately for the multiplicative version of X-11, as well.

[19] The steps can be found in the above mentioned document. They consider only one iteration step. Outlier treatment is not regarded as a relevant issue.

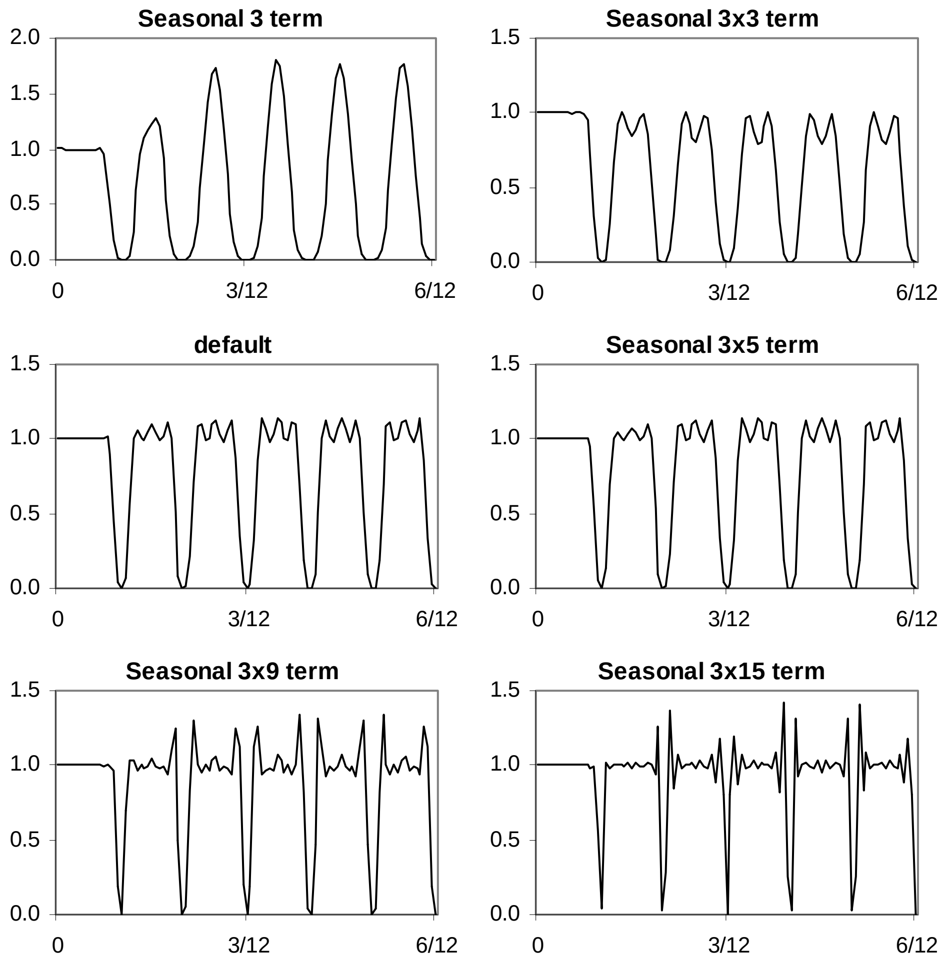


Chart 4.2.2: *Squared gain of different seasonal adjustment filters of X-11 using the 13-term Henderson trend*

The graphs for the seasonal adjustment filter do not show the case for a stable seasonal component that is available and in addition the set is much larger when using all different trend possibilities or when applying different seasonal filter to different months[20].

<u>*SEATS*</u>

The filter choices of TRAMO-SEATS are more flexible than for X-12-ARIMA with respect of the shape of the filters. A set of different possibilities is shown below:

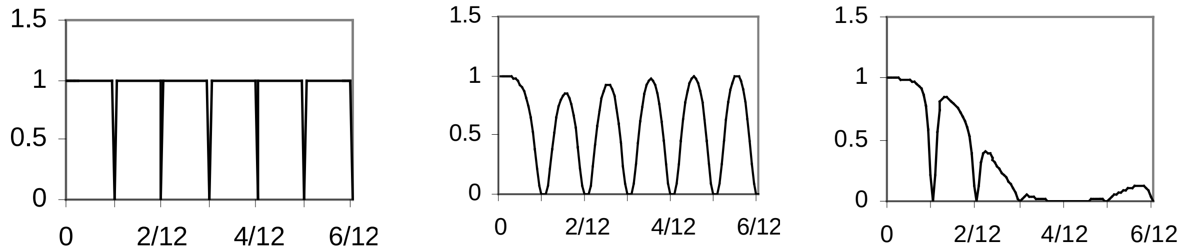


Chart 4.2.3: *Different seasonal adjustment filters in SEATS*

---

[20] Filter weights were kindly provided by Dr. Planas.

The first two squared gains of the filters were calculated from a decomposition of an ARILINE model.

The first set shows a filter for a stable seasonal and trend filter: the θ_1 parameter was set to -0.8 and the θ_{12} parameter of the Airline model to –0.98. The second example of a seasonal adjustment filter is an example with a rather stochastic trend and seasonal component. The θ_1 parameter was set to –0.33 and the seasonal parameter to –0.3. The third example was chosen to demonstrate that SEATS is able to handle more complex seasonal patterns than the above and than X-11. In this example a complex AR root has produced a cyclical behaviour with a frequency close to the 3rd, 4th and 5th seasonal frequency and was therefore assigned to the seasonal component. This case is discussed in the comparison below.

The trend filters of SEATS show a wider range of possibilities compared with X-11. Two extreme examples are shown in the chart below. In both cases, the Airline model was used with the seasonal moving average parameter θ_{12} set equal to –0.98. The regular MA parameter θ_1 was set equal to –0.8, corresponding to a stable trend (continuous line), and to 0.49, corresponding to a highly stochastic trend (dotted line).

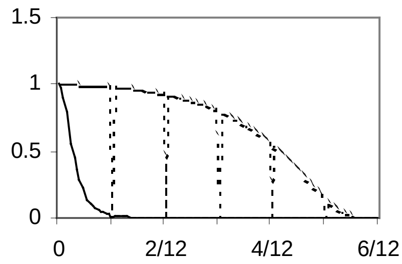


Chart 4.2.4: *Squared gains of different trend filters of the AIRLINE model*

From the graphs above one can see that SEATS should perform better than X-11 for series with a very stable seasonal component and a very unstable one. However, these cases are rare in practice. Whereas the X-11 filter showed some distortions and amplifications of special frequencies, this could not be observed in SEATS. Especially the three-term Henderson filter shows a high amplification of special frequencies. However, the better performance of the SEATS filter is mainly based on the fact that the charts show the filter when using an infinite amount of observations.

Another very important observation for both programs is that the trend often leaves spectral power between the first and especially the second seasonal frequency in (especially 9-term Henderson for X-12-ARIMA and regular moving average parameters in the case of the AIRLINE model distant from –1 for SEATS). This feature might be unwanted for economic trend analysis. For this purpose, a further smoothing of trend components might be necessary.

Comparison in literature

The existence of a large number of different empirical and model-based approaches has led to an extensive discussion about their advantages and disadvantages (see Bell and Hillmer, 1984). X-11 was approximated with signal extraction methods[21] and many critical papers have been published with regard to X-11, focusing especially on its inflexibility and the risk of over and under-adjustment.[22]

However, analysis is often only based on the use of the default filter of X-11. It does not take into account that the method is based on a large variety of filters and that it even offers criteria for the choice of these filters with the I/C ratio and the I/S ratio (see Dagum, 1988). In addition, the program was developed by practitioners for practitioners and offers a large set of diagnostics and options that guide the user in finding an acceptable decomposition for a large set of time series even if these diagnostics often lack full theoretical foundations. An impartial and meaningful comparison is therefore difficult to find in literature.

Another comparison of both procedures in the frequency domain was done by Planas and Depoutot (1998), where X-11 filter were approximated with the closest Wiener-Kolmogorov filter of SEATS (based on the Airline model). The distance is based on an empirical measurement in the frequency domain. They deal with a large set of possible trend/seasonal filter combinations of X-11 and show that they can be approximated with Airline models, using different regular and seasonal moving average parameter (θ_1 and θ_{12}). Their main results are summarised in the table below, showing the closest X-11 filters to the Wiener-Kolmogorov filters based on the Airline model with given parameter[23].

Table 4.2.3: *Seasonal adjustment and trend extraction filters*
(X-11 filters closest to Wiener Kolmogorov filters in the Airline model)

θ_{12} / θ_1	**-0.95**	**-0.8**	**-0.7**	**-0.6**	**-0.5**	**-0.4**	**-0.2**
-0.95	S3x15 H23	S3x15 H23	S3x9 H23	S3x5 H23	S3x3 H23	S3x3 H23	S3x3 H23
-0.8	S3x15 H23	S3x15 H23	S3x9 H23	S3x5 H23	S3x3 H23	S3x3 H23	S3x3 H23
-0.7	S3x15 H23	S3x15 H23	S3x9 H23	S3x5 H23	S3x3 H23	S3x3 H23	S3x3 H23
-0.6	S3x15 H17	S3x15 H17	S3x9 H17	S3x5 H17	S3x5 H17	S3x3 H23	S3x3 H23
-0.5	S3x15 H13	S3x15 H13	S3x9 H13	S3x5 H13	S3x5 H13	S3x3 H17	S3x3 H23
-0.4	S3x15 H13	S3x15 H13	S3x9 H13	S3x5 H13	S3x5 H13	S3x3 H13	S3x3 H17
-0.2	S3x15 H9	S3x15 H9	S3x9 H9	S3x5 H9	S3x3 H9	S3x3 H9	S3x3 H13
-0.0	S3x15 H9	S3x15 H9	S3x9 H9	S3x5 H9	S3x3 H9	S3x3 H9	S3x3 H9

21 See Cleveland and Tiao (1976) and Burridge and Wallis (1984).

22 See, for example, Harvey (1989) and Maravall (1996).

23 The abbreviation S3×*b* means a seasonal moving average of length three times *b*; H*n* refers to the length of the Henderson filter.

The approximation of the X-11 filter with the Wiener-Kolmogorov filters of Airline model allows a common basis to be obtained for the two programs and offers a way to compare both outputs. In fact, the two parameters θ_1 and θ_{12} can be interpreted as showing the extent to which the level and the seasonal component react to innovations. Values of θ_1 either close to (–1), corresponding to a stable trend, or between 0 and 1, linked to a fast changing trend, and of θ_{12} either close to (–1), stable seasonal pattern, or 0, very stochastic seasonal pattern, correspond to the lengths of the Henderson trend-filter and seasonal moving-averages respectively in the X-11 language. The higher the order of the Henderson trend, the more stable the trend estimation is; accordingly, the same applies to the seasonal moving averages.

Given the great importance of the Airline model or closely related models in applied work,[24] this table can provide important information. First, if the Airline model adequately describes the properties of one series, one can compare the SEATS filter with the chosen X-11 filter. If they are distant from each other, results of empirical comparisons are based on filters having different properties.[25] In this case, it is important to understand why the programs have chosen different filters. Second, the table also offers a valid check for the quality of the X-12-ARIMA settings. As shown in Dagum et al. (1996), the time series extension with ARIMA models with parameters distant from the implicit parameters used in the seasonal adjustment process can lead to distortions in the gain function and the phase function of the concurrent filters. This is especially true of the regular moving average parameter.

Conclusions for the comparison of the seasonal adjustment part

A summary of the possibilities offered by SEATS and X-11 can be found in the table below.

Table 4.2.4: *Choice of filters in SEATS and X-12-ARIMA*

SEATS	X-12-ARIMA (X-11)
Automatic choice of filters based on statistical criteria.	Empirical tool to choose filter, automatic choice of filters and recommendations of the filter do not cover the whole set of possible filters.
High variety of filters available; even more complex seasonal filter than in X-11.	Fixed but large set of filters with good coverage for empirical data.
No month-dependent seasonal filter available.	Different seasonal filters can be chosen for different months.
Numerically rather complicated.	Numerically easy and robust.
Consistent with pre-adjustment part.	As yet, no consistency check to pre-adjustment part.
Different steps complicated to explain.	Different steps easy to explain.
Overall effect possible to overview.	Overall effect complicated to overview.

24 See the results for the monetary aggregates or the large-scale study of industrial short-term indicators by Fischer and Planas (1998).

25 This can be misleading, particularly when analysing revisions. In fact, short seasonal filters normally lead to higher revisions but a fast convergence, whereas long seasonal filters lead to smaller revisions but a longer convergence process.

Regarding point 2, the higher variety of filters of SEATS is an advantage, but its flexibility has some drawbacks in practice. From a statistical point of view, full flexibility of the ARIMA model choice and the parameter choice are not desirable, if raw data is frequently revised (all estimations are done with an estimation error). A careful check of the adequacy of the ARIMA model for the time series has to be carried out to validate the correctness of the choice even if the AIRLINE model, in particular, is relatively robust. Institutions using SEATS often fix at least the ARIMA model for a predefined time and let the parameter vary. Therefore, in applied work, SEATS moves closer to the situation of a predefined set of filters such as those in X-11. More research should be undertaken in the field to establish measurements and indications on the robustness of estimation and cases where users can keep parameter values fixed. The cases where complex AR roots are assigned to the seasonal component have to be better presented in the output and should be linked to some automatic warning measures. In the example shown above, the AR root was motivated by a non-estimated calendar effect producing a cyclical behaviour close to the 4^{th} seasonal frequency and was therefore assigned to the seasonal component. The programs should inform users appropriately of these settings.

To ensure the consistency between REGARIMA and the X-11 part, X-12-ARIMA should provide some measurements comparing the explicit and implicit assumptions on component characteristics.

Finally, the table below shows the availability of further useful options for seasonal adjustment in the two programs.

Table 4.2.5: *Further facilities in the choice of filters in SEATS and X-12-ARIMA*

	X-12-ARIMA	***SEATS***
1. Yearly total of seasonally adjusted series equal to original	Available.	Available.
2. Further trend smoothing	Available. *Users specified length of Henderson filters.*	Available. *Option available for Airline model via the regular* θ_1 *parameter.*[26]
3. Deterministic seasonal filter	Available.	Not available. *but seasonal* θ_{12} *can be set close to (-1) in the Airline model.*
4. Extension of seasonal factors with forecast	Available. *Mixture of REGARIMA (for the original series) and asymmetric X-11 filters (for the seasonal factors).*	Available. *ARIMA forecast of components.*
5. Module for direct/indirect seasonal adjustment	Available.	Not available.

[26] An entirely new model that deals with smoother trends and the estimation of the business cycle will replace this option.

