Review of Concurrent Adjustment for Retail and its Application to QEAS

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1. Abstract

1. The concurrent seasonal adjustment methodology was adopted by retail trade in April 2000 and has provided estimates that approach the final series rapidly with no increase in provider burden or operational costs. In this paper the merits of applying the concurrent adjustment methodology to a monthly series are reviewed and the potential advantages for quarterly series discussed. Concurrent adjustment is particularly useful when surveys are undergoing methodological change. A case in point is the integration of business surveys into the Quarterly Economic Activity Survey (QEAS). Concurrent adjustment will be more responsive, than the current seasonal adjustment method, to methodological and questionnaire changes affecting the component survey data, providing consistent and coherent seasonal adjusted data. A simulation on QEAS data shows that there are substantial gains in accuracy for concurrently adjusting quarterly series. We therefore recommend introducing concurrent adjustment to this survey.

2. Introduction

2. The Australian Bureau of Statistics (ABS) uses an enhanced version of the X-11 seasonal adjustment package (Shiskin et al. 1967). This process assumes that an original time series can be decomposed into trend, seasonal and irregular, or residual, components. The seasonal component is estimated and removed from the original series to produce seasonally adjusted estimates, from which the irregular component can be smoothed to estimate the trend. For example under a multiplicative decomposition model;

$$O_t = T_t \times S_t \times I_t$$
$$SA_t = O_t / S_t$$
$$= T_t \times I_t$$

Where O_t and SA_t are the original and seasonally adjusted series at time t while T, S, I are the trend, seasonal and irregular components. Unlike model based time series analysis the irregular is not necessarily random and instead is defined to be the residual once the trend and seasonal components have been estimated.

3. Traditionally the ABS has adopted a forward factor analysis approach to seasonal adjustment. Under this method seasonal factors are generally estimated once per year, at the time of annual analysis, and seasonal factor forecasts for the following year are produced according to the following extrapolation formula;

$$S_t = S_{t-p} + \frac{1}{2}\left(S_{t-p} - S_{t-2p}\right) \qquad (2.1)$$

Where S_t is the seasonal factor calculated for use at time t and p is the periodicity of the data. The forward factor approach has the advantages that it is fast to compute and validate, and that it produces static seasonal factor estimates that will only be revised once per year.

4. The concurrent adjustment methodology is a relatively computationally intensive seasonally adjustment method requiring re-estimation of all of the seasonal factors each period as more data becomes available. However, technological advances have now made it possible to apply the concurrent adjustment method with little operational burden, or cost, at considerable speed. Unlike forward factor estimation no explicit

forecasting of the seasonal factors is required under concurrent adjustment as all of the available data is utilised each period to estimate the current seasonal factor. Under concurrent adjustment, the seasonal factors will also be more responsive to underlying changes than forward factors (ABS, 1999).

5. Concurrent seasonal adjustment methods are widely used by the international statistical community (see Appendix 1). Research by Wallis K.F., (1982) and Kenny P.B. & Durbin J., (1982) has highlighted the efficiency of the concurrent seasonal adjustment method. At the US Bureau of the Census, who developed the X-11 seasonal adjustment software package, initial studies (e.g McKenzie S.K. 1982) found an improvement in the order of a 12% reduction in the root mean square error of movement estimates. More recent studies (e.g. Pierce D.A. & McKenzie S.K., 1985 and Bobbit L. & Otto M. 1990) have extended this research to show the benefits of applying non-default seasonal adjustment options and model-based forecasts to concurrently adjusted series. Research in the ABS has shown considerable gains in accuracy can be realised by applying concurrent methods to ABS time series (e.g. ABS, 1999).

6. In April 2000 the retail trade series became one of the first Main Economic Indicators (MEIs) in the ABS to apply concurrent seasonal adjustment in the production environment. For this series, testing showed that concurrent adjustment would be a reliable and responsive method which would produce more accurate estimates than forward factor adjustment; although concurrent estimates will be subject to more frequent revision than under a forward factor adjustment regime. With the benefit of additional data it is now possible to review the performance of concurrent adjustment on the ABS retail series. This paper presents the key results for this series.

7. The ABS is currently integrating several business surveys into a single survey called the Quarterly Economic Activity Survey (QEAS). The current publications that fall within the scope of the QEAS are: the Wage and salary earners (ABS, 2000a); Company Profits (ABS, 2000b) and; Inventories and sales, selected industries (ABS, 2000c). At present, of the series that will be integrated to form the QEAS, only company profits is adjusted concurrently while the remaining series are seasonally adjusted with the forward factor approach.

8. During the integration of QEAS, changing to a concurrent adjustment methodology would allow the seasonal adjustment process to be more responsive to changes in the component surveys and ensure that a consistent seasonal adjustment methodology is applied throughout QEAS.

9. This paper presents a summary of investigations into the applicability of concurrent adjustment for retail, a review of its performance over the last 12 months (Section 3) and demonstrates how the concurrent adjustment methodology can be applied to ease the phase-in of the Quarterly Economic Activity Survey (QEAS), providing ongoing gains (Section 4). The implications of these results on ABS revision policy is presented in Section 5 while a concluding summary is presented in Section 6.

3. Review of concurrent seasonal adjustment for retails

10. Concurrent adjustment was extensively tested on retail trade data and introduced into the production environment in April 2000. It was demonstrated (ABS, 1999) that there would be extensive gains in accuracy from adopting a concurrent adjustment methodology in retail. The timing of this introduction was appropriate as concurrent estimation of seasonal factors is more responsive to exogenous influences such as those affecting retail data during the Olympics and the introduction of The New Tax System (TNTS). A review of the impact of TNTS on the Retail Trade series and how it

was to be treated and measured has been prepared by the ABS (ABS, 2000d).

11. Any estimate made of a particular period is subject to revision when more future data becomes available. For example the January 2000 initial estimate is the estimate using data up to January 2000. However this initial estimate is subject to substantial revision as future data points become available. When more than three years of subsequent data becomes available the estimates for a given month would be relatively stable (i.e. expected to be subject to very little revision). This 'historical' seasonally adjusted series is referred as the benchmark in this paper.

12. An example of the difference in estimation levels for the concurrent and forward factor methodologies for a single period of total Australian retail can be seen in Figure 3.1 below. It can be seen that the initial (December 1991) concurrent estimate for December 1991 was generally underestimated while the initial forward factor estimate was even further from the benchmark. The initial forward factor estimate used seasonal factors estimated in July 1991, the time of the last annual reanalysis and therefore the forward factor estimate for December 1991 would continue to remain unrevised until the next reanalysis in July 1992. In comparison the concurrent estimate would continue to be revised as additional data became available. In addition, the December 1991 seasonally adjusted estimate for retail converged to the benchmark more quickly than the forward factor estimates. Figure 3.1 shows that the concurrent December 1991 estimate at June 1994, has reached the benchmark estimate, while the forward estimate still faces substantial revision.

