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SEASONAL ADJUSTMENT SYSTEMS FOR OFFICIAL STATISTICAL AGENCIES. A PRACTICAL APPROACH

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Seasonal Adjustment Systems for Official Statistical Agencies - A Practical Approach

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1 Introduction

> *Seasonal adjustment is done to simplify data so that they may be easily interpreted by statistically unsophisticated users without significant loss of information (Bell and Hillmer 1984, p301]*

The Central Bank's experience with seasonal adjustment dates back to the late seventies. Indeed, Farrell and Soo Ping Chow (1983) probably represents the most comprehensive study of seasonality produced so far in the region. The Bank was also among the first official statistical agencies in the region to regularly publish seasonally adjusted numbers (over the period 1981 to 1992). Yet, an examination of the Bank's current economic reporting reveals that systematic use and analysis of seasonally adjusted data are confined exclusively to the reporting of the Bank's QGDP Index while the publication of seasonally adjusted monetary numbers was discontinued in December 1992! Indeed, this was the second time that the Bank stopped publishing its seasonally adjusted monetary numbers on "*technical*" grounds. The latest interruption in the Bank's seasonal adjustment program represents a critical gap in the country's statistical database, given the increased demand for timely short term analysis of economic developments brought about by the requirements of managing structural adjustment and liberalization programs. In the absence of officially sanctioned seasonal numbers, policy makers have been bridging the gap with ad-hoc methods and techniques. Past experience tends to show that such an approach

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The views expressed in this paper are those of the authors and not necessarily those of the Central Bank.

usually fails to provide policy makers with very reliable data. Consistent, reliable and plausible seasonal numbers can only be developed within the context of a systemic approach to the issue of seasonal adjustment.

This paper addresses the critical success factors for seasonal adjustment systems. In this context "success" is achieved only if *as large a group of interested parties as possible, that is, not only central bank economists or trained statisticians, but also government officials, journalists, students and even politicians(?) have the confidence in and are able to analyze the numbers intuitively*. Thus, in Section II we comment briefly on a number of practical issues which should be addressed in seasonal adjustment systems. These include the basic processes that need to be put in place, the kind of data processing environment and quality control regime required and then finally the important but often over looked issue of marketing the seasonally adjusted data. In Section III, we examine in more detail the issue of choosing an adequate seasonal adjustment technique from among the numerous techniques available. A number of simple tests were developed which were applied to six time series drawn from key areas of economic reporting. The final section of the paper presents a summary of the major findings and some suggestions for future research.

II STRUCTURING SEASONAL ADJUSTMENT SYSTEMS

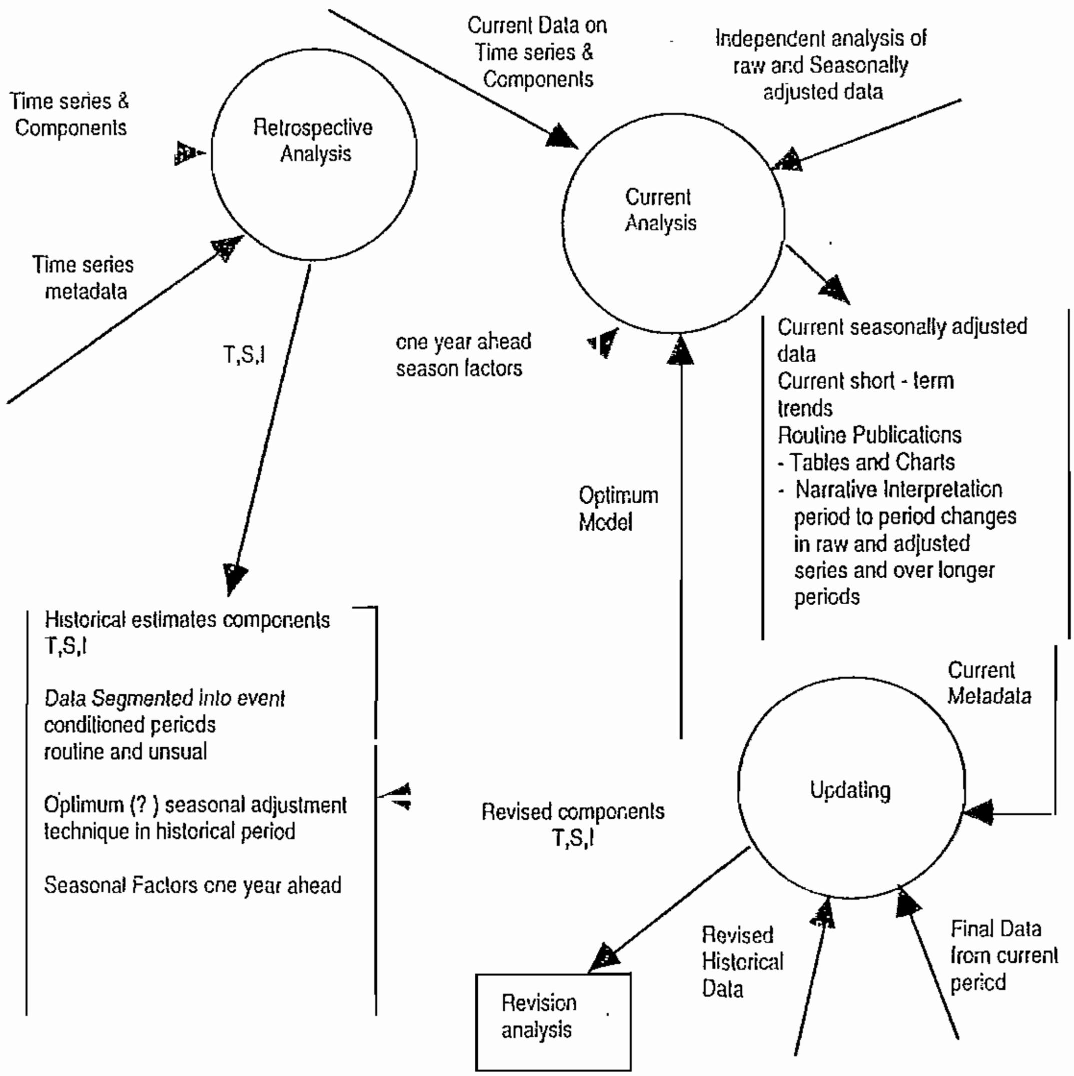
This section of the paper draws heavily on insights gleaned from an earlier study by Clarke and Francis [1994] which examined why the Bank's seasonal numbers failed to win widespread credibility and acceptance by the user community. Aside from pointing to a number of environmental factors and technical weaknesses in the previously published seasonal numbers, the major finding of this study was that these efforts had failed not because of a lack of technical sophistication, but rather because they did not appreciate the scope of the seasonal adjustment process. These earlier efforts tended to approach the issue as a "one shot" academic exercise so that while the initial investigations may have been of high quality, this work was usually confined to relatively few time series, and even fewer of these were actually published. This meant that analysts' never had the critical mass of seasonally adjusted data required to examine short trends across the economy. Moreover, once the initial studies had been completed the Bank did not devote sufficient human or computer resources to the seasonal program, while no quality control systems were put in place to ensure that the seasonal numbers remained plausible in light of structural changes in the economy. The net result was that the reliability of the seasonal numbers and eventually the relevance of the whole exercise were called into question. The requirements of a successful seasonal adjustment system essentially flow from this analysis.

Major Processes

We start by outlining the basic processes involved in the context diagram shown in Figure 1. below .

Figure 1.

Context Diagram Seasonal Adjustment System



The most fundamental process in the seasonal adjustment system is **retrospective analysis.** In this process the analyst determines the major components and characteristics of the series, chooses the best available adjustment technique or model, and obtains one year ahead seasonal factors to utilize in the current analysis process. The major inputs into this process include:

- The time series over a defined time interval including any sub-series

- Any related series (such as weather for series covering the production of agricultural commodities) and if available micro time data (i.e. weekly or daily data on the series)

- Metadata or data about the series itself. Basic time series metadata covers information on sources, units of measurement and so on. In historic analysis the scope of the metadata set is extended to include information on issues such as; any special conditions related to the collection, processing and reporting of the economic surveys which underlie the data. Experience has shown that these peculiarities (e.g., changes in methodology or rebasing) may have caused discontinuities in the data. Additionally, a chronology of the events which may have affected the time series over the period and the analysts' knowledge of the characteristics of the series under investigation should also form part of the metadata set. The net result is that the reasons for the fluctuations in economic activity over the months of any given year are fully described

- An appropriate set of seasonal adjustment techniques or models for testing or experimentation.

The major outputs of this process include, estimates of the behavior of the components - Seasonal (S), Trend (T), Irregular (I) - of the series (and sub-series) over the historical period. In some cases it may prove useful to segment the series into homogeneous intervals, distinguishing the effects of unusual events and to examine the characteristics of the components in these periods. Also, the most appropriate adjustment technique and forecasts of seasonal factors for the one year ahead period are obtained. The latter are major inputs into the current analysis process. In Section III, we present a number of simple tests which may assist in the choice of the most appropriate adjustment technique. However, it should be noted that choosing among the more well-established techniques (such as, Census X11, X11- ARIMA or SABL) is not likely to be a simple matter, because some techniques perform better on some tests than others. It may thus be important to attach weights to the tests that best represent the statistical agencies philosophy on its published statistics and its evaluation of the sophistication of the user community. For official statistical agencies like Central Banks, the relevant questions to ask of any seasonal adjustment method include

- The ease of use or computation - is software commercially available or how easy is it to program?
- Is it easy to explain to non-technicians?
- Is it widely used by other statistical agencies?
- Are the estimates of the seasonal components stable when new data is added?
- does it work well on a number of series from different areas of the economy without endless prior adjustment?

Current analysis represents the routine aspect of the seasonal adjustment program. Data continue to flow for the series and its components each month or quarter. These data are seasonally adjusted using either the one year ahead seasonal factors generated from the retrospective process or "concurrent" seasonal factors based on the new data. If the latter method is chosen, then revision analysis must be conducted every reporting period. It is important to analyze both the adjusted and unadjusted series to examine period to period changes or changes over longer periods. Furthermore, the analysts' need to determine if behavior is in line with current events and conditions and if there are any similarities (or differences) to the past. This serves as a initial quality control measure designed to trap short term shifts in the seasonal patterns, unusual periods, outliers and the like.

Updating builds on the initial quality control checks established in the current analysis by repeating retrospective analysis from time to time, usually after a complete year of data is available. An important aspect of this process is revision analysis and is critical if periodic reporting is chosen. In periodic reporting, the seasonal factors are revised on an annual basis and historic seasonally adjusted data also revised in light of updated seasonal factors. In such a system revision analysis serves to illuminate the adequacy of the initial model chosen for seasonal adjustment. In the case of concurrent reporting, updating is actually built into the current analysis process as seasonal factors are revised every reporting period (i.e., there is no reliance on year ahead seasonal factors). Concurrent adjustment is only practicable in the context of a highly integrated and flexible environment since the processing cycle is reduced to a single period.

Data Processing Environment

It should be quite evident from our discussion of processes in a seasonal adjustment system that such a system would require either a large cadre of analysts or statisticians or alternatively a very sophisticated, automated processing environment characterized by a high degree of integration. In such an environment primary data capture, statistical aggregation (series building), seasonal adjustment and routine reporting and analysis are tightly integrated. Ideally, this system should also be linked to time series forecasting or econometric modeling systems. It is only within such a context that the producers of the seasonal numbers can obtain feedback on the plausibility of the results of the seasonal adjustment process, as well as apply it as widely as possible. Moreover, formal quality control systems can more easily be implemented in such an environment. In other words, an integrated, production, reporting and analysis environment will involve an optimal level of interaction between the practical as well as the theoretical and is likely to result in a very responsive program of seasonal adjustment

Marketing Seasonal Numbers

The success of the seasonal adjustment program was measured by the degree to which policy makers and other non specialists like journalists and government ministers had the confidence to use the seasonal numbers intuitively. Given the relative lack of statistical sophistication of this client base in the Caribbean context, any statistical agency producing seasonal numbers would have to actively stimulate the demand for these data. In this regard, the following steps should be given active consideration:-

- Seasonal adjustment should be applied to key data in as many areas as practicable. The availability of reliable seasonal numbers across all areas of economic statistics will contribute to the improvement of the in-house technical analysis of the economy, but also other interested parties (the press, students etc.) will be better informed about the short run movements in the economy.

- Aside from the choice of adjustment technique, other technical issues should be given careful consideration such as; the timing of revisions (which should be standardized across the system), whether direct or indirect adjustment methods are applied, or whether the "adding up" problem needs to be addressed. With regards to the latter, while additivity is a desirable quality of seasonally adjusted monetary data this may be less relevant in the analysis of seasonally adjusted retail price data.

- Statistical Agencies should change the way economic data are tabulated or presented. Consideration should be given to the presentation of both seasonally adjusted and unadjusted series in the same table once there are marked seasonal patterns in the data and if such a presentation would serve to clarify the analysis. Additionally, where relevant, annualized growth rates and moving average growth rates based on deseasonalized data should also be presented, as these measures serve to highlight the trends in the series under investigation. These tables should be supplemented with "indicator" tables which contain movements in the major seasonally adjusted indicators. Clarity may also be improved if charts highlighting the trends in the series are presented along with the statistics. These practices have been successfully adopted by several other leading statistical agencies such as the Bank of Canada, Federal Reserve Board and the United Kingdom Statistical Office.

Finally, an effective regime of quality control is a critical component of a seasonal adjustment system and indeed all statistical processing systems. It is important to note that while the diagnostic assessment performed by seasonal adjustment software is an important quality control tool, experience has shown that *more is required.* Rizki [1993] *notes that one of the key elements in* assessing the reliability of any system of published economic statistics is by its revision performance. This is so because good statistical systems are continually engaged in updating and revising past data. These revisions arise from a number of causes such as, receipts of more comprehensive data, changes in estimating procedures, revisions due to seasonal updating and so on. Thus, if the statistical data is continually being revised for these reasons and these revisions are relatively small then it can be assumed that the level of quality assurance is high and the initial estimates of the economic indicators were unbiased. When this is not the case then decision makers will be misled about developments in the recent past and soon loose faith in the seasonal numbers. Thus, a formal system of revision analysis should be applied not only to seasonal data but also to all data published by statistical agencies. In the next section, we go on to illustrate some non-traditional areas where seasonally adjusted data may add to the clarity of data analysis.

III TESTING SEASONAL ADJUSTMENT METHODS

Over the years several seasonal adjustments programs have been developed for detecting and isolating seasonal variations in economic time series. In this paper six of these methods have been chosen for testing based on the availability of the software and the popularity of the method. The methods examined in this section are :-

- Fixed Additive Method
- Fixed Multiplicative Method
- Census I Method (or Ratio - to - Moving Averages Method)
- Census X-11
- X-11 ARIMA
- SABL

With the exception of the X11-ARIMA all these techniques are mechanical in nature and therefore adjustment of the various series by these methods is carried out in conformity with the same rules, without the specific characteristics of the individual series playing a part. Indeed, most of these methods represent improvements to the simple ratio to moving average method seasonal adjustment technique. By contrast, in the X11- ARIMA method an appropriate ARIMA (p,d,q)x(P,D,Q) serves as a starting point for the analysis. However, as utilized by practitioners in the field, X11- ARIMA simply represents an extension of the basic Census X11 framework where an ARIMA model is used to provide symmetrical weights to the observations at the end and beginning of the series. Moreover, when a large numbers of time series must be adjusted it is common to leave the choice of the ARIMA model up to the software package. In other words, X11-ARIMA as applied in practice, has a lot more in common with the mechanical adjustment methods than the model based or structural approaches. The heuristic nature of the mechanical models means that the statistical properties of the techniques are not fully determined, so that the these methods cannot be judged unambiguously by sharply defined formal statistical criteria. In what follows each method is described briefly and this will be followed by a discussion of its application to six actual Trinidad and Tobago macro-economic series.

Fixed Additive Method

This method can be written simply as:-

$$y_{ij} = T_{ij} + S_{ij} + I_{ij}$$

where T_{ij} is the centered 12-month moving average trend cycle component of the series y_{ij}. The means of the difference between the trend-cycle component and the original series is calculated for each month, to determine the preliminary seasonal component S_i'. The seasonal components are then derived from the preliminary component as follows:-

$$S_{ij} = S_i' - \frac{1}{12}\sum_{i=1}^{12} S_i'$$

where $$\sum_{i=j}^{12} S_i = 0$$

The irregular component is then derived as $I_{ij} = y_{ij} - T_{ij} - S_{ij}$
and the seasonally adjusted series y_{ij}^{sc} is calculated as

$$y_{ij}^{sc} = y_{ij} - S_{ij} = T_{ij} + I_{ij}$$

Fixed Multiplicative Method

This method can be expressed as:

$$y_{ij} = T_{ij}.S_{ij}.I_{ij}$$

where again T_{ij} (the trend-cycle component) is the 12-month moving av of the series y_{ij}, as it is in the fixed additive method. Howev multiplicative adjustment the size of the seasonal as well as the irre component is proportional to the trend value of the data. This relatio between the seasonal component and the series is expressed by the sea index s_{ij}, where

$$S_{ij} = \left(1 - \frac{1}{s_{ij}}\right) Y_{ij}$$

Like the fixed additive method, for each month i, the preliminary sea index is determined as the mean of $s_{ij}.i_{ij} = y_{ij} / T_{ij}$. This seasonal index ca expressed as:

$$s_{ij} = s_i = \frac{s_i'}{\frac{1}{12}\sum_{i=1}^{12} s_i'}, \text{ for all ij}$$

$$\text{where } \sum_{l=1}^{12} s_l = 12$$

The seasonally adjusted index is calculated as

$$y_{ij}^{sc} = y_{ij} - S_i = y_{ij} / s_i$$

and the irregular component is given by

$$I_{ij} = y_{ij}^{sc} - T_{ij} = \left(1 - 1/i_{ij}\right) y_{ij} / s_i$$

$$\text{where } i_{ij} = y_{ij} / \left(T_{ij} . s_i\right)$$

Census Method 1

This method was first developed at the Bureau of Census in 1954 to seasonally adjust economic time series. The seasonal and error variance is removed by calculating moving averages whose number of terms equals the periodicity. This procedure removes seasonality and reduces the unsystematic error throughout the series. Consequently, the trend-cycle component is derived; the ratio of the original series to the trend-cycle component is then calculated so that the seasonal and error components can be isolated. By repeating the monthly averaging process, the error term can be eliminated to obtain the pure seasonal component.

Census X-11

The X-11 variant of the Census Method II as outlined in Shiskin et. al. (1967), was developed at the U.S. Bureau of the Census, and was adopted since 1965 as their standard seasonal adjustment program. Like previous methods, this method is based on the ratio-to-moving average technique. The Census X-11 method offers a choice between additive and multiplicative models and can be applied to both monthly and quarterly time series. Moreover, the procedure contains options for adjusting for trading-day variations and provides for the treatment of outliers. Despite the ability to manipulate the program to some degree, in practice calculations are normally based on standardized procedures.

The Census X-11 method is widely used in practice because it can be easily applied to a variety of economic time series. However, in spite of its easy maneuverability, a few criticisms have been leveled against this procedure:-

(i) The procedure is not based on any statistical model or method. The absence of an underlying model is thought to be a serious deficiency and interesting attempts (see for example, Cleveland and Tiao 1976) have been made to base the Census X-11 method on some statistical model.

(ii) The Census X-11 Method tends systematically to underestimate the changes in the seasonal patterns at the beginning and at the end of the series.

X-11 ARIMA

The Statistics Canada X11-ARIMA method of seasonal adjustment was first developed by Dagum in 1975 and updated in 1978 and is an extension of the Census X-11 method. This method is thought to have some advantage over other linear smoothing techniques for two major reasons:-

(a) it offers an ARIMA model for the series;
(b) it minimizes the revision of the seasonal in mean square error.

The X-11 ARIMA models the original series by fitting an ARIMA (p,d,q)x(P,D,Q) and extends the series at both ends by 'forecasting' and 'backcasting'. Two options are available in the software package for model selection, one can either depend on automatic model selection or the analyst can select his own ARIMA model. In this paper we have chosen to go the way of automatic model selection. In this option the software package mechanically tests three alternative models, with models in the multiplicative variant been based on a logarithmic transformation of the series and the additive variant based on the actual series itself. The models tested are as follows:

$$(0,1,1) \times (0,1,1)_S$$

$$(0,2,2) \times (0,1,1)_S$$

$$(2,1,2) \times (0,1,1)_S$$

For each of these models the program checks whether the model yields an adequate description of the series and whether reliable out of sample forecasts were generated for the last three years of the sample period. The ARIMA model is rejected if the mean absolute forecast error is more than 5 per cent for normal series or more than 12 per cent for violently fluctuating series. The usual Box-Pierce test is conducted on the residuals to test for mutual independence of error terms. For the six series under review the automatic option successfully obtained a viable ARIMA model. The model chosen for each series is given in the Appendix along with the diagnostics. Automatic model selection has been criticized by Fase and Den Butter [1991], largely because it had been unsuccessful in the majority of cases. Moreover, in many of the time series examined, the best automatic model differed substantially from the best judgment based selection. However, Fase and Den Butter noted that when this was the case the seasonal factors based on the automatic selection were always more stable than those obtained by judgment selection. Indeed, where statistical agencies use the X11-ARIMA for adjusting a large number of time series the judgment option is only resorted to if the automatic option fails. These points may be taken as a weak justification for the use of the automatic option in this paper.

Whatever the option chosen the ARIMA model is simply used to extend and the resulting series is then seasonally adjusted by applying various linear filters of the X-11 type. In addition, an option of applying a centered 24-term filter instead of a 12-term filter, to estimate the preliminary trend-cycle component is provided. This new filter gives better results for series strongly affected by short cycles or sudden changes in trend.

SABL Method

The SABL procedure, like the Census X-11 method employs the technique of repeated filtering, to decompose the original series into its usual three components. Unlike the Census X-11 method however, its filters are more robust, thereby avoiding over adjustment at the beginning and end of the series. An important difference in the SABL method is that the concept of moving medians has been substituted for moving averages in the filtering process. The SABL method incorporates the option to apply the Box-Cox (1964) power transformation, whereby the optional transformation for the data can be found, as intermediate forms of adjustment i.e. between additive and multiplicative specification, are considered. In this paper however, in order to ensure that no method is given undue advantage over the other, the optimal transformation option was not selected, instead a log transform was applied to all series that were adjusted multiplicatively and no transformation for those series adjusted additively. Another important feature which distinguishes SABL from Census X-11 is its wide use of graphic displays as tools for analysis and diagnosis. This proves particularly useful when analyzing seasonality in a small number of series.

