

TESTBANK SOLUTIONS

Management Science: The Art of Modeling with Spreadsheets

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John Wiley and Sons 2007 Second Edition

February 20, 2008

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Model building problems

1. Benefits Costs in a Hospital Merger

The St. Mary ('Mary') and Mt. Sinai ('Sinai') hospitals are planning to merge. Together, they must design a new employee benefits plan that will cover all employees in the merged hospital. To save on administration costs, they have decided to adopt for the entire merged hospital *either* Mary's plan *or* Sinai's current plan.

The table below shows that Sinai's average benefits are more generous than Mary's. For example, an employee with a family receives, on average, \$550 in annual medical benefits under Mary's plan and \$830 in benefits under Sinai's plan. In total, the employee with a family would receive an average of $\$550 + \$90 + \$40 + \$15 = \$695$ under Mary's plan and significantly more under Sinai's. (Cost data are available in the file *merger_data.xls*.) Overall, 65% of all employees at both hospitals enroll under a family plan and the remainder enroll under the individual plan.

Benefit category	Type of employee	Mary	Sinai
Medical	Individual	\$300	\$400
	Family	\$550	\$830
Dental		\$90	\$85
Life Insurance		\$40	\$80
Disability Insurance		\$15	\$15

Average annual benefits costs, per employee, for current plans

The table displays average benefits, but either decision will significantly reduce benefits for some employees. Mary has 1200 employees, and if Sinai's plan is adopted then 12% of Mary's employees are expected to leave because of the reduction in benefits. Sinai has 750 employees, and if Mary's benefits are adopted then 30% are expected to leave Sinai. On average, it will cost \$45,000 to replace an employee who leaves either hospital. Replacement employees are similar to current workers: average costs are equal to those in the table and 65% enroll in a family plan. The hospitals would like to assess the total cost over the next 8 years of applying each plan to the entire merged hospital. Assume that the following events will occur now: the new plan is announced, some employees leave because of a reduction in benefits, and these employees are immediately replaced. Then, the costs described in the table above will be booked after 1 year. During years 2-8, total benefits costs will grow by 8% annually. Management uses a discount rate of 5%.

Build a spreadsheet model to answer the following questions.

a) Which benefits plan has the lower cost (expressed as an NPV)? Plan: **St. Mary's**

NPV of the lower-cost plan: **\$20,106,745**

b) At what growth rate in benefits costs do the two plans have an equal NPV? **4.2%**

2. Assortment Planning at Skihaus

Skihaus is a retail chain that specializes in the sales of Alpine skis. Skihaus sells its own brand of skis in three styles: S, DX and LX. The three skis cost Skihaus \$260, \$400, and \$480, respectively, to purchase from the manufacturer. Throughout the selling season the chain will sell them to consumers for \$300, \$450, and \$550, respectively. At the end of the season if the skis are not sold then they will be sold to a liquidator for \$50, \$230, and \$290. (These data are available in the file *skihouse_data.xlsx*). Skis are purchased from the manufacturer once, before the selling season.

Skihaus has identified two distinct segments of customers who purchase from the store: early buyers who prefer top-of-the-line skis (*Earlies*) and bargain-hunters (*Bargains*). As their name implies, Earlies arrive first in the season, and you may assume that *all* Bargains arrive at the end of the season, after all Earlies.

The two segments have different preferences for skis. Earlies prefer to buy LX skis. If LX skis are sold out, they will always buy DX skis, and if LX and DX skis are sold out, Earlies will always buy S skis. Bargains prefer S, then DX, and will not buy LX skis. Assume each customer buys one pair of skis.

Skihaus expects to see 5,000 buying customers during the season, of which 60% are Earlies and 40% are Bargains. Skihaus' purchasing manager plans to begin its season with 1,300 LX skis, 2,200 DX skis and 1,900 S skis, but she is considering alternate order quantities.