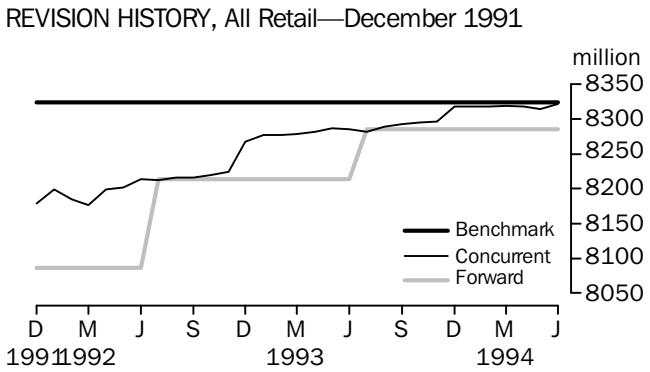

Figure 3.1: Revision history of Total Retail Trade December 1991 seasonally adjusted estimates

13. It can be seen in Figure 3.1 above that while the concurrent seasonally adjusted estimate is generally more accurate, i.e. will be closer to the benchmark, than the forward factor estimate, it is revised more frequently. In the forward factor case, revisions to the seasonally adjusted estimate occur only once per year at the annual re-analysis period, while under concurrent analysis the seasonally adjusted estimates are revised every period. In each case the revision of the data represents an improvement in the estimate as we utilise more of the available data and although the revision will not necessarily move the seasonally adjusted estimate closer to the final, or benchmark, estimate the revised estimate will always be more appropriate than the unrevised estimate based on the available data. In general it would be expected that the forward factor method will be less accurate for estimating the seasonal factors as it always applies forecasted seasonal factors while concurrent adjustment has the advantage that it will revise seasonal factors immediately.

14. The difference in the estimated level of a series, for a single time period was presented in Figure 3.1 above. The relative performance of forward factor and concurrent adjustment can be summarised by examining the average revision graph.

15. The revision against the benchmark can be interpreted as the total level of revision required for an estimate to reach the benchmark (or final) estimate; i.e. the estimate for a particular time t after more than 3 years (T) of additional data becomes available. It represents the total remaining revision between the current estimate of k periods ago (at lag k) to the final estimate.

16. The revision for each estimate, is defined in equation (3.1) following;

$$R_{t,k}^{X} = 100\frac{(\hat{X}_{t,k} - X_{t,T})}{X_{t,T}} \qquad (3.1)$$

Where $\hat{X}_{t,k}$ is the estimate of the quantity of interest, such as the level or period to period movement of the seasonally adjusted series, for time period t made using all of the information available up to time period t+k and $X_{t,T}$ is the corresponding benchmark estimate made using T periods of additional data (usually 3 years).

17. The average absolute revision defined in equation (3.2) following is a summarised statistical measure for the size of the revisions at a particular lag k;

$$\overline{R_k^X} = \frac{1}{n_k}\sum_{t=s}^{e}\left|R_{t,k}^{X}\right| \qquad (3.2)$$

where time t=e is the end point of the simulation, t=s is the start point of the simulation and n_k is the number of observations available in the simulation span at lag k. In other words, it is the average of the absolute revision between the estimate, produced k periods in the future, and the benchmark for that estimate at any time t in the simulation span.

18. The average revision graph presents the average absolute revision calculated from the experience of the series. These graphs show the average revision at particular lags of interest and can be used to indicate both the rate at which the series generally converges to the benchmark and the average level of revision required to reach the benchmark estimate.

19. Revision simulations are generally run on sub-spans of a time series with the sub-spans chosen so that there will be enough prior and subsequent values available to generate a stable estimate. This stable estimate is considered to be a benchmark against which the revision is calculated. Seasonal factor estimates can be generated iteratively for each possible point in this sub-span, assuming that data is only available up to a certain point in the simulation span. The output generated from a revision simulation is a benchmark value and a concurrent (or forward factor) estimate for each time point in the simulation span. Lagged estimates are obtained by using available data at successive time points. For example, a lag zero December 1999 estimate would be the initial estimate using data up to December 1999 while the lag one estimate would be the second estimate of December 1999 using data up to January 2000. As more data becomes available the concurrent estimate is revised to incorporate this new information. Thus for each time point in the simulation span, several concurrent estimates are calculated at different time lags, reflecting the different levels of data available for calculation of the concurrent estimate.

20. Estimates of the revision experience of a sub-span generated during a revision simulation will generally be indicative of the level of revision that can be expected for the entire time series. This expected level of revision can be examined using an average

revision graph. When interpreting the average revision graph, it is important to keep in mind that while concurrent estimates generally converge faster to the benchmark than forward factor estimates, this does not mean that all concurrent estimates will converge faster to the benchmarks. It means only that they converge faster on average. The average revision graph is based on the history of the series and will not necessarily reflect contemporary patterns in the data, though this may be a reasonable assumption for less volatile series.

21. The following series are presented below as representative of the retail trade series and used in a revision simulation to compare the performance of concurrent and forward factor adjustment from the historical data:
    - Retail turnover - Total Australia
    - Retail turnover - NSW
    - Retail turnover - Hospitality and services industry
    - Retail turnover - Food retailing industry
    - Retail turnover - Department stores

    These series were chosen as representative high level aggregates of the retail trade group. Generally it would be expected that there will be greater gains from moving concurrent for the smaller and more volatile disaggregates. Revision simulations have been performed on most of the series in the retail trade group and results for series not presented here are available on request.

22. In the average revision graphs, Figures 3.2 to 3.6 provided below, the points are the average absolute revision, to the level estimates, at the specified lag, while the black and grey lines are the average absolute revisions, to the level estimates, experienced under forward factor and concurrent analysis respectively.

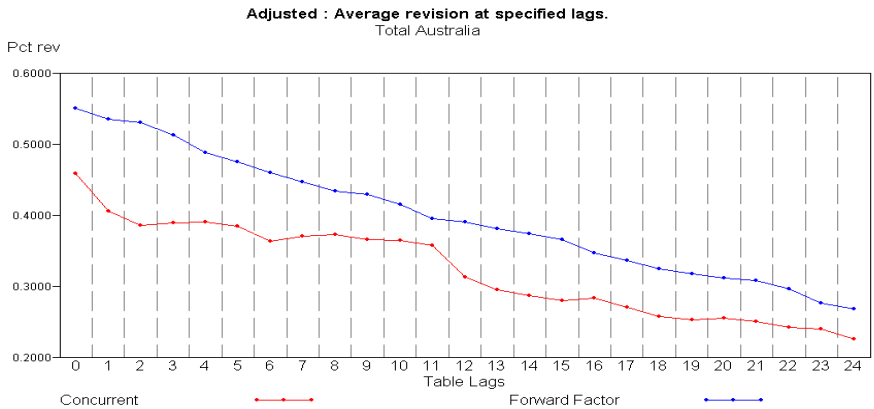

Figure 3.2: Average Revision Graph on Level Estimates of Retail Turnover - Total Australia

23. It is clear from the results shown in Figures 3.2 to 3.6 that on average, the concurrent seasonally adjusted estimates require less revision at each lag than the forward factor estimates and converge more quickly to the benchmark. Concurrent estimates of the seasonally adjusted series will be revised each period as more data becomes available, while forward factor estimates are only revised once per year at the annual reanalysis. Consequently concurrent estimates will generally be more accurate (i.e. closer to the final, or benchmark, value) than forward factor estimates.

24. It can also be seen in the average revision graphs in Figures 3.2 to 3.6 that there are gains, on average, from moving to concurrent analysis at each lag. The average revision path generally decreases indicating that as more subsequent observations become available for use in estimating the seasonal factor the total level of revision required to achieve the final, or benchmark, value decreases on average. In other words, as more

data becomes available, the estimates are generally becoming more accurate. The average level of revision required to reach the benchmark generally decreases smoothly under forward factors, at increasing lags, however there is often a large fall in the average level of revision required to reach the benchmark at lag 12 under concurrent. This occurs when a second observation of the same month becomes available and a better approximation to the symmetric seasonal moving average can be used. Further detail regarding this issue can be found in the technical notes (Section 9).

