Decision Making with LBA

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CS51: Formal Analyses

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Decision Making with LBA

Location-based inspiration

South Korea sells most of its goods wrapped in plastic, including vegetables. Based on this and the fact South Korea only recycles around 50% of its plastic production (Yoon, 2021), I chose the 3rd scenario to discuss what could happen in an agreement between the Korean Ministry of Environment and the three biggest Korean supermarkets (Lotte Mart, Emart, and Home Plus). The Ministry would require the supermarkets to start selling vegetables without plastic packages as an agreement. There would be an economic incentive for that to happen. However, the supermarkets could lose customers that think the presence of plastic is essential for the food's hygiene. To not lose money, the supermarkets would have to have enough incentives or strategies to attract customers, such as extra marketing of their products. The Government would have to balance a strategy to meet its goal without hurting the economy and citizens' health.

Decision trees and probabilities

In this scenario, the government is worried about the environmental impacts of plastic wrapping on vegetables. The supermarkets want to help so they can leave a good impression on the public. Koreans consume vegetables in almost all their meals through the culture of eating *banchan* (side dishes). However, Koreans are also meticulous about hygiene and based on how they behave, there would be a chance (80%) the consumption of vegetables would decrease in the country by around 40%. A decrease would impact the supermarket's revenue and the citizens' health, which the government does not want to happen. For the supermarkets, having a 30% reduction in taxes would mean saving up around 1.05 trillion Won yearly (see Appendix A), but that would only come with a decrease of 60% in the

plastic wrappings on vegetables. If things stayed the same, there would be an increase of 30%
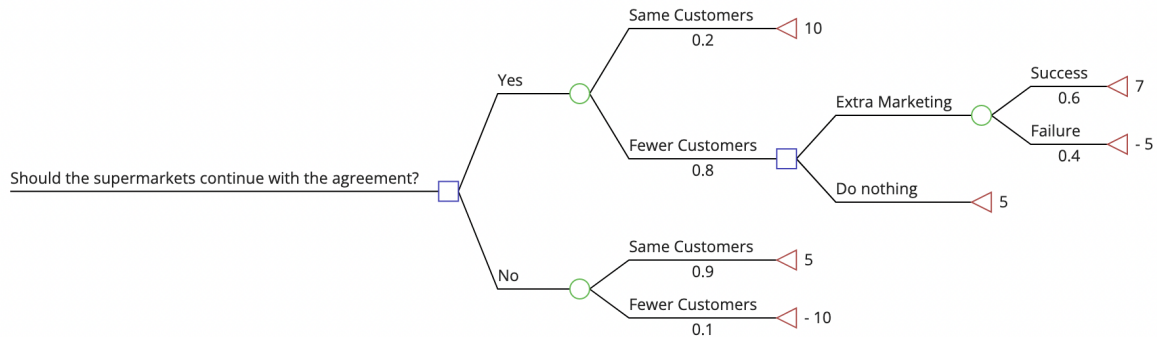in taxes (see Appendix for elaboration on the reasonings).

Figure 1: Decision tree. The tree shows the possibilities for the supermarkets given
the scenario. A utility is assigned to each outcome. The blue squares represent decision
nodes, the green circles chance nodes, and the red triangles represent end nodes. Probabilities
are assigned to each chance path, reflecting the real-world characteristics of the scenario.

For the expected value, the "Yes" will give us an expected value of 6 and the "No" a
3.5. This result means, logically and considering the whole scenario and information
available, "Yes" would be the most rational strategic choice. For maximax, choosing "Yes"
and "Same Customers" would be the action with the highest potential return, which would be
relevant if there were no possibility of drawbacks. For maximin, choosing "No" and "Fewer
Costumers" would be the path with the maximum worst-outcome payoff. This path would be
helpful if supermarkets did not care about losses. Since, in this case, a supermarket decision
impacts the economy, the ecosystem, consumers' behavior, and its revenue, the expected
value strategy would be the most logical. This strategy is advantageous here because it is a
long-term decision (since relevant impacts in plastic production and economic rebalance take

time to happen).[1]