4.2.4 Diagnostics for seasonal adjustment

Due to the different nature of the two programs, the diagnostics are substantially different. An advantage of the model-based approach is the possibility that diagnostics might cover the empirical measurements of programs like X-12-ARIMA as well as formal statistical tests. The X-11 diagnostics are based on empirical tools. When comparing the diagnostics of the software X-12-ARIMA and SEATS, one observes the fact that, due both to the enormous user group of X-11 and to constant work over more than 30 years,[27] the diagnostics cover a wide area of applied interest.

SEATS does not currently offer a satisfactory set of empirical criteria.[28]

However, some questions can only be answered by combining empirical and theoretical results. In some cases (for example, in the estimation of the spectrum and concurrent revisions), empirical results are even more relevant than theoretical results which report the performance of the whole time series. SEATS offers a wide and impressive range of important theoretical diagnostics, but does not use all the possibilities a model-based approach can offer (for example, the lacking test of seasonality in the program).

	X-12-ARIMA	**SEATS**
Quality statistics	The quality statistics cover the traditional measurements of X-11 ARIMA (M-statistics, Q-statistics, MCD, D8 versus D10 table) and are enhanced via the possibility of checking estimates of the spectrum of some components, the sliding spans diagnostics and the revision history discussed below.	As the seasonal adjustment program SEATS is consistent with the REGARIMA part, the quality statistics concerning the REGARIMA model also apply to the seasonal adjustment module. In addition, the program offers a control for the success of the filter estimation process (comparison between the variance of the theoretical estimator and the estimate) and information on the innovation variance of the components.
Revisions	With the help of the history spec, the empirical revisions for seasonal factors, the seasonally adjusted series, the trend and the growth rates can be printed out. The program offers high flexibility with regard to revisions of interest (options to specify the lag that has to be analysed). The SAS graph model offers the possibility of visualising results.	Due to the underlying model, the theoretical revision error is accessible and presented. In addition to the total amount, its convergence is presented. This has proven to be a useful tool as only the combination of the total revision error and the speed of convergence is informative.
Direct versus indirect	Two alternative roughness measurements introduced in X-11 ARIMA, that measure the smoothness of the directly and indirectly seasonally adjusted series. An additional module offers a range of comparison tools, all tables, such as the D8 table, and all quality measurements (MCD, M and Q-statistics, sliding spans, revision history, spectrum) are available for the directly and the indirectly adjusted series. The SAS graph module offers the possibility of visualising the results.	No direct access yet to a model-based criterion, some work is currently being undertaken by Professor Maravall and at JRC.
Concurrent versus forecast factors	Revision history available to monitor both cases.	The estimate of the reduction in the mean square error when using concurrent adjustment is available. This helps to assess the size of the loss when performing seasonal adjustment using projected seasonal factors instead of concurrent factors.

27 Important contributions came especially from Dagum (1980) and Findley et al (1998).

28 This is recognised by the authors and work has started to incorporate some X-12-ARIMA diagnostic tools (D8/D10 tables, sliding spans, periodogram, revision history).

4.3 Empirical criteria

4.3.1 Revision analysis

From a statistical point of view, revisions of seasonally adjusted data, although not always welcomed by users, are unavoidable. New information has to be considered in order to improve the accuracy of the results by, for example, replacing forecasts used in the adjustment procedure with actual observations.

In practice, it is very difficult to compare different methods with respect to their revision features as they are based on different definitions of components and have different final estimators. Moreover, revisions can be caused by an unstable estimation procedure, but also by changes in the seasonal pattern of a series. In this latter case, they cannot be ignored and may also have a positive effect on decision-making processes.

In this section, a small study shows whether major differences between X-12-ARIMA and TRAMO-SEATS can be detected. In TRAMO-SEATS, in addition to normal revisions caused by the replacement of forecast values with observed values, high revisions are observed when the model choice is frequently changed or when model parameters are changing fast. In the case of X-12-ARIMA, revisions occur in jumps when changes in the I/C or I/S ratios lead to a different automatic choice of the filters. Moreover, for a fair comparison, it is also necessary to set filter options in such a way that SEATS and X-11 are really comparable.[29]

In the case of monetary aggregates and the HICP, only very simple models are used for TRAMO-SEATS, showing a good fit over the whole range exercised, however. In addition, as models are normally kept fixed for at least one year, the problem is less pronounced. The same holds true of X-12-ARIMA when using fixed options. In X-12-ARIMA this has stronger consequences than in TRAMO-SEATS, since it means that fixed filters are used, whereas filters can change in the case of TRAMO-SEATS. Higher revisions in TRAMO-SEATS can therefore be due to either a change of filters or data volatility.

Large revisions are often linked to fast convergence and small revisions to slow convergence. Therefore, the following criteria have to be considered jointly:

- <u>the total amount of revisions</u>, i.e. the squared difference between the seasonal factors of a sample period when they were available for the first period lag and the "final" seasonal factors for the same period when data was available up to the end of the sample.
- <u>the speed of convergence</u>, i.e. revisions for the first 24 lags in the sample period. In order to have robust measurements, the value for lag *h* is calculated as the median of the squared

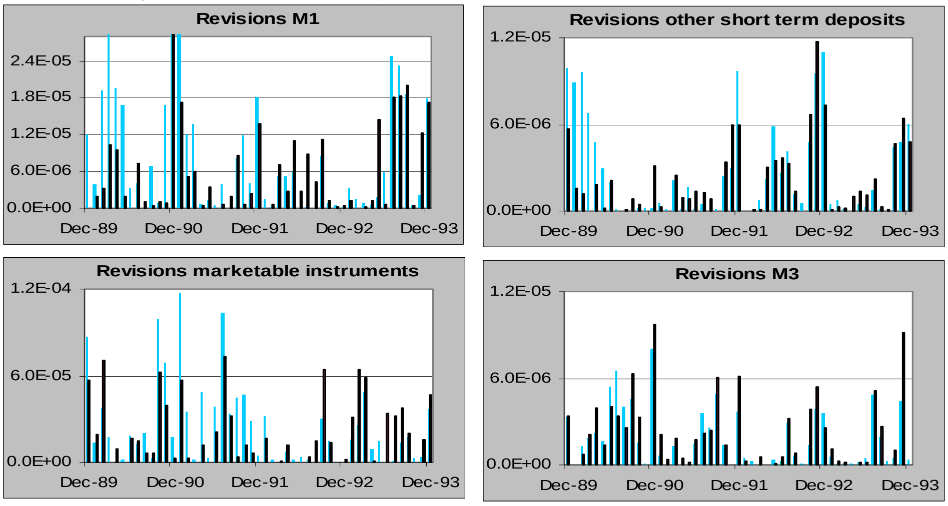
29 The concept of distance between filters introduced the previous section will be used in order to get for this purpose.

difference between the seasonal factors of month *m* at the time *m+h* and the seasonal factor of month *m* at time *m+h*-1, and divided by the "final" seasonal factor of month *m*. In order to have an approximate confidence interval for the values, the first and the third quartiles of the above measurements can also be computed.

The experiment. The time series M1, other short-term deposits, marketable liabilities and M3 were seasonally adjusted stepwise from the starting date 1980 to the ending dates December 1989 to December 1996. To avoid the distortions of outliers and the calendar effect, the time series was used free of outliers and trading-day effects. The "final" estimator was calculated by using the results of seasonally adjusting the time series from January 1980 to November 1999. The ARIMA models were fixed as well as the seasonal and trend filters in the X-11 module of X-12-ARIMA, thereby giving X-12-ARIMA an advantage as the filters in TRAMO-SEATS are allowed to vary.

The total amount of revisions has been calculated for the period December 1989 to January 1994 and the "final" seasonal factors for the same period, when data was available, up to November 1999. This difference is then shown relative to the final seasonal factor. The results for the above-mentioned criteria can be found in the chart below.

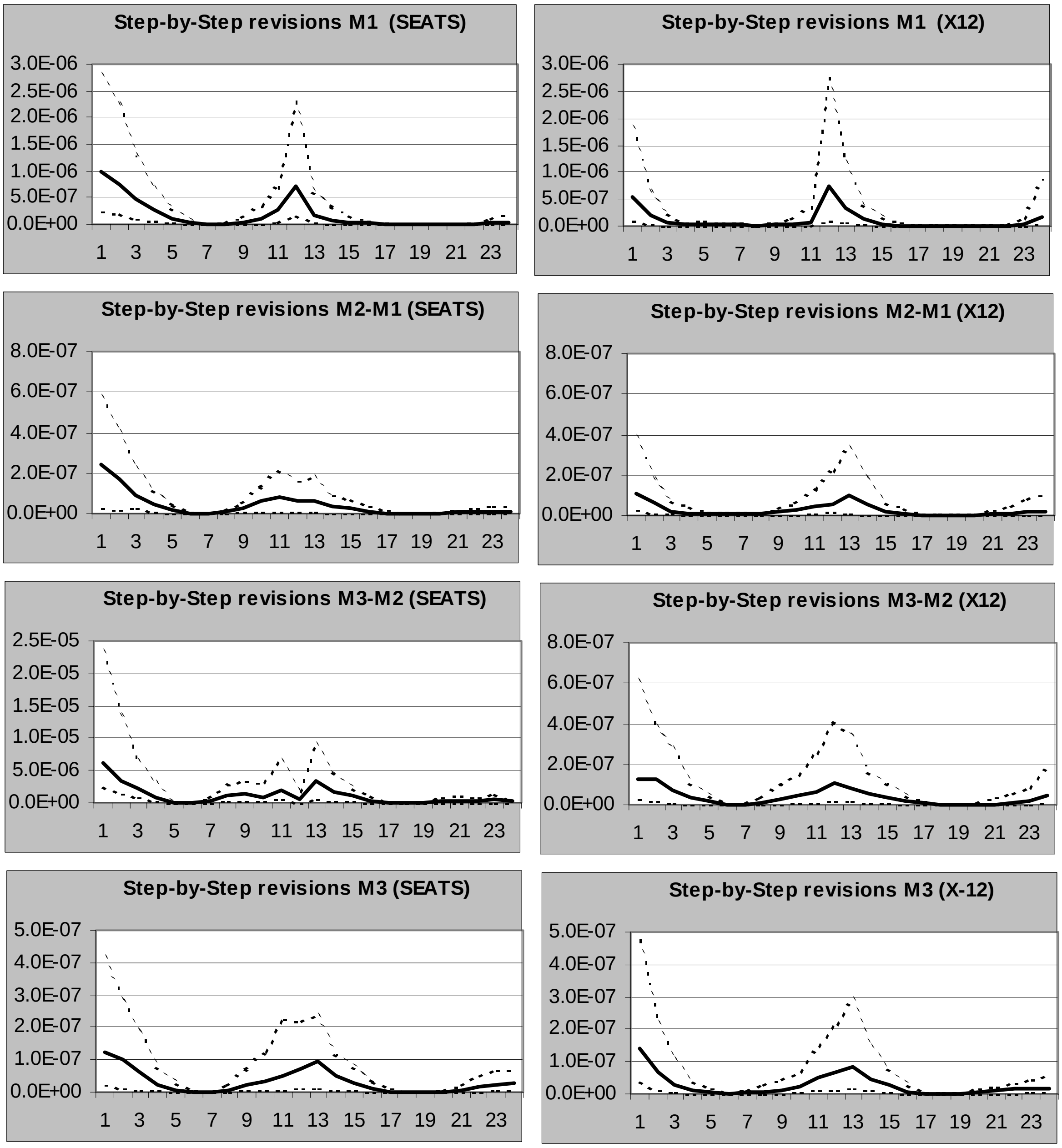
Chart 4.3.1: *Total amount of revisions in X-12-ARIMA (blue) and SEATS (black)*



X-12-ARIMA clearly shows fewer revisions for M1 and other short-term deposits. The situation is less clear for the marketable instruments, and a slight advantage of TRAMO-SEATS can be detected for M3. A generally superior behaviour, however, would be recognised, if the speed of convergence and the total amount of revisions were better for one method as compared with the other. For this latter point, the revisions for the first 24 lags were studied in the period from December 1989 to January 1994.

As can be seen in Chart 4.3.2, the results for M3 are highly for X-12-ARIMA and TRAMO-SEATS. For the other series, a slight longer convergence process can be detected for X-12-ARIMA. This is presumably caused mainly by a longer filter compared with TRAMO-SEATS, which partly explains the smaller revisions.

Chart 4.3.2*: Speed of convergence*



The experiment shows that, when combining the speed of convergence and the total amount of revisions, no “best” procedure can be detected. Smaller total revisions are linked to a slower convergence of the revision process. An important part of the difference in the total amount of revisions is therefore linked to general filter properties, independent of the method.

4.3.2 Idempotency

To demonstrate some basic features of X-12-ARIMA and TRAMO-SEATS concerning both the analysis of time series and indications of problematic time series, the following experiment was set up:

100 random walks (200 observations, standard deviation for noise equal to 2) were simulated and automatically seasonally adjusted by TRAMO-SEATS (automatic model identification) and by X-11. The time series do not contain any seasonal component by construction. The idempotency criterion measures the importance of the extracted seasonal in the different components.[30]

Part 1: Automatic run

Both programs were run automatically without controls by the user. By default, X-11 seasonally adjusted all time series, whereas TRAMO-SEATS, in the modelling stage, detected no seasonality for 71 of 100 time series and did not, consequently, seasonally adjust these series. In addition, SEATS changed two seasonal series from TRAMO into a random walk giving the message "Seasonality is too weak to be detected in SEATS", an undocumented test in SEATS.[31] Only the remaining 27 time series were seasonally adjusted.

Conclusions

Due to the flexible filter approach of SEATS and the modelling stage of TRAMO that could detect the non-seasonal behaviour of the time series, TRAMO-SEATS clearly performed better than X-11 for all series.

Part 2: User control of the output

When studying the question as to whether a time series contains identifiable seasonality, X11 offers an immediate indication whether the time series contains seasonality that can be detected by X-11. This indication is the combined test for stable and moving seasonality (M7). A value of M7 higher than 1 indicates that no identifiable seasonality for a given time series could be detected by X-11. For the 100 simulated time series, only four M7 statistics were below the "critical value" of 1, while 28 were between 1 and 1.5 and the rest above 1.5.

Conclusions

The empirical measurement of X-11 indicates that 96 of 100 time series do not contain identifiable seasonality and would not be seasonally adjusted, an impressive result that is not reached in SEATS.

The model-based approach offers of course possibilities to test for the significance of the seasonal component, but none of these possibilities are, in fact, immediately available in SEATS.[32] For 27 of 100 cases, SEATS used a model including a seasonal (0,1,1) term. No immediate indication was given that no identifiable seasonality could be detected.

---

30 Measured by the sum of the relative squared difference of the seasonally adjusted series, as compared with the original series, the superiority of the model-based approach can be detected immediately.

