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SEASABS: Australian Bureau of Statistics seasonal adjustment package

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1. Introduction

Seasonally adjustment and trend estimates are important analytical products which are regularly produced and published by Official Government Statistical agencies. Commonly used seasonal adjustment packages are X-12-ARIMA (Findley et. al, 1998) and TRAMO-SEATS (Gómez and Maravall, (1997, 2000)).

SEASABS (SEASonal analysis, ABS standards) is the seasonal adjustment system used at the Australian Bureau of Statistics (ABS). SEASABS allows both expert and non-expert use of an ABS enhanced version of the seasonal adjustment approach X-11 (Shiskin, et. al, 1967) and embeds selected X-12-ARIMA functionality. The SEASABS system is unique because it uses a knowledge base which can interpret seasonal adjustment output using an intelligent graphical interface to guide the time series analyst through the seasonal analysis process. A rich metadata collection is stored which includes seasonal adjustment parameters and prior correction factors. The SEASABS system performs four major functions: 1) data review and exploration capability, 2) seasonal reanalysis of time series for the creation of seasonal factors for directly adjusted time series and creation of seasonally adjusted and trend estimates for indirectly adjusted time series, 3) investigation of time series in a timely fashion, and 4) upholding ABS quality standards in a consistent way across multiple collections.

This paper describes the seasonal adjustment infrastructure and approach currently used at the Australian Bureau of Statistics and outlines the future directions for seasonal adjustment infrastructure within the Australian Bureau of Statistics.

2. Current seasonal adjustment infrastructure at Australian Bureau of Statistics

The SEASABS system consists of: SEASABS (seasonal adjustment and analysis tool), Time Series Update (higher level aggregate derivation tool), Aggregation package (construction and modification of aggregation structures), Time Series Toolkit (viewing and manipulating derived data), Housekeeping (modification of time series metadata), and Download (extracting time series metadata from the information warehouse). Figure 1 shows how the seasonal adjustment infrastructure interacts.

The main purpose of SEASABS is to reliably estimate high quality seasonal factors for an individual time series. As part of this process SEASABS identifies and corrects trend and seasonal breaks as well as extreme values, inserts trading day factors if necessary, chooses appropriate moving averages for the computation of trends and

seasonal factors, and allows for moving holiday corrections, such as Easter (Zhang et. al, 2001), Father's Day and other public holidays, the ability to insert regression-ARIMA corrections derived from X-12-ARIMA and can use the ARIMA forecasting capability of X-12-ARIMA to generate appropriate univariate forecasts.