[15 points]

a) Build a spreadsheet model that *evaluates* the base-case plan described above. You are not expected to optimize this model. The model should be flexible, allowing all of the parameters and decisions to change. You may, however, assume here that the *preferences* described above for each market segment will not change (e.g., you may assume in your calculations that Earlies will always prefer LX to DX to S).

Objective function value of your model: **\$ 189,000**

(This problem continues with part b on the next page)

[10 points]

- b) In the real world, customer preferences can be uncertain. Market research may show, for example, that Earlies really prefer DX to S and will not buy LX. Take your model from part (a), copy it to a new worksheet, and change it so that customer preferences can be updated easily. In other words, parameterize customer preferences.

NOTE: This is a challenging model. Do not attempt it until you have finished the rest of the exam.

Once you have built the model, find the objective function value with all parameters the same as in part (a) except that Earlies now prefer DX to S and will *not* buy LX: **\$ -61,000**

3. Evergreen College Endowment

Evergreen College holds an endowment currently worth \$700 million (an endowment is a permanent fund of money that generates income and also can be used to pay for projects). The Chief Investment Officer of the endowment has hired you to predict the performance of the endowment over the next 10 years.

Given the current investment strategy, money invested in the endowment is expected to grow by 8% per year. Over the next 7 years, Evergreen's development office is running a major capital campaign among its alumni. During the entire 7-year campaign the college expects to collect a total of \$300 million in contributions that will be added to the endowment, although the campaign may collect a total as low as \$150 million and as high as \$400 million.

A portion of the endowment is also spent each year to support ongoing activities at the college (this is called the *draw*). During this past year, the draw was \$65 million. During the next ten years the draw in each year will be calculated according to a formula that is the sum of two terms: (i) 70% of the *previous year's* draw and (ii) a certain percentage (p) of the value of the endowment at the beginning of the year. This percentage p depends on the level of the endowment itself, and is given in the following table:

Endowment value (millions)	draw percentage (p)
below \$500	0.0%
\$500-\$600	1.0%
\$600-\$700	2.0%
\$700-\$800	2.5%
\$800 or above	3.0%

For example, if the endowment is \$650 million at the beginning of the year, then the draw is equal to $(70\%)(\text{previous year's draw}) + (2\%)(\$650 \text{ million})$.

Questions

[20 points]

- a. Assume that the capital campaign collects \$300 million.

Build a spreadsheet to calculate the value of the endowment after the next 10 years. Your spreadsheet will be graded both for its technical correctness and for its adherence to the principles of spreadsheet engineering. Note that documentation of each calculation is not required, nor is extensive formatting for appearance. *However, if you need to make any assumptions beyond the problem description given above, you should include an explanation of these assumptions at the top of the spreadsheet.*

Endowment value at the end of year 10: **\$926 million**
(see spreadsheet and the note on grading, below)

Note on grading part (a). We gave credit for spreadsheets that are correct, flexible, and conformed to the principles of spreadsheet engineering as we have learned them in the course. Examples of violations of the principles include hard-coding parameters into the calculations, not clearly labeling the output value, and not stating assumptions including assumptions about the timing of cash flows.

[10 points]

b. In addition to the draw, the college may spend part of the endowment for a new science building. The decision to begin spending and construction for the building in any particular year depends on two goals being met: (i) the capital campaign reaching at least \$200 million by the beginning of the year and (ii) the total endowment reaching at least \$800 million by the beginning of the year. If and when both these goals are met, then the college will spend \$50 million from the endowment during the first year of construction and \$60 million during the second, for a total building cost of \$110 million. If the two goals are not met during the 10 years then the building will not be built.

Copy your model from part (a) onto a new worksheet and then extend the model to include this new information. Again, if you need to make any assumptions beyond the problem description given above, you should include an explanation of these assumptions at the top of the spreadsheet.

Given the parameters described above, including those in part a, find the value of the endowment after the next 10 years.

