Improving the Seasonal Adjustment of the Retail Sales Index using X-12-ARIMA

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Abstract: Sub-annual seasonally adjusted macro-economic statistics provide critical tools for economic policy makers, business cycle analysts and forecasters. Amongst the various economic metrics available, good quality seasonally adjusted monthly retail trade indices provide critical information on the economic well-being of any developed economy. Inappropriate or low-quality seasonal adjustment can generate misleading results and increase the possibility of false signals on the economy, e.g. the appearance of turning points in the business cycle.

The seasonal adjustment of the Irish retail sales figures is complicated by the standardised reporting period (SRP) used to collect the raw data. As retail tends to be governed by weekly cyclical patterns, the CSO collects micro-data using a 4-4-5 reporting system, rather than collecting data on a calendar month basis, i.e. each quarter comprises of a 4 week SRP followed by a 4 week SRP followed by a 5 week SRP. This reporting period is favoured by most of the large retailers as it coincides with their own accounting practices; however the reporting system results in complex atypical calendar effects[1] in the data, making seasonal adjustment of the unadjusted retail sales figures particularly challenging.

This paper describes the improved methodology and procedures adopted by the Central Statistics Office to seasonally adjust the retail sales indices. The X-12-ARIMA program, developed by the U.S. Census Bureau, is used to seasonally adjust the retail sales figures. The X-12-ARIMA program pre-treats each time series for calendar effects and outliers before then estimating seasonal factors for each series. The calendar effects adjusted for in the Retail Sales Series are; (i) the phase shift effects caused by the 4-4-5 reporting system, (ii) Easter effects, made more complicated by the 4-4-5 system and (iii) the October Bank Holiday effect resulting from the bank holiday switching between the 'October' and 'November' standardised reporting periods.
As a result of the improved methodology, seasonal adjustment of the CSO's retail sales figures is now conducted in full compliance with international best practice as outlined in the European Statistical System (ESS) Guidelines on Seasonal Adjustment (2009).

Keywords: Retail Sales, Seasonal Adjustment, X-12-ARIMA, Phase Shift Regressors, Calendar Effects.

[1] The structure and composition of calendars can affect economic activity, e.g. the composition of working days in a month differ from one year to the next or moving holidays such as Easter.

The background to the RSI

The Retail Sales Index (RSI) is the official short-term indicator of changes in the level of consumer spending on retail goods. It measures the average weekly sales for each month, after allowances are made for the 4-4-5 SRP. The RSI is published by the Central Statistics Office (CSO) at 28 days after the end of the reporting period.

The primary purpose of the RSI is to provide a short-term indication of changes in the value and volume (or quantity) of retail sales in Ireland. The CSO publish 44 unadjusted retail indices[2] and in doing so provides an accurate and objective measure of retail trading, as well as supplying a valuable guide to consumer spending behaviour in the Irish economy. More generally, in conjunction with several other monthly and quarterly economic indicators published by the CSO, the RSI offers a valuable tool for better understanding Ireland's general economic climate and performance. Data is compiled and published at national level only, i.e. NUTS 1 level[3].

The Retail Sales Index is classified in accordance with the statistical classification of economic activities in European Communities, i.e. NACE Rev. 2[4]. The RSI coverage is broader than the strict NACE (Rev. 2) retail trade classification (NACE 47) owing to the inclusion of the retail trade and repair of motor vehicles and motorcycles (NACE 45) and Bars (NACE 56.3).

Retail sales are subject to a high degree of seasonality. To facilitate interpretation of underlying trends, value and volume indices are adjusted to remove these seasonal fluctuations. Seasonal adjustment is conducted using the direct seasonal adjustment approach. Under this approach each individual series is independently adjusted, i.e. aggregate series are adjusted without reference to the component series. Each individual seasonally adjusted series is calculated based on unadjusted data spanning from January 2000 to the current period.

X-12 Seasonal Adjustment Methodology

The X-12-ARIMA program, developed by the U.S. Census Bureau, is used to seasonally adjust the unadjusted RSI data. Seasonal adjustments are completed by fitting regARIMA models to unadjusted data and then estimating seasonal factors, based on the prior-adjusted data, using the well established X-11 methodology, see Shiskin et al. (1967). The purpose of the regARIMA model is to provide forecasts (and backcasts) of a time series to improve the reliability of the estimated seasonal factors. The model also removes calendar and outliers effects that unless treated may have major negative impacts on the overall quality of the seasonal adjustment.

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[2] The CSO publishes 13 value (and 13 volume) component indices and 9 value (and 9 volume) composite series.
[3] Nomenclature of Territorial Units
[4] (For more information on the NACE Rev. 2 classification and a detailed breakdown of the codes see http://www.cso.ie/px/u/NACECoder/NACEItems/searchnace.asp).

RegARIMA models are regression models with autoregressive integrated moving average (ARIMA) errors.

$$y_t = \sum_i \beta_i x_{it} + z_t$$

Where y_t is the dependent time series, $\sum_i \beta_i x_{it}$ is the regression effect and z_t is the regression error term fitted by an ARIMA model. The model reduces to a simple ARIMA model if no regression effects are included. Typical regression effects that should be investigated for inclusion in a regARIMA model include:

- Calendar and holiday effects, e.g. the timing of Easter, trading day effects,
- Outliers, temporary changes and level shifts in the series,
- User defined regressors.

In most economic series, calendar and holiday effects are conveniently handled by applying the built-in regressors available in the X-12-ARIMA program. However, in the case of the RSI, the modelling of calendar effects is complicated by the standardised reporting periods (SRPs), discussed in the next section, adopted by the CSO. For additional information on the use of X-12-ARIMA see Findley et al. (1998).

The Standardised Reporting Period of the RSI

The CSO collects retail data via the monthly Retail Sales Inquiry survey form[5]. The form allows enterprises to provide turnover for a stated SRP or for the actual calendar month. Currently the CSO's preference, based on feedback from large retailers, is for the data to be reported for the SRP. The SRPs for 2011 are shown in Table 1 below.

The RSI indices are compiled using SRPs of 4, 4 and 5 weeks, i.e. the first two months of every quarter comprises of 4 weeks while the third month has 5 weeks. With this SRP approach the number of days in every quarter is equalised. So not only does each month have a standardised number of weeks, turnover is "trading day" adjusted so that effectively, each of those weeks are identical – every week begins with a Sunday and finishes on a Saturday. This methodology of using SRPs to compile retail trade figures is also used by other national statistical institutes, e.g. Statistics Canada and the Office of National Statistics (UK).