The Series Used

The seasonal adjustment methods described above were applied to six different macro-economic series, two of which were chosen from the monetary sector and four from the real sector, namely:

- Broad Money Supply M2 (TT$Mn)
- Private Sector Credit (TT$Mn)
- Local Sales of Cement ('000 tonnes)
- Retail Price Index-Housing (Sept 1993=100)
- All Items Sections of the Index of Retail Sales (Avg. 1979 = 100)
- Quarterly Index of Agricultural Production (Factor cost) (1985=100)

Of the six series listed above, the first four are monthly series and the last two are quarterly series. The sample period chosen for the series extends from 1982:1 to 1993:12 or 1982:1 to 1993:4 for the monthly and quarterly series respectively. As a first step to assessing the effects of the application of the various seasonal adjustment techniques on the series, the original series themselves were first plotted and an attempt made to identify any distinct seasonal fluctuations in the data.

Chart 1.1 presents the broad money supply (M2) in graphical form. Examination of this series shows that the seasonal components are not very stable, presumably because it reflects the weak seasonality of the dominant components - Time and Savings deposits, which swamp the seasonality in the Currency and Demand Deposits components. During the period 1982:1 to 1993:12, consistent seasonal highs were recorded in September and December and to a lesser extent in June. In addition between 1984 and 1993 seasonal

Chart 1.1 - Broad Money Supply M2 (TT$ Mn)

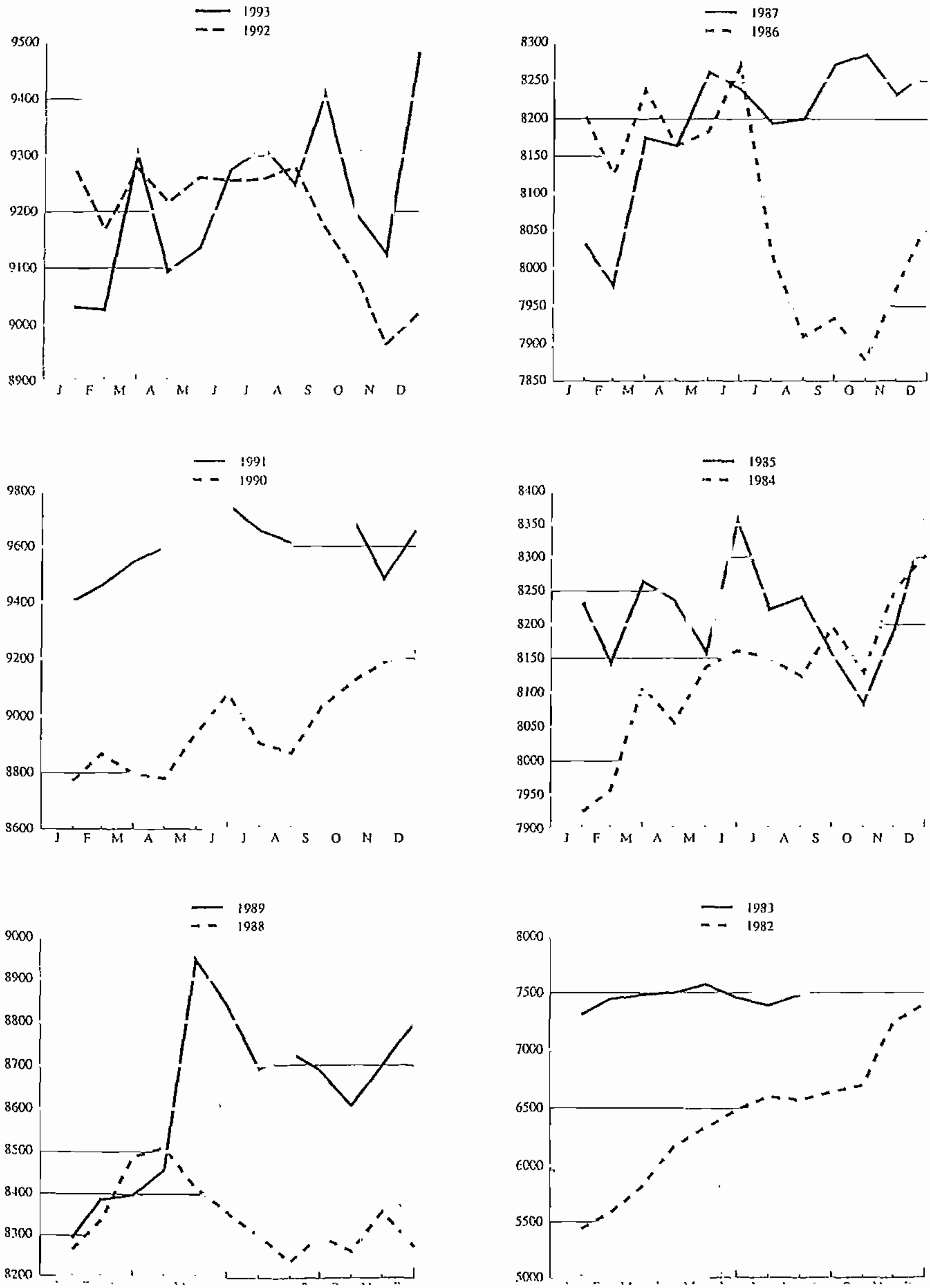


Chart 1.2 - Private Sector Credit (TT$ Mn)

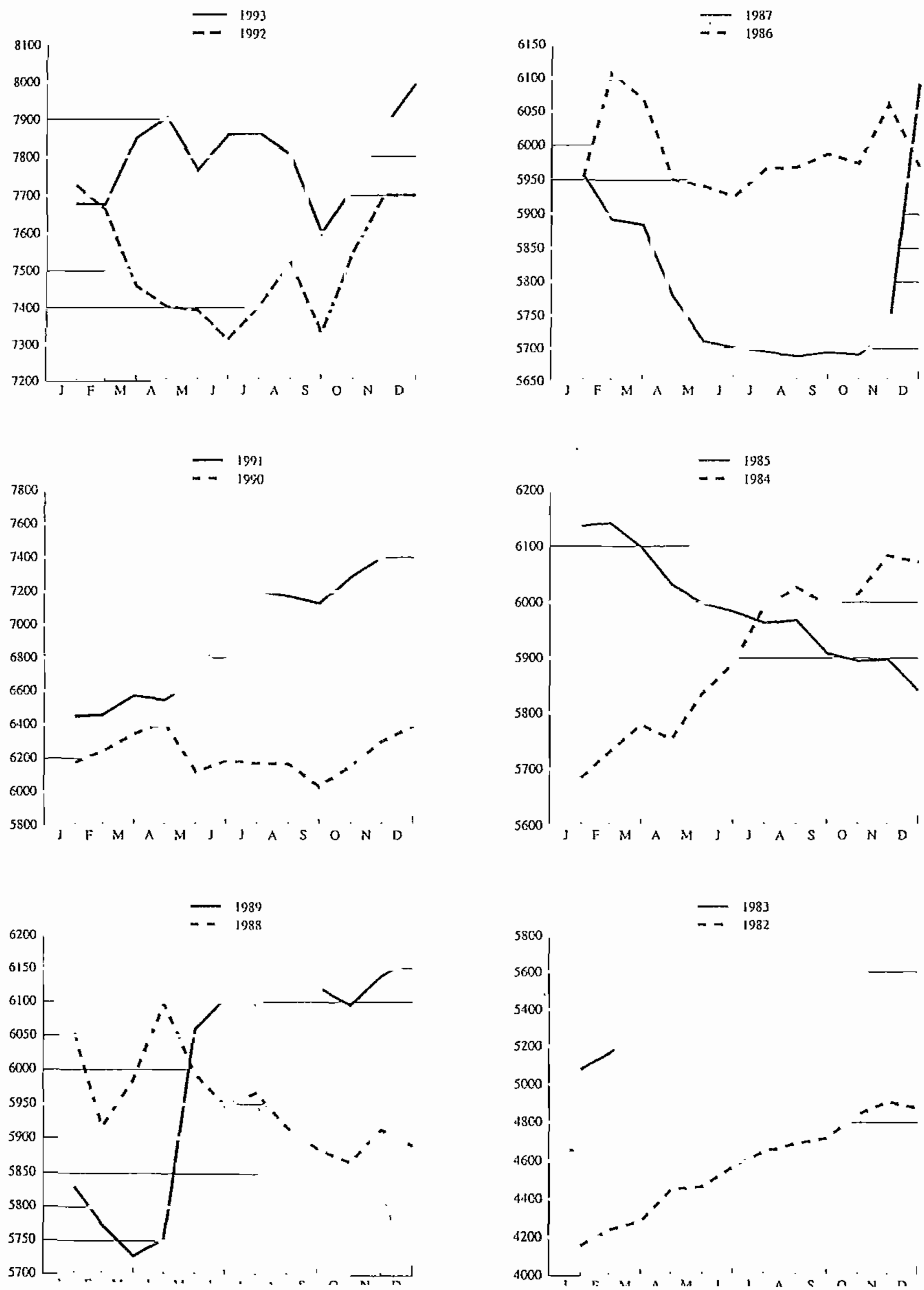


Chart 1.3 - Local Sales of Cement (tonnes)

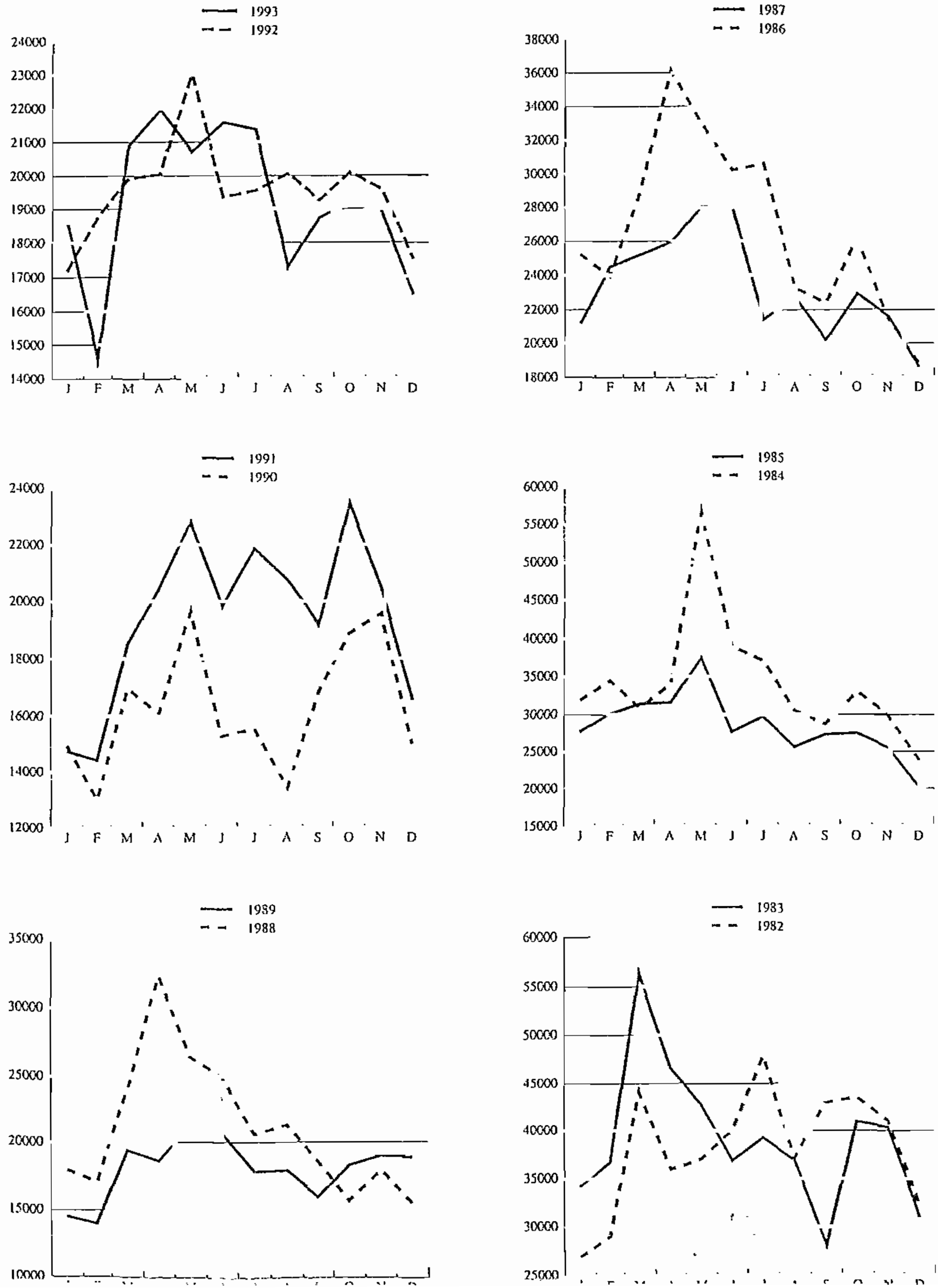
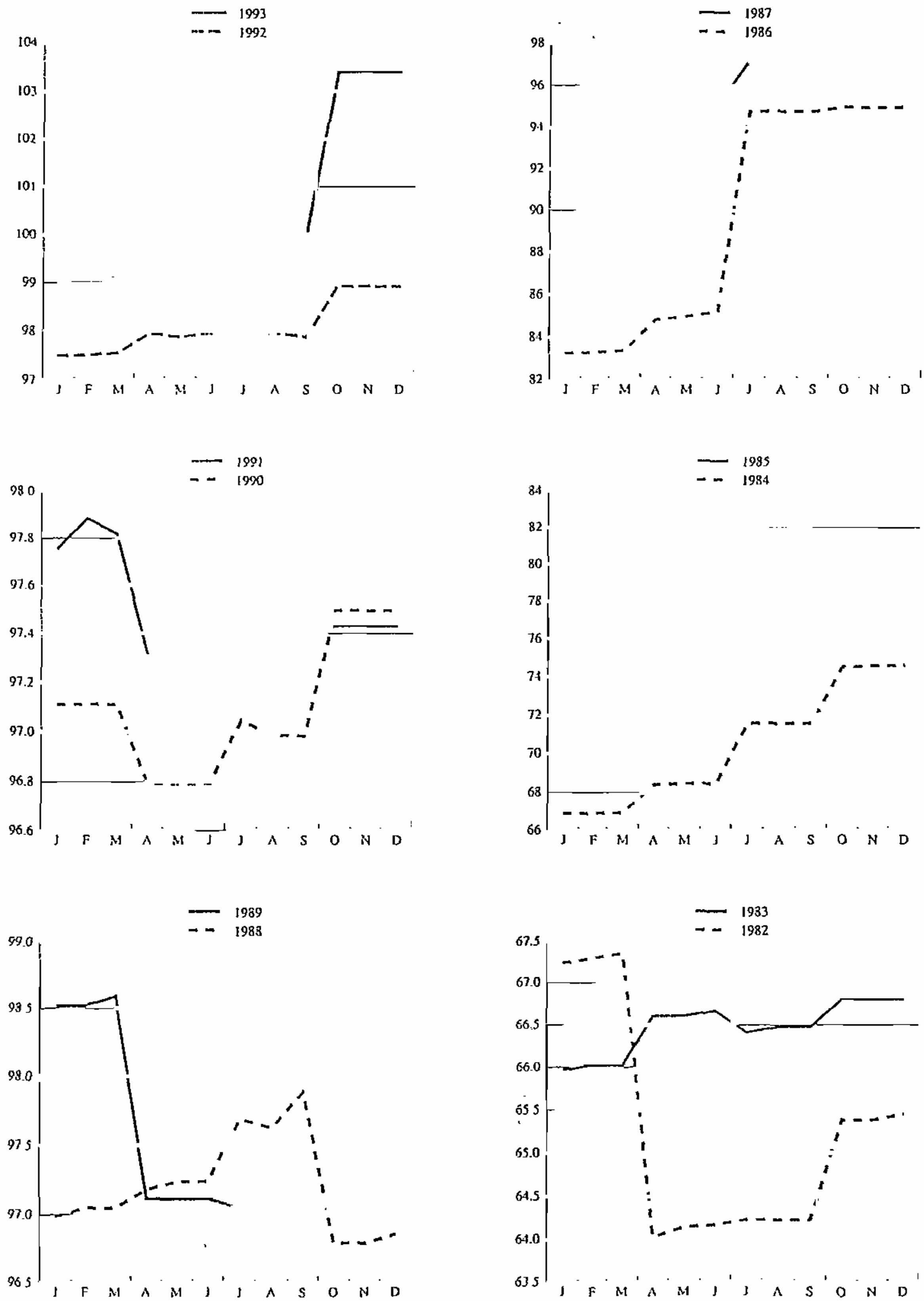


Chart 1.4- Retail Price Index - Housing (Sept 93 = 100)



Index of Retail Sales - All Sections (Avg 1979 =100)

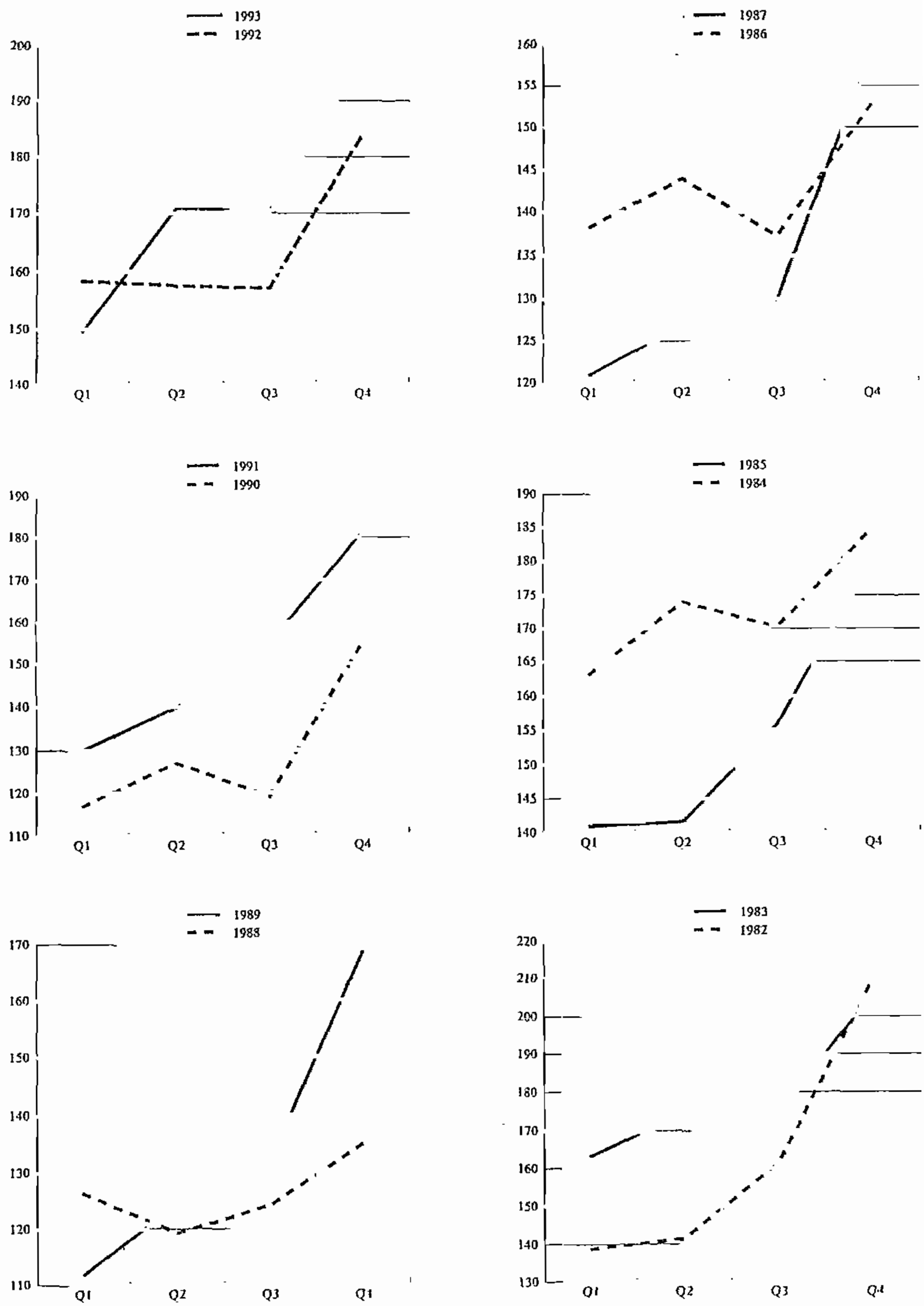
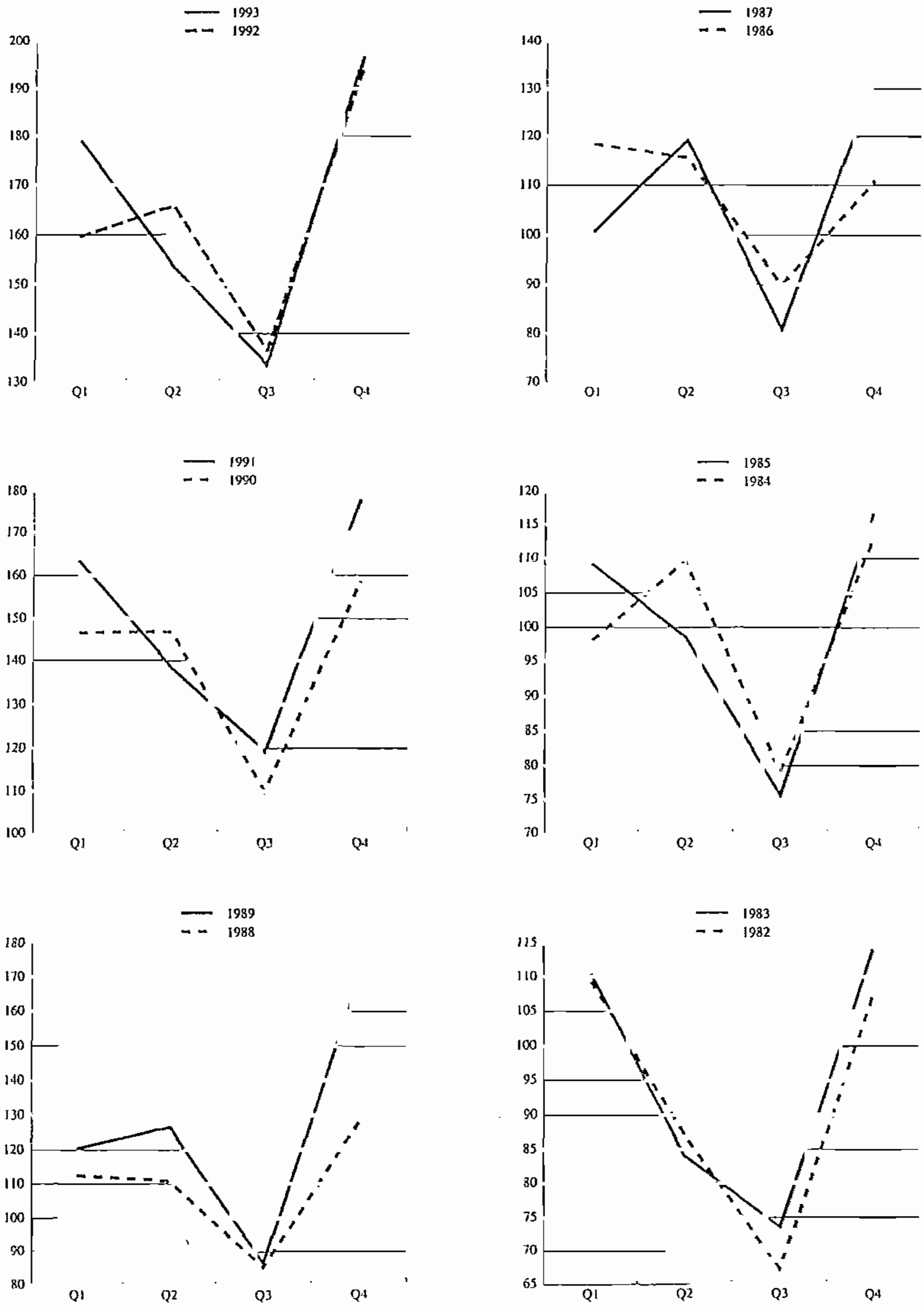


Chart 1.6 - GDP at Factor Cost in Agriculture (1985=100)



highs were also observed in March. Seasonal lows occurred in October in the earlier years of the series (1982 - 1989) and thereafter shifted to November. The December high reflects the corresponding high in the currency series. The year 1988 appeared to be an abnormal one; in that year an uncharacteristic seasonal low was recorded in December. This probably reflects the fact that in that year, Trinidad and Tobago was in the midst of a deep recession, which may explain the atypical pattern of low consumption in the holiday season.