For the scenario, there is an 80% chance that consumers would buy 40% fewer vegetables if the changes in plastic wrappings stay in place. However, a team of economists from Minerban University's Business School, one of the most respectable institutions in the area in South Korea, evaluated that since this is an agreement that envisions a more sustainable society, and customers would have to do nothing to become more eco-friendly, there would be a more considerable percentage of the population that would continue to buy the vegetables. Initially, there was an 80% probability the number of customers would decrease by 40% (prior), but after the studies from the University, the probability fell to 50% (posterior). However, the researchers can be wrong since, at any moment, something can make the population's feelings change, such as a wave of fake news regarding the hygiene of the vegetables or negationism over sustainability. The new information has the probability (likelihood) of being right 90% of the time. This could put less pressure on the supermarkets since they would probably be losing fewer customers than they thought, giving more support to maintain the agreement.[2]

Game theory

Analyzing the scenario from a Game Theory perspective, we would have two players: the Korean Ministry of Environment and the country's three biggest supermarkets. The Ministry needs to decrease the plastic packaging on vegetables without affecting the economy

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[1] **#decisiontrees:** A decision tree was created to map the break down of a decision scenario, separating possible outcomes into smaller decisions. Different strategies were defined and explained through assumptions and simplifications. Probabilities and new information were also added and justified along side an analysis of its impacts (more detailed in the Appendix).

[2] **#probability:** The information was explained and interpreted (detailed in the Appendix), representing different definitions such as prior, posterior, and likelihood. Bayes reasoning was used to explain what the probabilities mean in the scenario.

and the health of citizens. For that, the Ministry would give incentives so the supermarkets would reduce the amount of plastic in their products. The supermarkets want to be more eco-friendly, but they cannot afford to lose customers without enough incentives. There are four possible scenarios in the game:

Ministry / Supermarkets	Fewer customers	Same customers
Fewer taxes	0, 5	5, 10
More taxes	5, 0	10, 5

Table 1: Game matrix. The Ministry and the Supermarkets are the players, and their payoffs are described on the matrix for each scenario.

For (Fewer taxes, Fewer customers), the Ministry would have a payoff of 0 because it would be losing money from the fewer taxes, and it would be impacting the economy negatively (worse scenario for the Ministry), while the supermarkets would at least have to pay fewer taxes (even if suffering from fewer customers). (More taxes, Fewer customers) is similar to (Fewer taxes, Fewer customers) to the Ministry, but better only because they would receive more money from taxes. That is the worst-case scenario for the supermarkets since they would lose customers and pay more taxes. (Fewer taxes, Same customers) would mean fewer taxes for the Ministry but the perfect scenario for the supermarkets, since they would maintain the number of customers and pay fewer taxes. The contrary is applied to (More taxes, Same customers)—the perfect scenario for the Ministry but not the best one for the supermarkets since they would have to pay more taxes.

This is a normal, asymmetric, non-zero-sum game. Same customers strictly dominate Fewer customers for the supermarkets, and More taxes strictly dominates Fewer taxes for the

Ministry. This means Same customers and More taxes are the best strategies for the players, respectively. In this scenario, there is a Nash equilibrium in (More taxes, Same customers), following the trend set by the strict dominance of both players. This means neither players benefit from changing their strategy. Nash equilibrium follows the oddness theorem, where a finite game has an odd number of Nash equilibrium. Here, since we have only one Nash equilibrium—an odd number, there is no mixed strategy in the game.[3]

Utilities and biases

In the case of both institutions continuing with the agreement, the supermarkets may fall into the sunk cost fallacy when trying to increase the number of customers. There is a chance the extra marketing will not work. However, since this would cost a good amount of money, the supermarkets could continue so they "would not lose the effort." Assuming the supermarkets would not be aware of this tendency, the utility related to this scenario would stay the same in the short term.

To avoid this fallacy, boundaries could be set: the supermarkets would only expend a certain amount of money on the extra marketing, only increasing the value if the number of customers increases accordingly. Having this set from the beginning can change the utility related to this scenario to a higher number since new risks are being taken into account here, with more planning and strategies being applied. **WC: 148 words.**

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[3] **#gametheory:** A game matrix was defined given the context, along with the game's players and their strategies. Their payoffs were justified, and a Nash equilibrium was identified, justified and interpreted.

