Promotion Response Modeling

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INGENIOUS INSIGHTS

In today's discussion we will discuss following questions:

- What is "Promotion Response Modelling" ?
- Why bother ?
- What are the building blocks to "do" Promotion response modelling?
- What decisions are involved ? ... what does it look like ?
- Where can I apply the results?

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Agenda

Promotion Response: Overview

Promotion Response: Approach

Promotion Response: Applications

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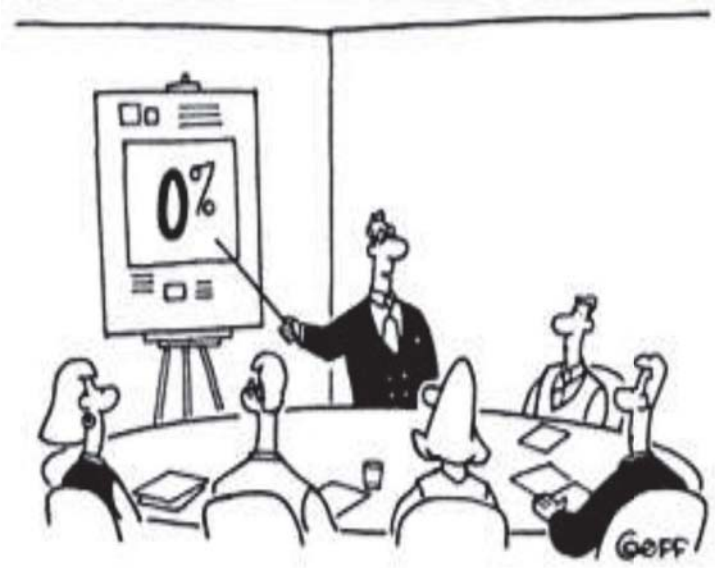
Why build response models?

To make trade-off decisions

- Whether I need to increase / reduce effort
- What effort is required to hit my brand forecast
- Which segments should I target more or less?
- Which channels should I spend more or less?
- …..

…**In a nutshell, to optimize promotional efforts**



"Our study concludes that this is the percentage of our customers who will buy from us without any effort whatsoever on our part."

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Basic concepts of response modeling

- Law of diminishing returns
- Response curve
- Marginal and Overall ROI
- Profit Maximization
- Base and incremental sales

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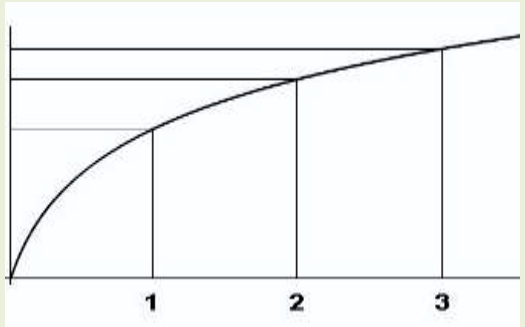
Law of diminishing returns

Law of diminishing returns

If you keep adding more of one unit of production to a productive process while keeping all others units constant, you will at some point produce lower per unit returns



Assisting marketing channels

There are multiple channels of promotion – no one channel is completely responsible for all sales

Example: Beyond a point, a particular channel promotion cannot make any difference to brand sales as other channels too have an impact on brand sales

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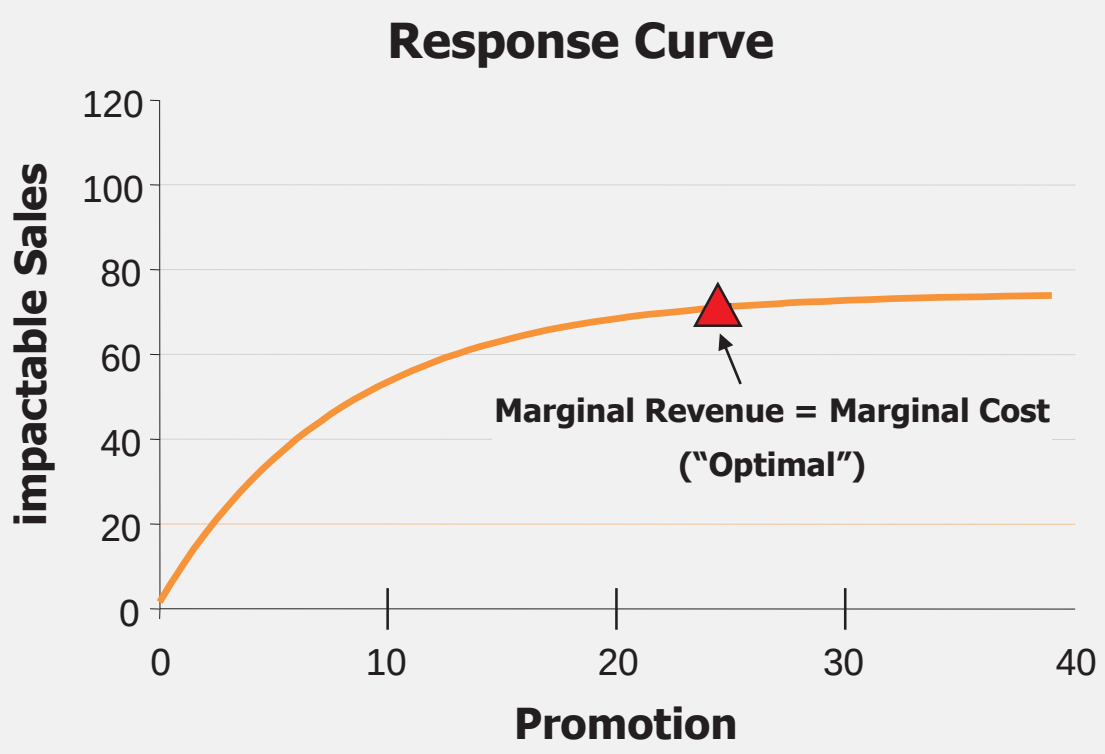
Response Curve: A response curve is a graphical (and/or mathematical) expression of the relationship between promotion and returns

Law of diminishing returns



1. Response curve starts from origin. Therefore, zero promotion would lead to zero impactable sales
2. Response curve is ***not*** sales curve; sales curve will not start from origin
   - Even at zero promotion brand sales are (usually) not zero
3. Response curves typically have two distinguishing parameters:
   - Asymptote
   - Curvature

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"Standard" Response model forms

Dependent variable = f (Independent variables)

"Left Hand Side" (LHS) = f ("Right Hand Side" variables)

Typically:

Some measure of sales (or share) = f(promotion, practice size, history, etc.)

But . . . what variables should we use?

. . . what model form should we use?

