Health Care Planning Decisions: A Simulation Approach

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Abstract

The value of flexibility is analyzed and discussed in the framework of a town's decision on providing health care to their employees. Through simulation, it is determined that the assumptions made – especially the "human" assumptions of how employees will react to certain decisions – are most important in determining which decision is best. However, more generally, we find that adding a second low-cost plan to the current high-cost option gives the town the flexibility to drop the high-cost plan if they receive enough employee support for the low-cost plan. This, in turn, opens up the possibility of budget savings that they previous did not have.

Table of Contents

Introduction

In the past decade, health care has become a very hot topic. Due to the historical structure of tax incentives in the United States, employers have for decades paid the majority of health care costs for most of the US workforce. With the recent trend of health care costs increasing at a much greater pace than other operating costs, companies and organizations across the US have been investigating ways to stay solvent while still staying competitive with respect to the rest of the market.

This paper investigates a test case loosely based on a real town government's struggle to make the best tradeoff between cutting health care benefits and retaining their workforce. In this test case, the town isevaluating changing from a low-deductible, higher-cost insurance plan to a high-deductible, lower-cost insurance plan. This change will affect current town employees, ranging from administration officials to fire fighters to teachers, etc., as well as retirees – a total of around 2,000 individuals and families. Despite layoffs, the town's costs have been rising at a rapid rate in large part due to health care cost increases. However, a major concern for the town is how a health care cut will affect its competitiveness in the market. The town is afraid that by changing this plan, it will encourage employees to start finding jobs elsewhere (in nearby towns or in the private sector) and will make it difficult to recruit new employees.

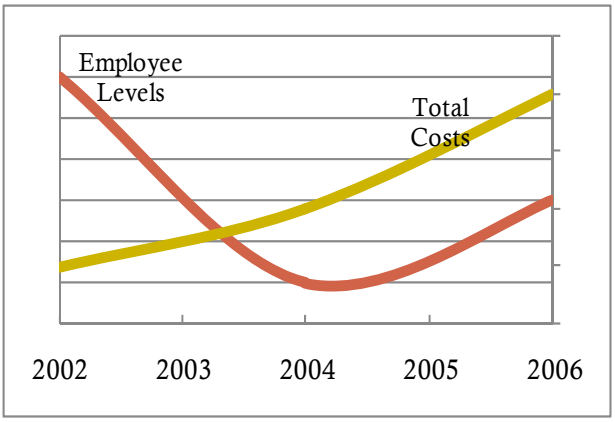

Figure 1 - Costs increasing despite reduced staffing

By making some approximations and modeling the various relevant cost value and yearly cost increase distributions as well as the likelihood of employees leaving the town, we attempt to simulate what the town's best decision might be. The decision options considered include:

1. Stay with the current high-cost plan
2. Immediately move to the low-cost plan
3. Start offering both plans and, when a critical percentage of employees enrolled in the low-cost plan is reached, drop the high-cost plan.

System Model Overview

As already discussed, one available option explores the possibility of expanding a town's health care offering from a high-cost offering to both a high- and low-cost offering and, at a given threshold, dropping the high-cost option. Given that employees may become disgruntled with the low-cost option and decide to quit because the effective total compensation package offered by the town is below what they could get elsewhere, there is a tradeoff between offering both options and retaining employees and offering only the low-cost option and losing employees.

The simulation focuses on minimizing the NPV over 6 years of the total cost of 1) paying employee salary, 2) paying employee health care, and 3) rehiring employees to replace those that have left.

In this problem, there are a large number of assumptions that determine the outcome of the simulation. These are broken up into four categories: salary, health care, town characteristics, and employee characteristics,

Salary

- The town currently pays an average salary of $70,170[1]
- The region's salary distribution was determined from real data and approximated by the inverse Gaussian distribution seen to the right with a mean of $71,680[2]

- Yearly salary changes in the town and the region are equal and will be determined by a log-logistic distribution found from historic yearly changes with a mean of 5%[3]

[1] Data from (Education n.d.)
[2] Data from (Education n.d.)
[3] Yearly changes were calculated from raw data from (Education n.d.)

