CONSUMPTION OF ELECTRICITY IN THE GREATER MANILA AREA

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INTRODUCTION

This paper discusses particular methods of time series analysis and, with the application of these methods in the analysis of monthly consumption of electricity in the Greater Manila Area, indicates how these methods may be used in the short-run type of problems in forecasting. Needless to say, the usefulness of these methods is not confined to consumption forecasting alone. They can be as effectively applied in the formulation of sales and production forecast, the preparation of an annual budget, as well as other problems of similar nature which confront management in business organizations.

A multiplicative model is assumed for the time series, namely,

$$Y = TxCxSxI,$$

where Y is the value of the variable in the time series, and T, C, S, and I stand for the effects of the secular trend, cyclical fluctuations, seasonal variation, and irregular fluctuations, respectively.[1]

In section 2, by means of the six-item iterated moving averages, an estimate of the S factor for each observation in the time series on the monthly consumption of electricity in the Greater Manila Area is obtained, and on the basis of these estimates, the kind of seasonal variation existing in the time series is determined. Section 3 derives regression equations for the monthly seasonal indices and estimates the seasonal indices for the year 1963. In section 4, with the aid of the values obtained in the previous sections, estimates of the monthly consumption of electricity in the Greater Manila Area are obtained for the year 1963 and uses of these values are indicated.

SEASONAL VARIATION

The data on the monthly consumption of electricity in the Greater Manila Area cover the period from January 1953 to December 1962 and are expressed in millions of kilowatt hours. For this period, five sets of data are available: the residential, commercial, industrial and other sales of electric power as well as the consumption of the Manila Electric Company (MERALCO) itself. Total monthly consumption is the sum of these five items.[2]

To determine the S component for each observation in the series, each value in the series is divided by an estimate of the trend-cycle irregular component ($TxCxI$). For a time series of monthly observations, the often used estimate of $TxCxI$ is the twelve-month centered moving average. However, Leong[3] has shown that a more convenient and desirable estimate is the six-item iterated moving average, which is an eleven-month moving average with triangular weights. Compared to the 12-month moving average, the 6-item iterated moving average can be computed with less effort and is more sensitive to the fluctuations in th original series.[4]

Let y_i be the observation for the $_ith$ temporal point of the period which the time series covers. The series, composed of n observations, may then be ordered as follows:

$$y_1, y_2, y_3, \ldots, y_{n-2}, y_{n-1}, y_n$$

The $_ith$ 6-item iterated moving average is defined as:[5]

$$u_i = \frac{1}{36} (R_{i-7} \; -2R_{i-1} \; +R_{i+5}), \text{ for } 6 = i \; = n\text{-}5, \qquad (2.1)$$

where

$$R_i = o \qquad , \text{ for } i < 1.$$

$$= \sum_{j=1}^{i} (i-j+1)\, y_j \text{ for } 1 = i \; = n, \qquad (2.2)$$

$$= R_n + k \sum_{i=1}^{n} y_i \text{ for } i = n+k, \text{ and integral values of } k \text{ from 1 to 5.}$$

In formula (2.1), the divisor 36 becomes 21 for $i = 1$, n; 26 for $i = 2$, $n - 2$; 30 for $i = 3$, $n - 3$; 33 for $i = 4$, $n - 4$; and 35 for $i = 5$, $n—5$.

To illustrate the computation of the R_i's and u_j's, a portion of the series on total consumption is taken and the truncated computation is shown in Table 1. The consumption of electricity for January 1953 is entered as the first item in column (3). The figure for February 1953 is then added and subtotalled; this becomes the second item in column (3). The continuous addition and subtotalling for the other months follow in order. The first item in column (3) appears as the first item in column (4). Adding the second item in column (3) to this and subtotalling gives the second item in column (4). Progressive summation and subtotalling of items in column (3) will complete column (4). Column (4) gives the values of the R_j's, whence the values of the moving averages can be computed by means of formula (2.1) and its indicated modifications. Notice that the computation of the R_i's is not as complicated as formula (2.2) may suggest.