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Response Model Construct

- LHS – some measure of
  - Sales (NRx, TRx, Units, Share)
  - Volume change (NRx, TRx, Units, Share)
- RHS
  - Constant
  - Prior volume (“auto-regressive” terms)
  - Current promotion (possibly transformed)
  - Lagged promotion (similarly transformed)
  - Seasonality indicators
  - Specialty groups
  - ...
- Level of data granularity
  - Time: Weekly, monthly, annual
  - Entity: Physician, segment, geography

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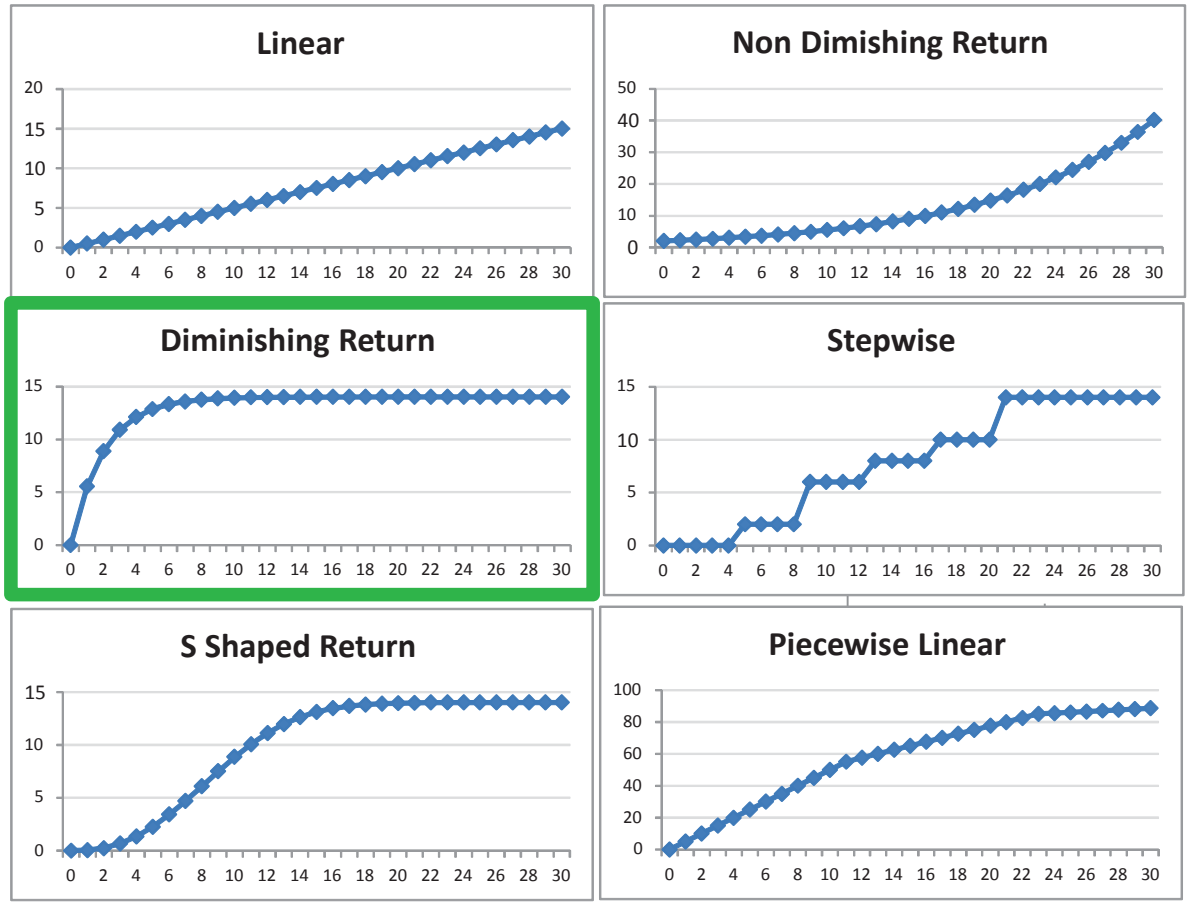
Response Model Forms

Simple, can calculate historical avg ROI but not "optimal"

Most commonly used (Negative Exponential, Log)

Accounts for threshold effect



Sometimes seen, not useful

Possibly realistic, but hard to model or to act on

Typically only when data is limited . . .

In all models: X axis: Effort Y axis: Return

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Most common forms for diminishing returns models

Negative exponential

LHS (share or sales in month_i) =

Constant

+ *Asymptote* * (1 – exp(-(*Scale* * promotion_i))

+ *Parameters* * other terms (covariates)

Logarithmic

LHS (share or sales in month_i) =

Constant + *Slope* * ln(*Scale* * promotion_i))

+ *Parameters* * other terms (covariates)

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Response curve

Unfortunately, these models are inherently non-linear (unless we resort to trickery)

Negative exponential

LHS (share or sales in month_i) =

Constant

+ *Asymptote* * (1 – exp(-(*Scale* * promotion_i))

+ *Parameters* * other terms (covariates)

Presence of "Scale" parameter makes model non-linear

Logarithmic

LHS (share or sales in month_i) =

Constant + *Slope* * ln(*Scale* * promotion_i))

+ *Parameters* * other terms (covariates)

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Response curve

We can "pre-set" the Scale parameter, and apply a transformation to the RHS variable . . . and then use linear regression

If *Scale* is pre-set, this entire structure can be "pre-calculated"

Negative exponential

LHS (share or sales in month_i) =

Constant

+ *Asymptote* * (1 – exp(-(*1.5* * promotion_i))

+ *Parameters* * other terms (covariates)

Pre-set variable

Logarithmic

LHS (share or sales in month_i) =

Constant + *Slope* * ln(*1.0* * promotion_i))

+ *Parameters* * other terms (covariates)

In this approach, you must either try multiple values of "Scale" to find best fit . . . Or just use non-linear estimation methods to find the value of that parameter (and others) directly

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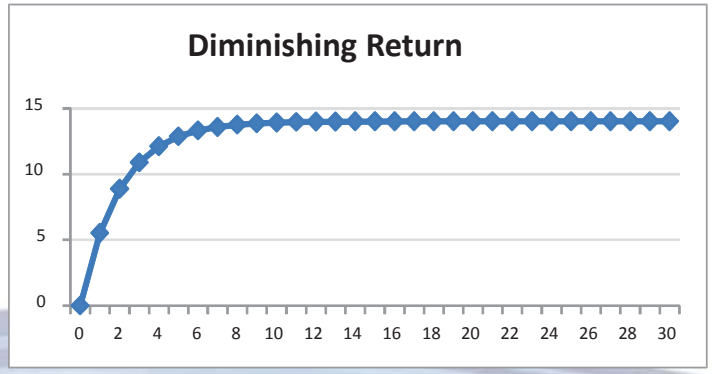
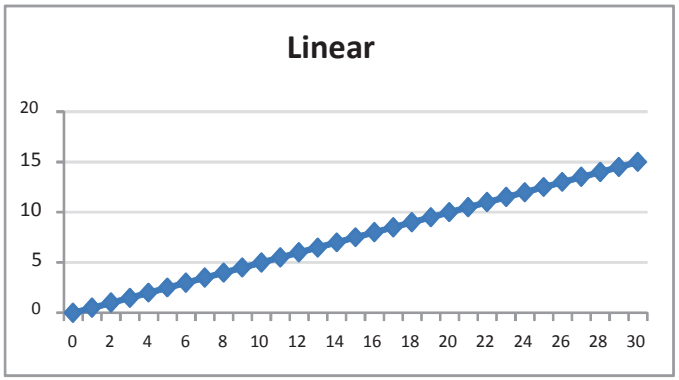
There are limits to the use of diminishing returns models

Response curve

- "Diminishing returns" models really only make sense if the promotional program you are measuring can be applied at varying levels of "intensity"
- Example: sales rep detailing . . . You can reasonably think of having any level of promotion between 0 and 4 (or even 5) calls / month
- But, a program that can really only be done once a year (speaker / dinner meeting?) or a program where you have only a binary "in/out" status indicator can't be modeled as curve . . . only a straight line





