Analyzing price seasonality

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Presented at the COMESA policy seminar
"Food price variability: Causes, consequences, and policy options"
on 25-26 January 2010 in Maputo, Mozambique
under the COMESA-MSU-IFPRI African Agricultural Markets Project (AAMP)

Outline

- Why seasonality analyses?
- Basic concepts
- Computing seasonal indices
- Applications
  - Examples
  - Limitations / Cautions
  - Using **Excel**

Why seasonality analyses? (1)

- Economic times series variables (e.g., prices, sales, purchase, etc.) are composed of various components
- One of the critical component is seasonality, especially in cases of:
  - Agriculture production
  - Marketing of goods
  - Prices of all commodities

Why seasonality analyses? (2)

- Understanding the patterns of movements in the time series variables is useful to make better forecasts, useful in
  - Making marketing decisions
    - When to buy?
    - When to sell?
    - How long to store?
  - Making production decisions
  - Food security interventions
  - Etc.

Basic concepts (1)

- A time series variable (e.g., prices, sales, purchases, stocks, etc) is composed of four key components:
  - Long-term trends (T)
  - Seasonal components (S)
  - Cyclical components (C)
  - Irregular or random components (I)
- These components, when examined individually can help to better understand the sources of variability and patterns of time series variables –hence time series decomposition

Basic concepts (2)

- There are several ways of decomposing time series variables (e.g., additive model, multiplicative model)
- The basic **multiplicative** model is given as:

$$\mathbf{P_t = T_t \times S_t \times C_t \times I_t}$$

Where:

P_t	is the time series variable of interest,
T_t	is the long-term trend in the data,
S_t	is a seasonal adjustment factor,
C_t	is the cyclical adjustment factor, and
I_t	represents the irregular or random variations in the series

Computing seasonal indices (1)

- There are several different techniques which are used to isolate and examine individually the different components of time series variables
- However, here, we focus on the **ratio–to-moving average** method, which is commonly used
- The key steps are demonstrated below:

Calculating seasonal indices (2)

- **Step 1**: Remove the short-term fluctuations from the data so that the long-term and cyclical components can be clearly indentified– **deseasonalizing**
  - The short-term fluctuations include both seasonal **(S_t)** patterns and irregular **(I_t)** components
  - The short-term fluctuations can be removed by calculating an appropriate moving average (MA) for the series
  - Assuming 12-month period, the moving average for a time period t (**MA_t**) is calculated as:
  - $MA_t = (P_{t-6} + .. + P_t + ... + P_{t+5}) / 12$

Calculating seasonal indices (3)

STEP 1: Continued….

- For monthly data, the number of period (12) is even and is not centered – need to center it.
- To center the moving averages, a two-period moving average is calculated as follows:

- $CMA_t = (CMA_t + CMA_{t+1}) / 2$
  $= T_t + x\ C_t$

  - Seasonal and irregular components are removed

Calculating seasonal indices (4)

- **Step 2**: Measuring the degree of seasonality
- The degree of seasonality is measured by finding the ratio of the actual value to deseaonalized value as follows:

- $SF_t = P_t / CMA_t$
  $= T_t \times S_t \times C_t \times I_t / T_t \times C_t$
  $= S_t \times I_t$

Where SF_t is the seasonal factor and others are defined as before.

Calculating seasonal indices (5)

- **Step 3**: Establish average seasonal index
- This is obtained by taking the average of seasonal factors for each season—e.g., take the sum of **SFs** for the month of January and divide by the number of **SFs** for January over the entire data period
- Pure seasonal index obtained, irregular component removed

- Note: the sum of indices for all months add-up to 12.
- **Issues**:
  - Predictability of seasonal patterns
  - Changes in seasonal patterns

Calculating seasonal indices (6)

Month	Seasonal Index
Jan	0.965522624
Feb	0.921371556
Mar	0.942636238
Apr	0.945834259
May	1.011026204
Jun	1.101787997
Jul	1.110037521
Aug	1.170524076
Sep	1.093278943
Oct	0.959423752
Nov	0.883398512
Dec	0.8947732
Aug	Seasonal High
Nov	Seasonal Low
Sum of indices	11.99961488

Other components (1)

- **Step 4**: Finding the long-term trend
- The long-term trend is obtained from the desaonalized data using OLS as follows:
- **CMA_t = a + b (Time)**
  - Where **Time**=1 for the first period in the dataset and increases by 1 each month thereafter
- Once the trend parameters are determined, they are used to generate an estimate of the trend value for **CMA_t** for the historical and forecast period.

Other components (2)

- **Step 5**: Finding the cyclical component (**CF**)
- The **CF** is given as the ratio of centered moving average (**CMA_t**) to the centered moving average trend (**$CMAT_t$**) as follows:

- **$CF = CMA_t / CMAT_t$**
  $= T_t \times C_t \times I_t / T_t$
  $= C_t$

Other components (3)

- **Step 6**: Finding the irregular component (I_t)
- The I_t is given as the ratio of seasonal factor (**SF**) to pure seasonal index (I_t) as follows:

- $I_t = S_t\ I_t / S_t$
  $= I_t$

- ***This completes the decomposition***

Applications (1)

- **Forecasting time series variable**
  - Prices for the next year can be forecasted
  - Timing of price changes
    - When will the prices be low?
    - When will the prices be high?
  - Magnitude of price level at specific future dates
  - Magnitude of temporal price differential (between seasonal high and low)
    - Is storage profitable?

Applications (2)

- **Two main ways of forecasting**
  - Forecast monthly values by multiplying estimated average value for the next year by the seasonal index for each month– this assumes no significant trend**,**
  - First estimate the 12-month trend for deseasonalized data and then apply the seasonal index to forecast the actual prices for the next year

Applications (3)

- **Limitations**
  - The seasonal analysis is used under normal conditions and there are several factors which alter the seasonal patterns
    - Drought, floods, earthquake, etc.
    - Government policy changes
  - **Abnormal years** should not be included in the computation of seasonal indices

Applications (4)

- **Using Excel**
- **Review exercises**