Homework II (Group)

Due date: 23:59 on October 30 (Friday), 2020

Please store the answers in a pdf file and upload the file onto WM5. Each group submits only ONE copy. Make sure names and IDs of students can be found on the file. Please show the written simulation program on the document too. NO late submission will be accepted.

Q1 (30%). Suppose a fraction 17% of the microchips produced by a leading manufacturer is defective. For the manufacturer, the number of microchips delivered to its client depends on how many microchips are inspected and accepted by 50 inspectors in the factory. Historically, given that a microchip is defective, an inspector wrongly accepts the chip 10% of the time, thinking it has no defect. If a microchip is not defective, an inspector, however, wrongly rejects the chip 5% of the time. In general, each of the 50 inspectors can inspect 20 chips per hour in a working day of 8 hours (lunch break NOT included in the 8 hours).

Use the *rbinom*( ) and whatever functions needed in *R* to write a simulation program for the case above. In a working day, the microchips delivered to the client contain some good ones (correctly accepted) and some bad ones. In your simulation program, calculate the ratio of good ones to the sum of good and bad ones. The simulation program should be a function called *dailychips*. The function must return 1) the daily number of delivered chips (that is *random*) and 2) the daily ratio of good ones mentioned above. Simulate the daily operations for 1,000 runs and answer the following questions based on simulation results.

(a) The manufacturer claims that the everyday chips delivered to its client has at least 98% good ones. What is the probability that such a claim is true?

(b) What is the probability that the manufacturer can deliver **6,400 microchips accepted by its inspectors** in a typical working day of 8 hours?

Q2 (20%) Use the *dailychips* function in Q1 to simulate *montlychips* and *quarterlychips*. The *monthlychips* is the sum of delivered chips over 30 days, whereas the *quarterlychips* is the sum of delivered chips over 90 days respectively. Ignore good ratios in the two cases and focus on the number of delivered chips over 30 and 90 days. Generate 1,000 random samples for the two numbers (*montly* and *quarterly*) of delivered chips.

Generate the histograms (use *hist*( ) in *R* and set breaks=20) of the simulated *montlychips* and *quarterlychips*. Do they look like normal distributions?

Use the *shaprio.test* ( ) in *R* to perform normality tests for *montlychips* and *quarterlychips* (if *p*-value<=0.05, reject H0: Normality holds). Do you find any evidence for normality? If yes, can you provide theoretical explanations for that (**hint**: check chapter 3 for a theorem)?

Q3 (50%) This case is adapted from Chapter 5 in Bertsimas & Freund (2004).

THE GENTLE LENTIL RESTAURANT

An Excellent Job Offer

Sanjay Thomas, a second-year MBA student at the M.I.T. Sloan School of Management, is in a very enviable position: He has just received an excellent job offer with a top-flight management consulting firm. Furthermore, the firm was so impressed with Sanjay's performance during the previous summer that they would like Sanjay to start up the firm's practice in its new Bombay office. The synergy of Sanjay's previous consulting experiences (both prior to Sloan and during the previous summer), his Sloan MBA education, and his fluency in Hindi offer an extremely high likelihood that Sanjay would be very successful, if he were to accept the firm's offer and develop the Bombay office's practice in India and southern Asia.

Sanjay is a rather contemplative individual who tries to see the bigger picture of events and decisions in life. He is very excited about the job offer for a number of good reasons. He likes the intellectual and business stimulation of management consulting, and the great variety of assignments and business situations that consultants have the opportunity to deal with. Also, the salary offer is excellent ($80,000 for the first year). However, he is also apprehensive. The lifestyle of management consultants is taxing. There is constant travel, and much of the travel is rather routine. Furthermore, in Sanjay's summer consulting experience he often had to cancel his personal plans at the last minute in order to accommodate spurts of unexpected work in the evenings and on weekends. While Sanjay is very energetic and motivated, and he enjoys hard work, he is also committed to maintaining a healthy personal life as well. Career development is but one piece of his many aspirations.

A Different Career Path?

The job offer has catalyzed Sanjay to think more seriously about one particular career alternative he has pondered over the last two years, namely to open his own upscale restaurant serving gourmet Indian cuisine. Sanjay is attracted to this plan for a number of reasons. For one, he has always wanted to start his own business. Second, he has always had a passion and talent for gourmet Indian cuisine. Third, he enjoys being a good host, and in fact hospitality has always been an integral part of his lifestyle.

In terms of lifestyle issues, Sanjay knows several restaurant owners who also work extremely long hours; his Aunt Sona owns a restaurant in Bethesda, Maryland, and she is always working. But as hard as his aunt works, Sanjay feels that these hours constitute a very different lifestyle from that of a management consultant. There would be very little if any travel involved and so he would be able to participate more in his community. And although the restaurant business might demand extreme effort from time to time, Sanjay figures that such situations would not arise as often as in a consulting career. The most important difference for Sanjay is that he would be working for himself, and that the business would be more fun than consulting (although he also has enjoyed consulting quite a bit as well). Sanjay believes that his high energy, management skills, and interest in gourmet Indian cuisine would form the essential ingredients needed to open and successfully operate his own restaurant, which he has temporarily named the Gentle Lentil Restaurant.

The non-financial advantages of consulting (variety of work, intellectual challenge) seem to be evenly matched against the non-financial advantages of opening the Gentle Lentil Restaurant (less travel, business ownership). The financial implications of the two alternatives might be very different, however. In addition to his desire to earn a good salary, Sanjay also would like to pay off his educational debt obligations, which are rather substantial. (Like many other students attending top business schools, Sanjay financed a big portion of his education through student loans.) In order to maintain a reasonable lifestyle while paying off his loans after graduation, Sanjay has figured that he would need to earn approximately $5,000 per month before taxes.