31 The author explained that a seasonal (0,0,1) model with $|\theta_{12}|<0.5$ generates such a message as well as a seasonal (1,0.0) model with $|\theta_{12}|<0.5$. Models of this type should not be seasonally adjusted.

32 Professor Maravall indicated that a test concerning the significance of the seasonal component would be available in the next SEATS version.

The parameters are close to 1, without any exceptions, leading to the seasonal moving average parameter to be almost cancelled out by the seasonal differencing operator. This will automatically lead to a seasonal filter that is very narrow around the seasonal frequency and to a very weak seasonal component in the random walk example, so that the automatic results are not very harmful.

However, the small experiment clearly suggests a general observation when dealing with both programs: the default seasonal adjustment in SEATS is often superior to that in X-11, due to its higher flexibility. On the other hand, the large variety of empirical tools and tests in developed for practitioners X-11 lead to a situation in which a normal practitioner can detect problematic time series much faster with X-11 than with SEATS, due to the lack of some relevant tests and empirical tools in SEATS.

Hood and Findley (1999) also stressed this problem when deciding which time series to seasonally adjust. In TRAMO-SEATS, a clear indication is missing, whereas X-12-ARIMA offers an empirical tool, with the sliding spans, that helps to detect problematic time series.

To be complete, it has to be added that the M7 statistics of X-11 are an empirical measurement with some clear theoretical limitations[33] and that a model-based approach makes it possible not only to use the same empirical tools, but also to develop more sophisticated tools. However, it is important that these tools are directly available in the software to assist the user in the process of making decisions.

4.4 Environmental criteria

4.4.1 Readability of input and error handling

The comparison of the two programs is based on the following example.

Example. M1 of the euro area is seasonally adjusted using a log transformation. A level shift in January 1999 and an additive outlier in March 1986 are treated as intervention effects. A user-designed regression matrix is used for estimating a stock trading-day effect. Seasonal factors for November are changing fast. The critical value for outlier detection is 3.7σ and the fixed ARIMA model is an ARIMA(0,1,2)(0,1,1) model.

<u>*X–12 ARIMA*</u>

Data file: *m1.txt*

Specification file: *m1.spc*

```
     series     {
            title="M1 EURO AREA"
            start=1980.1
            period=12
            file="m1.txt"
            spectrumstart=1991.jan
                }
     transform  {
            function=log
                }
     regression {
```

[33] See, for example, the remarks of Maravall in Findley et al (1998).

```
        variables=(ao1986.03 ls1999.jan)
        user=(mo tu we th fr sa mo1 tu1 we1 th1 fr1 sa1)
        usertype=tdstock
        start=1980.jan
        file="euend1.txt"
        save=(regressionmatrix  tradingday)
           }
outlier     {
        critical=3.7
             }
arima       {
        model=(0 1 2)(0 1 1)
             }
X-11         {
        appendfcst    = yes
        mode          = mult
        calendarsigma = all
        sigmalim      = (2.0 3.0)
        save          = (b1 d7 d8 d9 d10 c17 d11 d12 d13 d16)
        seasonalma    = (s3x5 s3x5 s3x5 s3x5 s3x5 s3x5 s3x5 s3x5 s3x5 s3x5 s3x3 s3x5)
        trendma       =9
              }
```

<u>*TRAMO – SEATS*</u>

```
MUM1
 239  1980  1 12
 25.8214

[complete set of raw data]

105.0750
$INPUT lam=0 p=0 d=1 q=2 bp=0 bd=1 bq=1 aio=2 iatip=1 va=3.7 ireg=14 SEATS=2 $
$REG  iuser=-1 nser=12 ilong=276  regeff=0  $
  eutrad1.txt
$REG    iseq=1  regeff=3    $
  75 1
$REG    iseq=1  regeff=1 $
  229 300
```

Readability of input

The two different programs offer quite different approaches regarding the input. X-12-ARIMA is characterised by the split between the data file and the specification file. This is convenient, as the specification file can be kept when new data arrives. It is well-structured in different parts, representing the different steps in performing seasonal adjustment. The commands are easy to learn and well-documented. Additional regression variables can easily be added and the style is independent of the length of the time series.

TRAMO-SEATS is less favourable in this respect. There is no split between the specification file and the data file (the above file shows only the first and last observations; the values in-between are not shown in order to limit the length of the output). The commands have to be added on top of the data and on the bottom. The commands are not structured. The addition of regression variables is complicated and has to be done with some care, as they are coded with the number of the observation and not with a specific date. This can be risky as the number of observations changes when the starting date changes.

Another inconvenient feature is the following: TRAMO and SEATS are two separate programs, i.e. files have to be transferred from TRAMO to SEATS to obtain the final seasonally adjusted series.

Both X-12-ARIMA and TRAMO-SEATS offer the possibility to be run for a large data set. Both programs distinguish between the use of one setting for all time series or the use of individual options for every single time series. Finally, both programs offer enough flexibility to determine the names and paths of the input and output files.

Error handling

Error handling is tested on four examples:

1. wrong spelling of one option;
2. numeric problem: ARIMA model cannot be estimated;
3. wrong settings; and
4. access denied to the output file.

Error 1: Wrong spelling of one option

(a) *Error for X-12-ARIMA: the option* `period=12` *is written as* `periode=12`.

X-12-ARIMA offers a good error checking and error messages are written on screen and in a separate file. In this case the error message is:

```
LINE 4:         periode=12
ERROR:          Argument name "periode" not found
```

The message is very helpful in guiding the user through the program.

(b) *Error for TRAMO-SEATS: The option* "`inic`" *was written as* "`inice`"

TRAMO-SEATS does not have an elaborate system for option checking. The error message is:

```
Error in the namelist "INPUT" for the series m1
```

As this error message also occurs when the number of observations is not correct, it is not very helpful.

Error 2: Numeric problems

A time series consisting of eight sequences of numbers from 1 to 12 was created which leads to an underflow or overflow in the ARIMA estimation process. Both programs can deal with this error in a convenient way, although the X-12-ARIMA error message is slightly more convenient.

The error message for X-12-ARIMA is:

```
NDP error - divide by zero (See Section 4.2.1 in Lahey Programmer's Reference)
 in x11pt4
 Called by x11ari
 Called by x12run
 Called by x12a
```

The error message for TRAMO-SEATS is:

```
***** NDP exceptions have occurred during this program. *****
Status word: /invalid operation./precision./
```

Error 3: Wrong settings

For a time series with negative values, a log transformation was required. Both programs are able to deal with the problem. X-12-ARIMA does not adjust this series and gives the error message:

```
ERROR: Multiplicative or log-additive seasonal adjustment cannot be done with
a series with zero or negative values.
```

The advantage is that the user has to change the settings and is aware of the change of options. The disadvantage is that no automatic correction is carried out and that no results are produced, which can be problematical when seasonal adjustment is done for a large-scale application.

TRAMO-SEATS automatically changes the option from log transformation to no transformation and produces adjusted results. The output file contains the sentence:

```
LAM CHANGED TO 1: SERIES HAS NEGATIVE OR ZERO VALUES
```

Error 4: Access denied to the output file

The output file of a previous run was opened in EXCEL, so that the program did not have access to the output file. X-12-ARIMA gave the following message indicating the problem correctly:

```
Unable to write file, FILE=m1.out, UNIT=11 RECORD=1, Position=0
 in fopen
 Called by genfor
 Called by x12run
 CALLED BY X12A
```

TRAMO-SEATS can handle the error in the same way by giving the message:

```
Fortran runtime error on external file
"D:\saison\tramojul\output\m1.out"(1036): Attempt to write to READONLY file
```

4.4.2 Flexibility of output

An important issue for users is the flexibility of the output. As shown in the quality report (see Section 2.5), different elements of the output are the input for further analysis and their availability is of high relevance.

In this respect, TRAMO-SEATS and X-12-ARIMA show different standards.

TRAMO-SEATS

TRAMO-SEATS offers five different options for the analytical output, from a highly detailed output for every series to no output. It offers the possibility of obtaining a short summary for all series, but this summary is hard-coded and cannot be influenced by the user. In addition, the design is different from TRAMO and SEATS. Different components and the analytical output (autocorrelation, filter, spectra, etc.) are stored in single ASCII text files, which are easily accessible for further analysis, with an unsatisfactory indication of the dates of the observations, however. Another problem in the output is the fact that the components and the analytical output are named independently from the time series with fixed names. In addition, these fixed names are not unique for some series. The name of the final seasonal factors, for example, depends on whether TRAMO performed a pre-adjustment or not.

The programs do not offer any options for the storage of different quality indicators in separate files.

However, a discussion with the programmer of TRAMO-SEATS has shown that these limitations may, at least in parts, be overcome after the last major redesign of the procedures and from a programming point of view. The direct access to all tables and diagnostics would, however, require some further changes to the programming of TRAMO and SEATS.

X-12-ARIMA

X-12-ARIMA offers the storage of all components including all relevant steps from the REGARIMA part and the seasonal adjustment part. The naming follows the well-established naming of the tables of X-11. The output includes the data as well as the dates separated by tabs, the standard column separator in EXCEL and most other softwares. The user can address every single table individually. The flexibility concerning the additional diagnostics is high. Nearly all diagnostics of the REGARIMA model and of the seasonal adjustment can be stored in separate files and are therefore immediately accessible for further analysis or for inclusion in a user-defined report. Fixed key words ease the access to the individual diagnostics.

Conclusions

The program X-12-ARIMA offers a high degree of flexibility of output in terms of components and diagnostics. The flexibility is extremely high and the use of the software to access the different components or diagnostics desired is simple.

TRAMO-SEATS clearly cannot reach the high standard of X-12-ARIMA. It offers a huge set of components and analytical output, but the user-handling and the flexibility is below the standard of X-12-ARIMA. However, the way TRAMO-SEATS has been redesigned in the last few years would make improvements in this direction technically possible.

4.4.3 Execution time

For purposes of comparing the execution time, some experiments were carried out. In all experiments, 151 time series of industrial production were seasonally adjusted using X-12-ARIMA and TRAMO-SEATS. The starting date for all time series was January 1990. The time series were run on a Pentium 166 MHz. To concentrate on the execution time, the output was reduced to a minimum. Four “typical” adjustments were carried out with X-12-ARIMA and two with TRAMO-SEATS. The results are summarised in the table below.

X-12-ARIMA				TRAMO-SEATS	
method=best	method=first	AIRLINE model	Pure X-11	automatic ARIMA modelling	AIRLINE model
5.05 minutes	2.21 minutes	1.37 minutes	27 seconds	1.55 minutes	1.02 minutes

Both programs offer an acceptable computing time. TRAMO-SEATS outperforms X-12-ARIMA in the speed of execution, especially when the ARIMA model is estimated in X-12-ARIMA with the option `method=best`.

Even when fixing the ARIMA model, the full model-based approach is slightly faster than X-12-ARIMA using the empirical method X-11 after the REGARIMA part. Comparing the execution time for pure X-11 for the 151 time series with TRAMO-SEATS, one can see that the model-based approach is now an alternative to the standard methods in terms of the computational burden.

4.4.4 Available documentation and training

Documentation on X-12-ARIMA

The official manual entitled "X-12-ARIMA Reference Manual" and the complementary article by D. Findley, B.C. Monsell, W.R. Bell, M.C. Otto and B.C. Chen (1998)[34] are the two main reference works. The latter is one of the few documents on seasonal adjustment software that can be considered to be very well documented, very well structured and nearly complete.

The Reference Manual covers the details and options of the procedure, with a short introduction into the REGARIMA methodology. Details and options are structured according the different steps of the procedure, important options are distinguished from rarely used options and a wide range of examples completes the description of the program options. The article discusses the new tools, giving practical examples, and provides an introduction into the output of the program and its possible use in applied work. In parts, it also overcomes the only real problem of the Reference Manual. The Reference Manual leaves out major explanations for the seasonal adjustment part, relying on the user being familiar with X-11 and X-11-ARIMA 88, and has the user manual of both programs at hand. The document gives a brief introduction to X-11 as well. The only major point missing in the documentation is therefore a detailed description of the quality statistics of the seasonal adjustment process of X-11 ARIMA (M- and Q-statistics) as well as the documentation of some other features introduced in X-11 ARIMA 88.

34 X-12-ARIMA can be downloaded from ftp.census.gov, together with the two documents mentioned.

Documentation on TRAMO and SEATS

In general, the available documentation is satisfactory. Unfortunately, the relatively frequent changes introduced in both programs are not always documented in time. Moreover, a comprehensive document covering all the features of TRAMO and SEATS is missing.

For TRAMO and SEATS, the official manual is contained in the paper "Programs TRAMO and SEATS: Instruction for the User (Beta Version: November 1997)" by Gomez and Maravall. The currently available versions of the programs (June 1998) can be downloaded from the website of the Banco de España.[35] The updates of the official manuals are available on the above-mentioned website.

The description of the full set of options available in the two programs is preceded by a short introduction on the model-based approach in series decomposition, which is essential but contains many references to existing literature. Practical examples to illustrate the use of the possibilities offered to users by both programs are reported at the end of the manual.

Considering the possible difficulties of new users, Gomez and Maravall prepared a "Guide for using the programs TRAMO and SEATS (Beta version: June 1998)". It contains a "step-by-step" description of the procedure and a detailed description of the parameters.

These documents are useful as far as the input is concerned, but offer only few explanations for the implemented algorithms and the output analysis, especially concerning SEATS. For the first point, the two papers by Gomez and Maravall (1998a and 1998b) contain good descriptions of many technical solutions adopted in the two programs. For the second point, two useful references are the articles by Maravall (1988, 1996).

Training

Facilities offered to practitioners at the euro area NCBs are very limited. At present, the Training of European Statisticians (TES) Institute in Luxembourg annually offers a one-week course held by Professor Maravall. The course focuses on the model-based approach and covers the filter derivation for signal extraction and REGARIMA models. X-12-ARIMA is presented by Professor Findley in special sessions of the same course.

The Joint Research Centre of the European Commission (JRC) has recently proposed a project for user support and training on topics related to seasonal adjustment, in particular the model-based approach.

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35 Both the manuals and the software related to TRAMO and SEATS can be downloaded at the following URL: http://www.bde.es.

4.4.5 Maintenance, development and copyrights of software

For X-12-ARIMA, the U.S. Bureau of the Census has the full rights to the product and is responsible for distributing, maintaining and developing it. X-12-ARIMA is only the most recent version of the software on seasonal adjustment developed by the U.S. Bureau of Census, which is the first – and, for a long time, only – public agency directly involved in developing high-level technology in this field. It first released seasonal adjustment software in the early 1960's.