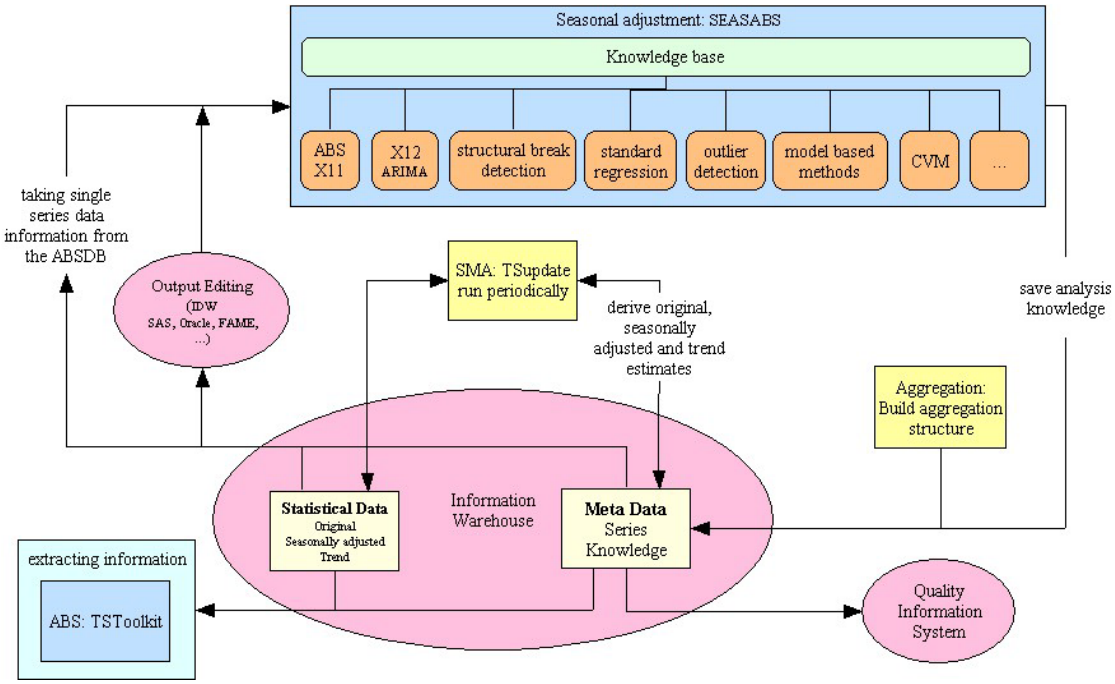

Figure 1: Seasonal adjustment infrastructure at the Australian Bureau of Statistics.

SEASABS meets the ABS needs within a production environment where a large number of series are involved, and enables seasonally adjustment by many statistical processing areas under the guidance of a centralised pool of experts. SEASABS is specifically built to integrate with the ABS software environment. It is only one part of the ABS time series processing system. In a broad sense, other aspects of the processing system include an ABS information warehouse, an automated publication system and FAME (www.fame.com). Relevant information about individual time series are stored within the information warehouse environment. For example, this information will include: the original estimates, series specific seasonal adjustment options, metadata relating to prior corrections such as the magnitude of prior corrections and any given real world reasons. The stored metadata information is accessed by SEASABS, which performs a seasonal adjustment and writes selected information back to the information warehouse. For example, information stored will include the estimated seasonal factors for an individual time series and any changes made as part of the seasonal adjustment process. Historical seasonal analysis of time series are kept so that diagnostics can be compared over time. The history of changes to the seasonal adjustment parameters and prior correction factors can also be viewed. Graphs of original, seasonally adjusted, trend, seasonal/irregular, X-11 outputs and toolset facilities are then available. The publication system automatically extracts relevant information to produce the final publication.

The three main systems that are used in conjunction with SEASABS are:

a. Time Series Update (TSupdate) creates and updates seasonally adjusted and trend estimates for direct and indirect time series. TSupdate is used by subject matter areas at each time period to apply and calculate seasonal factors using the stored seasonal parameter options. The seasonal factors are then applied to the original estimates to derive the seasonally adjusted and trend estimates for the direct and indirect time series. This information is then written directly back to the information warehouse. TSupdate has the ability to perform a seasonal adjustment at each period in order to calculate updated seasonal factors automatically.

b. Aggregation package allows relationships between time series to be created and maintained. For example, the sum of industry estimates to an industry total, splicing a time series in at a given point in time, or constructing complicated relationships between multiple time series such as chain volume measures. Seasonal factor options can also be set. For example, setting ceased to be seasonally adjusted before a given time point, freezing seasonal factors after a given time point, and choice of direct and indirect seasonally adjusted and trend estimates for an aggregated series.

c. Time Series Toolkit provides a time series view of data held in the information warehouse. It allows users to tabulate, graph and manipulate time series. Time Series Toolkit cannot alter data stored on the information warehouse. The output can be printed or saved for use with other data manipulation products.

3. Current seasonal adjustment approach at Australian Bureau of Statistics

The Time Series Analysis section at the ABS is responsible for quality assurance aspects of all published seasonally adjusted and trend estimates. The seasonal adjustment approach used within the ABS is currently being documented within a comprehensive best practice guide. The guiding principle and objective is to ensure the production of high quality seasonally adjusted estimates that are without systematic calendar related variation.

A seasonal adjustment annual reanalysis is performed once per year for every directly seasonally adjusted time series that is published. Over 2500 directly seasonally adjusted time series are assessed as part of this process for a diverse range of approximately 25 different client areas. Prior corrections and seasonal adjustment parameters are assessed and can be modified at the annual reanalysis time. Methodological enhancements are typically introduced at the annual reanalysis time of individual collections to minimise any impact in terms of revisions to time series estimates.

