Oncology Product Portfolio Forecast using Monte Carlo Models

Chris Pfeiffer and Matthew C. Hutcheson
Tegra Analytics, LLC., Chris@TegraAnalytics.com, Matt@TegraAnalytics.com

ABSTRACT

Tegra performed a multi-level net revenue forecast of an oncological product portfolio for a Top 10 Oncology pharmaceutical company. The portfolio contained both new launch and maturing products under four oncological indications.

Tegra's process included examining target physician overlap between indications, building a workload model to determine optimal sales force size, and developing a customized Monte Carlo simulation to forecast product portfolio sales based on revenue forecasting, a cumulative normal distribution curve, sales force expenses, and adjustments for market events (e.g., a competing product launch).

Tegra's sizing and forecasting models were used to guide field force resource allocation and position the company for success in the oncology market.

Index Terms – Sales Force Sizing, Product Forecasting, Monte Carlo Simulation, Statistical Modeling, Oncology

WHITE PAPER

I. Target Physician Overlap Analysis

The first objective was to determine how to *structure* the client's sales force. Given expected product launches, the client wanted to determine whether one sales force should sell to all three indications or whether multiple sales forces should sell to each indication separately.

To ascertain the optimal sales force structure, the physician overlap between oncology indications was determined via a physician-level overlap analysis. The overlap analysis focused on decile 3-10 target physicians for each indication, which make up the top 70% of physician total prescriptions. These physicians were chosen for having the most prescribing potential. The overlap between indications was conceptualized using Venn Diagrams. [1] [2]

Figure 1

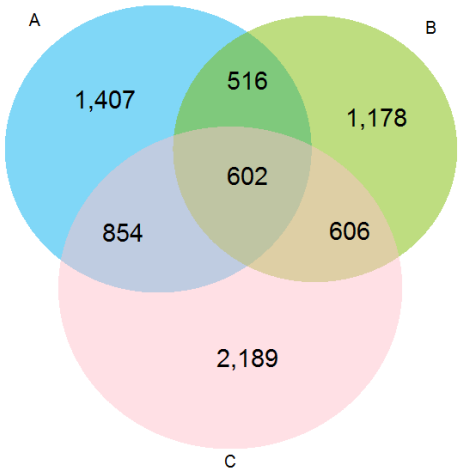

Figure 1 displays the overlap between the number of physicians that wrote prescriptions for the A, B, and C oncological indications. The following observations can be noted from Figure 1:

- 8.2% of physicians were in the top 70% of potential prescribing for all three indications (n=602),
- 35.1% of physicians were in the top 70% of potential prescribing for at least two indications (n=2,578), and
- 64.9% of physicians were in the top 70% of potential prescribing for only one indication (n=4,774).

Figure 2

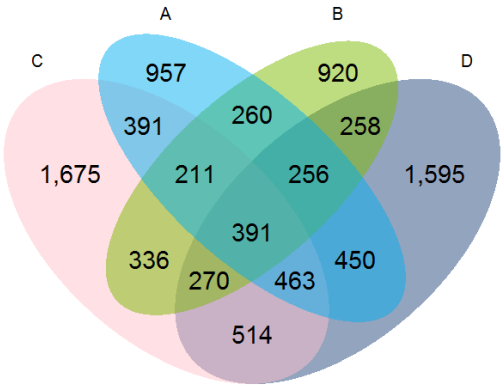

Figure 2 displays an alternative overlap analysis between the number of physicians that wrote prescriptions for the A, B, C, and D oncological indications. The client wanted to also examine overlap with indication D, which is currently promoted with its own sales force.

The following observations can be noted from Figure 2:

- 4.4% of physicians were in the top 70% of potential prescribing for all four indications (n=391),
- 17.8% of physicians were in the top 70% of potential prescribing for at least three indications (n=1,591),
- 42.4% of physicians were in the top 70% of potential prescribing for at least two indications (n=3,800), and
- 57.5% of physicians were in the top 70% of potential prescribing for only one indication (n=5,147).

The results of the overlap analysis determined that either sales force structure can be deployed depending on the sales force size. Due to the client's desire to minimize sales force disruption and maximize potential, the client decided to deploy a single sales force selling indications A, B, and C.

II. Sales Force Workload Modeling

The next objective was to determine the client's optimal sales force size. To calculate the sales force size in terms of full-time employees (FTEs), Tegra developed sales force sizing calculators with the following inputs:

- Target Decile Counts (1-10),
- Percentage Reach,
- Call Frequency per Month,
- Length of Visit, and
- Work Days per Year.

Based on these inputs, the following formula was used to approximate sales force size:

$$FF\ Size\ = \frac{D\ \times R\ \times F\ \times L}{W}$$

D = Decile Count of Prescribers,
R = Percentage Reach,
F = Call Frequency per Month,
L = Length of Call in Days, and
W = Work Days per Year.

The Percentage Reach, Call Frequency, Length of Call, and Work Days per Year assumptions were determined based on both industry standards and Tegra's market knowledge. The decile prescriber counts for the oncological products were based on total prescription volume sourced from IMS America.