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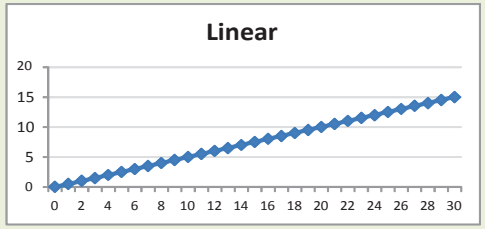
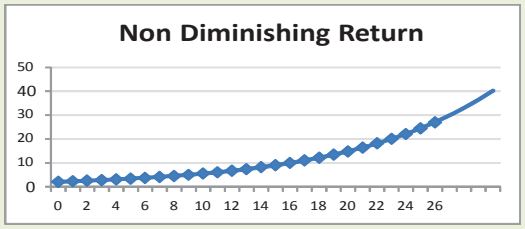
Appropriate transformations need to be applied to get a robust model

Response curve

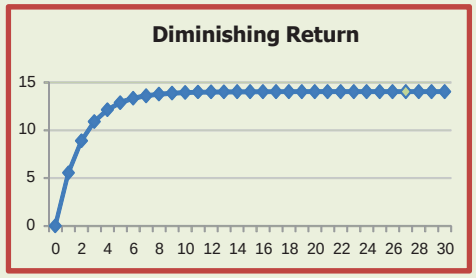
Simple, can calculate historical avg ROI but not "optimal"

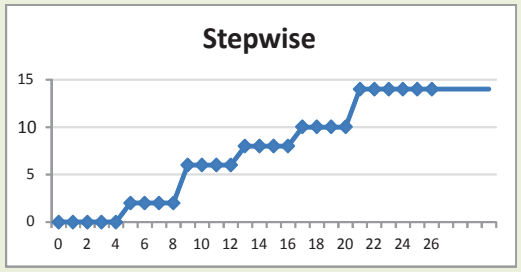




Sometimes seen, not useful

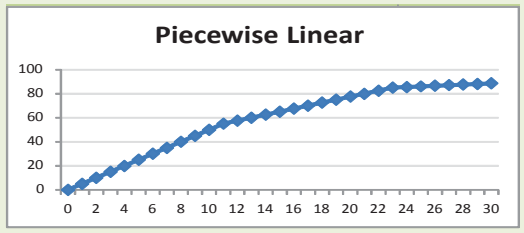
Most commonly used (Negative Exponential, Log)





Possibly realistic, but hard to model or to act on

Accounts for threshold effect



Good approximation for diminishing returns curve

In all graphs: X axis: Effort Y axis: Return

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Negative Exponential model framework

Response curve

- **<u>Equation form</u>**: **NRx =** a0 + a1*NRx1 + a2*NRx2 + a3*NRx3 + a4*NRx4 + A*(1 - Exp(-C*(PDE + c1*PDE1 + c2*PDE2 + c3*PDE3 + c4*PDE4)))

Parameters	Meaning
a0	Constant (Base); pure Brand Equity
A	Asymptote represents maximum impactable sales at infinite level of effort
a1	Impact of previous month sales on current month sales
a2, a3, a4	Impact of current month-2, current month-3, current month-4 on current month sales
c1	Promotional activity lag coefficients for current month-1
c2, c3, c4	Promotional activity lag coefficients for current month-2, current month-3, current month-4
Overall curvature = C*(1+c1+c2+c3+c4)	Rate at which impactable sales vary with promotion, higher curvature values imply a more "arched" response curve (will reach asymptote faster) and lower curvature implies flatter response curve (will reach asymptote slowly)

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Response curve

Slightly more advanced considerations (1 of 4)

- A bit out-of-scope for today's discussion, but:
  - Consider choice of LHS variable: sales, Rx, share, or month-to-month change of Rx volume
    - Use of auto-regressive terms on RHS is conceptually similar to using LHS as month-to-month change in Rx.

<u>Equation form</u>: **NRx =** a0 + a1*NRx1 + a2*NRx2 + a3*NRx3 + a4*NRx4

+ A*(1 - Exp(-C*(PDE + c1*PDE1 + c2*PDE2 + c3*PDE3 + c4*PDE4)))

- This also de-emphasizes cross-sectional ("between doctors") variation in your model and increases the importance of "within doctor, over time" variation (generally, a good thing)

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Response curve

Slightly more advanced considerations (2 of 4)

- A bit out-of-scope for today's discussion, but:
  - The structure of how to represent promotion (including lagged promotion (effort in previous time periods)) is open to a lot of debate . . . there is not one universally "correct" structure
  - The particular form used here has certain features (i.e., it treats lagged promotion as something that can be "traded off" against current promotion at an "exchange rate" dictated by the c1, c2, etc. coefficients) . . . but that may or may not be an advantage)

<u>Equation form</u>: **NRx =** a0 + a1*NRx1 + a2*NRx2 + a3*NRx3 + a4*NRx4

+ A*(1 - Exp(-C*(PDE + c1*PDE1 + c2*PDE2 + c3*PDE3 + c4*PDE4)))

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Response curve

Slightly more advanced considerations (3 of 4)

- A bit out-of-scope for today's discussion, but:
  - Consider normalizing each individual doctor's (or account's) values relative to seasonally-adjusted average over the time period, i.e.:
    - LHS becomes $Rx_{current_month} - Rx_{avg}$
    - RHS can be similarly normalized, or remain as original
    - As with using auto-regressive elements on the RHS, this approach also reduces the cross-sectional ("between doctors") component of the model and increases its dependence on "within doctor" variation over time
    - However, it makes creating projections from the model more difficult (possibly, much more difficult)

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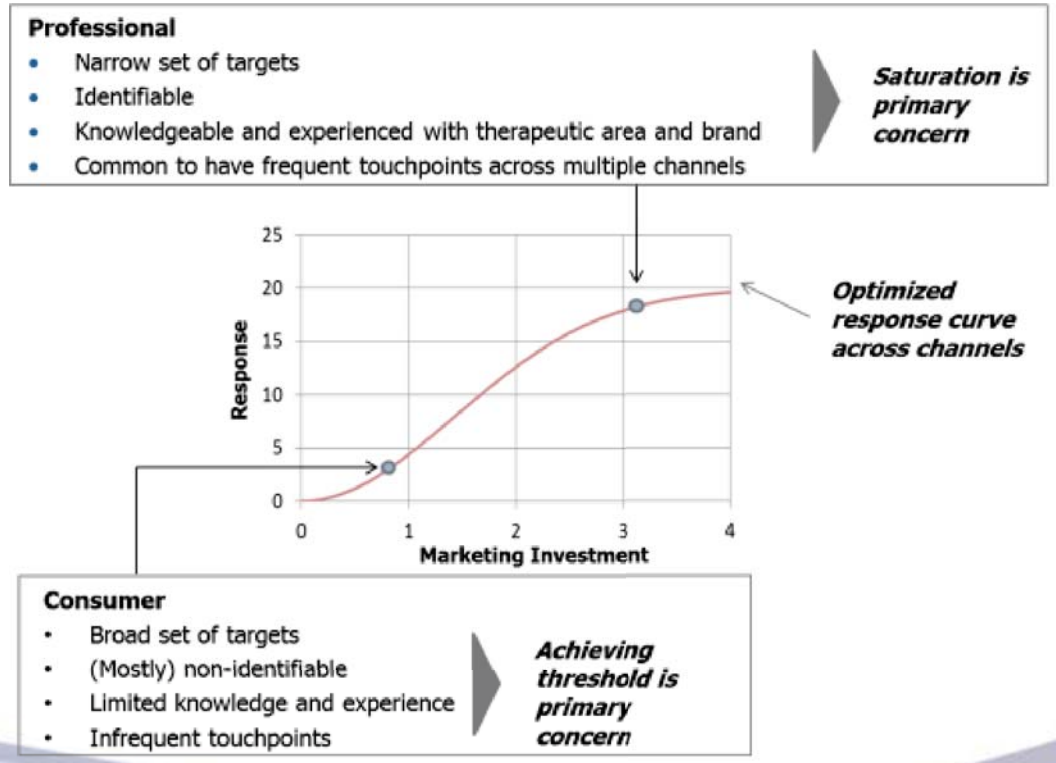
Slightly more advanced considerations (4 of 4)

Response curve

- A bit out-of-scope for today's discussion, but:
  - Introduction of S-shaped curves will (probably) represent reality a little better . . . but will significantly increase the complexity of both estimation, and optimization on the results.