The other seasonal variations in the series reflect the movements in the commercial bank deposits series. For instance, the March high possibly reflects the accumulation of demand and savings deposits in the period of low rates of private consumer spending, where loan demand has not yet peaked. The June, July high could occur because of increased loan demand to finance holiday travel abroad. The October, November troughs reflect the slower rate of deposit accumulation as private spending begins to accelerate and loan demand begins to rise in anticipation of Christmas.

Private sector credit is depicted in Chart 1.2, and observation shows that there is no readily discernible seasonal pattern. Examination of this figure indicates that stable seasonality is very weak, with a mild high occurring in November for the years 1982 to 1988 and thereafter shifting to December, and there are no genuine lows. However, in the recent past (1990-1993) a seasonal low which previously occurred around October, has emerged in September. However, at present no sound reason can be advanced for this emerging pattern.

The real sector series, local sales of cement is presented in Chart 1.3. Examination of the graph shows the presence of marked seasonal stability.

Distinct seasonal peaks normally occur in the dry months of May and October (the *petit careme*) and seasonal troughs usually occur in September and December. This series is highly correlated with construction activity in Trinidad and Tobago. The declining trend in local sales of cement appeared to have varied directly with the decline of the Construction industry during the recession (compares sales in 1982 to 1985 with sales from 1986 to 1993). The May peak which was approximately 55,000 tonnes in 1984, declined to approximately 23,000 tonnes in 1992 which coincided more closely with sales in October. More importantly construction is dependent upon weather conditions. In Trinidad and Tobago, construction activity usually peaks in the dry months of April, May, June and October.

Graphical examination of the Retail Price Index-Housing (September 1993=100) series shows a uncharacteristic step-like pattern (see Chart 1.4). Examination of the data reveals that these steps coincide with the timing of the surveys conducted by the Central Statistical Office (CSO) and as such induces a false seasonal pattern on the series. The existence of such and uncharacteristic pattern for this series seems to suggest that either:

- *a monthly survey of the series be conducted so that the true seasonal pattern of the series can be ascertained; or*
- *that the CSO could interpolate values for months for which no* data are available, rather than repeating the values until the next survey is conducted.

The All Items Sections of the Index of Retail Sales (Ave 1979=100) is a quarterly series. Chart 1.5 shows a characteristic seasonal pattern as a there is a seasonal peak in the fourth quarter as anticipatory consumption for the holiday season increases and a seasonal trough in the first quarter.

The final series depicted in Chart 1.6, GDP at Factor cost in Agriculture (1985=100), shows a seasonal trough in the third quarter and a seasonal peak in the fourth quarter. Over the years a peak has emerged somewhat in the second quarter, but this has not occurred on a regular enough basis to be described as typical. Agricultural production is highly correlated with weather conditions. The rainy months of July, August and September affect harvesting and planting and thereby contribute to the characteristic decline of the Index in the third quarter.

Tables 1 to 3 present the characteristics of the series in tabular form. Table 1 shows the means of the series for the whole period 1982 to 1993 and the means computed for the first and second half of the sample periods respectively i.e. 1982 to 1987 and 1988 to 1993. Examination of Table 1 reveals that for four of the six series, namely RPI - housing, broad money supply, private sector credit and real value added in Agriculture, the means in the second half of the sample period were larger than that in the first half.

Table 1

Running Means for the Series

	Retail Price Index - Housing (Sept. 1993 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$ Mn)	Local Sales of Cement (tonnes)	Real Value Added (Factor Cost) in Agriculture (1985=100)	Index of Retail Sales (Avg. 1979 =100)
Means						
1982 to 1993	88.06	8377.05	6177.43	25279.42	121.67	152.15
1982 to 1987	78.14	7764.89	5614.71	31657.75	100.83	157.91
1988 to 1993	97.97	8989.22	6740.14	18901.08	142.50	146.39

The average monthly and quarterly deviations of the series from their trend value is shown in Tables 2.a and 2.b. This measure provides a first indication of the size of the seasonal component. Table 2.a shows that the

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1988 to 1993	97.97	8989.22	6740.14	18901.08	142.50	146.39

The average monthly and quarterly deviations of the series from their trend value is shown in Tables 2.a and 2.b. This measure provides a first indication of the size of the seasonal component. Table 2.a shows that the

RPI - housing series has the smallest variations and the local sales of cement series the largest seasonal variations when compared with the other monthly series. In addition, the latter experiences a strong seasonal high in May and a seasonal trough in December. The broad money supply series, according to this measure has a seasonal high in June and a trough in October. Table 2.b indicates that for the Index of Retail Sales, a seasonal high occurs in the fourth quarter and a trough in the first quarter. Furthermore, our preliminary findings of a seasonal high in the fourth quarter and a low in the third quarter according to the graphical analysis of the GDP (factor cost) in Agriculture series were corroborated by the tabular analysis.

Table 2a

Mean Monthly Deviation From The Trend

	Retail Price Index -Housing (Sept. 93 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$ Mn)	Local Sales of Cement (tonnes)
January	0.27	-30.91	59.60	-3239.57
February	0.02	-45.60	37.32	-2516.42
March	-0.25	34.95	18.64	361.15
April	-0.36	10.50	-19.40	2716.93
May	-0.64	83.35	-39.37	6611.65
June	-0.91	112.32	-22.02	1936.12
July	0.79	1.33	5.58	851.10
August	0.47	-30.52	-0.72	-1037.68
September	0.20	-13.45	-72.94	-1709.18
October	0.42	-56.40	-42.39	354.12
November	0.14	-44.32	15.43	-647.25
December	-0.14	14.82	52.41	-3745.96

Note: *The mean of the actual deviation from the trend is calculated, not the mean of the absolute value from the trend*

Table 2b

Mean Deviation From The Trend Per Quarter

	Index of Retail Sales (Avg. 1979 =100)	Real Value Added (Factor Cost) in Agriculture (1985=100)
Qtr 1	-12.43	5.63
Qtr 2	-6.59	3.91
Qtr 3	-3.24	-28.14
Qtr 4	21.70	18.82

Note: *The mean of the actual deviation from the trend is calculated, not the mean of the absolute value from the trend*

Finally to determine whether the series in question were more suited to additive or multiplicative adjustment a trend regression was done on the individual series. The choice between the two types of adjustment can be made on ad-hoc basis by using a simple regression between preliminary trend and absolute value of the preliminary seasonal component of a series. This regression is of the form:

$$\left|y - y_T\right| = \alpha + \beta y_T$$

Where y is the value of the original series and y_T the centered moving average of y over the period of one year. If the components are not correlated, i.e., if β does not differ significantly from zero additive adjustment would probably be appropriate. If β is significant a multiplicative method may be best. Series with negative values must be adjusted additively since the multiplicative method is based on the log of the series. In practice this approach was less than satisfactory and tended to be very sensitive to outliers in the series. Alternatively, the power transformation tests can provide similar information. Table 3 presents the least squares estimates of the coefficients α and β, together with their corresponding t-values, the results of the transformation tests, and finally the choice of adjustment method adopted. Observation of the table reveals that some β's have t-values which suggest that the choice of adjustment should be neither purely additive or multiplicative, but rather an intermediate form of the two. However in this paper our analysis does not concern itself with intermediate adjustment techniques. As such, RPI - Housing, private sector credit, local sales of cement and real GDP (at factor cost) in Agriculture will be adjusted multiplicatively and the remaining two series would be adjusted additively.

Table 3

Identification Of Multiplicative Or Additive Adjustment

	Alpha	Beta	Power Transformation	Choice of Adjustment Method
Retail Price Index - Housing (Sept. 93 = 100)	1.48 (3.26)	-0.01 -(1.85)	0.75	Multiplicative
Broad Money Supply M2 (TT$ Mn)	324.90 (4.97)	-0.03 -(3.58)	None	Additive
Private Sector Credit (TT$ Mn)	-38.47 -(0.98)	0.02 (2.82)	-1.00	Multiplicative
Local Sales of Cement (tonnes)	-1182.63 -(1.53)	0.16 (5.67)	-0.25	Multiplicative
Index of Retail Sales (Avg. 1979 =100)	5.94 (0.55)	0.04 (0.54)	0.5	Additive
Real Value Added (Factor Cost) in Agriculture (1985=100)	1.82 (0.25)	0.11 (1.95)	Log	Multiplicative

Note: *Identification according to |Y - MAVEC(Y)| = Alpha + Beta * Y,*
t - values in parentheses

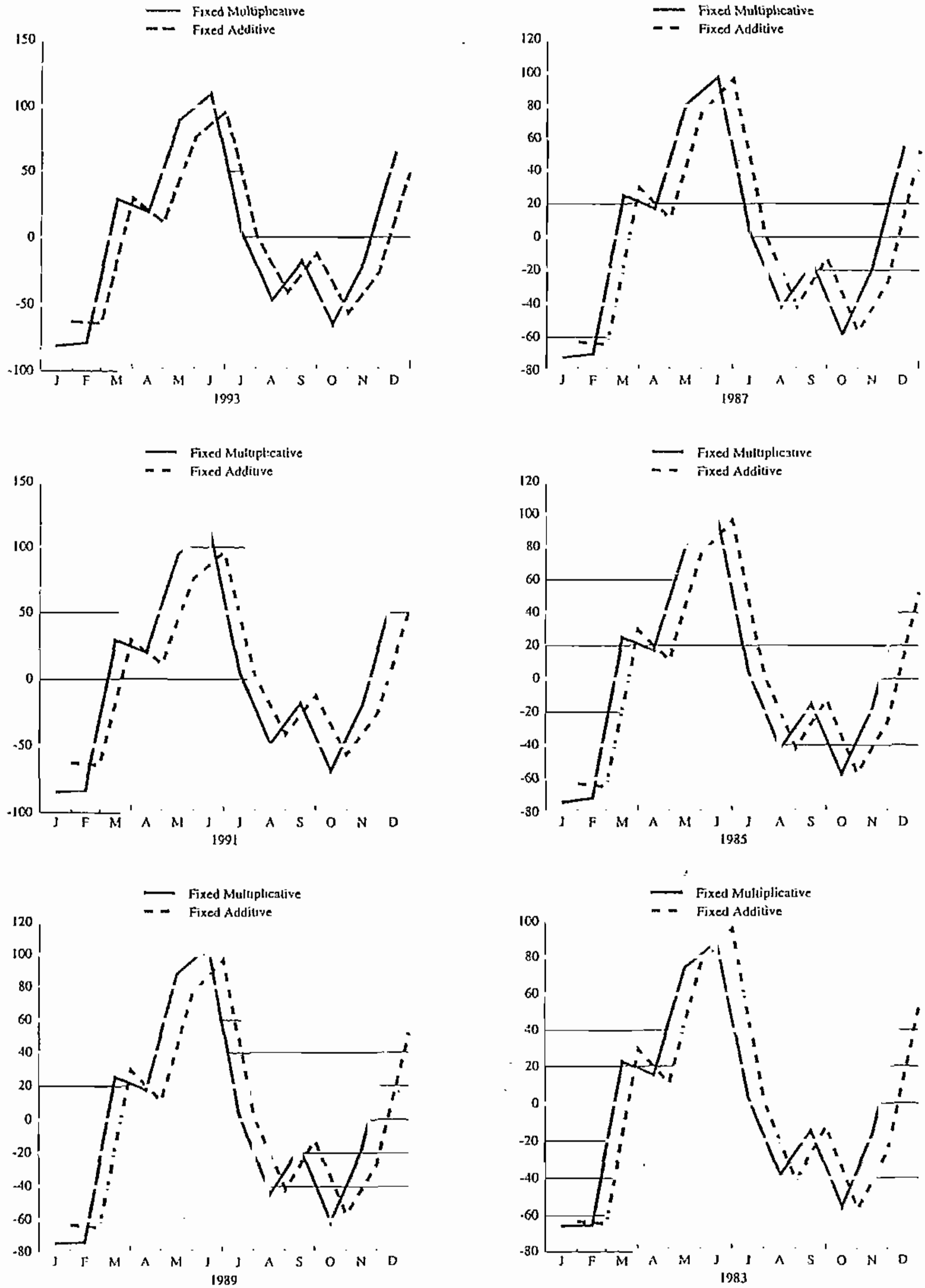
Application of Seasonal Adjustment Methods

In this section we evaluate the performance of the six methods when applied to the series described above. We start with an analysis of the differences in the components produced by each method and then go to examine the comparative performance of each method based on a number of criteria established by Fase and Den Butter [1991].

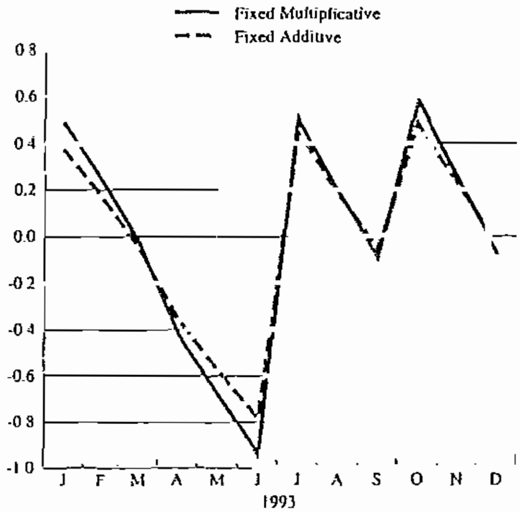
Fixed Additive vs. Fixed Multiplicative Methods

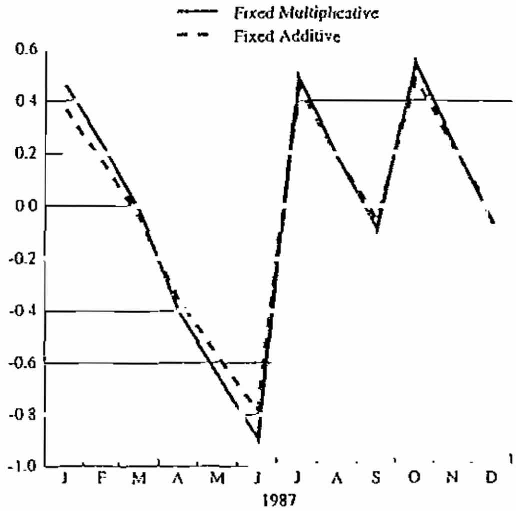
For all series concerned, the seasonal component according to the fixed additive method were identified each year (see Chart 1.7). The fixed multiplicative method yields seasonal components, which when compared with the fixed additive method deviate more widely from each other at the

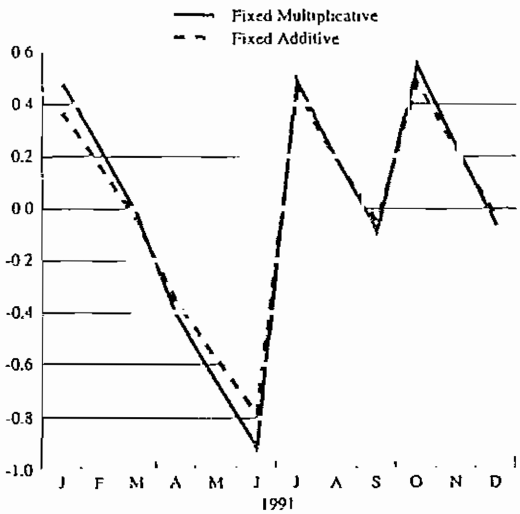
Chart 1.7 - Seasonal Components for the Series Broad Money Supply M2 (TT$ Mn)

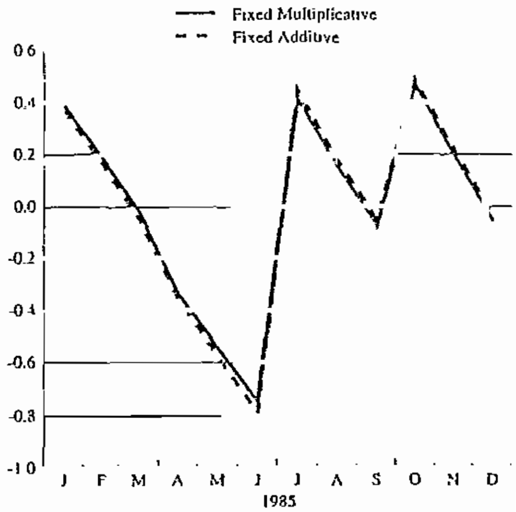


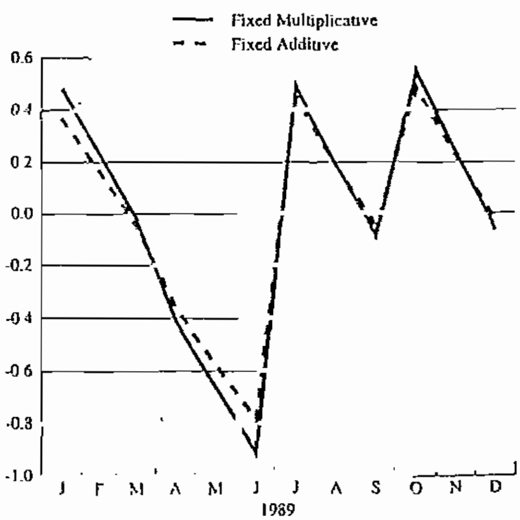
Seasonal Components for the Series
Retail Price Index - Housing (Sept 93 = 100)

