

Seasonal Adjustment of Economic Time Series

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Office of Economic & Demographic Research



What Is a Time Series?

- A time series is a sequence of measures of a given phenomenon taken at regular time intervals such as hourly, daily, weekly, monthly, quarterly, semi-annually, annually, or every so many years
 - Stock series are measures of activity at a point in time (e.g. the monthly labor force survey, it takes stock of whether a person was employed in the reference week)
 - Flow series are series which are a measure of activity to a date (e.g. sales tax collections, housing starts, visitor arrivals)
- Time series are of interest primarily for economic analysis--they can help to identify business cycles and their turning points



What Is a Time Series? (cont'd)

- They can be decomposed into various components
 - Underlying movements
 - Regular, or systematic variation
 - Irregular influences, such as those associated with one-time events
- These components are typically identified as
 - Trend/Cycle, or the underlying level of the original series
 - Seasonal, or the portion of the variation about the trend attributable to factors that reoccur systematically one or more times a year
 - Irregular, or the residual variation, remaining after trend and seasonal components have been removed



What is Seasonality?

- Seasonality is a pattern that repeats itself over fixed intervals of time
- It is reasonably stable with respect to timing, direction and magnitude
- It can be attributable to:
 - **Climate**, due to the variations of the seasons; examples of activities that vary according to the season are agriculture output and consumption of electricity (heating)
 - **Holidays** such as Christmas or Easter also produce repetitive movements for certain series, particularly those related to consumption
 - **Institutional factors** such as due dates on tax returns
 - **The calendar** can also cause a seasonal movement in monthly data because the number of trading days vary from one month to another



What is Seasonality? (cont'd)

The seasonal component of a time series comprises three main types of systematic calendar related influences

- Seasonal influences represent intra-year fluctuations; e.g., seasons such as warmth in summer and cold in winter, or traditional behavior such as Christmas or Independence Day
- Trading day influences, which reflect the number and type of days in a particular month
- Moving holiday influences such as Easter



What is Seasonal Adjustment?

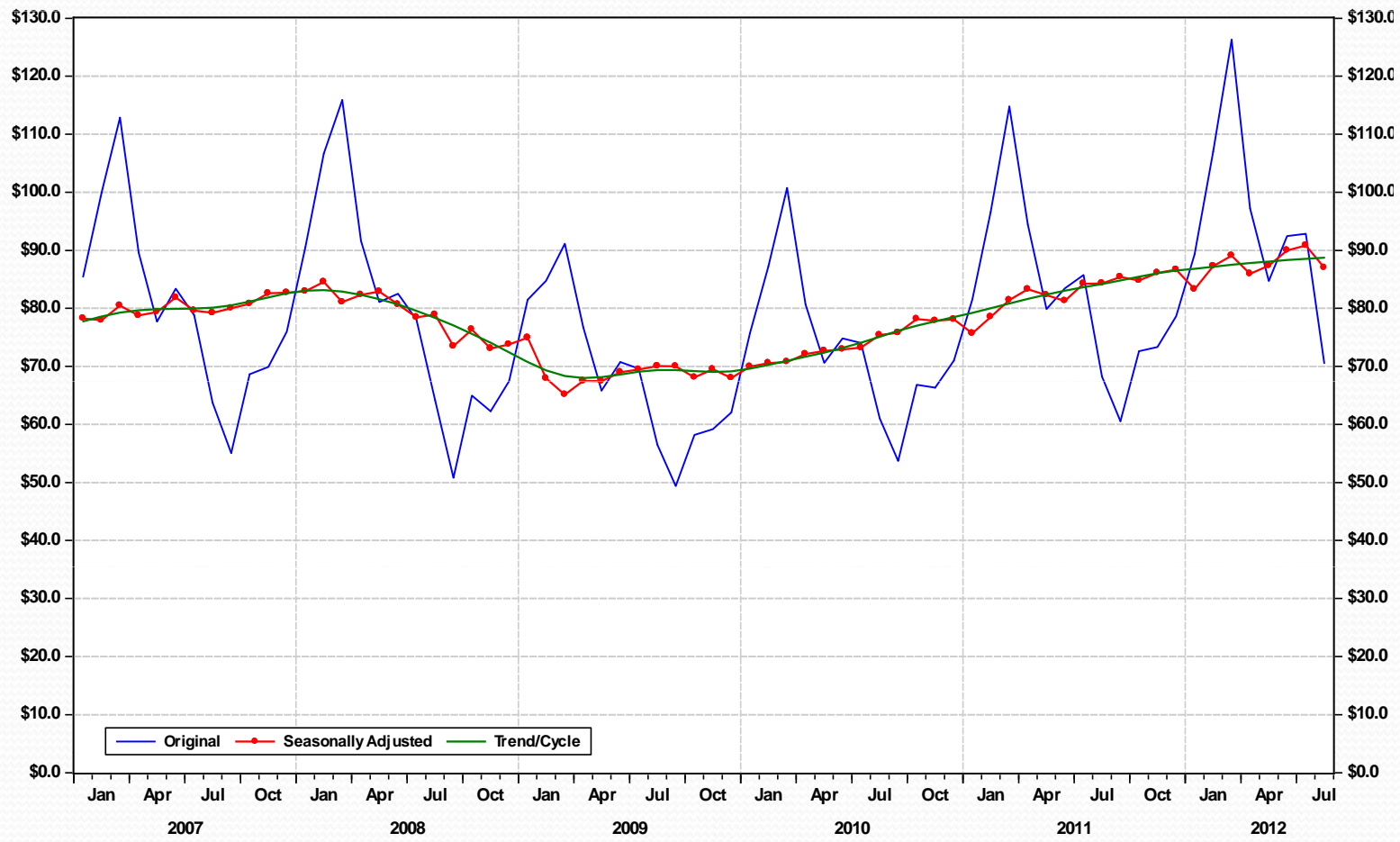
- Seasonal Adjustment is the process of estimating and removing the seasonal effects from a time series, and by seasonal we mean an effect that happens at the same time and with the same magnitude and direction every year
- The basic goal of seasonal adjustment is to decompose a time series into several different (unobservable) components
- Because the seasonal effects can mask other component parts of a time series, seasonal adjustment can be thought of as focused noise reduction