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Parameter Estimation Techniques

- Estimate those parameters which minimize overall sum of square errors in the model
- Parameters need to make business sense
- Different methods of estimating parameters include linear/non linear regression
- Tools generally used: SAS / SPSS / R / Excel / (almost anything)

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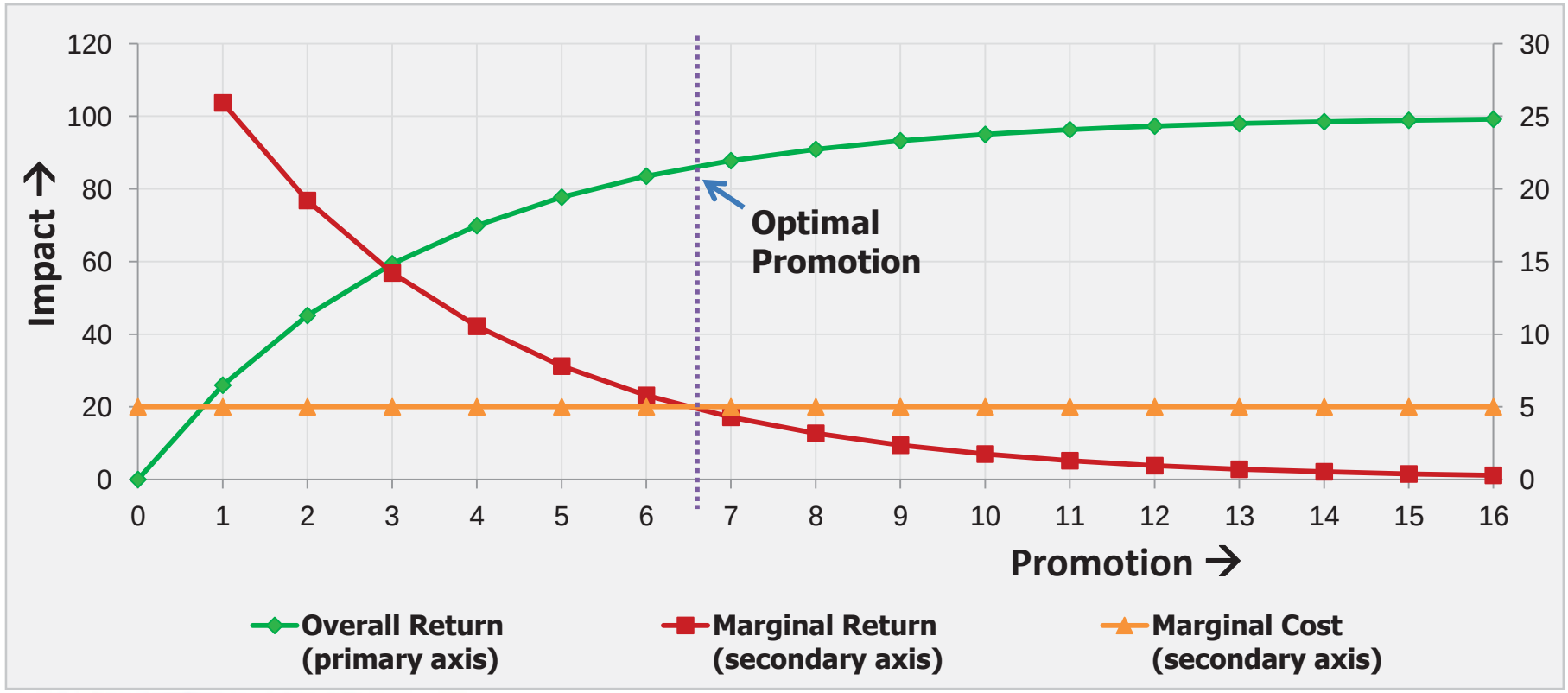
Marginal and Overall ROI

$$\text{Overall RoI} = \frac{\text{Overall Return}}{\text{Overall Cost}} - 1$$

$$\text{Marginal RoI} = \frac{\text{Marginal Return}}{\text{Marginal Cost}} - 1$$



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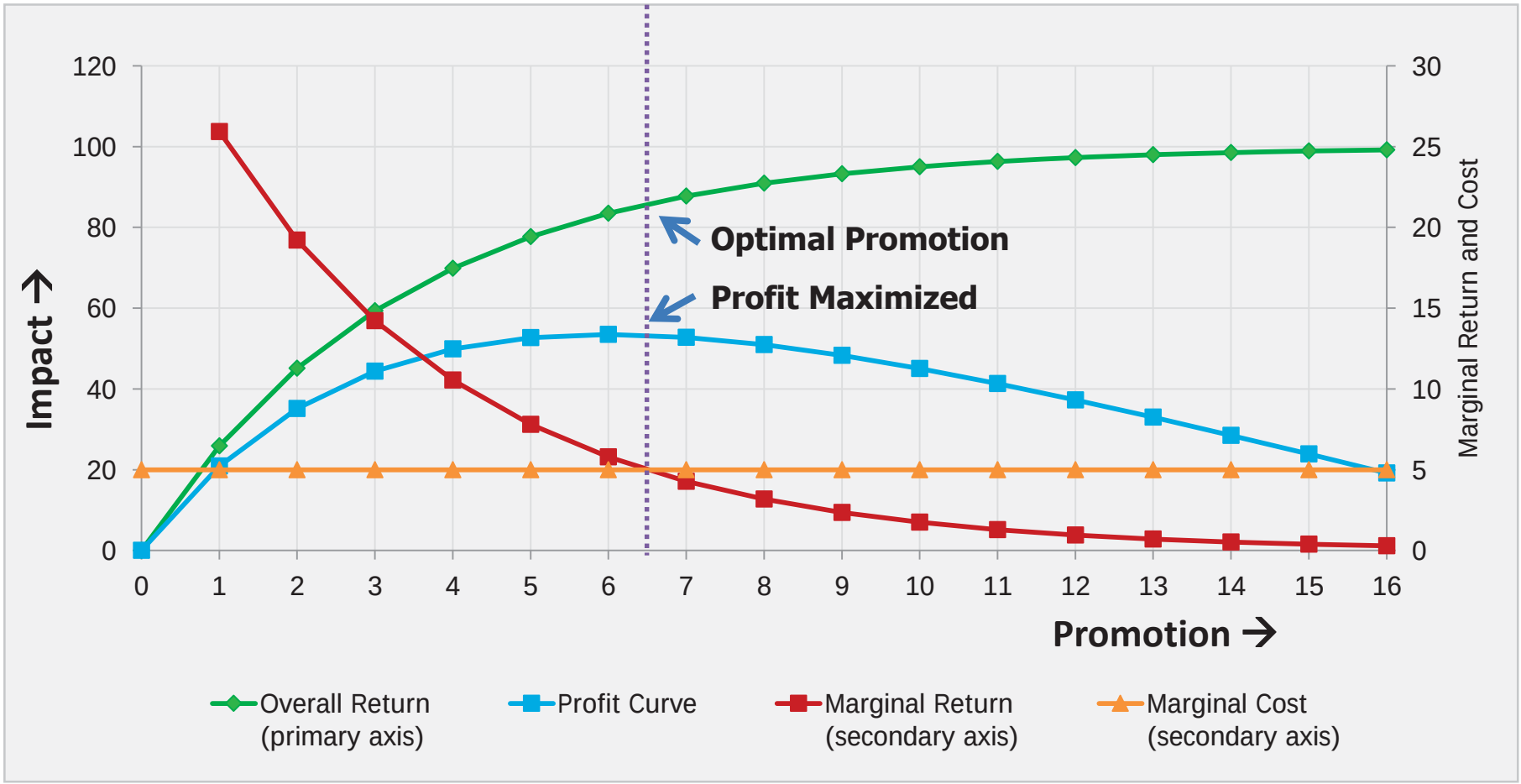
Profit is maximized where marginal revenue is equal to marginal cost