SEASABS offers different analysis choices. A research analysis is used if the series is new or if the user wishes the system to investigate any issues encountered with the analysis. An analysis approach which does not test the various hypotheses inherent in SEASABS can also be used which will not modify existing prior correction factors such as large extremes or seasonal and trend breaks. Since the in-built hypotheses are not tested this run is fast so that basic results can be viewed immediately. Currently, this option must also be used if the time series is additively or pseudo-additively adjusted.

Concurrent seasonal adjustment is the preferred seasonal adjustment approach within ABS and is currently used for all ABS published seasonally adjusted and trend estimates on a regular basis, apart from the majority of National Accounts time series. Seasonally adjusted and trend estimates are allowed to be revised along the length of the time series. The TSupdate package automatically performs the concurrent seasonal adjustment with no input from the user. It effectively runs an X11 process with the stored metadata. The TSupdate process produces an automated log file which highlights any potential issues at the current end of the time series. The log is automatically sent to a dedicated database where each logs can be inspected and acted on if required. Subject matter areas will seek advice from time series experts as required.

ARIMA models are currently applied for two collections, Retail Turnover and New Motor Vehicle Sales. ARIMA models are applied only when the use of ARIMA models will improve the average percentage revision of the seasonally adjusted and trend estimates. For example, 94% of Retail series use an ARIMA model (ABS, 2005a) and 15 out of 24 of New Motor Vehicle Sales series use an ARIMA model (ABS, 2005b). ARIMA models and parameter estimates are reassessed on an annual basis. Model choice and parameter estimates are fixed for a period of one year. Assessment and application of ARIMA models for all other ABS published seasonally adjusted time series is planned.

4. Future seasonal adjustment infrastructure at Australian Bureau of Statistics

New methodological capabilities and general improvements to the seasonal adjustment approach are included within the SEASABS system on a regular basis. New versions of the seasonal adjustment production systems are released on an approximately annual basis. The following sections describe planned improvements and directions.

4.1 Increase in ARIMA modelling capabilities

SEASABS is capable of directly linking to X-12-ARIMA for the purpose of using regression-ARIMA and estimation of ARIMA models and parameter estimates. SEASABS supplies the seasonal adjustment parameters directly to X-12-ARIMA. The output from X-12-ARIMA is then read directly back into SEASABS and chosen output is stored for retrieval. This link will strengthen with the development of SEASABS to use the built-in regression capabilities of X-12-ARIMA. For example, having the option to use and apply the large extreme or level shift regressions automatically available within X-12-ARIMA. The user will have the ability to choose between currently applied iterative algorithms based on X11 output and the more sophisticated approaches available in X-12-ARIMA. Automation of the application of regression-ARIMA and ARIMA models is a desirable direction to reduce dependency on individual users. Development of appropriate knowledge rules will be able to guide the non-expert and expert user in fitting an appropriate ARIMA model. This will ensure quality standards can be managed. Systematic storage and retrieval of custom and standard regressors with the associated metadata will also be addressed.

4.2 Consistency of published seasonally adjusted and trend estimates across collections

Typically, published official government statistics are derived using individual time series with limited knowledge of related time series from different areas. Future versions of SEASABS will include the ability to manage and measure the consistency of time series. For example, consistency of seasonal adjustment options between state totals and a national total, and consistency between seasonal adjustment options of source data and the equivalent data with a different scope used in another area. This is a significant issue within National Accounts time series as these time series typically use original estimates which are obtained from alternative data sources.

Consistency measures have recently been trialed as part of improving published ABS seasonally adjusted estimates. For example, once the relationship between different time series are known then consistency measures can be assessed. For example, the same seasonal adjustment decomposition, and whether the application and magnitude of prior factor corrections have been applied at identical time periods. Significant differences and cross correlations in percentage movements can also be calculated in the seasonally adjusted estimates.

