ADDITIONAL CASES

CASE 12.2 INTERNATIONAL INVESTMENTS

Charles Rosen relaxes in a plush, overstuffed recliner by the fire, enjoying the final vestiges of his week-long winter vacation. As a financial analyst working for a large investment firm in Germany, Charles has very few occasions to enjoy these private moments, since he is generally catching red-eye flights around the world to evaluate various investment opportunities. Charles pats the loyal golden retriever lying at his feet and takes a swig of brandy, enjoying the warmth of the liquid. He sighs and realizes that he must begin attending to his own financial matters while he still has the time during the holiday. He opens a folder placed conspicuously on the top of a large stack of papers. The folder contains information about an investment Charles made when he graduated from college four years ago. . . .

Charles remembers his graduation day fondly. He obtained a degree in business administration and was full of investment ideas that were born while he had been daydreaming in his numerous finance classes. Charles maintained a well-paying job throughout college, and he was able to save a large portion of the college fund that his parents had invested for him.

Upon graduation, Charles decided that he should transfer the college funds to a more lucrative investment opportunity. Since he had signed to work in Germany, he evaluated investment opportunities in that country. Ultimately, he decided to invest 30,000 German marks (DM) in so-called B-Bonds that would mature in 7 years. Charles purchased the bonds just 4 years ago last week (in early January of what will be called the "first year" in this discussion). He considered the bonds an excellent investment opportunity, since they offered high interest rates (see Table 1) that would rise over the subsequent 7 years and because he could sell the bonds whenever he wanted after the first year. He calculated the amount that he would be paid if he sold bonds originally worth DM 100 on the last day of any of the 7 years (see Table 2). The amount paid included the principal plus the interest. For example, if he sold bonds originally worth DM 100 on December 31 of the sixth year, he would be paid DM 163.51 (the principal is DM 100, and the interest is DM 63.51).

Charles did not sell any of the bonds during the first four years. Last year, however, the German federal government introduced a capital gains tax on interest income. The German government designated that the first DM 6,100 a single individual earns in interest per year would be tax-free. Any interest income beyond DM 6,100 would be taxed at a rate of 30 percent. For example, if Charles earned interest income of DM 10,100, he would be required to pay 30 percent of DM 4,000 (DM 10,100 − DM 6,100) in taxes, or DM 1,200. His after-tax income would therefore be DM 8,900.

Because of the new tax implemented last year, Charles has decided to reevaluate the investment. He knows that the new tax affects his potential return on the B-Bonds, but he also knows that most likely a strategy exists for maximizing his return on the bonds. He might be able to decrease the tax he has to pay on interest income by selling portions of his bonds in different years. Charles considers his strategy viable because the government requires investors to pay taxes on interest income only when they sell their B-Bonds. For example, if Charles were to sell one-third of his B-Bonds on

TABLE 1 Interest rates over the 7 years

Year	Interest Rate	Annual Percentage Yield
1	7.50%	7.50%
2	8.50%	8.00%
3	8.50%	8.17%
4	8.75%	8.31%
5	9.00%	8.45%
6	9.00%	8.54%
7	9.00%	8.61%

TABLE 2 Total return on 100 DM

Year	DM
1	107.50
2	116.64
3	126.55
4	137.62
5	150.01
6	163.51
7	178.23

December 31 of the sixth year, he would have to pay taxes on the interest income of DM 251 (DM 6,351 − DM 6,100).

Charles asks himself several questions. Should he keep all the bonds until the end of the seventh year? If so, he would earn 0.7823 times DM 30,000 in interest income, but he would have to pay very substantial taxes for that year. Considering these tax payments, Charles wonders if he should sell a portion of the bonds at the end of this year (the fifth year) and at the end of next year.

If Charles sells his bonds, his alternative investment opportunities are limited. He could purchase a certificate of deposit (CD) paying 4.0 percent interest, so he investigates this alternative. He meets with an investment adviser from the local branch of a bank, and the adviser tells him to keep the B-Bonds until the end of the seventh year. She argues that even if he had to pay 30 percent in taxes on the 9.00 percent rate of interest the B-Bonds would be paying in their last year (see Table 1), this strategy would still result in a net rate of 6.30 percent interest, which is much better than the 4.0 percent interest he could obtain on a CD.

Charles concludes that he would make all his transactions on December 31, regardless of the year. Also, since he intends to attend business school in the United States in the fall of the seventh year and plans to pay his tuition for his second, third, and fourth semester with his investment, he does not plan to keep his money in Germany beyond December 31 of the seventh year.

(For the first three parts, assume that if Charles sells a portion of his bonds, he will put the money under his mattress earning zero percent interest. For the subsequent parts, assume that he could invest the proceeds of the bonds in the certificate of deposit.)