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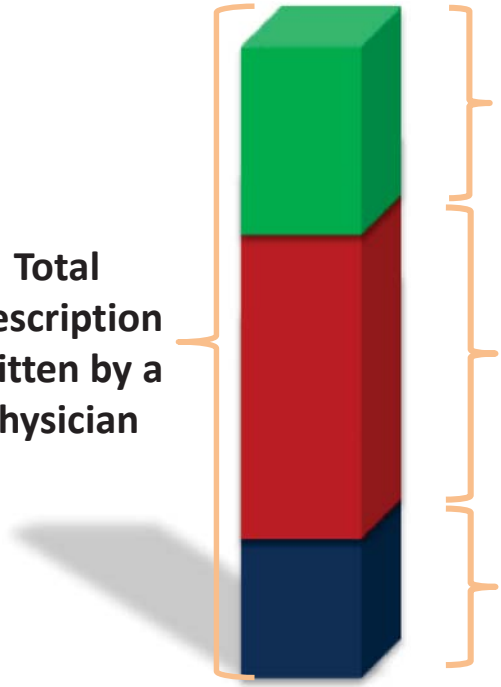
Base and incremental sales

Promotion Response Modeling helps in identifying the impact of promotional activity on physician prescribing behavior

Physician prescribing can be thought of as being influenced by 3 broad effects: Direct Detailing, Short-term Trends, and Long-term Trends. Promotion response modeling can use historical data to model the three component and identify contribution of promotional activity in sales results

Total prescription written by a physician



Long-term Trends: Effects attributable to factors with longer term persistence (e.g., brand equity, patient preference, market positioning)

Short-term Trends: A component that measures how the value obtained by promotion and brand equity play out over time. That is, if the effects will vanish quickly or if they will persist over many months

Direct Detailing Effect: Direct impact of detailing received in the current month and recent months

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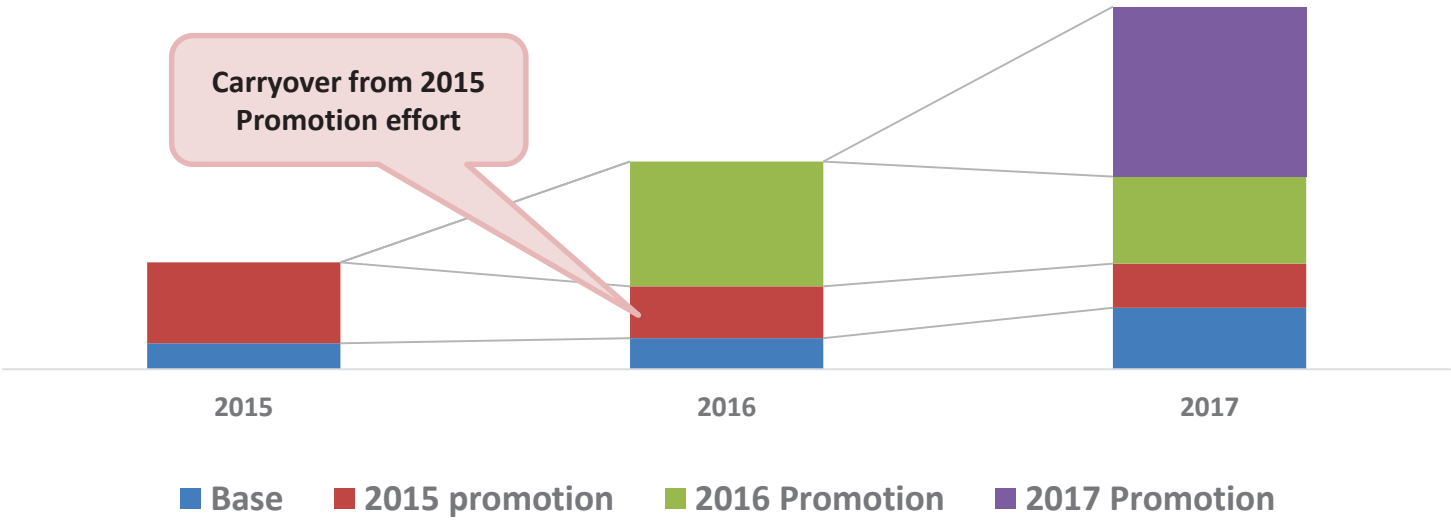
Base and incremental sales

Sales generated from effort in current year has a lingering effect into future periods, referred to as "carryover"



- ✓ During the launch phase direct impact of promotional activity on revenue is higher (50-70%) as compared to mature and stable brand (7-8 years after launch)
- ✓ Carryover increases as brand matures and its equity/long term persistence value increase

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Physician prescribing can be thought of as being influenced by 3 broad effects: Direct Detailing, Short-term Trends, and Long-term Trends. Promotion response modeling can use historical data to model the three component and identify contribution of promotional activity in sales results

Example promotion response equation :

$$Rx_{Current} = \Sigma\, \alpha\, Rx_{Previous\ month} + \Sigma\, \beta\, f\,(\text{Promotional activity}) + \text{Constant}$$

- $\Sigma\, \alpha\, Rx_{Previous\ month}$: Captures short-term trends by using prescribing behavior in previous months
- $\Sigma\, \beta\, f\,(\text{Promotional activity})$: Captures direct detailing effect by calculation estimates for promotional activity
- Constant: Coefficients to establish the "base" level of prescribing for each doctor

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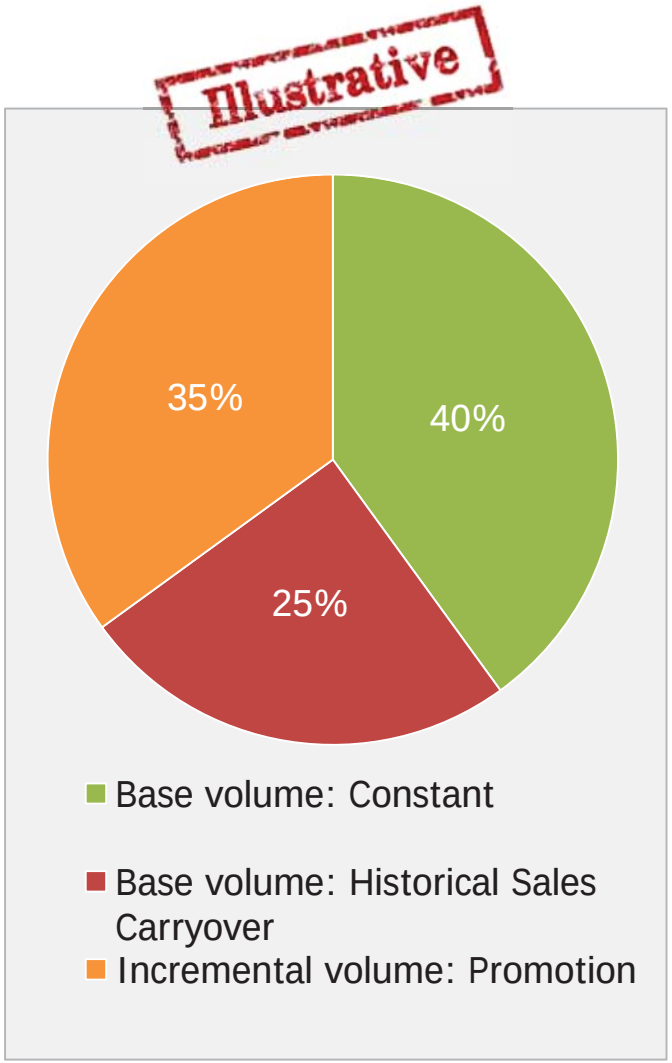
Base and incremental sales

