Chapter 3

**Optimization: Doing the Best You Can**

# Questions

1. Are people, households, businesses, and governments always exercising their optimal choice when making decisions?

*Answer*: Economists don’t assume that people are always successfully optimizing. However, they believe that they try to optimize given the available information. These economic agents are not perfect optimizers and their decisions are not always optimal because optimization is usually not easy. For example, a student has one week to prepare for two exams. He decides to allocate 3 days to the first exam and 4 days to the second exam. According to the student, this is the best allocation of time, which may or may not be the optimal choice.

1. How is optimization used to predict economic or business outcomes?

*Answer*: As stated in the chapter, “whatever choices people face, economists believe that they will choose optimally.” This means that ideally people will be consuming products or making economic or business decisions based on all available information, and by weighing these decisions against each other. Through seeking and providing advice, economists and business leaders can attempt to make optimal decisions by quantifying the effect of future decisions in order to gauge possible outcomes before the decision is finalized. With the help of optimization, they can not only predict what might happen but also why it will happen. Using input from various data sets, optimization, when implemented correctly, can have a large impact on how businesses make decisions. This is done by providing a scope for analysis of a number of areas—production, schedules, and inventory—and ensuring that the right products and services are put out in the market at the right time, which in turn will help optimize the experience of the consumers. This is the reason behind the success of websites that are used to compare identical or similar products and their prices, since they help make informed decisions regarding what to consume. Economic and business decision makers certainly hope that consumers do use optimization when consuming; therefore, when a product (such as an iPhone) is more expensive, people can be convinced that it offers more/better services.

Students should note that efficient optimization requires time—initially people will struggle to choose for instance the best products, however with time, they will learn from their mistakes and optimize better.

1. Suppose your workplace does not have a cafeteria. To grab a hot lunch you have to go out during your lunch break. You have two options: an expensive restaurant that is two minutes away or a cheaper one that is ten minutes away. Does picking the one that is ten minutes away necessarily imply that you are optimizing?

*Answer*: Not necessarily. You only have a 30-minute lunch break and you are spending 20 minutes of this in getting to the restaurant, almost devouring your food because of lack of time, which in turn, impacts your health. Also, if the opportunity cost of not working but eating is high (for instance because you need the money, you are closing in on a deadline, or you have a meeting coming up soon), then the optimal decision may be to save some time and eat at a location that is closer to your office.

1. Why does a change in one’s opportunity cost of time imply a change in one’s optimal apartment location?

*Answer*: When the opportunity cost of time is lower there is a lower cost to traveling a large distance to get to work and social activities. Thus somebody with a lower opportunity cost of time is likely to care less about where they live, and thus probably live farther from the places that he or she frequently visits. On the flip side, people who value their time greatly are more likely to pay a premium to live close to work.

1. Suppose you are trying to open a store at a local shopping mall. There are two open spaces: one is on the ground floor near the entrance; the other is on the topmost floor. Both spaces are identical in size, but the rent for the ground floor space is almost twice the rent for the top floor space. You choose the store on the top floor. Is your decision optimal? Explain.

*Answer*: The answer depends on a number of factors which include:

How frequented is the shopping mall? If this is the only one in your city, then you can presume you will have enough customers visiting stores on the top floor as much as they would the others.

Are you selling (luxury) goods that no one sells in the mall? If your answer is yes, then it does not really matter where you are located. If you are selling a product in demand it does not matter where you are located.

Is there a food court or a multiplex next to you? If yes, once again you have made an optimal decision by choosing to be located on the top floor. Otherwise you might have to make careful calculations whether the extra rent you have to pay on the ground floor can be offset by your increased sales.

Consider this example. The shop did not lose too many customers because of not being located on the ground floor, thus it makes sense saving on rent cost. For reasons why they profited by being located on the top floor see some examples below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Rent/month | Average spend by customers | Average number of customers | Total revenue | Total profit |
| Top Floor | $20,000 | $100 | 800 | $80,000 | $60,000 |
| Ground floor | $40,000 | $100 | 900 | $90,000 | $50,000 |

1. There is a proverb “anything worth doing is worth doing well.” Do you think an economist would agree with this proverb?