TRAMO-SEATS was developed by Professor Maravall and Dr. Gomez, mainly within academic institutions and, initially, almost exclusively for research purposes. Both programs are available free of charge for use by the ECB, NCBs, statistical offices and other academic institutions.

4.5 Conclusions

The Census X-11/X12 family and TRAMO-SEATS are the two most widely used programs at NCBs and NSIs.

The two programs are sufficiently documented and discussed in specialised literature. User support is available from the US Bureau of Census and Dr. Gomez/Professor Maravall respectively. Training sessions are provided to interested NCBs, for example by the TES Institute.

The theoretical framework of the model-based approach and its possibilities concerning statistical inference are appealing and an important argument for its use. The availability of additional options in TRAMO-SEATS, which are useful for the empirical work, makes it a useful tool for applied work, as does its robustness, for example, against overdifferencing. However, this software can be still improved, especially in its use of empirical measurements and the design of input and output.

The additional options available for the seasonal adjustment part (different seasonal filters for different months and different standard errors for different months in the outlier detection, module for indirect adjustment) in X-12-ARIMA and, in particular, the availability of a comprehensive set of diagnostic tools are very important for the quality of the results. For these reasons, the sole use of TRAMO-SEATS cannot be recommended at the current stage.

Looking at the results of the comparison performed in this chapter, the combined use of the two programs is the preferable option. In other words, it appears, from a statistical point of view, neither possible nor appropriate to exclude one of the two programs from further consideration. The REGARIMA parts of the two programs are very similar in general. Differences concern the automatic model selection, which is superior in TRAMO, but they are expected to disappear since the US Bureau of Census plans to incorporate this part of TRAMO in X-12-ARIMA. The seasonal adjustment part of the two programs differs by definition, with the advantage of the model use of TRAMO-SEATS and the "practical" advantages in the adjustment of X-12-ARIMA. The combination of the two approaches in one seasonal adjustment tool, as is apparently intended by the authors of the two programs, is the most promising way forward. These plans are another argument why the exclusion of one of the two programs would be not appropriate.

Finally, it is important to stress that seasonal adjustment is not a well-defined problem, so that no "best" solution can be found. The estimation process of seasonal adjustment is based on explicit or implicit assumptions that are sometimes not met in empirical time series (linearity, stationarity after differencing, etc.). Changes in the seasonal pattern, one-off effects and other outliers are difficult to identify, in particular at the current end of the time series that is most important for economic analysis. A close interaction between producers and users of seasonally adjusted data is therefore essential, irrespective of the method in use, in order better to understand the time series properties.

5 SEASONAL ADJUSTMENT OF OTHER REAL ECONOMY AND PRICE STATISTICS FOR THE EURO AREA

A set of real economy statistics for the euro area is used by the ECB in the context of the "second pillar" of its monetary policy. This chapter provides an overview of the availability and features of these statistics. It also contains recommendations for possible improvements.

5.1 Legislative basis for seasonally adjusted statistics in the euro area

European macroeconomic statistics are compiled from national data. Gentlemen's agreement or, to a growing extent, binding EU regulations are the basis for the provision of the data from the national statistical institutes (NSIs) to the European Commission (Eurostat). For individual countries, the European Commission (Eurostat) generally follows the "subsidiarity principle" and publishes the seasonally adjusted results that are provided by the Member States. This practice is either legally required (Short-term Indicator Regulation) or established practice (most other data). The regulations do not, in general, contain provisions for European aggregates.

The areas discussed in more detail in this report are the following:[36] (i) national accounts; (ii) short-term indicators; (iii) labour market statistics; (iv) external trade statistics; and (v) business survey data (compiled by DG ECFIN and discussed further in Sections 5.3 and 5.4).

In summary it can be said that:

- Only in the case of the Short-term Statistics Regulation does existing Community law contain requirements for seasonally adjusted data, but in an unbalanced way. It forces the European Commission (Eurostat) to use the seasonally adjusted results transmitted by the NSIs. This avoids inconsistencies with national NSI publications. At the same time, the Regulation includes nothing that would ensure an adequate comparability of the data provided by the NSIs.

- In all other cases, existing Community law includes no requirements concerning the provision of seasonally adjusted country data from the NSIs to the European Commission (Eurostat). However, the practice of the European Commission (Eurostat) is similar to the rule described above, i.e. when Member States supply seasonally adjusted data, the European Commission (Eurostat) only publishes these in order to avoid inconsistencies with the national publication.

- No legal provisions exist for EU and euro area aggregates compiled by the European Commission (Eurostat). However, the rules and practices described above affect the quality of aggregates (see Section 5.2).

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[36] Not covered in this section are HICPs, but also a range of other indicators that may be subject to seasonal influences as for example earnings, quarterly government finance or balance of payments statistics.

The following table gives a more detailed overview of those statistics for which EU Regulations exist.

Table 5.1.6: *Legislative basis for important euro area statistics and the provisions for seasonal adjustment*

	Legislative basis	***Seasonal adjustment***
National accounts	ESA 95 National Accounts Regulation Council Regulation (EC) No. 2223/96 of 25 June 1996 on the European system of national and regional accounts in the Community	The Regulation determines the provision of quarterly raw data for the main aggregates of the national accounts (Table 1), but contains *no requirements concerning seasonally adjusted data*. Detailed recommendations for seasonal adjustment, including those on the choice of method, have been worked out in the *Handbook on quarterly national accounts*, Eurostat 1999 (pages 200-229). This handbook has the status of a recommendation.
Short-term indicators	Short-term Statistics Regulation Council Regulation (EC) No. 1165/98 of 19 May 1998 concerning short-term statistics	The Regulation covers major macroeconomic indicators such as industrial production, new orders and turnover as well as retail sales. The Regulation obliges Eurostat to publish for individual countries the seasonally adjusted data supplied by the countries. Only for countries not sending seasonally adjusted data and for the compilation of EU/euro area aggregates can Eurostat publish seasonally adjusted data "on own account". At the same time, the Regulation contains no provision that would determine common methodological standards for the production of seasonally adjusted data. Technical details on seasonal adjustment procedures adopted both at Eurostat and in the NSIs for these indicators can be found in *Seasonal Adjustment Methods: A Comparison*, Eurostat 1998.
Labour market statistics	Labour Force Survey Regulation Council Regulation (EC) No. 577/98 of 9 March 1998 on the organisation of a labour force sample survey in the Community	The Regulation contains no requirements concerning the supply of seasonally adjusted data. This Regulation, which is currently in the process of being implemented in the Member States, will be the basis for important key indicators on unemployment and employment.
External trade statistics	External Trade Regulation In particular, Council Regulation (EEC) No. 3330/91 of 7 November l991 on the statistics relating to the trading of goods between the Member States	The Regulation contains no requirements concerning the supply of seasonally adjusted data.

5.2 Options for the compilation of euro area aggregates

No legal provisions exist on the compilation of seasonally adjusted EU/euro area aggregates. However, the rules and practices applied to the publication of national data by the European Commission (Eurostat) have important implications for the options available for the compilation of EU/euro area-aggregates. When euro area data are derived as the sum of country results, the quality of the euro area data depends on the comparability of the national data. When they are adjusted directly, the consistency between euro area aggregates and national data may be affected if the methods differ. A further option is to compile the euro area total from the seasonally adjusted country data, which are adjusted by the European Commission (Eurostat), but not published for individual countries (this option is not applied in practice).

The table below gives an overview of the available options, with their advantages and disadvantages.

Table 5.2.1: *Options for compiling adjusted euro area aggregates*

	Advantages	**Disadvantages**
Indirectly, as the sum of the national seasonally adjusted data provided by NSIs	Euro area aggregate can be broken down completely into country data.	Euro area aggregate is compiled from data of different and not fully comparable methods and practices.
Directly, by adjusting the euro area raw aggregate (or euro area working day-adjusted aggregate)	Euro area aggregate compiled on a fully consistent basis; appropriate in case direct adjustment is conceptually preferable.	Since country results do not add-up to euro area results, euro area aggregates cannot be consistently broken down into country results .
Indirectly, as the sum of the seasonally adjusted country data calculated by Eurostat (but the country results are not necessarily published)	Euro area aggregate compiled on a fully consistent basis; appropriate in case indirect adjustment is conceptually preferable.	Eurostat does not publish country data differing from data published by the NSIs, so that euro area data are not consistent with published national data.

5.3 Current availability of seasonally adjusted macroeconomic series

The Task Force reviewed the methods, which have been adopted in the different areas of the Commission to compile euro area aggregates, and the proposals for practical improvements. As basically different methodological approaches have been adopted for different statistics in Eurostat and by DG ECFIN, the following table provides details separately for each statistical domain.

Data provision from Member States	***Euro area aggregates***
Quarterly national accounts	
After all countries have introduced quarterly ESA 95 statistics, Eurostat will receive quarterly raw data from all countries. This is an improvement compared with the past, where no quarterly raw data were available for Spain and France as well as for a number of smaller EU countries. Countries use Census or TRAMO-SEATS (Germany BV4 and Census X-11 until 1999, and X-12-ARIMA only from 2000).	Seasonally adjusted euro area aggregates are compiled as sums of national data (indirect method). This choice was motivated by the unavailability of raw data for several countries in the past. Euro area aggregates are partially adjusted for working-day effects.
Short-term indicators	
Covers a broad range of monthly and quarterly indicators. Indices of industrial production and retail trade turnover are working-day adjusted by MSs, but according to different methods (proportional and regression approach). Seasonally adjusted series are produced in the Member States using different methods (mainly X-11 or similar and TRAMO-SEATS). The exception is Germany (BV4) which may affect comparability due to the different features of BV4. If countries do not provide adjusted series, Eurostat performs working-day or seasonal adjustment.	Raw and working-day adjusted indices for the euro area are computed as a weighted average of the national series. Seasonally adjusted series for the euro area are derived directly on the gross or working-day adjusted euro area aggregates via direct method, using TRAMO-SEATS.
Labour market statistics	
EU unemployment: harmonised country data is compiled by Eurostat on the basis of monthly and quarterly data received from the countries. Census X-11 is used. EU employment: currently available mainly from national accounts (see there). EU Labour Cost Indices: countries use Census or TRAMO-SEATS.	EU unemployment data: euro area aggregates are sums of adjusted country data (indirect method, Census X-11). EU employment aggregates: currently not available due to the lack of raw data. EU labour cost indices: direct adjustment of euro area raw series using TRAMO-SEATS.

External trade statistics	
Countries provide no seasonally adjusted series according to the Community concept. Eurostat plans to begin seasonal adjustment in 2000, using TRAMO-SEATS.	Working-day and seasonal adjustment by ECB for selected main series. Eurostat plans to begin seasonal adjustment in 2000, using TRAMO-SEATS.
Business surveys (DG ECFIN)	
Seasonal adjustment of raw series is carried out in many Member States for national surveys, using different methods. However, only raw series are sent to the DG-ECFIN.	Aggregations and seasonal adjustment are carried out by DG-ECFIN. Balances of positive and negative answers are adjusted directly, i.e. are not computed as differences between seasonally adjusted positive and negative replies. Euro area aggregates are adjusted directly from euro area raw data. The method in use is Dainties. According to available information, it is planned to replace Dainties with X-12-ARIMA. Raw data are not published.

5.4 Conclusions

The evaluation of seasonally adjusted euro area statistics by the Task Force confirmed a basic shortcoming in the provision of euro area data. The European Commission (Eurostat) generally follows the “subsidiarity principle” and publishes the seasonally adjusted results that are provided by the Member States. This practice – either legally required (short-term indicator regulation) or based on established practices (most other data) – avoids discrepancies to results published by the NSIs. It may also have the advantage that the NSI results benefit from the country-specific expertise of national producers of seasonally adjusted data.

In the absence of any standardised rules for seasonal adjustment, the trade-off between the coherence of Eurostat and NSI publications, on the one hand, and the coherence of the seasonally adjusted data between countries, on the other, is considerable in conceptual terms. The differences between the country data concern the methods, the application of these methods and the expected output. With regard to the methods, there is a dichotomy between X-12-ARIMA and TRAMO-SEATS, with the exception of the German NSI (BV4) where results are likely to differ systematically from the results of Census procedures and TRAMO-SEATS. However, the differences in the options used and the expected output between countries may be even more important. The current differences in the working-day adjustment of national account data in the Member States are one example of this.

Moreover, the subsidiarity principle and the absence of common rules for adjustment have implications for the euro area aggregates, as compiled by the European Commission (Eurostat). In order to ensure full additivity with national data, the European Commission (Eurostat) may decide on indirect adjustment based on NSI-adjusted results. For economic analysis, which often explains the development of the euro area aggregate by reference to the underlying country developments, this method has practical advantages. It appears not to be desirable to generally and completely disentangle the adjustment of euro area country and aggregate data from the results published at the national level. However, indirect adjustment has disadvantages as long as the seasonal adjustment causes differences to the results which are due to the method or the application of the method rather than to actual differences in economic developments. It reduces the quality of euro area aggregates.

This trade-off cannot be solved without generally reviewing the current basis for the seasonal adjustment of euro area results. The present practices of direct or indirect adjustment were adopted mainly on practical and historical grounds. They should be reviewed, also taking account of the conceptual arguments concerning the direct and indirect adjustment of time series as well as the close links between the main statistical areas (e.g. industrial production and national accounts or unemployment and employment data). Moreover, substantial improvements require a closer co-ordination of practices of the European Commission (Eurostat) and the NSIs and, in practical terms, more and detailed information on *how* the adjustments are carried out. For the euro area as a whole, this information is currently often not available and difficult to gather.

ANNEXES

A1. Task Force on Seasonal Adjustment at the ECB

From June 1999 to January 2000, the Task Force met four times. The names of the participants are listed below:

ECB

Henning Ahnert	*Chairman*
Ettore Kovarich	*Chairman*
Björn Fischer	*Secretary*
Stefano Nardelli	*Secretary*
Christopher Allen	
Mark Boxall	
Magnus Forsells	
Dieter Gerdesmeier	
Rodrigo Oliveira-Soares	
Jean-Pierre Villetelle	

NCBs

Daniel Desie	*Banque Nationale de Belgique*
Yves de Lombaerde	*Banque Nationale de Belgique*
Robert Kirchner	*Deutsche Bundesbank*
Alexandros Milionis	*Bank of Greece*
Alberto Cabrero	*Banco de España*
Johara Khelif	*Banque de France*
Riccardo Cristadoro	*Banca d'Italia*
Roberto Sabbatini	*Banca d'Italia*
Karin Dlaska	*Österreichische Nationalbank*
Kari Takala	*Suomen Pankki*
Simon Compton	*Office of National Statistics (ONS)*, representing the *Bank of England*

European Commission

Gian Luigi Mazzi	*Eurostat*

Invited speakers

Francesca Campolongo	*Joint Research Centre of the European Commission*
David Findley	*U.S. Bureau of Census*
Agustin Maravall	*Banco de España*
Christophe Planas	*Joint Research Centre of the European Commission*

A2. Example of Monthly Quality Report

The Monthly Quality Report presented below is split into the following parts:

1. Chart of the time series and its different components

   The chart shows the original time series, together with the time series, adjusted for outlier and regression effects, that is used for seasonal adjustment. In addition, it contains in addition the seasonally adjusted series, the trend, the seasonal, the irregular and the tradingday factors, if available. The three last components are shown at the same scale in order to make them comparable. This chart should be the start of the check as it shows the time series under consideration and the importance of the different components.