25. Period to period movements are often of interests. The movement for a period at time t , observed at a lag of k periods , is defined as $C_{t,k} = \frac{X_{t,k} - X_{t-1,k+1}}{X_{t-1,k+1}} \times 100\%$, where X_t is the series of interests. $C_{t,T} = \frac{X_{t,k} - X_{t-1,T}}{X_{t-1,T}} \times 100\%$ is the corresponding benchmark estimate made using T periods of additional data. The revision of the period to period movement of X_t is defined as $RC_{t,k} = C_{t,k} - C_{t,T}$. The Average absolute revision ($\overline{RC_k^X} = \frac{1}{n_k} \sum_{t=s}^{e} \left| RC_{t,k}^X \right|$ see equation 3.2) graphs can also be used to compare the performance of the concurrent and forward factor adjustment methodologies when estimating period to period movements. It is clear from the results shown in Figures 3.7 to 3.11 below that on average, the concurrent estimates of period to period movements in the seasonally adjusted series also require less revision at each lag than the forward factor estimates and converge more quickly to the benchmark.

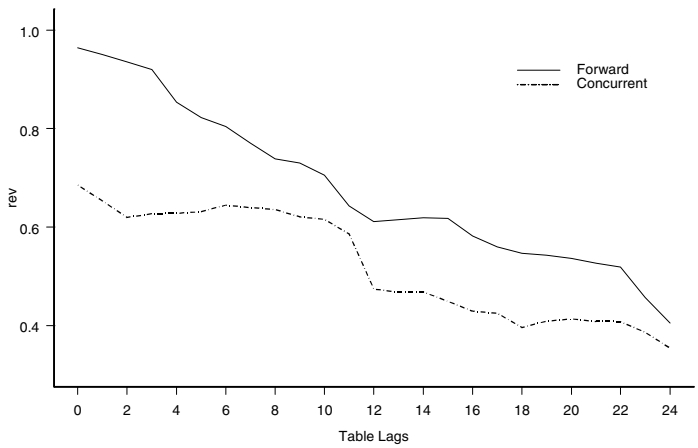

Figure 3.7: Average revision of movement estimates at specified lags - seasonally adjusted total Australian retail

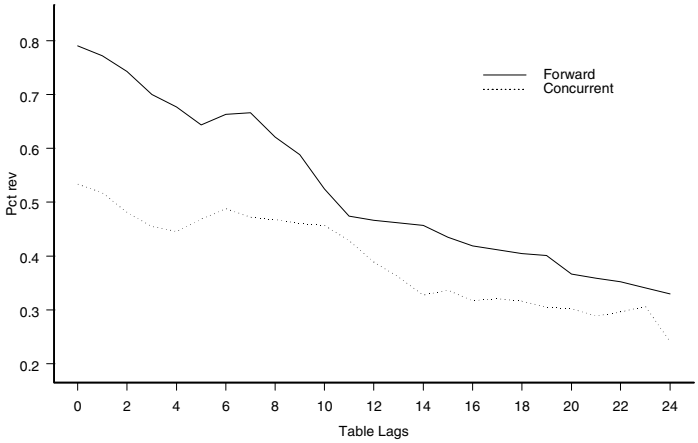

Figure 3.8: Average revision to movement estimates at specified lags - retail turnover, hospitality and services industry

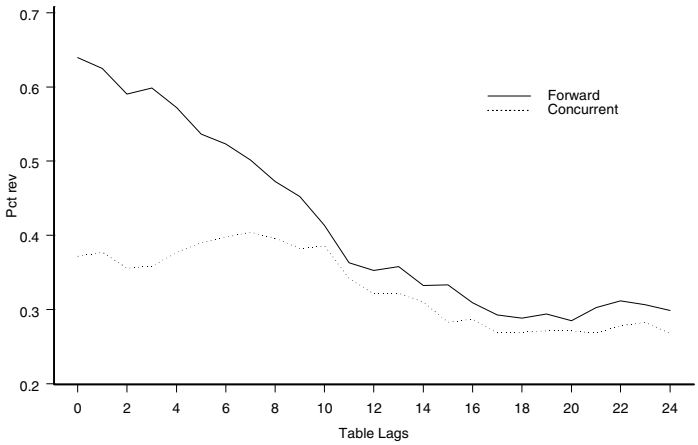

Figure 3.9: Average revision to movement estimates at specifies lags - food retailing industry

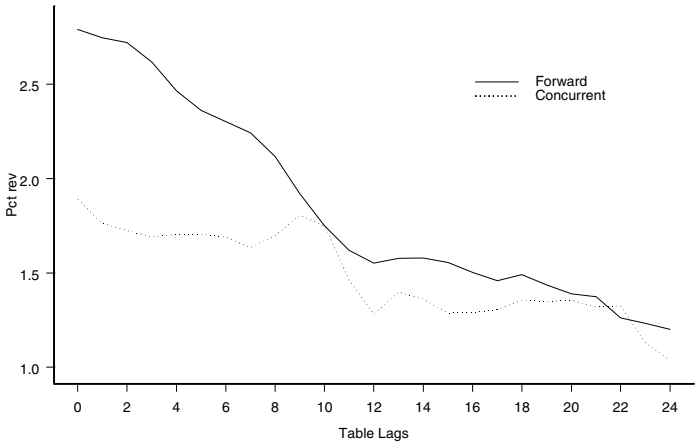

Figure 3.10: Average revision to movement estimates at specified lags - department stores

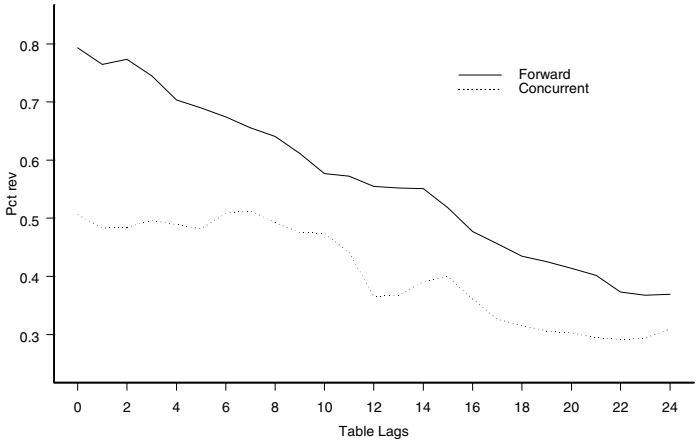

Figure 3.11: Average revision to movement estimates at specified lags - total retail NSW

26. There is generally a positive correlation between the volatility of a time series and the level of gain that could be expected from moving to concurrent analysis. The average absolute percentage change in the residual/irregular component, also referred to as the Stability of Trend and Adjusted series Rating (STAR measure), is a summary measure that can be used to indicate the volatility of a time series. The STAR is defined as in equation (3.3) following;

$$STAR = \frac{1}{N-1}\sum_{t=2}^{N}\left|\frac{100(I_t - I_{t-1})}{I_{t-1}}\right| \qquad (3.3)$$

Where I_t is the irregular component of the series as estimated at time t and N is the number of observations available in the time series. Generally the larger the STAR measure the more volatile the data and the more difficult it is to sufficiently isolate and remove the seasonal components during seasonal adjustment. Empirical testing (Sutcliffe, 2000 and ABS, 1969) has shown that the STAR measure is related to the level of revision that can be expected for a series. It would be expected that where the level of average successive annual revision is likely to be large, the gains from using the concurrent approach increase. Hence the STAR measure may provide users with a prior indication of the potential gains from using concurrent analysis.