- Base vs. incremental volume
  - Base: volume that would be generated in absence of any marketing activity
  - Incremental: volume generated by marketing activities in short run
- Base can grow or decline over long run and is also impacted by marketing activities
- Variation in base volume is good indicator of brand equity
- Base can be further sub-divided into historical sales carryover and pure "constant"
  - Historical sales carryover: Historical sales which are driving current sales
  - Constant: Pure Brand equity i.e. volume which is irrespective of any promotion



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Promotion Response: Overview

Promotion Response: Approach

Promotion Response: Applications

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Approach

Strategic Data Assessment	Model Estimation	Optimization	Forecasting / Projection
• Data collection, review and preparation • Aggregate brand level trends • Segment level trends – Overlaps – Key metrics: – Reach – Frequency – Brand sales / customer – Potential sales / customer	• Segmentation / Clustering • Estimation of key parameters using Generalized Linear or Non Linear methods • Model Validation	• Creation of response curves • Based upon financials and response curve parameters, estimate optimal effort for each segment • Steady state optimal or discounted cash flow	• Based upon model diagnostics and response curves, estimate forecast for base vs. incremental volume • At historical and optimal targeting • Layer in future market events

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Strategic Data Assessment

Collect

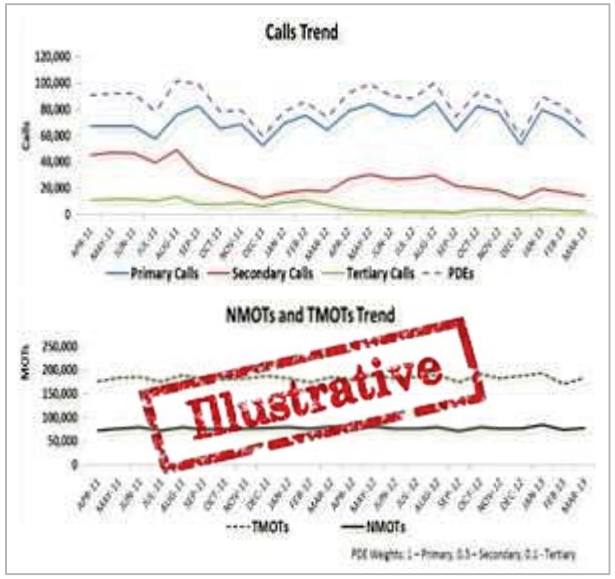
Data	Granularity
Prescription data	**Physician x Month (24M)**
Call data	**Physician x Month (24M)**
Market Definition	**Brand**
Current Price, anticipated price increases, Gross-to-Net discounting	**Brand**
Rep cost and Financials	**Sales Force**
Any other physician segmentation	Physician – Brand
Demographic Information	Physician
Forecast (Gross / Net / Unit)	Brand
Market Events (if relevant) (typically: major competitive launches or major competitor goes generic)	Brand
Any other Promotional Data (Samples ,Copay Cards)	Physician x Month
Managed Care Data	Brand x State

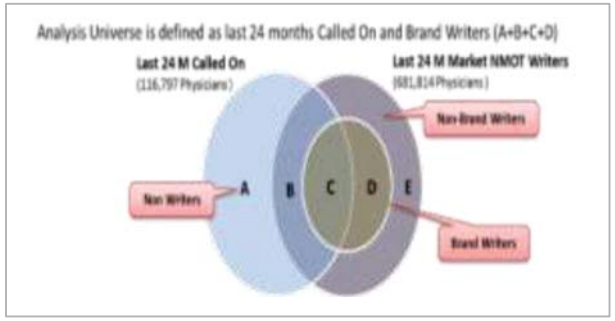
Process

Once the data is collected, process, clean and integrate all datasets to create preliminary summaries & perform a comprehensive "Data Health Check", in order to:

1. Ensure completeness and accuracy of the data collected
2. Understand historical trends & relationships
3. Confirm your interpretation of the preliminary insights
4. Identify additional data gaps / plans to bridge the data gaps

Analyze





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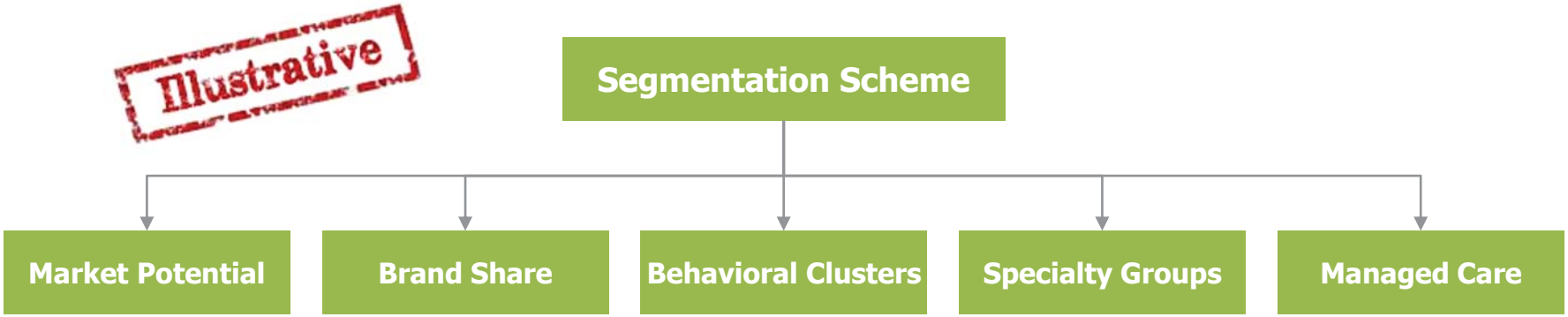
Segmentation

Next, we need to identify clusters of customers (physicians) which could ultimately warrant different levels of sales rep promotion (calls)

1. Different customers react differently to promotion
2. Resource allocation decisions based on the response estimation typically need to be made at a segment level.
3. Estimating the promotional response of a single customer using his data alone is (typically) not possible



