Totals	3360	840 000	Totals	2730–3900	745 000–890 000

CASE STUDY 12.2

Forecasting Ticket Sales at CineBarn

The CineBarn is a large cinema complex in Winnipeg. The complex has 18 screens and a total of 4620 seats. Ticket sales vary from day to day but are generally higher on the weekends (Friday and Saturday nights have the highest attendance). Also, children's matinees increase attendance on Sunday. A couple of years ago the CineBarn initiated a half-price policy on Tuesdays to help boost box-office sales on an otherwise slow night.

The CineBarn's co-owner and manager, Eryn Margolese, wants to develop a forecasting model for daily ticket sales at the complex, since this will help her to plan staffing schedules, order quantities for the concessions in the four-level building (there is one concession on each floor), and deal with other aspects of running a large multi-screen movie complex.

Eryn has decided that when the attendance is anticipated to be less than 2500 she will open only two of the four concessions (on the first and third floors), and she will reduce the staff by four persons. The co-owner of the CineBarn, Liam Smith, points out that popular movies usually run simultaneously on two or more screens and recommends that on slow nights those films be shown on only one screen, thereby cutting the staff even further.

In a strategic planning meeting, Liam says, "You know, all of this is highly speculative, we can't make any meaningful decisions until we analyze the data and see what the ticket sales look like on the various days of the week." Eryn nods and replies, "I manage the day-to-day operations of the CineBarn, so we have all the data on file. I will produce a spreadsheet showing attendance for the last month or so and we can use that to develop a plan for the future."

"Great idea," Liam says. "As soon as the spreadsheet is ready send it to me as an attachment. My sister Waverly is a whiz with statistics—I will ask her to run a statistical analysis to detect the weekly pattern of ticket sales."

Eryn asks, "Which statistical analyses would *you* recommend, Liam?" Liam says, "Well, we can try to construct a causal model using regression analysis but we would need to include some explanatory variables—what other data can you include in the spreadsheet?"

DAY	TICKET SALES				
	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5
Mon	2120	2096	2246	2256	3421
Tues	2870	2768	2872	2879	3041
Wed	2230	2185	2224	2320	2076
Thurs	2459	2543	2446	2654	2580
Fri	3120	3200	3180	3280	3175
Sat	3564	3480	3560	3568	3762
Sun	3342	3312	3427	3342	

DAY	TEMPERATURE (CELSIUS)				
	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5
Mon	–8	3	2	–6	6
Tues	–2	–1	2	–4	2
Wed	0	–5	1	–7	–3
Thurs	–4	–3	–4	–2	–5
Fri	1	7	3	4	0
Sat	4	10	7	7	6
Sun	5	8	6	5	

Liam and Eryn spend the next half hour brainstorming the problem of which explanatory variables to include in a multiple regression model. After serious consideration, they decide that a useful regression model would involve a variable that differentiates between weekdays (Monday to Thursday) and weekends (Friday, Saturday, Sunday). Therefore, they decide to include the variable

$$X_1 = \begin{cases} 1 \text{ if day} = \text{Monday, Tuesday, Wednesday, or Thursday} \\ 0 \text{ if day} = \text{Friday, Saturday, or Sunday} \end{cases}$$

The other major factor affecting attendance is climate. In fact, the data were collected during five winter weeks when the temperature was quite variable. Therefore, Eryn includes the average daily temperature in her spreadsheet. The regression analysis will use the two explanatory variables X_1, as defined above, and X_2, average daily temperature.

The tables below show the daily number of ticket sales for the 34 days for which the ticket sales were recorded, and the average daily temperatures for the same period.

"OK," Liam says, "I can run that analysis, but I would like to consult with Waverly to get her take on this." Liam calls Waverly and interrupts her in the middle of a busy schedule. He quickly explains the problem to her and asks if he is on the right track. She replies, "Hmmm, I think I would start with a multiplicative decomposition to try to establish some seasonal indices for the different days of the week—that would help to develop a good forecasting model that explicitly incorporates the daily pattern of ticket sales in the forecast."

"That sounds like a great idea," says Liam, "but I would not have a clue where to begin! Can you be a nice sis and do it for me?" Waverly sighs and says, "OK Liam, but there are two conditions: first, you run the regression model. That's pretty straightforward in Excel. Then we can compare the forecasting error from that model with my multiplicative decomposition model." "What's the second condition?" Liam asks.

Waverly replies, "A year of free passes to the CineBarn."

DISCUSSION QUESTIONS

1. Develop a forecasting model based on Liam's suggestion to use a multiple regression model.
2. Develop a forecasting model based on Waverly's suggestion to use a multiplicative decomposition model.
3. Compare the two models. Which model yields more accurate forecasts for daily ticket sales?
4. For the multiplicative decomposition forecast the next week (seven days) of ticket sales.
5. Assuming that the pattern established in the sample data can be regarded as representative of daily ticket sales, on which days of the week would you recommend that the staff should be reduced by four persons?

justify your answer.

(c) Determine the optimal value of α that minimizes MAPE.

12-26 A provincial credit union has been growing steadily since it was established in 1961. Deposits have increased slowly but surely over the years, despite some years when the economy has been sluggish. To help develop a strategic plan, management at the credit union wants to develop a one-year forecast of deposits. Historical data for deposits from the inception of the credit union in 1961 up until 2004 are shown in the table above. The table also shows the provincial GDP for the corresponding years.

(a) Using three forecasting models: (1) exponential smoothing with $\alpha = 0.6$, (2) trend analysis, and (3) linear regression, discuss which forecasting model fits best for the credit union's strategic plan. Justify why one model should be selected over another.

(b) Examine the data carefully. Can you make a case for excluding a portion of the information? Why? Would that change your choice of model?

12-27 Bus and subway ridership in Toronto during the summer

Table for Problem 12-26

YEAR	DEPOSITS (IN MILLIONS)	GDP (IN BILLIONS)	YEAR	DEPOSITS (IN MILLIONS)	GDP (IN BILLIONS)	YEAR	DEPOSITS (IN MILLIONS)	GDP (IN BILLIONS)
1961	$0.25	$0.4	1976	$ 2.3	$1.6	1991	$24.1	$3.9
1962	0.24	0.4	1977	2.8	1.5	1992	25.6	3.8
1963	0.24	0.5	1978	2.8	1.6	1993	30.3	3.8
1964	0.26	0.7	1979	2.7	1.7	1994	36.0	3.7
1965	0.25	0.9	1980	3.9	1.9	1995	31.1	4.1
1966	0.30	1.0	1981	4.9	1.9	1996	31.7	4.1
1967	0.31	1.4	1982	5.3	2.3	1997	38.5	4.0
1968	0.32	1.7	1983	6.2	2.5	1998	47.9	4.5
1969	0.24	1.3	1984	4.1	2.8	1999	49.1	4.6
1970	0.26	1.2	1985	4.5	2.9	2000	55.8	4.5
1971	0.25	1.1	1986	6.1	3.4	2001	70.1	4.6
1972	0.33	0.9	1987	7.7	3.8	2002	70.9	4.6
1973	0.50	1.2	1988	10.1	4.1	2003	79.1	4.7
1974	0.95	1.2	1989	15.2	4.0	2004	94.0	5.0
1975	1.70	1.2	1990	18.1	4.0			

12-28 Kelsey Ross, a Toronto psychologist, specializes in treating [illegible] afraid to leave their homes. The [illegible] Ross has

Dr. Ross's patient load. Is a linear model between these two variables reasonable?

(b) Apply linear regression to study the relationship [illegible] and Dr. Ross's patient load.