Health Care

- The town currently supports a health care plan that costs $20,000 per employee[4]
- The region's average health care costs are $17,800 per employee[5]
- Market-wide health-care cost increases will be applied equally to the town and the region, where those increases are characterized by logistic distribution found from historic data with a mean of 8%[6]

- The low-cost plan costs 20% less than the high-cost plan[7]
- The percentage of employees on the high-cost/low-cost plans will determine the total cost of health care to the city. This percentage will change either by voluntary decisions by employees to enter the low-cost plan (enticed by lower up-front costs to the employee) or by dropping the high-cost option.

Town Characteristics

- The town has 2,000 employees[8]
- The town's discount rate is 4%[9]
- The cost for the town to rehire employees is $100,000/employee[10]

Employee Characteristics

- All employees are assumed to be the same. This implies they are paid the same salary and receive the same health care options
- The number of employees that would initially choose the low-cost plan as well as eventually jointhis plan is uncertain.
    - Estimates for initial entry into the low-cost plan are described by a Weibull curve with a mean of 22%[11], while

[4] Guessed from knowledge that the town had a premium plan even compared to other towns
[5] Data from (Agency for Healthcare Research and Quality n.d.)
[6] Historic data from (Agency for Healthcare Research and Quality n.d.)
[7] Guessed approximation
[8] True rounded value
[9] Assumed from typical public sector discount rates
[10] Guess based on manhours spent finding talent plus additional incentives to attract talent. Used a high value in the end in order to shift the outcome to a more dynamic result. With lower values, as discussed later, the best decision is always to only offer a low-cost healthcare option

  - the yearly change to that distribution is described by a normal distribution with parameters a mean of 3%[12]

- The number of employees quitting their jobs is dependent on where their expectation of the town's total compensation lies within the region's total compensation distribution, where "total compensation" is defined as the sum of the salary and health care costs.
  - Prior to dropping the high-cost plan, all employees will effectively calculate the town's total compensation with the better high-cost plan when comparing against the region's total compensation distribution
  - Once the high-cost plan is dropped, the percentage of employees already in the low-cost plan will effectively compare the region's total compensation against the town's total compensation as calculated with the high-cost health plan since they are equally satisfied with the low-cost plan as with the high-cost plan while the remaining employees will use the worse low-cost plan in their comparison.
  - The percentage of employees lost will be calculated by a weighted and scaled cumulative probability $P[tot\_comp_{TOWN} \geq tot\_comp_{REGION}(x)]$[13]

[11] Guessed
[12] Guessed
[13] Weights and scaling have both been guessed to achieve reasonable defection rates around 1-20% depending on total compensation disparities. The loss function used was MAX((1-RiskTarget(MarketValue,TownValue+ShiftValue)*ScaleFactor,0), where ShiftValue=10,000 and ScaleFactor=0.5

Evaluating the options

Four methods of evaluating the results were used:

1. Mean NPV of the total cost to the town
2. 5% value of the total cost NPV distribution
3. 95% value of the total cost NPV distribution
4. Total number of employees lost over 6 years – this value would be a good indicator of the more emotional aspects of changing the town's health care options

Mean NPV Evaluation

Table 1 - Mean NPV Results for Options

Percentage Threshold Criteria	Mean NPV Total Cost	Difference from best
0%	$1,387,910,000	$5,761,981
20%	$1,383,640,000	$1,496,328
25%	$1,382,610,000	$461,053
30%	$1,382,450,000	$301,293
40%	**$1,382,150,000**	**$0**
60%	$1,382,400,000	$254,288
80%	$1,382,520,000	$373,720
No flexibility (i.e. 100%)	$1,382,530,000	$381,130
Current Plan	$1,396,490,000	$14,347,735

From this metric, the best option seems to be to offer both plans and drop the high-cost plan when 40% of employees enroll in the low-cost plan. Compared to the current plan, this option would save around $14 million off the mean.

5% NPV Value Evaluation

Table 2 - 5% NPV Results for Options

Percentage Threshold Criteria	NPV (5%) Total Cost	Difference from best
0%	$1,356,000,000	$3,140,353
20%	$1,354,500,000	$1,638,569
25%	**$1,352,900,000**	**$0**
30%	$1,353,500,000	$628,454
40%	$1,352,900,000	$40,451
60%	$1,353,700,000	$844,222
80%	$1,353,600,000	$786,256
No flexibility (i.e. 100%)	$1,353,600,000	$786,256
Current Plan	$1,376,400,000	$23,582,953

From this metric, the best option seems to be to offer both plans and drop the high-cost plan when 25% of employees enroll in the low-cost plan. Compared to the current plan, this option would save around $23 million off the 5% distribution value.

