Annual BSP-UP Professorial Chair Lectures
15 – 17 February 2010
Bangko Sentral ng Pilipinas
Malate, Manila

Lecture No. 7

Enhancing Seasonal Adjustment of Philippine Time Series: Procedures under Seasonal Volatilities

by

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ABSTRACT

A number of Philippine time series exhibit volatilities in their seasonal behavior. Such a situation results in estimated seasonal factors contaminated by irregularities which should be in the irregular component. This paper proposes enhancing the current official procedure of seasonally adjusting volatile series through the use of statistical modeling. The procedure has three stages:(1) use of the current seasonal adjustment through X11-ARIMA, (2) statistical modeling of volatility of the resulting seasonal component and its extraction from the seasonal component, (3) use of X11-ARIMA to seasonally adjust the series less the volatility extracted from stage 2. This modification produces an additional component – seasonal volatility separate from the usual irregular component. Illustration of the procedure using series with varying degrees of seasonal volatility – Imports and Unemployment Rate.

Key Words: seasonal adjustment, seasonal factor, trend-cycle, irregular component, ARIMA, GARCH, X11ARIMA, seasonal volatility, Canova-Hansen test.

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Introduction

Seasonal adjustment is the identification, estimation, and removal of seasonal variations as well as effects of trading days and moving holidays, if present, from a time series. The final product of the process is the seasonally adjusted series or deseasonalized series. Such a series is used for the following:(1)to read the trend of an economic time series without being hampered by seasonal movements; (2) as transformations on data used for statistical modeling; and, (3) for preliminary estimation of business cycles.

The Philippine Statistical System recognizes the importance of seasonally adjusted series and, thus, started the official generation of such series in the 1990s for the following:

- Palay production and prices by the Bureau of Agricultural Statistics (BAS);
- Monetary aggregates/M3 by the Bangko Sentral ng Pilipinas (BSP);
- Consumer Price Index (CPI); and,
- National Accounts of the Philippines (GNP, GDP,GVA AFF, GVA Industry, GVA Services, PCE)

using X11ARIMA developed by Statistics Canada. Bersales(1993) discusses the methodology while Apostol(1993): Braganza, Mota and Padrinao(1993); Buenaobra, Daguidi and Edora(1993); Cruz(1993; Dimaandal and Asence(1993); and, Gador(1993) provide the first results for specific series.

Since the initial releases, enhancements to the methodology have been constantly done through the Technical Working Group and Technical Committee on Seasonal Adjustment of Philippine Time Series being coordinated by the National Statistical Coordination Board. Foronda(2005) and Bersales et al.(2007) discuss enhancements and updates, resp. Albert(2002) suggests X12 RegArima and TRAMO-SEATS as alternative methodologies but the official methodology remains X11ARIMA.

It is noted that difficulties in the official seasonal adjustment of Philippine time series are usually the following: breaks in the time series caused by rebasing or changes in definitions used in surveys that produce the series; presence of unusual values or outliers due to interventions such as the 1997 regional currency crisis and El Niño/La Niña; and, volatilities including seasonal volatility.

Redoblado (2005) used the Canova-Hansen test for changing seasonality to show that the following exhibit unstable seasonal patterns in varying degrees:

- GNP, GDP and their components within 1981-2003
- CPI within 1968-2003
- M2 and M3 within 1978-2003
- Exports within 1981-2003.

The focus of this paper is seasonal adjustment in the presence of such unstable seasonal patterns, i.e., seasonal volatilites.

Objective of the Study

A number of Philippine time series exhibit volatilities in their seasonal behavior. Such a situation results in estimated seasonal factors contaminated by irregularities which should be in the irregular component. This paper proposes a modification of seasonal adjustment to address such a situation

The Current Official Seasonal Adjustment of Philippine Time Series

The current official seasonal adjustment procedure is X11 ARIMA, a variant of the U.S. Bureau of Census X-11 Method II developed by Statistics Canada. X11 ARIMA was developed to produce more accurate estimates of current seasonally adjusted series when seasonality changes rapidly in a stochastic manner. Dagum(1980,1988) provides details about the procedure.