*Answer*: Probably not (unless this economist is one of your parents). An economist is likely to tell you that you should follow the Principle of Optimization at the Margin and that you should do something well only if the marginal benefits of doing it well are at least as large as the marginal costs. Suppose you are thinking of painting your room and you have three options: decide not to paint, paint but do a sloppy job, or paint and be meticulously careful. An economist would tell you to paint your room carefully if the marginal benefit of being careful (i.e., the difference between how your room would look if you are careful and how it would look if you are sloppy) is at least as large as the additional cost of painting carefully. Remember that because of scarcity, we cannot have everything we want. Suppose you get 95% of the benefit from painting your room to perfection while doing a sloppy job. The additional 5% in benefits from striving for perfection may well cost more than it is worth, in terms of alternative uses for your time.

1. Economists like using marginal analysis to illustrate a point. Suppose you have been working very hard and are considering taking a vacation. Use marginal analysis to illustrate how you would approach taking (i) one additional day and (ii) one additional week of vacation.

*Answer*:

(i) Suppose that you have been working hard and you need a vacation, but you cannot decide whether to go for 3 or 4 days. By using marginal analysis, you can get an approximation on whether that extra day of vacation is going to make you more relaxed and ready to work.

(ii) However, if you are overworked it probably does not make any difference whether you take 3 or 4 days—the question should be whether to take 1 or 2 weeks, instead. Using our previous analysis, we can also calculate whether an extra week of holiday is going to make us more relaxed. The answer is still yes, but by a far smaller margin than in the case of a 3- versus a 4-day holiday.

The textbook will refer to similar examples as diminishing marginal returns.

1. Define optimization in differences and optimization in levels. Do they yield the same result?

*Answer*: Optimization in levels calculates the total net benefit of different alternatives and chooses the best one. Optimization in differences calculates the change in net benefits when a person switches from one alternative to another and then uses these marginal comparisons to choose the best alternative. Optimization in difference and optimization in level give identical results.

1. A normative model answers optimization questions like what is the optimal way of solving things. Why do you think economists are being taught early on about normative models and optimization?

*Answer*: Economics and business is about not having infinite resources. This means that in order to maximize our benefits (such as utility, income, and happiness) we have to give up some of our goods. For instance, the textbook mentions the tradeoff in terms of rent and travelling time between the city center and the outskirts. Economics is about choices and decisions. The sooner people start thinking in terms of “what could be the benefit of an extra unit of investment or expenditure,” the easier it will be to make optimal decisions in terms of cutting back on investments in an industry if there are no more benefits to be obtained, or increasing their investment if there is still an option for extra income.

# Problems

1. Suppose you are making two different decisions: the first decision is to buy a financial stock. The second decision is to buy a good to consume. Identify how you would behave in each decision so as to optimize your choice. Does optimal choice always mean obtaining the highest values?

*Answer:* When you buy a financial stock, you optimize your choice by balancing the risk of the stock with its benefits. When you buy a good for consumption purposes, you optimize your choice by maximizing your satisfaction from this consumption. In both cases, you are optimizing. Optimizing does not mean always obtaining the highest values at all times. In the first decision, minimizing the risk means that you are buying the stock with the lowest value of risk relative to a given level of benefit. However, in the second decision you are seeking highest value of utility.

1. Suppose you applied to three jobs and are accepted for all three. Considering all factors:
2. How would you make an optimal decision on which job to choose?
3. The jobs that you have applied for only require a Bachelor’s degree; however, you may wish to pursue your Masters. How can you make an optimal decision on whether to work or continue your studies?

*Answers:*

1. Some of the factors to consider are:
2. Wages to be paid by the employer.
3. Working conditions such as office space, whether it is clean or not.
4. Number of vacation days being offered.
5. Is the employer offering health insurance or pension contribution?
6. Potential job satisfaction and growth.
7. Potential difficulty of the job and how much work is expected from you.

To make an optimal choice, you need to look at the total benefits from the three jobs. You also need to calculate what sort of commitment is required from you and whether that aligns with the compensation. You should then choose the job that offers you the maximum net benefit.