For the six sets of data that we have (residential sales, commercial sales, industrial sales, other sales, MERALCO's consumption and total consumption), the 6-item iterated moving averages are computed and the ratios of the actual observations to the corresponding moving averages are considered as the estimates of the S components in the time series. These ratios, written down as percentages, are indicated in Table 2.

An examination of these ratios will help to determine whether the seasonal variation that exists in the time series is constant or changing.

The seasonal variation is constant if the seasonal factors operate in precisely the same fashion year after year, bringing about a recurrent systematic pattern unchanging in form. A changing seasonal variation is usually classified as to whether the amplitude or timing changes. By amplitude is meant the range of variation of the highest and lowest values of the observations throughout the year. A change in timing means the shifting of the high and low points from year to year.

For the sake of brevity, the analysis of the items in Table 2 will be confined only to those values for the total consumption of electricity.

It can be observed that the amplitude of the fluctuation from the 100 line has changed considerably over the decade. The range of the fluctuation for 1953 is from 96.6 to 101.0; for 1954, from 98.0 to 101.3; for 1955, from 97.2 to 102.9; for 1956, from 98.4 to 101.6; for 1957, from 96.7 to 103.7; for 1958, from 98.1 to 101.4; for 1959, from 96.0 to 103.6; for 1960, from 97.3 to 103.7; for 1961, from 96.1 to 103.7, and 1962, from 97.8 to 103.4.

TABLE I

COMPUTATION OF THE 6-ITEM ITERATED MOVING AVERAGE OF THE CONSUMPTION OF ELECTRICITY

Year and Month (1)	Original Data (2)	Progressive Summation (3)	Progressive Summation Iterated Once (4-	6-Item Iterated Moving Average (5)
1953				
January	37.4	37.4	37.4	38.2
February	37.6	75.0	112.4	38.6
March	37.6	112.6	225.0	38.9
April	39.8	152.4	377.4	39.4
May	39.6	192.0	569.4	39.9
June	40.9	232.9	802.3	40.5
July	40.8	273.7	1076.0	41.0
August	41.8	315.5	1391.5	41.6
September	42.4	357.9	1749.4	42.1
October	42.6	400.5	2149.9	42.5
November	43.1	443.6	2593.5	42.9
December	42.7	486.3	3079.8	43.2
1954				
January	43.7	530.0	3609.8	43.7
February	44.9	574.9	4184.7	44.1
March	43.8	618.7	4803.4	44.5
April	44.1	662.8	5466.2	45.0
May	44.6	707.4	6173.6	45.5
June	47.0	754.4	6928.0	46.2
July	47.1	801.5	7729.5	46.7
August	47.2	2848.7	8578.2	—
September	48.1	896.8	9475.0	—
October	48.8	945.6	10420.6	—
November	48.1	993.7	11414.3	—
December	47.9	1041.6	12455.9	—

TABLE 2

RATIO OF ACTUAL CONSUMPTION OF ELECTRICITY TO THE 6-ITEM ITERATED MOVING AVERAGE
1953-1962

	Residential Sales (1)	Commercial Sales (2)	Industrial Sales (3)	Other Sales	Meralco's Consumption	Total Consumption
1953						
January	102.5	96.7	86.4	100.0	96.5	97.9
February	99.4	99.2	90.3	97.7	95.6	97.4
March	100.0	96.7	90.6	93.3	100.0	96.6
April	98.1	103.3	109.1	95.6	102.6	101.0
May	96.8	101.6	101.4	97.9	101.4	99.2
June	96.9	100.8	105.6	106.2	99.2	101.0
July	98.2	99.2	98.6	100.0	97.5	99.5
August	100.0	100.0	100.0	100.0	102.5	100.5
September	98.8	99.2	102.6	103.8	102.5	100.7
October	97.7	98.4	103.9	101.9	108.5	100.2
November	100.0	102.4	97.4	98.1	104.3	100.4
December	100.0	100.8	95.0	98.1	99.1	98.8
1954						
January	106.4	98.4	93.8	98.1	93.6	100.0
February	102.3	100.0	107.2	101.8	96.3	101.8
March	101.2	97.7	98.8	96.4	98.1	98.4
April	99.4	98.5	98.8	96.4	99.0	98.0
May	98.3	97.0	100.0	100.0	99.0	98.0
June	97.8	100.7	106.7	110.3	99.0	101.7
July	103.3	106.6	96.7	86.4	99.0	100.8
August	99.4	97.1	103.3	103.3	99.0	100.0
September	99.4	100.0	102.2	106.7	101.9	101.0
October	100.5	102.1	102.2	101.6	100.0	101.7
November	98.4	101.4	100.0	100.0	99.1	99.8
December	98.9	99.3	96.8	100.0	98.2	98.8