2. Table with the revisions of the original data

   The table shows the revisions to the original data. The revision of original data may affect the appropriateness of the seasonal factors that were previously estimated.

3. Specification file to see the parameters that had been used.

   The table shows the full specification file.

4. Parameter page

   This page contains the parameters of the REGARIMA model, split into regression parameters, the parameters of the REGARIMA model and the innovation variance of the residuals. The parameters are important to understand the characteristics of the time series. This could, of course, be done only once a year, but it is important to monitor changes of the parameters. For this purpose, a stability check has been added that works as follows: besides the parameter values and the standard errors, the page shows a column with a rough chart of the position of the parameter value of the current run within the 95% confidence interval of the last run, at which the seasonal and trading-day factors had been forecast. The confidence interval is split into 10 equally spaced parts inside the band, and into two parts to the left and right of the confidence interval. The position of the parameter within these possible locations is shown. If the parameters are located far outside the interval, a warning is displayed. The stability check provides a rough and fast overview of the stability of the parameters within certain confidence bands.

5. Summary page of the seasonal adjustment

   The summary page shows some quality criteria for the REGARIMA model (significant lags of the autocorrelation of the residuals, normality test for residuals, Kurtosis, forecast errors) and some quality criteria for the seasonal adjustment run, mainly M1 to M11, the q statistics, MCD, I/S, I/C ratio, warning about significant seasonal and trading-day peaks in the spectrum of the irregular, differenced seasonally adjusted series, etc.)

6. Forecast error and revision page

It is always important for the purpose of understanding the time series and for monitoring the ARIMA model to check the forecast errors. They very often already give an indication of problematic months and should lead to a check if there are economic reasons for a huge forecast error, an inappropriate model (for example important regressors missing) or data quality problems. The revision of the seasonal factors gives some indications of a problematic outlier treatment, indications of a month with rapidly evolving seasonality or of other problems. The one-month-ahead forecast error is given a prominent role in the table and, consequently, the four largest forecast errors are highlighted with grey bars within the moving interval of 30 observations.

7. Tables

The program output tables that are considered necessary for the monthly quality report are:

A1: Original series

B1: Linearised series

C16, D8, D9, D10, D11, D12, D13 and D16

However, the design of the original tables does not contain sufficient information as X-11 has been linked to a system starting with the REGARIMA modelling. The following modifications of the original program output were introduced:

The D8 table is a key table and work has therefore been undertaken to modify it. It contains, first, information on the outliers detected in X-11. The observations classified as outliers are displayed within boxes that are shaded in three different shades of grey. The darkest grey represents major outliers detected in X-11, for which a weight of between 0 and 0.1 had been assigned. The lighter grey represents outliers with a weight of between 0.1 and 0.5. The light grey represents minor outliers with a weight higher than 0.5. The table also contains information on the outliers detected in the REGARIMA part (AO, LS, TC). Grey letters indicate an outlier with a negative effect; black letters indicate an outlier with a positive effect. As it is important to check the appropriateness of outliers –especially level shifts – level shifts are also signalled one observation before and one observation after their occurrence (LS-1, LS+1). The length of the effect of a temporary change can vary and might be very long (decreasing exponential weights); the main effect is normally negligible after four periods, so that only the first four periods of a temporary change are marked with (TC, TC+1, TC+2, TC+3).

In addition, the table shows the seasonal factors for the current run and the forecast factors at the series end.

In addition to the seasonally adjusted figures, the D11 table shows the effect of an update of the seasonal factors on the seasonally adjusted results at the series end.

8. Chart of D8, D9 versus D10 concurrent and D10 with forecast seasonal factors per month

This chart shows preliminary seasonal factors, outlier adjustment and final seasonal factors. It summarises the information provided by the output tables D8 to D10 in a user-friendly manner. Where applicable, previously estimated forecast factors can be added to the chart.

9. Bargraphs and tables showing the difference in percentage points and the absolute value of the direct versus the indirect approaches

This page is meant to inform the users of unusually high differences that have occurred between the direct and the indirect approaches in the recent months. Hugh differences very often indicate problems in one of the approaches (e.g. outlier adjustments) and should be checked.

10. Specific chart for M3

This chart shows the D8 versus the D10 graph of X-12-ARIMA for M3, calculated on the basis of the direct and the indirect approaches, using the special module of X-12-ARIMA for indirect adjustment.

Table 2.4 Revision compared to last ECB DATABANK update

Monetary aggregates [1) 2)]

(EUR billions (not seasonally adjusted) and annual percentage changes, unless otherwise indicated)

1. Levels outstanding at the end of the period

	M2								Repurchase agreements	Money market fund/shares units and money market paper	Debt securities up to 2 years
	M1				Deposits with agreed maturity up to 2 years	Deposits redeemable at notice up to 3 months	Total	Index Dec 98=100 [3)]			
	Currency in circulation	Overnight deposits	Total	Index Dec 98=100 [3)]							
	1	2	3	4	5	6	7	8	9	10	11
1998 Feb.	0.0	0.0	0.0	-0.03	0.0	0.0	0.0	-0.01	0.0	0.0	0.0
Mar.	0.0	0.0	0.0	-0.03	0.0	0.0	0.0	-0.01	0.0	0.0	0.0
Apr.	0.0	0.0	0.0	-0.03	0.0	0.0	0.0	-0.01	0.0	0.0	0.0
May	0.0	0.0	0.0	-0.03	0.0	0.0	0.0	-0.01	0.0	0.0	0.0
June	0.0	0.0	0.0	-0.03	0.0	0.0	0.0	-0.01	0.0	0.0	0.0
July	0.0	0.0	0.0	-0.03	0.0	0.0	0.0	-0.01	0.0	0.0	0.0
Aug.	0.0	0.0	0.0	-0.03	0.0	0.0	0.0	-0.01	0.0	0.0	0.0
Sep.	0.0	0.8	0.8	0.02	0.0	0.0	0.8	0.01	0.0	1.2	0.0
Oct.	0.0	1.9	1.9	0.08	0.0	0.0	1.9	0.04	0.0	0.0	0.0
Nov.	0.0	1.1	1.1	0.03	0.0	0.0	1.1	0.01	0.0	0.0	0.0
Dec.	0.0	0.5	0.5	0.00	0.0	0.0	0.5	0.00	0.0	0.0	-0.1
1999 Jan.	0.0	4.9	4.9	0.25	0.0	0.2	5.2	0.12	0.0	0.0	0.0
Feb.	0.0	6.2	6.2	0.32	0.0	0.0	6.2	0.15	0.0	0.0	0.0
Mar.	0.0	1.8	1.8	0.07	0.0	0.0	1.8	0.03	-0.1	0.0	0.1
Apr.	0.0	1.4	1.4	0.05	0.0	0.0	1.4	0.02	0.0	0.0	0.2
May	0.0	6.4	6.4	0.33	-0.1	0.0	6.4	0.15	-0.1	0.0	0.2
June	0.0	3.0	3.0	0.14	-0.8	0.0	2.3	0.05	-0.3	-0.1	3.7
July	0.0	2.4	2.4	0.10	-0.8	0.1	1.7	0.03	-0.5	-0.1	2.5
Aug.	0.0	0.5	0.5	0.08	-0.8	0.0	-0.2	0.02	-0.5	-0.1	3.4
Sep.	0.0	0.8	0.8	0.13	-0.9	0.0	-0.1	0.05	-0.4	-2.2	0.6

2. Flows [4)]

	M2								Repurchase agreements	Money market fund/shares units and money market paper	Debt securities up to 2 years
	M1				Deposits with agreed maturity up to 2 years	Deposits redeemable at notice up to 3 months	Total	Annual percentage change [4)]			
	Currency in circulation	Overnight deposits	Total	Annual percentage change [4)]							
	1	2	3	4	5	6	7	8	9	10	11
1998 Mar.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep.	0.0	0.8	0.8	0.1	0.0	0.0	0.8	0.0	0.0	1.2	0.0
Oct.	0.0	1.1	1.1	0.1	0.0	0.0	1.1	0.1	0.0	-1.2	0.0
Nov.	0.0	-0.8	-0.8	0.1	0.0	0.0	-0.8	0.0	0.0	0.0	0.0
Dec.	0.0	-0.5	-0.6	0.0	0.0	0.0	-0.6	0.0	0.0	0.0	-0.1
1999 Jan.	0.0	4.4	4.4	0.3	0.0	0.2	4.6	0.1	0.0	0.0	0.1
Feb.	0.0	1.2	1.2	0.4	0.0	-0.2	1.0	0.2	0.0	0.0	0.0
Mar.	0.0	-4.4	-4.4	0.1	0.0	0.0	-4.4	0.0	-0.1	0.0	0.1
Apr.	0.0	-0.4	-0.4	0.1	0.0	0.0	-0.4	0.0	0.0	0.0	0.1
May	0.0	5.1	5.1	0.4	-0.1	0.0	5.0	0.2	0.0	0.0	-0.1
June	0.0	-3.4	-3.4	0.2	-0.7	0.0	-4.1	0.1	-0.2	-0.1	3.5
July	0.0	-0.7	-0.7	0.1	0.0	0.0	-0.7	0.0	-0.2	0.0	-1.2
Aug.	0.0	-0.4	-0.4	0.1	0.0	0.0	-0.4	0.0	0.0	0.0	0.9
Sep.	0.0	0.9	0.9	0.1	0.5	-0.1	1.4	0.0	0.1	-1.9	3.0

Source: ECB

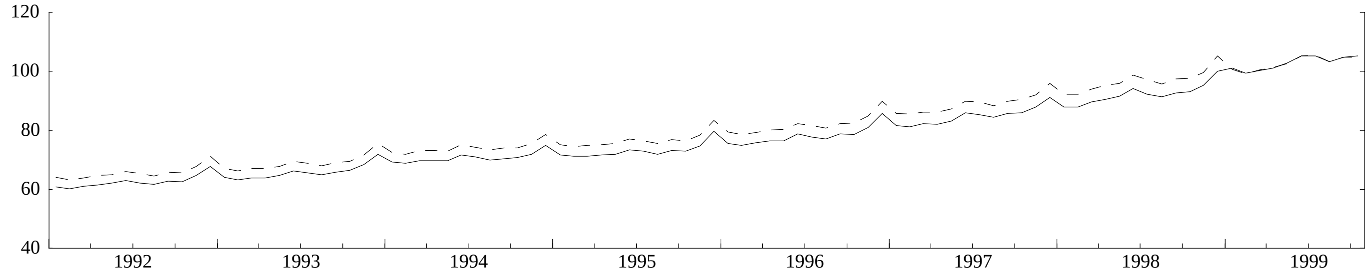
1) *Monetary aggregates comprise monetary liabilities of MFIs and central government (Post Office, treasury) vis-a-vis non-MFI euro area residents excluding central government.*
2) *Data have been revised in the light of new information.*
3) *Taking the December 1998 outstanding level (not seasonally adjusted) as 100, the index shows the cumulative product of changes from that date calculated from flows as described in footnote 4. The percentage change in the index between any two dates corresponds to the change in the aggregate excluding such reclassifications, etc.*
4) *Calculated from monthly differences in levels adjusted for reclassifications, other revaluations, exchange rate variations and any other changes which do not arise from transactions. For the calculation of growth rates, see the technical notes on page 17.*

M3			Memo : Non-monetary liabilities of MFIs						
Total			Deposits	With agreed maturity over 2 years	Redeemable at notice over 3 months	Debt securities over 2 years	Capital and Reserves	Total	
12	13	14	15	16	17	18	19	20	
0.0	-0.01	-	0.0	0.0	0.0	0.0	0.0	0.0	1998 Feb.
0.0	-0.01	-	0.0	0.0	0.0	0.0	0.0	0.0	Mar.
0.0	-0.01	-	0.0	0.0	0.0	0.0	0.0	0.0	Apr.
0.0	-0.01	-	0.0	0.0	0.0	0.0	0.0	0.0	May
0.0	-0.01	-	0.0	0.0	0.0	0.0	0.0	0.0	June
0.0	-0.01	-	0.0	0.0	0.0	0.0	0.0	0.0	July
0.0	-0.01	-	0.0	0.0	0.0	0.0	0.0	0.0	Aug.
2.0	0.04	-	0.0	0.0	0.0	0.0	0.0	0.0	Sep.
1.9	0.03	-	0.0	0.0	0.0	0.0	0.0	0.0	Oct.
1.1	0.02	-	0.0	0.0	0.0	0.0	0.0	0.0	Nov.
0.4	0.00	-	1.4	1.4	0.0	0.1	0.3	1.8	Dec.
5.2	0.11	-	1.6	1.6	0.0	0.0	0.0	1.6	1999 Jan.
6.2	0.13	-	1.5	1.5	0.0	0.0	0.0	1.5	Feb.
1.9	0.03	-	1.1	1.1	0.0	-0.1	0.2	1.2	Mar.
1.6	0.03	-	1.1	1.1	0.0	-0.3	0.0	0.8	Apr.
6.5	0.14	-	1.2	1.2	0.0	-0.4	0.0	0.8	May
5.7	0.12	-	2.4	2.4	0.0	-3.6	-3.9	-5.1	June
3.6	0.07	-	2.4	2.4	0.0	-4.5	-3.8	-6.0	July
2.6	0.08	-	1.2	1.2	0.0	-4.5	-3.7	-7.1	Aug.
-2.1	0.14	-	1.2	1.2	0.0	-1.3	-4.8	-4.9	Sep.