Based on the workload calculator output, the sales force could be sized appropriately between 120-160 FTEs depending on the percentage of decile 1-2 (bottom 20%) of locations the client wanted to pursue. To help the client determine the appropriate size incorporating financial risk, Tegra also developed an ROI model using a Monte Carlo simulation.

III. Monte Carlo Simulation

To determine the optimal number of sales force FTEs from a revenue perspective, Tegra developed a customized Monte Carlo simulation model.

Monte Carlo is a statistical technique that applies repeated random sampling to assess the risk of outcomes of a statistical model [3].

Our model contained the following components:

- Model Inputs,
- Model Curve,
- Monte Carlo Simulation, and
- Fixed Expenses.

The Model Inputs included expected annual product revenues from the client and market event considerations. These market event considerations included adjustment factors for competitor launches, accelerated product growth rates, promotional responsiveness, sales force efficiency, share of voice, and low sales force turnover. The model could be repeated by including or excluding any combination of products or factors.

These inputs were applied towards the Model Curve, which is a cumulative normal distribution function. The following is the formula used as a foundation for the Model Curve [4]:

$$F(x)\ = \int_{-\infty}^{x} \frac{e^{-x^2}/2}{\sqrt{2\pi}}$$

A cumulative normal distribution function was used to incorporate the diminishing returns associated with increasing the sales force size past a reasonable level. The minimum limit on the Model Curve was set at 20% of potential net revenue, as this would be the expected revenue associated with a sales force size of zero.

Ten-thousand Monte Carlo Simulations were run based on the combined Model Inputs and Model Curve. Repeated random sampling was conducted on the annual product revenues using a random number generator that generated normally distributed results with a mean equal to the annual product revenue and a standard deviation equal to $1/6^{th}$ of the annual product revenue.

The final component of the model was subtracting the fixed expenses from each simulation result. Fixed Expenses included the following:

- Sales Representative Cost / Year and
- Sales Manager Cost / Year

These costs were driven by the following factors:

- Sales Force Size and
- Span of Control.

The simulation results were sorted in ascending order and grouped into the following quantiles:

- Quantile 1 = 25th Percentile ("Worst Case"),
- Quantile 2 = 50th Percentile ("Middle Case"), and
- Quantile 3 = 75th Percentile ("Best Case").

Figure 3

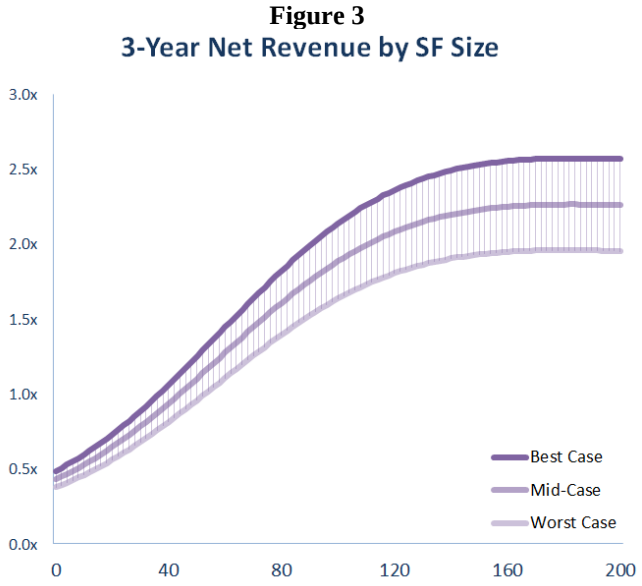

Figure 3 displays the three year Net Revenue by Sales Force (SF) Size based on the range of Quantile 1 through Quantile 3 simulated Net Revenues.

The net revenues are relatively flat at a sales force size of 160 FTEs. Once the sales force size exceeds 180, the combined diminishing sales returns and sales force cost results in a decline in net revenues.

Based on the ROI and Sizing analyses, the optimal sales force size is 160 FTEs to ensure that a substantial percentage of potential sales are captured without sacrificing revenues due to sales force costs.

REFERENCES

[1] Chen H (2016). _VennDiagram: Generate High-Resolution Venn and Euler Plots_. R package version 1.6.17, <URL: https://CRAN.R-project.org/package=VennDiagram>.

[2] Wickham H (2016). _scales: Scale Functions for Visualization_. R package version 0.4.1, <URL: https://CRAN.R-project.org/package=scales>.

[3] Frost, J. (2017, April 25). Understanding Monte Carlo Simulation with an Example. Retrieved March 19, 2018, from http://blog.minitab.com/blog/adventures-in-statistics-2/understanding-monte-carlo-simulation-with-an-example

[4] Normal Distribution. (n.d.). Retrieved March 19, 2018, from https://www.itl.nist.gov/div898/handbook/eda/section3/eda3661.htm

AUTHOR INFORMATION

Chris Pfeiffer is a Senior Analyst at Tegra Analytics, LLC. Chris is a candidate for a Master of Science in Government Analytics at The Johns Hopkins University and received his Bachelor of Science in Finance from La Salle University in 2013.

Matthew C. Hutcheson is the Founder and Partner at Tegra Analytics, LLC and an adjunct professor at Delaware Valley University. Matthew graduated from Cornell University, where he received both his Master of Science in Statistics in 1995 and a Bachelor of Science (with Honors) in 1992.