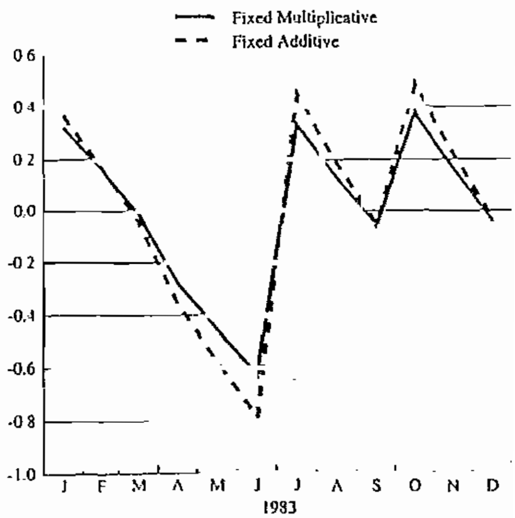




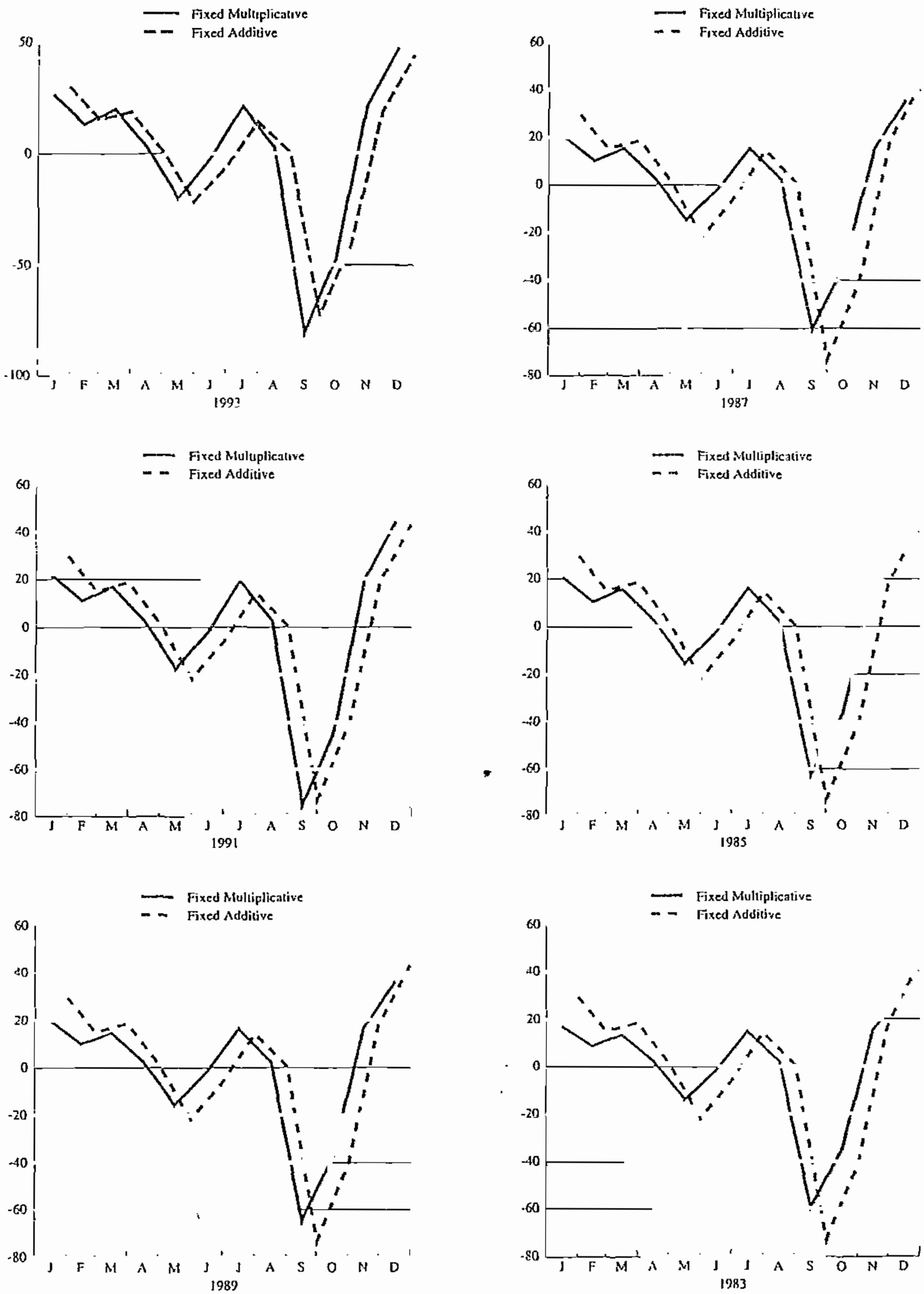




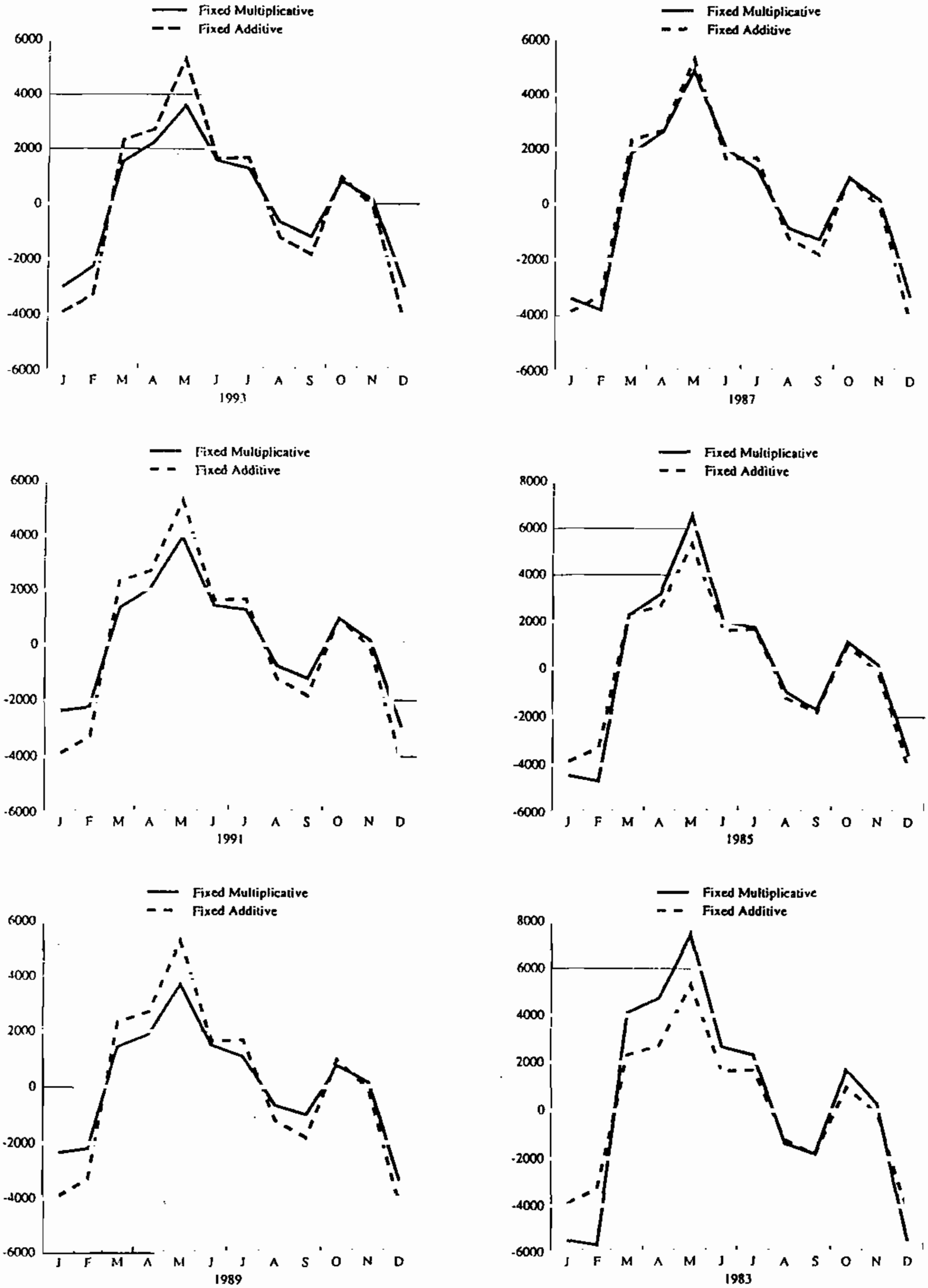




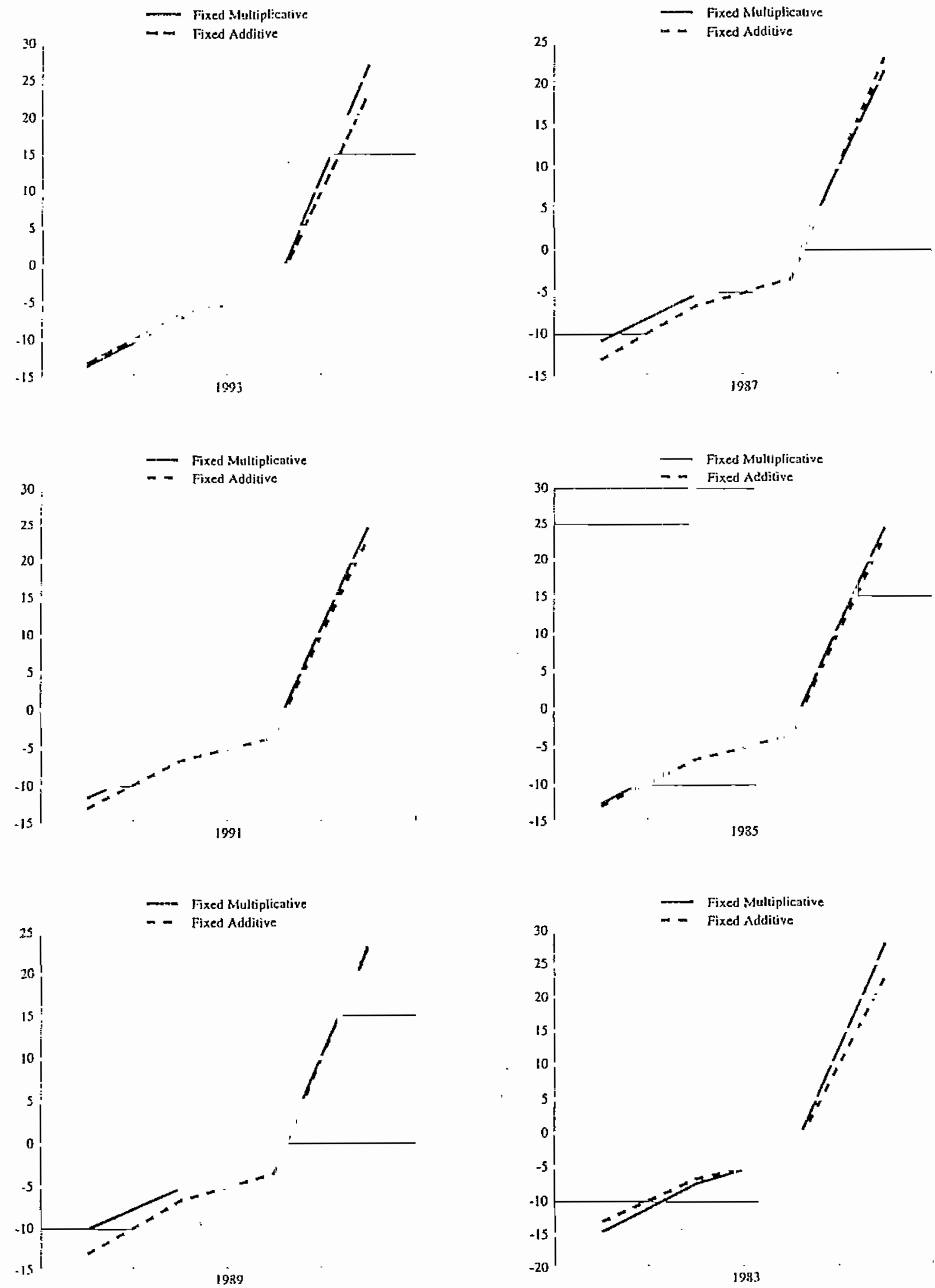
Seasonal Components for the Series
Private Sector Credit (TT$ Mn)



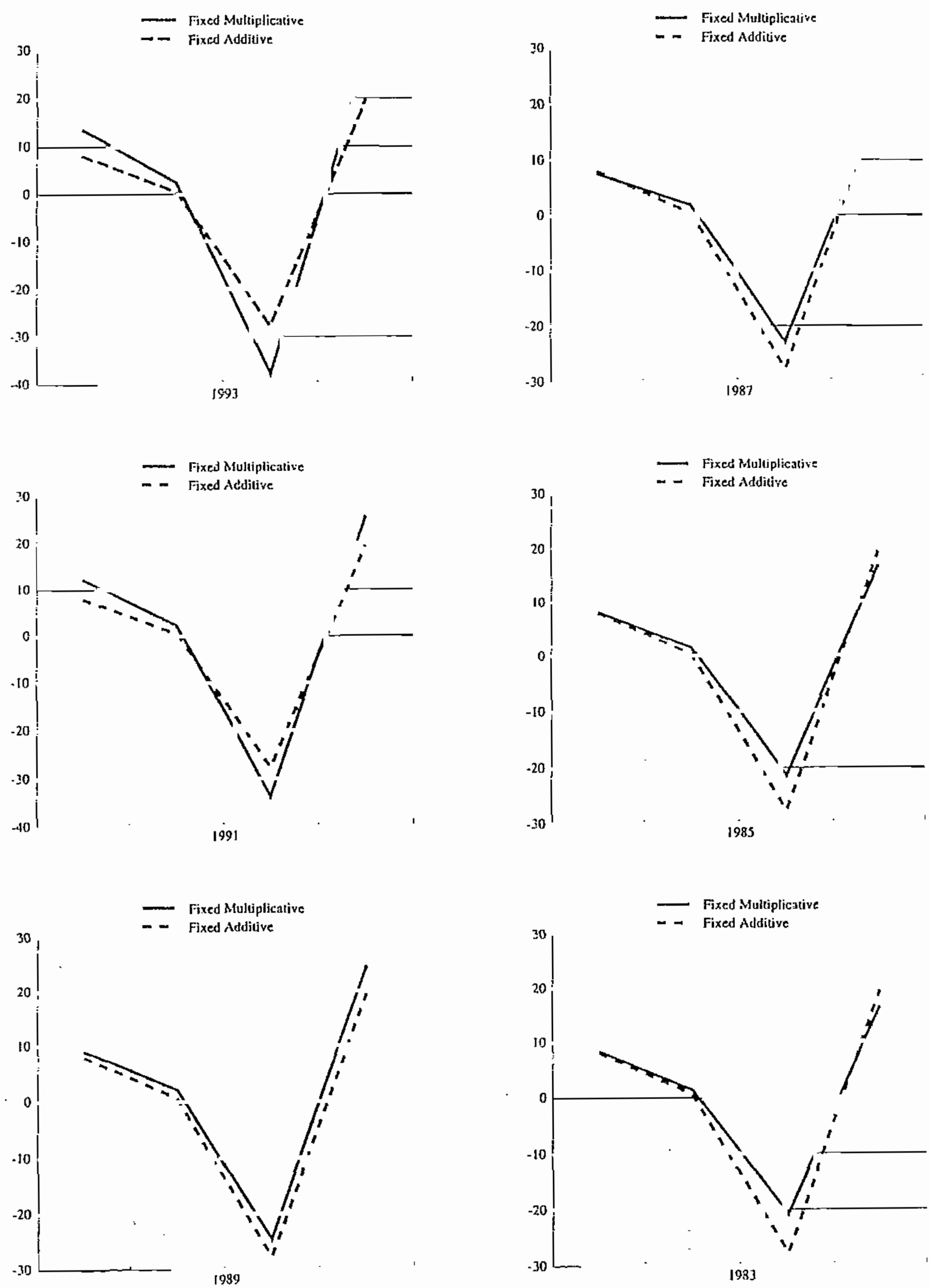
Seasonal Components for the Series
Local Sales of Cement (tonnes)



Seasonal Components for the Series
Index of Retail Sales (Avg 1979 =100)



Seasonal Components for the Series
Real Value Added (Factor Cost) in Agriculture (1985=100)



beginning and end of the sample period but otherwise follow each other quite closely. A couple of exceptions here are the broad money supply series (M2) and public sector credit whose seasonal components according to the additive method appear to lag about a half-period behind the seasonal components of the other.

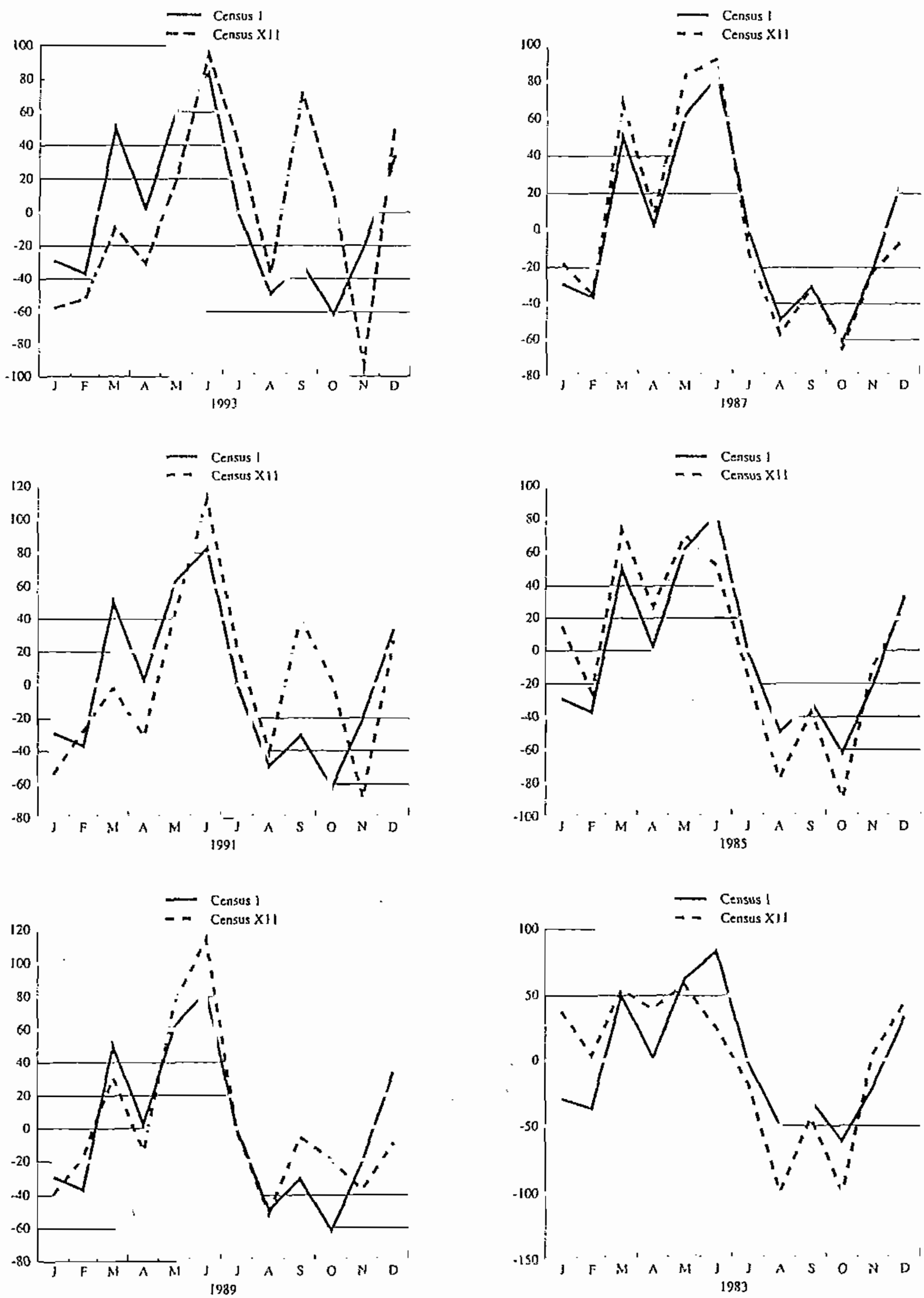
Census 1 vs. Census X-11 Method

Chart 1.8 reveals that for the Census 1 Method shifts in the seasonal pattern are reflected in changes in the size of the seasonal component. The seasonality however appears to be stable in that the shape of the picture produced according to the estimated annual seasonal pattern, changes little over the years. This method then is less sensitive to the changing seasonality in a series. For instance, the application of the Census Method 1 (additive variant) to the broad money supply series, rendered seasonal components which changed very little over the years, even though seasonality in this series was obviously changing. The multiplicative variant of the Census Method 1, appears to be more sensitive to changes in the size of the seasonal component, even though it still fails to reflect changing seasonal patterns.

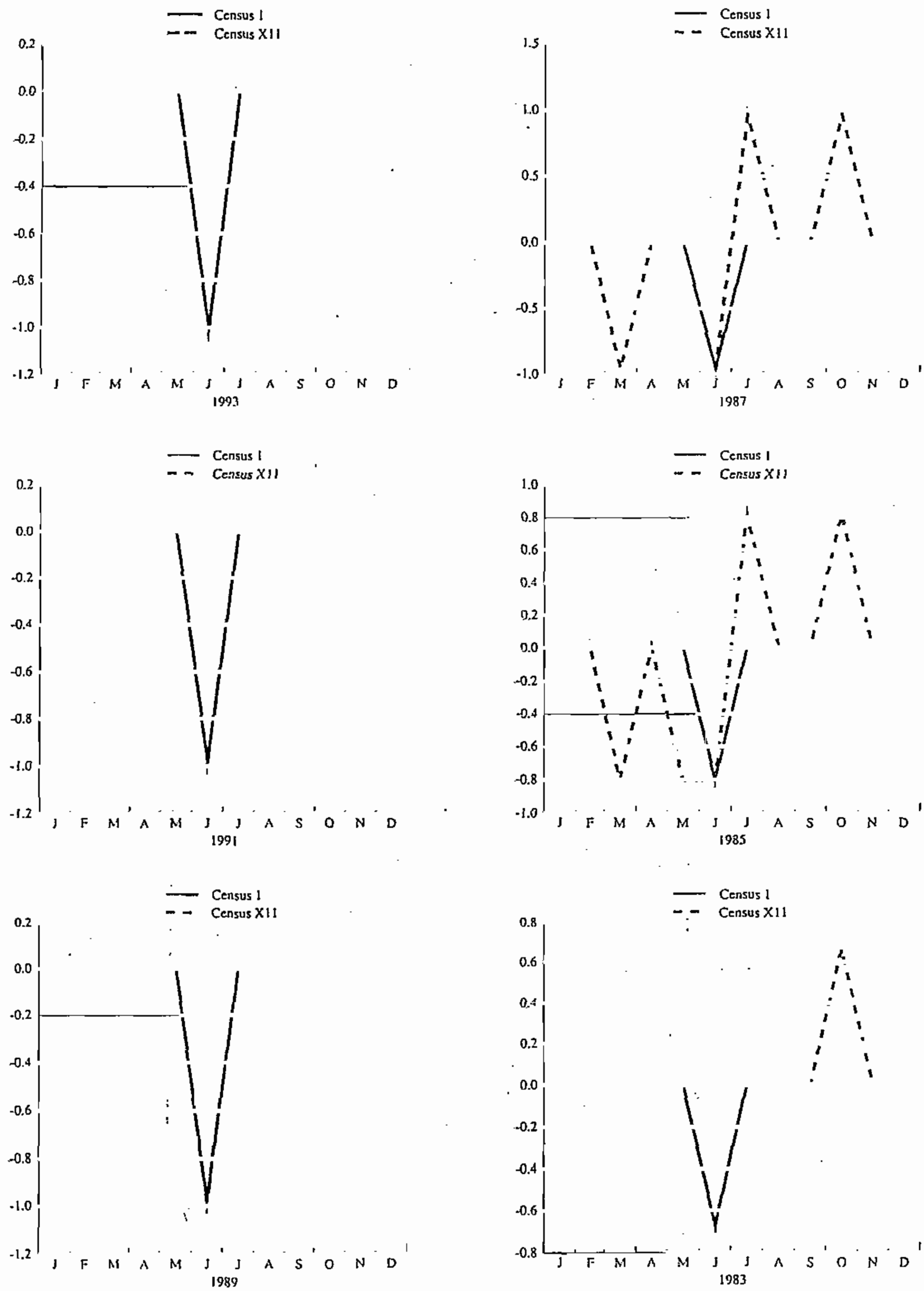
Observation of Chart 1.8 seems to suggest that, the Census X-11 Method (whether additive or multiplicative variant) is more sensitive to the changing seasonality in a series than the Census 1 Method. Although, this method tends systematically to underestimate the changes in the seasonal pattern at the beginning and end of the series, the application of the method to the series renders better seasonal components than the other methods previously considered.