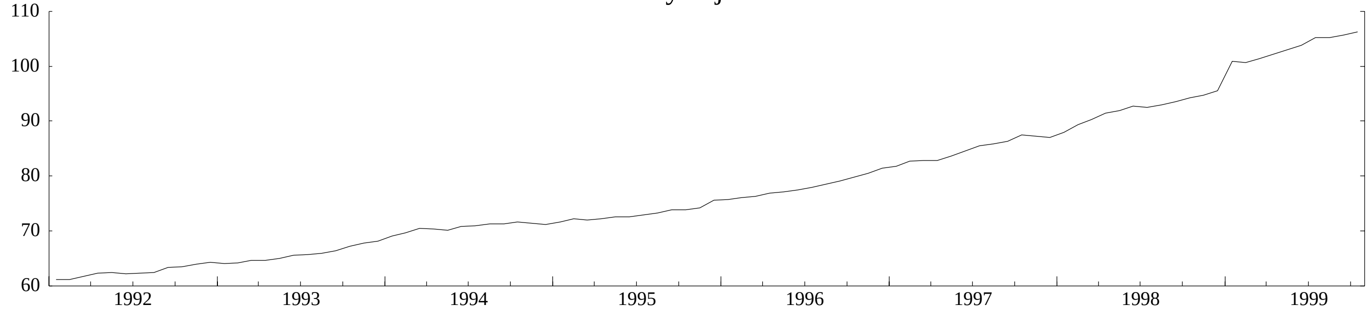
M3			Memo : Non-monetary liabilities of MFIs						
Total	Annual percentage change	3-month moving average (centered)	Deposits	With agreed maturity over 2 years	Redeemable at notice over 3 months	Debt securities over 2 years	Capital and Reserves	Total	
12	13	14	15	16	17	18	19	20	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-0.7	1998 Mar.
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Apr.
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	May
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	June
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	July
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Aug.
2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Sep.
-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Oct.
-0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Nov.
-0.7	0.0	0.1	1.4	1.4	0.0	0.1	0.2	1.7	Dec.
4.8	0.1	0.1	0.2	0.2	0.0	-0.1	-0.5	-0.4	1999 Jan.
1.0	0.1	0.1	-0.1	-0.1	0.0	0.0	-0.1	-0.3	Feb.
-4.3	0.0	0.1	-0.4	-0.4	0.0	-0.1	0.1	-0.5	Mar.
-0.3	0.0	0.1	0.0	0.0	0.0	-0.2	-0.3	-0.4	Apr.
4.9	0.1	0.1	0.1	0.1	0.0	-0.1	-0.1	-0.1	May
-0.9	0.1	0.1	1.2	1.2	0.0	-3.2	-4.0	-6.0	June
-2.0	0.1	0.1	0.0	0.0	0.0	-1.0	0.6	-0.4	July
0.5	0.1	0.1	-1.2	-1.2	0.0	0.0	0.7	-0.6	Aug.
2.6	0.1	-	0.3	0.3	0.0	4.5	-0.6	4.3	Sep.

ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

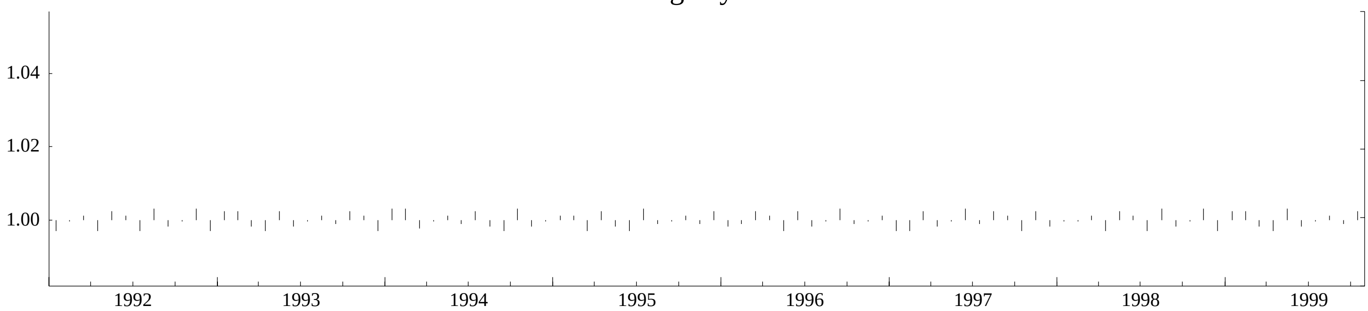
Original Series and linearise series passed to the seasonal adjustment



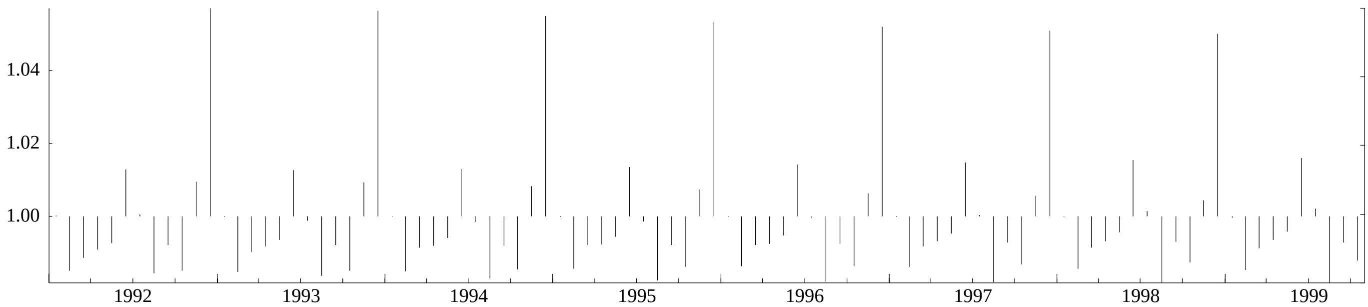
Seasonally adjusted series



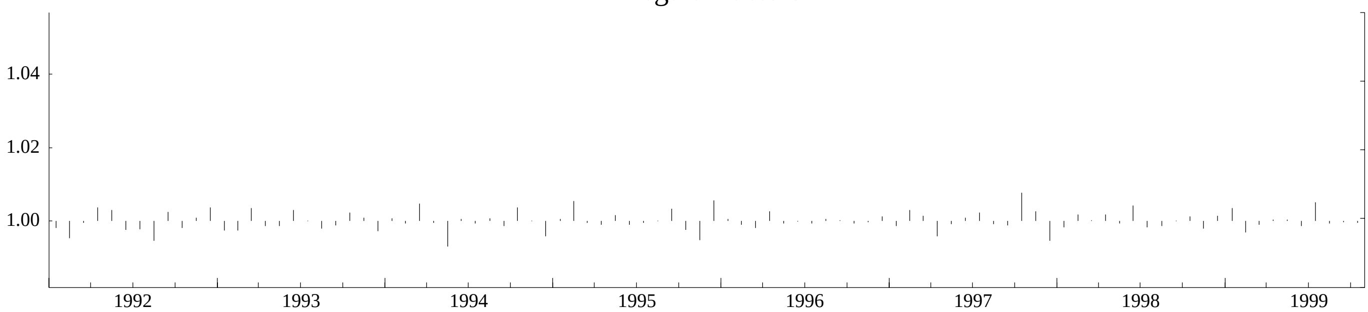
Trading day factors



Seasonal factors



Irregular factors



SPECIFICATION_FILE

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  FORMAT        = DATEVALUE
  NAME          = "ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E"
  PERIOD        = 12
  SPECTRUMSTART = 1991.Jan
  TITLE         = "M1_EURO_AREA"
  }
#
TRANSFORM
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  FUNCTION = LOG
  }
#
X11
  {
  APPENDFCST    = YES
  CALENDARSIGMA = ALL
  MODE          = MULT
  SAVE          = (ADJORIGINAL TREND TRENDD7 UNMODSI REPLACSI SEASONAL
                  SEASADJ IRREGULAR ADJUSTFAC IRRWT MODORIGINAL)
  SAVELOG       = (M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 Q Q2 MOVINGSEASRATIO
                  ICRATIO FSTABLEB1 FSTABLED8 MOVINGSEASF IDSEASONAL)
  SEASONALMA    = (S3X5 S3X5 S3X5 S3X5 S3X5 S3X5 S3X5 S3X5 S3X5 S3X5 S3X3 S3X5)
  SIGMALIM      = (2.0,3.0)
  TRENDMA       = 9
  }
#
REGRESSION
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  SAVE      = (LEVELSHIFT TEMPORARYCHANGE AOUTLIER)
  TCRATE    = 0.5
  USER      = (MO TU WE TH FR SA MO1 TU1 WE1 TH1 FR1 SA1)
  USERTYPE  = (TDSTOCK)
  VARIABLES = (AO1986.Mar LS1999.Jan)
  }
#
ARIMA
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  MODEL =  (0 1 2)(0 1 1)
  }
#
ESTIMATE
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  PRINT   = (+ROOTS)
  SAVE    = (RESIDUALS ESTIMATES ROOTS)
  SAVELOG = (AIC AICC BIC AVERAGEFCSTERR)
  }
#
OUTLIER
  {
  CRITICAL = 3.7
  }
#
CHECK
  {
  SAVELOG = (NORMALITYTEST LJUNGBOXQ)
  }
#
HISTORY
  {
  ESTIMATES = (FCST SEASONAL)
  SAVE      = (FCSTHISTORY SFREVISIONS)
  SAVELOG   = (AVEABSREVCHNG AVEABSREVINDSA AVEABSREVTREND
              AVEABSREVTRENDCHNG AVEABSREVSF AVEABSREVSFPROJ)
  START     = 1997.Sep
  }
#
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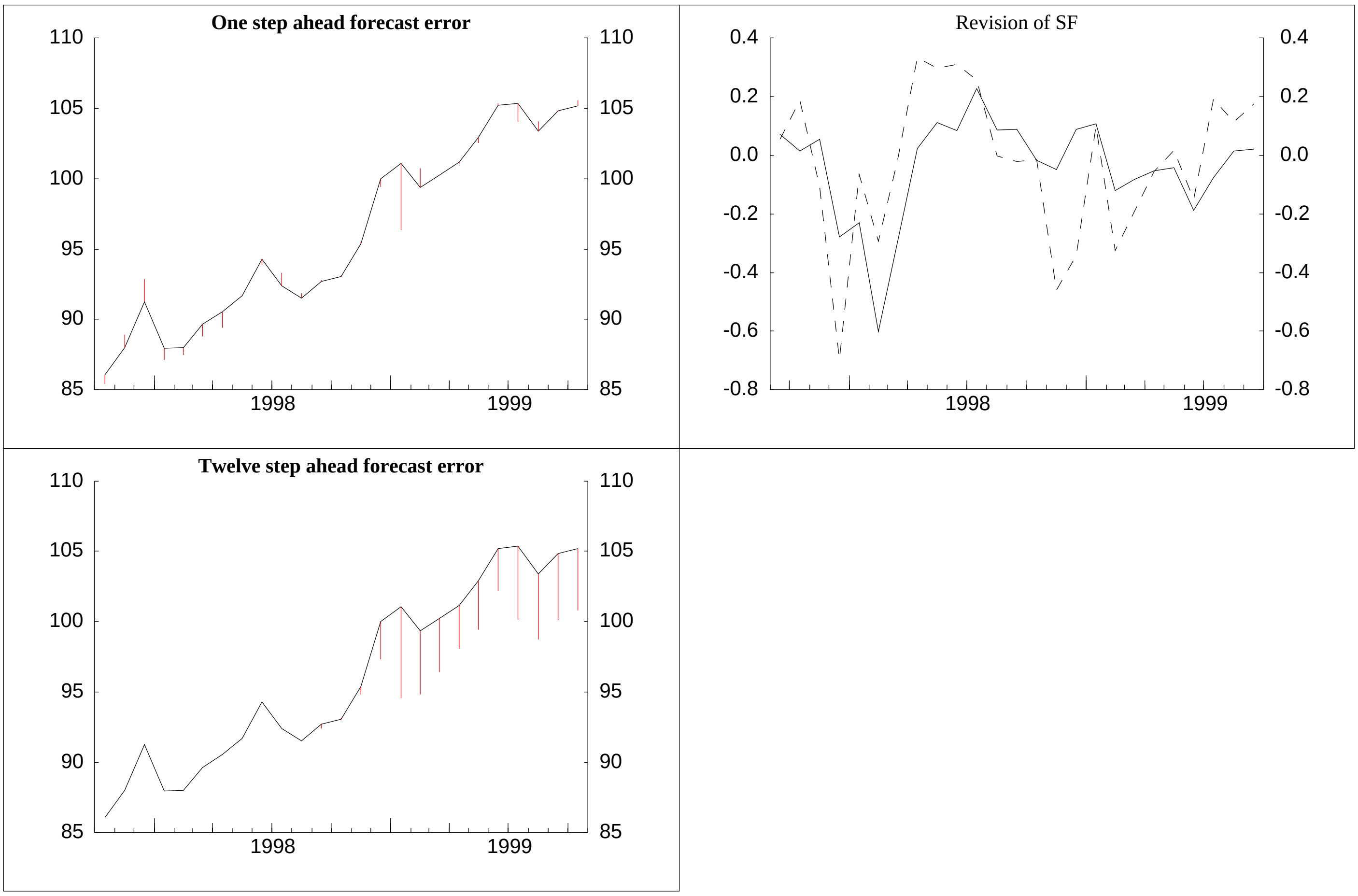
ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E
1-step and 12-step ahead forecast error plus revision of seasonal factors



One and twelve step ahead forecast error

	1-step	12-step
Oct-1997	0.653	--
Nov-1997	-0.935	--
Dec-1997	-1.618	--
Jan-1998	0.813	--
Feb-1998	0.543	--
Mar-1998	0.871	--
Apr-1998	1.167	--
May-1998	-0.048	--
Jun-1998	0.420	--
Jul-1998	-0.939	--
Aug-1998	-0.350	--
Sep-1998	-0.063	0.327
Oct-1998	0.030	-0.106
Nov-1998	-0.163	0.564
Dec-1998	0.583	2.686
Jan-1999	4.731	6.507
Feb-1999	-1.376	4.555
Mar-1999	-0.030	3.861
Apr-1999	0.097	3.100
May-1999	0.392	3.507
Jun-1999	-0.142	3.042
Jul-1999	1.327	5.227
Aug-1999	-0.709	4.662
Sep-1999	0.031	4.767
Oct-1999	-0.391	4.371

Revision of seasonal factors (concurrent/forecast)

	Concurrent	Projected
Sep-1997	0.072	0.055
Oct-1997	0.016	0.187
Nov-1997	0.054	-0.107
Dec-1997	-0.278	-0.696
Jan-1998	-0.230	-0.065
Feb-1998	-0.602	-0.294
Mar-1998	-0.295	-0.017
Apr-1998	0.023	0.333
May-1998	0.112	0.297
Jun-1998	0.085	0.309
Jul-1998	0.229	0.257
Aug-1998	0.087	-0.002
Sep-1998	0.089	-0.022
Oct-1998	-0.018	-0.015
Nov-1998	-0.049	-0.459
Dec-1998	0.090	-0.341
Jan-1999	0.107	0.099
Feb-1999	-0.121	-0.324
Mar-1999	-0.083	-0.193
Apr-1999	-0.053	-0.055
May-1999	-0.043	0.018
Jun-1999	-0.188	-0.150
Jul-1999	-0.076	0.193
Aug-1999	0.015	0.114
Sep-1999	0.022	0.176

PARAMETERS OF THE REGARIMA MODEL FOR ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

REGRESSION PARAMETERS

GROUP	VARIABLE	ESTIMATE	STDE	STABILITY CHECK (*)
AO1986.Mar	AO1986.Mar	0.011808	0.003965	..[.....X.....]..
LS1999.Jan	LS1999.Jan	0.047716	0.006054	..[......X....]..
User-defined	MO	0.003797	0.000639	..[.....X.....]..
User-defined	TU	0.002590	0.000671	..[.....X.....]..
User-defined	WE	0.000670	0.000651	..[.....X.....]..
User-defined	TH	-0.000094	0.000682	..[.....X.....]..
User-defined	FR	-0.008020	0.000728	..[.....X.....]..
User-defined	SA	-0.002736	0.000658	..[.....X.....]..
User-defined	MO1	0.002579	0.000858	..[.....X.....]..
User-defined	TU1	0.001116	0.000814	..[.....X.....]..
User-defined	WE1	-0.001464	0.000737	..[.....X.....]..
User-defined	TH1	-0.000897	0.000881	..[.....X.....]..
User-defined	FR1	-0.003287	0.000911	..[.....X.....]..
User-defined	SA1	-0.000392	0.000856	..[.....X.....]..