5 http://www.cso.ie/en/media/csoie/surveysandmethodologies/surveyforms/documents/distributionservices/pdfdocs/retail_sales-index.pdf

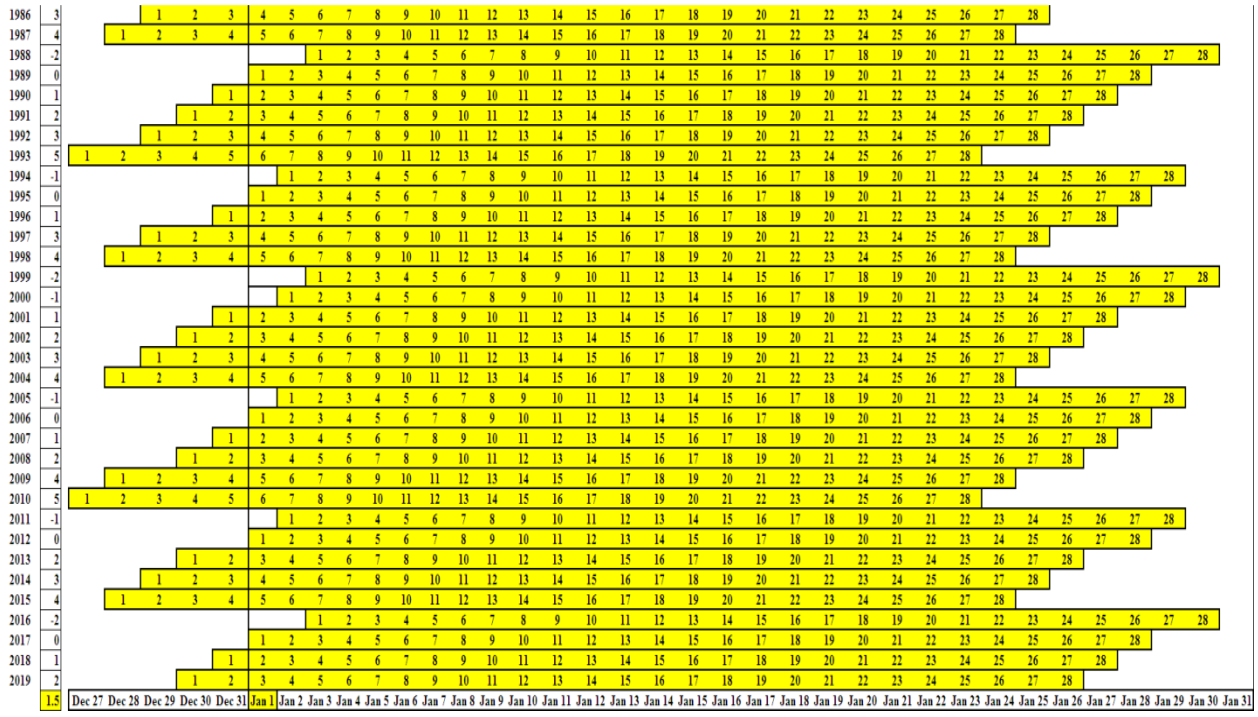
Table 1: Standard Reporting Periods for 2011

Month	Length	Dates
'January'	4 Weeks	Sunday 2nd January - Saturday 29th January
'February'	4 Weeks	Sunday 30th January - Saturday 26th February
'March'	5 Weeks	Sunday 27th February - Saturday 2nd April
'April'	4 Weeks	Sunday 3rd April- Saturday 30th April
'May'	4 Weeks	Sunday 1st May - Saturday 28th May
'June'	5 Weeks	Sunday 29th May - Saturday 2nd July
'July'	4 Weeks	Sunday 3rd July - Saturday 30th July
'August'	4 Weeks	Sunday 31st July - Saturday 27th August
'September'	5 Weeks	Sunday 28th August - Saturday 1st October
'October'	4 Weeks	Sunday 2nd October- Saturday 29th October
'November'	4 Weeks	Sunday 30th October - Saturday 26th November
'December'	5 Weeks	Sunday 27th November - Saturday31st December

Many retailers, especially smaller enterprises, return data on a calendar month basis. When enterprises supply data on a calendar month basis this data is then adjusted using calendar correction factors to the standardised month. The calendar correction factors take into account the composition of the month, e.g. the number of Fridays or Saturdays in the month. These calendar correction factors are based directly on trading day micro data provided by enterprises on the RSI sample. Every 5 years, as part of the rebasing process, enterprises are asked to distribute the average weekly sales over the 7 days of the week. This data is then compiled to build trading day weights. These weights are then subsequently used in the construction of the calendar correction factors.

The 4-4-5 pattern adds up to 364 day year as opposed to the 365 days in a year (366 in a leap year). Therefore, the SRP for a particular month slips back by one day (or two days in a leap year) each year. Figure 1, illustrates the phenomenon for the month of January. In Figure 1 the January SRP is superimposed on the calendar month of January and the last 5 days of the previous December. For example, the January 1986 SRP starts on Sunday, 29th December 1985, whilst the January 1987 SRP starts on Sunday, 28th December 1986. Consequently, the approach requires a re-calibration every 5th or 6th year (depending on when a leap years fall) to account for the accrued missing week. Re-calibration is completed by replacing the exact 52 week year by an exact 53 week year. The additional week is added to February, replacing the 4-4-5 pattern with a 4-5-5 pattern for the 1st quarter of the re-calibrated year. In Figure 1 this re-adjustment is evident for the January SRPs of; 1988, 1994, 1999, 2005, 2011 and 2016. The consequences, if any, of this year to year movement of the SRPs on the retail figures is referred to as the 'phase shift effect'.

Figure 1: The Movement of the Standard Reporting Period for January relative to the Calendar Month of January, 1986-2019



As noted by Jones (2003) this feature of the retail sales index has important implications for time series analysis conducted from retail trade data compiled using a 4-4-5 reporting pattern. The slippage of the standardised months relative to the corresponding calendar months operates on a cyclical basis. The cycle should have a cycle of seven years but because of leap years the actual cycle is 28 years (Jones 2003).

The RSI RegARIMA Model

The fact that the reporting period of the RSI does not coincide with the calendar month is referred to as the phase shift effect (Jones 2003). The phase shift effect implies that many of the in-built regressors within X-12-ARIMA for modelling calendar effects, such as the Easter effect, are not valid for use in the RSI model. However, the calendar effects induced in the series by the 4, 4, 5, recording period can be estimated and removed using the RegARIMA tool in X-12-Arima seasonal adjustment program by using purpose built (user defined) regressors. In retail sales the following calendar (regression) effects are adjusted for:

1. The phase shift effect resulting from year to year movement of the standard recording periods.

2. Easter effects, resulting from the Easter holiday moving between the Retail Sales' standardised 'March' and 'April' periods.

3. An October Bank Holiday[6] effect resulting from the holiday moving between the Retail Sales' standardised 'October' and 'November' periods.