TABLE 2

RATIO OF ACTUAL CONSUMPTION OF ELECTRICITY TO THE 6-ITEM ITERATED MOVING AVERAGE
1953-1962

	Residential Sales (1)	Commercial Sales (2)	Industrial Sales (3)	Other Sales	Meralco's Consumption	Total Consumption
1955						
January	107.4	100.0	87.4	95.1	93.2	99.8
February	97.4	98.6	99.0	100.0	87.6	98.4
March	98.4	94.5	101.0	95.2	82.5	97.4
April	97.9	98.0	99.0	98.4	76.4	98.2
May	99.5	102.0	106.7	98.5	67.6	101.7
June	98.0	103.3	110.3	101.5	141.3	102.9
July	99.0	95.7	96.3	100.0	113.2	98.5
August	101.0	101.3	97.2	100.0	99.2	100.2
September	100.0	100.6	99.1	101.4	92.1	100.0
October	100.9	100.6	98.2	101.4	129.2	100.7
November	100.5	101.9	101.8	101.4	97.1	101.2
December	98.6	98.1	93.8	97.3	95.7	97.2
1956						
January	104.2	98.1	91.4	98.7	100.0	99.1
February	100.5	100.6	102.5	105.1	92.9	101.6
March	98.1	96.3	103.2	97.5	98.2	98.5
April	99.1	98.2	97.7	100.0	104.2	98.6
May	99.5	101.8	97.0	98.8	102.1	99.3
June	97.3	102.4	103.6	100.0	100.7	100.5
July	100.0	101.2	99.3	97.6	101.0	99.8
August	102.2	102.3	100.0	101.1	103.5	101.4
September	99.1	100.0	99.4	100.0	102.1	99.4
October	99.6	98.3	98.7	97.8	102.1	98.6
November	99.2	102.3	104.3	101.1	94.6	101.3
December	99.6	98.9	96.4	97.9	95.0	98.4
1957						
January	107.0	100.0	94.8	101.0	95.8	101.3