X11 ARIMA uses the Census X11 procedure on augmented data - the time series plus one year of monthly or quarterly forecasts and one year of backcasts from an ARIMA model. The X11 ARIMA procedure basically consists of:

a) modeling the original series using an ARIMA model;
b) forecasting one year of unadjusted data at each end of the series from ARIMA models that fit and project the original series well; and
c) seasonally adjusting the augmented series using X11-Method II variant.

The Easter and trading-day adjustments are applied even before a) is done if one asks for it.

There are two decomposition models used for seasonal adjustment:

- Additive Model: $Y=TC+S+I$
- Multiplicative Model: $Y=TC*S*I$

where Y is the observed time series and its unobserved components are: TC(Trend-Cycle), S (Seasonal Component), and I (Irregular Component which can be furthered decomposed into outliers, trading day effects, effects of moving holidays).

The seasonally adjusted series for the additive model is $Y^{sa}= Y-S$. For the multiplicative model, the seasonally adjusted series is $Y^{sa}= Y/S$.

The main steps of the X11- Method II variant using a additive(multiplicative) decomposition model are:

Step 1. Estimate a preliminary trend-cycle by using a moving average, e.g., CMA that eliminates most of the other movements present including the seasonal variations.

Step 2. Subtract (a) from the original series (divide the original series by (a)) to obtain the remainder variations, that is, seasonality and the irregular component, usually known as the S-I differences (SI ratios).

Step 3. Smoothen the S-I differences (SI ratios) for each month or quarter over the whole space of the series by applying an average again, e.g., MA. This gives an estimate of the seasonal factor S (seasonal index S).

Step 4. Subtract S from S-I (divide SI by S) to get I.

Step 5. Subtract S from the original series (divide the original series by S). This will give the seasonally adjusted series.

Evaluation Measures of Seasonal Adjustment using X11 ARIMA

The advantage of X11 procedures over TRAMO-SEATS is the availability of evaluation measures referred to as M statistics. These evaluation measures are:

- M1. The relative contribution of the irregular over periods(months or quarters)
- M2. The relative contribution of the irregular to the stationary portion of the series
- M3. The amount of period to period change in the irregular component as compared to the amount of period to period change in the trend-cycle
- M4. The amount of autocorrelation in the irregular as described by the average duration of run
- M5. The number of quarters it takes the change in the trend- cycle to surpass the amount of change in the irregular
- M6. The amount of year to year change in the irregular as compared to the amount of year to year change in the seasonal
- M7. The amount of moving seasonality present relative to the amount of stable seasonality
- M8. The size of the fluctuations in the seasonal component throughout the whole series.
- M9. The average linear movement in the seasonal component throughout the whole series
- M10. Same as M8, calculated for recent years only
- M11. Same as M9, calculated for recent years only

A composite measure , Q statistic, is computed by getting the weighted average of M1 to M11:

- Q = 0.13 M1 + 0.13 M2 + 0.10 M3 + 0.05 M4 + 0.11M5 + 0.10 M6 + 0.16 M7 + 0.07 M8 + 0.07 M9 + 0.04M10 + 0.04M11.

The standard is for all the M statistics and Q to be less than 1.00 for the seasonal adjustment to be considered a success.

Another measure to evaluate the seasonal adjustment is a Measure of Smoothness:

$S= \sum \left| Y^{sa}_{t} - Y^{sa}_{t-1} \right| / N$

where Y^{sa}_{j} is the seasonally adjusted series at time j, N is the number of observations in the series, and the summation is over all N observations.

S is a function of units of data and the standard for S is for it to be as small as possible. When this is achieved, it means that smoothness is achieved by the seasonal adjustment.

The Proposed Procedure for Seasonal Adjustment under Seasonal Volatilities

The procedure proposed in this paper assumes that seasonal patterns exhibit the behavior of a Generalized Autoregressive Conditional Heteroscedasticity(GARCH) process. This follows the approach of Ghysels et. al.(1997) that focuses exclusively on ARCH models as a specific class of models in developing linear and nonlinear filters under (seasonal) volatility dynamics and Martens et. Al.(2007) that also used GARCH on the deseasonalized log of squared returns of the spot exchange rates of the Deutsche Mark and the Japanese Yen against the US dollar.

