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The Seasonal Adjustment of Philippine Time Series Using X11 ARIMA

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1.0 Introduction

Although the major statistical agencies regularly produce and publish statistics on a monthly or quarterly basis, seasonally adjusted (deseasonalized) figures are not included in these releases. In July 1992, the National Statistical Coordination Board (NSCB) with the technical assistance of the Asian Development Bank (ADB) started the process that would equip the agencies to compile and publish seasonally adjusted time series on a regular basis. The statistical agencies which have supported this endeavor are the Bureau of Agricultural Statistics (BAS), the Bureau of Labor and Employment Statistics (BLES), the Bangko Sentral ng Pilipinas (BSP), and the National Statistics Office (NSO). The National Planning and Policy Staff of the National Economic Development Authority (NEDA) also participated in the first phase which focused on training workshops on seasonal adjustment.

After undergoing a series of technical workshops and sessions on the analysis, interpretation and presentation of seasonally adjusted data, the concerned agencies then worked on several key series they regularly compiled. The following statistical series were found to have stable seasonality and, thus, were seasonally adjusted:

- Volume of Palay Production
- Wholesale, Retail and Farm Prices of Palay
- Employment Statistics
- Unemployment Statistics
- Underemployment Statistics
- Narrow Money (M1)
- Quasi Money (M2)
- Domestic Liquidity (M3)
- Export of Garments
- Gross Domestic Product (GDP)
  - by Industrial Origin
  - by Expenditure Item
- Gross National Product (GNP)
- Consumer Price Index (CPI)

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Except for CPI, these series have been updated until the second quarter of 1993 and are being considered for official release this year. CPI did not show strong seasonality and was, thus, excluded from the list of series for release within 1993. It is, however, being updated and will be evaluated for inclusion for the 1994 releases. Other series slated for eventual inclusion in the official releases are other trade statistics, building permits, and series from the Survey of Key Enterprises in Manufacturing (SKEM). All of these are compiled by NSO.

This paper will discuss the importance of seasonal adjustment. It will also document the experience of the Philippine Statistical System in the pioneering stages of the institutionalization of seasonal adjustment of its key series.

2.0 Seasonal Adjustment: Some Concepts

A *time series* is a sequence of measurements of some numerical quantity made at or during successive periods of time. Philippine GNP and GDP as well as the labor statistics and agricultural production are estimated quarterly while CPI, and agricultural prices as well as the M1, M2, M3 series are compiled on a monthly basis.

Many economic and agricultural series exhibit regular periodic patterns or fluctuations that repeat from year to year. Such pattern is referred to as *seasonality*. Four common causes of seasonality are: calendar effects (Christmas, dates of national holidays), institutional factors (periods during which taxes are paid, dates when bonuses and pensions are paid, start and end of classes), weather or climate, and expectations (increase in production of toys for Christmas, extension of capacity of beach houses during summer). Seasonality of the time series can mask trend movement and cause confusion when viewing the economic picture. Christmas buying may cause an increase in GDP during the fourth quarter and can make the economy look prosperous when in fact there is no growth, Thus, of interest is the "unmasked series" without the seasonal variation. This unmasked series is called the *seasonally adjusted series* and it is derived through a process of seasonal adjustment.

Seasonal adjustment consists of the indentification, estimation and removal of seasonal variations from a time series. This involves the decomposition of a time series (O) into the following four components and focusing on components other than the seasonal:

- Trend (T) - a slow variation, sometimes upward and sometimes downward, over a long period of years generally associated with the structural causes of the phenomenon in question

- Cycle (C) - a quasi-periodic fluctuation characterized by alternating periods of expansion and contraction which is hypothesized to relate to economic fluctuations

- Irregular Component (I) - unforseeable movements related to events of all kinds not captured by the other components. This component has a stable random appearance and may include outliers caused by floods, earthquakes, strikes, or political crises.

- Seasonal Component (S)

The feasibility of this decomposition was proved by Wold (1938). Two decomposition models are used in the process:

$$O = T + C + S + I \qquad \text{(additive)}$$
$$O = T \times C \times S \times I \qquad \text{(multiplicative)}$$

which yield the following seasonal adjustment:

$$O^a = O - S = T + C + I$$

and

$$O^a = O/S = T \times C \times I, \quad \text{respectively.}$$

The seasonally adjusted figures are comparable from month to month or quarter to quarter. Thus, seasonal adjustment allows comparisons over recent months and gives the short-term trend movements of the series. One does not have to wait for one year to get a picture of the growth of a seasonal series when seasonally adjusted figures are available.

