台灣景氣指標季節調整之檢討與改進
期末報告

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摘要

本文針對台灣台灣景氣指標, 說明如何作交易日數, 農曆年及一般性的季節調整。另外, 詳細介紹季節調整的原理與步驟,X13-ARIMA-SEATS 使用者的觀點及使用者需要決定的參數, 並解讀程式的結果檔案, 尤其重視季節調整結果的診斷。

結論與建議

1. 針對「如何調整交易日(含颱風假, 彈性調整假期, 年假) 的影響?」這個重要的問題, 本計畫建議如下:
   建構每月交易日變數及農曆年變數, 以外生變數的方式加入季節調整前的 ARIMA 模型, 估計並抽離其影響, 然後, 再對調整過的數列做雙向移動平均, 分解成長期趨勢, 季節性因子, 與干擾項。

2. X13-ARIMA-SEATS 的作法假定每年交易日與春節的(3種) 效應固定是線性的, 與既有的季節因子是獨立的, 應而以線性外生變數的方式分離其效果。這些假設在實際情形上都有可能被違背, 因此希望能夠調整出一個完全乾淨, 完全沒有交易日與農曆年效應的結果很難。若每年的「季節性」的型態都有些不一樣, 過份重視「平滑(smooth)」, 很容易落入「過渡配適」(overfitting) 的陷阱。另一個重要的問題是, 組成份數列(component series) 年節的效果完全不同, 直接(direct) 與 間接(indirect adjustment) 的年節效果會有很大的差異。一方面, 我們最關心近期的交易日或年節前效應, 但在「時間數列的期末(end-of-the-series)」下, 要準確的估計其效果很難。

3. X13-ARIMA-SEATS 有內建 交易日變數, 惜美國的假日與台灣不同, 不見得適用, 宜以台灣的實例, 自行建構交易日變數。

4. 直接用 genhol, 產生年節前, 年節後的變數, 再用本計畫的程式產生年節中的變數, 將3種假日變數放在一個檔案中。注意要 做calendar-mean adjusting。結果即使有殘餘的年節效應, 也不要加虛擬變數(dummy variables) 或 其他事後(ad hoc) 調整。

5. 若年假與一般週末或颱風假的影響相同, 將交易日合併成一組變數;若不同, 分別建構交易日變數與年假變數。可以參考 AICC, 迴歸估計結果及季節調整過後數列的診斷統計量(M1-M11)。

6. 建議選定於每年的某一月份(如4月), 選擇最適並固定季節調整中的參數設定, 然後至下一年度(如3月) 前, 所有的季節調整皆以此組參數做季節調整。注意, 進行每月季節調整的程式中關閉自動選模功能 (automdl=NULL,transform.function=”none” 或 ”log” ,regression.aictest=NULL)。

1 季節調整的程式

官方常用季節調整的程式有 2 個:

- TRAMOS/SEATS:
  Time Series Regression with ARIMA Noise, Missing Observations and Outliers/ Signal Extraction in ARIMA Time Series
  由 Agustin Maravall of Banco de Espana 發展, 建構於正則 (Canonical) ARIMA 時間數列模型上, 歐盟官方採用。

- X-13ARIMA-SEATS:
  由美國 Census Bureau 所發展, 前身爲X-11, 建構於一連串的雙邊移動平均(two-sided moving average), 現內含以模型爲主幹的SEATS 當作另一選項, 美國官方採用。

考量過去國內各機構大都採用後者 , 本計畫亦以爲主X-13ARIMA-SEATS 爲主。

2 X-13ARIMA-SEATS 的基本原理與步驟

2.1 基本原理

- 用一連串的雙邊移動平均分解季節因子, 長期趨勢及不規則因子。

- 建立ARIMA 模型, 用以預測(forecast), 推溯(backcast) 及事前調整該數列。前兩者延伸數列兩端的樣本值, 以作爲雙邊移動平均之用, 後者則包含交易日效果(trading days effects), 農曆年效果, 離群值(outliers) 及其他外生變數控制。

2.2 季節調整模型

$$y_t = f(Y_t) = \begin{cases} Y_t \\ log(Y_t) \\ \lambda^2 + (Y_t^\lambda - 1)/\lambda, \quad \lambda \neq 0 \end{cases}$$

$$\phi_p(B)\Phi_P(B^s)(1-B)^d(1-B^s)^D(y-\beta' X_t) = \theta_q(B)\Theta_Q(B^s)\epsilon_t$$

式中X_t代表外生變數,ϵ_t是白干擾,$\phi_p(z), \Phi_P(B), \theta(z), \Theta_Q(z)$爲$z$的多項式, 階(order)分別爲$p, P, q, Q$且根在單位圓外。

令 $Z_t = y_t - \beta' X_t$, 有乘法(Multiplicative, M), 加法(Additive, A) 及假加法(Pseudo-Additive, PA) 三種分解模型:

$$(M) : z_t = T_t S_t I_t \tag{1}$$

$$(A) : z_t = T_t + S_t + I_t \tag{2}$$

$$(PA) : z_t = T_t(S_t + I_t - 1) \tag{3}$$

其中 PA 適用於當變數部分季節經常爲 0 或很小的狀況。

2.3 X-13ARIMA-SEATS 的步驟

1. 迴歸分析(RegARIMA Models,Forecasts, Backcasts, Preadjustments)
2. 季節調整(SEASONAL ADJUSTMENT,Enhanced X-11)
3. 診斷分析(DIAGNOSTICS,including revisions, sliding spans, spectra, M1 M11, Q, etc.)

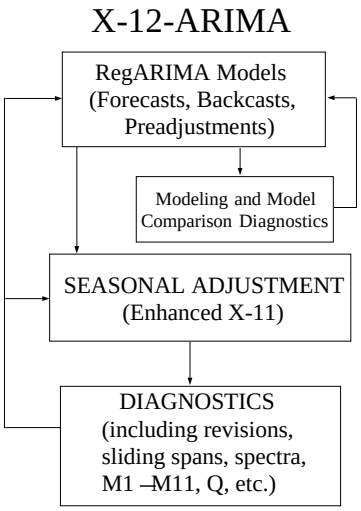

Figure 1: Flow chart of X-13ARIMA-SEATS
Note: Taken from Findley, Monsell, Bell,Otto and Bor-Chung Chen (1998).

2.4 事前調整

- 交易日效果
- 復活節影響
- 移動假日如農曆年, 中秋節等。

2.5 季節調整的步驟

2.5.1 第一階段: 最初估計(Initial Estimates)

1. 初步趨勢估計(以"centered 12-term" (13-term) moving average)

$$T_t^{(1)} = \frac{1}{24}Z_{t-6} + \frac{1}{12}Z_{t-5} + \cdots + \frac{1}{12}Z_t + \cdots + \frac{1}{12}Z_{t+5} + \frac{1}{24}Z_{t+6}$$

2. 初步 SI ratio 估計

$$\begin{aligned}(M, PA) : SI_t^{(1)} &= Z_t / T_t^{(1)} \\ (A) : SI_t^{(1)} &= Z_t - T_t^{(1)}\end{aligned}$$

3. Initial Preliminary Seasonal Factor via "3x3" seasonal moving average:

$$\hat{S}_t^{(1)} = \frac{1}{9}SI_{t-24}^{(1)} + \frac{2}{9}SI_{t-12}^{(1)} + \frac{3}{9}SI_t^{(1)} + \frac{2}{9}SI_{t+12}^{(1)} + \frac{1}{9}SI_{t+24}^{(1)}$$

4. Initial Seasonal Factor:

$$\begin{aligned}(M, PA) : S_t^{(1)} &= \frac{\hat{S}_t^{(1)}}{\frac{1}{24}\hat{S}_{t-6}^{(1)} + \frac{1}{12}\hat{S}_{t-5}^{(1)} + \cdots + \frac{1}{12}\hat{S}_{t+5}^{(1)} + \frac{1}{24}\hat{S}_{t+6}^{(1)}} \\ (A) : S_t^{(1)} &= \hat{S}_t^{(1)} - (\frac{1}{24}\hat{S}_{t-6}^{(1)} + \frac{1}{12}\hat{S}_{t-5}^{(1)} + \cdots + \frac{1}{12}\hat{S}_{t+5}^{(1)} + \frac{1}{24}\hat{S}_{t+6}^{(1)})\end{aligned}$$

5. Initial Seasonal Adjustment:

$$\begin{aligned}(M) : A_t^{(1)} &= \frac{Z_t}{S_t^{(1)}} \\ (A) : A_t^{(1)} &= Z_t - S_t^{(1)} \\ (PA) : A_t^{(1)} &= Z_t - T_t^{(1)}(S_t^{(1)} - 1)\end{aligned}$$

2.5.2 第2階段:Seasonal Factors and Seasonal Adjustment

(2H+1) -Term Henderson Weights

$$h_j^{(2H+1)}, \quad -H \le j \le H(h_j = h_{-j})$$

Suppose that, for $-(H+3) \le 3 \le H$,

$$A_{t+j} = \alpha + \beta(t+j) + \gamma(t+j)^2 + I_{t+j}$$

式中 I_{t+j} 爲Gaussian variates with mean o and variance σ^2 which fore different j are independent

1. Intermediate Trend
$$T_t^{(2)} = \sum_{j=-H}^{H} h_j^{(2H+1)} A_{t+j}^{(1)}$$

2.
$$\begin{aligned}(M, PA) : SI_t^{(2)} &= Z_t / T_t^{(2)} \\ (A) : SI_t^{(2)} &= Z_t - T_t^{(2)}\end{aligned}$$

3. Preliminary Seasonal Factor via "3x5" seasonal moving average

$$\hat{S}^{(2)} = \frac{1}{15} SI_{t-36}^{(2)} + \frac{2}{15} SI_{t-24}^{(2)} + \frac{3}{15} SI_{t-12}^{(2)} + \frac{3}{15} SI_t^{(2)} + \frac{3}{15} SI_{t+12}^{(2)} + \frac{2}{15} SI_{t+24}^{(2)} + \frac{1}{15} SI_{t+36}^{(2)}$$

4. Seasonal Factor

$$\begin{aligned}(M, PA) : S_t^{(2)} &= \frac{\hat{S}_t^{(2)}}{\frac{1}{24}\hat{S}_{t-6}^{(2)} + \frac{1}{12}\hat{S}_{t-5}^{(2)} + \cdots + \frac{1}{12}\hat{S}_{t+5}^{(2)} + \frac{1}{24}\hat{S}_{t+6}^{(2)}} \\ (A) : S_t^{(2)} &= \hat{S}_t^{(2)} - \left(\frac{1}{24}\hat{S}_{t-6}^{(2)} + \frac{1}{12}\hat{S}_{t-5}^{(2)} + \cdots + \frac{1}{12}\hat{S}_{t+5}^{(2)} + \frac{1}{24}\hat{S}_{t+6}^{(2)}\right)\end{aligned}$$

5. Seasonal Adjustment

$$\begin{aligned}(M) : A_t^{(2)} &= \frac{Z_t}{S_t^{(2)}} \\ (A) : A_t^{(2)} &= Z_t - S_t^{(2)} \\ (PA) A_t^{(2)} &= Z_t - T_t^{(2)}(S_t^{(2)} - 1)\end{aligned}$$