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1953-1962

	Residential Sales (1)	Commercial Sales (2)	Industrial Sales (3)	Other Sales	Meralco's Consumption	Total Consumption
February	98.8	98.3	98.4	104.0	88.9	100.1
March	96.7	95.6	96.8	98.4	102.3	96.7
April	99.6	100.5	100.0	99.0	101.0	99.9
May	100.4	99.5	101.9	98.1	103.1	100.1
June	97.2	101.6	104.1	99.1	102.4	100.5
July	98.1	99.0	101.3	100.0	102.1	99.5
August	104.2	103.6	103.5	104.4	103.8	103.7
September	100.0	101.0	100.0	103.4	101.2	100.7
October	101.0	101.5	105.5	100.9	105.0	102.7
November	97.8	101.5	98.7	96.6	97.0	98.6
December	99.6	98.0	93.3	99.1	101.2	97.2
1958						
January	106.8	101.5	94.7	100.0	100.0	101.1
February	96.4	98.0	100.4	104.2	90.9	98.9
March	98.2	96.0	101.2	97.5	97.3	98.4
April	98.2	98.5	98.9	97.5	93.5	98.3
May	98.6	99.5	103.3	98.3	102.0	100.3
June	100.3	102.9	102.9	97.6	100.0	101.3
July	102.0	101.4	100.4	102.4	112.4	101.4
August	101.3	100.5	100.0	103.2	109.6	101.0
September	100.7	101.4	101.0	104.8	96.3	101.4
October	99.0	100.9	99.0	101.6	96.8	99.8
November	98.4	100.9	99.4	103.2	93.0	100.0
December	99.4	99.5	95.0	99.2	100.3	98.1
1959						
January	103.5	100.0	94.8	94.3	98.6	98.7
February	101.0	90.2	102.2	94.2	96.0	98.0
March	96.5	97.7	94.5	95.9	95.2	96.0
April	96.9	98.2	98.2	100.0	96.7	98.2
May	99.1	101.8	102.8	96.4	106.9	100.8
June	101.2	104.3	105.7	102.3	104.7	103.6
July	103.6	103.8	102.9	102.3	100.5	103.2
August	99.1	99.2	99.0	101.5	102.0	99.3
September	99.4	100.4	104.9	103.0	99.5	101.9
October	101.7	102.0	104.4	100.0	101.5	102.6
November	97.7	100.8	98.4	99.3	95.0	98.7
December	97.2	99.6	96.9	99.3	97.5	97.9
1960						
January	105.6	100.8	88.5	94.9	96.8	97.3

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1953-1962

	Residential Sales (1)	Commercial Sales (2)	Industrial Sales (3)	Other Sales	Meralco's Consumption	Total Consumption
February	98.4	94.3	101.2	103.6	94.8	99.0
March	99.7	96.4	101.0	99.3	98.8	94.4
April	98.1	99.2	101.9	100.7	100.2	100.1
May	102.1	98.0	102.1	95.8	100.4	100.5
June	100.8	103.1	102.3	98.6	103.3	101.5
July	98.4	101.5	96.6	94.0	102.8	97.9
August	99.2	102.6	99.1	105.9	106.9	100.7
September	103.3	103.0	104.5	103.8	111.8	103.7
October	99.0	98.9	98.2	96.2	106.0	98.4
November	103.0	101.5	100.2	101.8	93.0	101.5
December	98.5	99.6	99.1	101.2	87.5	99.2
1961						
January	101.5	97.4	92.1	92.8	85.3	96.1
February	94.5	96.4	103.8	105.8	103.2	99.8
March	97.5	97.5	95.5	98.3	103.6	96.8
April	99.0	103.2	100.2	104.5	94.5	100.9
May	102.4	101.1	103.1	100.6	111.6	102.2
June	102.6	103.9	105.7	100.0	106.0	103.7
July	99.1	96.5	94.6	92.3	106.7	96.1
August	101.2	102.1	102.8	103.8	97.2	102.3
September	97.5	99.3	103.1	102.2	92.9	100.3
October	100.9	100.4	98.6	97.3	92.3	99.6
November	104.5	102.8	99.3	101.6	83.1	101.7
December	98.4	97.5	99.1	99.0	116.2	98.6
1962						
January	101.3	98.9	96.9	99.0	99.8	98.8
February	95.4	95.1	95.1	103.8	98.8	99.0
March	96.5	96.6	96.6	97.4	114.0	97.8
April	99.4	101.4	101.4	97.1	94.0	98.7
May	97.7	98.7	98.7	98.0	84.3	98.0
June	104.8	102.9	102.9	103.1	108.2	103.4
July	105.3	102.6	102.6	99.5	108.6	100.8
August	99.2	102.2	102.2	101.1	102.6	100.7
September	100.4	97.5	97.5	105.0	99.2	102.0
October	101.0	99.7	99.7	98.2	89.5	99.2
November	101.0	103.4	103.4	103.0	99.8	102.6
December	98.0	99.7	99.1	105.0	104.8	99.6

Further inspection also shows that the timing of the seasonality has changed. For example, the low point for 1953 is March; April and May for 1954; December for 1955 and 1956; March for 1957; December for 1958; March for 1959; January for 1960; January and July for 1961; and March for 1962. The changes in the high points are also evident from the table.

