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Integrating Wearable Fitness Data into Group Health Insurance Incentive Programs to Promote Cost Savings and Improve Policyholder Health

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ABSTRACT

In recent years, wearable fitness devices have changed the way people track and manage their health. Being able to accurately measure various data points relating to physical activity, personal health, and even sleep quality has given the modern consumer immense power over their well-being. However, research has found that many people stop using these devices shortly after they begin, limiting the positive impact this data could provide. Health insurance companies, who have both a moral and financial interest in the well-being of customers, could bridge the gap and ensure that this technology is utilized on a broader scale to promote health and well-being. This thesis examines the feasibility of incentive programs in group health insurance that offer premium discounts for meeting certain goals using wearable fitness devices. In this paper, a variety of factors are explored in a model to measure the impact of integrated incentive programs on cost savings in the group health insurance industry.

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Chapter 1

Introduction

For health insurance companies, bettering the health of their policyholders is an initiative that is both good for business and society, as a whole. Healthier policyholders means fewer trips to the doctor, fewer hospital visits, fewer medical operations, and fewer claims. Fewer claims means more profit for the insurance company, which is why companies often strive to improve the health of their members through various strategic initiatives. Health and life insurance companies have offered incentive programs for many years, giving policyholders reduced premiums for healthy behaviors like quitting smoking and buying healthy foods at the grocery store [1]. With the emergence of wearable fitness tracking devices in recent years, there is more opportunity than ever for health insurance companies to improve the health of their members and potentially help their business.

Group health insurance plans are purchased by employers and offered as a benefit to employees of the company. Generally, premiums are priced on an aggregate basis using the cumulative information of everyone in the group, and every member pays the same premium for the same level of coverage [2]. For any incentive program that health insurance companies use to improve the health of their policyholders, there has to be some reward to the policyholder for participating and meeting the stated goals. Usually, this incentive comes in the form of a premium reduction. Premium reductions can be carried out retroactively, in the form of a refund of premium at the end of the year, or proactively, by lowering the member's premium for the next year during the renewal process. Reducing premiums will cut into the health insurance

company's revenue, so there must be some tangible benefit to the insurance company to offer such a discount. While rewarding customers for healthy behaviors can have a tangible, positive impact on factors like brand image and customer loyalty, insurance companies also want to see a material impact on their bottom line in the form of reduced claim costs. For the purposes of this paper, only the direct financial impact of reduced claims costs will be examined.

For any premium-related incentive program offered by a health insurance company, the decrease in claims costs caused by the improved health of policyholders should outweigh the decrease in premiums collected caused by the discounts. If this is not the case, the incentive program would not be a sound business decision for the health insurance company and would likely not be offered as a part of group health insurance plans.

With the increased prevalence of wearable fitness tracking technology in recent years, there is more data readily available for individual consumers, healthcare providers, and insurance companies to utilize. Some insurance companies already offer rewards programs that incentivize healthy behavior, but these programs often have limitations and use simple data like steps, which does not necessarily correlate to improved health outcomes [3]. Existing incentive programs and their strengths, weaknesses, and early results will be discussed in more detail later in this paper. By leveraging the more advanced information available from wearable fitness tracking devices, incentive programs could potentially be integrated into the group health insurance industry specifically on a much broader scale. A properly designed incentive program could both increase the health and well-being of policyholders and improve the profitability of the insurance company. However, designing an incentive program that benefits all parties involved can be a difficult task, especially given the abundance of data available from wearable fitness technology and the variation from one group health plan to another.

This paper will examine the feasibility of integrating wearable fitness data into a group health insurance premium discount program. The next chapter will discuss group health insurance as a product and how premiums are typically calculated. Chapter 3 will elaborate on the rise of wearable fitness tracking technology and how it has evolved over the past several years, as well as its common uses. Following the chapters on this background information, a baseline model for calculating the fair premium for a group health insurance policy will be constructed, and the related assumptions will be discussed. Then, in Chapter 5, a health parameter – which can be obtained using data from wearable fitness trackers – will be defined. Then, this health parameter will be integrated into the previously built pricing model through an incentive program, and various assumptions will be tested and explored to determine the financial viability of integrating this data into a premium discount program. Finally, Chapter 7 will state the conclusions obtained from this exercise.

Chapter 2

Group Health Insurance

Group health insurance is a type of insurance where members of a group – typically employees of a company – receive coverage under the same plan. Group health insurance policies are usually purchased by companies, and coverage under the plan is offered to employees as a benefit. The idea of employer-sponsored health insurance began in the 1940's, as employers looked for ways to attract and retain workers in an era where wage growth was stagnant.

Health coverage under an employer-sponsored plan remains an attractive benefit for employees today for multiple reasons. First, employers will typically pay for a majority of each employee's premium cost, leaving only a portion of the premium to be paid by the employee themselves. Being part of a group health plan often means lower rates, as well. Especially in groups with many members, the risk to the insurance company is spread across more people, so the premiums will be lower than if each person purchased plans individually. Altogether, opting into a group health insurance plan offered by an employer is a very attractive option for an employee looking for health insurance coverage because costs will be much lower than if they were to seek to purchase coverage on their own.

Additionally, there are more options that add flexibility for employees as part of a group health insurance plan. Coverage can be extended to family members as a part of most plans, and in some cases, employees can choose from multiple tiers of coverage as a part of the plan. These added layers of flexibility allow employees to tailor the coverage they get through their employer to best meet their needs and the needs of their families [4]. The model discussed later in this paper will make some broad assumptions regarding these additional options for the sake of

simplicity, but noting that employees can have several options under the same group health plan is important to understanding this type of insurance. The specific assumptions used in this paper's model will be explored in a later section.

Another important aspect of group health insurance that makes it a unique product is the way it is priced. Premiums for group health plans are not calculated by looking at each individual employee and determining their specific risk. Rather, the entire employee base is examined as a whole, and the premium that is calculated is what all members of the group have to pay. Again, it is worth noting that in many cases, there are different levels of coverage offered as part of the same plan, with different premiums for each level based on the amount of coverage. However, in general, all employees will pay the same premium for the same type of coverage.

Factors that influence the premium for a given group health insurance plan include the average age of the group's members, the amount and type of coverage purchased, and the group's past claims history [2]. These factors are all aggregate measures of the entire group's collective characteristics. Because of the averaging effect that is caused by this type of premium calculation, group health insurance is especially attractive to individuals who consume a greater than average amount of healthcare.

Despite all the benefits that make this type of insurance so widely utilized, there are some drawbacks to group health insurance. First and foremost, because most group health insurance plans are employer-sponsored, if a person was to lose their job, they would also be at risk of losing their health insurance coverage. There are public options available to help bridge this gap, but the fact that coverage under the group plan is reliant on job security does pose a risk to individuals. Critics also state that employer-sponsored healthcare is a major contributor to the

fragmentation of the United States healthcare system as a whole, which is a major reason for the country's high healthcare costs and poor healthcare outcomes [5].