2.5.3 第3階段:Final Henderson Trend and Final Irregular

1. Final Trend: For data-determined H, possibly different from Stage 2(i)

$$T_t^{(3)} = \sum_{j=-H}^{H} h_j^{2H+1} A_{t+j}^{(2)}$$

2. Final Irregular

$$\begin{aligned}(M, PA) : I_t^{(3)} &= \frac{A_{(2)}}{T_t^{(3)}} \\ (A) : I_t^{(3)} &= A_t^{(2)} - T_t^{(3)}\end{aligned}$$

最終的分解爲:

$$\begin{aligned}(M) : Z_t &= T_t^{(3)} S_t^{(2)} I_t^{(3)} \\ (A) : Z_t &= T_t^{(3)} + S_t^{(2)} + I_t^{(3)} \\ (PA) : Z_t &= T_t^{(2)} (S_t^{(2)} - 1) + T_t^{(3)} I_t^{(3)}\end{aligned}$$

3 X-13ARIMA 程式中使用者需要決定的參數

在X-13ARIMA-SEATS 中, 用X11指令可以自行設定 Seasonal filter 與Trend filter 的長度。

3.1 Symmetric Seasonal Filters

n as in $2n + 1$ of SI ratio symmetric moving average used in step 3 of Stage 1

$$S_t^{(2n+1)} = \frac{1}{3}(S_{t-12}^{(2n+1)} + S_t^{(2n+1)} + S_{t+12}^{(2n+1)})$$

with

$$S_t^{(2n+1)} = \frac{1}{2n+1} \sum_{j=-n}^{n} SI_{t+12j}$$

3.2 Symmetric Trend Filters

As for Henderson trend $h_j^{(2H+1)}$

1. 13 terms

2. 15 term
3. 17 terms
4. automatic selection procedure between 9, 13 and 23

3.3 ARIMA model

ARIMA 模型的設定影響資料兩端的差補值, 對於季節調整有很大影響。常見的模型設定法有:

- 使用X-13內建的 automdl, 用BIC_{2N} 及其他準則自動挑選模型。
- 使用者自行用 ACF, PACF, EACF 及其他information criteria 選定
- 用R -package forecast 中的 auto.arima 來選定

3.4 外生變數

若資料期間含有特殊事件, 政策、制度或資料定義變動時, 可加入外生變數。舊曆年,Easter Day、Trading day effects 都是外生變數。

3.5 離群值

離群值(outlier) 對模型估計與季節調整有很大影響, 一定需處理。X-13 中的outlier 指令很好用。

4 交易日與農曆年的季節調整

X13-ARIMA-SEATS 建構分別建構每月交易日與移動假期變數來處理交易日與農曆年的季節調整。金對美國的交易日,X13-ARIMA-SEATS 有內建的交易日變數。對於流量(flow) 與存量(stock) 變數需做不同的處理。對於流量變數有 4 種選擇:

1. regression{variables = td} → 6 contrast variables + leap year adiustment
   6 contrast variables:

$$\begin{aligned} T_{1,t} &= (\text{ no of Mondays}) - (\text{ no of Sundays}) \\ &\vdots \\ T_{6,t} &= (\text{ no of Saturdays}) - (\text{ no of Sundays}) \end{aligned}$$

   leap year adjustment

$$\bar{m}_{Feb} Y_t / m_t$$

where Y_t is the original time series, $\bar{m}_{Feb} = 28.25$ and m_t is the length of month t (28 or 29).

2. regression{variables = tdnolpyear} → 6 contrast variables
3. regression{variables = td1coef} → One Coefficient Trading Day + leap year adjustment
   One Coefficient Trading Day:

$$(\text{ no: of weekdays}) - 5/2 * (\text{ no: of Saturdays and Sundays})$$

4. regression{variables = td1nolpyear} → One Coefficient Trading Day

對於存量變數有2種選擇:

1. regression{variables = tdnstock[w]} → stock trading day

$$D(w)_{1,t} = \begin{cases} 1 & \bar{w}^{th} \text{ day of month t is a Monday} \\ -1 & \bar{w}^{th} \text{ day of month t is a Sunday} \\ 0 & otherwise \end{cases}$$

   where $\bar{w}$ is the smaller of w and the length of month t. For end-of-month stock series, set w to 31, i.e., specify tdstock[31]. ,:

$$D(w)_{6,t} = \begin{cases} 1 & \bar{w}^{th} \text{ day of month t is a Saturday} \\ -1 & \bar{w}^{th} \text{ day of month t is a Sunday} \\ 0 & otherwise \end{cases}$$

2. regression{variables = tdnstock1coef[w]} → One Coefficient Stock Trading Day:

$$I(w)_t = -3/5D(w)_{1,t} - 1/5D(w)_{2,t} + 3/5D(w)_{3,t} + 3/5D(w)_{4,t} + D(w)_{5,t}$$

   For end-of-month stock series, set w to 31, i.e., specify tdstock1coef[31].

對於台灣而言, 得自行建構每月交易日, 並納入颱風假的影響。

5 農曆年調整

農曆年是移動假期, 最早是1月21日, 最晚則爲2月20日。農曆年的落點會影響1月及2月的工作天數, 對於變數的數值大小有很大的影響。其他移動假期包含 Easter day, 回教的齋戒月。X-13解決辦法爲創造年節前(before the holiday), 年節中(around the holiday), 及年節後(after the holiday) 3個外生變數, 在ARIMA 模型中分離它的影響。

5.1 3個年節變數的設定

1. 假設節日變數每天的影響是相同的, 以該變數落在每月的比率設定之。

$$H_i(\tau, t) = \frac{\tau_{it}}{\tau_i}, \quad i = 1, 2, 3$$

式中,i=1,2,3代表年節前, 年節中, 年節後;τ_{it}第i個年節變數落在t月的天數,τ_i第i個年節變數總天數。

genhol.exe 這個程式的目的即是建立移動假日變數, 需該假日每年的確切日期。

5.2 τ_{it}的選取

1. 用 AICC 準則選取
2. 年節中可依人事行政局發佈的年假日期(含彈性連假) 設定。

若有日資料(如貨幣總計數), 可放鬆每日相同權數的限制, 以日資料計算$H_i(\tau)$。

6 季節調整診斷

1. Diagnostic checking of a regARIMA model
   - regARIMA 殘差的 ACF, PACF, 殘差平方的ACF
   - 離群值診斷 (Chang, Tiao and Chen (1988), additive outlier (AO), temporary outlier (TO), level shifts (LS)
2. Spectral plots
   - 只對月資料劃 spectral plots
   - 需要72樣本點
   - monthly trading day (每月星期日的個數) frequency 0.348
3. Sliding Spans Diagnostics
   爲當樣本期間有系統移動時時, 描述每月季節調整如何變動的敘述統計量。令 A_t^j 表第 j-th 樣本, 季節調整的值, 若有下列情況則認定爲「不穩定(unstable)」

$$\frac{max_j A_t^j - min A_t^j}{min_j A_t^j} > 0.03 \tag{4}$$

or

$$max_j \frac{A_t^j}{A_t^j} - min \frac{A_t^j}{A_{t-1}^j} > 0.03$$

令 $A(\%), MM(\%)$ 分別代表 4, 3 的比率, 則 $A(\%) > 25$ (> 15 則表示有問題, 不理想),$MM(\%) > 40$表示季調調整不穩定。

4. Revisions History Diagnostics
對於時間數列$y_t, t = 1, 2, \cdots, T$, 令 $A_{t|n}$ 代表用$y_1, y_2, \cdots, y_n$所計算出來y_t的季節調整值, 則 $A_{t|T}$爲用全樣本所計算出來y_t的季節調整值。定義

$$R_t = \frac{A_{t|T} - A_{t|t}}{A_{t|t}}$$

$$C_{t|n} = \frac{A_{t|n} - A_{t-1|n}}{A_{t-1|n}}$$

$$RY_t = \frac{A_{t|t+24} - A_{t|t+12}}{A_{t|t+12}}$$

$$RY_{t,lag} = \frac{A_{t|t+lag} - A_{t|t}}{A_{t|t}}$$

可設定不同的 sadjlags 與 trendlags 值

7 解讀程式執行結果

”本節係摘錄 *chapter 19 of Guide to Seasonal Adjustment with X-12-ARIMA, Draft by ONS Methodology and Statistical Development.*”

The output file consists of a fairly long list of Tables, which can be easily over 4000 lines. The output file is identified by a capital letter followed by a number, and they are organised as follows:

- ”Tables A” (i.e., preceded by the letter ”A”): These tables show the prior adjustment of the series. These include any prior adjustments that are specified by the user in the ”transform” spec, but also the effects of the regression part of the regARIMA model and any automatically identified outliers or breaks.
- Tables ”B”, ”C” and ”D”: A seasonal adjustment run consists of 3 iterations of the ”X11 method”. The output of the first iteration is saved on the B-tables, the output of the second is saved on the C-tables, and the output of the final iteration is saved on the D-tables. Of course only the D-tables are final.

- Tables ”E” and ”F”: These tables provide diagnostics of the seasonal adjustment.
- Tables ”G”: These are graphics
- Tables ”R”: These tables show the revision histories.
- Tables ”S”: These tables show the sliding spans diagnostics.

7.1 Output Diagnostics

An X12 output starts by repeating the specification file that was used to generate it. Read them to make sure there is no mistake in coding. Table A1 follows immediately after and shows the original series. Check the data.

By specifying the ”outlier” spec in the spec file, one can automatically identify any unaccounted outliers or level shifts. (Of course only those among them that are ”valid” should be included in the regression。

Table D8 (SI ratios): If for one or more months / quarters there is a sudden increase / decrease this might imply a seasonal break. This is more likely if it occurs for many months / quarters and at the same time.

Table E5 (month-to-month or quarter-to-quarter changes in the unadjusted series). These are expected to be dominated by the seasonal component, thus it is expected that at least some months quarters have the same sign all the time. If this pattern changes this implies a seasonal break.

Table E6 (month-to-month or quarter-to-quarter changes in the adjusted series). As with Table E5, outliers show up as large numbers which are followed by a change back, while level shifts don't change back.

Table C17 (final weights of the irregular component): The weight of each point in table C17 is 100, unless this point has been picked up as an outlier in the irregular component, during the X11 iterations. Thus Table C17 is very useful in identifying problems such as breaks or outliers. For example, if there is a concentration of outliers (values lower than 100) within a particular year or month this could be indicative of a seasonal break; if outliers dominate March and April this may indicate a need for Easter adjustments.

7.2 Diagnostics of the seasonal adjustment

The M-diagnostics in Table F3. These take values from 0 to 3, and a value higher than 1 indicates a source for potential problems for the seasonal adjustment. In particular:

M7 is the most important among the M-diagnostics, showing the amount of moving comparing to stable seasonality, or in other words how regular the seasonal pattern is. Although M7 is also used as a test for existence of seasonality, it is important to remember that it is not a binary (existent / non existent) test but it takes continuous values.

Next most important is M1, which shows how large the irregular component is compared to the seasonal. Failure (i.e., a value higher than 1) of M1 implies that the irregular component is large and therefore it might be difficult to estimate the seasonal component accurately.

M6 measures the irregular too, but is valid only when a 3x5 seasonal filter is used. Failure of M6 means that a shorter than 3x5 filter should be used.

Next most important are the M8 through M11 diagnostics, which show the fluctuations in the seasonal component. These diagnostics are useful in showing potential problems in the seasonal component, such as seasonal breaks. M10 and M11 are the same as M8 and M9, but only for the end of the series. Thus comparison of M10 and M11 with M8 and M9 can also help identify problems at the end of the series. It should be also noted that M10 and M11 might fail even if there are no problems with the seasonal adjustment, for example if the fit of the ARIMA model that was used to generate forecasts is poor. Finally, it must be mentioned that if M7 is high then M8-M11 are likely to be high as well.