Although these percentages may also reflect the effects of stochastic fluctuations, it is hardly conceivable that the shift in the high and low points as well as the changes in amplitude are due solely to random factors. Thus, for the analysis of the ratios, we can definitely say that no constant seasonal variation exists for the total consumption of electricity. The same statement can be asserted with regard to the other sets of data.

Thus, the pattern of seasonal variation for the consumption of electricity in the Greater Manila Area must be changing. What factors, then, bring about such changes in the seasonal variation? Morris M. Blair [6] states:

> Seasonal activity in business frequently changes. An index which measures present conditions accurately may not do so after a few years. The opening of a new industry or the exploitation of new resources may so change the total economic activity of a community that a new seasonal distribution of business may develop. Even new methods of selling, packaging, delivery or of credit extension may either accentuate or reduce the amplitude of seasonal variation or shift the high and low points of the year to earlier or later months.

The seasonal variation of the consumption of MERALCO's electricity changed due to similar factors cited by Blair. For the first few years, the changes may have been due to the problem of distributing energy. This is no longer the cause of such shifts in the later years since the amount of commercial and industrial consumption had been substantial.

The shifts in residential consumption can be explained by the ever-increasing number of customers as well as the use of many household electric appliances. These go hand in hand with the population expansion in the Greater Manila Area. The changes in seasonality of commercial and industrial consumption indicate the increase in the number of such establishments. The change in the pattern of seasonal variation in other sales, i.e., sales to the government and other electric utilities, is due to the additional number of government offices and more street lighting, as well as increased service extension to electric utilities in the surrounding areas.

Decisions of management as to when to increase plant capacity as well as the expansion of the service area of the MERALCO system also affect the pattern of seasonality. For example, in June 1959, an electric company in Laguna was merged with MERALCO and its sales included to that of the latter's sales. Unless the pattern of seasonality in the consumption of electricity in Laguna is exactly like that of Manila, such merger will definitely affect the seasonal variation of the MERALCO system.

Other factors which are decided outside the firm also influence the seasonality of electric consumption. Some of the more important factors could have been the import control and the dollar allocation, monetary policies which brought about alternating tightening and easing of credit, fiscal policies employed to bring about a faster rate of economic development, restrictions made on repatriation of profits, the decontrol and the changing political picture.

SEASONAL INDICES

We have shown in the previous section that the pattern of seasonal variation of the consumption of electricity is changing. Since this is so, to estimate the seasonal index for a given month and year in the future, a linear trend[7] is fitted to the ratios contained in Table 2.

Let S_{ij} and X_{ij} be the seasonal index and the ratio, respectively, for the $_ith$ month of the $_jth$ year where

$$i=1, \ldots, 12 \text{ and } j=1, \ldots, n.$$

By means of the least squares method of regression, the straight line trend is as follows:[8]

$$S_{ij} = a_i + b_i\, t_j \qquad (3.1)$$

where t_j is the value of the j^{th} year in the coded scale.

$$a_i = \frac{100 + 6\,(w - w_i)}{n-1} - \frac{2\,(2n+1)\,(\bar{x} - \bar{x}_i)}{n-1}$$

$$b_i = \frac{6\,(\bar{x} - \bar{x}_i)}{n-1} - \frac{12\,(w - w_i)}{n^2 - 1}.$$

$$w_i = \frac{1}{n} \sum_{j=1}^{n} x_{ij} t_j$$

$$w = \frac{1}{12} \sum_{i=1}^{12} w_i$$

$$\bar{x}_i = \frac{1}{n} \sum_{j=1}^{n} x_{ij}$$

$$\bar{x} = \frac{1}{12} \sum_{i=1}^{12} \bar{x}_i$$

For the six sets of data, the point of origin was taken to be 1952 so that in the coded scale, the value corresponding to 1953 is $t_j = 1$. Furthermore, since our series covers the period from 1953 to 1962, the values of j will range from 1 to 10. Using formula (3.1), the following equation is obtained for the series on total consumption: [9]