PARAMETERS OF STOCHASTIC ARIMA MODEL (0 1 2)(0 1 1)

OP.	FACTOR	PER.	LAG	ESTIMATE	STDE	STABILITY CHECK (*)
MA	Nonseasonal	01	01	0.076745	0.065787	..[.....X.....]..
MA	Nonseasonal	01	02	0.100730	0.065761	..[.....X.....]..
MA	Seasonal	12	12	0.540245	0.055835	..[.....X.....]..

INNOVATION VARIANCE

OPERATOR	VARIANCE
mle	0.00003500

(*) The stability check shows the position of the concurrent point estimtate within the 95% confidence interval
of the estimates, when forecasting the factors.

Quality criteria of X-11 for ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

CRITERIA	PARAMETER VALUE
Average Absolute Percentage Error	within-sample forecasts
AAPE(Last year)	0.45
AAPE(Last-1 year)	0.85
AAPE(Last-2 year)	1.76
AAPE(Last 3 years)	1.02
AIC	169.6918
AICC	173.0122
BIC	231.1816
No significant Ljung-Box Qs	
Geary's a statistic	0.7605 (significant)
Kurtosis	3.4897
Moving seasonality ratio	3.747
I/C Ratio	0.451
Stable Seasonal F, B1 table	198.289
Stable Seasonal F, D8 table	360.029
Moving Seasonal F, D8 table	0.917
Identifiable seasonality	yes
M01	0.062
M02	0.034
M03	0.000
M04	0.140
M05	0.000
M06	0.101
M07	0.116
M08	0.337
M09	0.128
M10	0.316
M11	0.296
Q	0.110
Q2	0.121
AveAbsRev of Seasonal	0.121
AveAbsRev of Projected Seasonal	0.191

B1

ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	27.029	26.915	27.122	27.212	27.532	28.246	28.376	27.914	28.278	28.508	29.555	29.944	28.052
1981	29.252	29.144	29.096	29.354	29.596	30.237	30.038	29.521	30.024	29.978	30.906	31.854	29.917
1982	31.011	30.868	31.062	31.363	31.694	32.662	32.522	32.250	32.751	32.798	34.039	35.060	32.340
1983	34.249	34.131	34.368	34.628	35.097	36.174	36.213	35.677	36.013	36.005	37.153	38.499	35.684
1984	37.282	36.888	36.966	37.183	37.443	38.472	38.384	37.980	38.548	38.561	39.704	41.447	38.238
1985	40.281	39.917	40.033	40.058	40.311	41.375	41.481	40.800	41.480	41.627	42.825	44.418	41.217
1986	43.009	42.757	43.118	43.649	44.225	45.146	45.402	44.751	45.409	45.660	46.867	48.390	44.865
1987	47.103	46.485	46.844	47.765	47.789	49.344	49.385	48.466	49.151	49.321	50.558	52.296	48.709
1988	50.634	49.942	50.297	51.025	51.447	52.951	53.353	52.355	52.781	53.048	54.550	56.511	52.408
1989	54.565	53.907	54.649	54.547	54.957	56.902	57.030	56.057	56.709	56.819	58.483	61.555	56.348
1990	59.233	58.271	58.170	58.579	58.940	60.749	60.731	59.879	60.818	60.519	62.021	65.630	60.295
1991	62.148	61.654	61.506	61.996	62.403	63.974	63.542	62.508	62.909	62.508	64.460	68.174	63.148
1992	64.112	63.163	63.957	64.719	65.026	66.090	65.430	64.438	65.899	65.591	67.712	71.281	65.618
1993	67.139	66.231	67.188	67.247	67.697	69.592	68.771	68.004	69.137	69.503	71.764	75.547	68.985
1994	72.471	71.921	73.279	73.212	73.069	75.190	74.240	73.465	74.140	74.077	75.489	78.683	74.103
1995	75.091	74.618	74.918	75.121	75.658	77.189	76.426	75.548	76.880	76.402	78.385	83.459	76.641
1996	79.406	78.632	79.374	80.088	80.404	82.419	81.656	80.890	82.372	82.530	84.990	89.807	81.881
1997	85.828	85.499	86.204	86.260	87.356	89.990	89.677	88.466	89.934	90.542	92.078	95.877	88.976
1998	92.279	92.343	93.918	95.276	95.943	98.785	97.192	95.701	97.425	97.653	99.717	105.206	96.786
1999	100.844	99.128	100.429	101.478	102.601	105.400	105.407	103.248	104.965	104.941	107.276	112.885	104.050

D8

ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	100.118	99.035	99.153	98.866	99.362	101.204	100.865	98.391	98.939	99.155	102.281	103.137	100.042
1981	100.277	99.369	98.643	99.056	99.553	101.418	100.423	98.293	99.451	98.741	101.229	103.725	100.015
1982	100.307	99.090	98.897	99.040	99.284	101.503	100.261	98.588	99.267	98.584	101.484	103.666	99.998
1983	100.392	99.173	98.980	98.810	99.201	101.307	100.643	98.606	99.095	98.593	101.158	104.224	100.015
1984	100.444	99.005	98.840	98.986	99.165	101.283	100.367	98.635	99.429	98.735	100.820	104.288	100.000
1985	100.495	98.984	98.943	98.767	99.063	101.182	100.797	98.436	99.344	98.986	101.150	104.217	100.030
1986	100.200	98.766	98.670 *AO*	98.997	99.527	100.912	100.786	98.591	99.294	99.177	101.224	103.953	100.008
1987	100.546	98.476	98.399	99.497	98.808	101.375	100.902	98.472	99.325	99.188	101.214	104.245	100.037
1988	100.432	98.421	98.384	99.013	99.003	101.100	101.195	98.715	99.005	99.046	101.373	104.450	100.011
1989	100.293	98.567	99.412	98.679	98.774	101.498	100.973	98.622	99.211	98.776	100.873	105.327	100.084
1990	100.716	98.704	98.322	98.774	98.962	101.349	100.561	98.498	99.504	98.588	100.601	105.992	100.048
1991	99.977	98.875	98.396	98.897	99.160	101.264	100.310	98.600	99.121	98.232	100.964	106.485	100.023
1992	99.908	98.098	98.823	99.443	99.531	100.965	99.738	97.809	99.399	98.319	101.083	106.162	99.940
1993	99.829	98.306	99.435	99.068	99.209	101.491	99.787	98.066	99.002	98.717	101.039	105.399	99.946
1994	100.161	98.539	99.705	99.177	98.697	101.282	99.682	98.291	98.982	98.873	100.812	105.075	99.940
1995	100.140	99.227	99.263	99.201	99.597	101.198	99.744	98.203	99.493	98.310	100.165	105.888	100.036
1996	100.098	98.606	99.105	99.543	99.428	101.389	99.871	98.262	99.240	98.546	100.542	105.268	99.991
1997	99.837	98.925	99.346	98.935	99.490	101.589	100.300	98.125	99.142	99.417	100.788	104.474	100.031
1998	99.762	98.710	99.133	99.504	99.519	102.036	100.043	98.105	99.320	98.849	100.195	105.071 *LS-1*	100.021
1999	100.255 *LS*	98.151 *LS+1*	98.989	99.391	99.676	101.545	100.832	98.182	99.292	98.730	--	--	99.504

SEASONAL FACTORS OF CONCURRENT RUN

1998	99.985	98.574	99.151	99.327	99.562	101.542	100.152	98.190	99.298	98.735	100.446	104.991	99.996
1999	99.974	98.535	99.137	99.358	99.587	101.593	100.221	98.184	99.293	98.797	100.382	104.906	99.997

SEASONAL FACTORS OFFICIALLY IN USE

1998	99.987	98.561	99.188	99.367	99.522	101.558	100.137	98.195	99.249	98.751	100.459	104.981	99.996
1999	99.979	98.508	99.186	99.409	99.534	101.609	100.204	98.190	99.233	98.818	--	--	99.467

D9

ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	--	--	--	--	--	--	--	--	--	--	101.173	--	101.173
1981	--	--	--	--	--	--	--	--	--	--	--	--	NC
1982	--	--	--	--	--	--	--	--	--	--	--	--	NC
1983	--	--	--	--	--	--	--	--	--	--	--	--	NC
1984	--	--	--	--	--	--	--	--	--	--	--	--	NC
1985	--	--	--	--	--	--	--	--	--	--	--	--	NC
1986	--	--	--	--	99.091	--	--	--	--	--	--	--	99.091
1987	--	--	--	98.950	--	--	--	--	--	--	--	--	98.950
1988	--	--	--	--	--	--	--	--	--	--	--	--	NC
1989	--	--	98.375	--	--	--	--	--	--	--	--	--	98.375
1990	100.178	--	--	--	--	--	--	--	--	--	--	--	100.178
1991	--	--	--	--	--	--	--	--	--	--	--	105.873	105.873
1992	--	--	--	--	--	--	--	98.398	--	--	--	--	98.398
1993	--	--	--	--	--	--	--	98.336	--	--	--	--	98.336
1994	--	--	99.244	--	99.412	--	--	--	--	--	--	--	99.328
1995	--	98.663	--	--	--	--	--	--	--	--	100.686	--	99.675
1996	--	--	--	--	--	--	--	--	--	--	--	--	NC
1997	--	--	--	--	--	--	--	--	--	98.653	--	--	98.653
1998	--	--	--	--	--	101.505	--	--	--	--	--	--	101.505
1999	--	--	--	--	--	--	100.102	--	--	--	--	--	100.102

D10 ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	100.267	99.175	98.919	98.970	99.379	101.375	100.545	98.460	99.210	98.801	101.264	103.629	100.000
1981	100.290	99.168	98.920	98.966	99.358	101.364	100.532	98.472	99.212	98.781	101.278	103.700	100.003
1982	100.330	99.149	98.899	98.947	99.312	101.349	100.514	98.490	99.246	98.752	101.249	103.847	100.007
1983	100.361	99.094	98.880	98.936	99.247	101.309	100.523	98.526	99.283	98.774	101.172	103.983	100.007
1984	100.403	99.014	98.840	98.924	99.167	101.268	100.588	98.548	99.313	98.841	101.106	104.118	100.011
1985	100.424	98.888	98.776	98.934	99.092	101.211	100.694	98.569	99.303	98.946	101.125	104.190	100.013
1986	100.433	98.769	98.674	98.925	99.023	101.200	100.810	98.564	99.282	99.015	101.196	104.306	100.016
1987	100.399	98.667	98.557	98.916	98.980	101.213	100.871	98.572	99.267	99.016	101.219	104.500	100.015
1988	100.346	98.623	98.464	98.890	98.961	101.272	100.870	98.583	99.256	98.929	101.132	104.808	100.011
1989	100.267	98.591	98.436	98.923	99.018	101.291	100.755	98.593	99.265	98.782	100.979	105.180	100.007
1990	100.171	98.571	98.524	98.960	99.089	101.317	100.558	98.570	99.262	98.638	100.884	105.495	100.003
1991	100.078	98.539	98.684	99.031	99.187	101.296	100.299	98.514	99.245	98.557	100.903	105.661	99.999
1992	100.018	98.517	98.866	99.086	99.273	101.289	100.060	98.440	99.224	98.517	100.950	105.693	99.994
1993	100.005	98.483	99.021	99.176	99.362	101.266	99.888	98.372	99.210	98.524	100.940	105.631	99.990
1994	100.001	98.506	99.155	99.203	99.412	101.306	99.846	98.314	99.205	98.557	100.834	105.482	99.985
1995	100.006	98.574	99.220	99.241	99.446	101.356	99.871	98.258	99.220	98.616	100.740	105.315	99.989
1996	100.008	98.632	99.218	99.252	99.485	101.419	99.955	98.223	99.255	98.648	100.636	105.177	99.992
1997	100.002	98.621	99.175	99.313	99.529	101.472	100.046	98.199	99.284	98.686	100.558	105.083	99.997
1998	99.985	98.574	99.151	99.327	99.562	101.542	100.152	98.190	99.298	98.735	100.446	104.991	99.996
1999	99.974	98.535	99.137	99.358	99.587	101.593	100.221	98.184	99.293	98.797	100.382	104.906	99.997