Endowment value at the end of year 10: **\$805 million (see spreadsheet)**

Now suppose that the capital campaign collects only \$150 million. What is the final endowment value?

Endowment value at the end of year 10: **799 million**

Now suppose that the capital campaign collects \$300 million, but that the initial endowment value is only \$250 million. What is the final endowment value?

Endowment value at the end of year 10: 685 million

As in part (a), we graded the model rather than the numerical answers (the question asks you to “extend your model...”). We looked for a model that correctly evaluates both the decision of whether or not to build the building and the timing of the decision. Hard-coding the \$50 and \$60 into years 6 and 7 of the model received very little credit. As always, our goal is to build a model that is both correct and flexible.

4. Kurbe Marketing Research

Kurbe Marketing Research (KMR), located in Boston, specializes in marketing research in the consumer goods industry. Each year KMR conducts hundreds of research studies for a variety of clients utilizing focus groups, internet surveys and telephone surveys. KMR is currently studying the resources it dedicates to telephone surveys.

Demand for KMR’s telephone research varies throughout the year. KMR conducts the vast majority of its research in-house, but if it cannot handle all of the work at peak demand times, it is forced to subcontract some of the phone interviewing, which results in a lower profit margin. Also, outsourcing the phone interviews means that KMR loses some control of the process. This can result in problems such as missed deadlines and a decrease in quality. However, dedicating enough resources to ensure no outsourcing would not be very efficient, since it would result in more costs and decreased productivity due to idle time during slower periods. Nonetheless, based on the recent amount of outsourcing, KMR management feels that the company has too few operators conducting telephone survey research. You have been assigned the task of studying this problem and making a recommendation.

The annual fixed costs (management, facilities and other overhead charges) associated with the telephone survey group are \$320,000. Every operator needs a computer-assisted telephone interviewing station (known as a CATI). Currently KMR has 48 CATIs and they are considering purchasing additional ones this year. Of the 48 CATIs currently on hand, 16 per year will be replaced each year for the next 3 years. New CATIs will not need replacement over this time period.

The purchase cost of a CATI is \$36,000 and is likely to remain stable for the next 3 years. The cost of an operator (one per CATI) per month is \$2,200. Assume that only additional CATIs (beyond the current number of 48) require training (replacement CATIs do not since they already have operators). The one-time training cost for a new operator is \$1,100.

The time frame for the study is the next three years. Demand varies by month and forecasted demand for the coming year is shown in the table below (demand is expressed in dollars of revenue). A CATI can handle approximately \$12,000 of work per month. Demand is expected to grow by 10% per year (the forecasted amounts in the table have already factored this in for next year). Assume that each month’s demand will grow by this amount in years 2006 and 2007. This increase in revenue will come from increased volume of work rather than increases in pricing (the forecast assumes stable pricing).

Month	Demand (\$000)
January	\$890
February	\$820
March	\$575
April	\$860
May	\$695
June	\$330
July	\$740
August	\$700
September	\$255
October	\$750
November	\$170
December	\$160

Forecasted demand (in dollars of revenue) for 2005

Management is looking for the best level of in-house operation (number of CATIs). KMR receives 15% of the revenue for the work that is outsourced to an outside vendor. Finally, for studies such as this, KMR uses an annual discount rate of 10% and their tax rate is 34%.

Questions:

[25 points]

a. Build a spreadsheet to help KMR analyze this situation. In your base case, evaluate the NPV of net income after taxes assuming KMR maintains 48 CATIs in all years.