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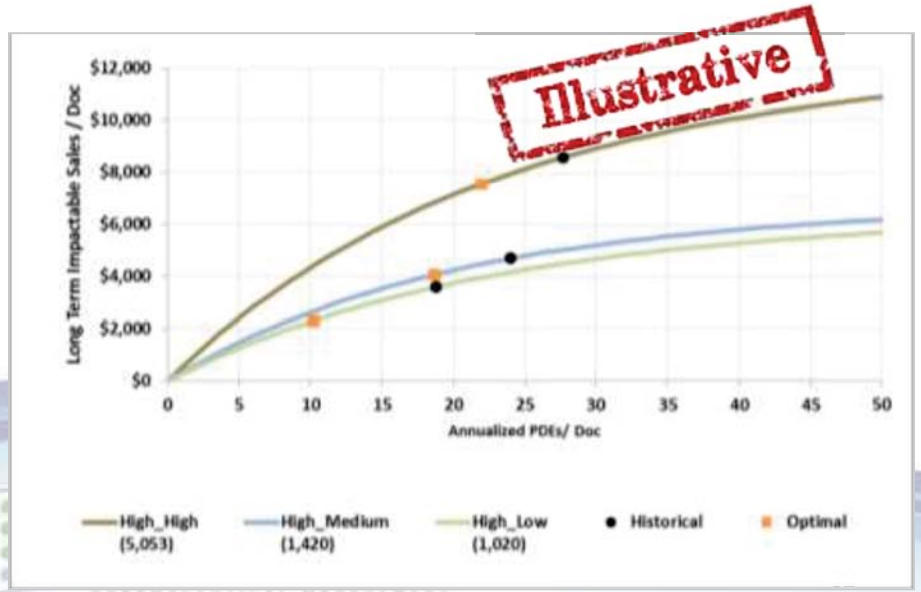
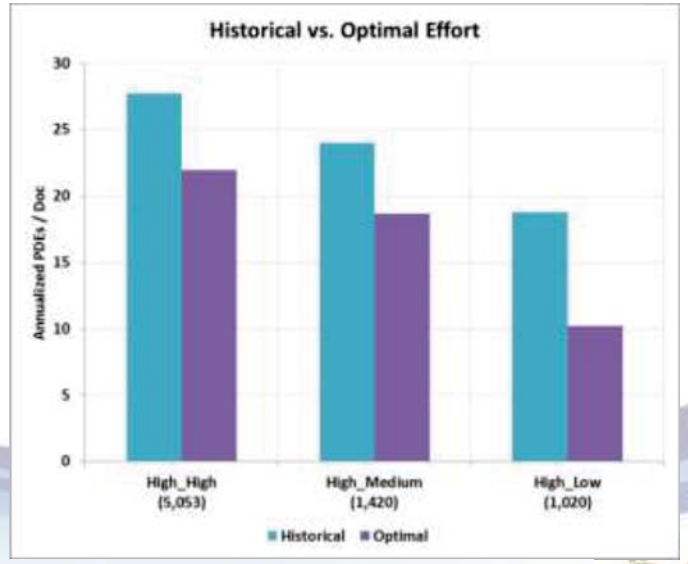
Optimal results by segment can be aggregated up to estimate total promotional needs

Brand Potential	# Physicians	% Physicians	Called on Physicians	% Reach	Brand NRx / writer	Brand TRx / writer	TRx / NRx Ratio	Market NRx / Doctor	% of Brand NRx	PDEs / Called on Physician	% of PDEs
High	7,493	5%	5,950	79%	45.8	111.0	2.4	446.8	39%	25.8	15%
Medium	9,322	6%	7,504	80%	17.9	44.5	2.5	239.3	19%	19.9	15%
Low	95,999	61%	50,757	53%	3.9	8.7	2.3	92.3	42%	10.7	54%
Zero	44,289	28%	30,902	70%	0.0	0.0	-	48.5	0%	5.0	15%
Total	**157,103**	**100%**	**95,113**	**61%**	**5.6**	**13.2**	**2.4**	**105.6**	**100%**	**10.5**	**100%**





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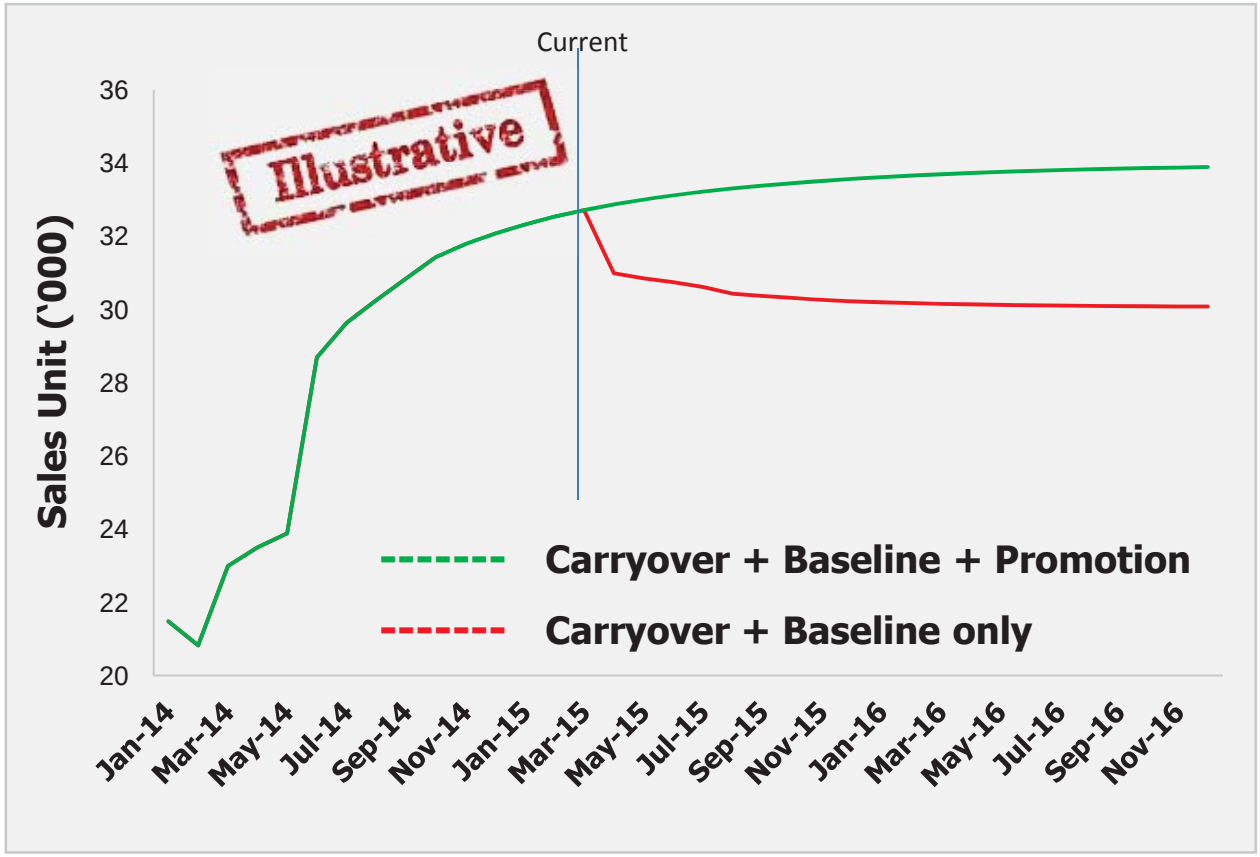
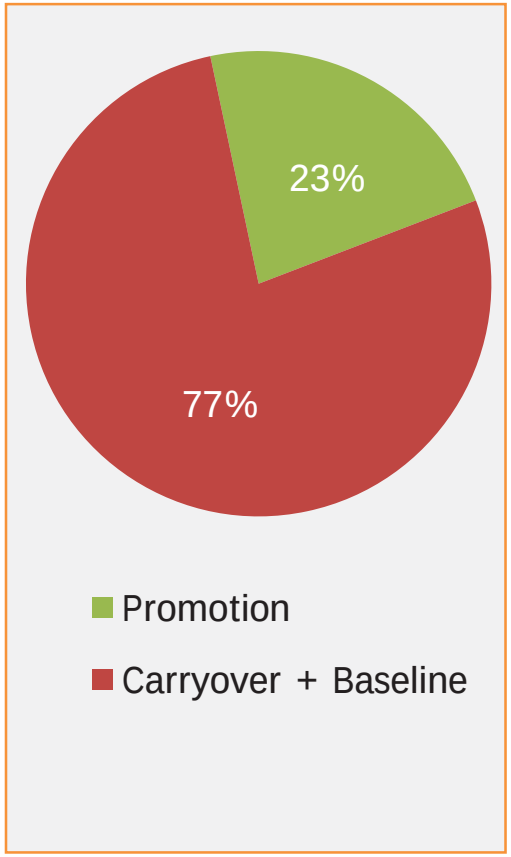
Promotion response models enable analysts to understand the split of base volume vs. incremental volume in projecting sales forward in time