1. This partially depends on your opportunity costs as well as how you see your future. For instance, you will have to decide which one has the higher opportunity cost for you: having a job and not studying, or studying but not having a job? Your opportunity cost can depend on for instance whether you are being supported by your family, or whether you wish to indebt yourself with a student loan or not. There is a third option: many universities offer part-time Master’s degrees, which means you can study and work at the same time. In this case, you are sacrificing your free time, in order to get a better education.
2. Determine if the following statements use optimization by total values or optimization by marginal analysis.
3. Kelly is working as an administrator at a university. The university is now facing the decision whether to launch a new bachelor’s and a new master’s programme. The expected net benefit of the bachelor’s programme is €100 thousand, whereas that of the master’s programme is €80 thousand.
4. Jan is living in New Jersey but frequently travels to Europe for work. He has three major airline loyalty schemes to choose from: Star Alliance, Sky Team, and One World. Assuming that Star Alliance offers the best services onboard (net benefit is $100 per trip), Sky Team the best prices (net benefit is $80 per trip), and One World the fastest planes (net benefit is $60 per trip), which option should Jan pick? Which optimization strategy is he using?
5. Megan is thinking about buying a car. She likes fast sports cars and is considering buying either a Nissan Skyline or a BMW M3. The Nissan Skyline was featured in many movies and, should she drive it, she hopes that everyone will think of her as being cool. On the other hand, buying a BMW M3 is probably going to be less expensive. She also assigns net benefits to both cars: $1,500 for the Nissan and $1,200 for the BMW. Which strategy is she using?
6. Justin is thinking about buying a yacht for one of the Great Lakes in Canada. One of the biggest decisions when selecting yachts for purchase is how large the cabin area is. An extra 5 square meters would mean two additional bunk spaces and an extra cost of $5,000. Which strategy is in use?.

*Answers*:

1. This is an example of optimization by marginal analysis. What is the net benefit of having one or two new educational programmes, is the question being considered here.
2. Jan should be taking the Star Alliance operated flight as this has the highest net benefit for him. He is also using optimization by total values.
3. This is an example of optimization by total values. For Megan, the benefit of driving a car which is famous is higher than the cost of purchase.
4. Justin is using marginal analysis by looking at the increase of square meters. An extra square meter on the boat will cost an additional $1000.
5. Pascal is taking three courses this semester: economics, calculus, and statistics. Pascal’s goal is to maximize his average grade on the three term exams. Using optimization in marginal analysis, help Pascal decide how much time to spend studying for each exam if he has only one day in total to prepare for the three exams. How should he allocate that day across the three subjects? Repeat the analysis assuming that he has two days in total to prepare. Finally, repeat the analysis assuming he has three days. Note: Pascal can only choose to study in increments of one day. Results are given from 0 to 100, where 0 is the worst and 100 is the best grade. He must achieve at least 50 to pass an exam, and he must pass all exams.

|  |  |  |  |
| --- | --- | --- | --- |
| Days of Study | Economics | Calculus | Statistics |
| 0 | 60 | 45 | 50 |
| 1 | 65 | 50 | 52 |
| 2 | 69 | 52 | 57 |
| 3 | 75 | 60 | 62 |

*Answer*:

|  |  |  |  |
| --- | --- | --- | --- |
| Days of Study | Economics | Calculus | Statistics |
| 0 to 1 | 5 | 5 | 2 |
| 1 to 2 | 4 | 2 | 5 |
| 2 to 3 | 6 | 8 | 5 |

The table above contains the marginal differences for each and every day of extra study. If Pascal had just one day, it might seem that he had options between the three subjects, however in reality without studying he would fail in calculus. Therefore, his first day of study should be in calculus. Now that Pascal is passing all exams, you can decide on maximizing GPA. The options are overall: study 1 day of economics (grade change of 5), study 1 extra day of calculus (grade change of 2), or study statistics (grade change of 2). The highest improvement can be achieved by studying economics.

So, the first day is being spent on calculus, the second on economics. The third day marginal improvements are the following: an extra day at economics (grade change of 4), extra day of calculus (grade change 2), and an extra day of statistics (grade change 2). Once again Pascal’s best option would be to study economics.

Therefore, Pascal’s final results will be economics: 69; calculus: 50; statistics: 50. Grade average will be: 56.3, which is quite low. Maybe Pascal should have spent more time in university than with his personal life.