$$\hat{S}_{1j} = 100.49 - 0.22t_j$$
$$\hat{S}_{2j} = 100.05 - 0.08t_j$$
$$\hat{S}_{3j} = 97.87 - 0.01t_j$$
$$\hat{S}_{4j} = 99.34 + 0.01t_j$$
$$\hat{S}_{5j} = 98.87 + 0.05t_j$$
$$\hat{S}_{6j} = 101.03 + 0.17t_j$$
$$\hat{S}_{7j} = 100.50 - 0.11t_j$$
$$\hat{S}_{8j} = 101.93 + 0.02t_j$$
$$\hat{S}_{9j} = 100.33 + 0.15t_j$$
$$\hat{S}_{10j} = 101.56 - 0.20t_j$$
$$\hat{S}_{11j} = 99.98 + 0.13t_j$$
$$\hat{S}_{12j} = 98.05 + 0.09t_j$$

By letting $t_j = 11$, the seasonal indices for the year 1963 for the series on total consumption are computed. The same procedure is applied to the regression equations for the other 5 sets of data and the results obtained are indicated in Table 3.[10]

TABLE 3

SEASONAL INDEX OF THE CONSUMPTION OF ELECTRICITY
(1963)

Month	Residential Sales	Commercial Sales	Industrial Sales	Other Sales	Meralco's Consumption	Total Consumption
January	101.7	104.7	96.2	95.3	96.1	98.1
February	95.7	95.9	104.4	102.2	99.1	99.2
March	96.4	98.2	98.7	101.2	107.1	97.8
April	98.7	97.8	95.1	102.9	95.9	99.4
May	101.1	100.0	101.0	95.8	101.6	100.4
June	104.3	102.3	102.3	97.6	102.5	102.8
July	102.1	101.4	99.0	95.4	107.4	99.3
August	99.9	100.4	100.8	103.2	103.1	101.2
September	100.5	100.2	104.2	102.5	99.6	102.0
October	101.1	100.6	98.2	96.5	85.6	99.4
November	100.7	100.8	100.6	102.7	90.4	101.4
December	97.8	97.7	99.5	102.0	111.6	99.0

FORECAST OF 1963 MONTHLY CONSUMPTION

Let C_i be the estimate of the consumption of electricity for the i^{th} month of 1963. Then

$$C_i = \frac{S_j \, (Y)}{1200} \tag{4.1}$$

where S_i is of course the seasonal index (in per cent) for the i^{th} month, and Y the estimated consumption for the year 1963, expressed as before in millions of kilowatt hours.

The values of Y for residential, commercial, industrial, and other sales as well as MERALCO's consumption are 628.3, 423.7, 835.2, 289.7 and 7.363. These values are computed on the basis of the following respective least-squares linear trend equations:

$$\begin{aligned} Y &= 160.8 + 42.5t \\ Y &= 124.5 + 27.2t \\ Y &= 4.1 + 76.3t \\ Y &= 34.5 + 23.2t \\ Y &= 1.357 + 0.546t \end{aligned}$$

where the origin is 1953.

With the use of the above values, estimates of the monthly consumption of electricity for 1963 are obtained and are indicated in Table 5. Evidently, an estimate of the total monthly consumption is the sum of the monthly residential, commercial, industrial, and other sales and the consumption of MERALCO itself.

How can this forecast of sales be put to use? First of all an estimate of revenues can be made for 1963. For example, using 1961 sales and revenue figures, the revenues per thousand kilowatt hours are ₱72.82, ₱59.68, ₱36.83 and ₱44.38 for residential, commercial, industrial and other sales, respectively. Thus the expected revenues for 1963 are ₱45,800,000, ₱25,300,000, ₱30,800,000 and ₱12,800,000, respectively, making a total of ₱114,700,000. A monthly estimate of revenue can be similarly determined.