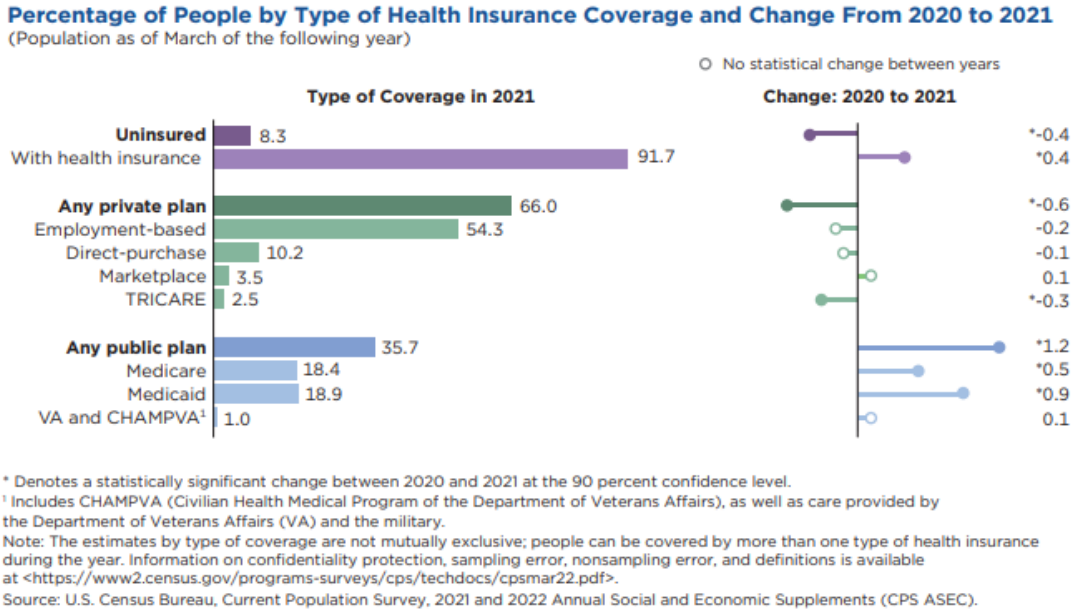

Figure 1: Health Insurance Coverage by Type (2021)

As seen in the Figure 1 [6], group health insurance is the most common type of health insurance in the United States, with 54.3% of the population being covered by employment-based insurance in the year 2021 [7]. There are some clear benefits to this type of insurance product; namely, lower costs and more flexibility for consumers. However, critics do have some complaints about the structure of employer-sponsored health insurance and its impact on the United States healthcare system as a whole. Regardless of what one might think about this type of insurance, it is the most popular form of health insurance in the United States, and it has a major influence on the country's healthcare system. Learning how to leverage the strengths of

group health coverage in a complex insurance marketplace could be an important tool to improve health outcomes in the United States.

Chapter 3

Wearable Fitness Technology and Existing Incentive Programs

The history of wearable fitness tracking technology in the U.S. begins in 2009, when an unknown company called Fitbit released its first product – the Fitbit Tracker. The Fitbit Tracker was nothing like the Fitbit products we know today. Instead of a watch-like device with a display and several options to track data, the original Fitbit was a small piece of plastic with a single screen that displayed a flower that grew as the user progressed towards their goal of 10,000 daily steps. Over the first few years after its initial release, the company continued to release new products. By 2014, the company had nearly two-thirds of the market share for the activity tracking industry, with more advanced trackers that synced to mobile apps, allowing users to log fitness statistics like walking distance and calories burned over time. Marrying the fitness tracking data from the wearable device with mobile apps that tracked food consumption and weight loss proved to be a powerful tool for consumers.

The trajectory of Fitbit and the fitness tracking industry as a whole changed dramatically when Apple introduced the first Apple Watch in 2015. While more enthusiastic runners and athletes remained loyal to Fitbit due to its advanced health tracking capabilities at the time, many consumers abandoned the activity tracker in favor of the more stylish and broadly functional Apple Watch. While later generations of the phone manufacturer's newest product prioritized health-oriented functionality, the original Apple Watch was marketed as more of a fashion accessory and complement to the iPhone, which appealed to the average non-athlete consumer. By 2017, Fitbit's stock had plummeted over 50% from when it first went public in 2015, and it seemed like the Apple Watch had fully taken over the functional wristwear space.

In 2017, Fitbit released its own smartwatch to compete with Apple. While the Fitbit Ionic and subsequent generations of the company's smartwatches did not boast the same app-based functionality and compatibility as Apple's product, they did represent an upgrade from previous Fitbit products. The Fitbit smartwatches were not only easier to use and more fashionable than the previous fitness trackers, but they offered a variety of new metrics that weren't available before. Some of the new features included stress sensing, goal-based exercise logging, water intake tracking, and weight management logging. Apple continued to add more fitness tracking capability to the Apple Watch in subsequent generations, and today it has many of the same features as the Fitbit smart watches [8].

In summary, wearable fitness tracking devices have been around for a while, but the technology has gotten increasingly advanced and precise over the past couple of years. Today, consumers have countless options to track their physical well-being beyond just Fitbit and Apple Watches. These devices can track several key health datapoints: from steps to resting heart rate to quality of sleep. This data gives consumers incredible power to measure and improve their physical health and well-being.

Despite the opportunity to positively impact health provided by the emergence of wearable fitness technology, a 2016 Gartner study found that 30% of users abandon using these devices within the first six months of use [9]. A 2021 paper from the International Journal of Information Management stated that "one possible explanation for this rate of abandonment is that the device is useful but fails to have a meaningful impact on users' behaviors and habits; in other words, the device is an object that provides data but does not inspire action" [10]. This sentiment is in line with the reasoning for why many users left Fitbit for the original Apple Watch in 2015. Having the data is a great resource, but the data alone does not provide enough of

a value proposition to users to outweigh other factors in areas beyond fitness like style or functionality [11]. The data needs to be paired with some form of inspiration or motivation to fully empower users to change their behavior and improve their health.

A 2016 study found that pairing Fitbit use with a cash incentive produced a significant increase in activity levels and device usage through six months [12]. If the data from wearable fitness tracking devices alone is not enough to inspire action for many users, a financial incentive could be the key to motivate users to stick with their use of technology and utilize it for the purpose of improving their health. A 2019 UnitedHealthcare national wellness survey found that "68% of Americans said that as little as $2 a day would motivate them to spend at least an hour a day improving their health" [13]. Health insurance companies could help provide this financial incentive, which could improve usage rates and motivate users to utilize their fitness data to become healthier.