The proposed procedure is a three-step procedure starting with the usual X11ARIMA. This is followed by modeling the volatility of the resulting seasonal component once the evaluation statistics indicate moving seasonality..an indication of stochastic seasonality. The third and last stage is repeating X11ARIMA on the series without the irregular component derived from the model in the second stage.

The following are the stages:

Stage 1 Given a series Y, do the usual decomposition using the steps of X11ARIMA to produce the components: $TC^{(1)}$, $S^{(1)}$, $I^{(1)}$

Stage 2 Build a statistical model to estimate volatility of $S^{(1)}$.

Stage 3 Do X11ARIMA of , Y*, the original series less the residuals from Stage 2 to produce: $TC^{(2)}$, $S^{(2)}$, $I^{(2)}$.

The seasonally adjusted series is $Y^{sa} = Y^*/S^{(2)}$.

These stages may be iterated to produce some targeted degree of smoothing that may be identified using a relative measure of smoothness, which could be a variant of S.

Results

The procedure is illustrated in this paper using two series:

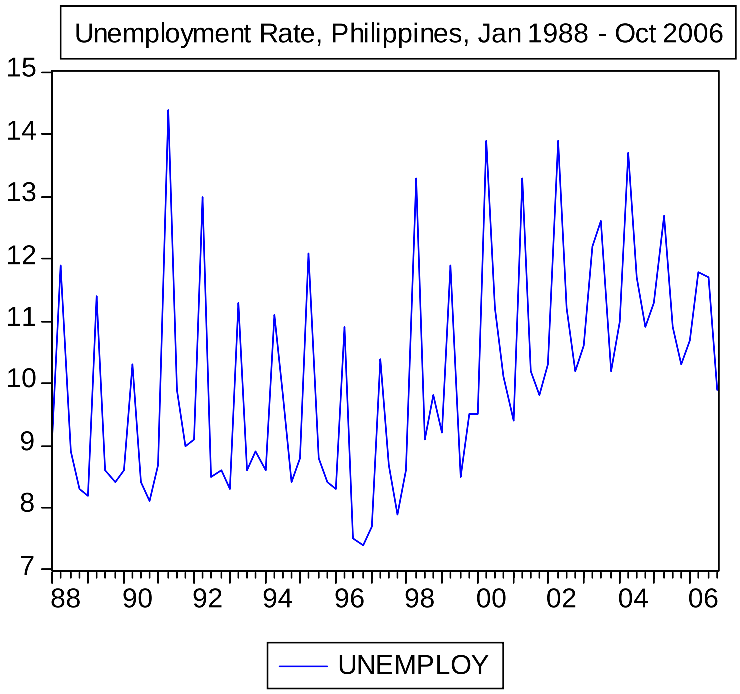
- Series with less pronounced seasonal volatility:
  Unemployment rate (quarterly, Q11988 - Q42006)

- Series with more pronounced seasonal volatility:
  Imports(monthly, Jan 1980 – Dec 2004)