3.0 Seasonal Adjustment Methods

Most of the seasonal adjustment methods developed and widely used so far are univariate methods which use only the information of the time series of interest. These are often referred to as "autoadjustment" procedures. More recent researches are on procedures using wider-context information such as multivariate methods. Pierce (1980) and Dagum (1983) provide a survey of references for such procedures. Autoadjustment procedures are further classified into regression methods and methods using moving averages. In regression methods, the seasonal component is estimated using linear combinations of periodic variables (sines and cosines or seasonal dummy variables) while the trend is estimated using linear combinations of powers of the time variable. A modification which would make the procedure non-automatic would be to model trend as a function of some other non-seasonal variable. Methods using moving averages are simpler since the components are estimated by averaging k (a constant) values of the series through time, e.g., 12 monthly values through time. Examples of these latter methods are the U.S. Bureau of Census' X11 method and the Statistics Canada's X11 ARIMA method. The method used in the seasonal adjustment of the Philippine time series is the X11 ARIMA and the software used is the 1988 version of this procedure.

4.0 General Features of the X11 ARIMA

The X11 ARIMA method of seasonal adjustment is a modification of the X11 method. The procedural steps of the X11 method for the standard multiplicative decomposition of monthly series (Plewes, 1980) are described below:

1. Computes the ratios between the original series and a centered 12-term moving average.

2. Estimates seasonal factors by applying a weighted 5-term moving average to the SI ratios.

3. Adjusts to sum to 12.

4. Estimates the irregular component by dividing the factors into the SI ratios.

5. Identifies and removes the "extreme" irregulars.

6. Obtains preliminary seasonal factors by applying a weighted 5-term moving average to the SI ratios with extremes replaced.

7. Adjusts to sum to 12.

8. Obtains preliminary seasonally adjusted series by dividing these values into the original observations.

9. Obtain estimates of the trend-cycle by applying a 13-term Henderson moving average to the preliminary adjusted series.

10. Estimates new SI ratios by dividing the trend-cycle into the original observations.

11. Estimates seasonal factors by applying a weighted 7-term moving average to the SI ratios.

12. Adjusts to sum to 12.

13. Divides seasonal factors into the original series to obtain a seasonally adjusted series.

This procedure is iterative and, thus, the steps above may be repeated to obtain a smoother result. It should be noted that the above is a standard procedure, i.e., the default options when running the software. By modifying the standard program, one can choose the additive model instead of the multiplicative, allow selective temporary prior adjustments to the input data, provide for trading-day variations as an additional component of the decomposition, establish different sigma-limits for identifying extreme irregular fluctuations, and select moving averages of different lenghts.

The X11 ARIMA is a modified version of the (Method II-) X11 variant and has been shown to produce more reliable seasonal factors when seasonality changes rapidly in a stochastic manner . Dagum (1975,1976, 1978, 1988) gives a comprehensive discussion of X11 ARIMA and its advantages. The main steps of the procedure are the following:

1. The original series is modelled using ARIMA or Box-Jenkins models. The software has four built-in models. These are (0,1,1) (0,1,1)s, (0,1,2) (0,1,1)s, (2,1,0) (0,1,1)s and (0,2,2) (0,1,1)s.

2. Forecasts of the series using the ARIMA model chosen in the first step are computed and augmented to the original series.

3. The augmented series is seasonally adjusted using the Method II-x11 variant.

Aside from trading day variation, the Easter effect as a moving holiday can be incorporated into the procedure as another component in the decomposition. Also, the procedure uses some tests and quality-assessment measures to assess the "success" of the seasonal adjustment. The following tests are employed:

1. A test for the presence of seasonality assuming stable seasonality and a test for the presence of moving seasonality (ANOVA is done and an F test is used).

2. A test for the presence of Easter effect (ANOVA is done and an F test is used).

3. A test for the presence of trading day variation using regression analysis.

4. Test for smoothness (average percentage change and month (quarter)-for-cyclical dominance or MCD (QCD), average duration of runs or ADR).