27. Table 3.1 following summarises the simulated improvement from applying concurrent adjustment to a number of indicative retail trade series. However, it can be seen that the STAR value of the series does not always indicate the extent of this improvement. In this case the percentage improvement is a simple comparison measure of the average revision required at a specified lag for the estimate to reach the benchmark. This has been defined as follows;

$$\%\text{Improvement at lag k} = 100\left(\frac{\overline{R_k^X}_{ff} - \overline{R_k^X}_{conc}}{\overline{R_k^X}_{ff}}\right)$$

where $\overline{R_k^X}_{ff}$ is the average revision required to reach the benchmark at lag k under forward factor adjustment and $\overline{R_k^X}_{conc}$ is the average revision required to reach the benchmark at lag k under concurrent adjustment.

Table 3.1: Summary of Improvement of Concurrent over Forward Factor Adjustment at Selected Lags

Retail Turnover Series	**STAR**	**Improvement (%) at lag 0**		**Improvement (%) at lag 24**	
Estimate Type		**Level**	**Movement**	**Level**	**Movement**
Total Australia	0.68	16.4	29.6	23.3	11.6
Hospitality and services industry	1.13	20.7	32.1	28.1	24.2
Total NSW	0.89	24.3	36.5	20.0	18.4
Food retailing industry	0.74	30.2	41.5	20.0	12.9
Department stores	2.66	32.4	35.7	31.3	19.2

28. The presented results are based on highly aggregated data, and thus with a relatively low degree of volatility. We would expect the gains from using concurrent to be even greater for the disaggregated lower level series, where the data would be expected to contain a higher degree of volatility. The ABS has examined the performance of the concurrent methodology on many of the component series in the retail trade group and found that there were consistent gains for the group as a whole.

29. It has been shown that there were substantial gains from applying the concurrent methodology on the retail trade series. The concurrent methodology allows the seasonal factor estimation process to be more responsive to external factors causing seasonal factor changes. It is therefore likely that during the Olympics and the introduction of TNTS concurrent adjustment will have been a more responsive and accurate method of seasonal adjustment. This will be assessed in greater detail once at least 2 years of subsequent data becomes available and estimates begin to stabilise.

4. Case for QEAS

30. It has been demonstrated in Section 3 that there are substantial gains from applying the concurrent seasonal adjustment methodology to monthly series such as retail trade. Current ABS policy is to examine surveys on a series by series basis to determine whether concurrent adjustment is more appropriate than the forward factor methodology. While there might still be gains from applying the concurrent methodology for quarterly series these gains would be less substantial than those observed in monthly data. This is because seasonality is often less evident in quarterly series and under the forward factor methodology the seasonal factors would only be forecast for three periods between the annual reanalysis. Despite this it is expected that seasonal factors estimated using all of the available data (i.e. under the concurrent methodology) would be more appropriate than using forecast data and that there should still be substantial gains from applying the concurrent methodology to quarterly series.

31. The ABS is integrating the surveys of Stocks and Sales, Company Profits and Employment and Earnings (SEE) under the discipline of a single survey called the Quarterly Economic Activity Survey (QEAS). The objectives of the QEAS are to (Parsons, 1995),
    i. provide more consistent and coherent quarterly data for the National Accounts;
    ii. provide detailed, comprehensive and timely quarterly, economy-wide economic indicator series;
    iii. provide output measures in the services industries;
    iv. achieve a reduction in perceived provide load, and;
    v. avoid duplication in data collection;

    A parallel run of the QEAS, alongside all existing survey, will occur for the first quarter 2001. The parallel run will continure, but only in respect of SEE, until the last quarter of 2001.

32. There are many methodological changes to be introduced during the switch to QEAS that may potentially affect the seasonality of the component data series. For example the new questionnaire and the backcasting of data may lead to the QEAS exhibiting very different seasonal patterns to that observed in the individual surveys. If the data from the new questionnaire exhibits a radically changed seasonal pattern the concurrent method would allow the seasonal factors to react more quickly and provide more appropriate seasonal factors for use in the seasonal adjustment process. Similarly if the seasonality of the existing data were changed during the backcast, the concurrent method would revise the existing seasonal factor estimates as the next observation became available. In comparison the forward factor method will not revise seasonal factors, neither existing nor forward, until the annual analysis time and will not be very responsive to changes in seasonality introduced during the switch to QEAS.

33. Of the series that will be integrated into QEAS only Company Profits is adjusted concurrently, while the remaining series are seasonally adjusted using forward factors calculated at different annual reanalysis periods. Moving to a concurrent adjustment regime with a consistent annual re-analysis period for all of the QEAS component series

would provide more consistent and coherent seasonally adjusted input data for the national accounts.

34. A number of indicative quarterly series were selected for the purpose of comparison. The selected series were a mixture of high level aggregates which were chosen to cover the breadth of the QEAS. These series reflected many of the characteristics of their components and were generally considered to be representative of the QEAS, however as aggregate series they were often less volatile than their components. Generally it would be expected that concurrent adjustment will return smaller gains for less volatile series as forward factor estimation assumes that the seasonal factors will remain relatively stable over the following year. Hence it would be expected that during a simulation the observed gains of applying the concurrent methodology to these series would be less than for the disaggregative component series. However, it is recognised that some of the component series may generate atypical results and these component series are currently being tested in greater detail.

35. Taking the Survey of Employees and Earnings (SEE) as an example, it can be seen in Figure 4.1 that the initial (3rd Q 1991) concurrent estimate for 3rd Q 1991 was generally underestimated while the initial forward factor estimate was even further from the benchmark. The concurrent estimate is revised each period as more data becomes available and it can be seen in Figure 4.1 that the concurrent estimate approaches the benchmark more rapidly than the corresponding forward factor estimate. Under the situation presented in Figure 4.1 the forward factor estimates of the seasonally adjusted series are only revised once per year and would appear to be more stable to the users, however this apparent stability would come at the cost of less accurate estimates.

36. The following series were chosen to be representative of the QEAS and used in a revision simulation to compare the performance of concurrent and forward factor adjustment from the historical data:
    - Survey of employment and earnings: Total Australian salary and earnings;
    - Inventories and sales: Total manufacturers' sales;
    - Capital expenditure: Total building - Australia;
    - Capital expenditure: Total capital expenditure - Australia.

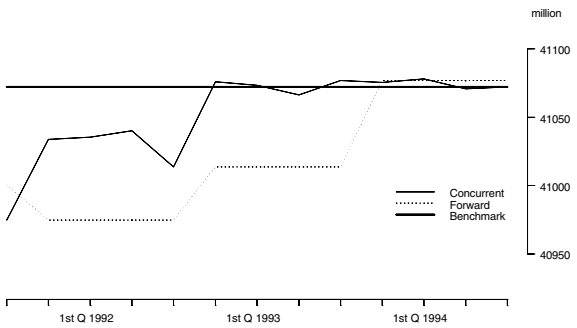

Figure 4.1: Revision history of Total Australian Earnings Third Quarter 1991 seasonally adjusted estimates

37. In Figures 4.2 to 4.6 following average revision graphs on the level estimates have been used to compare the relative performance of the concurrent and forward factor adjustment methodologies for the selected series.