In order to estimate these regression effects 16 separate regressors are constructed. There are 12 phase shift regressors – one for each month, 3 Easter regressors and 1 October Bank Holiday regressors. For each RSI time series 10 of the phase shift regressors ('January' – 'September' and 'December') are formally tested for statistical significance using the standard t-test. The 'November ', 'October' and October Bank Holiday regressors are jointly tested using the log likelihood ratio test. The Easter regressors are similarly jointly tested. Only regressors that are proven to be statistically significant are included in the final regression model.

Outliers, temporary changes and level shifts are also modelled in the RSI regARIMA models. Outliers, temporary changes and level shifts are abrupt changes in an underlying time series that can affect the quality of the seasonal adjustment if not treated correctly. The X-12-Arima seasonal adjustment program automatically identifies outliers, temporary changes or level shifts and removes them from the original series before the seasonal adjustment factors are calculated. Similarly, if knowledge of a time series suggests that other potential outliers[7] may exist, then these potential outliers can be tested and introduced if proven to be statistically significant. Once the seasonal adjustment factors are calculated these outliers, temporary changes and level shifts are then re-introduced into the final seasonally adjusted series as they provide evidence of specific events.

In keeping with Jones (2003) and the ONS (2007) the RSI is not trading day adjusted. A consequence of the 4-4-5 reporting period is that the composition of any particular month, in terms of the number and type of days, is the same each year.

Calculating the Phase Shift Regressors

Twelve phased shift regressors, one for each month, are calculated to model the phase shift effect, (see Jones 2003). To illustrate the calculation of the phase shift regressor the January phase shift regressor will be used as an example. The January phase shift regressor has a value of 0 for each month except for January. For the January periods the value of the phase shift regressor is calculated as follows:

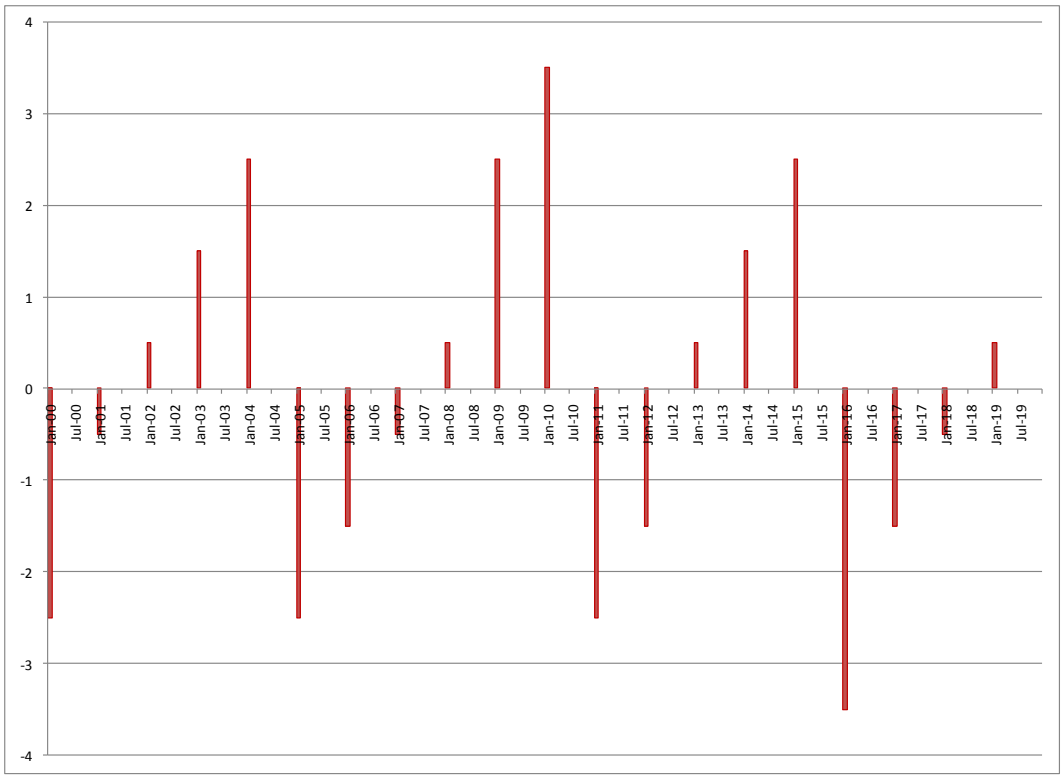
[6] The October bank holiday is different from other Irish bank holidays in that it occurs at the end of the month and therefore is more likely to occur in the RSI's November SRP than in the October SRP.
[7] E.g. change in motor tax regime, ash cloud, strikes etc.

The number of days between the start of January and the start of the January SRP, D_t, is calculated for each year over the period 1992 and 2019[8], see Figure 1. Then;

- The mean value of D_t is then calculated (equals 1.5 for the January regressor).
- The actual value for the January phase shift regressor, in January, is then calculated as the mean-centred value of D_t , i.e. (D_t – 1.5).

The phase shift regressor for January is shown in Figure 2. The phase shift regressors are mean-centred to ensure that the removed regression effects have a mean equal to 0 and have no fixed seasonal component (see Jones 2003). The calculated phase shift regressors for each month are shown in Appendix 1.

Figure 2: Phase Shift Regressor for January, 2000-2019



Calculating the Easter Regressors

The Easter regressors are also calculated using a methodology developed by the ONS, (see Jones 2003). The timing of Easter Sunday can vary anywhere between March 22nd and April 25th. The

[8] The period selected represents a full 28 year cycle.

April SRP also starts on a Sunday and moves between 29th March and 5th April. Therefore the occurrence of Easter can be described relative to the beginning of the April SRP as follows:

Type 1. Easter occurs 2 weeks before the start of the April SRP
Type 2. Easter occurs 1 week before the start of the April SRP
Type 3. Easter coincides with the start of the April SRP
Type 4. Easter is 1 week after the start of the April SRP
Type 5. Easter is 2 weeks after the start of the April SRP
Type 6. Easter is 3 weeks after the start of the April SRP

In keeping with Jones (2003) these 6 occurrences are reduced to just four distinct classes because Type 1 and Type 6 are rare events and their impacts would be difficult to distinguish from the impact of Type 2 and Type 5 effects, respectively. Therefore the following four Easter events remain to be modelled:

Class 1. Easter occurs 1 or 2 weeks before the start of the April SRP
Class 2. Easter coincides with the start of the April SRP
Class 3. Easter is 1 week after the start of the April SRP
Class 4. Easter is 2 or 3 weeks after the start of the April SRP

Each of the four kinds of Easter, (i.e. $i = 1, 2, 3$ and 4), is treated separately and in the model the increase (or decrease) in sales that occurs in Easters $i = 1, 2$ and 3 is compared to when $i = 4$. E_{it} ,where $i = 1,2,3$ and $t = 1, \ldots, T$, is defined as follows;

$$E_{it} = \begin{cases} 0.8 & \text{In March for years where Easter is of class } i \\ -1 & \text{In April for years where Easter is of class } i \\ 0 & \text{Otherwise.} \end{cases}$$

The Easter variable used is actually $(E_{it} - \overline{E}_{it})$, where $\overline{E}_{it}$ is the long run monthly means calculated for March and April, computed over the interval 1986-2019. The variable is 0 except for March and April. The predefined calendar regression variables used in the X-12-ARIMA seasonal adjustment program are mean centred in a similar fashion, see U.S. Census Bureau (2011, Table 4.1). The calculated Easter regressors are shown in Figures 3.a, 3.b and 3.c and the values are given in Appendix 1.