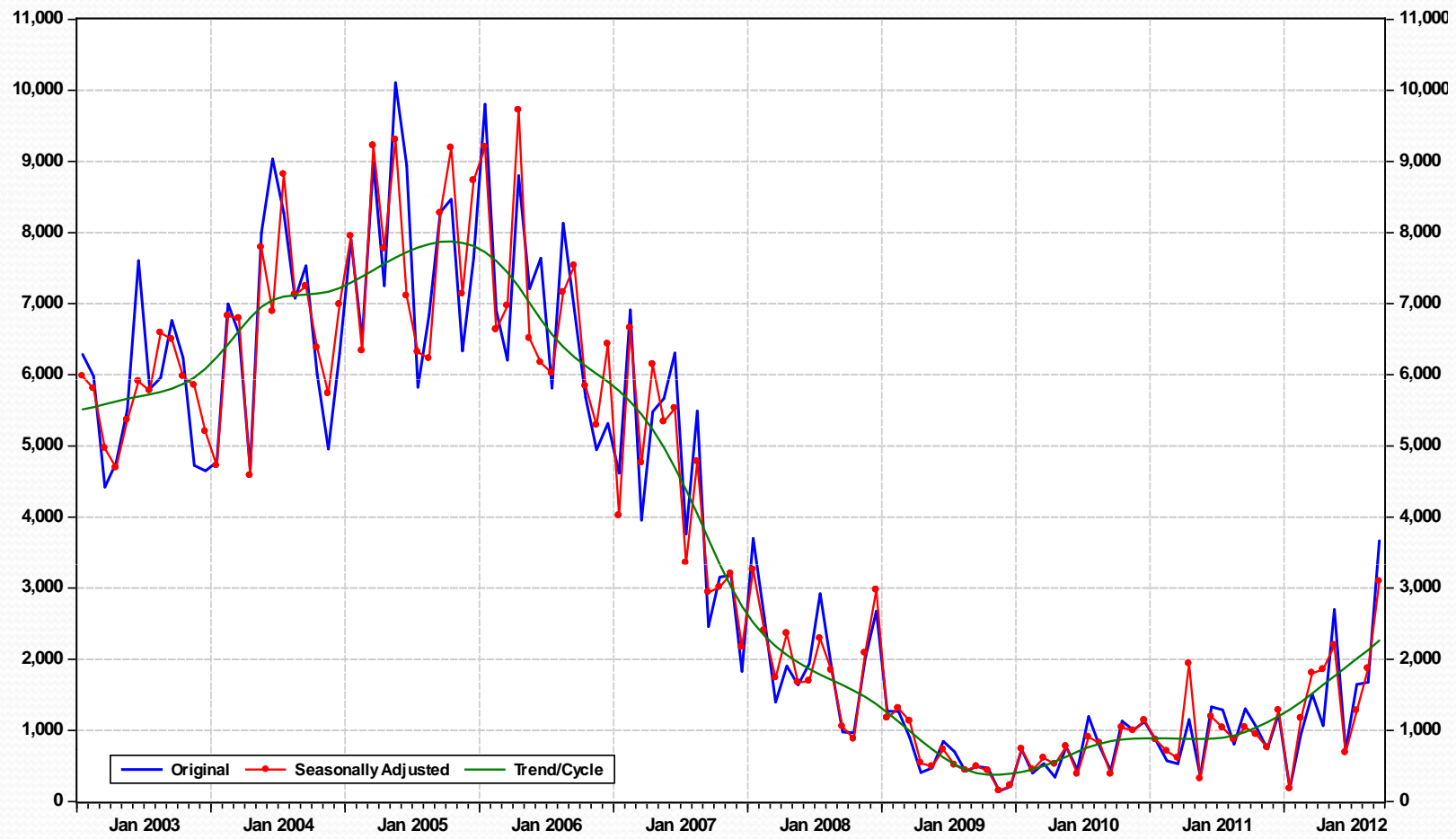
Why Seasonally Adjustment?