Many life and health insurance companies already offer incentive programs that use some element of fitness tracking data. John Hancock's Vitality program offers users an Apple Watch for as little as $25 or an Amazon Halo smart watch completely free. Group members can then earn up to 25% off their life insurance premiums if they exhibit healthy behaviors [14]. Additionally, UnitedHealthcare's Motion rewards programs allows policyholders to receive over $1,000 of their premium back each year for completing daily activity goals like walking, running, or swimming, which are tracked through a complimentary fitness tracking device. Members of employer-sponsored health insurance plans through UHC are eligible to sign up for the program online, but it is not integrated on a broad scale across entire groups [15].

The overall effectiveness of wearable fitness tracking devices on achieving better health is still up for debate. A 2018 study from the Journal of Clinical and Experimental

Otorhinolaryngology found a statistically significant decrease in weight and BMI for users of a smartphone-based fitness tracking app when compared to a control group [16]. However, a 2016 study from the Journal of the American Medical Association found no change in long-term weight loss for users of wearable fitness devices [3].

Overall, research is conflicted, but specifically in the context of health insurance, existing incentive programs have shown effectiveness in improving the health of policyholders. For the previously mentioned UnitedHealthcare Motion program, the company has found that 70% of members increased their activity levels during the program, and 60% maintained those increased activity levels beyond six months. UnitedHealthcare also offers a managed weight loss incentive program called Real Appeal, and the company has found that 56% of at-risk members have been able to successfully lose weight through the program [13]. A 2021 study of the program found that it led to 12% lower medical costs for participants [17]. While a weight loss program is not a direct comparison to a program that integrates wearable fitness data, the results still show that incentive programs can successfully help lower medical costs and improve health. There is currently not much research on the cost-effectiveness of incentive programs at companies other than UnitedHealthcare, but the results of UHC's programs are a promising indicator that group health insurance can be a vessel to motivate positive lifestyle change and improved health.

Chapter 4

Group Health Insurance Pricing Model

For a baseline group health insurance pricing model, we will take the simplistic approach of calculating fair premiums as the total expected loss to the insurer divided by the number of members in the group. The model will examine one hypothetical group health insurance policy, offered by a company to its employees as a benefit. Various scenarios will be examined in Chapter 6 to test the viability of incentive programs under different conditions and assumptions. The baseline model discussed in this chapter will be called **Scenario 0**, and the expected aggregate loss and fair premium calculated in this scenario will be used as a baseline for comparison. The following assumptions will be used for the model.

1. **There are 500 members in the group:** The number of members in the group is largely irrelevant, but it is valuable for the model to be as representative as possible of a typical company that offers health insurance to its employees. As seen in Figure 2 [18], 99% of companies with 200 or more employees offer health insurance benefits to their employees. To be even more conservative, we will use a hypothetical company with 500 employees for our model.

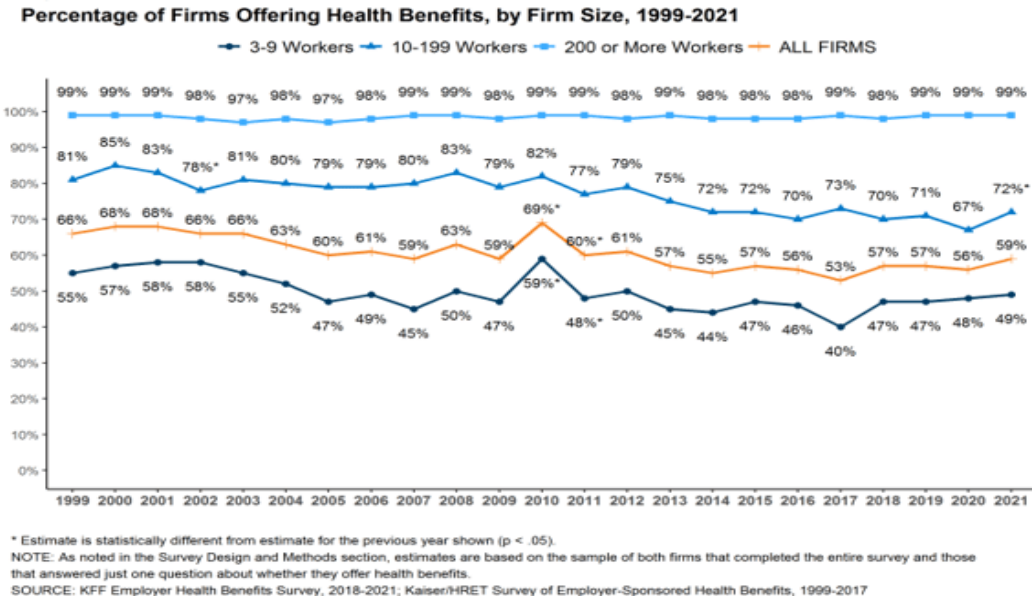

Figure 2: Employer-sponsored healthcare statistics

2. **All employees will opt-in to the group health insurance plan for themselves only. There will be no extension of coverage to family members:** While this assumption is not realistic, for the simplicity of this model, we will assume that only the individual employees will be covered under the company's policy. This assumption will create uniformity amongst group members, which will allow us to create a base model that can easily isolate the influence of integrated fitness tracking data, when introduced in later sections.
3. **There are no levels or tiers to the coverage offered under the plan. All employees will pay the same premium for the same coverage:** Again, we will make a simplifying assumption that all employees have the same coverage under the group plan. This assumption will serve the same purpose as the previous one – allowing us to create a simple base model where the impact of integrating fitness tracking data can be isolated and studied.
4. **Employers will pay for 80% of premiums, while employees will cover the remaining 20%:** A 2021 Kaiser Family Foundation study found that, on average, employers paid for

83% of employees' self-only insurance plans, leaving the employee to pay 17% of premiums for themselves [7]. Since we are assuming that all employees are purchasing coverage for themselves only, we will use an 80% to 20% employer to employee split to determine how much of the premium the employee is responsible for paying. This is an important piece of information because the discount offered by any incentive program will only apply to the employee's portion of the premium, since they are the one that is incentivized to improve their individual health. Despite not receiving any financial benefit from offering an incentive program to employees, including such a program is still attractive to employers because it enhances the value of their benefits package by offering employees complimentary fitness tracking devices and the potential to lower their premiums.

5. **All employees are equally healthy:** Again, this assumption is not realistic, but having uniformity in the health of all employees will allow us to use independent and identically distributed random variables to calculate the expected total loss for the group.

Understanding the behavior of the aggregate loss of the group is the main goal of this model. Finding some distribution for the aggregate loss will allow us to find a fair premium for this base model, and then explore the impact of multiple factors relating to the inclusion of wearable fitness device data in later sections. Comparing the total loss in that case to the total loss in this simplistic model will help illustrate any cost savings that are achieved by implementing incentive programs.