The value 0.8 (rather than 1) is used for March because March is a 5 week SRP. Therefore a fixed amount of retail sales moving from a 4 week SRP to a 5 week SRP would have a different impact on the 4 week period as opposed to the 5 week period.

Figure 3.a: Class 1 Easter Regressor for 2000-2019

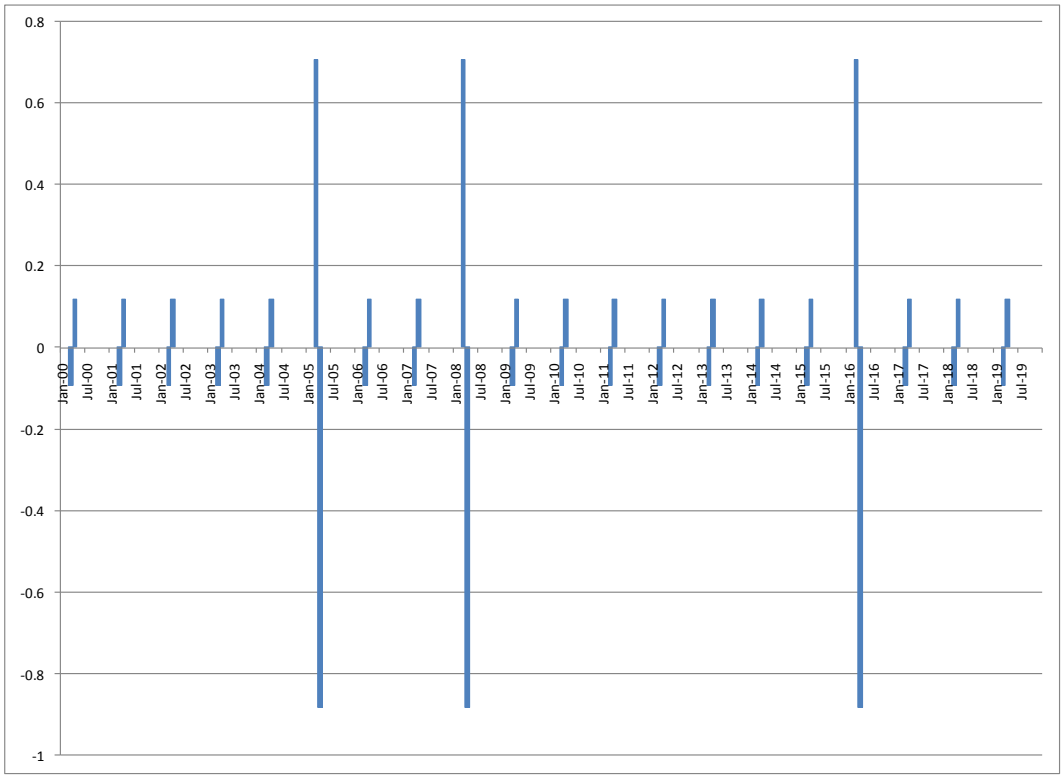


Figure 3.b: Class 2 Easter Regressor for 2000-2019

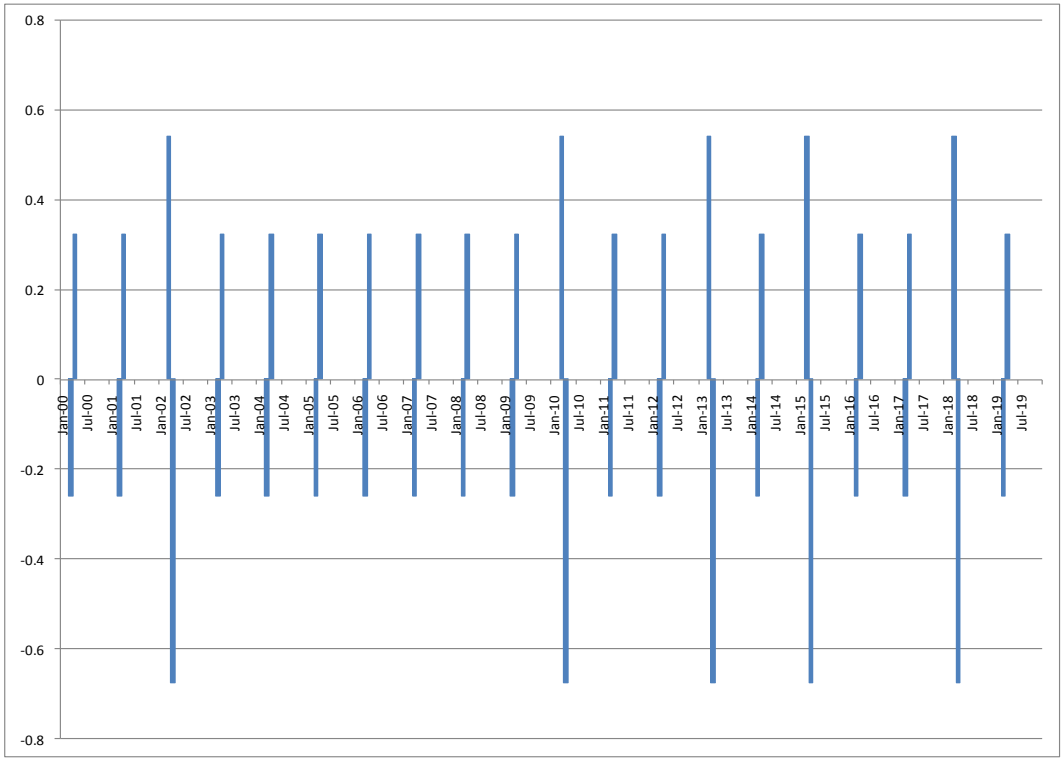
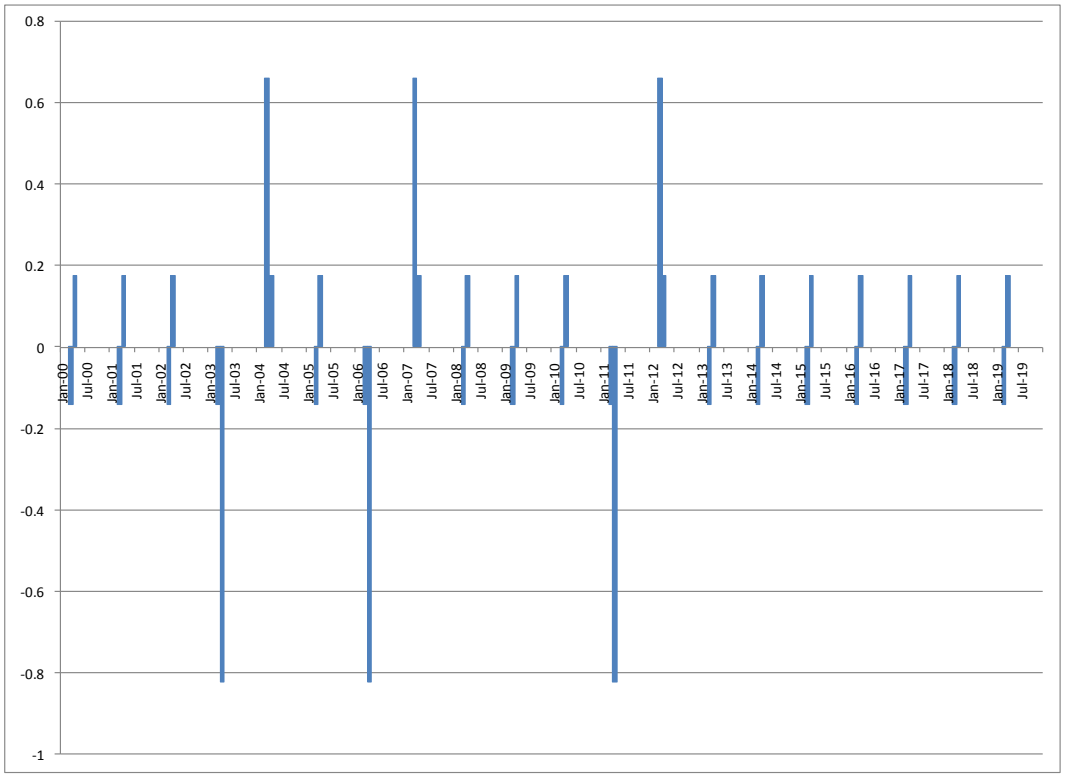