Making an Informed Decision

As part of one of his course projects last semester on entepreneurship, Sanjay actually conducted a profitability analysis of a sample of gourmet Indian restaurants in major East Coast cities, starting with his aunt's restaurant. After adjusting the data to reflect the cost-of-living standard in Boston, Sanjay used the information to define benchmark costs and revenues for the Gentle Lentil Restaurant concept. These data are based on siting the restaurant, with a seating capacity of 50 patrons, in the Harvard Square area, borrowing money to construct the interior structure, and leasing all capital equipment for the restaurant.

Sanjay estimated the monthly non-labor fixed costs of operating the Gentle Lentil Restaurant to be $3,995 per month, see the cost analysis in Appendix 1 at the end of the case. He also estimated the variable costs of food to be $11/meal served. Among the many uncertainties in the restaurant business, there were three uncertain variables that tended to dominate the profitability equation: the number of meals sold (per month), the revenue per meal, and the (fixed) labor costs of the restaurant. From his conversations with many restaurant owners, Sanjay was able to estimate actual distributions for these three crucial uncertain variables, as follows.

- **Number of meals sold.** Sanjay estimated that for a restaurant like the Gentle Lentil suitably sited in the environs of Harvard Square with a seating capacity of 50 persons, the number of meals sold per month would obey a Normal distribution with a mean of $\mu = 3{,}000$ meals and a standard deviation of $\sigma = 1{,}000$ meals.
- **Revenue per Meal.** Since The Gentle Lentil Restaurant would provide a gourmet dining experience, Sanjay would plan to offer prix fixe (fixed price) meals and would set the price of the meals according to his own estimate of what the local economy and what the market for gourmet dining would support. His own personal estimate, based on discussions with friends and gourmet food aficionados, is shown in Table 5.12. In this range of meal prices, we will assume, for modeling purposes, that the monthly demand will not be affected by the meal price.
- **Labor Costs.** Sanjay estimated that the labor costs for the Gentle Lentil Restaurant would be somewhere between $5,040 per month and $6,860 per month. (For the details of how he arrived at these two numbers, see Appendix 2 at the end of the case.) Without any other information, Sanjay assumed that actual labor costs would obey a continuous uniform distribution in this range.

An Unusual Partnership Opportunity

It was obvious to Sanjay that there would be substantially more risk involved in the Gentle Lentil Restaurant than in accepting the consulting position. When he mentioned this to his aunt in a phone conversation, she offered him the following financial "partnership" opportunity to increase his incentive to undertake the Gentle Lentil venture. Under the financial partnership, his aunt would guarantee Sanjay a monthly salary of at least $3,500. That is, if earnings in a given month fell below $3,500, she would cover the difference. In exchange for this, his aunt would receive 90% of all monthly earnings in excess of $9,000. If earnings were between $3,500 and $9,000, all such moneys would go to Sanjay. It seemed to Sanjay that the effect of this partnership was to reduce the likelihood that his monthly salary would be very low, but it would also reduce the likelihood that his monthly salary would be very high.

TABLE 5.12
Likelihood of prix fixe meal price.

Scenario	*Prix Fixe Meal Price*	*Probability*
Very healthy market	$20.00	25%
Healthy market	$18.50	35%
Not so healthy market	$16.50	30%
Unhealthy market	$15.00	10%

Appendix 1

Monthly Non-Labor Fixed Costs for the Gentle Lentil Restaurant

Table 5.13 shows Sanjay Thomas' estimate of the monthly non-labor fixed costs for the Gentle Lentil Restaurant.

1. Sanjay assumed that Gentle Lentil would lease all restaurant equipment, and that all other capital expenditures would be financed through loans.
2. Description of fixed cost categories is as follows:
   - Rent: cost of restaurant space
   - Leased Equipment: kitchen equipment, furniture, cash register, computer
   - Utilities: gas, electricity, water
   - Insurance: general liability, fire
   - Loan repayment: repayment on 5-year bank loan at market rate
   - Advertising/Promotion: general marketing activities (advertisements, matchbooks, etc.)
   - Miscellaneous: menus, furniture repair, etc.

TABLE 5.13
Monthly non-labor fixed costs for the Gentle Lentil Restaurant.

Category	*Monthly Cost ($)*
Rent	$3,000
Leased Equipment	$275
Utilities	$265
Insurance	$155
Loan Repayment	$125
Advertising/Promotion	$100
Miscellaneous	$75
Total Non-Labor Fixed Costs	$3,995

Labor Costs for the Gentle Lentil Restaurant

Sanjay estimated the minimum and maximum monthly labor costs as shown in Table 5.14.

TABLE 5.14
Monthly labor costs for the Gentle Lentil Restaurant.

Position	*Wage ($/hour)*	*Minimum Staff*	*Maximum Staff*
Chef	$16.00	1	1
Wait Staff	$3.00	2	4
Kitchen Staff	$7.00	2	3
Total Labor Cost		$5,040	$6,860

Note: Employee hours worked is based on a seven hour day, five days per week, four weeks per month.

Your job in this homework is to read the case and apply simulation modeling to answer the following three questions.

(1) Without considering the partnership opportunity, what would be Sanjay's expected monthly salary at Gentle Lentil? How does this compare to his monthly salary at the consulting firm?

(2) With considering the partnership opportunity, what would be Sanjay's expected monthly income at Gentle Lentil? How does this compare to his monthly salary at the consulting firm and his salary without the partnership at Gentle Lentil?

(3) If you were Sanjay, what quantitative questions about the potential salary at Gentle Lentil (with and without the partnership opportunity) would you want to answer with the aid of simulation modeling, before deciding whether to launch the Gentle Lentil Restaurant or to accept the consulting position? Show answers to the quantitative questions based on your simulation model.