D11 **ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	25.701	25.874	26.140	26.214	26.413	26.564	26.907	27.029	27.175	27.510	27.826	27.549	26.742
1981	27.809	28.020	28.044	28.279	28.399	28.440	28.487	28.582	28.852	28.934	29.095	29.286	28.519
1982	29.469	29.683	29.944	30.220	30.426	30.725	30.848	31.219	31.463	31.665	32.053	32.188	30.825
1983	32.536	32.839	33.138	33.369	33.715	34.043	34.346	34.523	34.583	34.754	35.011	35.299	34.013
1984	35.402	35.519	35.657	35.836	35.998	36.220	36.381	36.744	37.007	37.196	37.440	37.953	36.446
1985	38.242	38.485	38.641	38.603	38.785	38.975	39.276	39.464	39.825	40.111	40.375	40.645	39.285
1986	40.828	41.273	42.156	42.068	42.581	42.532	42.939	43.287	43.606	43.966	44.155	44.231	42.802
1987	44.729	44.918	45.315	46.038	46.031	46.481	46.677	46.877	47.207	47.491	47.622	47.712	46.425
1988	48.108	48.280	48.701	49.193	49.565	49.850	50.428	50.633	50.699	51.124	51.427	51.406	49.951
1989	51.884	52.129	52.930	52.571	52.916	53.560	53.965	54.208	54.467	54.840	55.217	55.796	53.707
1990	56.377	56.361	56.291	56.437	56.711	57.165	57.580	57.917	58.415	58.496	58.613	59.313	57.473
1991	59.206	59.653	59.423	59.686	59.983	60.213	60.401	60.495	60.434	60.468	60.907	61.515	60.198
1992	61.114	61.127	61.676	62.273	62.451	62.209	62.344	62.408	63.320	63.476	63.949	64.299	62.554
1993	64.007	64.118	64.691	64.646	64.957	65.520	65.640	65.909	66.440	67.258	67.783	68.187	65.763
1994	69.093	69.610	70.459	70.362	70.077	70.762	70.889	71.243	71.252	71.659	71.376	71.118	70.658
1995	71.588	72.170	71.989	72.168	72.535	72.607	72.959	73.304	73.873	73.864	74.183	75.555	73.066
1996	75.700	76.008	76.271	76.932	77.054	77.480	77.886	78.517	79.124	79.763	80.518	81.408	78.055
1997	81.827	82.655	82.870	82.809	83.680	84.553	85.458	85.891	86.362	87.472	87.300	86.988	84.822
1998	87.993	89.313	90.309	91.452	91.875	92.751	92.523	92.924	93.542	94.295	94.649	95.536	92.263
1999	100.870	100.601	101.303	102.134	103.027	103.748	105.175	105.157	105.712	106.219	--	--	103.395

Seasonally adjusted series when using the official forecast seasonal/trading day factors

1998	88.045	89.332	90.273	91.438	91.939	92.769	92.439	92.887	93.549	94.327	94.649	95.529	92.265
1999	100.905	100.605	101.253	102.110	103.149	103.776	105.096	105.057	105.756	106.248	--	--	103.396

Month to month percentage variation concurrent run

1998	1.2	1.5	1.1	1.3	0.5	1.0	-0.2	0.4	0.7	0.8	0.4	0.9	0.8
1999	5.6	-0.3	0.7	0.8	0.9	0.7	1.4	-0.0	0.5	0.5	--	--	1.1

Month to month percentage variation when using the official forecast seasonal/trading day factors

1998	1.2	1.5	1.1	1.3	0.5	0.9	-0.4	0.5	0.7	0.8	0.3	0.9	0.8
1999	5.6	-0.3	0.6	0.8	1.0	0.6	1.3	-0.0	0.7	0.5	--	--	1.1

D12

ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	25.728	25.900	26.072	26.242	26.424	26.617	26.825	27.050	27.253	27.417	27.553	27.677	26.730
1981	27.800	27.949	28.115	28.256	28.354	28.436	28.524	28.634	28.781	28.944	29.108	29.278	28.515
1982	29.473	29.699	29.945	30.196	30.440	30.682	30.923	31.180	31.447	31.713	31.978	32.249	30.827
1983	32.534	32.821	33.112	33.417	33.730	34.037	34.294	34.481	34.636	34.810	35.015	35.224	34.009
1984	35.401	35.539	35.673	35.823	35.999	36.207	36.448	36.697	36.953	37.232	37.546	37.892	36.451
1985	38.217	38.452	38.585	38.680	38.804	38.987	39.232	39.513	39.807	40.092	40.358	40.621	39.279
1986	40.909	41.270	41.672	42.055	42.382	42.664	42.954	43.280	43.605	43.893	44.131	44.357	42.765
1987	44.636	44.987	45.386	45.781	46.130	46.424	46.680	46.942	47.194	47.414	47.615	47.803	46.416
1988	48.034	48.349	48.724	49.131	49.557	49.958	50.293	50.591	50.848	51.077	51.307	51.571	49.953
1989	51.846	52.107	52.376	52.679	53.043	53.464	53.871	54.215	54.517	54.865	55.299	55.738	53.668
1990	56.076	56.267	56.369	56.505	56.757	57.132	57.568	57.948	58.269	58.543	58.821	59.091	57.445
1991	59.312	59.467	59.581	59.733	59.959	60.190	60.356	60.409	60.493	60.680	60.911	61.095	60.182
1992	61.234	61.423	61.714	62.041	62.264	62.364	62.487	62.753	63.169	63.600	63.894	64.065	62.584
1993	64.177	64.288	64.464	64.741	65.051	65.331	65.641	66.045	66.528	67.104	67.729	68.379	65.790
1994	69.046	69.657	70.128	70.406	70.573	70.729	70.938	71.191	71.356	71.394	71.384	71.418	70.685
1995	71.553	71.779	72.034	72.240	72.424	72.681	73.002	73.301	73.629	74.053	74.578	75.139	73.034
1996	75.662	76.086	76.415	76.738	77.108	77.495	77.944	78.477	79.119	79.814	80.554	81.304	78.060
1997	81.950	82.414	82.757	83.161	83.750	84.488	85.270	85.969	86.478	86.804	87.067	87.458	84.797
1998	88.153	89.158	90.302	91.287	91.949	92.363	92.688	93.051	93.539	94.176	94.853	95.407	92.244
1999	100.515	100.925	101.410	102.100	102.989	103.890	104.641	105.242	105.758	106.286	--	--	103.376

D13

ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	99.895	99.899	100.261	99.893	99.959	99.804	100.306	99.925	99.713	100.340	100.990	99.539	100.044
1981	100.029	100.254	99.748	100.079	100.159	100.014	99.872	99.818	100.248	99.967	99.954	100.030	100.014
1982	99.986	99.946	99.995	100.079	99.955	100.143	99.757	100.124	100.049	99.848	100.233	99.811	99.994
1983	100.006	100.053	100.077	99.859	99.956	100.017	100.153	100.123	99.848	99.840	99.988	100.211	100.011
1984	100.003	99.945	99.955	100.035	99.995	100.037	99.818	100.128	100.144	99.903	99.718	100.161	99.987
1985	100.066	100.084	100.143	99.800	99.951	99.969	100.111	99.875	100.045	100.047	100.044	100.059	100.016
1986	99.800	100.008	101.162	100.031	100.468	99.690	99.963	100.016	100.001	100.164	100.055	99.715	100.089
1987	100.208	99.848	99.845	100.562	99.787	100.121	99.993	99.861	100.027	100.161	100.015	99.809	100.020
1988	100.155	99.856	99.953	100.126	100.015	99.784	100.268	100.083	99.706	100.092	100.233	99.679	99.996
1989	100.073	100.042	101.058	99.797	99.760	100.180	100.174	99.987	99.908	99.954	99.852	100.104	100.074
1990	100.537	100.168	99.860	99.878	99.919	100.058	100.021	99.946	100.251	99.919	99.647	100.376	100.048
1991	99.821	100.313	99.734	99.920	100.039	100.037	100.074	100.142	99.902	99.649	99.993	100.688	100.026
1992	99.804	99.517	99.938	100.373	100.300	99.751	99.770	99.451	100.239	99.806	100.085	100.366	99.950
1993	99.735	99.736	100.352	99.854	99.856	100.289	99.998	99.793	99.869	100.229	100.080	99.720	99.959
1994	100.069	99.932	100.473	99.937	99.297	100.047	99.932	100.073	99.855	100.371	99.990	99.579	99.963
1995	100.049	100.545	99.937	99.901	100.153	99.899	99.941	100.005	100.332	99.745	99.471	100.553	100.044
1996	100.050	99.897	99.812	100.252	99.931	99.980	99.927	100.051	100.006	99.936	99.955	100.128	99.994
1997	99.850	100.293	100.137	99.577	99.916	100.077	100.221	99.910	99.866	100.770	100.267	99.463	100.029
1998	99.819	100.174	100.008	100.181	99.920	100.420	99.822	99.863	100.004	100.126	99.786	100.135	100.021
1999	100.354	99.679	99.895	100.033	100.037	99.863	100.511	99.919	99.957	99.936	--	--	100.018

D16 ECB_BSI1.M.U2.N.V.M10.X.I.U2.2300.Z01.E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVGE
1980	100.255	98.444	99.380	99.053	99.081	101.846	100.532	98.834	99.493	98.073	101.649	103.717	100.030
1981	99.989	98.870	99.202	98.237	99.736	101.653	99.791	98.930	99.296	98.484	101.749	102.936	99.906
1982	100.711	99.526	98.982	98.218	99.690	101.434	100.212	98.771	99.233	99.127	101.538	103.082	100.044
1983	100.828	99.555	98.442	98.639	99.530	101.296	100.905	98.609	98.552	99.233	101.258	103.671	100.043
1984	100.690	99.097	98.544	99.385	99.544	100.964	100.875	97.821	99.690	98.829	100.361	104.602	100.033
1985	100.412	98.876	99.151	99.217	98.362	101.596	100.779	98.273	99.765	98.934	100.821	104.487	100.056
1986	99.693	98.041	99.133	99.008	98.725	101.671	100.798	98.939	99.566	98.286	101.580	104.394	99.986
1987	100.098	98.371	98.839	98.187	99.356	101.502	100.128	99.031	99.350	98.718	101.690	103.730	99.917
1988	100.728	99.082	98.064	98.593	99.243	101.259	101.253	98.666	98.524	99.389	101.217	104.493	100.043
1989	100.553	98.872	97.711	99.299	99.102	100.544	101.224	98.581	98.967	99.064	100.966	105.580	100.039
1990	100.255	98.654	98.228	99.420	99.077	101.013	100.845	97.844	99.639	98.626	100.141	105.986	99.977
1991	100.066	98.526	99.058	99.313	98.456	101.681	100.384	98.218	99.707	98.545	100.600	105.963	100.043
1992	99.715	98.474	98.987	98.786	99.506	101.413	99.757	98.751	99.041	98.475	101.269	105.373	99.962
1993	100.240	98.714	98.839	98.876	99.595	101.080	99.845	98.492	99.092	98.755	101.064	105.311	99.992
1994	100.316	98.817	98.932	99.160	99.534	101.186	100.081	98.134	98.905	98.869	100.649	105.437	100.002
1995	100.129	98.695	98.920	99.474	99.263	101.049	100.186	98.142	99.177	98.737	100.621	105.563	99.996
1996	99.824	98.515	99.451	99.374	99.184	101.657	99.772	98.180	99.568	98.531	100.593	105.307	99.996
1997	99.700	98.323	99.408	99.131	99.486	101.792	99.928	98.430	99.406	98.388	100.795	104.890	99.973
1998	99.942	98.532	99.273	99.027	99.796	101.667	99.849	98.500	99.115	98.693	100.763	104.673	99.986
1999	100.208	98.766	98.955	99.057	99.901	101.406	100.178	98.305	99.176	99.029	100.506	104.588	100.006

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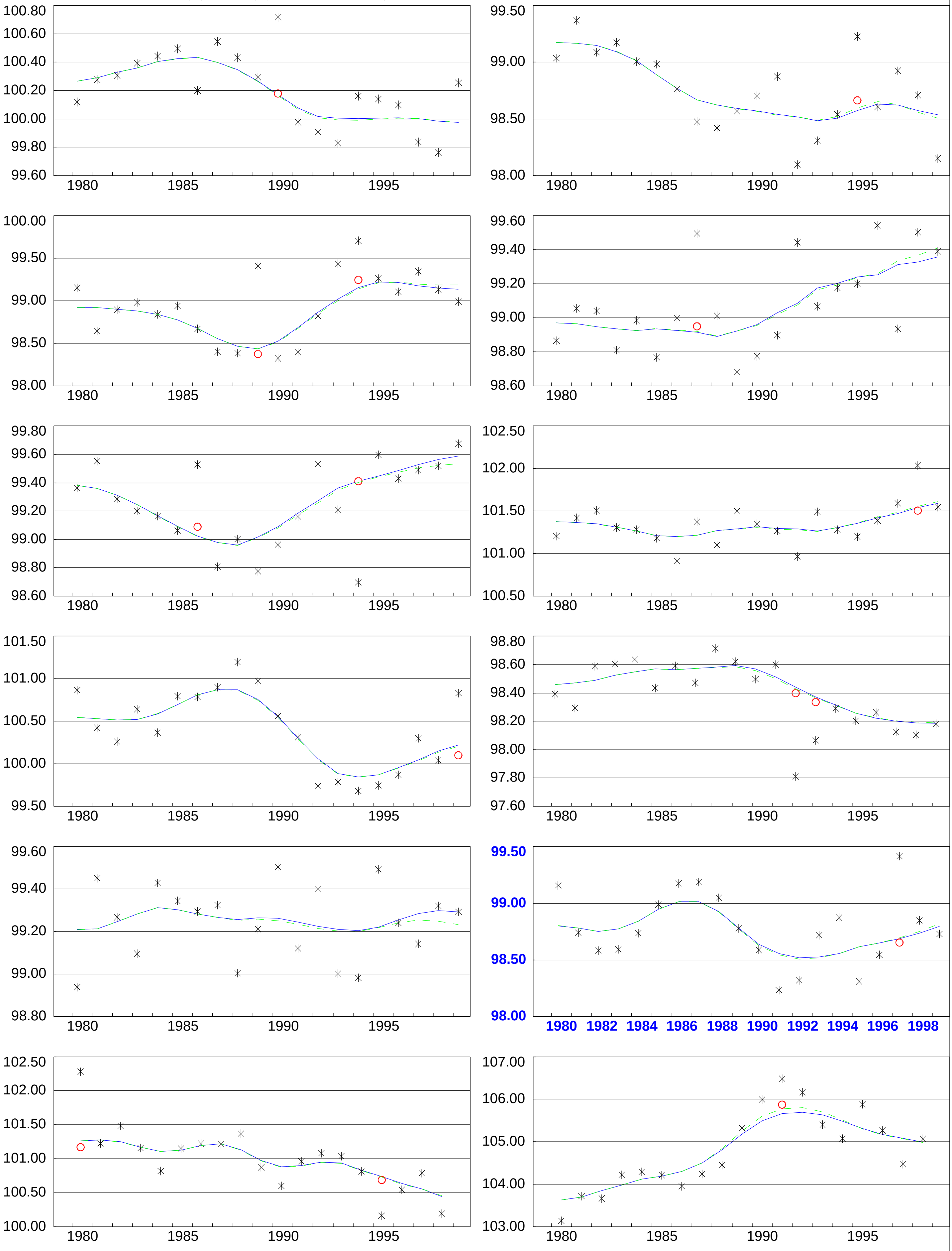
D8 (*), D9 (o) versus D10 (solid line concurrent, dashed line safed factors)



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