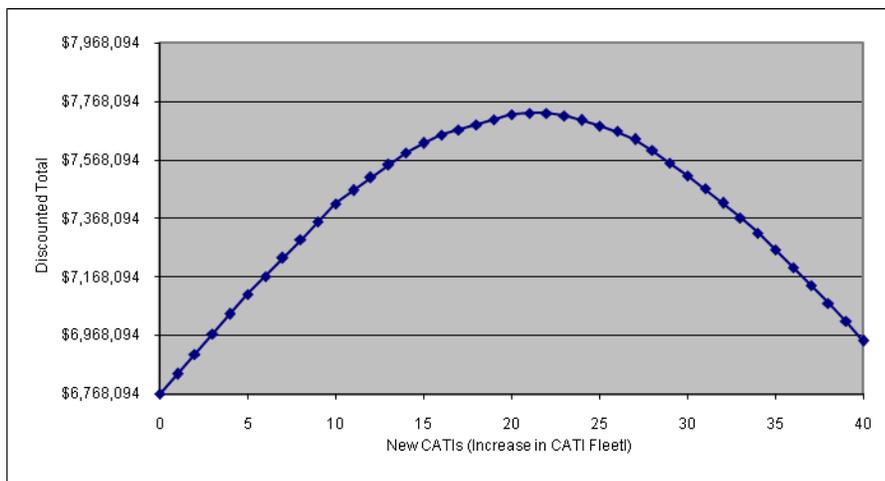
You may use the following page to sketch your spreadsheet (although your sketch will not be graded). Your spreadsheet will be graded both for its technical correctness and for its adherence to the principles of spreadsheet engineering. Note, however, that documentation is not required, nor is extensive formatting for appearance.

Total Number of CATIs		48		
		2005	2006	2007
Revenue	In-house Revenue	\$5,522,000	\$5,614,500	\$5,715,150
	Outsource Revenue	\$213,450	\$303,750	\$403,245
Cost	CATI Operator Cost	\$1,267,200	\$1,267,200	\$1,267,200
	New Operator Training	\$0		
	New CATI Purchase	\$0		
	Replacement CATI Purchase	\$576,000	\$576,000	\$576,000
	Fixed Costs	\$320,000	\$320,000	\$320,000
	Net Before Taxes	\$3,572,250	\$3,755,050	\$3,955,195
	Taxes	\$1,214,565	\$1,276,717	\$1,344,766
	Net After Taxes	\$2,357,685	\$2,478,333	\$2,610,429
NPV After Taxes		\$6,768,094		

A common mistake was ignoring the revenue implications of variation in monthly demand. Other minor mistakes: ignoring training costs, ignoring CATI replacement costs and errors in calculating in-house revenue versus outside revenue.

[10 points]

b. Construct a graph on a separate sheet in your workbook to show the sensitivity of the NPV of net income after taxes to the number of CATIs. Sketch your results here, showing numerical scales for the horizontal and vertical axes, and clearly identify the optimal number of CATIs.



Optimal number of CATIs:

Current	48
New	21
Total	69

[5 points]

c. In the base case (with 48 CATIs) how much lower does KMR's tax rate have to be to increase the NPV of net income after taxes by 10%?

Use goal seek: 27.4%

Database Analysis

1. Population and Tissues

Note: To answer this question you will need to use two databases on the P-drive: *Population.xlsx* and *Tissues.xlsx*.

Population database: shows U.S. state populations from 1990 to 1999.

[2 points]

- a. Which state(s) had a 1990 population less than 5 million and a 1999 population more than 5.5 million? **Washington** It is easiest to use the 'Filter' tool to answer this question.

[3 points]

- b. Which state had the largest *absolute* growth in population over the period 1990-1999?

California

[3 points]

- c. Which state had the largest *relative* (percentage) growth in population over the period 1990-1999?

Nevada

[2 points]

- d. By how many more people has the average of the populations of the 50 states grown from 1995-1999? **193,873 (including DC); 198,396 (not including DC); both answers accepted.**

Tissues database: shows purchases of bathroom tissues at stores in a grocery chain over a period of several weeks.

[2 points]

- e. What was the total number of cases sold for all brands over this period (calculate a single, grand total)? **101,345**

[2 points]

- f. What was the total number of cases sold by Kleenex over this period? **12,969**