5.0 Seasonal Adjustment Using X11 ARIMA: The Philippine Experience

As mentioned in the earlier sections, technical workshops were conducted for participants from the different agencies. These were in-house/on-the-job trainings conducted separately for each agency and with the participants working with their own series.

The first phase in the series of technical workshops were attended by an average of twenty participants in each agency. The training started with basic concepts in time series analysis and eventually focused on seasonal adjustment in general and X11 ARIMA in particular. A major part of the sessions were computer hands-on sessions. The goal was for the participants to know the seasonal adjustment and how to evaluate the seasonal adjustment based on tests of X11 ARIMA. A second component of this

first phase was a training conducted by Dr. Estela Dagum, the operational consultant, and it focused on interpretation and analysis of the seasonally adjusted series.

The participants in the trainings of the second phase were those tasked to produce the seasonally adjusted series on a regular basis. Thus, this set of trainings focused on the evaluation and analysis of the key series chosen for release listed earlier. The following topics were part of these trainings/discussions:

1. Determination of the presence of stable seasonality, trading day variations, and Easter effects through statistical tests.

2. Choosing between additive and multiplicative decomposition.

3. Characteristics of built-in ARIMA models used by the software and selected in the runs.

4. Analysis of the statistical tests and other measures used in evaluating the seasonal adjustment.

5. Determination of indirect versus direct seasonal adjustment for aggregate series.

6. Checking the consistency of the results of the different but related series.

7. Checking the stability of the seasonal factors as new observations are added to the series.

8. The use of temporary prior adjustments for very irregular series.

9. Correction of options if summary measures indicate failure in seasonal adjustment. These include cutting the time period considered when there are changes in the behavior of the series through time and forcing an ARIMA model when built-in models fail.

10. The use of appropriate charts in the presentation of the results.

A problem encountered at the start was that the available computers in most of the agencies did not meet the needed hardware specifications for the X11 ARIMA. However, this was solved with the help of ADB. A more difficult problem was and still is the short time series available for seasonal adjustment. The data size requirement for the procedure is at least five full calendar years. Also, a number of series indicated changes in the behavior, especially during the 1985-1987 period. The method can not be applied to this situation but this was solved by cutting the series and starting seasonal adjustment from 1988. Aside from changes in behavior, there was still irregularity. This was corrected either by considering longer moving averages or doing temporary prior adjustments.

6.0 Status of the Project

The last phase of the activities are on the institutionalization of the seasaonal adjustment. This includes planning for the continuation of the conduct of training workshops on seasonal adjustment. It is recommended that the Statistical Research and Training Center (SRTC) conduct these trainings. An improved version of the training materials used in the previous trainings will constitute a training manual for SRTC. The other part of the institutionalization is the release of the official seasonally adjusted series. It is suggested that NSCB take charge of the release of all the seasonally adjusted series. Thus, the release will be simultaneous and the date of release specified beforehand. It is also recommended that two committees be formed:

1. A Technical Working Group to do the seasonal adjustment. Agency staff who will comprise this group should be trained on seasonal adjustment.

2. A Technical Committee to evaluate the seasonally adjusted series and to oversee the analyses of the series. Members will include directors of the agencies or immediate supervisors of the agency staff. These are people who are more acquainted with the series and the factors that affect them. This committee will also make technical decisions which may include the determination of what series will be added for possible seasonal adjustments.

The following are recommended in the seasonal adjustment:

1. An evaluation of the options chosen (additive versus multiplicative, length of moving averages, ARIMA model used, indirect versus direct seasonal adjustment, period covered in the estimation) during the year will be done at the end of the year as soon as the data for the calendar year are complete.

2. The options chosen in the evaluation at the end of the previous year will be used in the seasonal adjustment of the months/quarters of the current year. This may have to be studied for the sytem of the national accounts which undergoes several revisions. An alternative procedure would be to do the evaluation of the options twice - at the end of the year, i.e., after the fourth quarter figure is revised and after the second quarter figure is revised - and use the forecasts of the seasonal factors derived during these evaluations to get the seasonally adjusted figures for the first and the third quarters.

3. A study of ARIMA models for the series should be conducted to check if the built-in models being used are really the "best" ones. Also, fitting ARIMA models should be done for the more irregular series for which none of the built-in models of the software were adequate.

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