4.3 Enhancement of methodological aspects

Current and planned research projects that will directly impact on future versions of SEASABS are described below:

a. Implementation of an improved approach to pro-ration for systems of time series. Currently a partial approach to pro-ration approach is used within the Australian Retail Trade series (ABS, 2005a). Stuckey et. al (2004) investigated the application of the Generalised Benchmarking Approach (Cholette 2004) and a bi-proportional raking method (Evans, 2005). Results show that a balance can be achieved between minimising changes to the seasonally adjusted estimates and the introduction of residual seasonality. The ABS chosen approach aligns well with methodology proposed within the Generalised Benchmarking System developed within Statistics Canada. The chosen approach outperforms the current pro-ration method in SEASABS, and raking method used in Bureau of Labor Statistics (BLS) in terms of reducing changes to seasonally adjusted movement estimates and minimises the risk of introducing seasonality to seasonally adjusted series. This improved methodology has been incorporated into the latest release of SEASABS.

b. An improved approach to the assessment of seasonality in time series and assessment of residual seasonality is required. The currently applied F-tests available within X-12-ARIMA may not be appropriate in all situations. Research into the use of the seasonal unit root approach (Hylleberg et. al, 1990) for use with official statistics is ongoing. Preliminary results suggest that testing for static seasonality using the F-test, then for moving seasonality using the seasonal unit root approach may lead to an improved overall test for seasonality.

c. Improving the approach to estimating trading day for quarterly time series is important. The ABS applies a moving trading day prior correction for all monthly flow series. For quarterly time series static trading day is applied but only when there is strong evidence of a trading day effect, either estimated using the estimated daily weights from the quarterly time series or equivalent monthly time series. In general, estimation of trading day for quarterly time series is difficult. Research is underway to investigate the use of moving trading day using regression-ARIMA framework (Zhang and Poskitt, 2006). This may lead to gains in improving the quality of seasonally adjusted estimates for quarterly time series.

d. Original estimates for quarterly time series can be calculated by using the original estimates from monthly time series. The seasonally adjusted estimates derived from the quarterly original estimates will have coherence issues with the seasonally adjusted estimates derived from the monthly original estimates. For example, Balance of Payments estimates can be estimated for both monthly and quarterly time periods and the seasonally adjusted and trend estimates derived for both situations. The sum of the monthly seasonally adjusted estimates will not equal the directly adjusted quarterly estimate. One approach may be to derive the seasonally adjusted quarterly estimates directly from the seasonally adjusted monthly estimates. This would significantly reduce the workload required to produce seasonally adjusted quarterly estimates provided the equivalent monthly estimates are available. There will need to be analysis to ensure there was no loss of quality. This research is ongoing.

5. Discussion

Robust and methodological defensible seasonal adjustment infrastructure and published seasonally adjusted and trend estimates are important for all official government agencies. There is a need to quality assure output for all published seasonally adjusted and trend estimates. This can be achieved by improving diagnostics on seasonally adjusted estimates, applying sophisticated and defensible approaches where available, and improving on currently applied methodology. There is also a need to facilitate non-expert and expert users to perform seasonal adjustment at an appropriate and adequate consistent quality level. This is important in situations where the expertise of dedicated time series analysts is either not available or can change over time.

SEASABS has been developed to aid and assist users in producing high quality seasonally adjusted and trend estimates. The high quality graphical interface is built around appropriate diagnostics and series knowledge rules with links to the external package X-12-ARIMA. The future release of X-13-SEATS (Monsell et. al, 2003) will provide users with increased choice between the two most common seasonal adjustment packages for official statistics, TRAMO-SEATS and X-12-ARIMA and provide improved quality diagnostics for the TRAMO-SEATS package. SEASABS is well positioned to take advantage of the X-13-SEATS output and integrate this into the graphical and series knowledge aspects.

Additional areas that are a focus for the ABS in the longer term provision of seasonal adjustment include: a) increasing transparency of the seasonal adjustment process by making available the full seasonal adjustment decomposition of the time series of original estimates b) publishing specific metadata about prior corrections such as estimated magnitude and real world reasons, and c) provision of seasonal adjustment capabilities on the internet as part of a National Statistical Service.

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