M4 is a measure of autocorrelation in the irregular component. It is a less important diagnostic, as good quality of seasonal adjustment does not require an uncorrelated irregular.

M2 measures the amount of the irregular compared to a straight-line trend. As a consequence, M2 is misleading if the series has a trend that is not well-approximated by a straight line. (In the US Bureau of Census they disregard M2 completely).

M3 and M5 measure the irregular compared to the trend. They are not important diagnostics.

7.3 Other diagnostics

Tests for residual seasonality, shown after table D11. If the tests show that ”residual seasonality is present”, it can be eliminated by one of the following means:

1. If the series is very long one might consider cutting off the first few years, as the cause of the problem might be that the seasonal pattern has changed with time.

2. Alternatively one might wish to change the lengths of the seasonal filters. This also includes the option of using different filters for different months / quarters, if appropriate.

Table E6: This Table, previously mentioned as useful for checking for outliers and breaks, can be also used to check for residual seasonality. In particular, the

seasonally adjusted series is not supposed to have any seasonal elements. Consequently, if the month-to-month change always has the same sign for some months this might imply residual seasonality. (However if the same sign is present for most of the values of the table this is probably due to steady trend, and not to residual seasonality).

Table D9a (moving seasonality ratio) gives the annual change of the (preliminary) seasonal and irregular component for each month / quarter. This is used by the programme to automatically select the appropriate seasonal moving average (unless a particular filter was specified by the user). However, sometimes one might need to use different seasonal filters for some months or quarters. This is the case when in a particular month / quarter the seasonal component evolves too fast, or the irregular component fluctuates too much. In such cases one might wish to use a shorter filter for the month / quarter in question. Table D9a can be used to identify a problem of this kind. Of interest is the second line of the Table, which gives the fluctuation of the seasonal component. If this is much higher for one month than the others it probably implies the need for a shorter filter.

Another criterion for heteroskedasticity is the SI ratios (from Table D8 or from the corresponding graph). If they fluctuate too much for one month (yet not in the way that implies a seasonal break), this is also evidence that a shorter filter might be needed.

Graphical output of the spectrum of some components is produced immediately after the F tables. These graphs (labelled G.0 to G.2) are the only parts of the G outputs which are produced by default. The effect to be looked for is a seasonal or trading day peak in either the seasonally adjusted series or the irregular. A peak is defined as a value which exceeds the adjacent values by at least six "stars" on the plot. Any such peaks are mentioned in a brief note just above the G.0 plot. (If regARIMA modelling has been carried out, a similar plot of the spectrum of the regARIMA residuals appears after the modelling output, with a similar note if any peaks are found.) Any peaks found are also mentioned in the console output and the error file.

7.4 Most important seasonal adjustment tables

Tables A6, A7, A8 and A9 show the trading day, holiday, outlier and user-defined regression components respectively, as they are estimated from the regARIMA model. These components include the effects of both programme and user-specified variables, as long as the latter have been assigned the appropriate "usertype". The effects given in tables A6-A9 can be used not only for analysis, but also as prior adjustments for production running- as an alternative to re-estimating these effects every time a new data point becomes available.

Table B1 shows the original series, after all prior adjustments- including the

regression model and automatically detected outliers. It is effectively the series in B1 that goes through the "X11 box".

Table B1a shows the forecasts of the prior-adjusted original series.

Table D10 shows the final seasonal component. On the top of the table the seasonal moving average filter that was used is shown, which should be fixed and used till the next re-analysis.

Table D11 shows the seasonally adjusted series. However, if one wants to constrain the annual totals then Table D11A is the appropriate table.

Table D12 shows the final trend component. On the top of the table the Henderson moving average filter that was used is shown. This should be fixed and used for production running till the next re-analysis.

Table D18 shows the combined trading day and holiday factors that are used in the seasonal adjustment and it is equal to the sum (or product for multiplicative series) of tables A6 and A7. As with those tables, it includes the effects of both programme and user-defined calendar effect variables, and it can be used for analysis or as prior adjustment for production running- if the calendar effects are kept constant between seasonal adjustment reviews.

8 X-13ARIMA-SEATS vs X-12ARIMA vs seasonal / seasonalview in R

X-13ARIMA-SEATS combines the current filters used in X-12-ARIMA with ARIMA-model-based adjustment as implemented in the program SEATS (Signal Extraction in ARIMA Time Series). In SEATS, the seasonal and trend filters are estimated simultaneously based on the ARIMA model. The capability to generate ARIMA-model-based seasonal adjustment using a version of the SEATS procedure originally developed by Agustin Maravall at the Bank of Spain as well as non-parametric adjustments from the X-11 procedure.

Although there is not a great need to switch to X-13-ARIMA-SEATS for X-12 users, the Census Bureau will probably stop supporting X-12-ARIMA in the future. Thus, switching to X-13 would be much more important. On the other hand, for the most part, most X-12 specs will run in X-13, so switching would be fairly simple for most users.

seasonal and seasonalview are two R packages. seasonal is an easy-to-use interface to X-13-ARIMA-SEATS while seasonalview is a graphical user interface to the seasonal package and X-13ARIMA-SEATS. They are self-contained with an independent X13binary so that installation of X-13ARIMA-SEATS is not required. Both packages implement almost all features of X-13-ARIMA-SEATS except for composite. They are highly recommended for excellent graphics and full integration of R

capacities.

To install both packages, type within R install.packages(”seasonal”) install.packages(”seasonalview”)

For a demo, type

```
m <- seas(AirPassengers)
final(m)
plot(m)
summary(m)
view(m)
```

For details, see http://www.seasonal.website/

9 安裝及執行 R, seasonal 與 seasonalview

9.1 Obtaining R

1. browse http://www.r-project.org/
2. click CRAN
3. select http://cran.csie.ntu.edu.tw/, http://mirror.bjtu.edu.cn/cran, or any mirror site close to your location.
4. click Download R for Windows or other appropriate platform
5. click base
6. click Download R 3.4.3 to download R-3.4.3-win.exe (As of Feb. 8, 2018)
7. also download appropriate Rblas.dll from /bin/windows/contrib/ATLAS. Be sure that you choose the right CPU version for your computer.

9.2 Installing R

1. Execute R-3.4.3-win.exe. I accept all the defaults during installation process.
2. Replace the original C:/Program Files/R/R-3.4.3/bin/i386/Rblas.dll(<200K) with the Rblas.dll (about 2Meg) optimized for your CPU. This will typically speed up the computation twice faster.

3. Edit C:/Program Files/R/R-3.4.3/etc/Rconole by changing 'language = ' to 'language = en' provided you like the English environment.

4. Activate *R*, click on the button 'Package' and select 'Install packages'. Select 'http://cran.csie.ntu.edu.tw/' or ' http://mirror.bjtu.edu.cn/cran' as reposit site and install all packages. It takes about a long while but you need only to do it once. As some *R* libraries requires additional components or compilation, there might be some error or warning messages. This will generally be harmless for normal operation.

9.3 Installing seasonal and seasonalview

seasonal is a full-featured R-interface to X-13ARIMA-SEATS. It does not require any manual installation. For detailed information about seasonal and seasonalview, visit http://www.seasonal.website/ where documents and voluminous example codes are available.

In case you do not intend to install all the libraries of R but just these two packages, in R, execute

```
install.packages{"seasonal"}
```

When prompted

```
--- Please select a CRAN mirror for use in this session ---
```

select a website in Taiwan

install.packages{"seasonalview"}

In R, execute the following commands to check if two packages are properly installed.

library(seasonal)
m < − seas(AirPassengers)
view(m)

You shall see an error message as below:

```
Error in parse(file, keep.source = FALSE, srcfile = src, encoding = enc) :
  invalid multibyte character in parser at line 154
```

錯誤產生係因 view 指令用到 R 的 shiny 套件, 而後者對於不同語系的 encoding 相當敏感, 解決之道爲:

用 notepad++(免費程式) 或其他程式 將 C:/Program Files/R/R-3.4.3/library/seasonalview/app/global.R 改成 ANSI 編譯 或者以 附檔global.R 取代之。

安裝 R3.4.3中 seasonalview 時, 需以notepad++ /編碼/轉換至UTF-8 碼格式 (檔首無BOM)

10 安裝及執行 win-X13 與 X13 graphics

10.1 安裝

websites:

- https://www.census.gov/srd/www/x13as/
- https://www.census.gov/srd/www/x13graph/
- https://www.census.gov/srd/www/genhol/
- `https://www.java.com/zh_TW/`

需下載檔案:

- winx13.zip: for WinX13
- x13data.zip: for X13Data, 將 excel 資料檔轉換成 X13-ARIMA-SEATS 的形式, 相當方便有用。
- x13graphjava.zip: for JAVA graphics, 看季節調整結果圖形, 免費的程式, 另一選擇爲 SAS。
- genhol.zip: 用以產生農曆年假日變數

安裝程序: 解壓即可

1. 下載上述 4 個檔案到 C drive, 解壓後即完成安裝。
2. 下載及安裝最新的 JAVA (Version 8 Update 40 as of 2015/3/29)。
3. 執行 WinX13, 在 setup 畫面填入 正確的次目錄名稱

有用的說明檔:

1. winx13.doc: Windows 版的使用說明
2. `gettingstartedx13_winx13.pdf`:

   簡介win X13的程式檔, 及變數資料。
3. docX13AS.pdf: X-13ARIMA-SEATS Reference Manual: 完整的程式說明檔, 有 285 頁。
4. X13GraphJavaDoc.html: X-13-Graph-JAVA 使用說明

10.2 處理大量資料

- metafiles: 一次執行多個spec files 的季節調整
- data metafiles: 應用同一個spec 檔對多個變數做季節調整。
- 在 Win X-13 建立 metafiles or data metafiles.