95% NPV Value Evaluation

Table 3 - 95% NPV Results for Options

Percentage Threshold Criteria	NPV (95%) Total Cost	Difference from best
0%	$1,433,200,000	$4,780,042
20%	$1,430,500,000	$2,082,473
25%	**$1,428,400,000**	**$0**
30%	$1,429,800,000	$1,315,948
40%	$1,429,800,000	$1,314,718
60%	$1,430,500,000	$2,082,473
80%	$1,430,500,000	$2,082,473
No flexibility (i.e. 100%)	$1,430,500,000	$2,082,473
Current Plan	$1,443,500,000	$15,069,929

From this metric, the best option seems to be to offer both plans and drop the high-cost plan when 25% of employees enroll in the low-cost plan. Compared to the current plan, this option would save around $15 million off the 95% distribution value.

Total Employees Lost Evaluation

Table 4 - Total # Employees Lost for Options

Percentage Threshold Criteria	Total number of employees lost over 6 years
0%	1749
20%	1749
25%	1394
30%	1164
40%	**1135**
60%	**1135**
80%	**1135**
No flexibility (i.e. 100%)	**1135**
Current Plan	**1135**

From this metric, it seems that offering both plans and dropping the high-cost plan when 40-100% of employees enroll in the low-cost plan loses the same number of employees over the 6-year period as staying with the current high-cost plan.

Sensitivity Analysis

In order to validate the model's robustness, the mean total NPV was used as a qualifying metric and several assumptions were modified to see whether the best option changed.

Table 5 - Option Sensitivity Analysis

Assumption	Original Value	New Value	Best Resulting Option
All assumptions same	N/A	N/A	Dual plan – drop at 40%
Cost to rehire	$100K	$50K	Dual plan – drop at 0% (effectively only offer low-cost option)
Discount rate	4%	8%	Dual plan – drop at 40%
Low-cost plan cost difference	20%	10%	Dual plan – drop at 40%
Low-cost plan cost difference	20%	30%	Dual plan – drop at 50%
Employee loss function[14]	Scale by factor X1=0.5, Shift by value Y1=10,000	Scale by a different factor X2, Shift by different value Y2	Can shift along entire option spectrum of only offering low-cost option to offering both plans and not dropping at any time depending on new factors and values used to scale and shift the loss function.

From these tests, it seems that the rehiring cost and employee loss functions are two of the more critical assumptions to get right. The employee loss function is very difficult to emulate reality given human unpredictability.

[14]MAX((1-RiskTarget(MarketValue,TownValue+ShiftValue)*ScaleFactor,0)

Conclusions

From the various metrics, it seems that given the selected assumptions, the best option is some variant of offering both health care plans with the option of dropping the high-cost option when between 25% and 40% of the employees enroll in the low-cost plan.From the data, as a manager, I would personally select the 40% option since it both offers the lowest mean ENPV metric as well as the best more emotional metric of employees lost.

However, when looking at this option through lens of the mean ENPV metric and modifying some of the base assumptions, it becomes evident that the model is less than robust. Especially in a decision that has as much emotional weight and human psychology involved as this one – on health care – it is almost certain that the outcome will be different than the expected one.

That being said, while the exact best decision may not be clear at this point, it is clear that flexibility in shutting down the high-cost option by offering the low-cost plan in tandem is an economically beneficial decision.

Over the course of working on this project, I learned that it is not always appropriate to only use analytical tools to make decisions. It also became apparent that this analysis was somewhere in between a screening model and a full model in its complexity. With a little bit less effort, I could have come to the same conclusion that 1) the model is too dependent on assumptions which are pure guesses and which could vary significantly, 2) flexibility is worthwhile, and 3) decisions involving social dynamics require a large human element in the decision making process. Overall, however, the process got me to think about what type of decision-making aid is appropriate (e.g. simulation over lattice analysis, decision analysis, etc.) as well as what type of assumptions must be made in decisions of this complexity. These tools will certainly be useful to me in my future career.

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