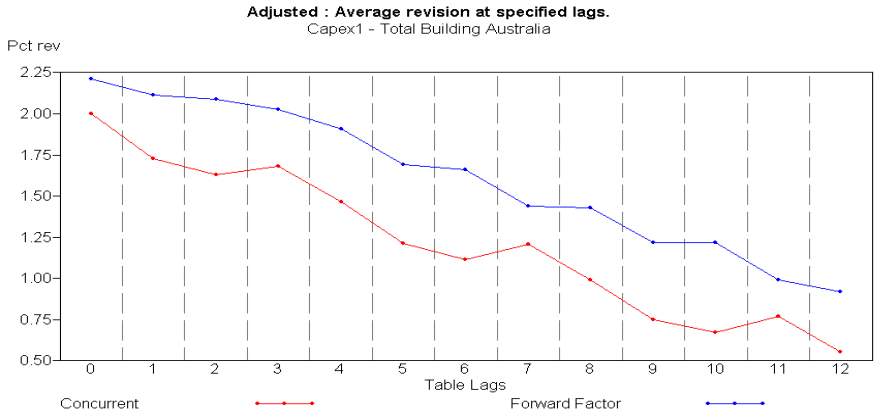

Figure 4.2: Average Revision Graph on Level Estimates of Total Building Australia

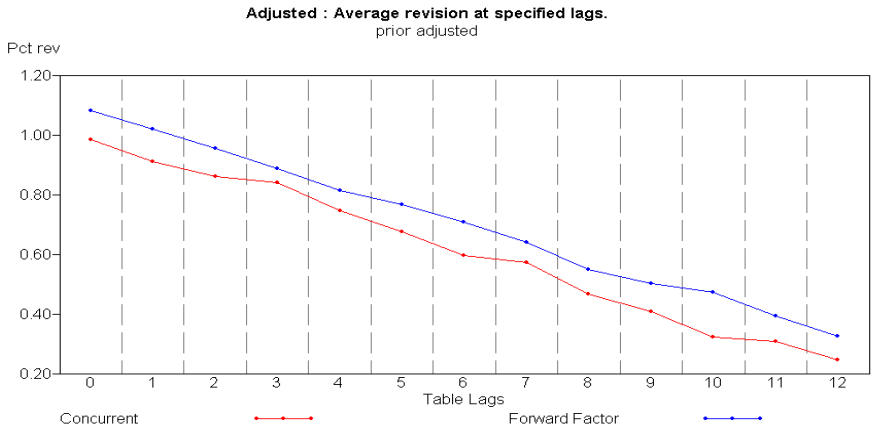

Figure 4.3: Average Revision Graph on Level Estimates of Total Capital Expenditure Australia

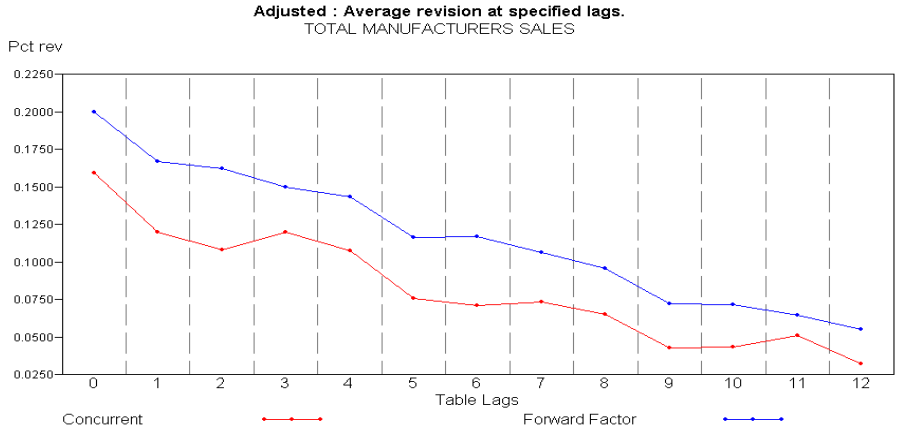

Figure 4.4: Average Revision Graph on Level Estimates of Total Manufacturers Sales

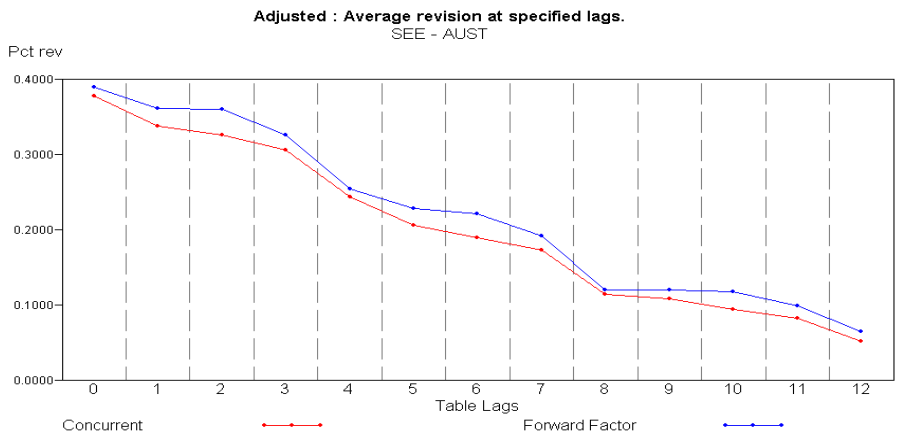

Figure 4.5: Average Revision Graph on Level Estimates of Total Earnings Australia

38. It is clear from the results shown in Figures 4.2 to 4.5 that on average, the concurrent seasonally adjusted estimates require less revision at each lagged estimate than the forward factor estimates and converge more quickly to the benchmark. For the concurrent method there are occasionally 'peaks' in the revision path at lags 3,7 and 11, see Figures 4.2 and 4.4. These 'peaks' indicate that the average level of revision required to achieve a stable estimate increases over the previous lag, that is the addition of more recent data at these lags actually leads to a less accurate estimate. Despite this there are still gains in applying concurrent over forward factor adjustment at these lags. It may seem somewhat counter-intuitive that the addition of more recent data at these lags actually leads to a less accurate estimate, however this effect is generally very minor. This suggests that there is very little gain from revising quarterly estimates once three subsequent observations become available as observations three quarters after the current period have little influence on the level of the current estimate.

39. Figures 4.6 to 4.9 below compare the average revision of the period to period movement estimates experienced under the concurrent and forward factor methodologies in seasonally adjusted QEAS series. It can be seen that on average, the concurrent estimates of period to period movements in the seasonally adjusted series require less revision at each lag than the forward factor estimates and converge more quickly to the benchmark.

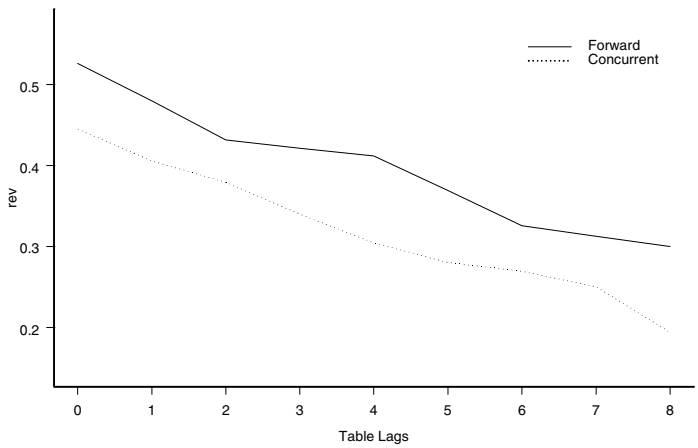

Figure 4.6: Average revision of movement estimates at specified lags - seasonally adjusted total earnings Australia