- It has been suggested that seasonal adjustment has three main purposes
 - To aid in short term forecasting
 - To aid in relating time series to other series or extreme events
 - To allow series to be compared from month to month
- The presence of seasonality in a series can mask the movements in the time series that we wish to focus on

Sales Tax Collections from Transient Rentals



Multi-family Housing Starts





How to Adjust Data for Seasonality

- The method chosen depends on the underlying data the analyst is working with
- In the simplest case where there is little or no growth (or decline) in the data and no trading day or moving holiday effects, you could simply average the data within the year and calculate each month as a proportion of the average. Alternatively, you could use multiple years in the calculation, which would help to reduce the influence of irregular factors.
- Another alternative for those with familiarity with regression analysis is to construct a model with seasonal dummies—i.e., 1 if month i , zero otherwise
- If the magnitude of seasonal fluctuations are proportional to the level of the series you can take logarithms and proceed as above.
- In many instances, as when trading day effects or moving holidays are present, the data will require more sophisticated methods

More Robust Methods of Seasonal Adjustment...

- X-12-ARIMA (Census Bureau) contains models the program can automatically select from.
 - Outliers can be automatically detected and removed.
 - Predefined regression variables are available for holiday, trading-day, and similar effects.
 - Optional user-defined regression variables can be included to capture trend and business cycles.
- TRAMO/SEATS (Bank of Spain) is an alternative to X-12-ARIMA
 - TRAMO is a program for estimation and forecasting of missing and future values of the time series
 - SEATS is a program for estimation of unobserved components in time series following the so-called ARIMA-model based method
 - When used for seasonal adjustment, TRAMO preadjust the series to be adjusted by SEATS.
- For the practitioner, the main difference between the above two methods is that X12 does not allow missing values while TRAMO/SEATS will interpolate the missing values (based on the estimated ARIMA model)



Seasonal Adjustment...

- Both of these packages are available for download free of charge; they each have a windows interface.
- Additionally, both are included in EViews, the modeling software widely used in economic forecasting.
- If you have the ETS module of SAS you also have access to X-12-ARIMA.
- Much of the data used in the conference process has not been seasonally adjusted.
- For example, DEO (BLS) Current Employment Statistics Data (CES) has only been seasonally adjusted at the highest aggregate levels. An EViews program is used to seasonally adjust CES data.
- Seasonal adjustment is typically done at a disaggregated level and then aggregated to higher levels (indirect adjustment).
- Much of the tax data is also seasonally adjusted in EViews, with some of it being adjusted using the routines available in SAS.
- Typically, the conferences use a spline fit of seasonally adjusted quarterlies to monthlies, and then multiply by seasonal factors.