Census X-11 vs. X-11 ARIMA

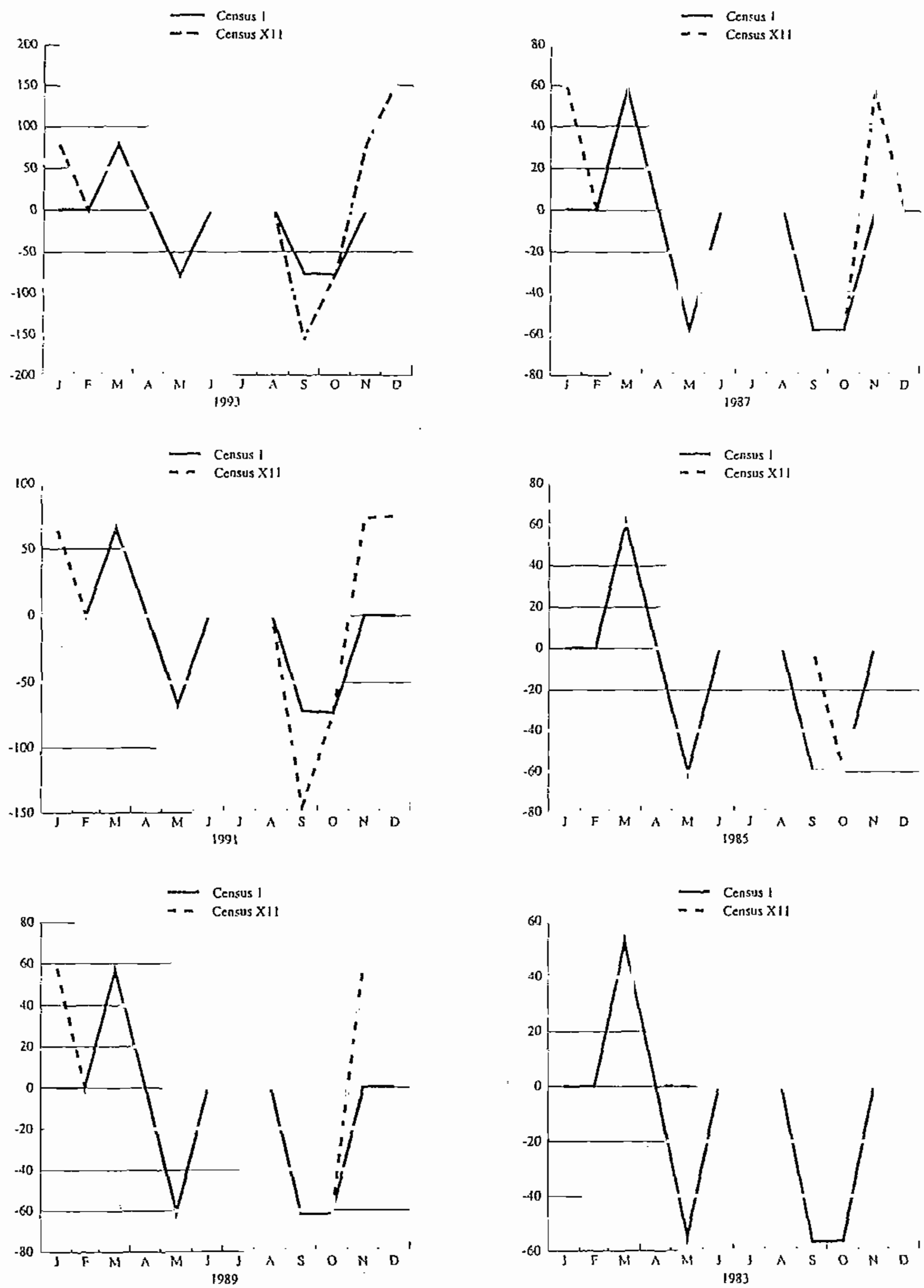
Chart 1.8 - Seasonal Components for the Series
Broad Money Supply M2 (TT$ Mn)



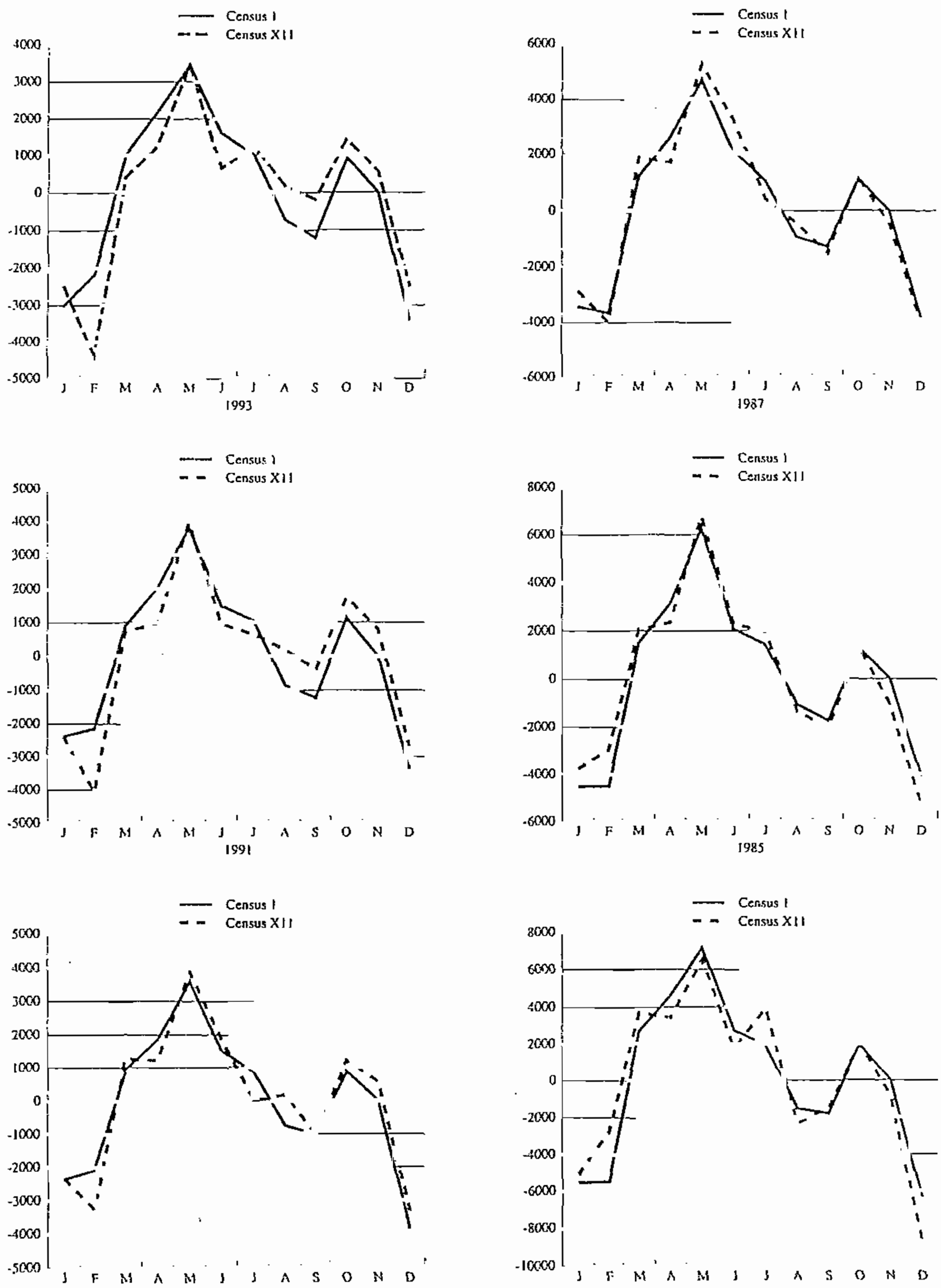
Seasonal Components for the Series
Retail Price Index - Housing (Sept 93 = 100)



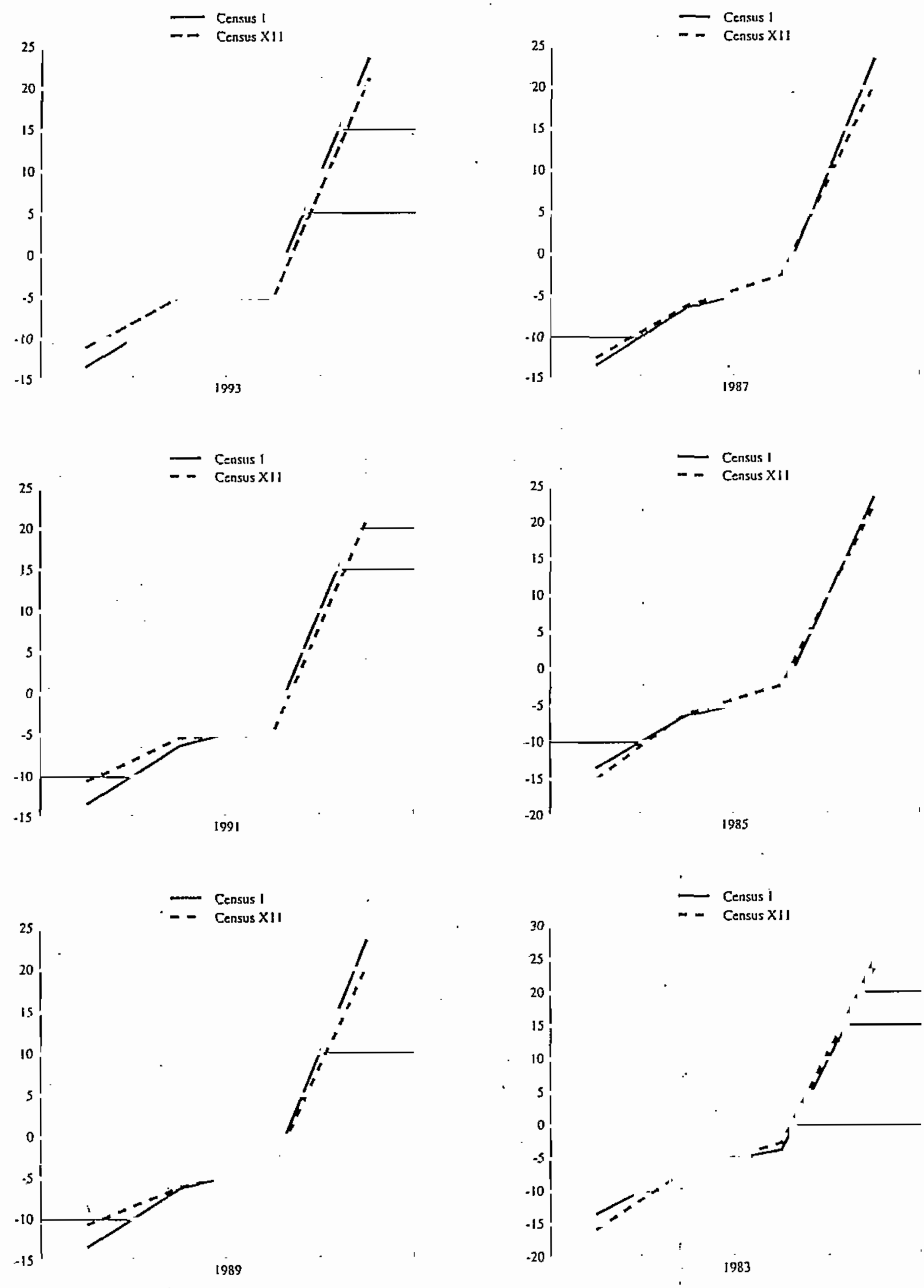
Seasonal Components for the Series Private Sector Credit (TT$ Mn)



Seasonal Components for the Series
Local Sales of Cement (tonnes)



Seasonal Components for the Series
Index of Retail Sales (Avg 1979 =100)



Seasonal Components for the Series
Real Value Added (Factor Cost) in Agriculture (1985=100)

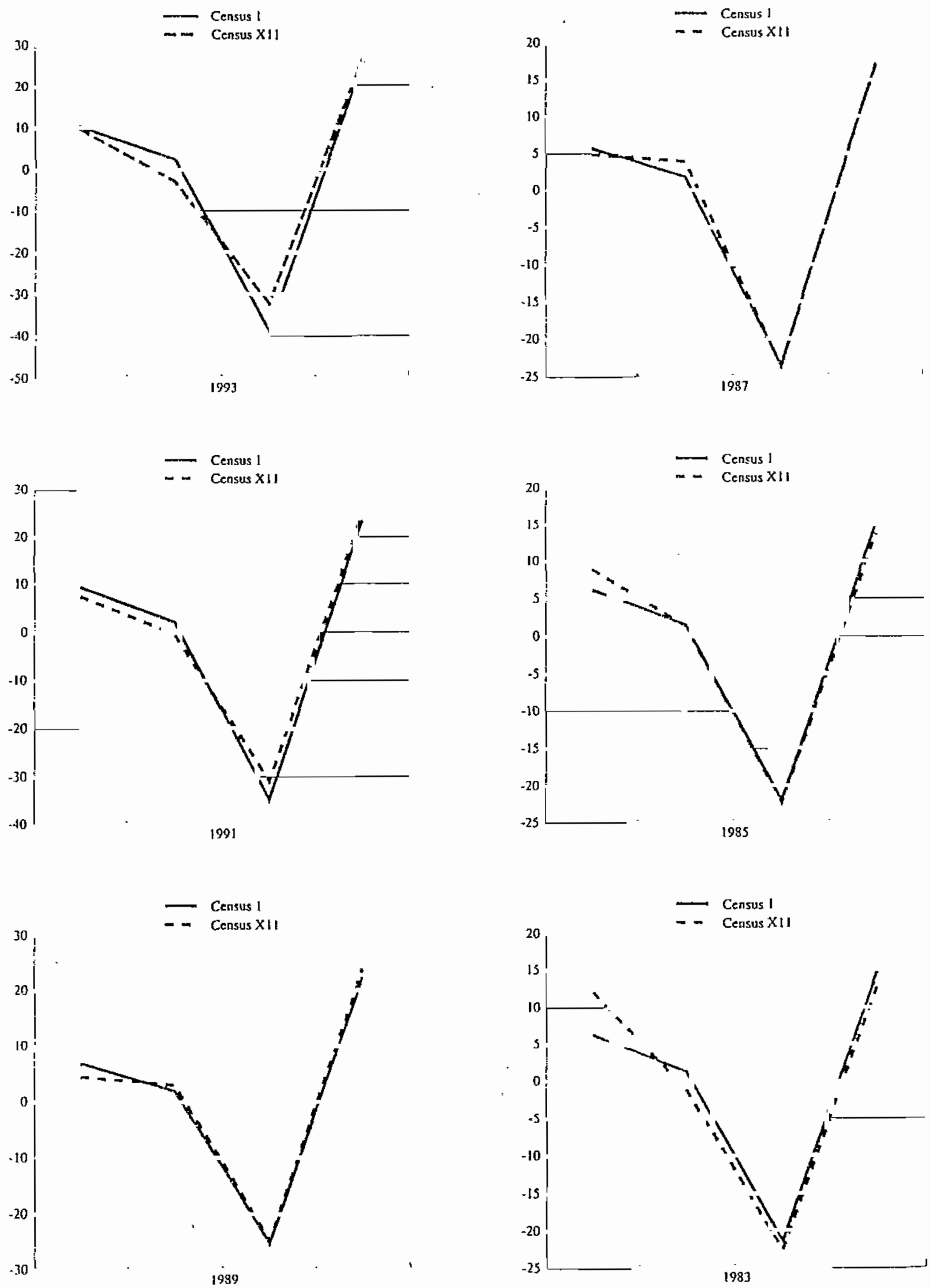


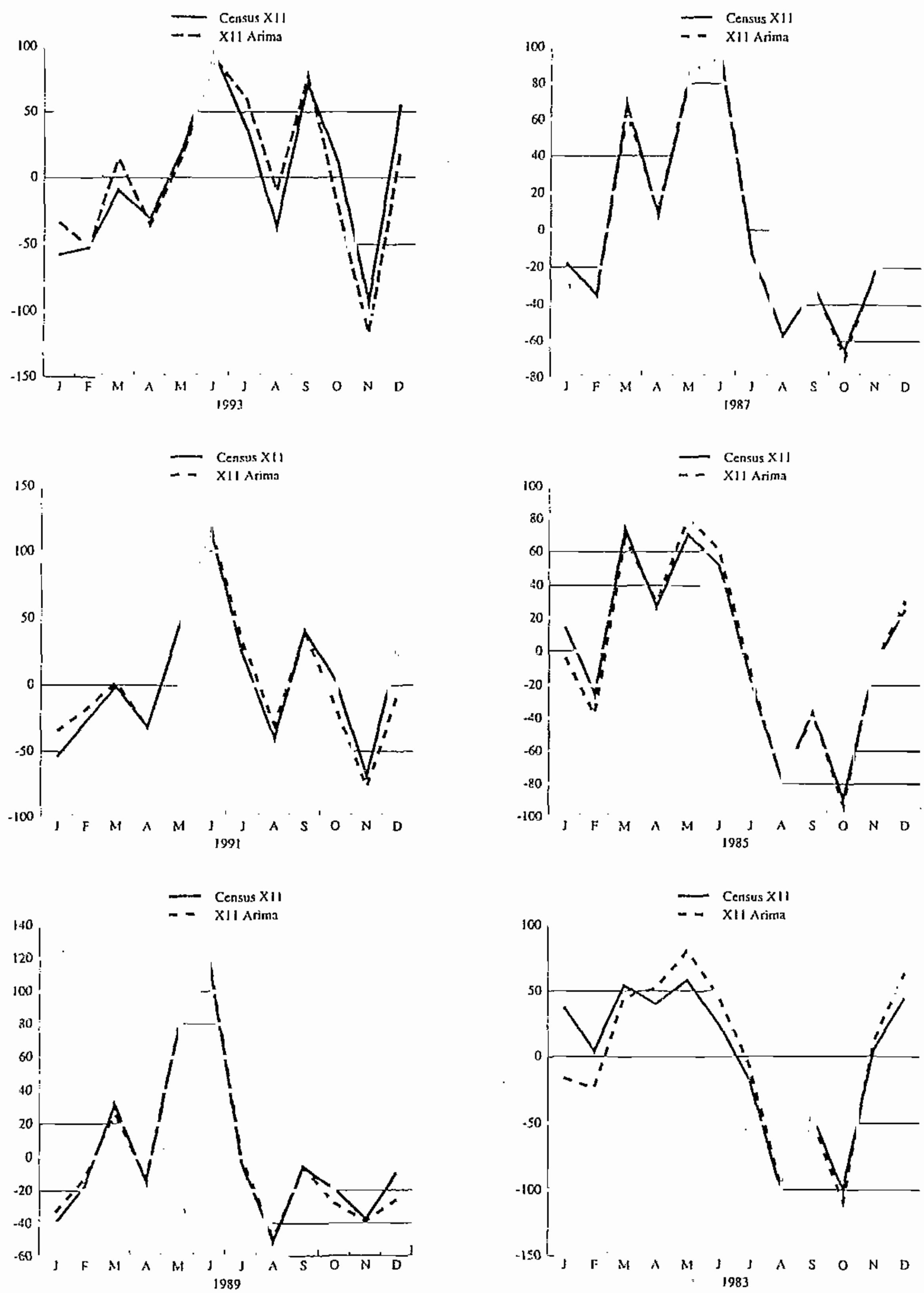
Chart 1.9 shows that adjustment of the individual series by these two methods yield very similar seasonal components. Except for public sector credit and the RPI - Housing series, in which stable seasonality is quite weak, the seasonal components obtained by these two methods track each other closely (see the local sales of cement series). For the broad money supply series, the X-11 ARIMA method appears to be more sensitive to the changing seasonality in the series than the Census X-11 method. The difference between the two methods are larger at the beginning and end of the sample period, but otherwise the differences in the size of the estimated seasonal components are small.

From 1989 to 1993, seasonal adjustment of the RPI-Housing series by either of the methods yielded a straight line, as the seasonal components produced by these methods were so minute the picture of the seasonal pattern appeared as a straight line when plotted. Recall that seasonality observed in this series was spurious and was induced by the survey methodology employed.