This estimate of sales can also be used in the determination of the amount of electricity that would have to be produced. As mentioned earlier, electricity generated by MERALCO and that purchased from the National Power Corporation is always greater than the amount of electricity consumed due to transmission losses and meter tapping. The amount of electric power which is not accounted for by sales or by the consumption of the company varies from 25% to 30% of the total production. Taking the larger figure of 30%, the amount of electricity that would have to be produced for 1963 should be 2,839.6 million kilowatt hours. A monthly breakdown of this can be made easily.

TABLE 5

PROJECTED MONTHLY CONSUMPTION OF ELECTRICITY IN THE GREATER MANILA AREA FOR 1963
(Millions of Kilowatt Hours)

Month	Residential Sales	Commercial Sales	Industrial Sales	Other Sales	Meralco Consumption	Total Consumption
January	53.2	37.2	66.9	23.0	0.589	180.9
February	50.1	33.8	72.8	24.8	.608	182.1
March	50.4	34.6	68.7	24.4	.658	178.7
April	51.6	34.5	66.2	25.0	.588	177.9
May	52.9	35.3	70.3	23.1	.623	182.2
June	54.9	38.1	71.2	23.6	.629	186.4
July	53.5	35.4	68.9	23.0	.660	181.9
August	52.3	35.4	70.1	25.1	.632	183.5
September	52.6	35.5	72.6	24.8	.611	186.0
October	52.9	35.5	68.3	23.3	.525	180.5
November	52.7	35.6	70.0	25.0	.554	183.9
December	51.2	34.5	69.2	24.7	.686	180.3
Total	628.3	423.7	835.2	289.7	7.363	2,184.3

Going a step further, an estimate of fuel requirement can also be determined. The amount of electricity generated by MERALCO is mainly thermoelectric power whereas that supplied by the National Power Corporation is hydro-electric power. The generation of hydroelectric power depends on the level of rainfall. This explains why the purchases of MERALCO from the NPC is greatest for the months of August, September and October. For the other months, MERALCO would have to increase thermoelectric generation to meet the demand. In other words, thermoelectric generation of electricity can be varied depending on the changes in the input of fuel. In 1962, the average number of U.S. 42 gallon barrels of bunker fuel used by MERALCO per million kilowatt hours was 1,677.6 barrels. Using this information, a projection of fuel need for 1963 in done in Table 6.

CONCLUSION

In business organizations, statistical analysis of related data has become a necessary basis of management decisions. One can indicate but a few of the fields wherein statistical analysis has eliminated guess work and "hit-or-miss" methods: quality control, market planning, sales and advertising promotion, and production and consumption forecasting.

TABLE 6

PROJECTED CONSUMPTION, PRODUCTION AND FUEL REQUIREMENT

	Total Consumption (mil. kwh)	Total Production (mil. kwh)	% of Production Generated by MERALCO in 1962	Estimated Production to be generated by MERALCO in 1963 (mil. kwh)	Fuel Requirement 1963 (thousand 42 gal. barrels)
January	180.9	235.2	81.9	192.6	323
February	182.1	236.7	81.7	193.4	324
March	178.7	232.3	79.1	183.7	308
April	177.9	231.3	82.0	189.7	318
May	182.2	236.9	80.5	190.7	320
June	166.4	242.2	81.7	197.9	332
August	183.5	238.6	45.4	108.3	182
September	186.0	241.8	44.6	107.8	181
October	180.5	234.6	46.5	109.1	183
November	183.9	239.1	72.6	173.6	291
December	180.3	234.4	77.6	181.9	305
Total	2,183.3	2,839.6		1,995.4	3,347

Furthermore, because of the dynamic and ever-changing free enterprise economy, the data analyzed for purposes of forecasting and planning for the future are usually in the nature of time series — the data are observations recorded at successive intervals of time.