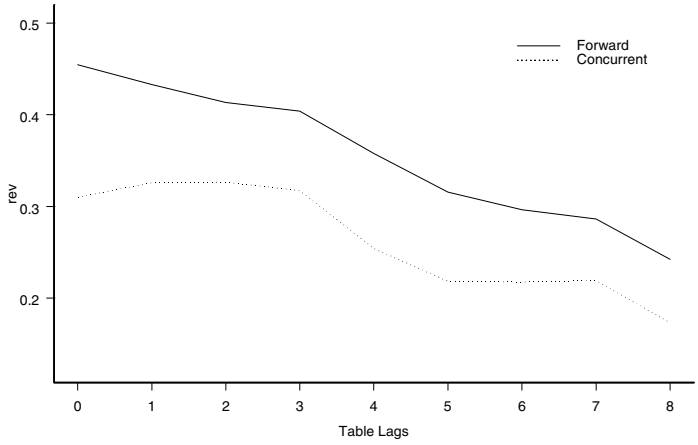

Figure 4.7: Average revision of movement estimates at specified lags - seasonally adjusted total manufacturing sales

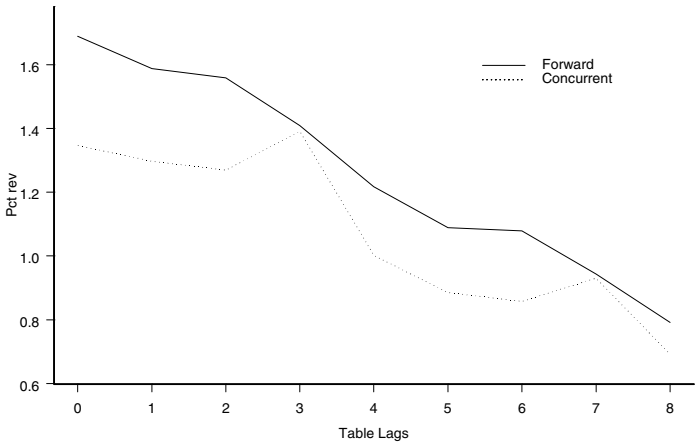

Figure 4.8: Average revision of movement estimates at specified lags - Total capital expenditure Australia

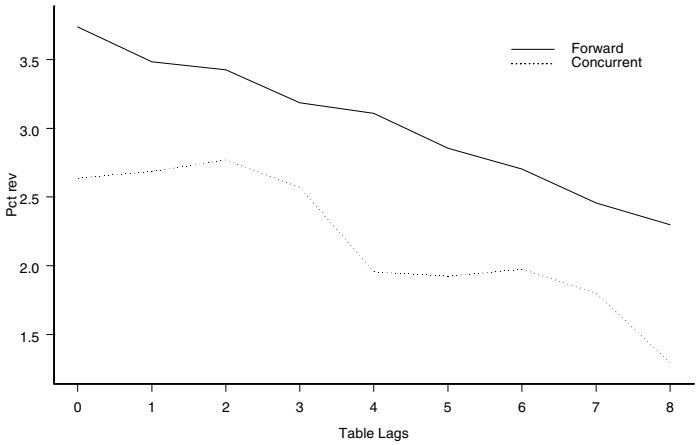

Figure 4.9: Average revision to movement estimates at specified lags - total building Australia

40. It is important to use a long data span when estimating average revisions so that the results will be representative. In the case of the QEAS series presented in Figures 4.6 to 4.9 above there was generally around 5 years of data available for use in the simulation span and consequently these results may not be fully representative of the series in question. For example in the total Australian capital expenditure series, changing the length of the simulation span can result in the forward factor adjustment methodology requiring less revision on average than concurrent adjustment at specific lags. However given the available data span, these results generally suggest that concurrent adjustment leads to improved movement estimates for QEAS data.

41. Table 4.1 following summarises the simulated improvement from applying concurrent adjustment to a number of indicative QEAS series. It can be seen that in there are gains from applying the concurrent methodology and that the extent of this improvement is not reliably indicated by the STAR value of the series.

Table 4.1: Summary of Concurrent Adjustment Improvement at Selected Lags

QEAS Component Series	**STAR**	**Improvement (%) at lag 0**		**Improvement (%) at lag 8**	
Estimate Type		**Level**	**Movement**	**Level**	**Movement**
Total Building Australia	6.66	11.0	29.3	27.6	43.8
Total Capital Expenditure Australia	3.31	9.0	20.6	17.2	12.3
Total Manufacturers Sales	0.65	20.0	32.6	30.0	26.9
Total Earnings Australia - SEE	0.76	1.5	14.3	3.8	35.5

42. The presented results are based on highly aggregated data, and thus with a relatively low degree of volatility. We would expect the gains from using concurrent to be even greater for the disaggregated lower level series, where the data would be expected to contain a higher degree of volatility. Further analysis of these lower level series is currently being conducted.

5. Discussion

43. Concurrent seasonal adjustment methods are widely used by the international statistical community. Concurrent adjustment uses the latest available information to produce seasonally adjusted and trend estimates. They approach the final or benchmark series rapidly and are more accurate than forward factor estimates. On balance the ABS believes that the concurrent adjustment method will produce the best data for analysts to understand the behaviour of series with seasonal influences such as retail trade and QEAS data. Although the gain from moving to a concurrent adjustment regime is generally greater for monthly series, our analysis has shown that there are substantial gains in accuracy and consistency from concurrently adjusting the quarterly QEAS series. The main argument against the use of concurrent seasonal adjustment is that the seasonally adjusted estimates will be revised more frequently, i.e. each period rather than annually.

44. The main benefits to be derived from utilising a concurrent adjustment approach are related to the accuracy and timeliness of the individual estimates, however there are also a variety of costs associated with the introduction of this methodology. All seasonal factor estimates will be revised each period as new data becomes available and consequently the seasonally adjusted and trend series will also be revised. It is difficult to quantify how these revisions will initially affect user confidence of ABS data and there will be an onus on subject matter areas to educate users as to the impact of this change.

45. The concurrent revisions policy determined for retail trade is to publish the most accurate estimate possible for each time period. Therefore under concurrent adjustment seasonally adjusted retail figures are revised each month to incorporate new data as it becomes available and improve the current estimate. It may be necessary to formulate a new concurrent revisions policy for QEAS as quarterly data generally exhibits a different revision pattern to monthly series.

46. Constant revision to the seasonally adjusted series is not desirable, although it is tolerable if it leads to an improvement in the estimate. It has been shown that with concurrent adjustment, revisions lead to significant improvements in the estimates of the previous one or two quarters in the case of QEAS series as well as four quarters prior, however revision did not always lead to an improvement in the estimate of the third quarter prior to the current observation. One possibility is to limit the revisions to the seasonally adjusted series resulting from concurrent analysis to the previous quarter and the same quarter one year ago e.g. if estimates for the December 2000 quarter were being released, the seasonally adjusted series will only be revised for the September quarter 2000 and the December quarter 1999. The risk is, using this example, that the difference between the June quarter and the September quarter estimates may be accentuated because the June 2000 figure is not revised.

47. Even with concurrent adjustment it will still be necessary to undertake an annual reanalysis of the QEAS. The objective of the annual reanalysis for the concurrent method is to examine the changing seasonal and trading day factors and other factors, such as trend breaks, seasonal factor breaks and outliers at a detailed industry by state level. It is possible that some issues will only emerge over a number of quarters and may not be as obvious when the focus is on concurrent adjustment for seasonal and trading day factors every quarter. The annual reanalysis will not normally result in significant changes as each data point in the previous year back period will have already been revised at least once as a result of concurrent adjustment (i.e. the initial estimate is revised when data for the next quarter becomes available). However due to the constraints placed upon the seasonal factors and the outliering process applied by the X11 seasonal adjustment software package substantial revisions to the seasonal factors may occasionally be observed for any month during the previous year.