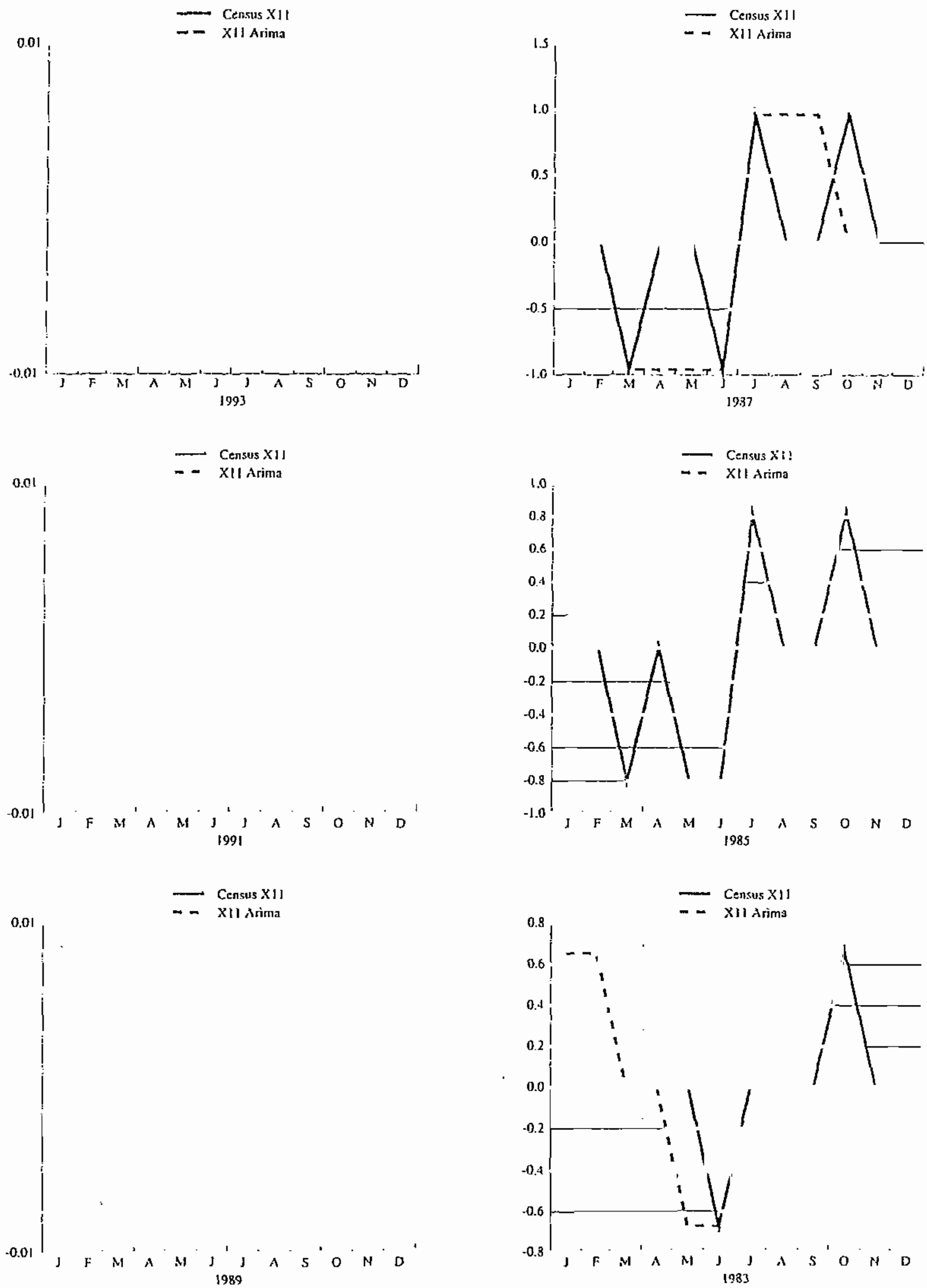
4. X-11 ARIMA vs. SABL Method

Except for those series where relative stable seasonality is present, the difference in seasonal components and seasonal patterns produced by the two methods are very apparent. For those series, like public sector credit and RPI-Housing where uncharacteristic seasonal patterns are reported by all of the other seasonal adjustment methods, the SABL method produces a regular seasonal pattern. For the broad money supply, the SABL method tended to overestimate the changes in the seasonal components at the beginning and

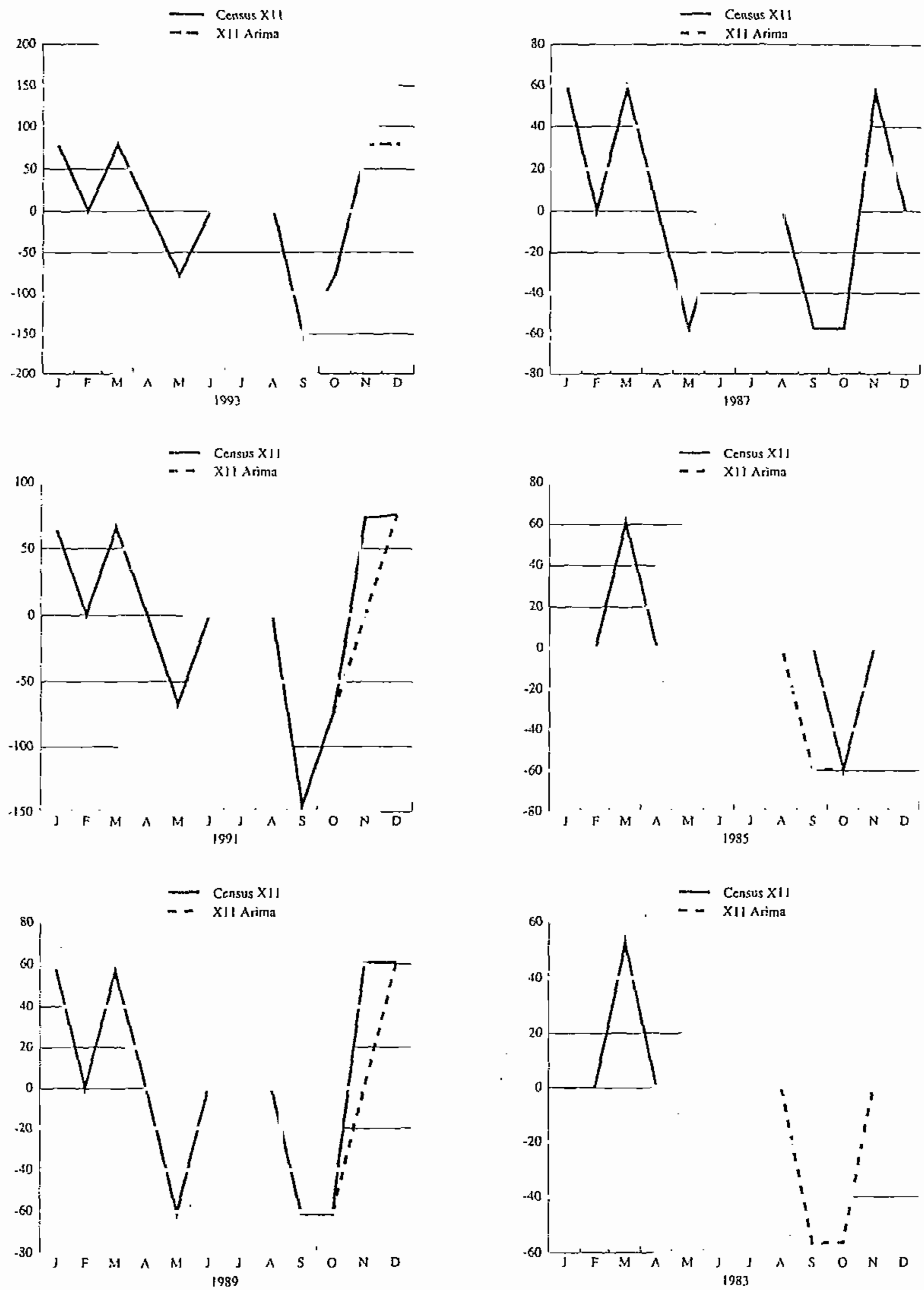
Chart 1.9 - Seasonal Components for the Series Broad Money Supply M2 (TT$ Mn)



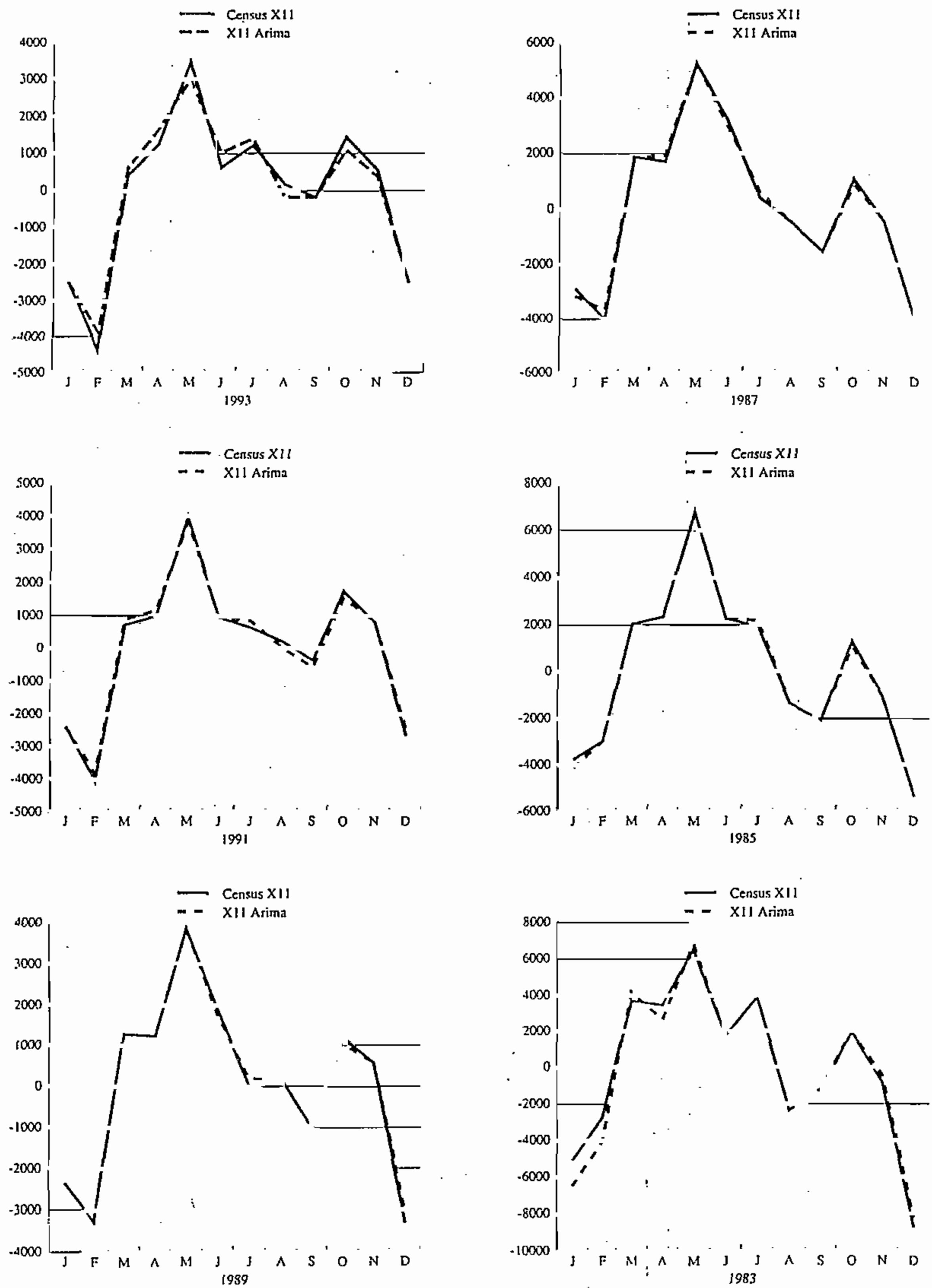
Seasonal Components for the Series
Retail Price Index - Housing (Sept 93 = 100)



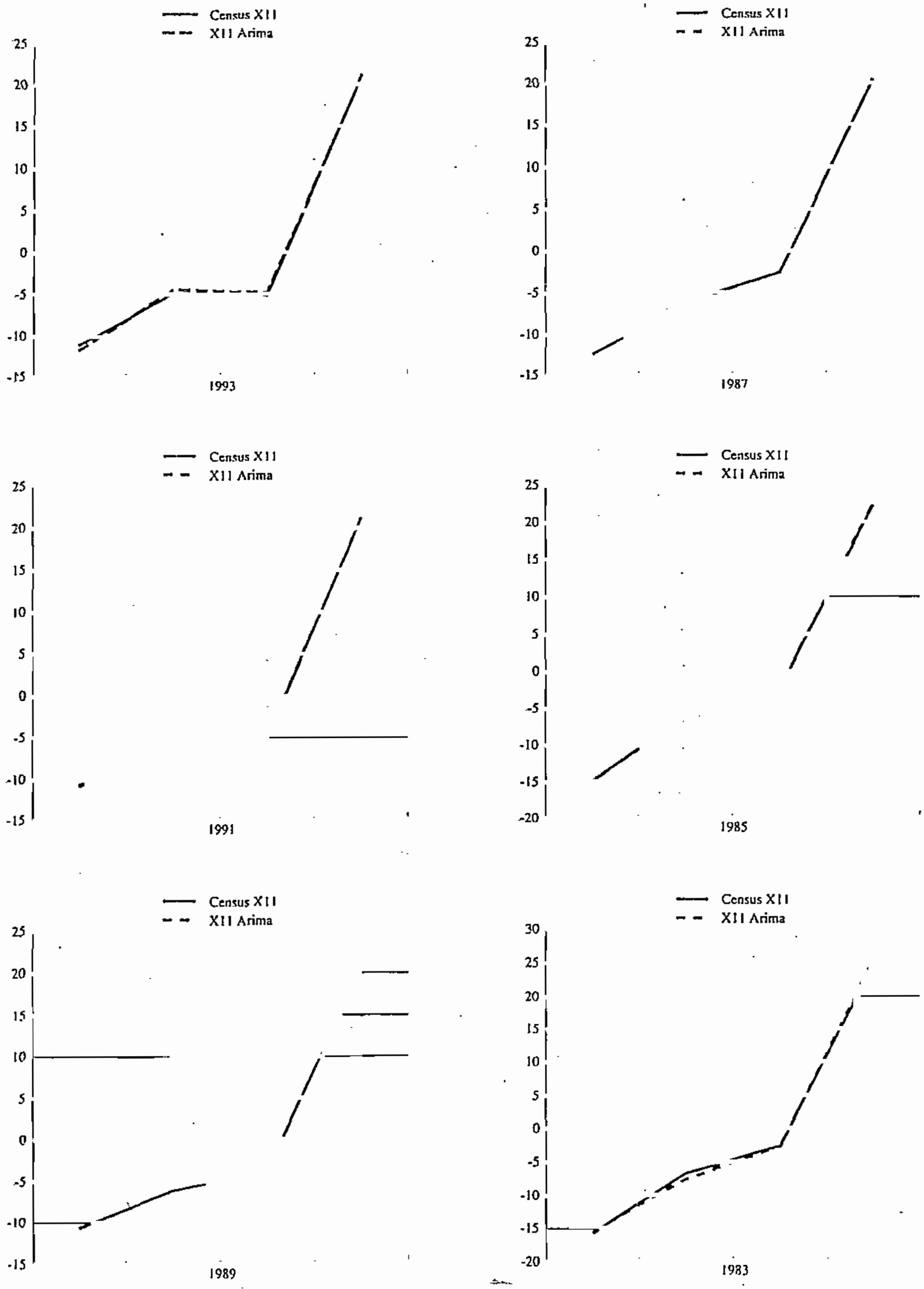
Seasonal Components for the Series
Private Sector Credit (TT$ Mn)



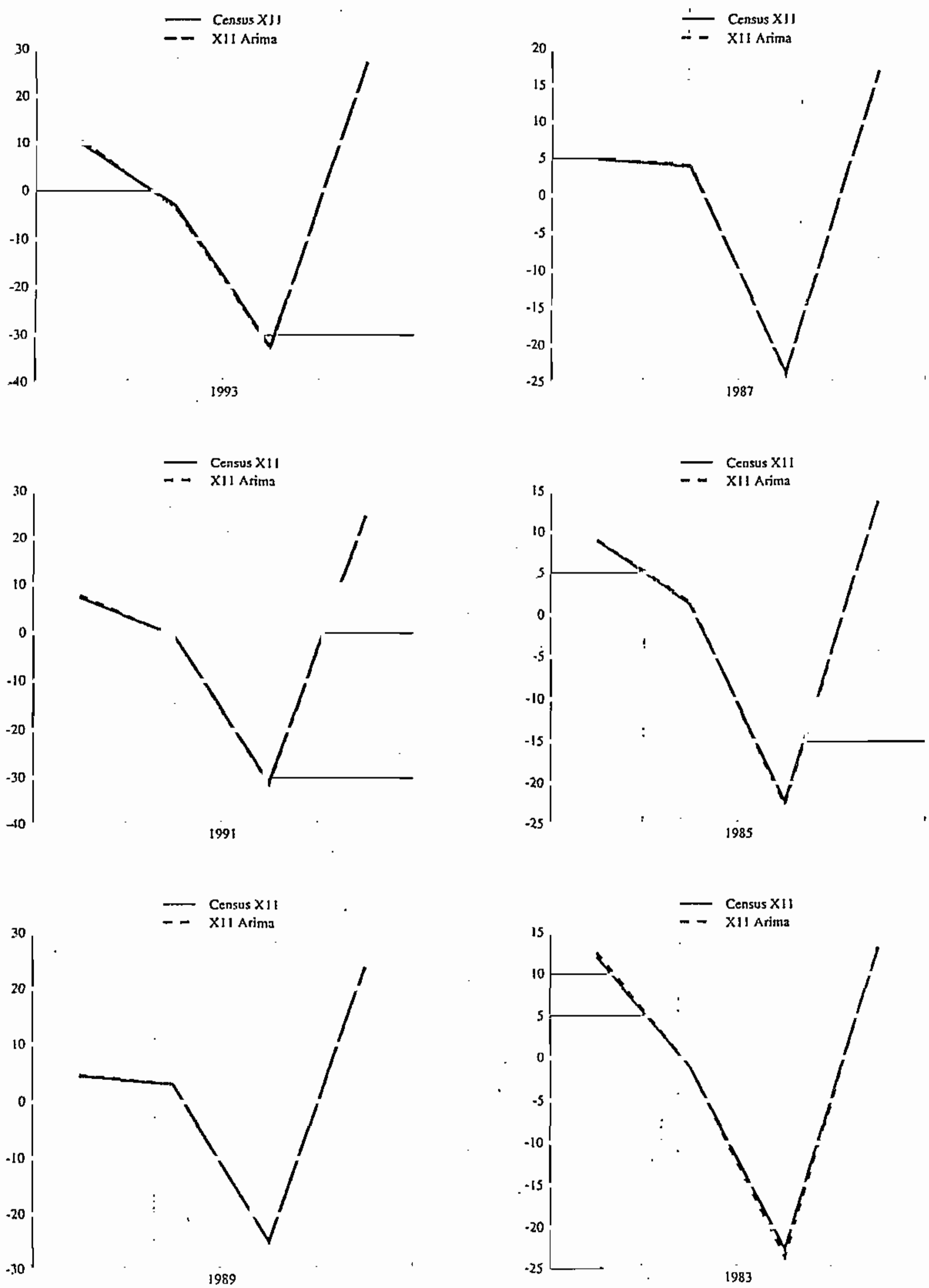
Seasonal Components for the Series
Local Sales of Cement (tonnes)



Seasonal Components for the Series
Index of Retail Sales (Avg 1979 =100)



Seasonal Components for the Series
Real Value Added (Factor Cost) in Agriculture (1985=100)



end of the series. For the local sales of cement series, the SABL method was better able than X-11 ARIMA to detect the changes in the seasonal pattern.

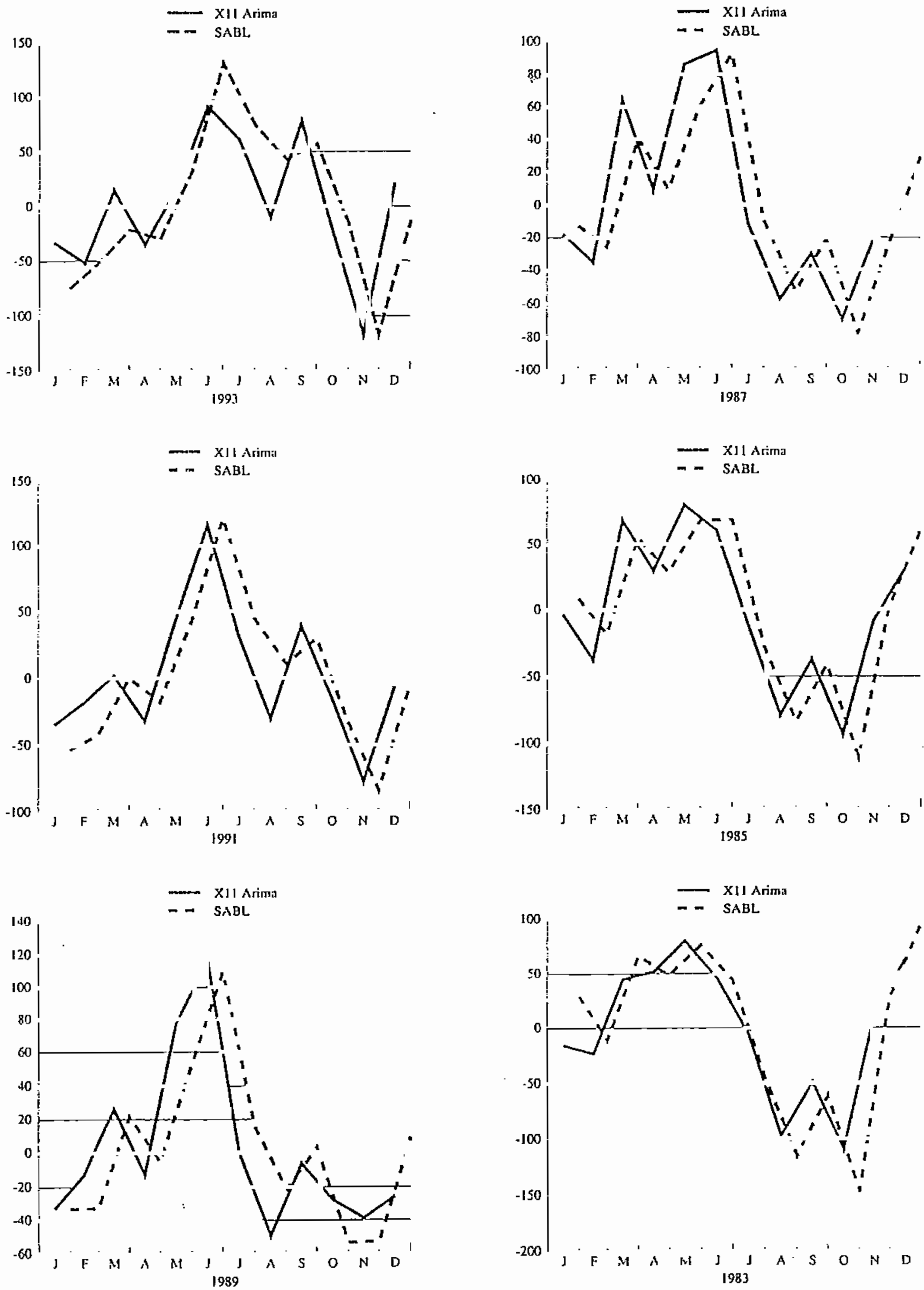
In order to summarize the differences obtained from applying the six adjustment methods considered, we start by examining Table 4 which shows the average periodic (monthly or quarterly) absolute percentage change in the original and seasonally adjusted series. This statistic represents a measure of smoothness of the series. Generally, seasonally adjusted data should be smoother than the original series, therefore, intuitively the value of the statistic for the seasonally adjusted data should be smaller than the original data. This was true in all instances except one, i.e. the RPI-Housing series where in all cases, this statistic was larger for the seasonally adjusted series. Additionally, in all instances except two, i.e. All sections Index of Retail Sales and real value added in agriculture series, where the Census X-11 method yielded the lowest statistics, the statistics produced by the X-11 ARIMA method were always the lowest.