10.3 執行**X13 graphics**

1. right click 在 x13graphjava 次目錄下的 X13GraphJava.jar
2. 滑鼠左健 點擊 Add series, 選取欲分析的 gmt 檔
3. 在 Options 勾選 View Two Graphs
4. 在上方panel 選取 Factor Graphs(Seasonal graphs,Combined Holiday Factors), 在下方panel 中選取 (Original Series, Seasonally Adjusted Series, Trend), 調整兩個圖的大小

11 Direct vs indirect seasonal adjustment

很多數列是由很多成分數列加總而成, 如失業率可依年齡(15-24 歲者失業率,25-44 歲者失業率,45-64 歲者失業率), 或依教育程度(國中及以下者失業率, 高中(職) 者失業率, 大專及以上者失業率) 進一步細分。總失業率爲子項目失業率的加權平均。准此, 有兩種方法來計算總失業率的季節調整。第一種稱爲Indirect seasonal adjustment, 係先對每一子項目失業率做季節調整, 然後將其季節調整值加權加總成總失業率。這個辦法的優點在於可以維持總失業率與子項目失業率間的加權關係。缺點則爲, 子項目數列可能不穩定, 季節調整的品質不佳。第二種方法稱爲Direct seasonal adjustment, 及分別直接對子項目失業率及總失業率作季節調整。優點爲總失業率的季節調整通常品質較佳, 但缺點則爲季節調整後總失業率與子項目失業率間的加權關係通常不會成立。composite 這個指令專門處理Indirect Seasonal Adjustment。

Direct vs indirect seasonal adjustment 的選擇視個案而定。當總數列與子數列間的加權關係非常重要時, 且子項目數列季節調整的品質佳時, Indirect seasonal adjustment 是唯一選擇。若不然, 則可比較兩種季調方法結果的品質, 是其結果做決定。檢定的標準爲表 D8的IDS test:

- Test for seasonality assuming stability;
- Nonparametric test for the presence of seasonality assuming stability;
- Moving seasonality test

- Sliding spans analysis
- Revision history analysis

若子數列不穩定, 但總數列與子數列間的加權關係又很重要時, 可考慮第三種方法: 作direct seasonal adjustment 但調整子數列的季節調整值, 使其加種關係成立。調整的法有3種:

1. 將加總誤差分配到最大或最不重要的的子數列
2. 依各子數列的水準值當比率, 將加總誤差依比率分配到各子數列。
3. 依各子數列的irregular components 當比率, 將加總誤差依比率分配到各子數列。

12 實例解析: 台灣的海關出口與機械及電機設備進口

分析7種模型

1. CNY 再加上X13arima 內建的TD
2. CNY 再加上用交易日做的TD
3. CNY 再加上仿造X13arima 的TD (與x13arima 內建的結果相近)
4. CNY 再加上用中秋節做before during after 交易日調節, 加上X13arima 內建的TD
5. CNY 再加上用中秋節做before during after 交易日調節, 將X13arima 內建的TD 移除
6. CNY 再加上用genhol 做中秋節before during after 調節, 加上X13arima 內建的TD
7. CNY 再加上用genhol 做中秋節before during after 調節, 將X13arima 內建的TD 移除

Table 1: 各種參數下的AIC: 台灣的海關出口

	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
A3	4816.507	4815.928	4789.206	4811.739	4815.2	4816.512	4816.56	4818.564	4815.583	4794.891	4793.852	4793.804	4798.939	4802.174	4806.878	4821.725	4822.51	4807.894
A4	4814.936	4814.395	4785.479	4810.434	4814.776	4815.898	4815.603	4817.569	4814.119	4793.704	4792.713	4792.332	4797.934	4815.799	4821.148	4820.996	4821.728	4823.126
A5	4814.47	4813.536	4764.588	4763.011	4777.945	4780.153	4778.221	4781.63	4809.454	4805.194	4789.841	4802.889	4809.264	4811.815	4818.81	4818.423	4819.112	4821.059
A6	4812.365	4811.994	4782.75	4808.123	4781.098	4783.555	4782.819	4785.14	4808.57	4805.055	4789.311	4788.654	4795.417	4811.702	4818.793	4818.312	4819.142	4805.898
A7	4814.726	4814.368	4813.656	4810.059	4813.778	4814.851	4814.373	4815.762	4810.647	4791.836	4790.554	4789.94	4796.414	4813.69	4820.29	4819.832	4820.623	4806.532
A8	4814.973	4814.636	4813.653	4810.257	4813.821	4814.942	4814.632	4815.943	4811.408	4792.282	4791.115	4790.591	4796.92	4814.675	4820.756	4820.363	4821.153	4806.619
A9	4814.996	4815.081	4814.174	4810.917	4814.345	4815.33	4815.061	4816.115	4811.725	4792.322	4791.061	4790.643	4796.925	4815.099	4821.024	4820.593	4821.368	4806.476
A10	4815.499	4816.01	4815.149	4811.66	4814.309	4815.335	4815.17	4816.281	4812.58	4793.023	4791.929	4791.765	4797.51	4801.494	4806.714	4805.938	4821.703	4806.757
A11	4812.701	4812.473	4811.882	4808.954	4811.835	4813.034	4812.976	4814.394	4812.191	4792.04	4790.809	4790.557	4796.267	4800.148	4820.257	4819.729	4805.264	4804.928
A12	4815.618	4815.455	4814.07	4811.335	4814.289	4815.533	4815.52	4816.861	4814.702	4794.116	4792.905	4792.633	4797.992	4801.676	4806.367	4805.53	4806.338	4805.958
A13	4816.147	4816.154	4814.569	4811.964	4814.621	4815.867	4815.925	4817.262	4800.712	4794.607	4793.427	4793.22	4798.407	4801.925	4806.279	4805.483	4806.302	4805.915
A14	4816.938	4817.294	4815.878	4813.661	4801.916	4802.608	4802.227	4803.529	4800.446	4794.21	4792.986	4792.785	4798.193	4801.934	4806.56	4805.724	4806.544	4806.078
A15	4816.764	4817.074	4815.353	4813.399	4801.397	4802.134	4801.613	4802.938	4800.438	4794.243	4792.937	4792.7	4798.216	4802.322	4821.912	4806.134	4806.912	4806.417
A16	4814.705	4814.926	4813.81	4811.779	4799.839	4800.584	4800.121	4801.614	4799.402	4793.028	4791.698	4791.449	4797.025	4800.865	4820.392	4804.544	4820.47	4804.623
A17	4816.519	4816.83	4815.16	4813.261	4801.36	4802.126	4801.831	4803.116	4800.558	4794.369	4793.165	4792.995	4798.258	4801.862	4820.858	4820.423	4806.123	4805.538
A18	4817.018	4817.433	4815.617	4813.771	4802.351	4803.097	4802.934	4818.642	4801.673	4795.479	4794.34	4794.245	4799.129	4802.419	4821.289	4820.843	4806.391	4805.752
A19	4817.589	4817.985	4816.421	4814.705	4816.84	4803.75	4803.665	4804.82	4802.372	4795.947	4794.826	4794.801	4799.424	4802.58	4821.49	4805.715	4821.594	4805.837
A20	4817.122	4817.563	4815.958	4814.691	4816.712	4817.762	4818.079	4805.119	4802.953	4796.599	4795.435	4795.459	4799.77	4802.834	4821.088	4820.67	4821.194	4805.909

Table 2: 各種參數下的AIC: 台灣的海關出口

	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
A3	4458.448	4459.124	4456.882	4467.25	4446.275	4447.975	4448.076	4448.388	4462.538	4490.114	4489.932	4490.703	4463.412	4464.129	4453.799	4441.861	4454.028	4472.607
A4	4457.799	4458.23	4456.519	4462.563	4447.287	4448.92	4448.568	4448.551	4461.2	4489.368	4489.026	4489.649	4461.804	4462.826	4465.969	4442.528	4455.356	4461.04
A5	4458.333	4448.293	4458.146	4453.449	4472.731	4474.313	4460.177	4460.005	4458.662	4481.949	4480.912	4480.906	4473.02	4459.199	4451.788	4477.904	4479.213	4478.661
A6	4457.65	4486.146	4480.033	4453.101	4497.766	4498.45	4461.019	4499.122	4499.818	4479.112	4478.029	4478.677	4482.609	4485.338	4490.578	4475.278	4476.956	4475.759
A7	4458.314	4458.979	4493.949	4457.511	4474.205	4448.827	4448.334	4461.605	4460.45	4481.447	4480.415	4481.198	4484.545	4487.642	4453.378	4478.036	4479.727	4478.009
A8	4457.958	4458.774	4493.822	4453.753	4473.922	4448.597	4448.254	4447.899	4502.535	4481.249	4480.264	4480.788	4472.553	4488.183	4453.703	4478.882	4480.526	4478.694
A9	4458.669	4476.849	4483.902	4453.389	4475.086	4476.342	4448.564	4447.895	4461.023	4482.038	4480.782	4481.486	4484.909	4476.827	4453.915	4467.999	4469.563	4479.214
A10	4471.608	4484.426	4492.029	4446.261	4482.845	4482.657	4495.754	4494.311	4498.23	4479.009	4478.48	4479.451	4482.968	4499.687	4452.284	4488.914	4490.624	4477.131
A11	4457.605	4458.517	4491.975	4451.455	4496.145	4496.579	4498.106	4497.761	4503.605	4482.913	4482.474	4483.431	4473.802	4476.577	4453.986	4466.438	4467.917	4478.651
A12	4458.682	4459.596	4493.577	4454.191	4445.476	4447.304	4446.813	4500.514	4493.103	4485.083	4484.595	4485.48	4476.29	4479.165	4454.958	4469.239	4455.168	4480.635
A13	4459.605	4460.578	4493.246	4453.883	4445.493	4498.786	4446.982	4500.284	4463.424	4485.913	4485.377	4486.22	4476.997	4479.989	4455.243	4470.001	4471.373	4481.276
A14	4460.283	4461.471	4495.316	4454.621	4445.486	4501.04	4446.789	4463.965	4464.338	4486.915	4486.303	4487.139	4476.496	4465.085	4454.545	4469.578	4470.914	4470.055
A15	4460.339	4476.08	4492.77	4454.53	4445.885	4487.202	4488.182	4474.317	4464.69	4474.203	4485.819	4474.632	4475.863	4479.388	4455.373	4469.711	4470.983	4469.991
A16	4459.668	4460.699	4482.54	4458.96	4445.36	4447.292	4446.254	4447.061	4464.593	4475.435	4487.654	4475.864	4477.031	4480.023	4455.554	4469.661	4470.867	4469.639
A17	4460.754	4462.153	4496.44	4462.524	4446.255	4448.085	4447.94	4448.117	4451.936	4466.523	4489.411	4466.466	4464.79	4465.398	4466.703	4483.433	4454.275	4482.602
A18	4461.451	4462.902	4497.064	4492.481	4447.151	4448.782	4448.69	4448.869	4452.279	4490.86	4490.239	4450.51	4449.923	4465.726	4466.942	4442.473	4454.482	4483.084
A19	4462.81	4450.929	4499.768	4448.979	4447.136	4448.688	4448.55	4448.616	4451.941	4492.589	4491.963	4492.651	4449.619	4466.245	4454.477	4442.344	4454.355	4472.636
A20	4463.638	4452.246	4499.785	4450.244	4448.502	4450.065	4450.01	4450.117	4453.095	4493.007	4492.34	4492.999	4450.675	4466.74	4455.173	4454.939	4455.071	4472.944