Figure 3.c: Class 3 Easter Regressor for 2000-2019



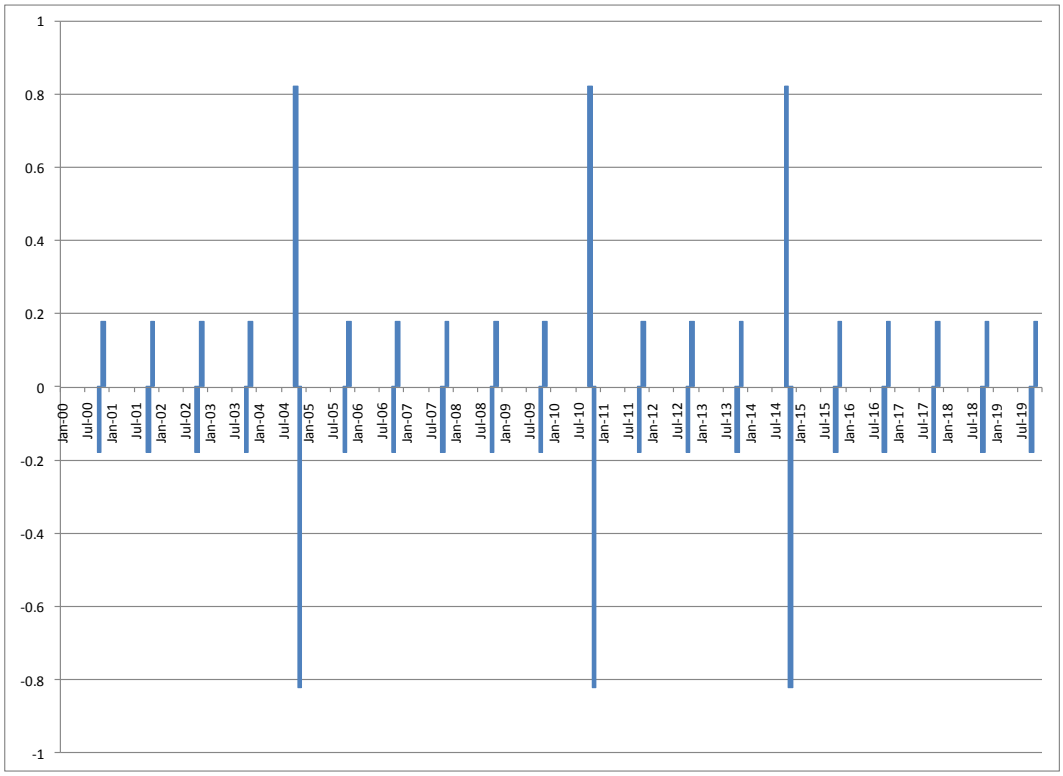
October Bank Holiday

The movement of the SRPs also results in the October bank holiday switching between the October and November SRP. The bank holiday occurs on the last Monday in October. The October bank holiday regressor is defined as follows:

$$OBH_t = \begin{cases} 1 & \text{In October, for years where the bank holiday is in the October SRP} \\ -1 & \text{In November, for years where the bank holiday is in the October SRP} \\ 0 & \text{otherwise} \end{cases}$$

Again the variable used is $(OBH_t - \overline{OBH_t})$, where $\overline{OBH_t}$ is the long run monthly mean computed over the interval 1992-2019. The calculated October Bank Holiday regressor is shown in Appendix 1. The calculated October Bank Holiday regressor is shown in Figures 4 and the values are given in Appendix 1.

Figure 4: October Bank Holiday Regressor for 2000-2019



Current Seasonal Adjustment Practices

The regARIMA models for each of the 44 published RSI time series are reviewed on an annual basis. The test procedure involves testing each of the in-built regressors for statistical significance. In keeping with Jones (2003) the 3 Easter regressors are tested jointly and are included in the model for a time series if the regressors are jointly significant at the 5% level of significance. X-12-ARIMA produces χ^2-statistics to assess the significance of groups of regression parameters, see U.S. Census Bureau (2011, section 4.3). Similarly, the October Bank Holiday regressor is jointly tested for statistical significance with the October and November phase shift regressor.