Table 4

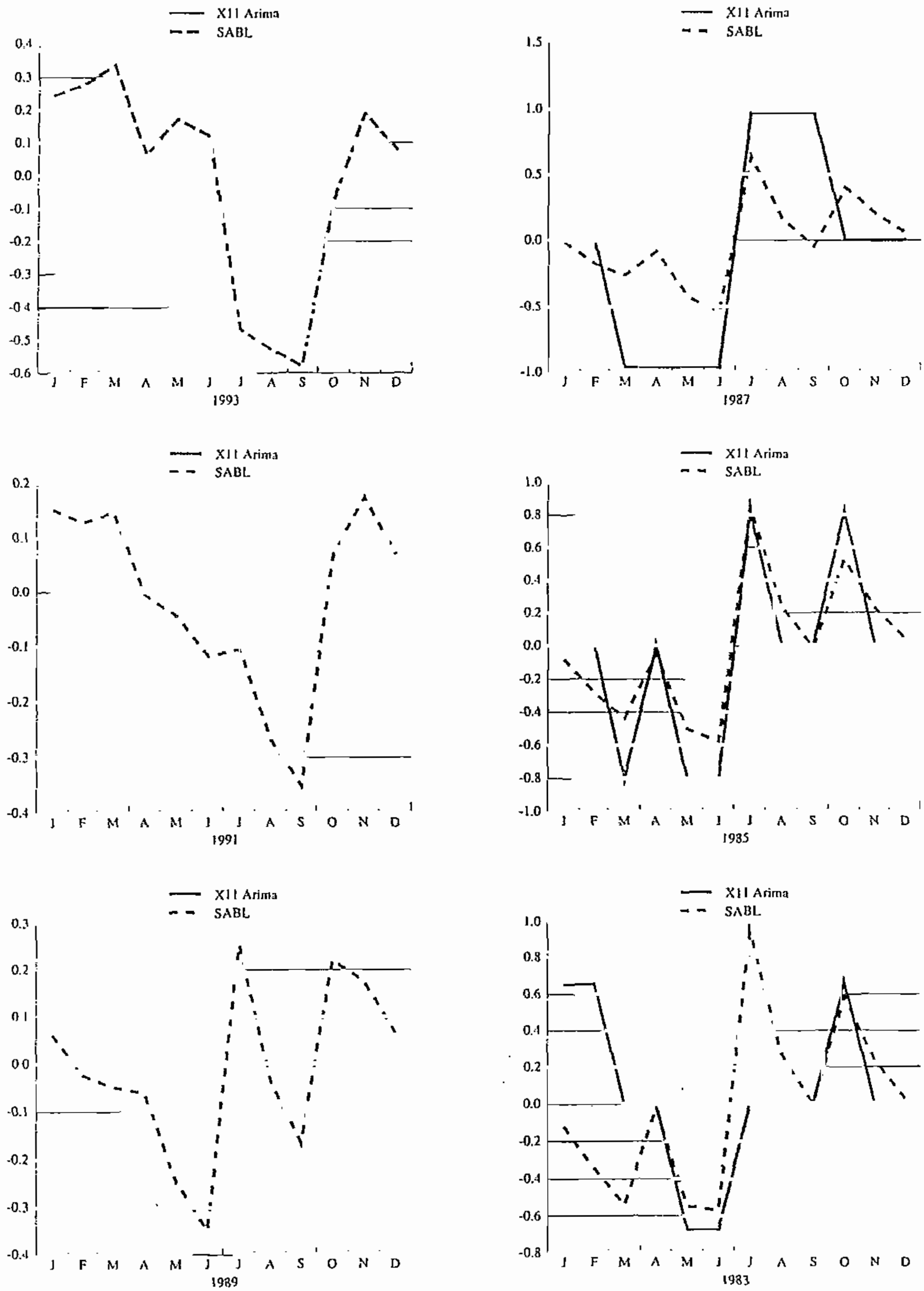
Average Periodic Absolute Percentage Change In Original And Seasonal Adjusted Series

	Retail Price Index - Housing (Sept. 93 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$Mn)	Local Sales of Cement (tonnes)	Index of Retail Sales (Avg. 1979 =100)	Real Value Added (Factor Cost) in Agriculture (1985=100)
Unadjusted data :	0.45	0.98	1.10	12.33	12.31	22.98
Seasonally adjusted data:						
Fixed Additive	0.62	0.85	1.08	9.98	4.89	8.32
Fixed Multipilcative	0.65	0.86	1.07	9.53	4.59	7.66
Census Method 1	0.58	0.83	1.04	9.49	4.95	7.41
Census X-11	0.48	0.80	0.98	8.41	4.58	7.00
X11 ARIMA	0.46	0.79	0.97	8.33	4.61	7.03
SABL	0.51	0.81	1.04	8.96	4.86	7.51

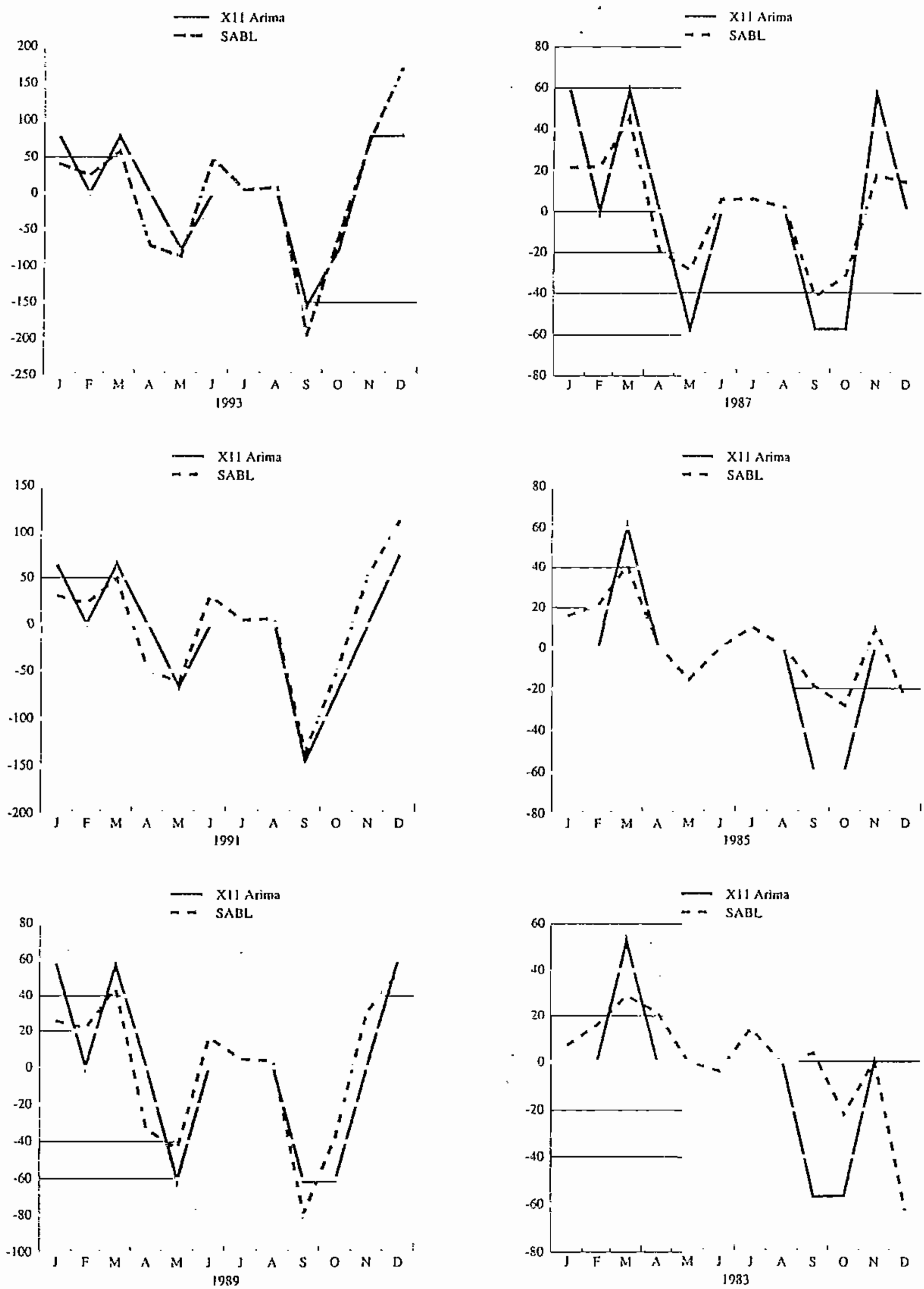
Chart 1.10 - Seasonal Components for the Series Broad Money Supply M2 (TT$ Mn)



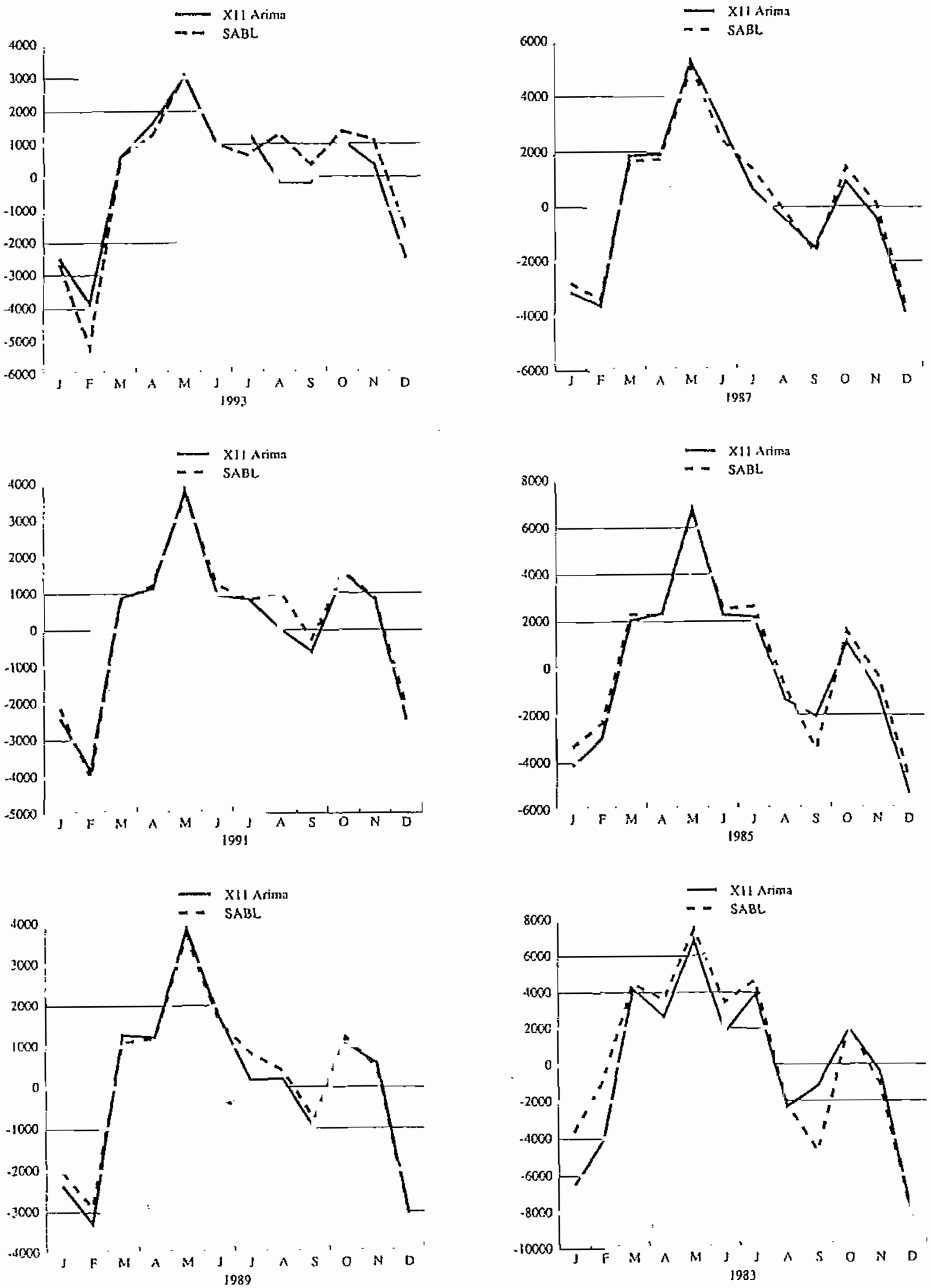
Seasonal Components for the Series
Retail Price Index - Housing (Sept 93 = 100)



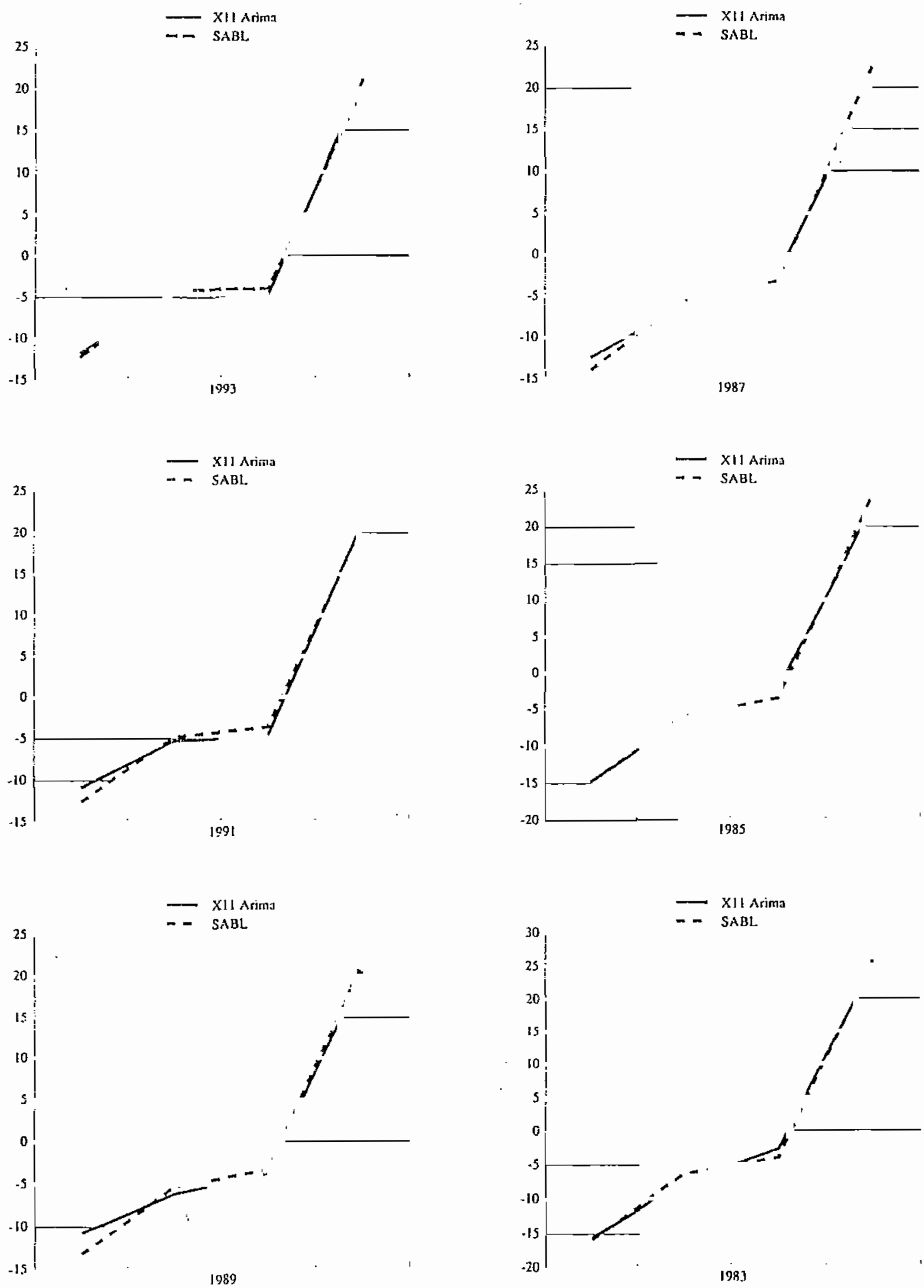
Seasonal Components for the Series
Private Sector Credit (TT$ Mn)



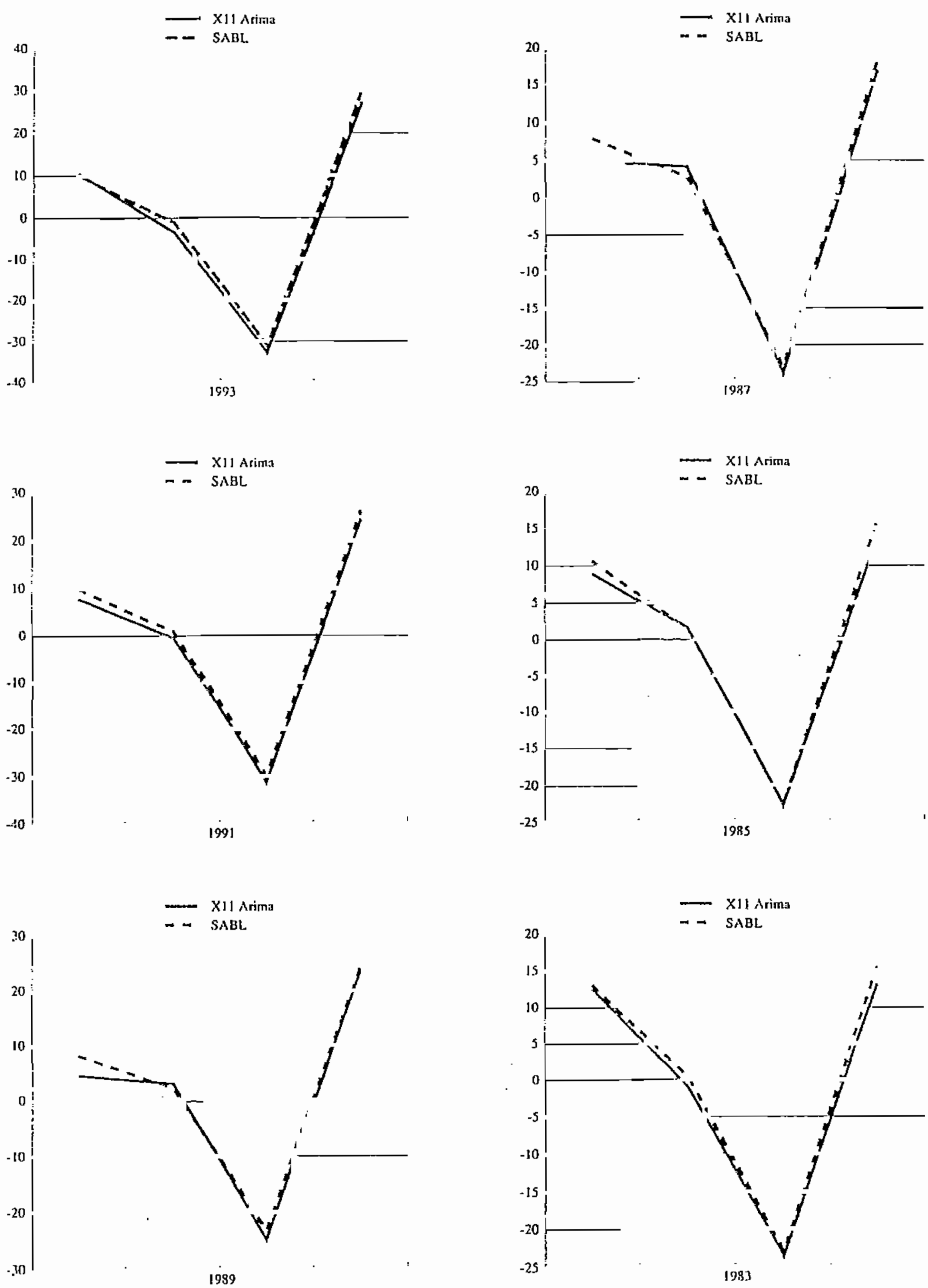
Seasonal Components for the Series
Local Sales of Cement (tonnes)



Seasonal Components for the Series
Index of Retail Sales (Avg 1979 =100)



Seasonal Components for the Series
Real Value Added (Factor Cost) in Agriculture (1985=100)



To determine to what extent the estimated seasonal components differ from one another, Theil's Inequalities Coefficient (IC) is used as the criterion for evaluation

$$IC_{m,n} = \frac{\sqrt{\sum_{t=1}^{N}\left(S_t^{(m)} - S_t^{(n)}\right)^2}}{\sqrt{\sum_{t=1}^{N} S_t^{(m)^2}}\sqrt{\sum_{t=1}^{N} S_t^{(n)^2}}}$$

It follows then, that if $IC_{m,n} = 0$, then the two methods m and n have produced identical seasonals. However, if $IC_{m,n}$ equals one, then the seasonal components according to one method differ on average as much from the other, as they would have if the other series were not seasonally adjusted. Table 5 shows that the values of most of these coefficients were close to zero, indicating that in most instances the various methods produced similar seasonals. The highest coefficients were reported for the RPI-housing series, which is a series which displayed a highly irregular seasonal pattern, and the lowest statistics were reported for the local sales of cement series.