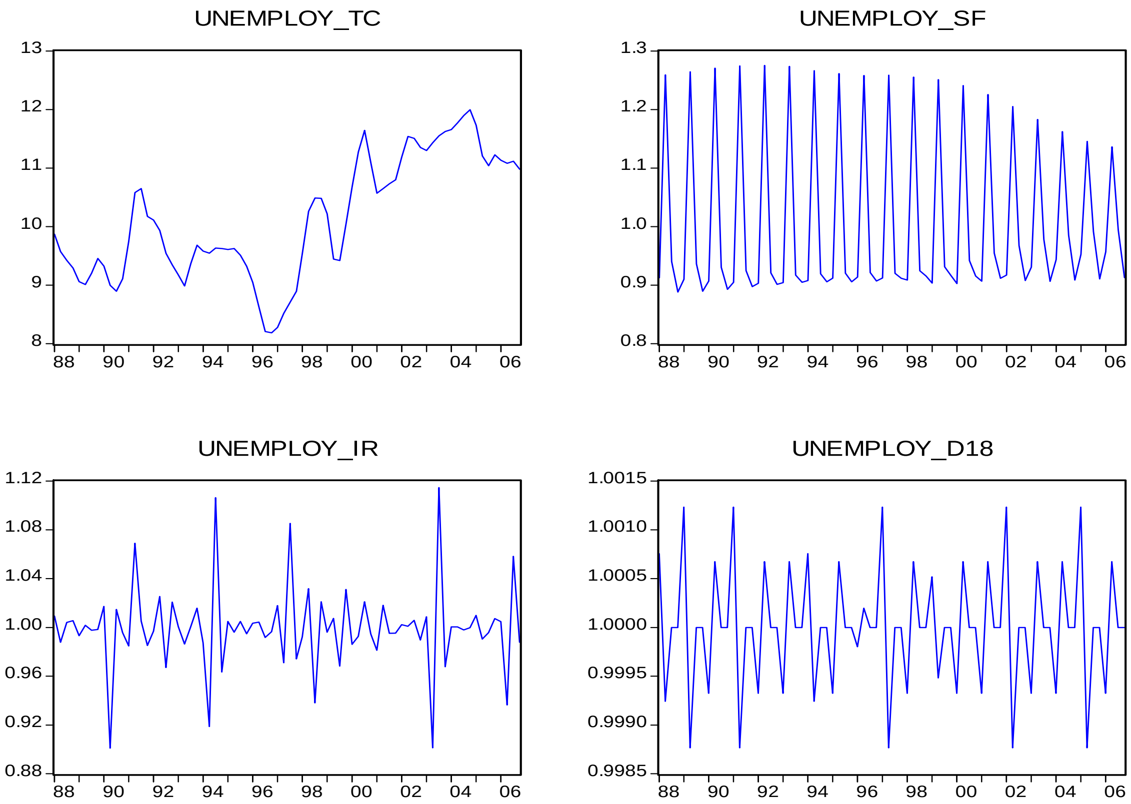
It is observed that the proposed procedure produces smoother seasonally adjusted series compared with the usual X11ARIMA procedure when seasonal volatility is more pronounced.

Quarterly Unemployment Rate

The following historical plot shows Quarterly Unemployment Rate of the Philippines:



The following plots show the components that result after Stage 1 of the proposed procedure:



The following tests in Stage 1 indicate the instability of the seasonal pattern:

A.Test for the presence of seasonality assuming stability.

	Sum of Squares	Dgrs.of Freedom	Mean Square	F-Value
Between quarters	12436.0552	3	4145.35172	**153.619****
Residual	1942.8936	72	26.98463	
Total	14378.9488	75		

**Seasonality present at the 0.1 per cent level.

B. Moving Seasonality Test

	Sum of Squares	Dgrs.of Freedom	Mean Square	F-value
Between Years	664.2838	18	36.904653	**1.925**
Error	1035.0612	54	19.167801	

C. Conclusion: Moving seasonality present at the five percent level

The M-Statistics and the Q-statistic already indicate successful seasonal adjustment, however:

1. M1 = 0.255
2. M2 = 0.209
3. M3 = 0.743
4. M4 = 0.712
5. M5 = 0.939
6. M6 = 0.235
7. M7 = 0.197
8. M8 = 0.389
9. M9 = 0.245
10. M10 = 0.826
11. M11 = 0.798

Q (without M2) = 0.48 ACCEPTED.

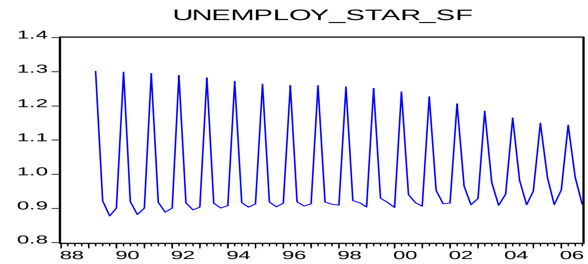
*** ACCEPTED *** at the level 0.45

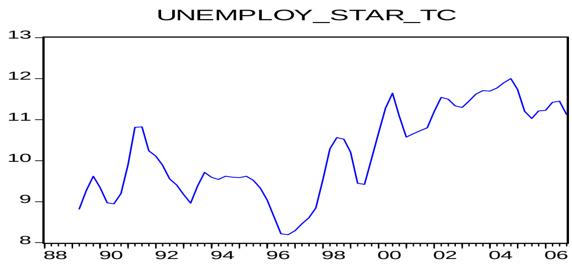
Stage 2 resulted in the following:

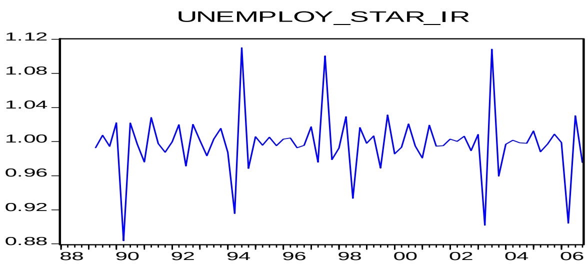
- UNEMPLOY_SF, the seasonal component from Stage 1 resulted in significant presence of ARCH-type heteroskedasticity
- Variance of Diff $Diff_4$UNEMPLOY_SF modelled as GARCH(1,1) under the assumption of Generalized Error Distribution
- The residuals from the model are considered as the “Seasonal Irregular Component” and removed from UNEMPLOY to produce UNEMPLOY_STAR

Stage 3 resulted in the following components:

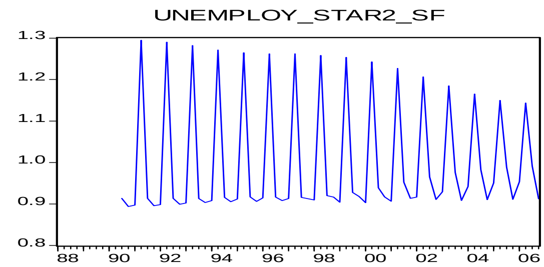
First Iteration of the procedure

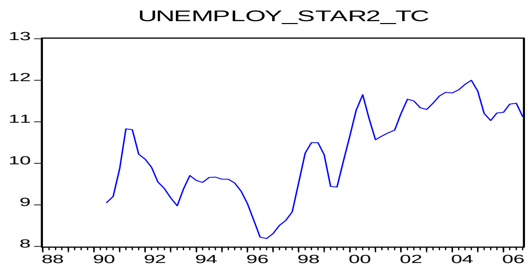






Second Iteration of the procedure is done to produce the seasonally adjusted series UNEMPLOY_STAR2



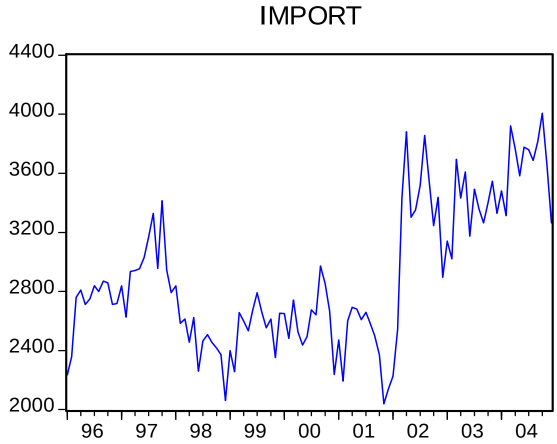


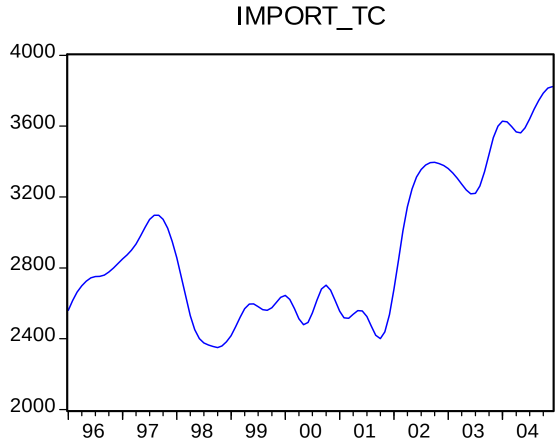
The following table shows that there is no improvement in the seasonal adjustment using the proposed procedure both using one and two iteration/s.