The remaining 10 phase shift regressors[9] are individually tested for statistical significance, using the standard t-test. Individual phase shift regressors are included in the model if a t-statistic value greater than 1.96 is observed.

Three other types of regression variables are included in the regARIMA models. These are level shifts, additive outliers and temporary changes. The variables model abrupt changes in the level of the unadjusted series. If these outliers are detected and are found to be significant they need

[9] January, February, March, April, May, June, July, August, September and December phase shift regressors.

to be removed from the series prior to seasonal adjustment in order to ensure high quality seasonal adjustment. The X-12-ARIMA program can automatically identify these abrupt changes and regressors are included[10] in the model to remove their effect. Alternatively, if knowledge of a time-series suggests that a potential outlier exists due to some known event then this outlier can be tested for statistical significance and included if appropriate.

The X-12-ARIMA program will automatically select the best ARIMA model parameters that fit the residuals of the regression model. X-12-ARIMA will also output diagnostics in the form of graphs, statistics and tables. These diagnostics are reviewed to ensure that each model is adequate. If the model diagnostics for any series are found to be unsatisfactory then the automatically selected model can be revised to remedy any outstanding issues. For more details on diagnostics checking see ONS (2007), Eurostat (2009) McDonald-Johnson et al. (2010) and U.S. Census Bureau (2011).

To avoid continuous revisions models are held constant for one year. However, for each series, seasonal adjustment factors are re-calculated each month as each new data point becomes available. This practice is referred to as partial-concurrent seasonal adjustment and this is best practice as recommended by Eurostat (2009).

Seasonal adjustment is conducted using the direct seasonal adjustment approach. Using this approach each aggregate series is independently seasonally adjusted without reference to its (seasonally adjusted) component series. Adopting the direct seasonal adjustment approach, as opposed to the in-direct approach, ensures optimal seasonal adjustment in the composite series but in some cases this may be at the cost of consistency and additivity in relation to the component series. The issue is particularly salient for the RSI time series as the Motor Trade series has a completely different seasonal pattern to other retail series. Whether it is appropriate to use a direct versus an indirect approach to seasonal adjustment is very much an open question in the literature. And neither the ONS (2007) nor Eurostat (2009) state clearly their preferences for the competing methods.

One other development that should be mentioned is the recent availability of Version 1.0 of X-13ARIMA-SEATS from the U. S. Census Bureau. The key difference in this program is the inclusion of the ARIMA model-based seasonal adjustment program developed at the Bank of Spain by Victor Gomez and Agustin Maravall. However, the U.S. Census Bureau advise that for the vast majority of series, this version of X-13ARIMA-SEATS will produce X-11 seasonal adjustments that are identical to those generated by the last release of X-12-ARIMA. For more information see U.S. Census Bureau (2012).

[10] They can be programmed to be included automatically with t-values for automatic inclusion set above 3.

Summary

High quality seasonally adjusted retail sales figures are critical to providing accurate signals on the Irish economy. The X-12-ARIMA program, developed by the U.S. Census Bureau, facilitates the CSO to conduct seasonal adjustment to the highest international standards. However the 4-4-5 reporting system adopted by the CSO in collecting the retail figures generates atypical calendar effects into the final unadjusted retail sales time series figures. These atypical calendar effects, i.e. Easter effects, October Bank Holiday effect and the phase shift effects, can not be dealt with using the in-built regressor within the X-12-ARIMA program. Adopting a methodology developed by the ONS, the CSO have constructed purpose built regressors to model these atypical effects. The construction of these purpose built regressors has been outlined in this paper.

X-12-ARIMA also allows outliers in a time series, i.e. additive outliers, level shifts and temporary changes, to be modelled to improve the quality and reliability of the final seasonally adjusted figures. In line with international best practice retail sales regARIMA models are reviewed on an annual basis, however actual seasonal adjustment factors are updated every month. The practices and procedures adopted by the CSO have resulted in much higher quality and more reliable seasonally adjusted information on the Irish retail sector.

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Appendix 1
The User Defined Regressors for the RSI

RSI: Phase Shift Regressors, Easter Regressors, October Bank Holiday Regressor

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Eas1	Eas2	Eas3	OBH
Jan-07	-0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb-07	0	-0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar-07	0	0	0.5	0	0	0	0	0	0	0	0	0	-0.09	-0.26	0.659	0
Apr-07	0	0	0	0.5	0	0	0	0	0	0	0	0	0.118	0.324	0.176	0
May-07	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
Jun-07	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0
Jul-07	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
Aug-07	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0
Sep-07	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0
Oct-07	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	-0.18
Nov-07	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0.179
Dec-07	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0
Jan-08	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb-08	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar-08	0	0	2.5	0	0	0	0	0	0	0	0	0	0.706	-0.26	-0.14	0
Apr-08	0	0	0	2.5	0	0	0	0	0	0	0	0	-0.88	0.324	0.176	0
May-08	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0
Jun-08	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0
Jul-08	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0
Aug-08	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0
Sep-08	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0
Oct-08	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	-0.18
Nov-08	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0.179
Dec-08	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0
Jan-09	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb-09	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar-09	0	0	3.5	0	0	0	0	0	0	0	0	0	-0.09	-0.26	-0.14	0
Apr-09	0	0	0	3.5	0	0	0	0	0	0	0	0	0.118	0.324	0.176	0
May-09	0	0	0	0	3.5	0	0	0	0	0	0	0	0	0	0	0
Jun-09	0	0	0	0	0	3.5	0	0	0	0	0	0	0	0	0	0
Jul-09	0	0	0	0	0	0	3.5	0	0	0	0	0	0	0	0	0
Aug-09	0	0	0	0	0	0	0	3.5	0	0	0	0	0	0	0	0
Sep-09	0	0	0	0	0	0	0	0	3.5	0	0	0	0	0	0	0
Oct-09	0	0	0	0	0	0	0	0	0	3.5	0	0	0	0	0	-0.18
Nov-09	0	0	0	0	0	0	0	0	0	0	3.5	0	0	0	0	0.179
Dec-09	0	0	0	0	0	0	0	0	0	0	0	3.5	0	0	0	0
Jan-10	3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb-10	0	3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar-10	0	0	-2.5	0	0	0	0	0	0	0	0	0	-0.09	0.541	-0.14	0
Apr-10	0	0	0	-2.5	0	0	0	0	0	0	0	0	0.118	-0.68	0.176	0
May-10	0	0	0	0	-2.5	0	0	0	0	0	0	0	0	0	0	0
Jun-10	0	0	0	0	0	-2.5	0	0	0	0	0	0	0	0	0	0
Jul-10	0	0	0	0	0	0	-2.5	0	0	0	0	0	0	0	0	0
Aug-10	0	0	0	0	0	0	0	-2.5	0	0	0	0	0	0	0	0
Sep-10	0	0	0	0	0	0	0	0	-2.5	0	0	0	0	0	0	0
Oct-10	0	0	0	0	0	0	0	0	0	-2.5	0	0	0	0	0	0.821
Nov-10	0	0	0	0	0	0	0	0	0	0	-2.5	0	0	0	0	-0.82
Dec-10	0	0	0	0	0	0	0	0	0	0	0	-2.5	0	0	0	0
Jan-11	-2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb-11	0	-2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar-11	0	0	-1.5	0	0	0	0	0	0	0	0	0	-0.09	-0.26	-0.14	0
Apr-11	0	0	0	-1.5	0	0	0	0	0	0	0	0	0.118	0.324	-0.82	0
May-11	0	0	0	0	-1.5	0	0	0	0	0	0	0	0	0	0	0
Jun-11	0	0	0	0	0	-1.5	0	0	0	0	0	0	0	0	0	0
Jul-11	0	0	0	0	0	0	-1.5	0	0	0	0	0	0	0	0	0
Aug-11	0	0	0	0	0	0	0	-1.5	0	0	0	0	0	0	0	0
Sep-11	0	0	0	0	0	0	0	0	-1.5	0	0	0	0	0	0	0
Oct-11	0	0	0	0	0	0	0	0	0	-1.5	0	0	0	0	0	-0.18
Nov-11	0	0	0	0	0	0	0	0	0	0	-1.5	0	0	0	0	0.179
Dec-11	0	0	0	0	0	0	0	0	0	0	0	-1.5	0	0	0	0

