

Executive Summary

Disclaimer: the following is a hypothetical scenario. The group members do not engage in, nor condone engaging in the trade of banned products.

a. Background

i. The Problem:

California boasts some of the strictest firearm regulations in the country. One of the most controversial of these regulations is the ban on the import, manufacture, sale, and transfer of large-capacity magazines. Large-capacity magazines are defined as magazines capable of holding greater than 10 rounds. MagzDistro, Inc.--the fictitious distribution company described in this project--distributes large-capacity magazines throughout California with the goal of maximizing revenue, while limiting its probability of getting caught.

ii. Motivation:

California's ban on large-capacity magazines proves largely unenforceable. Because manufacture dates are not stamped on magazines, it is virtually impossible to prove that a magazine in someone's possession was manufactured after the ban date of January 1, 2000. Unless authorities actually witness a transfer or have enough evidence to prove someone is manufacturing or importing these magazines, they cannot prosecute. Due to the enforcement difficulty, the loopholes in the law basically allow criminals to import, buy, sell, and possess banned magazines. Therefore, the ability of law-abiding citizens to defend themselves is significantly reduced, while little is done to restrict the ability of criminals to carry out violent crimes.

Large-capacity magazines prove extremely useful to law-abiding citizens during multiple-offender home invasions and times of civil unrest. For example, during the 1992 Los Angeles riots, several residents and business owners in Koreatown posted themselves on their rooftops when police were unable to come to their defense. Armed with rifles and large-capacity magazines, they were able to defend their families and property against large crowds of rioters. If they had not had access to large-capacity magazines, they would have severe difficulty defending themselves against such large numbers. The founders of MagzDistro, Inc. believe that the residents of California should have access to large-capacity magazines in order to better defend their families and property.

iii. Concept:

MagzDistro, Inc. imports large-capacity magazines from out of state and distributes them throughout the more populated areas of California by ground and air. The distributor flies all of their shipments out of Watsonville Municipal Airport, and into smaller airports adjacent to large population centers. From there, the magazines are shipped by truck to the adjacent cities and sold.

b. Objective

The objective of this study is to identify how the Monterey, CA-based company MagzDistro, Inc. can best distribute high-capacity magazines throughout the state of California. The company's goal is to maximize revenue while also minimizing the probability of capture by authorities.

c. Question

Given the expected revenue per city, expected probability of capture per city, distributor scheduling limitations, and distributor resource limitations:

1. Which cities should be supplied? How much supply?
2. Which airports should be utilized to supply those cities?

d. Constraints/Assumptions/Formulations

1. Project will last for 1 season. Formulations may change for following season.
2. The season will last 1 month and consist of 20 workdays (20 total shipments).
3. Cessna Super CargoMaster will transport cargo (max weight: 18,000 magazines; cost per nautical mile: \$2.29).
4. One flight (round-trip) will be made per workday.
5. Supplier able to supply more than plane weight and workday schedule restrictions (360k magazines).
6. To ensure sufficient demand, only California's 34 largest cities are considered.
7. Only small- to medium-sized airports within 50NM of those cities will be considered.
8. Demand (in magazines) for each city: $D_{City} = 0.0525 \times Population_{City}$, based off of 21% gun ownership in CA and conservative estimate of 25% of gun owners desiring large-capacity magazines.
9. Relative probability of capture: $P_{City} = 0.2976 \times Dist_{Airport \rightarrow City} \times CrimeRate_{City}$
10. Price per magazine in each city: $C_{City} = \log_{10}\left(\frac{0.0525 \times Population_{City}}{1000}\right) \times \30 , based off of \$30 base price per magazine (the high-end price of a magazine in a state where they are legal).
11. Edge costs:
 - a. $Cost_{Watsonville \rightarrow Airport} = \$2.29 \times Dist_{Watsonville \rightarrow Airport}$
 - b. $Cost_{Airport \rightarrow City} = P_{City}$
 - c. $Cost_{City \rightarrow Market} = -C_{City} \times D_{City}$
12. Edge Upper Bounds (in magazines):
 - a. $Watsonville \rightarrow Airport: \infty$
 - b. $Airport \rightarrow City: 180,000$
 - c. $City \rightarrow Market: D_{City}$

e. Analysis

i. Data:

Two separate programs were used to determine the solution sets of various probabilities and sensitivities. The first program maximizes revenue and uses the probability of capture as a constraint to ensure that the optimal solution does not produce a probability of capture over a user-mandated “limiting” probability. The second program utilizes probability in the objective function, minimizing the logarithm of the Probability of Capture and the negative revenue gained from sales. A weighting coefficient was applied to the probability variable in the objective function to vary the weight of probability of capture against the revenue.

ii. Validation:

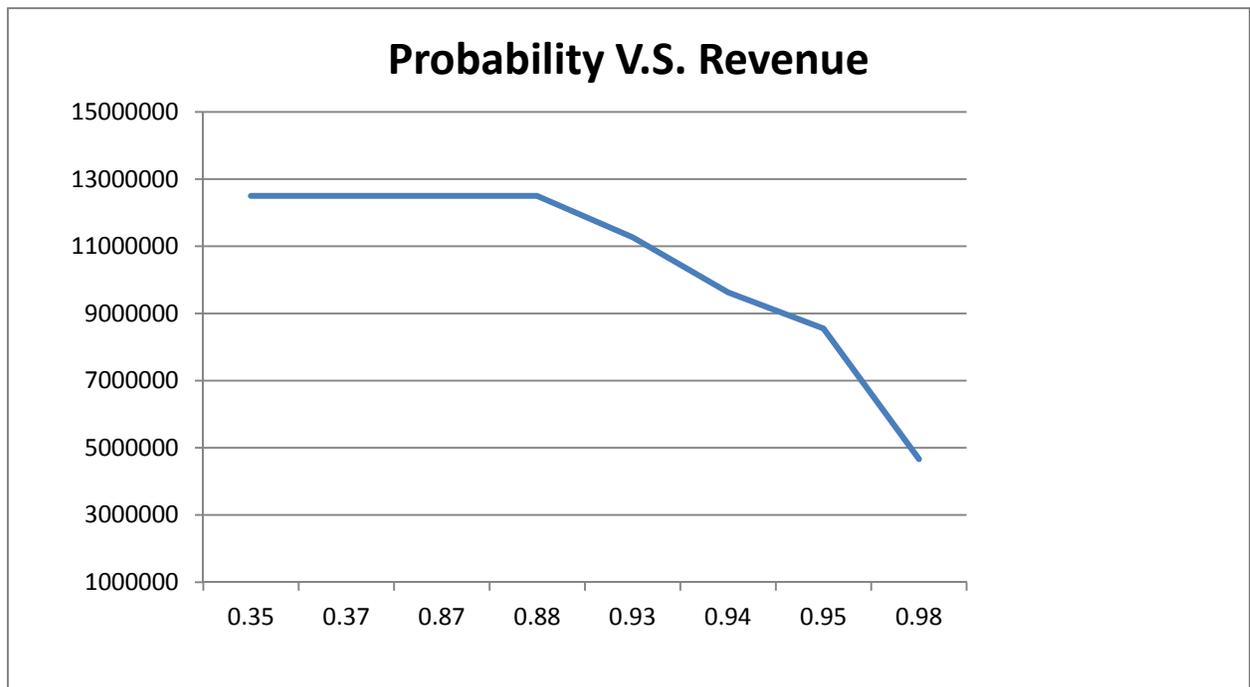


Figure 1: Revenue generated and probability of not being captured given by optimal solutions with various values for the weight coefficient of probability of capture

As the weight of the probability variable increases, the probability of avoiding capture increases. As seen in Figure 1, increasing probability weight results in decreased revenue. This is intuitive for higher-revenue cities having a higher probability of capture. The GAMS results for the program using the probability of capture as a constraint gave intuitive results as well. As the user-given constraint increases, fewer cities were visited and less revenue was generated.

This model, given the aforementioned assumptions and constraints, produces a seasonal revenue figure of \$11.9 million with a .9 relative probability of avoiding capture. Overall, the model provides MagzDistro, Inc. with an optimal plan to execute its mission. The company may use actual data from the first season to create more accurate formulations for future seasons, which can then be quickly updated in the models for new updated optimized plans.