1. Richard has begun running to improve his health. The first column lists the distance he is jogging in meters, the second column the total benefits in U.S. dollars.

|  |  |  |
| --- | --- | --- |
| Meters ran | Total Benefit | Marginal Benefit |
| 0 | 0 | — |
| 500 | 40 |  |
| 1000 | 100 |  |
| 2000 | 200 |  |
| 3000 | 320 |  |
| 4000 | 420 |  |
| 5000 | 490 |  |
| 6000 | 540 |  |
| 7000 | 550 |  |

1. Find the marginal benefit, the opportunity cost, and the net benefit for each distance.

b. Being a busy lawyer, Richard cannot run as much as he would like to every day. He can run 1,000 meters in 10 minutes and the opportunity cost of an hour spent running is $600. What is the optimal distance to run for him?

*Answer*:

1. The marginal benefit for running each week are shown in the table below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Meters ran | Total Benefit | Marginal Benefit | Opportunity cost | Net benefit |
| 0 | 0 | X | 0 |  |
| 500 | 40 | 40 | 50 | –10 |
| 1000 | 100 | 60 | 100 | 0 |
| 2000 | 200 | 100 | 200 | 0 |
| 3000 | 320 | 120 | 300 | 20 |
| 4000 | 420 | 100 | 400 | 20 |
| 5000 | 490 | 70 | 500 | –10 |
| 6000 | 540 | 50 | 600 | –60 |
| 7000 | 550 | 10 | 700 | –150 |

1. 1) marginal benefit approach: If Richard is completing 1,000 meters in 10 minutes, then the opportunity cost of 1,000 meters of running is $100. His marginal benefits are low at the beginning, which is if he stops running after 500 meters than it was not worthwhile and should not have even started. The marginal benefits will equal the opportunity cost at 2,000 meters and 4000 meters. However, running an extra kilometer can provide higher benefits than costs from 2,000 meters. Therefore, the optimal distance should be 4 kilometers. After that, the benefits will be diminishing and the costs increasing. 2) Net benefit approach: net benefits are +20 at both 3,000 and 4,000 meters run; thus, it is up to you to choose which one you prefer.
2. Viktoria, a business consultant, has to travel quite frequently from Singapore to other parts of Asia. She has a frequent flyer card with Singapore Airlines and can choose from four different classes—First Class, Business Class, Premium Economy, and Economy. The following table provides the price of the seats and Viktoria’s valuation of each. All else equal, she likes to choose a class that offers comfort and allows her to work. What is the optimal seat allocation?

|  |  |  |
| --- | --- | --- |
| Class | Price | Viktoria’s Value of Seat |
| First Class | $2000 | $1600 |
| Business Class | $1100 | $1200 |
| Premium Economy | $750 | $700 |
| Economy | $500 | $400 |

For a trip to Hong Kong, Viktoria has four options to reach the city—a chauffeur-driven car, a taxi, a bus, or a train. The following table contains the prices of each service and the duration. Viktoria prefers one that is fast and clean. Which mode of transportation would she choose?

|  |  |  |  |
| --- | --- | --- | --- |
| Transportation Mode | Cost of services | Duration | Benefit of  Arrival Time and Comfort |
| Chauffeur | $950 | 40 min | $450 |
| Taxi | $370 | 40 min | $300 |
| Train | $110 | 24 min | $400 |
| Bus | $48 | 67 min | $60 |

*Answer*: Viktoria will be choosing the Business Class seat as that maximizes comfort, but is not overpriced. The marginal cost increase from Business to First Class is $900, whereas the marginal benefit only $400. Therefore, this improvement in seating is at a net loss of $500. Upgrading from Economy to Premium Economy has net benefits of 300 – 250 = $50, and from Premium Economy to Business Class 500 − 350 = $150. Therefore, the best option for her is to travel Business Class.

Viktoria will be choosing the Airport Express Train as it maximizes arrival time, comfort and price. Travelling by bus is at a small gain of 60 – 48 = 12 HKD (Hong Kong Dollar). Switching to the train has a marginal benefit of 340 HKD and marginal cost of 62 HKD, which is a net gain of 278 HKD. Switching from the train to the taxi has a marginal benefit of −100 HKD and a marginal cost increase of 260 HKD. Therefore, choosing this option is at a net loss of 360 HKD. Switching from the taxi to the chauffeur driven car has a marginal benefit of 150 HKD and a marginal cost of 580 HKD. Therefore, this is at a net loss of 430 HKD.