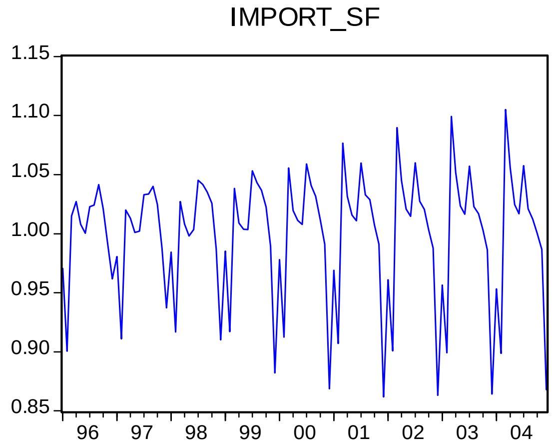
Period Covered	Measure of Smoothness of the Seasonally adjusted series through X11ARIMA (SMOOTH_ORIG)	Measure of Smoothness of the Seasonally adjusted series through the Proposed Procedure (SMOOTH_STAR)	Measure of Smoothness of the Seasonally adjusted series through second iteration of the Proposed Procedure (SMOOTH_STAR2)
2000-2006	0.56	0.57	0.57
1988-2006	0.55	0.59	0.57

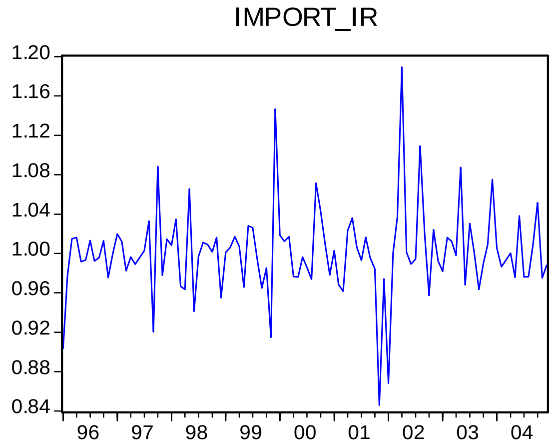
Monthly IMPORT

The following plots show monthly Philippine Imports(IMPORT) and the components that result after Stage 1 of the proposed procedure:









The M-Statistics and the Q-statistic indicate irregularities that caused unsuccessful seasonal adjustment:

1. M1 = 2.267
2. M2 = 0.218
3. M3 = 0.749
4. M4 = 0.284
5. M5 = 0.674
6. M6 = 0.573
7. M7 = 0.635
8. M8 = 1.385
9. M9 = 0.360
10. M10 = 1.249
11. M11 = 1.218

Q (without M2) = 0.89 CONDITIONALLY ACCEPTED AT LEVEL .81
but Check the 4 above measures which failed

Stage 2 resulted in the following:

- IMPORTS_SF, the seasonal component from Stage 1 resulted in significant presence of ARCH-type heteroskedasticity
- Variance of IMPORTS_SF modelled as GARCH(2,1) under the assumption of Generalized Error Distribution
- The residuals from the model are considered as the "Seasonal Irregular Component" and removed from IMPORTS to produce IMPORTS_STAR

Stage 3 shows more improved seasonal adjustment after one iteration of the proposed procedure:

1. M1 = 1.171
2. M2 = 0.377
3. M3 = 0.279
4. M4 = 0.060
5. M5 = 0.609
6. M6 = 0.239
7. M7 = 0.809
8. M8 = 0.936
9. M9 = 0.862
10. M10 = 1.375
11. M11 = 1.343

*** Q (without M2) = 0.70 ACCEPTED.

*** ACCEPTED *** at the level 0.66

But Check the 3 above measures which failed

The following table indicates improvement in the seasonal adjustment using the proposed procedure both using one and two iterations.

Period Covered	Measure of Smoothness of the Seasonally adjusted series through X11ARIMA (SMOOTH_ORIG)	Measure of Smoothness of the Seasonally adjusted series through the Proposed Procedure (SMOOTH_STAR)	Measure of Smoothness of the Seasonally adjusted series through second iteration of the Proposed Procedure (SMOOTH_STAR2)
2000-2004	159.7945	159.4536	159.4533
1996-2004	143.9151	142.7023	142.7031

Next Steps

There is a need to provide clearer evidence of the improved seasonal adjustment using the proposed procedure using simulations wherein seasonal volatilities may be constructed in varying degrees. Furthermore, the question of how to determine "how smooth is smooth". S can also be replace using a relative measure of smoothness.

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