To model the aggregate loss random variable **S**, we will use a collective risk model with a compound distribution [19]. The primary distribution of the model will measure **N**, the claim frequency random variable. The secondary distribution of independent and identically distributed

random variables $\mathbf{X_1, \ldots, X_N}$, will measure claim severity. We will use the following distributions to model the frequency and severity random variables **N** and $\mathbf{X_i}$:

$$\mathbf{N \sim Negative\ Binomial\ (r = 500,\ \Theta = 0.2)}$$

$$\mathbf{X_1, \ldots, X_N \sim Pareto\ (\alpha = 3,\ \gamma = 3{,}600)}$$

Because we are using a compound distribution to model the aggregate loss random variable **S**, we can calculate its expected value simply, using the following formula:

$$\mathbf{E(S) = E(N) * E(X)}$$

Given the parameters for the primary and secondary distribution listed above, the expected total loss to the health insurer in this model (Scenario 0), can be calculated as follows:

$$\mathbf{E(N)} = (r * (1 - \Theta)) / \Theta = (500 * (1 - 0.2)) / 0.2 = \mathbf{2000}$$

$$\mathbf{E(X)} = \gamma / (\alpha - 1) = 3600 / (3 - 1) = \mathbf{\$1{,}800}$$

$$\mathbf{E(S)} = E(N) * E(X) = 2000 * \$1{,}800 = \mathbf{\$3{,}600{,}000}$$

The expected total loss to the insurer in this scenario is $3,600,000, as seen in the calculations above. The fair premium for this group policy can then be found using the following formula:

$$\mathbf{Premium} = 0.2 * (E(S) / n) = 0.2 * (\$3{,}600{,}000 / 500) = \mathbf{\$1{,}440}$$

The factor of 0.2 represents the 20% of the total premium that is covered by the employee. Again, we are only interested in examining this portion of the premium because the incentive only applies to the employee's portion of the premium, not the 80% that is covered by the employer. This fair premium tells us that every group member in this scenario would pay $1,440 out of their own pocket annually to be covered by their employer's health insurance. In our model, every employee receives the same exact coverage under the plan, as there are no levels of coverage or extensions of coverage to family members. The average employee dollar amount contributed towards health insurance premiums was $1,299 in 2021, according to the Kaiser Family Foundation, so our calculation of $1,440 is reasonable. Additionally, our model has employees covering 20% of premiums, whereas the $1,299 actual figure is based on an average contribution of 17%, so it makes sense that our premium is slightly higher than what was seen in reality [7].

The baseline model seen here in Scenario 0 is extremely simple and restrictive due to the many assumptions we had to make. Despite its simplicity and unrealistic nature, the model can still provide value as we compare it to incentive programs in other scenarios in later chapters. The purpose of this paper is focused on examining the feasibility of widely implemented incentive programs based on wearable fitness device data, so we are less concerned with the realism and exact specifications of the models used. The main focus in the coming chapters will be on remaining consistent in the basis and underlying assumptions of our model, and examining the relative impact of broadly adopted incentive programs on the frequency and severity of claims, as well as the profitability of the hypothetical health insurance company in the model.

Chapter 5

Choosing a Health Parameter from Fitness Tracking Data

As mentioned earlier, there are countless options for fitness tracking devices and smartwatches on the market today, and each one has an arsenal of statistics and data that can be used to track health. Because of the large amount of datapoints that are available to measure and track, designing an incentive program that maximizes its impact on group member health is difficult.

Existing rewards programs offered by life and health insurers commonly use metrics like steps and weight loss as incentives to get people healthier. However, these datapoints are flawed, as losing weight or taking a lot of steps does not necessarily translate to better health [12]. A person could reach their daily goal of 10,000 steps or show acceptable levels of physical activity on their fitness tracker every day but still eat an incredibly unhealthy diet and continue to see their physical state worsen. A person could lose weight in hopes of receiving a financial incentive, but if they lose weight too fast or become too thin, other health complications could arise. Additionally, someone who is overweight will have a much easier time losing weight than someone who is already at a healthy body weight, so using weight loss as a deciding factor for an incentive program lacks an element of fairness.

The ideal health parameter to use in an incentive program should have a couple of important characteristics to maximize its fairness and its overall impact. First, everybody should have a relatively equal chance of improving the parameter and subsequently earning the reward from the incentive program. While the purpose of premium discount incentive programs is to help people become healthier, and naturally, they are tailored towards individuals who are currently unhealthy, every member of a group health plan should have an opportunity to earn a

discount, regardless of their health status at the beginning of the period. Secondly, the health parameter used in the program should truly be a measure of overall health. The goal of an incentive program is to improve the health of members and decrease claim costs for the insurer. It is imperative that the metric at the heart of any rewards program actually has an impact on an individual's overall health.

There are several potential datapoints to choose from when integrating wearable fitness data into group health insurance, but with those two characteristics in mind, there is one health parameter that truly encapsulates the purpose of incentive programs: **Fitbit's Cardio Fitness Score.** The cardio fitness score is meant to quantify each person's relative cardiovascular health, and it is calculated through the user's resting heart rate and personal demographic information. Resting heart rate is one of the top determinants of overall health, and the cardio fitness score combines this metric with a user's personal information like age, gender, and weight to give a wholistic and relative view of overall health [20]. Figure 3 [21] shows the defined ranges for this health parameter, as well as an example of how it is shown on the Fitbit display.

Figure 3: Fitbit cardio fitness score example

The cardio fitness score is standard in all modern Fitbit smartwatches and fitness trackers. While using this metric does limit what products can be provided to group members as part of any program, there are still several options within Fitbit's product line that can be used to track this datapoint, so an element of choice still exists when creating an incentive program.

Regarding the important characteristics of the health parameter, the cardio fitness score satisfies both. Because the score uses personal information to gauge a user's starting point, every person has the opportunity to improve their score over the course of the rewards period. The score is relative too, so it is based on a user's comparison to others their age and gender, allowing all members of a group health insurance plan, regardless of those factors, to have a fair chance to meet the criteria and earn the discount. Additionally, the score is a great measure of overall health. Improving your cardio fitness score is a sound way to improve overall health, especially given that Fitbit knows the state of your health when you first started using the device

[20]. As mentioned before, resting heart rate is a great measure of both cardiovascular and overall health, and it serves as the basis for the cardio fitness score [22],[23].

Fitbit's cardio fitness score is a great health parameter to use for an incentive program for the reasons mentioned above. This paper will not make specific recommendations for how to design an incentive program around this measurement, but there are several options. Health insurers could offer a premium discount for group members that increase their score by a certain number of points or by a certain percentage. Additionally, rewards and discounts could be given to employees that move their score up a bracket, from average to good, for example. Regardless of the structure of the incentives, similar programs that already exist have shown the ability to lower medical costs and improve the health of members. By integrating a health parameter that has an even greater correlation to an individual's overall health than weight loss or activity levels, the impact could be far greater than existing programs.