6. Conclusion

48. Concurrent adjustment uses the latest available information to produce more accurate seasonally adjusted and trend estimates. The concurrent seasonal adjustment methodology was adopted by retail trade in April 2000 and initial investigations have suggested that this technique has provided estimates that stabilise close to the final or benchmark series after only a few months with no increase in burden or operational costs.

49. During the integration phase of QEAS concurrent adjustment will be more responsive to methodological and questionnaire changes affecting the component survey data and will provide consistent and coherent seasonally adjusted input for the national accounts.

50. It has been shown that there are substantial gains in accuracy to concurrently adjusting quarterly series such as the QEAS and consequently Time Series recommends introducing concurrent adjustment to this survey.

51. The ABS will continue to examine the performance of the concurrent methodology, for quarterly series, in greater detail, with the aim of identifying potential risk factors which may indicate smaller gains from applying concurrent over the forward factor methodology. The ABS will continue to examine data on a survey by survey basis to

determine whether it is more appropriate to apply the forward factor of the concurrent methodology.

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8. Technical Notes

52. For further information regarding gain functions and moving averages please refer to ABS (2001).

53. Gain functions can be used to examine the effect of a linear filter at a given frequency on the amplitude of a cycle in a time series.

54. The first step in the X11 approach to seasonal adjustment is to attempt to remove the seasonal characteristics of the time series. This can be achieved by using filters designed to remove seasonal harmonics.

55. Symmetric seasonal filters are used in the middle of a series, however near the ends of the time series there are not enough subsequent (or prior) observations available to apply the symmetric filter and an asymmetric approximation is used. Consequently seasonally adjusted estimates are revised as more data becomes available.

    The symmetric and asymmetric weights for the 3 x 5 term seasonal filter can be found in Table 8.1 following. For detail regarding how these weights are calculated, see ABS (2001).

    Table 8.1: Symmetric and Asymmetric Weights for S_{3x5} when estimating any period in year t

Estimate of period in year t made during year	Weight applied to same period in year						
	t-3	t-2	t-1	t	t+1	t+2	t+3
t	0.150	0.283	0.283	0.283	NA	NA	NA
t+1	0.067	0.183	0.250	0.250	0.250	NA	NA
t+2	0.067	0.133	0.217	0.217	0.217	0.150	NA
t+3	0.067	0.133	0.200	0.200	0.200	0.133	0.067

56. Table 8.1 can be interpreted as follows. Assuming that we want to estimate any period (month or quarter) in any year t, then the seasonal moving average weights for use in the year t are presented in the first row, the seasonal moving average weights that can be applied in the following year (i.e. year t+1) are in the second row and so on. The weights to be applied on the same period in successive years (for example each August from 1994 to 1997) are given in columns depending on the year to which the weight should be applied. For example if we were estimating August of 1997 in August 1997, a weight of 0.283 would be applied to the August 1997 observation while a weight of 0.150 would be applied to the August 1994 (1994 = t-3) observation. A plot of these weights can be seen in Figure 8.1.

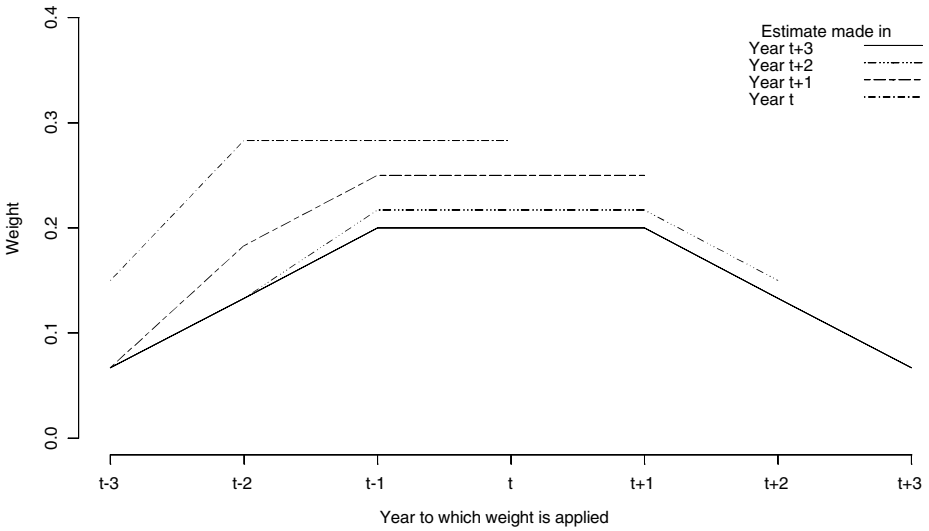

Figure 8.1: Moving Average Weights to be Applied on the Same Month/Quarter in Successive Years for the Symmetric and Asymmetric S_{3x5} Filters when Estimating any Period in Year t

57. For the 3 x 5 term seasonal filter, once a second observation of the same period becomes available, an improved asymmetric approximation and a more appropriate estimate of the seasonal factor can be made. Once three subsequent observations become available the symmetric 3 x 5 term seasonal filter can be applied.

58. The number of years of data required before the symmetric seasonal filter can be applied depends on the length of the seasonal moving average chosen for the time series. However, until the symmetric seasonal filter can be applied there will be revisions to the seasonal factor estimate each year as another observation of the same period becomes available. This could be seen as a large improvement in the accuracy of the estimates in the average revision graphs, (see Figures 3.2 to 3.6 and 4.2 to 4.5) at lag 12 for monthly series and lag 4 for quarterly series.

59. Figure 8.2 shows gain functions for the symmetric and the first asymmetric seasonal filters. An ideal seasonal moving average would filter out all of the power at the non-seasonal frequencies, while leaving seasonal frequencies unchanged. Figure 8.2 shows the asymmetric filter does not filter out all of the power at the non-seasonal frequencies and introduces more undesirable features into the seasonal filter.

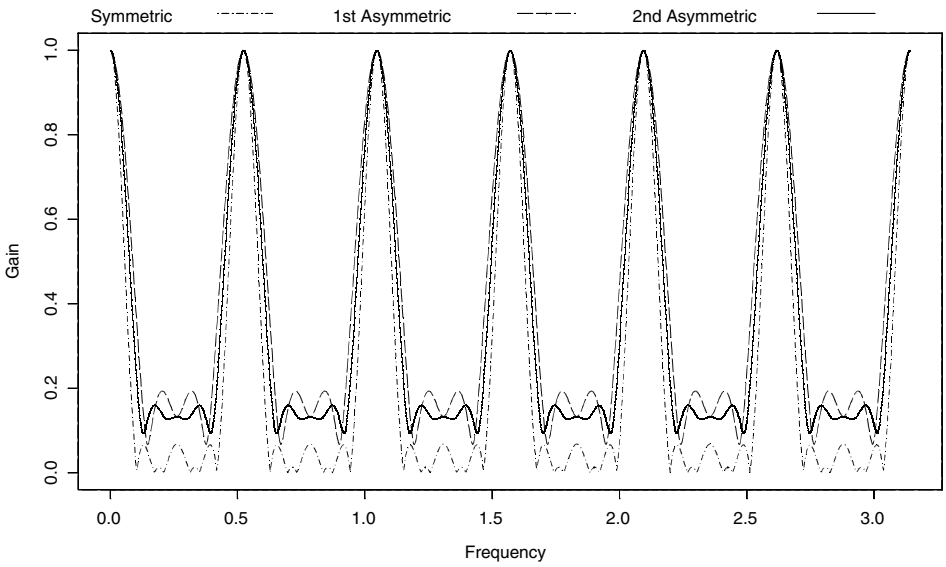

Figure 8.2: Gain Functions for Symmetric and First Asymmetric 3 x 5 Seasonal Filters

60. The most commonly applied seasonal filter for monthly series is the 7 term (S_{3x5}) moving average. The 5 term (S_{3x3}) moving average is applied to the majority of quarterly time series. Figures 8.2 and 8.3 show the gain functions of the filters under concurrent and one step ahead forward factor adjustment approaches. Note that the concurrent gain function presented in Figure 8.3 is the same as the asymmetric gain function presented in Figure 8.2. Hence the properties of the gain functions presented in Figure 8.3 will be improved as further observations become available and a closer approximation to the symmetric seasonal filter can be applied.