Appendix 2
Retail Sales Index – Seasonal Adjustment
Model Information

Series	ARIMA Model	Seasonal Moving Average	Trend Moving Average	M7 Stat.	Regressors
b1val - Motor Trade (value)	Log (0 1 1)(0 1 1)	3x1 3x3 3x3 3x9 3x3 3x3 3x3 3x3 3x3 3x5 3x3 3x3 3x3	13	0.19	AO2008.Jul + LS2009.Jan + AO2010.jan + AO2010.Dec + AO2011.dec + Easter 1-3
b1vol - Motor Trade (volume)	Log (0 1 1)(0 1 1)	3x1 3x3 3x3 3x9 3x3 3x3 3x3 3x3 3x3 3x5 3x3 3x3 3x3	13	0.19	AO2008.jul + LS2009.Jan + AO2010.jan + AO2010.dec + AO2011.dec + Easter 1-3
b2val - NSS (value)	Log (0 1 1)(0 1 1)	3x3	9	0.2	AO2002.nov + AO2003.Apr + AO2007.feb + LS2007.jul + Easter 1-3 + Apr + Dec
b2vol - NSS (Volume)	Log (0 1 1)(0 1 1)	3x3 3x3 3x3 3x3 3x5 3x5 3x3 3x3 3x3 3x5 3x3 3x1	13	0.2	AO2002.nov + AO2003.Apr + AO2007.feb + LS2007.jul + Easter 1-3 + Apr + Dec
b3val - Dept. Stores (Value)	(Log (0 1 1)(0 1 1)	3x5	13	0.1	LS2009.Feb
b3vol - Dept Stores (Volume)	Log (0 1 1)(0 1 1)	3x5	13	0.11	LS2009.Feb
b4val - Food, Beverages & Tobacco (Value)	Log (2 1 0)(0 1 1)	3x3 3x5 3x5 3x5 3x5 3x3 3x3 3x5 3x3 3x5 3x5 3x3	13	0.14	Easter 1-3 + Feb + Mar
b4vol - Food, Beverages & Tobacco (Volume)	Log (2 1 0)(0 1 1)	3x3 3x5 3x5 3x5 3x5 3x3 3x3 3x5 3x3 3x5 3x5 3x3	23	0.14	Easter 1-3 + Feb + Mar
b5val - Fuel (Value)	Log (0 1 1)(0 1 1)	3x5	13	0.79	LS2008.Nov + AO2010.jan + AO2010.dec + Aug + Oct + Nov + OBH
b5vol - Fuel (Volume)	Log (0 1 1)(0 1 1)	3x3	13	0.89	TC2005.jan + AO2005.oct + LS2008.jun + AO2010.jan + AO2010.dec + Aug + Oct + Nov + OBH

b6val - Pharmaceuticals, Medical & Cosmetic Articles (Value)	Log (0 1 1)(0 1 1)	3x3	13	0.2	LS2009.Sep + Eas 1-3 + Jan + Apr + May
b6vol - Pharmaceuticals, Medical & Cosmetic Articles (Volume)	Log (0 1 1)(0 1 1)	3x5	13	0.2	LS2009.Sep + Eas 1-3 + Jan + Apr + May
b7val - Clothing, Footwear & Textiles (Value)	Log (0 1 1)(0 1 1)	3x3	13	0.1	AO2008.May + Eas 1-3 + Apr + May + Oct + Nov + OBH
b7vol - Clothing, Footwear & Textiles (Volume)	Log (0 1 1)(0 1 1)	3x3	13	0.11	TC2007.Apr + AO2008.May + Eas 1-3 + Apr + May + Oct + Nov + OBH
b8val - Furniture & Lighting (Value)	Log (0 1 1)(0 1 1)	3x5	13	0.45	LS2009.aug
b8vol - Furniture & Lighting (Volume)	Log (0 1 1)(0 1 1)	3x5	13	0.46	LS2009.aug
b9val - Hardware, Paints & Glass (Value)	Log (0 1 1)(0 1 1)	3x5	13	0.24	AO2003.may + AO2007.apr + Eas 1-3
b9vol - Hardware, Paints & Glass (Volume)	Log (0 1 1)(0 1 1)	3x5	13	0.25	AO2003.may + AO2007.apr + Eas 1-3
b10val - Electrical Goods (Value)	Log (0 1 1)(0 1 1)	3x5	13	0.1	AO2000.Nov + AO2006.jun
b10vol - Electrical Goods (Volume)	Log (0 1 1)(0 1 1)	3x5	13	0.11	AO2000.nov + AO2006.jun