Table 5

Differences Between the Seasonal Components According to the Adjustment Methods Considered, Measured by Theil's Inequality Coefficient

	Fixed Additive	Fixed Multiplicative	Census Method 1	Census X-11	X11 ARIMA	SABL
Retail Price Index - Housing (Sept. 93 = 100)						
Fixed Additive	0.00	0.07	0.48	0.51	0.48	0.44
Fixed Multiplicative	0.07	0.00	0.49	0.54	0.50	0.48
Census Method 1	0.48	0.49	0.00	0.61	0.63	0.57
Census X-11	0.51	0.54	0.61	0.00	0.40	0.36
X11 ARIMA	0.48	0.50	0.63	0.40	0.00	0.44
SABL	0.44	0.48	0.57	0.36	0.44	0.00
Broad Money Supply M2 (TT$ Mn)						
Fixed Additive	0.00	0.07	0.18	0.33	0.32	0.32
Fixed Multiplicative	0.07	0.00	0.22	0.35	0.35	0.35
Census Method 1	0.18	0.22	0.00	0.30	0.30	0.32
Census X-11	0.33	0.35	0.30	0.00	0.10	0.19
X11 ARIMA	0.32	0.35	0.30	0.10	0.00	0.16
SABL	0.32	0.35	0.32	0.19	0.16	0.00
Private Sector Credit (TT$ Mn)						
Fixed Additive	0.00	0.09	0.38	0.40	0.35	0.39
Fixed Multiplicative	0.09	0.00	0.39	0.41	0.37	0.40
Census Method 1	0.38	0.39	0.00	0.38	0.33	0.41
Census X-11	0.40	0.41	0.38	0.00	0.19	0.26
X11 ARIMA	0.35	0.37	0.33	0.19	0.00	0.28
SABL	0.39	0.40	0.41	0.26	0.28	0.00
Local Sales of Cement (tonnes)						
Fixed Additive	0.00	0.16	0.16	0.20	0.19	0.23
Fixed Multiplicative	0.16	0.00	0.05	0.15	0.13	0.17
Census Method 1	0.16	0.05	0.00	0.15	0.13	0.18
Census X-11	0.20	0.15	0.15	0.00	0.04	0.09
X11 ARIMA	0.19	0.13	0.13	0.04	0.00	0.10
SABL	0.23	0.17	0.18	0.09	0.10	0.00
Index of Retail Sales (Avg. 1979 =100)						
Fixed Additive	0.00	0.06	0.01	0.06	0.06	0.05
Fixed Multiplicative	0.06	0.00	0.06	0.06	0.06	0.07
Census Method 1	0.01	0.06	0.00	0.07	0.06	0.04
Census X-11	0.06	0.06	0.07	0.00	0.01	0.05
X11 ARIMA	0.06	0.06	0.06	0.01	0.00	0.04
SABL	0.05	0.07	0.04	0.05	0.04	0.00
Real Value Added (Factor Cost) in Agriculture (1985=100)						
Fixed Additive	0.00	0.11	0.10	0.10	0.10	0.10
Fixed Multiplicative	0.11	0.00	0.04	0.07	0.07	0.05
Census Method 1	0.10	0.04	0.00	0.06	0.06	0.07
Census X-11	0.10	0.07	0.06	0.00	0.01	0.05
X11 ARIMA	0.10	0.07	0.06	0.01	0.00	0.05
SABL	0.10	0.05	0.07	0.05	0.05	0.00

We also examined the extent to which the various adjustment methods attribute fluctuations in the series to seasonality. An appropriate summary measure is the average size of the seasonal component (AS) defined as

$$AS = \frac{1}{n}\sum_{t=1}^{N} |S_t|$$

Table 6 suggests that for local sales of cement, the average size of the seasonal component according to the fixed additive method, is larger than those produced by the other methods. For the broad money supply (M2), the fixed multiplicative adjustment method produced the largest AS statistic. This indicates that these methods overestimated the average size of the seasonal component and are probably not the most appropriate methods to smooth these series. For the other series, the average size of the seasonal component varied little from one seasonal adjustment method to the next.

Table 6

Average Size Of The Seasonal Components

	Retail Price Index - Housing (Sept. 93 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$ Mn)	Index of Retail Sales (Avg. 1979 =100)	Real Value Added (Factor Cost) in Agriculture (1985=100)	Local Sales of Cement (tonnes)
Fixed Additive	0.31	44.22	23.60	11.59	13.88	2420.75
Fixed Multipilicative	0.34	48.62	20.51	10.80	14.84	2153.60
Census Method 1	0.08	38.41	20.87	11.76	13.97	2105.58
Census X-11	0.14	40.29	29.06	10.77	13.74	2140.90
X11 ARIMA	0.23	40.62	28.82	10.81	13.89	2141.89
SABL	0.22	41.78	31.22	11.22	14.43	2128.37

To ascertain the extent the adjustment methods tend to identify correctly or incorrectly, changes in the seasonal patterns, Table 7 shows the average change in the seasonal component. This statistic is calculated as follows:

$$(AC) = \frac{1}{n-1}\sum_{j=1}^{n-1} \frac{\sum_{i=1}^{12}\left|S_{j.12+i} - S_{(j-1).12+i}\right|}{\sum_{i=1}^{12}\left|S_{j.12+i}\right|}$$

where AC = Average Change in the Seasonal Component

Table 7

Average Absolute Percentage Change Seasonal Components

	Retail Price Index - Housing (Sept. 93 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$ Mn)	Local Sales of Cement (tonnes)	Index of Retail Sales (Avg. 1979 =100)	Real Value Added (Factor Cost) in Agriculture (1985=100)
Fixed Additive	0.00	0.00	0.00	0.00	0.00	0.00
Fixed Multipilcative	0.04	0.04	0.05	0.16	0.09	0.10
Census Method 1	0.04	0.00	0.05	0.17	0.00	0.10
Census X-11	0.24	0.67	0.20	0.32	0.06	0.51
X11 ARIMA	0.24	1.58	0.14	0.34	0.06	0.77
SABL	3.16	1.29	0.51	0.39	0.03	1.00

Examination of the table shows that as expected for the fixed additive method, the calculated seasonal components do not change. Of the more sophisticated adjustment methods, Census X-11, X-11 ARIMA and SABL, the latter by comparison, computes relatively large changes in the seasonal components, except for the Index of Retail Sales series. On average, the Census 1 Method produced the smallest average absolute percentage changes in its seasonal components. From examination of this table, one can conclude that the SABL method is probably the most sensitive to changes in the seasonal patterns of the RPI-Housing, Private Sector Credit, local sales of cement and real value added (factor cost) in Agriculture series. For the broad money supply series, the X-11 ARIMA method is the most sensitive to changes in the seasonal pattern and for the Index of Retail Sales the fixed multiplicative method was best.

Comparative Analysis

Fase and Den Butter [1991], outline the ideal properties for seasonal adjustment procedures. They suggest that any seasonally adjusted series should satisfy basic axiomatic properties of orthogonality, idempotency and symmetry. In practice, though, an important criterion for the assessment of any seasonal adjustment technique is the **stability** of the seasonal estimates when new observations are added. This is very important, as the more stable the seasonal components rendered by any seasonal adjustment technique, the more likely are policy makers to make use of seasonal figures in their analysis.

Orthogonality

Ideally, in assessing the strength of any particular seasonal adjustment method, orthogonality of the seasonal and trend-cycle components should not exist, i.e. the seasonal components and the seasonally adjusted series should not be correlated. Table 8. shows that the correlation coefficients of the seasonal components and the seasonally adjusted series are small for all series and the methods under review. As such, this test does not really discriminate between the various methods.

Table 8

Correlation Coefficient Of Seasonal Component And Seasonally Adjusted Series

	Retail Price Index -Housing (Sept. 93 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$ Mn)	Local Sales of Cement (tonnes)	Index of Retail Sales (Avg. 1979 =100)	Real Value Added (Factor Cost) In Agriculture (1985=100)
Fixed Additive	0.02	0.00	-0.01	0.02	-0.07	-0.01
Fixed Multipilicative	0.01	0.01	0.00	0.08	-0.05	-0.02
Census Method	-0.02	-0.00	-0.06	0.08	-0.08	-0.01
Census X-11	0.11	0.01	-0.04	0.10	-0.02	0.02
X11 ARIMA	0.09	0.01	-0.08	0.10	-0.03	0.01
SABL	0.08	-0.00	0.00	0.13	-0.06	0.01

Idempotency

Idempotency of a time series exists if repeated applications of the method yields exactly the same seasonally adjusted series as the first application. The statistic used to test for idempotency (ID) is calculated as follows:

$$ID = \frac{100}{12n}\sum_{i=1}^{12}\sum_{j=1}^{n}\frac{\left|S_{ij}^{sc} - S_{ij-1}^{sc}\right|}{y_{ij}^{sc}}$$

where y_{ij}^{sc} = seasonally adjusted series

S_{ij}^{sc} = estimated seasonal component

n = number of yrs in the sample period

Where idempotency exists ID equals zero. Table 9 shows that the fixed additive method by definition is fully indempotent. For the RPI-Housing series, index of retail sales and the broad money supply series application of the Census 1 Method to these series also produced ID's of zero.

Table 9

Idempotency of Methods

	Retail Price Index - Housing (Sept. 93 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$ Mn)	Local Sales of Cement (tonnes)	Index of Retail Sales (Avg. 1979 =100)	Real Value Added (Factor Cost) in Agriculture (1985=100)
Fixed Additive	0.00	0.00	0.00	0.00	0.00	0.00
Fixed Multiplicative	0.02	0.02	0.02	1.76	0.83	1.31
Census Method 1	0.00	0.00	0.02	1.70	0.00	1.21
Census X-11	0.10	0.13	0.11	2.23	0.37	1.49
X11 ARIMA	0.17	0.13	0.09	2.20	0.39	1.54
SABL	0.07	0.13	0.12	2.32	0.26	1.30

Residual seasonality

Residual seasonality exists when the irregular component of a particular month still shows a seasonal pattern. This may be revealed by an examination of the Autocorrelation Function for particular months or quarters over the years of the sample period. As such, the Box-Pierce Q statistic calculated for each period over the years of the sample provides an adequate summary measure. The Q statistic composed of the first K residual autocorrelations is denoted by

$$Q = T\sum_{k=1}^{K}\hat{r}_k^{\,2}$$

and is approximately distributed as chi square with K degrees of freedom. Tables 10.1 and 10.2 show the number of significant periods in the test for positive autocorrelation of the irregular components per month and per quarter respectively. Table 10.1 shows that the SABL method produced the greatest number of significant months (i.e. where residual autocorrelation existed) among all the methods. For the quarterly series, it was the X 11 ARIMA method that produced the greatest number of significant periods, a possible indication that these methods were overadjusting the series.

Generally, for the well-behaved series, the number of periods that tested significant for residual autocorrelation were low.

Table 10.1

Number Of Significant Months In The Test On Positive Autocorrelation Of The Irregular Components Per Month

	Retail Price Index - Housing (1993=100)	Broad Money Supply M2 (TT$Mn)	Private Sector credit (TT$Mn)	Local Sales of Cement (tonnes)	TOTAL
Fixed Additive	6	1	5	0	12
Fixed Multiplicative	6	1	5	0	12
Census Method I	3	4	3	1	11
Census X-11	5	5	4	1	15
X11 ARIMA	5	5	5	0	15
SABL	6	6	6	1	19

Table 10.2
Number Of Significant Months In The Test On Positive Autocorrelation Of The Irregular Components Per Quarter

	Index of Retail Sales (Avg. 1979=100)	Real Value Added (factor cost) in Agriculture (1985=100)	TOTAL
Fixed Additive	0	0	0
Fixed Multiplicative	0	0	0
Census Method I	0	0	0
Census X-11	2	1	3
X11 ARIMA	3	1	4
SABL	1	0	1

Residual Trend Cycle Movements

This occurs when the series has not been effectively decomposed into its constituent trend cycle and other components. This was tested by an examination of autocorrelation of the irregular component for the whole series over all the months and years. Again the Box-Pierce Q statistic served as a summary measure. Table 11.1 shows that on average the X-11ARIMA method performed best on this test for the monthly series while Table 11.2 shows that all methods produced similar results.

Table 11.1

Test On Positive Autocorrelation Of The Irregular Component Per Whole Series

	Retail Price Index - Housing *(1993=100)*	Broad Money Supply M2 *(TT$Mn)*	Private Sector credit *(TT$Mn)*	Local Sales of Cement *(tonnes)*	Total number of series with *a significant* test value
Fixed Additive	*	*	*	*	4
Fixed Multiplicative	*	*	*	*	4
Census Method I	*	*	*	*	4
Census X-11	*	*	*	*	4
X11 ARIMA			*		1
SABL		*	*	*	3

*Note: * Indicates significant positive autocorrelation*

Table 11.2

Test On Positive Autocorrelation Of The Irregular Component Per Whole Series

	Index of Retail Sales (Avg. 1979=100)	Real Value Added (factor cost) in Agriculture (1985=100)	Total number of series with a significant test value
Fixed Additive	*	*	2
Fixed Multiplicative	*	*	2
Census Method I	*	*	2
Census X-11	*	*	2
X11 ARIMA	*	*	2
SABL	*	*	2

Note: * Indicates significant positive autocorrelation

Stability

For official statistical agencies, the stability test is the most important criterion for assessing the suitability of a particular seasonal adjustment method. An adjustment procedure is stable if the seasonally adjusted series is not unduly affected by updating when new data becomes available. This is an important requirement for decision-making purposes. Fase and Den Butter suggests that the stability of the estimates of the seasonal component can be determined by comparing the seasonals obtained from different, though overlapping, sample periods. The series concerned were adjusted successively from 1982-1990, 1982-1991, 1982-1992, 1982-1993, to obtain the corresponding seasonal components for the above periods. For each pair of successive periods, the inequality between the relevant seasonals were measured. The stability measure is summarized as:

$$ST = \frac{1}{3}\left(CP_{91}^{90} + CP_{92}^{91} + CP_{93}^{92} \right)$$

where CP summarizes the inequality between seasonals for the periods concerned. When ST equals zero, full stability exists. Table 12 presents the mean of the inequalities between seasonals and concludes that generally all ST's are close to zero. The worst result was obtained by the application of the XII ARIMA adjustment method to the real value added (factor cost) in Agriculture series. This result is quite surprising since the *raison d'être* for the ARIMA extension of the basic Census X11 is enhanced stability. Low ST's were produced by all method for the local sales of cement and index of retail sales series indicating the relative stability of these series. Examination of tables 12 shows that on average the Census X-11 procedure produced the most stable seasonal components. It should noted that Fase and Den Butter obtained a similar result and for this reason the Census X11 method was chosen by the Netherlands Central Bank for the seasonal adjustment of a large number of macro economic and financial data.

Table 12

Stability Of The Seasonal Components Upon Extension Of The Adjustment Period By One Year

	Retail Price Index - Housing (Sept. 93 = 100)	Broad Money Supply M2 (TT$ Mn)	Private Sector Credit (TT$ Mn)	Local Sales of Cement (tonnes)	Index of Retail Sales (Avg. 1979 =100)	Real Value Added (Factor Cost) in Agriculture (1985=100)
Fixed Additive	0.07	0.12	0.23	0.04	0.01	0.03
Fixed Multipilcative	0.06	0.13	0.22	0.04	0.02	0.02
Census Method 1	0.19	0.11	0.27	0.04	0.02	0.02
Census X-11	0.16	0.11	0.19	0.03	0.02	0.03
X11 ARIMA	0.12	0.12	0.25	0.04	0.03	0.61
SABL	0.19	0.16	0.29	0.09	0.05	0.06

IV SUMMARY AND CONCLUSION

The paper examined the major issues involved in establishment of successful seasonal adjustment programs for official statistical agencies. A number of critical success factors were identified including, the processes required, the role of an integrated processing environment and the need for the statistical agency to market the seasonal numbers. The paper also examined in some detail the issues that ought to be considered when choosing among different seasonal adjustment methods. A number of tests were developed to discriminate among seasonal adjustment methods and the performance of six commonly available seasonal adjustment methods were examined using a number of actual Trinidad and Tobago time series. Unfortunately, this process did not yield a clear winner as some methods which performed well on some tests did not fare so well on others. This is particularly true of the Census X11 and the X-11 ARIMA methods which emerged as top contenders. However, if stability was given the highest weight the performance of the X11 Arima was quite disappointing as the Census X11 method outperformed it in this area.

A major limitation of this study is the omission of the application spectral methods. Granger and Newbold (1977) demonstrated how the adequacy of seasonal adjustment methods can be diagnosed by using spectral analysis. However, as summary statistics for spectral analysis are not well developed the inclusion of this type of analysis would have greatly added to the amount of diagrams and charts in the paper.

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SEASONAL ADJUSTMENT BY THE X11 ARIMA METHOD

X11ARIMA

Series name-	Summary	Related Prvar
CHR	No	(none)

Period covered- 1st month 1982 to 12th month 1993.
Type of run- Multiplicative seasonal adjustment.

ARIMA extrapolation model (Forecast)

Average percentage standard error in forecasts

Model: (0,1,1)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
.78	1.20	.57	.56	26.72%	.9892

Estimated parameters: -.0042 .4620

Model: (0,2,2)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
1.04	1.30	1.28	.55	34.98%	.9886

Estimated parameters: 1.0291 -.0812 .5101

The model chosen is (0,1,1)(0,1,1) with transformation - LN

ARIMA extrapolation model (Backcast)

Average percentage standard error in backcasts

Model: (0,1,1)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
5.64	2.67	4.23	10.03	48.66%	.9925

Estimated parameters: -.0035 .7394

The model chosen is (0,1,1)(0,1,1) with transformation - LN

Series name-	Summary	Related Prvar
PSC	No	(none)

Period covered- 1st month 1982 to 12th month 1993.
Type of run- Multiplicative seasonal adjustment.

ARIMA extrapolation model (Forecast)

Average percentage standard error in forecasts

Model: (0,1,1)(0,1,1)   Transform: LN   Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
4.50	1.51	5.19	6.79	11.00%	.9750

Estimated parameters: -.1367 .6688

Model: (0,2,2)(0,1,1)   Transform: LN   Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
5.83	1.56	8.76	7.16	28.09%	.9753

Estimated parameters: .9223 .0107 .7362

The model chosen is (0,1,1)(0,1,1) with transformation - LN

ARIMA extrapolation model (Backcast)

Average percentage standard error in backcasts

Model: (0,1,1)(0,1,1)   Transform: LN   Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
4.54	8.33	2.83	2.46	35.88%	.9813

Estimated parameters: -.1511 .7793

The model chosen is (0,1,1)(0,1,1) with transformation - LN

Series name-	Summary	Related Prvar
LSC	No	(none)

Period covered- 1st month 1982 to 12th month 1993.
Type of run- Multiplicative seasonal adjustment.

ARIMA extrapolation model (Forecast)

Average percentage standard error in forecasts

Model: (0,1,1)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
9.33	7.63	5.65	14.71	88.33%	.7989

Estimated parameters: .5993 .6328

Model: (0,2,2)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
12.95	8.93	10.64	19.27	1.51%	.7490

Estimated parameters: 1.0842 -.0692 .6731

The model chosen is (0,1,1)(0,1,1) with transformation - LN

ARIMA extrapolation model (Backcast)

Average percentage standard error in backcasts

Model: (0,1,1)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
13.60	20.39	10.67	9.75	69.26%	.8450

Estimated parameters: .6665 .7976

The model chosen is (0,1,1)(0,1,1) with transformation - LN

Series name-	Summary	Related Prvar
M2	No	(none)

Period covered- 1st month 1982 to 12th month 1993.
Type of run- Additive seasonal adjustment.

ARIMA extrapolation model (Forecast)

Average percentage standard error in forecasts

Model: (0,1,1)(0,1,1) Transform: NONE Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
4.41	3.00	8.14	2.08	79.44%	.9457

Estimated parameters: -.0251 .5330

Model: (0,2,2)(0,1,1) Transform: NONE Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
4.97	5.53	7.74	1.64	94.45%	.9466

Estimated parameters: 1.0592 -.1271 .6351

The model chosen is (0,1,1)(0,1,1) with transformation - NONE

ARIMA extrapolation model (Backcast)

Average percentage standard error in backcasts

Model: (0,1,1)(0,1,1) Transform: NONE Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
6.03	12.48	4.26	1.34	61.85%	.9742

Estimated parameters: .0013 .6324

The model chosen is (0,1,1)(0,1,1) with transformation - NONE

Series name-	Summary	Related Prvar
RSAL.ALL	No	(none)

Period covered- 1st quarter 1982 to 4th quarter 1993.
Type of run- Additive seasonal adjustment.

ARIMA extrapolation model (Forecast)

Average percentage standard error in forecasts

Model: (0,1,1)(0,1,1) Transform: NONE Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
7.69	4.19	3.55	15.33	11.20%	.7744

Estimated parameters: .0712 .5803

Model: (0,2,2)(0,1,1) Transform: NONE Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
8.91	4.19	8.21	14.34	11.02%	.7041

Estimated parameters: .8519 -.0600 .5791

The model chosen is (0,1,1)(0,1,1) with transformation - NONE

ARIMA extrapolation model (Backcast)

Average percentage standard error in backcasts

Model: (0,1,1)(0,1,1) Transform: NONE Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
9.55	14.79	2.35	11.52	35.91%	.7986

Estimated parameters: .1035 .7735

The model chosen is (0,1,1)(0,1,1) with transformation - NONE

Series name-	Summary	Related Prvar
GDPFC	No	(none)

Period covered- 1st quarter 1982 to 4th quarter 1993.
Type of run- Multiplicative seasonal adjustment.

ARIMA extrapolation model (Forecast)

Average percentage standard error in forecasts

Model: (0,1,1)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
1.64	.91	1.28	2.73	39.64%	.9477

Estimated parameters: .2848 .5526

Model: (0,2,2)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
1.64	2.33	1.51	1.09	57.01%	.9221

Estimated parameters: .8948 -.3977 .6356

The model chosen is (0,1,1)(0,1,1) with transformation - LN

ARIMA extrapolation model (Backcast)

Average percentage standard error in backcasts

Model: (0,1,1)(0,1,1) Transform: LN Additive constant: .000

Last 3 years	Last year	Last-1 year	Last-2 year	Chi-square probability	R-squared value
2.02	3.55	.94	1.58	35.84%	.9720

Estimated parameters: .2438 .6013

The model chosen is (0,1,1)(0,1,1) with transformation - LN