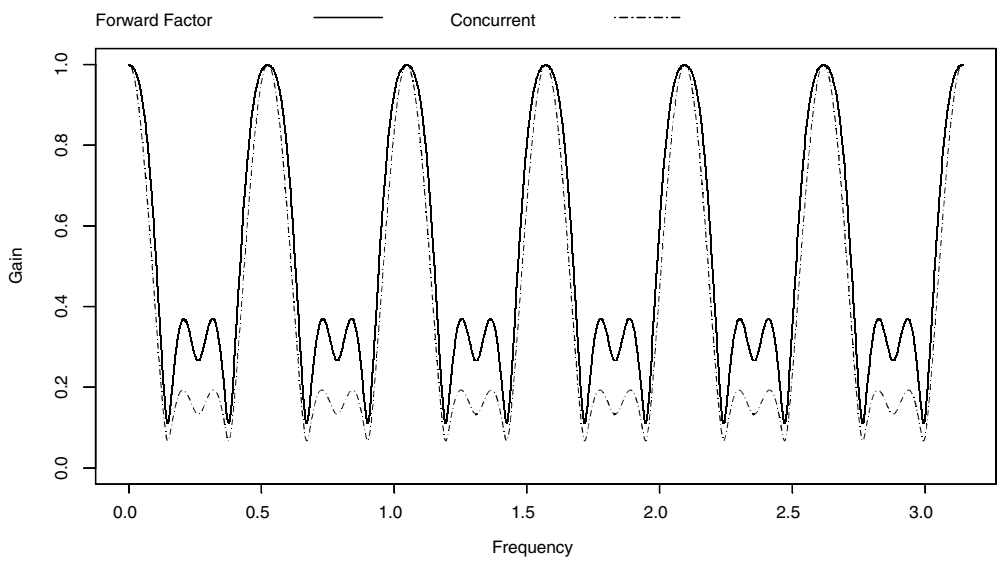

Figure 8.3: Comparison of Concurrent and One Step Ahead Forward Factor Gain Functions for S_{3x5} filter

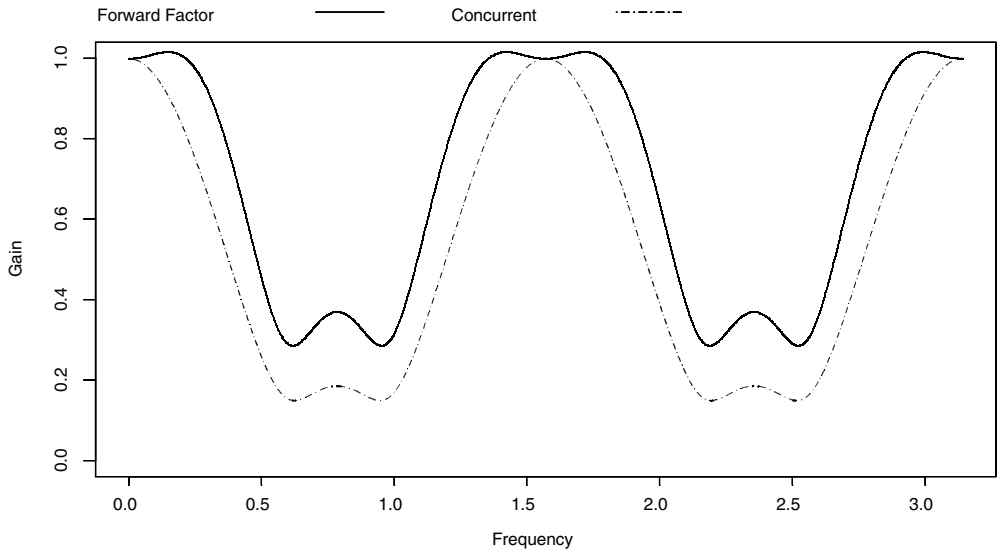

Figure 8.4: Comparison of Concurrent and One Step Ahead Forward Factor Gain Functions for S_{3x3} filter

61. In practice filters can never achieve the theoretical ideal of filtering out all of the power at the non-seasonal frequencies, while leaving seasonal frequencies unchanged. Figures 8.3 and 8.4 show that the gain function of the seasonal filter under the forward factor methodology introduces more undesirable features into the seasonal filter.

9. Appendix

Table A1: Summary of Seasonal Adjustment Methods used in International Statistical Agencies and their Concurrent Revision Policies.

Organisation	Seasonal adjustment package	Seasonal adjustment revision	Trend revision	Standard policy	Annual update
Bureau of Census (US)	X12	Normally, each month, but revise three months back for provisional data. For some series, previous month and the same month of previous year for some series.	Trend not published	No.	Yes. The revisions of the last three to five years of both raw data and the seasonally adjusted series.
ONS (UK)	X11-ARIMA	Without calendar: year constraints: revise previous month and the same month in the previous year. With Calendar Year constraints: Revise the previous month only; except when completing a year, when the whole year should be revised, or when the first observation after a year is published when that last year should be revised. All other factors are fixed.	As for seasonally adjusted revisions. Publish graph of trend only.	No. A revisions policy should be decided upon taking user requirements and revisions of raw data into account.	Yes. The revisions of the last three years of both raw data and the seasonally adjusted series.
StatCan (Canada)	X11-ARIMA	Normally, one month back; but two or three months back if there are revisions in the original data.	Only publish lagged Trend-cycle estimates.	One period back if there is no raw data revision.	Yes. The revisions of the last three years of both raw data and the seasonally adjusted series.
SNZ (New Zealand)	X12	No uniform policy on revisions.	No uniform policy on revisions.	No.	na.
US Bureau of Economic Analysis (BEA)	X11-ARIMA	Concurrent adjustment not applied.	Trend not published.	na.	na.
US Bureau of Labor Statistics (BLS)	X11-ARIMA	Concurrent adjustment not applied.	Trend not published.		
ABS (current - monthly)	Seasabs (No ARIMA available)	All parameters fixed except seasonal factor and moving trading day. All seasonally adjusted estimates revised.	Fix all parameters except seasonal factor and moving trading day. All Trend-Cycle estimates revised.	No.	Yes. free all the parameters. All the estimates revised.
ABS (Proposed-Quarterly)	Seasabs (No ARIMA available for the moment)	All parameters fixed except seasonal factors and moving trading day. Estimates of the previous period and same quarter one year previously are revised, remaining estimates are fixed.	Fix all parameters except seasonal factor and moving trading day. Revise estimates of the previous period and fix the rest.	Trial policy - the last of both raw data and the seasonally adjusted series are revised if there is no raw data revision. If the raw data is revised, revisions will be made back to all observations back to the point of the revised raw data.	Yes. Free all the parameters. Revise all the estimates.