b11val - Books, Newspapers & Stationery (Value)	Log (0 1 1)(0 1 1)	3x3	13	0.14	Eas 1-3 +Apr + Jun + Oct + Nov + OBH
b11vol - Books, Newspapers & Stationery (volume)	Log (0 1 1)(0 1 1)	3x5	13	0.14	Eas 1-3 +Apr + Jun + Oct + Nov + OBH
b12val - Other Retail Sales (Value)	Log (0 1 1)(0 1 1)	3x9 3x5 3x9 3x5 3x5 3x5 3x5 3x3 3x3 3x5 3x9 3x9	13	0.04	AO2001.Dec + LS2007.may + LS2008.Nov + TC2010.Feb +AO2012.Apr + Eas 1-3
b12vol - Other Retail Sales (volume)	Log (0 1 1)(0 1 1)	3x5 3x3 3x5 3x3 3x5 3x5 3x5 3x3 3x3 3x3 3x5 3x9	13	0.05	AO2001.Dec + LS2007.may + TC2010.Feb + AO2011.feb + AO2011.Apr + Eas 1-3
b14val - Bars (value)	Log (0 1 1)(0 1 1)	3x5 3x3 3x9 3x5 3x9 3x5 3x5 3x9 3x5 3x9 3x3 3x5	13	0.15	AO2004.mar + Eas 1-3 + Oct + Nov + OBH
b14vol - Bars (volume)	Log (0 1 1)(0 1 1)	3x5	13	0.15	AO2004.mar + LS2004.apr + User-defined
g1val - All Businesses (value)	Log (0 1 1)(0 1 1)	3x3 3x3 3x5 3x9 3x3 3x5 3x5 3x5 3x9 3x9 3x3 3x3	13	0.21	LS2008.may + AO2008.jul + LS2009.Jan + AO2010.Jan + AO2010.dec + AO2011.dec + Feb + Eas 1-3
g1vol - All Businesses (volume)	Log (0 1 1)(0 1 1)	3x3 3x3 3x5 3x9 3x3 3x9 3x9 3x9 3x9 3x9 3x3 3x3	13	0.22	LS2008.feb + LS2008.may + AO2008.jul + LS2009.Jan + AO2010.Jan + AO2010.dec +AO2011.dec + Feb + Eas 1-3
g2val - All Businesses Excl. Motors (Value)	Log (1 1 2)(0 1 1)	3x5 3x3 3x5 3x3 3x9 3x5 3x5 3x5 3x9 3x9 3x3 3x3	13	0.09	LS2003.May + Mar + Eas 1-3 + Nov

g2vol - All Businesses Excl. Motors (Volume)	Log (1 1 0)(0 1 1)	3x5 3x3 3x5 3x3 3x9 3x3 3x5 3x5 3x5 3x9 3x3 3x5	13	0.06	LS2003.may + Mar + Eas 1-3 + Nov
g3val - All Businesses Excl. Motors & Bars (Value)	Log (0 1 2)(0 1 1)	3x5 3x3 3x5 3x3 3x5 3x3 3x3 3x5 3x9 3x5 3x3 3x3	9	0.1	LS2003.May + Eas 1-3
g3vol - All Businesses Excl. Motors & Bars (Volume)	Log (0 1 1)(0 1 1)	3x5 3x3 3x5 3x5 3x9 3x5 3x9 3x5 3x5 3x9 3x5 3x5	13	0.05	LS2002.Jan + AO2003.May + Eas 1-3
g4val - Motors & Fuel (value)	Log (0 1 1)(0 1 1)	3x3 3x3 3x3 3x3 3x3 3x3 3x3 3x5 3x5 3x5 3x3 3x3	13	0.16	LS2008.may + AO2008.Jul + LS2009.Jan + AO2010.Jan + AO2010.Dec + AO2011.dec +User-defined
g4vol - Motors & Fuel (volume)	Log (0 1 1)(0 1 1)	3x3 3x3 3x3 3x5 3x3 3x3 3x5 3x5 3x9 3x5 3x3 3x3	13	0.16	LS2008.may + AO2008.Jul + LS2009.Jan + AO2010.Jan + AO2010.Dec + AO2011.dec + Eas 1-3
g5val - All Businesses Excl. Motors, Fuel & Bars (Value)	Log (0 1 2)(0 1 1)	3x3 3x3 3x5 3x3 3x5 3x3 3x3 3x5 3x5 3x5 3x3 3x3	9	0.1	AO2000.dec + AO2003.apr + Eas 1-3
g5vol - All Businesses Excl. Motors, Fuel & Bars (Volume)	Log (2 1 2)(0 1 1)	3x5 3x3 3x5 3x3 3x9 3x3 3x5 3x9 3x5 3x9 3x3 3x3	13	0.06	AO2000.dec + AO2002.jan + AO2003.may + Eas 1-3

g6val - All Businesses Excl. Motors, Fuel & Bars_Food Businesses (Value)	Log (0 1 1)(0 1 1)	3x3 3x5 3x3 3x3 3x5 3x3 3x3 3x3 3x3 3x5 3x3 3x3	9	0.16	AO2003.apr + AO2007.feb + Dec + Eas 1-3
g6vol - All Businesses Excl. Motors, Fuel & Bars_Food Businesses (Volume)	Log (0 1 1)(0 1 1)	3x3 3x3 3x3 3x3 3x9 3x3 3x3 3x3 3x3 3x5 3x3 3x3	13	0.16	AO2003.Apr + AO2007.feb + Dec + Eas 1-3
g7val - All Businesses Excl. Motors, Fuel & Bars_Non-Food Businesses(Value)	Log (3 1 0)(0 1 1)	3x3 3x3 3x5 3x3 3x9 3x5 3x5 3x3 3x9 3x5 3x3 3x3	13	0.08	AO2000.dec + LS2010.feb
g7vol - All Businesses Excl. Motors, Fuel & Bars_Non-Food Businesses(Volume)	Log (3 1 0)(0 1 1)	3x3 3x3 3x5 3x3 3x5 3x5 3x3 3x3 3x5 3x3 3x3 3x3	13	0.07	AO2000.dec + AO2002.jan + LS2010.feb
g8val - Household Equipment (value)	Log (3 1 1)(0 1 1)	3x3 3x3 3x3 3x5 3x5 3x5 3x9 3x5 3x5 3x3 3x3 3x3	13	0.11	AO2000.nov + AO2000.dec + TC2001.oct + LS2007.jan
g8voll - Household Equipment (volume)	Log (3 1 1)(0 1 1)	3x3 3x3 3x5 3x5 3x5 3x5 3x3 3x5 3x5 3x3 3x3 3x3	13	0.13	TC2001.oct + LS2007.feb

g9val - Books, Newspapers Stationery & Other Goods (value)	Log (1 1 0)(0 1 1)	3x5 3x3 3x5 3x3 3x5 3x5 3x5 3x3 3x5 3x9 3x3 3x5	13	0.04	AO2001.Dec + LS2007.May + LS2008.Nov + LS2009.Oct + LS2010.Feb + AO2011.Apr
g9vol - Books, Newspapers Stationery & Other Goods (volume)	Log (0 1 1)(0 1 1)	3x9 3x3 3x9 3x5 3x5 3x5 3x5 3x3 3x5 3x5 3x5 3x5	13	0.04	AO2001.dec + LS2007.May + TC2010.Feb + AO2011.Apr + Eas 1-3