REFLECTION

Based on the decision tree, the best decision the supermarkets could make would be to maintain the agreement. However, the game theory analysis indicates it would be better to break the agreement and pay more taxes but have the same number of customers. This happens because the game matrix considers only a fraction of the scenario, analyzing only economic aspects—a limitation. The tree takes into account more information, though, being more reliable to define the best strategy—in this case, being more useful. This aspect makes the tree more normative—even though it describes more information, it still relies on probabilities and how both organizations ought to behave. The game matrix, even though more limited, brings information in a more direct, simple, and descriptive way.[4]

Word count: 1374 words (with headings but without appendix).

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[4] **#utility:** I assigned values and weights to each outcome given the scenario, based on the information available and its analysis. I identified the consequences of the sunk cost fallacy in the context, while also proposing possible solutions to it and its impact on the decision's tree utility outcomes.

References

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Appendix

I followed up on the next steps to calculate the taxes rates and the revenue of vegetable consumption by Koreans.

1. 22% of the revenue of supermarkets is taxed based on the Korean Taxation rules on tax bases over 20 billion won.

2. Lotte Shopping (Lotte Mart, Lotte Duty-Free, Lotte Department, and Lotte-Assi Plaza) has a revenue of around 16.2 trillion won (Statista, 2021). Considering each branch of Lotte Shopping produces the same revenue, Lotte Mart would generate 4.05 trillion won per year. In a simplification, the same value was used for the other two supermarkets (Emart and Home Plus).

3. That means each of these supermarkets pays around 3.5 trillion in taxes per year.

4. A decrease in taxes should be better than losing part of the revenue from vegetable deals.

To calculate how much each supermarket gains from selling vegetables, I followed the next steps:

1. Based on my observations in supermarkets, one kilo of a random vegetable ranges from 2,000 Won to 10,000 Won, which would give us a mean of 6,000 Won.

2. Koreans consume around 150Kg vegetables per year (per capita) (Statista, 2021).

3. Korea has 51.8 million people (The World Bank, 2020).

4. Based on these numbers, 46.62 trillion Won are spent on vegetables per year.

5. Considering Lotte Mart has 100 stores in Korea, and to simplify, so do the other two supermarkets, there would be 300 stores Koreans could go to but vegetables. However, there are many street markets, other branches of supermarkets, and small neighborhood stores in the country. Based on this, let's consider that 30% of the

vegetables are bought in these three supermarkets, which would give them around 14 trillion of the total revenue, 4.6 trillion separately.

6. Considering there would be a chance of 80% that 40% decrease in vegetable consumption if 60% of them start coming without plastic packaging, the revenue would go to 2.76 trillion Won, a loss of 1.84 trillion Won (per supermarket).

With this in mind, the tax increase would have to be enough, so the supermarkets would prefer having a loss in consumption paired with the decrease in tax.

For the calculation of probabilities:

1. For the "Yes" path, there is an 80% chance there would be a decrease in buying vegetables in those supermarkets since Koreans care about the idea of hygiene plastic wrappings bring.

2. On the second decision node, if supermarkets work correctly on their marketing and promote they are helping the planet, which is a positive thing, customers may be convinced (60% chance) and buy the vegetables.

3. For the "No" path, there is a 10% chance some customers would stop buying vegetables in those supermarkets for disagreeing with not promoting a more eco-friendly policy.

For the calculation of utilities:

1. Yes—Same costumers = 10: this is economically good for the supermarkets, and they are becoming more eco-friendly as they wished, and having a decrease in taxes.

2. Extra Marketing Success = 7: the supermarkets are becoming more eco-friendly and decreasing taxes, but they need to spend an extra amount of money to get their customers back, and they are succeeding.

3. Extra Marketing Failure = - 5: the supermarkets are becoming more eco-friendly and decreasing taxes, but they need to spend an extra amount of money to get their customers back, and they are failing.

4. Do nothing = 5: the supermarkets are becoming more eco-friendly, they are losing money for not trying to get customers back, but they still have a decrease in taxes, which compensates a bit.

5. No—Same Customers = 5: taxes would increase here, and the supermarkets would not be eco-friendly as they wish.

6. Fewer Costumers = - 10: taxes would increase here, the supermarkets would not be eco-friendly as they wish, and they would lose revenue.