This paper has attempted to show, by means of a concrete example, how statistical analysis may be applied to such a type of data to arrive at information which may be used as a basis for management decision. Analyzing data on the monthly consumption of electricity in the Greater Manila Area, we have identified the kind of seasonal variation affecting such time series, estimated the monthly seasonal indices for 1963, formulated a forecast of the monthly consumption of electricity for the Greater Manila Area and used such predictions to estimate the total revenue for 1963 expected from the purchase of such amount of electricity, the amount of electricity that would have to be made available, as well as the amount of fuel required for 1963 to generate such amount of electricity.

Today many business organizations in the Philippines still rely on the feel of the situation and on a modicum of facts and know-how in forecasting. Perhaps, cost-wise, they were justified in doing so during the years of import and foreign exchange controls when they were catering to a captive market. But the advent of decontrol has changed the economic picture significantly. To retain their share of the market, or perhaps even just to stay in business, the managers of these concerns must be guided in their decisions by meaningful tools. This paper has offered one of those meaningful tools — a method of time series analysis which provides a basis for management decisions.

NOTES

[1] The assumption concerning the number and kind of categories of factors affecting the time series, and the manner in which these factors interact to form the observable aggregate time series, embodies the classical approach to the decomposition of time series for statistical analysis.

The accuracy of the results of the analysis will ultimately depend on the validity of this assumption. Of course, its validity can be conclusively tested if the effects of the four factors are known for each corresponding value of the variable. However, one will immediately agree that such a test is on a purely ideal level, since what is generally observable and known is the value of the variable alone.

Perhaps the test can be based, not on the true values, but on the estimates of the effects of the four components. If this be the case, the estimates must be obtained without using the assumed manner of interactions of the components—otherwise, at the outset, the assumption to be tested is considered to be true. Experience has shown that this necessary condition on the procedure of estimation presents difficulties in obtaining the estimates.

Furthermore, assuming that estimates of the four components are obtained independently of the assumption under consideration, the test will still presuppose that there are only four distinguishable categories of factors affecting the series. Moreover, what will be tested is not only the validity of the multiplicative model but also the accuracy of estimates of the four components.

Under these considerations, it seems that one cannot conclusively test the validity of the assumed model and its use rests upon the acceptance of its general compatibility with respect to economic and business considerations. Or, if the assumption is to be used in a statistical analysis for forecasting, the validity of the model may be tested against the accuracy of the predictions made. However, in this case, the objections raised in the preceding paragraph also hold.

One must bear in mind these aforementioned considerations in evaluating the statistical method to be discussed.

[2] The data were gathered directly from the financial statements of MERALCO, since there are no published figures for electricity consumption. Production data are available from Central Bank publications which include electricity generated by MERALCO and that purchased from the National Power Corporation. The difference between electricity produced, or more appropriately, electricity made available, and total electricity consumed is accounted for mainly by losses in transmission and meter tapping.

[3] Leong, Y. S., "The Use of an Iterated Moving Average in Measuring Seasonal Variations," *Journal of the American Statistical Association*, Vol. 57, 1962.

[4] This statement has been verified to be applicable to data on the cons mption of electricity in the Greater Manila Area in E. T. Velasco, "Seasonal Variation in the Consumption of Electricity in the Greater Manila Area."

[5] *Ibid.*, p. 152.

[6] Blair, Morris, *Elementary Statistics.* New York: Henry Holt and Co., 1952.

[7] Peter Steiner, in his book *An Introduction to the Analysis of Time Series* (New York: Rinehart & Co., 1957), further distinguishes three types of changing seasonal variation. It may be either oscillating or abruptly changing or gradually changing. Assuming a linear relationship between time (t_j) and the seasonal index (S_{ij}) is tantamount to assuming that the pattern of seasonal variation in the particular series is gradually changing.

[8] Foote, R. J. and Fox, K.A., *Seasonal Variation: Methods of Measurement and Test of Significance,* Agricultural Handbook No. 48, B.A.E., U.S. Department of Agriculture, September 1952, pp. 6-7.

[9] The summation of constants (a_i) on equation (3.1) is equal to 1200 and that of the regression coefficient (bi) is equal to zero.