This proves that Hong Kong has a very cost-efficient railway connection to the airport.

1. Scott is planning to buy a car. He can choose between six types of powering: petrol, diesel, gas, hybrid, electric, or hydrogen. Being environmentally conscious, his total benefit will reflect the amount of greenhouse gases a car releases. The total cost is the price and upkeep of the car. He has a seventh option, using public transport. Assume Scott has been using public transport and has received zero total benefits and costs.

|  |  |  |
| --- | --- | --- |
| Type of Car | Total Benefit | Total Cost |
| Public transport | 0 | 0 |
| Petrol | 15 | 10 |
| Diesel | 16 | 12 |
| Gas | 18 | 12 |
| Hybrid | 30 | 25 |
| Electric | 40 | 36 |
| Hydrogen | 60 | 58 |

1. Find the total net benefit for each.
2. Use optimization in total value to determine the best option for Scott when he is trying to be conscious of the environment and save some money at the same time.
3. Find the marginal benefit and the marginal cost for each.
4. Show that marginal analysis would also make him buy a gas powered car.

*Answers*:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| (1)  Type of car | (2)  Total Benefit | (3)  Total Cost | (4)  Total Net Benefit | (5)  Marginal Benefit | (6)  Marginal Cost |
| Public transport | 0 | 0 | 0 | X | X |
| Petrol | 15 | 10 | 5 |  |  |
| Diesel | 16 | 12 | 4 |  |  |
| Gas | 18 | 12 | 6 |  |  |
| Hybrid | 30 | 25 | 5 |  |  |
| Electric | 40 | 36 | 4 |  |  |
| Hydrogen | 60 | 58 | 2 |  |  |

1. Scott should buy a gas-powered car, which probably is not the best for performance nor for the environment, but it provides the highest net benefits.
2. The table below shows the marginal benefits and costs for Scott’s choices.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| (1)  Type of car | (2)  Total Benefit | (3)  Total Cost | (4)  Total Net Benefit | (5)  Marginal Benefit | (6)  Marginal Cost |
| public transport | 0 | 0 | 0 | X | X |
| petrol | 15 | 10 | 5 | 15 | 10 |
| diesel | 16 | 12 | 4 | 1 | 2 |
| gas | 18 | 12 | 6 | 2 | 0 |
| hybrid | 30 | 25 | 5 | 12 | 13 |
| electric | 40 | 36 | 4 | 10 | 11 |
| hydrogen | 60 | 58 | 2 | 20 | 22 |

1. Scott should improve on cars until the net marginal benefits still outweigh the net marginal costs. In this case, it is offered by the gas-powered car.
2. In the United Kingdom, the following tax rates have been implemented:

|  |  |  |
| --- | --- | --- |
| **Band** | **Taxable Income** | **Tax Rate** |
| Personal Allowance | Up to £11,500 | 0% |
| Basic rate | £11,501 to £45,000 | 20% |
| Higher rate | £45,001 to £150,000 | 40% |
| Additional rate | Over £150,000 | 45% |

Someone who earns £60,000 would have a marginal tax rate of 20 percent and an average tax rate of 21.16 percent.

You are earning £40,000 (pre-tax) in the banking sector working 30 hours in a 40-hour week. You have been offered a promotion where you would be making £80,000, but for a full 40-hour week (pre-tax). Working part time helped you avoid paying for childcare. Accepting the promotion would cost £1,500/month for childcare. How much more will you be making marginally? Should you take the offer?

*Answers:*

Originally you were earning post tax: (£40,000 − £11,501) × 0.8+£11500 = £34,299.

After the promotion you shall be making: (£80,000 − £45,001) × 0.6 + (£45,000 − £11,501) × 0.8 + £11,500 = £59,298.

At the margin you will earn £40,000, however, post-tax this shall amount only to £24,999 more money. You shall also have to employ a nanny for £1,500/month, which amounts to £18,000 a year. Therefore, you will be better off by £6,999. You should take the offer.