Seasonal Adjustment...

```
' Obtaining forecasts from X12-ARIMA

' -----
'   gdir= option dumps files for graphics which has longer forecasts and
'   confidence bounds (only for raw data). You need to read the data back
'   yourself using the read command. look at the file evx12tmp.gmt file
'   and Table 2-2 of the X12 manual for a description of each file in gdir
' -----

' Set paths to read output data files

%gdir_path = "c:\temp\x12graphs\"

smpl 1974M01 @LAST
freeze(tab2) TEMP.X12(%gdir_path, mode=1, tf=0, amd1=B, arima="(0 1 2)(0 1 1)", _
    reg="td easter[8] thank[8]", F, flead=48, save="B1 D10 D11 D12 D13 D16 D18") TEMP

' Read forecasts from file in %gdir_path

SMPL 2012M09 @LAST
%filename=%gdir_path + "evx12tmp.fct"
read(skiprow=2,skipcol=1) %filename TEMPF TEMPF_low TEMPF_upp

' Read seasonal factors from file in %gdir_path

smpl 1974M01 @LAST
%filename=%gdir_path + "evx12tmp.d10"
read(skiprow=2,skipcol=1) %filename TEMPF_SF

' Read combined seasonal and trading day factors from file in %gdir_path

smpl 1974M01 @LAST
%filename=%gdir_path + "evx12tmp.d16"
read(skiprow=2,skipcol=1) %filename TEMPF_d16
```


Importance of Proper Alignment of Activity

BASED ON MONTH OF COLLECTION

Variable	Parameter Estimate	Standard Error	t-value
Trading Day			
Mon	0.0022	0.00440	0.50
Tue	0.0014	0.00445	0.31
Wed	-0.0010	0.00438	-0.22
Thu	-0.0025	0.00441	-0.57
Fri	0.0019	0.00441	0.43
Sat	-0.0056	0.00449	-1.25
*Sun (derived)	0.0036	0.00440	0.82
Easter[8]	-0.0095	0.00951	-0.99
Thanksgiving[8]	-0.1949	0.13084	-1.49

Chi-squared Tests for Groups of Regressors

Regression Effect	df	Chi-Square	P-Value
Trading Day	6	4.45	0.62

BASED ON MONTH OF ACTIVITY

Variable	Parameter Estimate	Standard Error	t-value
Trading Day			
Mon	-0.0035	0.00415	-0.84
Tue	0.0083	0.00420	1.99
Wed	-0.0079	0.00413	-1.92
Thu	0.0064	0.00416	1.55
Fri	-0.0029	0.00416	-0.70
Sat	0.0101	0.00425	2.37
*Sun (derived)	-0.0105	0.00415	-2.53
Easter[8]	0.0287	0.00891	3.22
Thanksgiving[8]	-0.2518	0.12327	-2.04

Chi-squared Tests for Groups of Regressors

Regression Effect	df	Chi-Square	P-Value
Trading Day	6	17.85	0.01



Seasonal Adjustment...

Seasonal adjustments are not always appropriate. Examples:

- Non-stationary (random walk) data series. Many data series may actually be of this nature.
- Data series with large or unexpected breaks in economic activity (as in business cycles). An alternative may be to use year-over-year data.
- Some data series may not lend themselves to seasonal adjustment theory. The assumption of constancy necessary for seasonality may not be reflective of the voluntary nature of human behavior. Seasonality is merely a statement of past behavior – not necessarily a predictor of future behavior.

“The crux of the problem is that people's responses to various seasons or holidays, are never automatic but rather part of a conscious purposeful behavior. The choices being driven out of the data are as much a part of the underlying reality as the data set.”

Frank Shostak (Austrian School)



Translation to Monthlies...

The **Trading-Day Effect** is related to months having different numbers of each day of the week from year to year --- that is, months having differing weekday composition such as the number of Sundays, Mondays, Tuesdays, etc.

- The number and composition of extra days (those days that occur 5 times in a month) affect the data for the month.
- This influence is revealed when monthly values consistently depend on which days occur five times in the month.
- The effect can also be caused by the length of the month or purely administrative practicalities (how often certain entities are open.)

Trading-Day Effects should be taken into account when you are using monthly time series that are accumulations of daily values (e.g. flow series) that are affected by the day-of-week composition.