Chapter 6

Integrating the Health Parameter into the Group Health Model

Equipped with a baseline group health insurance model and a reliable health parameter, the viability and cost-effectiveness of premium discount incentive programs can finally be evaluated. For this evaluation, there will be five scenarios, in addition to the baseline model (Scenario 0). For each scenario, three different cases will be examined: the ambitious case, the base case, and the conservative case. Table 1 describes the specifications used in each of these three cases.

Case	Impact on Frequency	Impact on Severity	Overall Impact on Expected Losses
Ambitious	Decrease 8%	Decrease 8%	Decrease 15.36%
Base	Decrease 6.5%	Decrease 6.5%	Decrease 12.58%
Conservative	Decrease 5%	Decrease 5%	Decrease 9.75%

Table 1: Frequency and severity impacts of the three examined cases

The reasoning behind the choices for these three cases is based on the study of the UnitedHealthcare Real Appeal program from 2021. The study found that the program decreased medical expenses by 12%, so a total impact on expected losses similar to that amount was used in the base case [17]. The ambitious and conservative cases were chosen so that the impacts on frequency and severity would be the same in either direction from the base case. It is highly likely that the actual impact of integrating the cardio fitness score would differ from the results of the weight loss program, in reality. However, given that resting heart rate and cardiac fitness levels are more tied to overall health than pure weight loss, it is reasonable to assume that a

program that incentivizes improving one's cardio fitness score will produce similar – if not better – results than a program that simply incentivizes weight loss [22]. Additionally, only about a quarter of the active participants in the UHC program lost 5% or more of their body weight, which was the threshold for premium reimbursement [17]. If the weight loss program could lead to a 12% reduction in medical expenses with less than 25% of active participants meeting the defined criteria for healthy weight loss, it is reasonable to assume a similar result could be achieved with a health parameter that allows all members to have a fairer chance of meeting the program requirements.

Before beginning the scenario analysis, there are additional assumptions pertaining to the incentive programs that must be addressed. All of the assumptions from the baseline model still apply, as well.

6. **The insurer will give a 25% discount to any members of the group that meet the program requirements:** A 25% premium discount is in line with most programs that already exist in the life and health industries [13],[14]. This discount is high enough to motivate users to act on the fitness data that is provided to them with their complimentary fitness tracking devices, but low enough that it doesn't drastically impact the insurer's revenue. The 25% discount used in this analysis is in no way a concrete recommendation of how an incentive program should be set up in reality, but rather a parameter for the model that was fixed at a certain level based on industry standards. This assumption will be modified in Scenario 5, but it applies for Scenarios 1 through 4.
7. **The cost to the health insurer to provide the wearable fitness tracking devices will be $100 per device:** Again, this price point is not a firm recommendation on how an incentive program must look in reality. Because the health parameter being used is the Fitbit cardio

fitness score, only Fitbit products can be used, which limited the potential options. The company offers several smartwatches and fitness trackers, all of which track cardio fitness score, so for this analysis, it is assumed we are providing group members with a Fitbit Luxe [24]. The Luxe sells for $130 on Fitbit's website, but because any health insurer who offered the product as part of an incentive program would likely be buying it in large quantities, it is reasonable to assume that the actual per unit price would be lower. In reality, other more expensive Fitbit products could be offered, but for this model, a per unit cost of $100 was used.

8. **A wearable fitness device will be provided to all group members:** In all of the following scenarios, it is assumed that every employee that is covered by the plan receives a complimentary wearable fitness device. Because there is no downside risk for the group members to have their premium raised due to poor health, it can be assumed that all members of the group, acting as rational consumers, will take the free product that is offered to them, even if they have no intention of making a concerted effort to reach the health goals established by the program. Given that there is no initial cost to the employee and by participating in the program, members have the chance to lower their premium, it can be assumed that all group members will at least take the free Fitbit that is offered. Because of this, the cost of providing the wearable fitness devices to the group members is a fixed cost in every scenario. No matter what proportion of employees legitimately make an effort to earn the incentive, the health insurer will always have to bear the upfront cost of providing the devices to all policyholders. In this model, the fixed cost to the insurer for providing the devices is equal to $50,000 (500 members at $100 each).

9. **Achieving the fitness goal of the incentive program affects every member's health identically, and the members who earn the incentive do not differ from those who do not earn the incentive in any way:** This assumption is not realistic, but for the simplicity of the model, we will assume that everyone is impacted the same way by improving their cardio fitness score. This will allow us to focus on the impacts to frequency and severity caused by the improved health of policyholders without abandoning our baseline model and point of reference from Scenario 0.

With an understanding of the additional assumptions for the modified models, we can now examine the first four of the five additional scenarios that were studied. The only element that changes in each of these four scenarios is the percentage of group members who are able to participate and earn the incentive. All of the group members will receive the free Fitbit, as previously mentioned, so this "participation" percentage is more of a reflection of the proportion of group members who are effectively motivated by the program and achieve the required improvement to cardio fitness score in order to earn the incentive. While some of these scenarios may not be too realistic, the goal of this initial analysis is to examine a spectrum of different levels of group member achievement and active participation to determine potential trends and see the overall financial viability of offering a premium-based incentive program to all group members.

Scenario 1

Scenario 1 involves all group members – after receiving their free Fitbit – actively participating in the program and achieving the fitness goal. 100% of members will improve their cardio fitness score, become healthier, and receive the premium discount.

Scenario 2

Scenario 2 assumes that 75% of the group members achieve the stated fitness goal of the program and earn the premium discount.

Scenario 3

Scenario 3 assumes that 50% of the group members achieve the stated fitness goal of the program and earn the premium discount.

Scenario 4

Scenario 4 assumes that 25% of the group members achieve the stated fitness goal of the program and earn the premium discount.

Each scenario was tested in R for each of the three previously mentioned cases (ambitious, base, conservative). The R code used to test these scenarios is found in the appendix. In the various scenarios, as the percentage of members that earns the incentive fluctuates, the reduction in claim frequency and severity for that individual case fluctuated in proportion. For example, the frequency and severity improvements used in calculations for Scenario 4 were 25% of those used in Scenario 1 because the "participation" rate in Scenario 4 was 25% of that in

Scenario 1. For each combination of scenario and assumption strictness, the following values were calculated:

- Expected total loss to the insurer
- Employee's hypothetical individual fair premium, at the reduced levels of frequency and severity specified by the individual scenario and case
- Cost to the health insurer of providing the incentive program (fixed cost of providing the wearable fitness devices and variable cost of premium reductions, based on the proportion of the group that earns the discount)
- Savings to the health insurer due to the reduced claims caused by the incentive program
- Net impact on the health insurer's revenue due to the incentive program (also referred to as net savings, equal to savings minus costs)
- Return on Investment (also denoted ROI, equal to net savings divided by the cost to the insurer)

The results of the scenario analysis are summarized in Tables 2 through 5, and the full output can be found in the appendix.