(a) Identify one of the model types described in this chapter that is applicable to this problem, and then formulate a model of this kind to be used in the following parts.
(b) What is the optimal investment strategy for Charles?
(c) What is fundamentally wrong with the advice Charles got from the investment adviser at the bank?
(d) Now that Charles is considering investment in the certificate of deposit, what is his optimal investment strategy?
(e) What would his optimal investment strategy for the fifth, sixth, and seventh years have been if he had originally invested DM 50,000?
(f) Charles and his fiancée have been planning to get married after his first year in business school. However, Charles learns that for married couples, the tax-free amount of interest earnings each year is DM 12,200. How much money could Charles save on his DM 30,000 investment by getting married this year (the fifth year for his investment)?
(g) Due to a recession in Germany, interest rates are low and are expected to remain low. However, since the American economy is booming, interest rates are expected to rise in the United States. A rise in interest rates would lead to a rise of the dollar in comparison to the mark. Analysts at Charles' investment bank expect the dollar to remain at the current exchange rate of DM 1.50 per dollar for the fifth year and then to rise to DM 1.80 per dollar by the end of the seventh year. Therefore, Charles is considering investing at the beginning of the sixth year in a 2-year American municipal bond paying 3.6 percent tax-exempt interest to help pay tuition. How much money should he plan to convert into dollars by selling B-Bonds for this investment?

■ CASE 12.3 PROMOTING A BREAKFAST CEREAL (REVISITED)

Reconsider Case 3.4. Recall that Claire Syverson, vice president for marketing of the Super Grain Corporation, is planning an advertising campaign for the company's new breakfast cereal (Crunchy Start) with the help of a leading advertising firm, Giacomi & Jackowitz. The campaign will use three advertising media: television commercials on Saturday morning programs for children, advertisements in food and family-oriented magazines, and advertisements in Sunday supplements of major newspapers. The problem being addressed is how to determine the best mix of these advertising media.

The ultimate goal of the advertising campaign is to maximize the company's profits that are attained due to resulting sales. However, it is difficult to make a direct connection between advertising exposure and profits. Therefore, the expected number of exposures (where each viewing of an advertisement by some individual counts as one exposure) was chosen as a rough approximation for profit.

Having done this, Claire is uneasy. She realizes that the assumption that the total profit from the introduction of Crunchy Start is proportional to the total number of exposures from the advertising campaign is only a rough approximation. The most important reason why is that running too many advertisements in any of the media passes a saturation level in an individual so that the effect of one more advertisement is substantially less than that of the first one. Nevertheless, when the objective function is the expected number of exposures, having an individual see the advertisement one more time after being saturated adds the same amount to the objective function as seeing the advertisement for the first time.

To check the results obtained in Case 3.4, Claire decides to try defining profit as the overall measure of performance to be incorporated directly into the objective function. She carefully defines profit as the total profit obtained from first-time sales of Crunchy Start that occur because of the advertising campaign. This excludes profits from impulse purchases of Crunchy Start by customers who have seen no advertisements, since these sales have no relevance for evaluating the advertising campaign. Repeat purchases of Crunchy Start also are excluded from consideration because these depend mainly on the reaction to the cereal from the first purchase instead of the advertising campaign.

Claire asks Sid Jackowitz, one of the senior partners of Giacomi & Jackowitz, to develop estimates of the number of first-time purchases of Crunchy Start that should result from various numbers of advertisements in each of the media. His estimates are shown in Table 1.

TABLE 1 The impact of advertising levels on first-time purchases of Crunchy Start

Number of TV Spots	Number of Sales	Number of Magazine Ads	Number of Sales	Number of Ads in Sunday Supplements	Number of Sales
1	1,000,000	5	700,000	2	1,200,000
2	1,750,000	10	1,200,000	4	2,200,000
3	2,450,000	15	1,550,000	6	3,000,000
4	2,800,000	20	1,800,000	8	3,500,000
5	3,000,000	25	2,000,000	10	3,750,000

Sid also reports that it is reasonable to assume that the sales that result from advertising in one of the media are not substantially affected by the amount of advertising in the other media since the audiences for the different media are usually different.

It is estimated that the company's gross profits from Crunchy Start will be 50¢ per sale. However, this gross profit excludes the advertising costs and planning costs specified in Case 3.4 for the advertising campaign. Therefore, Claire wants to include these costs in her definition of the total profit that should be considered for determining the best advertising mix.

(a) For each of the three advertising media, draw a graph of the number of sales versus the number of advertisements by plotting the sales for the five points provided by Sid Jackowitz and then drawing a smooth curve through (or very near) these points. (Fractional advertisements are allowed by using only a portion of the available outlets.)

(b) For each of the advertising media, use Excel's curve fitting method to obtain a nonlinear formula for the sales graph and then to construct the graph. In each case, try three Excel options for the form of the graph—a polynomial of order 2 (the quadratic form), a polynomial of order 3, and the logarithmic form—and then choose the option that you feel provides the best fit.

(c) Using your results from part (*b*), write an expression for the total profit (as defined by Claire) in terms of the number of advertisements of each type.

(d) Using your result from part (*c*), formulate and solve a nonlinear programming model that maximizes total profit instead of the expected number of exposures.

(e) Use the sales tables provided by Sid Jackowitz to apply separable programming to this problem when maximizing total profit.

(f) Compare your results in parts (*d*) and (*e*), and then give your recommendation (with a brief explanation) for the best advertising mix. Do you feel it was worthwhile to introduce a nonlinear profit function into the model in order to refine the linear programming model maximizing the expected number of exposures that was requested in Case 3.4?