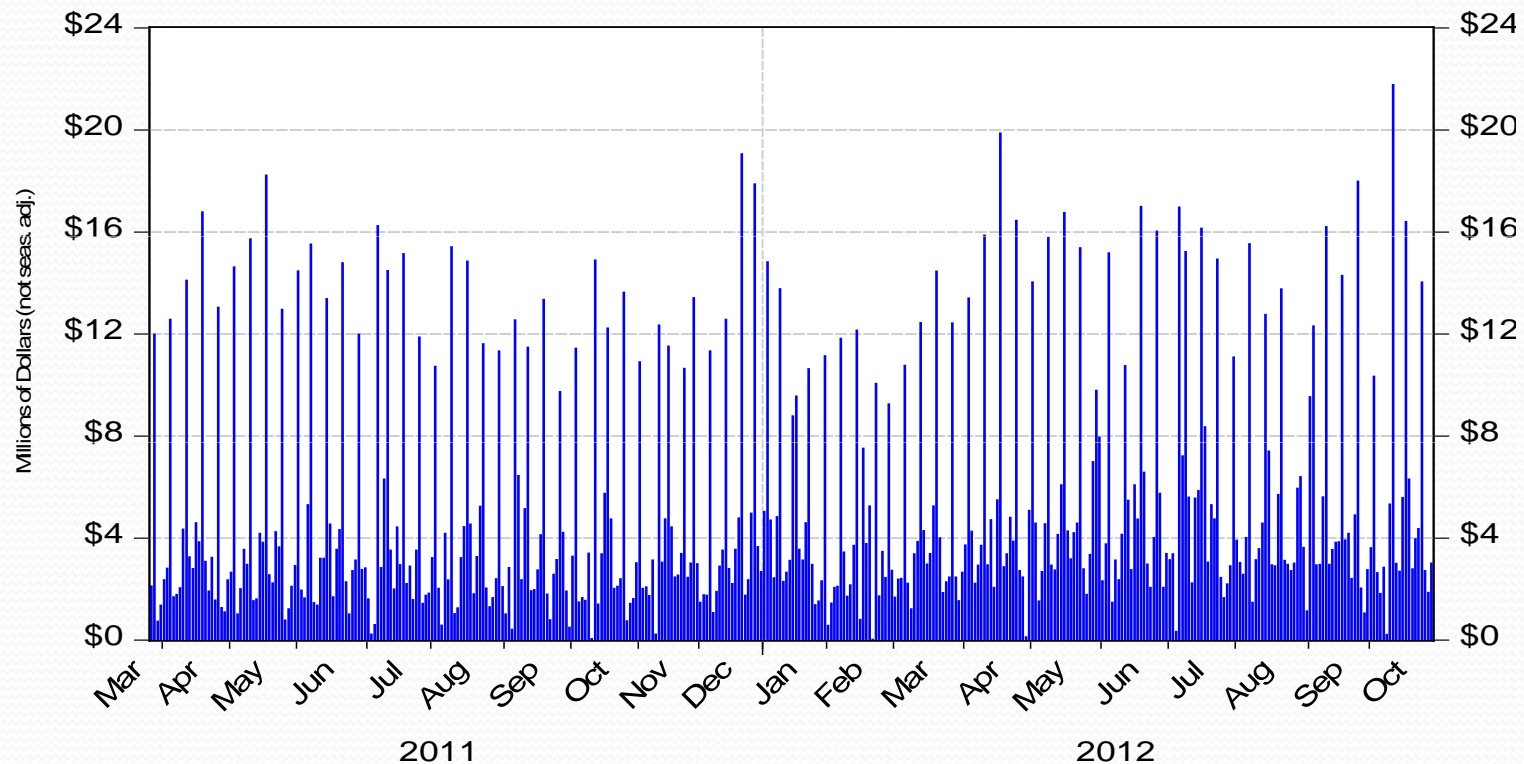
Translation to Monthlies...

- Identify holidays (especially moving holidays) and their potential effects on collections, including the impact of “grace” periods for remittances.
- Recognize unique collection patterns. For example, if your data is remitted by clerks or some other entity on certain days of the week, check how many of those days are within the month. Then construct a factor to take account of this pattern, or allow your seasonal adjustment package construct it for you

Translation to Monthlies

A prime example of the importance of trading days is the documentary stamp tax where county clerk deposits show up in DOR collections on Tuesdays

DOR Daily Doc Stamp Collections Reported





Translation to Monthlies...

- Recognize and address any irregular components in prior years that occur from accidental or fortuitous events that are not expected to be repeated. The best example in Florida relates to prior-year hurricanes.
- Recognize and address outliers that occur for any other reason when they otherwise alter a stable trend.



Any Question?