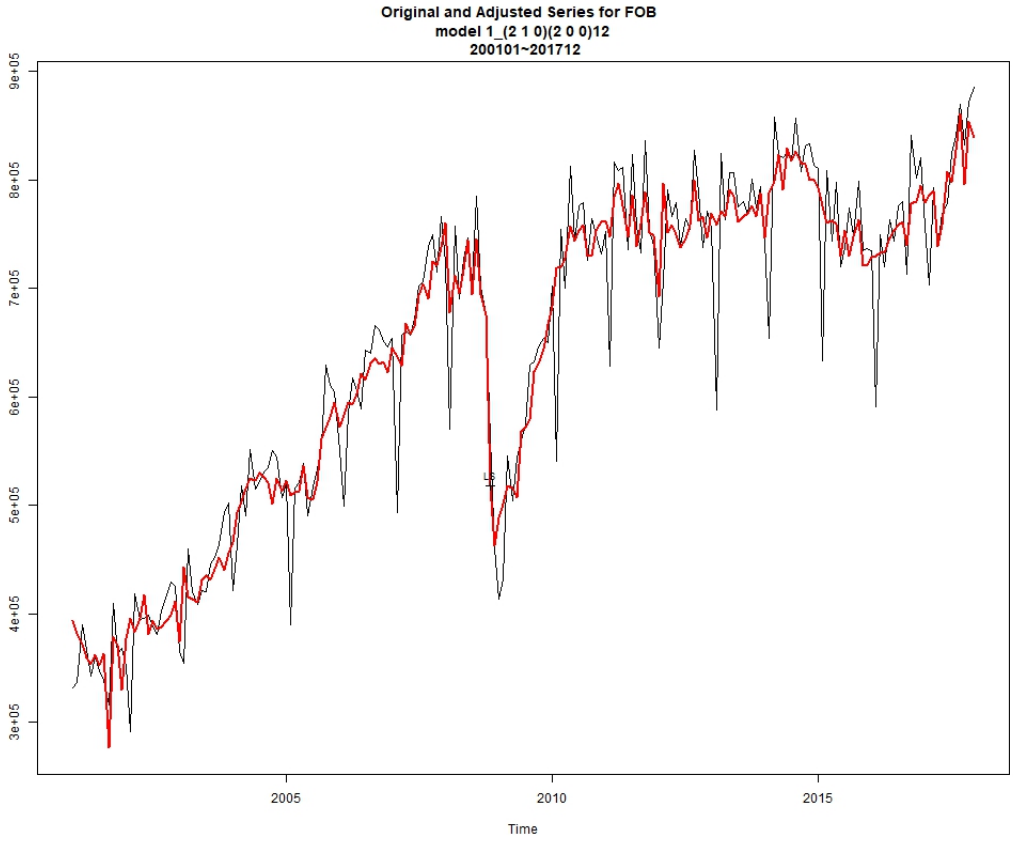

Figure 2: 台灣的海關出口: 模型1

實證分析結果彙整

1. CNY 有影響,
2. 用交易日做的TD 會使後段序列有向下平移的結果
3. 中秋節效應(B3A6) 不顯著,
4. TD 效應幾乎在周四 周六都顯著
5. ARIMA 模型階數方面, 比較在auto.arima 指令下加入外生變數(CNY), 與不加的結果, 顯示都是一樣階數。

13 結論與建議

1. 針對「如何調整交易日(含颱風假, 彈性調整假期, 年假) 的影響?」這個重要的問題, 本計畫建議如下:

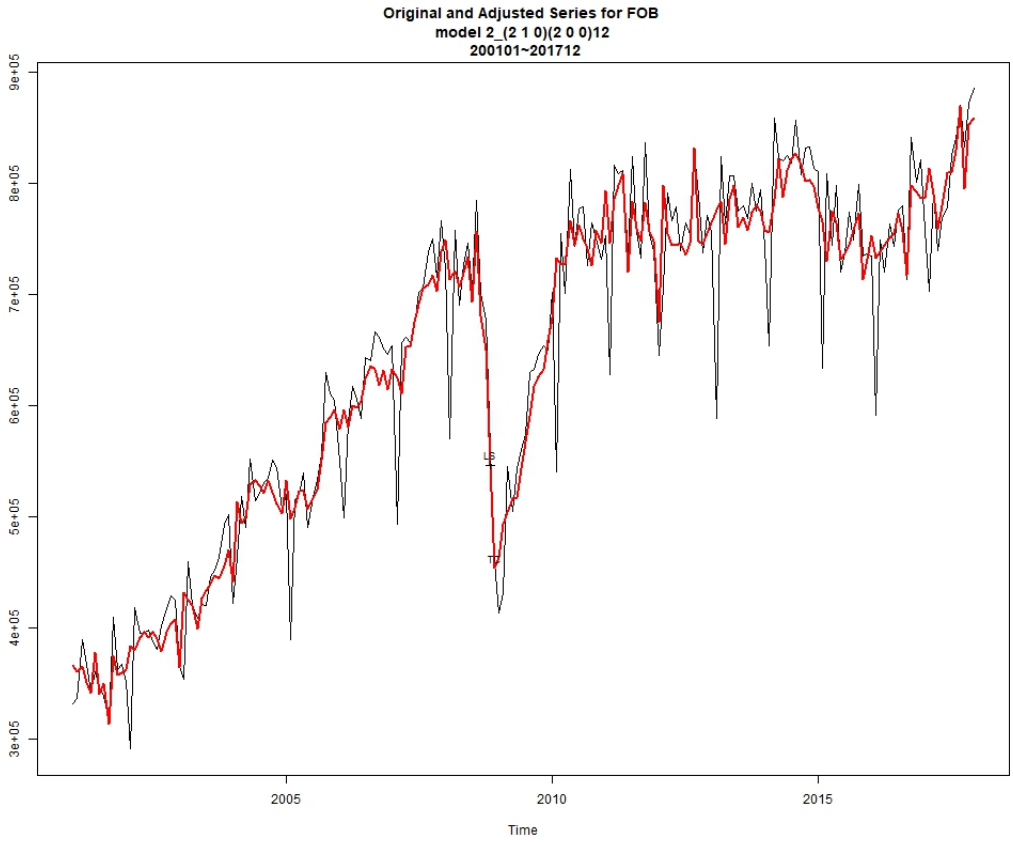

Figure 3: 台灣的海關出口: 模型 2

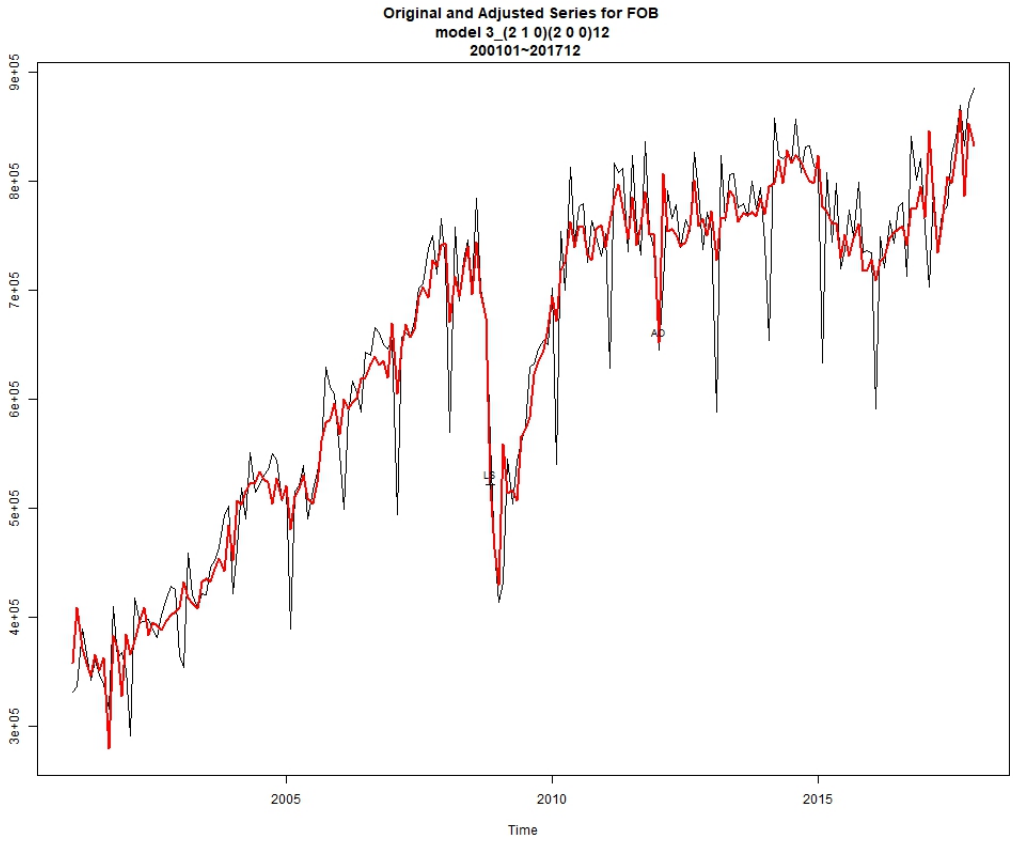

Figure 4: 台灣的海關出口: 模型 2

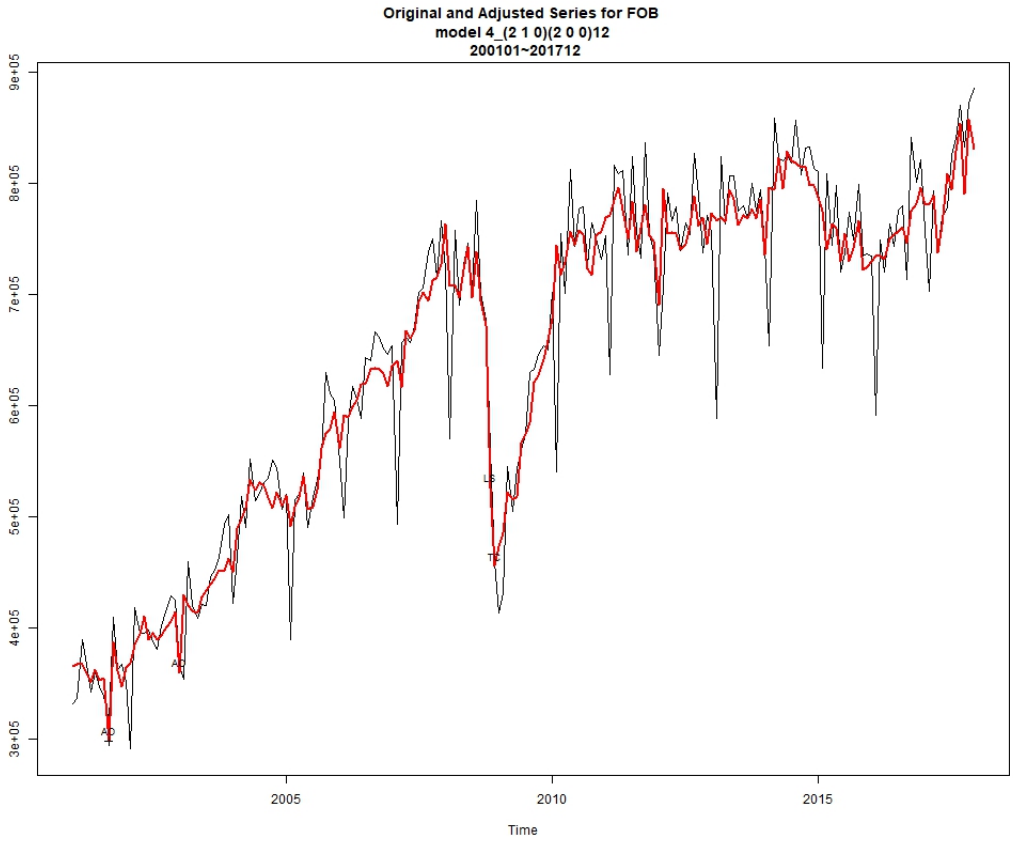

Figure 5: 台灣的海關出口: 模型 4

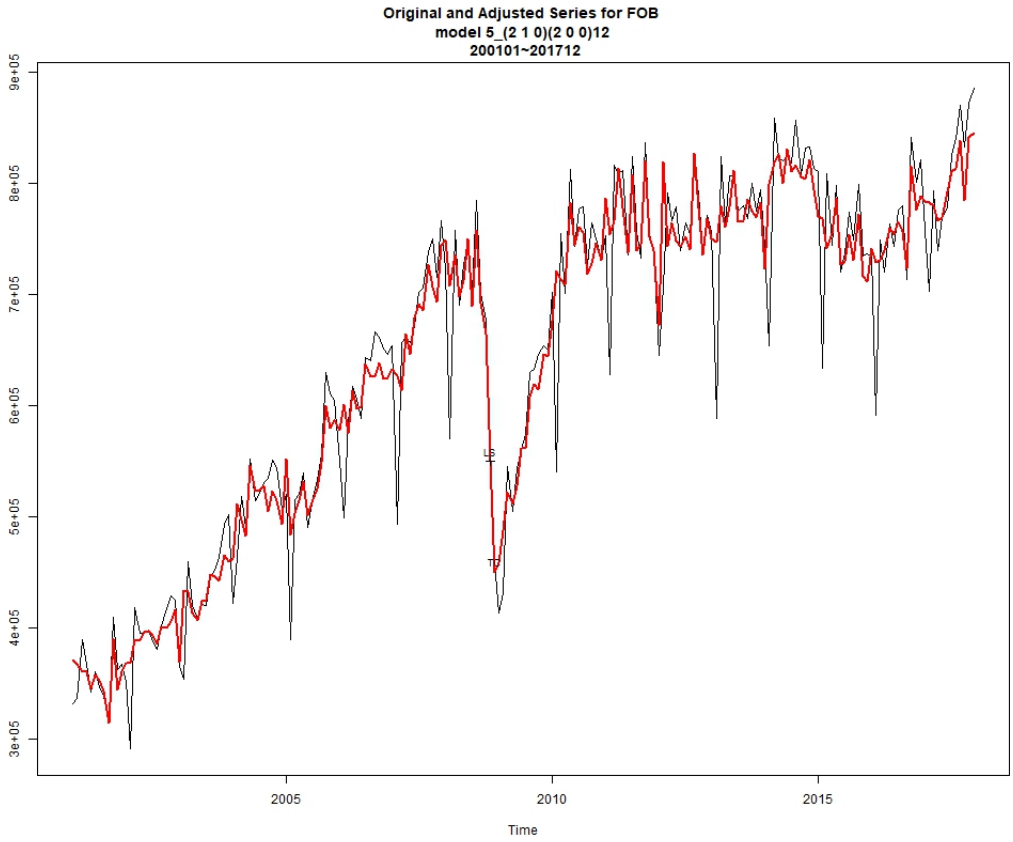

Figure 6: 台灣的海關出口: 模型5

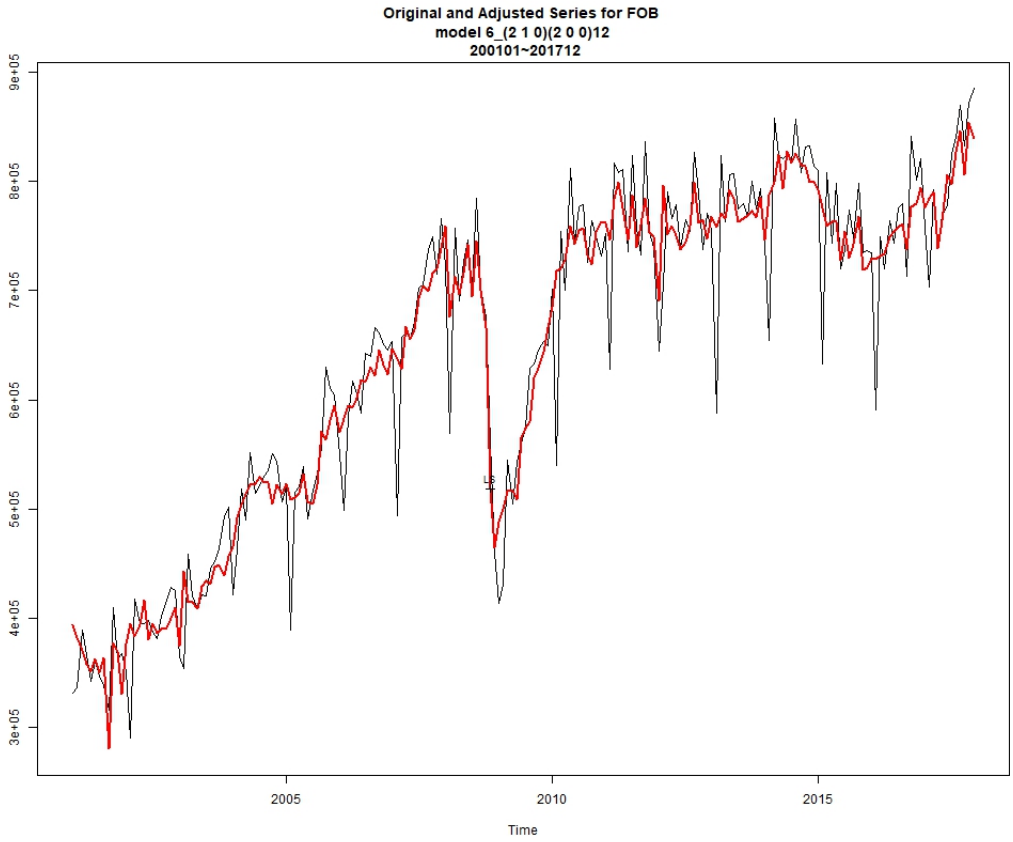

Figure 7: 台灣的海關出口: 模型7

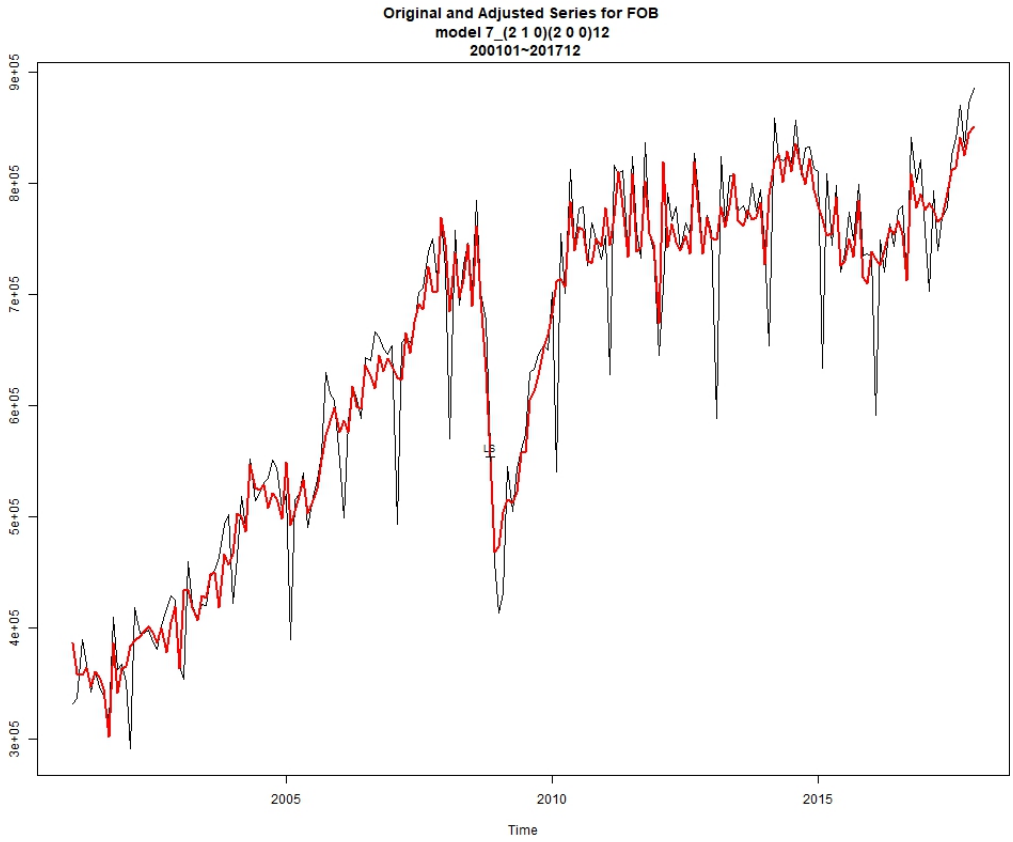

Figure 8: 台灣的海關出口: 模型7

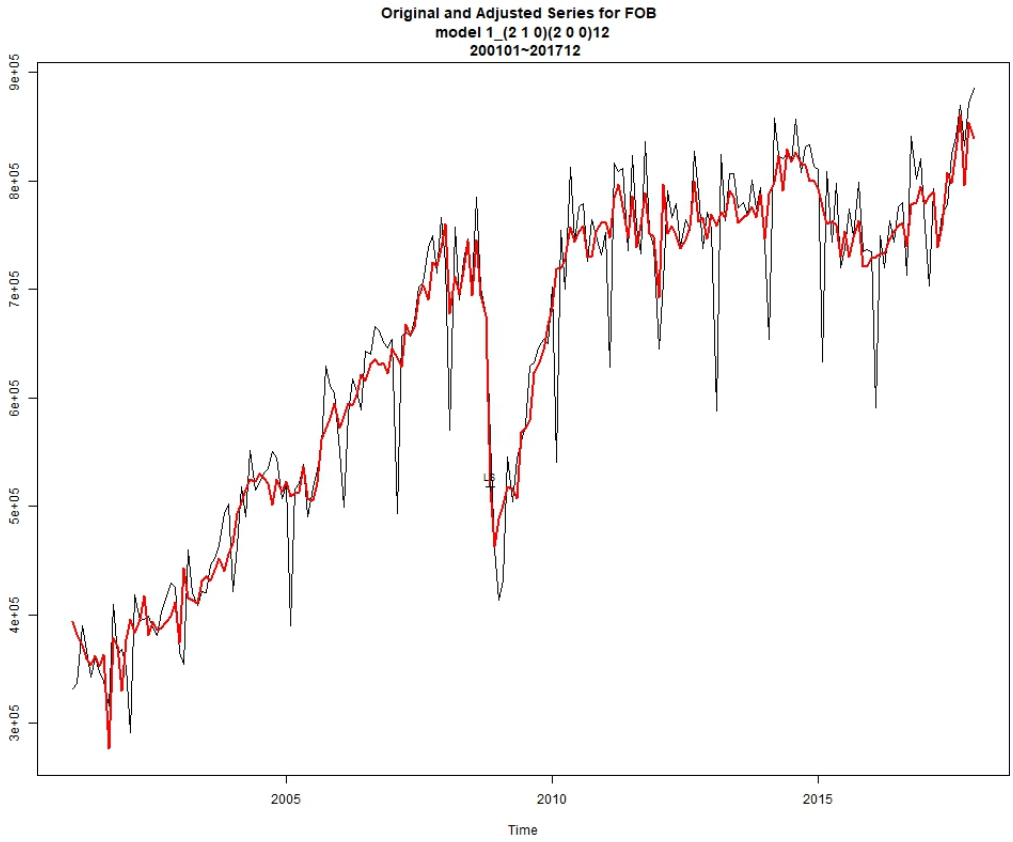

Figure 9: 台灣機械及電機設備進口: 模型1

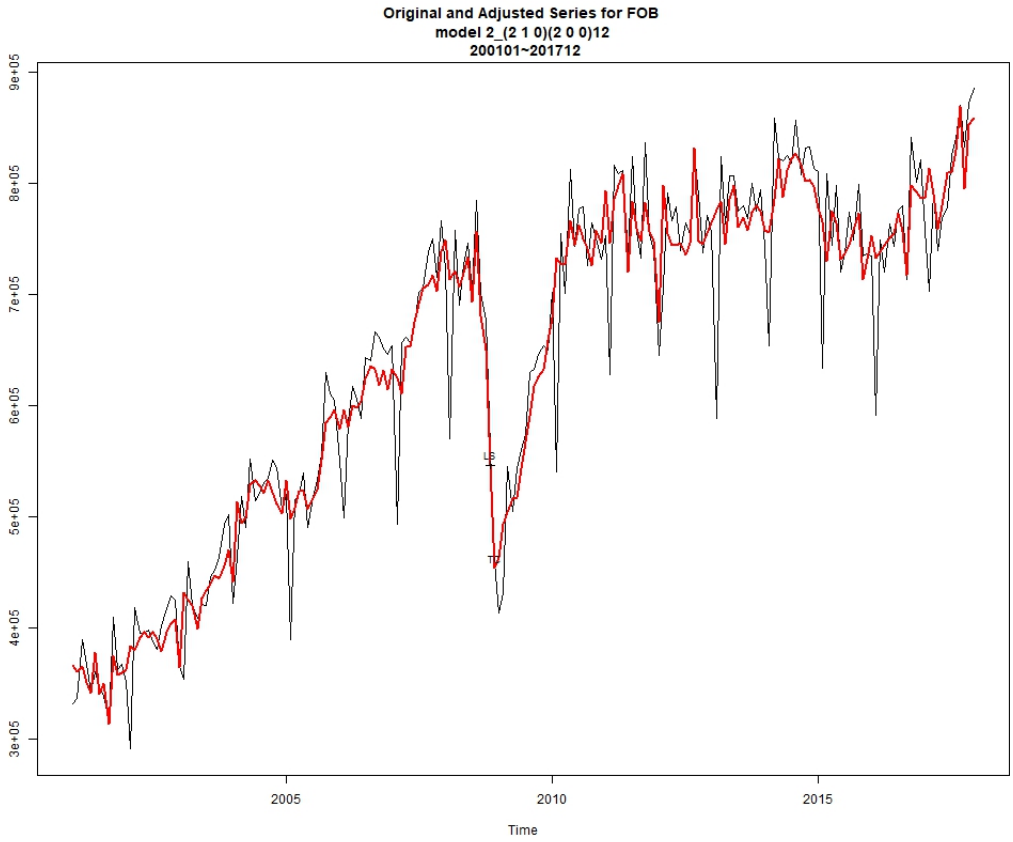

Figure 10: 台灣的機械及電機設備進口: 模型 2

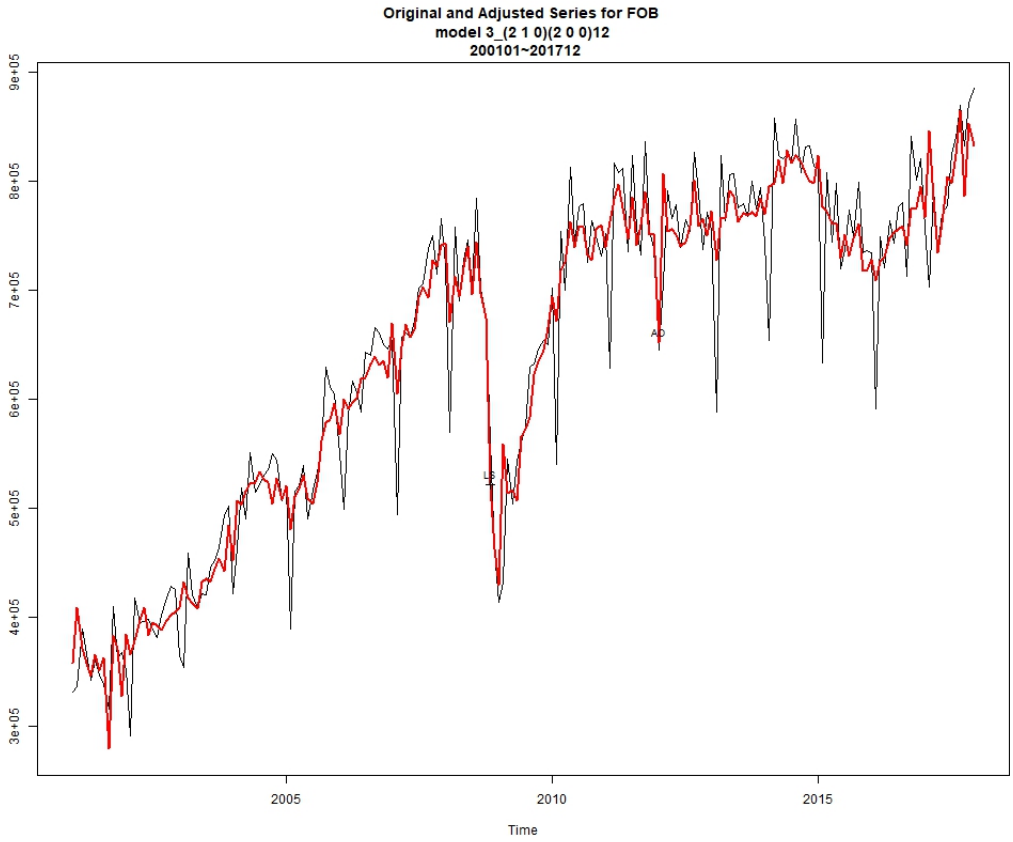

Figure 11: 台灣的機械及電機設備進口: 模型 2

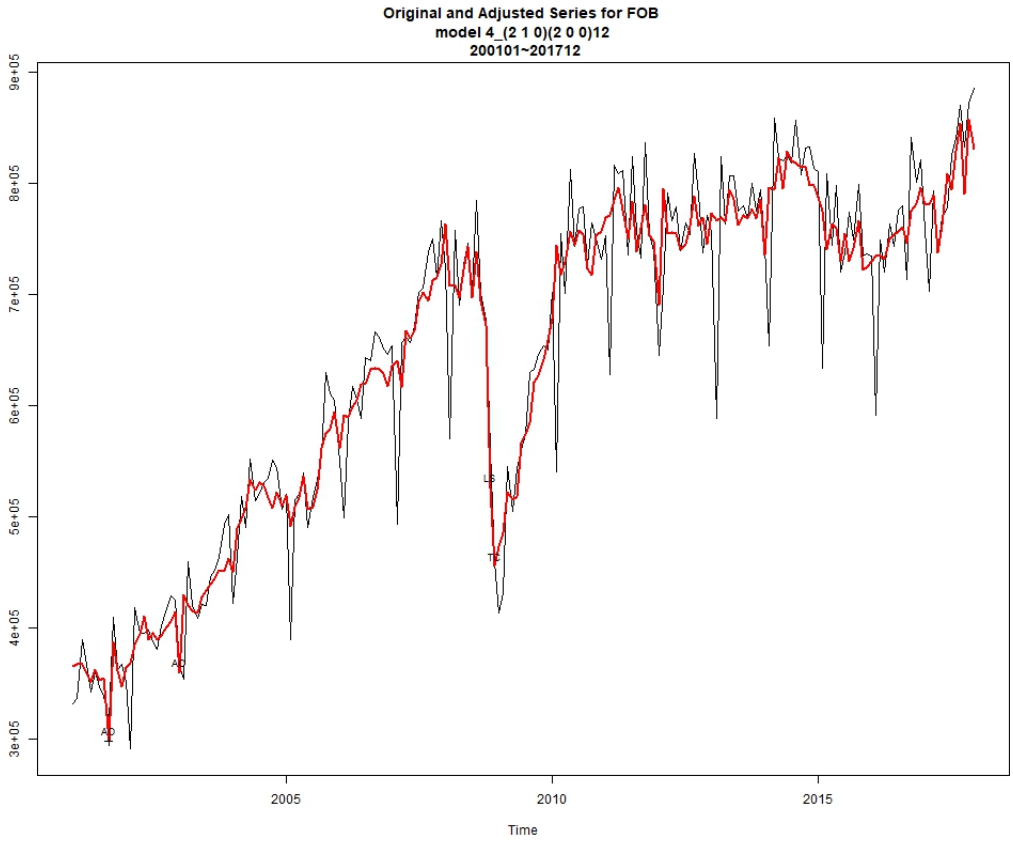

Figure 12: 台灣的機械及電機設備進口: 模型 4

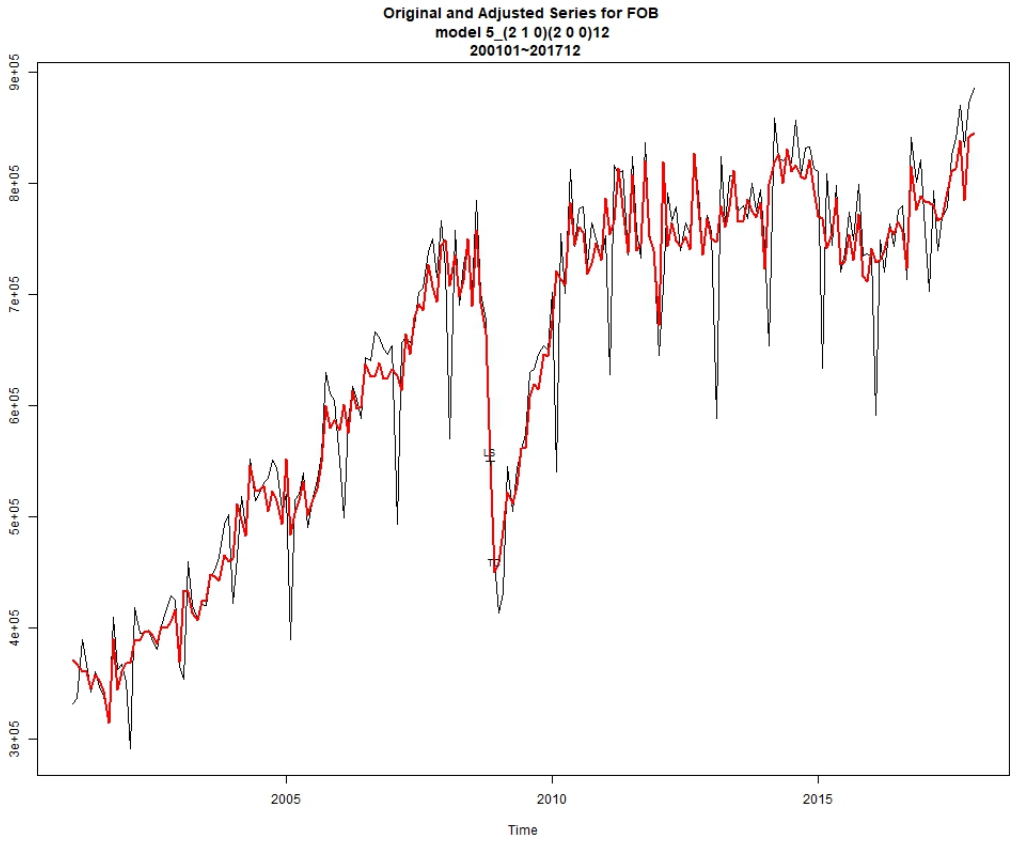

Figure 13: 台灣的機械及電機設備進口: 模型5

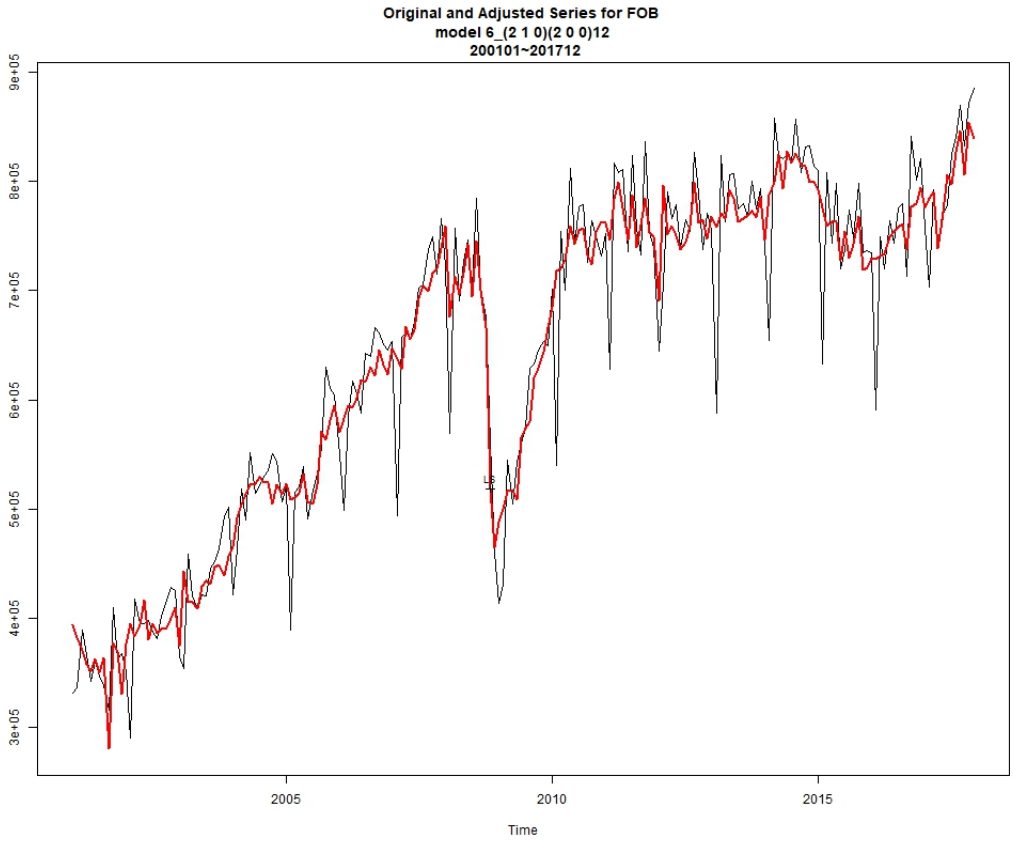

Figure 14: 台灣的機械及電機設備進口: 模型7

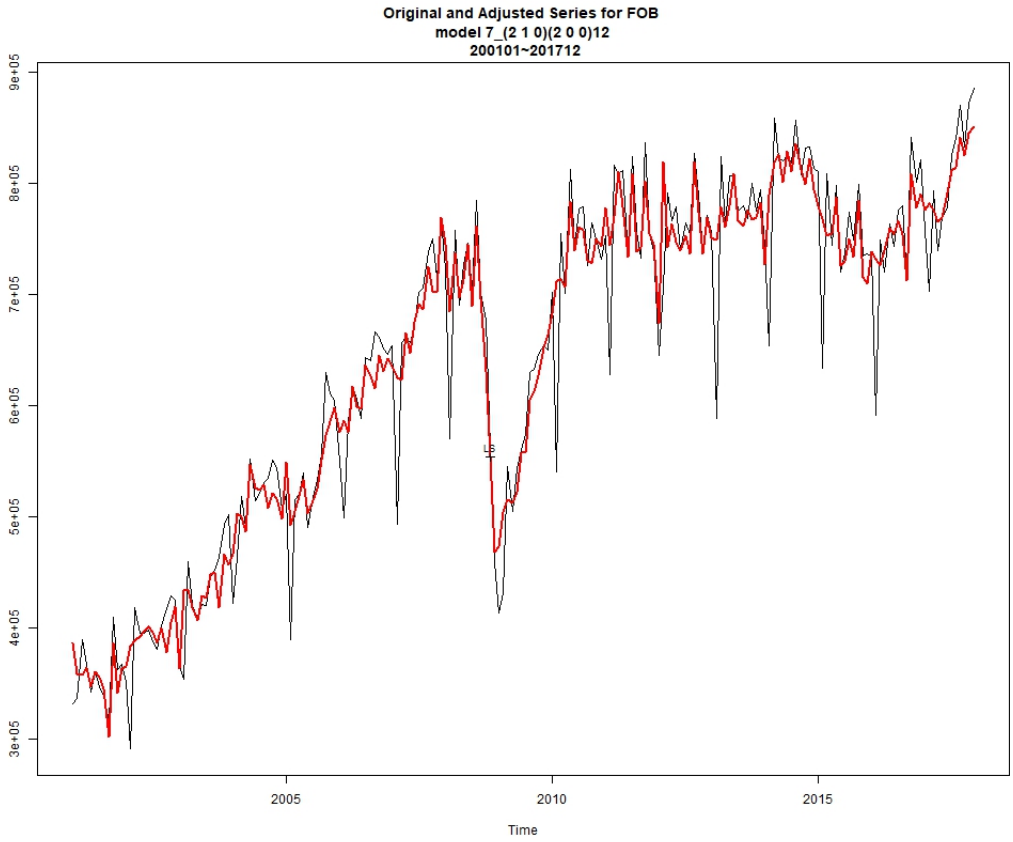

Figure 15: 台灣的機械及電機設備進口: 模型7

建構每月交易日變數及農曆年變數, 以外生變數的方式加入季節調整前的 ARIMA 模型, 估計並抽離其影響, 然後, 再對調整過的數列做雙向移動平均, 分解成長期趨勢, 季節性因子, 與干擾項。

2. X13-ARIMA-SEATS 的作法假定每年交易日與春節的(3種) 效應固定是線性的, 與既有的季節因子是獨立的, 應而以線性外生變數的方式分離其效果。這些假設在實際情形上都有可能被違背, 因此希望能夠調整出一個完全乾淨, 完全沒有交易日與農曆年效應的結果很難。若每年的「季節性」的型態都有些不一樣, 過份重視「平滑(smooth)」, 很容易落入「過渡配適」(overfitting) 的陷阱。另一個重要的問題是, 組成份數列(component series) 年節的效果完全不同, 直接(direct) 與 間接(indirect adjustment) 的年節效果會有很大的差異。一方面, 我們最關心近期的交易日或年節前效應, 但在「時間數列的期末(end-of-the-series)」下, 要準確的估計其效果很難。

3. X13-ARIMA-SEATS 有內建 交易日變數, 惜美國的假日與台灣不同, 不見得適用, 宜以台灣的實例, 自行建構交易日變數。