Scenario 1

Case	Expected Loss	Net Savings	ROI
Conservative	$3,249,000	$121,000	52.61%
Base	$3,147,210	$452,790	96.87%
Ambitious	$3,047,040	$322,960	140.42%

Table 2: Scenario 1 output

Scenario 2

Case	Expected Loss	Net Savings	ROI
Conservative	$3,335,063	$79,937	43.21%
Base	$3,257,556	$157,444	85.10%
Ambitious	$3,180,960	$234,040	126.51%

Table 3: Scenario 2 output

Scenario 3

Case	Expected Loss	Net Savings	ROI
Conservative	$3,422,250	$37,750	26.96%
Base	$3,369,803	$90,197	64.43%
Ambitious	$3,317,760	$142,240	101.60%

Table 4: Scenario 3 output

Scenario 4

Case	Expected Loss	Net Savings	ROI
Conservative	$3,510,563	($5,563)	(5.86%)
Base	$3,483,951	$21,049	22.16%
Ambitious	$3,457,440	$47,560	50.06%

Table 5: Scenario 5 output

As shown in Tables 2 through 5, most scenarios generated significantly positive ROI's. Only the conservative case of Scenario 4, which featured a 25% achievement rate and 5% reduction in frequency and severity of claims, resulted in a negative ROI. All other combinations

of scenarios and cases boast at least a 22.16% ROI. While some of the ROI's may seem outlandish and unachievable – especially given the many assumptions that were made throughout the process of constructing the model – it is worth noting that the study on UnitedHealthcare's Real Appeal program found that the 12% medical cost savings generated a 230% ROI for the company [17]. Compared to UHC's weight loss incentive program, the ROI's for even the most ambitious case seem like a relatively reasonable result.

Scenario 5

As mentioned earlier, Scenario 5 involves a modification of the 6th assumption in the model: **the insurer will give a 25% discount to any members of the group that meet the program requirements.** In the earlier analysis, we examined the impact of various rates of effective participation on the incentive program's cost savings and ROI, but we maintained that the discount offered through the program remained fixed at 25%, in line with industry standards. A more realistic and interesting scenario to examine, however, is one where participation rates are a function of the discount that is offered as part of the program. It makes sense that if a larger discount is offered, more employees will be motivated to achieve the goal of the program and earn the incentive. To model participation rate as a function of the discount that is offered by the health insurer, the following formula was used.

$$\mathbf{P = \ln(1.5d + 1),\ 0 \leq d \leq 1,}$$

where **P** = participation rate and **d** = discount

Figure 4 shows the relationship between the discount offered and the participation rate, according to the function defined above.

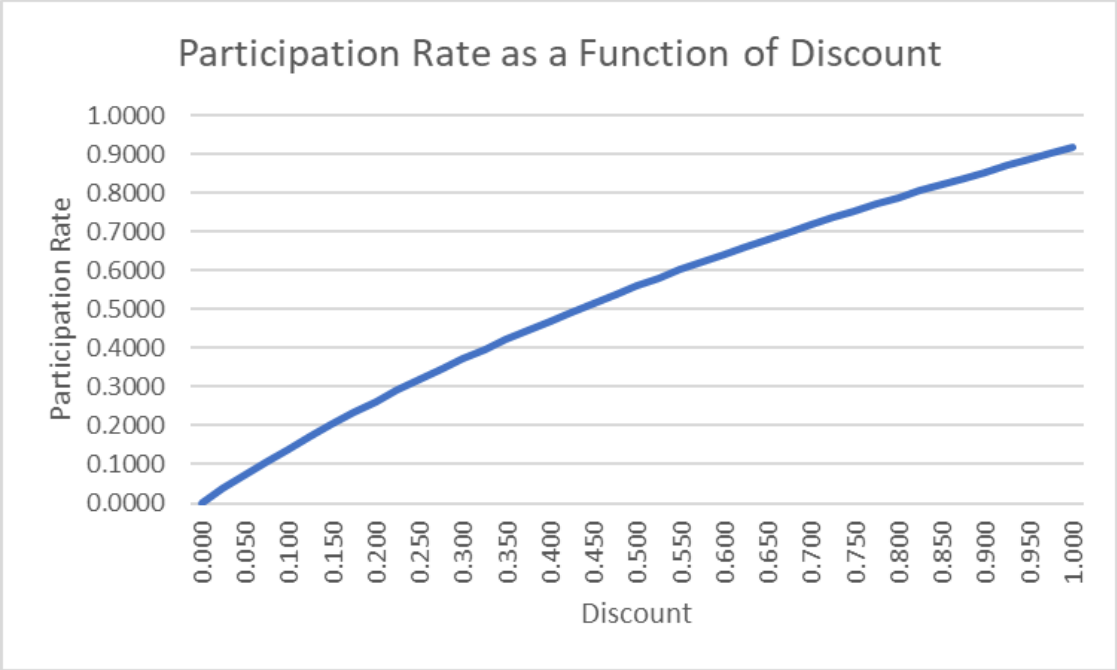

Figure 4: Graph of participation rate function

The function proves to be reasonable for this relationship for multiple reasons. First, P = 0 when d = 0. If no discount is offered, there is no incentive for members to participate in the program. Additionally, when d = 1, P = 0.9163. Essentially, even when a 100% discount is offered, only about 90% of members will achieve the program's health goals and earn the incentives. This assumption is realistic because even when offering the maximum possible discount percentage, it is unreasonable to expect every single group member to be able to meet the required criteria to earn the discount. Finally, recall the UnitedHealthcare survey that found that 68% of Americans would be motivated to improve their health by as little as $2 per day [13]. About $2.56 per day for an entire year would translate to a 65% discount on the original $1,440

premium calculated in the scenario with no incentive program. According to the function above, a 65% discount would produce a participation rate of 68.06%, in line with the results of UNH's survey.

For this scenario, two separate analyses were performed using Excel's Solver tool, each examining results in the three different cases used earlier. The first calculations found the discount percentage that maximized the health insurer's ROI for the incentive program. The results are summarized in Table 6.

Case	**Discount**	**Participation**	**Net Savings**	**ROI**
Conservative	21.44%	27.89%	$6,640.59	**7.14%**
Base	21.40%	27.84%	$36,216.37	**38.98%**
Ambitious	21.36%	27.79%	$65,565.54	**70.70%**

Table 6: Scenario 5 output, part 1 (maximizing ROI)

As seen in Table 6, nearly identical discounts and subsequent participation rates were achieved in all three cases. All three cases generated positive ROI's, but the ROI's did fluctuate heavily based on the assumptions regarding the effectiveness of improvements to frequency and severity of claims after the introduction of the incentive program.

