

## **DETAILED DESCRIPTION OF THE METHODOLOGY USED FOR THE SEASONAL ADJUSTMENT OF MONETARY SERIES**

1 The standard procedure used at the ECB to seasonally adjust the monetary series is to run X-12-ARIMA as follows:

Step 1. Run the program in default mode.

Step 2. Assess the adjustment and model obtained from Step 1 using available diagnostics and correct problems thereby detected.

Step 3. For significant stock trading day effects, check their statistical robustness and economic plausibility.

Step 4. Decide which series should be indirectly adjusted in order to ensure additivity.

2 Specifically, the steps involved can be detailed as follows:

*Step 1. Run the program in default mode*

X-12 ARIMA is run in default mode. By default mode we specifically refer to the following:

- sequentially test for outliers using the X-12 built-in detection procedures based in the sequential Chang-Tiao algorithms;
- automatically search for an ARIMA specification using X-12's AUTOMODL spec and obtain estimates by exact maximum likelihood in order to mitigate the effects of potential seasonal overdifferencing;
- test for possible stock trading day effects;
- run default X-11 using the automatic seasonal filter selection based on the X-11 ARIMA/88 moving seasonality ratio (MSR) criterion.

*Step 2. Assess the adjustment and model obtained from Step 1 using available diagnostics and correct problems thereby detected*

In certain instances, some of the automatically selected options in Step 1 has to be overridden when diagnostics show evidence of misspecification or of an inadequate framework to apply the standard X-11 filters. In particular:

- when no ARIMA model is selected by X-12 using the automatic selection criterion based on the within-sample forecast error test, the most parsimonious ARIMA model providing consistent estimates is selected;

- when an ARIMA model automatically selected by X-12 shows evidence of mis-specification, the same criterion as above in the selection of an alternative model is followed;
- in series with evidence of a largely stochastic seasonal pattern, the number of months used for forecasting and backcasting is reduced when this improves the suitability of the default X-11 filters. Exclusive reliance on X-11's asymmetric filters is on occasion used at the beginning of the sample for short time series;
- the seasonal filter selection based on the X-11 ARIMA/88 MSR criterion is on occasion overridden for series with evidence of a largely stochastic seasonal pattern;
- X-11's automatic selection of the Henderson filter for trend-cycle estimation is on occasion overridden for series with evidence of a largely stochastic trend;
- when lack of evidence of seasonality or trading day effects is found, the series is not adjusted. This is established using the relevant X-12's time-domain tests and the estimated spectrum of the first-differenced series.

*Step 3. For significant stock trading day effects, check their statistical robustness and economic plausibility*

For short time series, it is more likely than usual to find spuriously significant trading day effects for a certain day of the week, as the estimates may on occasion be dominated by a single extreme observation. Thus, for series comprising less than 10 years of data, the following measures are taken on a yearly basis:

- ensure that the F-test for the joint significance of the trading day effects rejects the null at the 1% level;
- ensure that above F-test remains significant, and that the trading day pattern remains substantially unchanged, when the sensibility in the detection of outliers in X-12 is significantly increased beyond that implied by the default critical value for the Chang-Tiao algorithm;
- ensure that above F-test remains significant, and that the trading day pattern remains substantially unchanged, when one year of data is removed from each end of the time series.

In addition, all trading day patterns are checked for economic plausibility.

*Step 4. Decide which series should be indirectly adjusted in order to ensure additivity.*

Wherever series are defined as a total, the SA results of one of the elementary series is derived indirectly, to ensure additivity. The following rules summarise the procedures that have been followed in the selection of the series to be indirectly adjusted:

- the series with large seasonal patterns which at the same time are more amenable to adjustment using X-11-type filters are adjusted directly;
- for those series that produced ARIMA models with better results in terms of their in-sample forecast tests, preference is given to direct adjustment;
- in absence of any obvious choice when applying the two criteria above, preference is given to the indirect adjustment of series that are derived as aggregation of other components.