4. 直接用 genhol, 產生年節前, 年節後的變數, 再用本計畫的程式產生年節中的變數, 將3種假日變數放在一個檔案中。注意要 做calendar-mean adjusting。結果即使有殘餘的年節效應, 也不要加虛擬變數(dummy variables) 或 其他事後(ad hoc) 調整。

5. 若年假與一般週末或颱風假的影響相同, 將交易日合併成一組變數;若不同, 分別建構交易日變數與年假變數。可以參考 AICC, 迴歸估計結果及季節調整過後數列的診斷統計量(M1-M11)。

6. 建議選定於每年的某一月份(如4月), 選擇最適並固定季節調整中的參數設定, 然後至下一年度(如3月) 前, 所有的季節調整皆以此組參數做季節調整。注意, 進行每月季節調整的程式中關閉自動選模功能 (automdl=NULL,transform.function="none" 或 "log" ,regression.aictest=NULL)。

14 程式檔

見附檔

15 程式檔使用說明

操作說明書

(一) R 安裝及相關 library

Library 應包括 forecast、timeSeries、seasonal 及 xlsx，其中 xlsx 需要額外再安裝 JAVA(https://java.com/zh_TW/)

(二) 執行程式前設定

1. 存檔路徑設定: outputpath、temppath
2. 資料檔路徑 ：setwd
3. 資料包括 ：
   (1) Cnytmp： 每年除夕的國曆日期(至 2049 年)
   (2) h815： 每年中秋節的國曆日期(至 2050 年)
   (3) daymap： 由 19930105 至 20171130 每日交易日(可使用匯率日資料，第一欄為序號，第二攔為日期)
   (4) FOB、Machine: 欲作調整之月資料，可設定 xseries0<-FOB 來執行 FOB 之調整。
4. 參數設定
   (1) 農曆春節效應，Before1 為農曆春節前天數，After1 為農曆春節後天數。第一次使用時可以執行程式中 452 行至 464 行，透過 3~20 的調整來決定最佳天數，輸出的檔案名稱為 aic_調整變數名稱_arima 模型_資料起始年.xlsx，例如 aic_FOB_(2 1 0)(2 0 0)12_start2001.xlsx 。
   (2) 中秋節效應，Before_h815 為中秋節前天數 ；After_h815 為中秋節後天數，若使用 genhol，則中秋節期間設定為，中秋節前 1 天及中秋節後 2 天。
   (3) ARIMA 模型設定，依據 min aicc 來決定二種模式下的最佳階數；第一種直接由調整序列中找出最佳階數(summary.txt 中 auto.arima fit)，第二種為以加入春節調整後(以春節因子為外生變數，summary.txt 中 auto.arima fit with xreg of CNY)。若需要自行設定則須設定 448 行中的 arima_model0 變數為"(1 0 1)(1 0 0)12"之格式(如下圖)。

   修改前:

16 參考文獻

說明:*X-13ARIMA-SEATS Reference Manual*可謂是X13-ARIMA-SEATS 的聖經, 使用者最重要的資訊來源。我無意間發現英國統計局的 *Guide to Seasonal Adjustment with X-12-ARIMA, Draft*雖然在8年前出版, 但內容非常豐富與深入, 強烈建議使用者詳細閱讀。*Seasonal Adjustment Diagnostics Checklists*當然也是重要的文件, 值得詳讀。另外, 以下前兩個資料是匈牙利及歐盟探討季節調整的 quality report, 值得參考借鏡