The second set of calculations for this scenario involved finding the discount percentage that maximized the health insurer's net savings from the program, calculated as the savings from reduced claim costs minus the fixed cost of providing the wearable devices to group members and the cost of offering the discount to policyholders that earned the incentive. The findings are summarized in Table 7.

Case	Discount	Participation	Net Savings	ROI
Conservative	22.86%	29.49%	**$6,830.10**	6.93%
Base	28.97%	36.08%	**$41,630.03**	33.24%
Ambitious	34.76%	41.96%	**$82,628.44**	53.31%

Table 7: Scenario 5 output, part 2 (maximizing net savings)

When maximizing the net savings, ROI's were expectedly lower, but they all remained positive. Unlike the first calculation, the discount percentages varied significantly from case to case, with the conservative case maximizing its net savings at a 22.86% discount and the ambitious case yielding a 34.76% discount. It makes sense that the discount percentage that maximizes the health insurer's net savings would increase as the assumptions regarding the impact of frequency and severity of claims get more aggressive. If the company is expecting group member participation to have a relatively high impact on the number and amount of claims, it follows that they should try to incentivize more members to participate in the program by offering a higher discount.

Scenario 5 broke from the previous four scenarios by treating discount rate as a variable and modelling group member participation as a function of the discount that was offered. In both of this scenario's analyses, the incentive program generated positive ROI's and an overall net savings for the health insurance company, just like almost all of the cases from Scenarios 1 through 4. While the models of this paper feature many unrealistic simplifying assumptions, the results of this scenario analysis show that incentive programs can be a financially viable way for group health insurers to help improve the health of their members.

Chapter 7

Conclusion

Summary and Interpretation of Results

The largely positive return on investment generated for health insurance companies in the previous chapter's scenario analysis serves as proof that incentive programs can certainly achieve their purpose of improving the health of policyholders and bettering the insurer's business. Existing programs have shown many positive results in helping people lose weight, be more active, and reduce their medical expenses. However, these established incentive programs are not integrated into the group health insurance industry on a broad scale. The wearable fitness devices that allow members to participate in these programs are not automatically given to members of participating groups. Instead, individual members of the group are responsible for finding their way to the incentive program and signing up to participate.

The numerical analysis in this paper shows that higher participation in these programs leads to both improved member health and increased cost savings and return on investment for the health insurer that offers the program. Even when the health insurer bears the full up-front cost of supplying every member of participating groups with a wearable fitness device, net savings and ROI were positive in almost all cases. In the scenario where participation rates were a function of the discount offered to the employees, the study found that more conservative assumptions regarding the impact on the frequency and severity of claims led to a lower ideal participation rate. Even in the most conservative case, however, the incentive program still generated positive net savings and ROI for the insurer. Integrating these incentive programs into the group health insurance industry on a broader scale could boost member participation, which can help improve the health of employees and reduce costs for insurance companies.

In an era where health and healthcare are struggling in the United States, more action must be taken to promote better health and reduce healthcare costs. The results of the scenario analysis show that higher participation and accomplishment in the incentive programs lead to higher ROI's for the health insurance company, in addition to the fact that more people are improving their health along the way. By integrating a wholistic health parameter like Fitbit's cardio fitness score into a rewards program, health insurance companies can be the catalyst for a new wave of fitness. A well-designed premium discount incentive program has the power to improve the health of individuals by giving them the financial motivation they need to utilize today's powerful fitness tracking technology for their own good. A program like this also can reduce the burden of healthcare costs on insurance companies and the healthcare system as a whole, which could lead to lower premiums, cheaper healthcare, and better outcomes in the future.

Limitations, Weaknesses, and Opportunities for Further Research

While the early results of existing incentive programs are positive and the conclusions drawn from the scenario analysis in this paper are encouraging, there are some limitations to the work that has been discussed in this thesis. As mentioned throughout the paper, several simplifying assumptions were made that restrict the real-world applicability of the results of this analysis. Namely, we assumed that the health and results of each group member were uniform, individuals only purchased coverage for themselves, and there were no tiers to the coverage. All of these assumptions detract from the realism of the model used in this paper. Additionally, due to the lack of data on the impact of resting heart rate or cardio risk score on the frequency and severity of claims, more assumptions had to be made based on the UnitedHealthcare weight loss

program results, which may not necessarily align with the impact of a hypothetical incentive program based on resting heart rate.

All of these factors can be seen as limitations or weaknesses with this model, but they are also opportunities for future research. The field of wearable technology is continuing to evolve, and as insurance companies, healthcare providers, and individuals continue to learn how to make the most of an avalanche of fitness data, there is tremendous opportunity to grow and improve. From learning exactly how changes in resting heart rate impact health insurance consumption to increasing the model's complexity by removing some of the simplifying assumptions, there are countless ways to expand on this research. The power of wearable fitness data has been well documented throughout this paper. As the knowledge base surrounding this subject continues to grow, so will the opportunities to create a healthier country, and through incentive programs, health insurance companies have the chance to be at the forefront of that movement.