1. Erika Foldesi, Erika, Peter Bauer, Beata Horvath and Beata Urr (2007), "SEASONAL ADJUSTMENT METHODS AND PRACTICES," Hungarian Central Statistical Office。

2. ESS, "GUIDELINES ON SEASONAL ADJUSTMENTESS (2009)," The European Statistical System, EU

3. Hylleberg, Svend ed. *Modelling Seasonality*, New York: Oxford University Press, 1992. McDonald-Johnson, Kathleen M., Brian Monsell, Ryan Fescina, Roxanne Feldpausch, Catherine C. Harvill Hood and Monica Wroblewski (2010), " Seasonal Adjustment Diagnostics Checklists," US Census Bureau

4. Lin, Jin-Lung and Tian-Syh Liu (2003), "Modeling Lunar Calendar Holiday Effects in Taiwan," *Taiwan Economic Forecast and Policy*, 33, no. 2, 1-37.

5. Liou, Shuw-Miin, Jin-Lung Lin, Chun-Neng Peng (2012), "Using High Frequency Data to Model Moving Holiday Effects: An Empirical Investigation of Taiwanese Monetary Aggregates," *Taiwan Economic Forecast and Policy*, 43, 171-192.

6. Office for National Statistics, UK, *Guide to Seasonal Adjustment with X-12-ARIMA, Draft* , ONS Methodology and Statistical Development, 2007.

7. Census Bureau (2013), *X-13ARIMA-SEATS Reference Manual*, Time Series Research Staff, Statistical Research Division, U.S. Census Bureau

8. Sax, C (2016), "Introduction to seasonal: R interface to X-13ARIMA-SEATS," available within *R* help via *help(package=seasonal)*.