Appendix

Model Code and Output

```
#Define parameters

n = 500 #number of members in the group


r = 500 #input parameter for N ~ NegBin in cases 0-4

theta = 0.2 #input parameter for N ~ NegBin in cases 0-4

alpha = 3 #input parameter for X ~ Pareto in cases 0-4

gamma = 3600 #input parameter for X ~ Pareto in cases 0-4


freq_improv = 0.08 #improvement to frequency based on improved health of members

sev_improv = 0.08 #improvement to severity based on improved health of members


discount = 0.25 #amount of discount given for reaching incentive

wearable_cost = 100 #cost to provide each wearable device to a group member



#Scenario 0: Base model without wearable fitness data or incentives

EN_0 <- r*(1-theta)/theta

EX_0 <- gamma/(alpha-1)

ES_0 <- EN_0 * EX_0

prem_0 <- 0.2*(ES_0/n)
```

```
ES_0

prem_0



#Scenario 1: All group members participate and earn the incentive

r1 <- r * (1 - freq_improv)

gamma1 <- gamma * (1 - sev_improv)

EN_1 <- r1*(1-theta)/theta

EX_1 <- gamma1/(alpha-1)

ES_1 <- EN_1 * EX_1

prem_1 <- 0.2*(ES_1/n)


cost_1 <- n*prem_0*discount + n*wearable_cost

savings_1 <- ES_0 - ES_1

net_rev_change1 <- savings_1 - cost_1

ROI_1 <- net_rev_change1/cost_1


ES_1

prem_1

cost_1

savings_1

net_rev_change1

ROI_1
```

```
#Scenario 2: 75% of group members participate and earn the incentive

r2 <- r * (1 - 0.75*freq_improv)

gamma2 <- gamma * (1 - 0.75*sev_improv)

EN_2 <- r2*(1-theta)/theta

EX_2 <- gamma2/(alpha-1)

ES_2 <- EN_2 * EX_2

prem_2 <- 0.2*(ES_2/n)


cost_2 <- 0.75*n*prem_0*discount + n*wearable_cost

savings_2 <- ES_0 - ES_2

net_rev_change2 <- savings_2 - cost_2

ROI_2 <- net_rev_change2/cost_2


ES_2

prem_2

cost_2

savings_2

net_rev_change2

ROI_2
```

```
#Scenario 3: 50% of group members participate and earn the incentive

r3 <- r * (1 - 0.50*freq_improv)

gamma3 <- gamma * (1 - 0.50*sev_improv)

EN_3 <- r3*(1-theta)/theta

EX_3 <- gamma3/(alpha-1)

ES_3 <- EN_3 * EX_3

prem_3 <- 0.2*(ES_3/n)


cost_3 <- 0.50*n*prem_0*discount + n*wearable_cost

savings_3 <- ES_0 - ES_3

net_rev_change3 <- savings_3 - cost_3

ROI_3 <- net_rev_change3/cost_3


ES_3

prem_3

cost_3

savings_3

net_rev_change3

ROI_3



#Scenario 4: 25% of group members participate and earn the incentive

r4 <- r * (1 - 0.25*freq_improv)
```

```
gamma4 <- gamma * (1 - 0.25*sev_improv)

EN_4 <- r4*(1-theta)/theta

EX_4 <- gamma4/(alpha-1)

ES_4 <- EN_4 * EX_4

prem_4 <- 0.2*(ES_4/n)


cost_4 <- 0.25*n*prem_0*discount + n*wearable_cost

savings_4 <- ES_0 - ES_4

net_rev_change4 <- savings_4 - cost_4

ROI_4 <- net_rev_change4/cost_4


ES_4

prem_4

cost_4

savings_4

net_rev_change4

ROI_4
```

Scenario	Case	Total Expected Loss	Employee's Fair Premium	Total Cost of Program	Savings due to Program	Net Change in Revenue	ROI
0	Ambitious	$3,600,000	$1,440.00	-	-	-	-
0	Base	$3,600,000	$1,440.00	-	-	-	-
0	Conservative	$3,600,000	$1,440.00	-	-	-	-
1	Ambitious	$3,047,040	$1,218.81	$230,000	$552,960	$322,960	140.42%
1	Base	$3,147,210	$1,258.88	$230,000	$452,790	$222,790	96.87%
1	Conservative	$3,249,000	$1,299.60	$230,000	$351,000	$121,000	52.61%
2	Ambitious	$3,180,960	$1,272.38	$185,000	$419,040	$234,040	126.51%
2	Base	$3,257,556	$1,303.02	$185,000	$342,444	$157,444	85.10%
2	Conservative	$3,335,063	$1,334.03	$185,000	$264,937	$79,937	43.21%
3	Ambitious	$3,317,760	$1,327.10	$140,000	$282,240	$142,240	101.60%
3	Base	$3,369,803	$1,347.92	$140,000	$230,197	$90,197	64.43%
3	Conservative	$3,422,250	$1,368.90	$140,000	$177,750	$37,750	26.96%
4	Ambitious	$3,457,440	$1,382.97	$95,000	$142,560	$47,560	50.06%
4	Base	$3,483,951	$1,393.58	$95,000	$116,049	$21,049	22.16%
4	Conservative	$3,510,563	$1,404.22	$95,000	$89,437	-$5,563	-5.86%

Table 8: Scenarios 0-4 full output

Parameter	Conservative	Base	Aggressive
Discount	21.44%	21.40%	21.36%
Participation	27.89%	27.84%	27.79%
Frequency Improvement	5.0%	6.5%	8.0%
Severity Improvement	5.0%	6.5%	8.0%
Savings from Program	$99,703.33	$129,118.95	$158,308.34
Costs from Program	$93,062.74	$92,902.58	$92,742.81
Net Change in Revenue	$6,640.59	$36,216.37	$65,565.54
ROI	**7.14%**	**38.98%**	**70.70%**

Table 9: Scenario 5, part 1 full output (maximizing ROI)

Parameter	Conservative	Base	Aggressive
Discount	22.86%	28.97%	34.76%
Participation	29.49%	36.08%	41.96%
Frequency Improvement	5.0%	6.5%	8.0%
Severity Improvement	5.0%	6.5%	8.0%
Savings from Program	$105,370.03	$166,887.48	$237,633.95
Costs from Program	$98,539.93	$125,257.45	$155,005.51
Net Change in Revenue	**$6,830.10**	**$41,630.03**	**$82,628.44**
ROI	6.93%	33.24%	53.31%

Table 10: Scenario 5, part 2 full output (maximizing net savings)

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EXPERIENCE

Reliance Standard Life Insurance — **Philadelphia, PA**
Actuarial Valuation Intern — June 2022 – October 2022

- Won the company's "Shark Tank" business pitch challenge, consisting of interns from all departments, with a presentation focused on improving cross-departmental communication and collaboration
- Ran quarter-end LTD recovery rate tests in R and analyzed the results in a presentation to senior leaders
- Performed sensitivity tests for 3 risk models and summarized results in a report to non-actuarial personnel

Munich Re U.S. Life — **New York, NY**
Individual Life Pricing Intern — June 2021 – August 2021

- Enhanced existing pricing tools using VBA, allowing the tools to quickly process over 100,000 rows of policy-level data from clients, compared to 20,000 before the update
- Used Excel to analyze client data and examine client underwriting logic, allowing our team to quickly price multiple reinsurance deals and provide quotes to clients
- Collaborated with fellow interns to research and present on the business implications of Covid-19

INVOLVEMENT & SKILLS

Actuarial Science Club

- Director of Finance — January 2021 – January 2022
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- Student Mentor — January 2021 – Present
  - Provided academic and career guidance to multiple undergraduate students

Teaching Assistant, Risk Management 214 — August 2021 – May 2022

- Prepared and delivered lectures to students, prepared and graded homework and exams

Sigma Pi Fraternity, Theta Chapter

- THON Alternative Fundraising Chair — February 2021 – February 2023
  - Planned, organized, and lead several fundraising events for Penn State THON, growing our fundraising total from $88,000 to $274,000 over three years
- Academic Chair — April 2021 – Present
  - Organized academic programs to promote scholarly achievement within the chapter, leading to a 3.62 cumulative GPA, 2nd among Penn State fraternities
- Standards Board Chair — January 2022 – May 2022
  - Established a standardized process for the handling of internal chapter incidents

Penn State Consulting Organization — August 2020 – May 2021

- Learned important teamwork and problem-solving skills relevant to consulting and other industries by participating in a case competition and various other educational exercises

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