Trend at Historical Targeting



Impact Breakout



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Promotion Response: Overview

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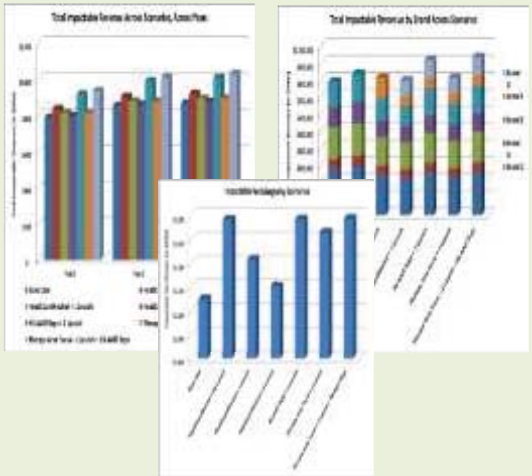
Many applications in life sciences for promotion response modeling

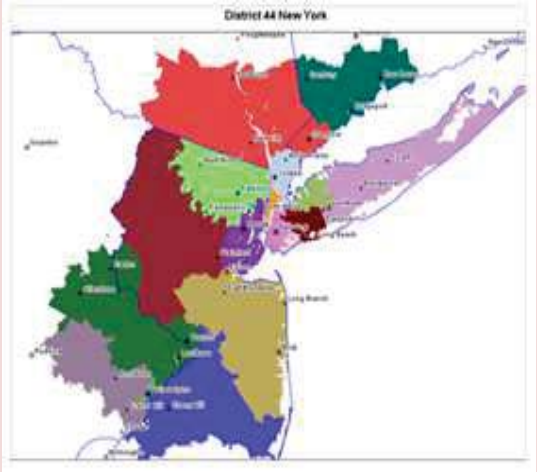
Sales Force Size and Structure

Optimal promotion required by the entire portfolio – how many sales team? What size? What structure?



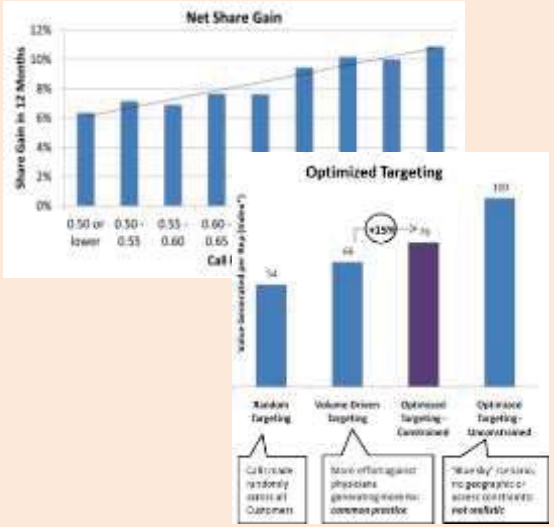
Territory Alignments

How to deploy those sales teams / sales reps geographically?



Call Planning

Who all to promote? How frequently? Which products?



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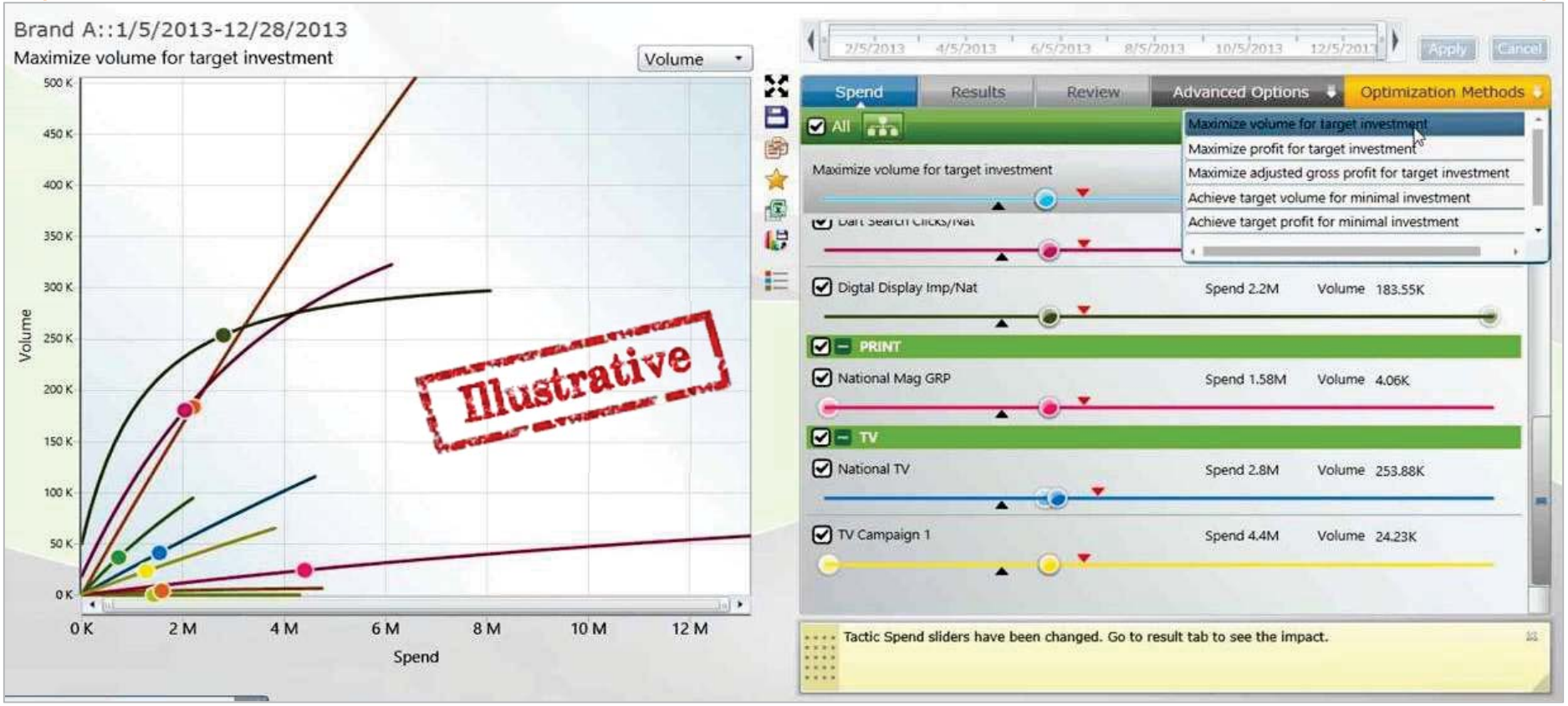
Response models allow marketers to optimize spend across marketing channels – this technique is widely used across industries

Marketing Mix Optimization



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Thank you

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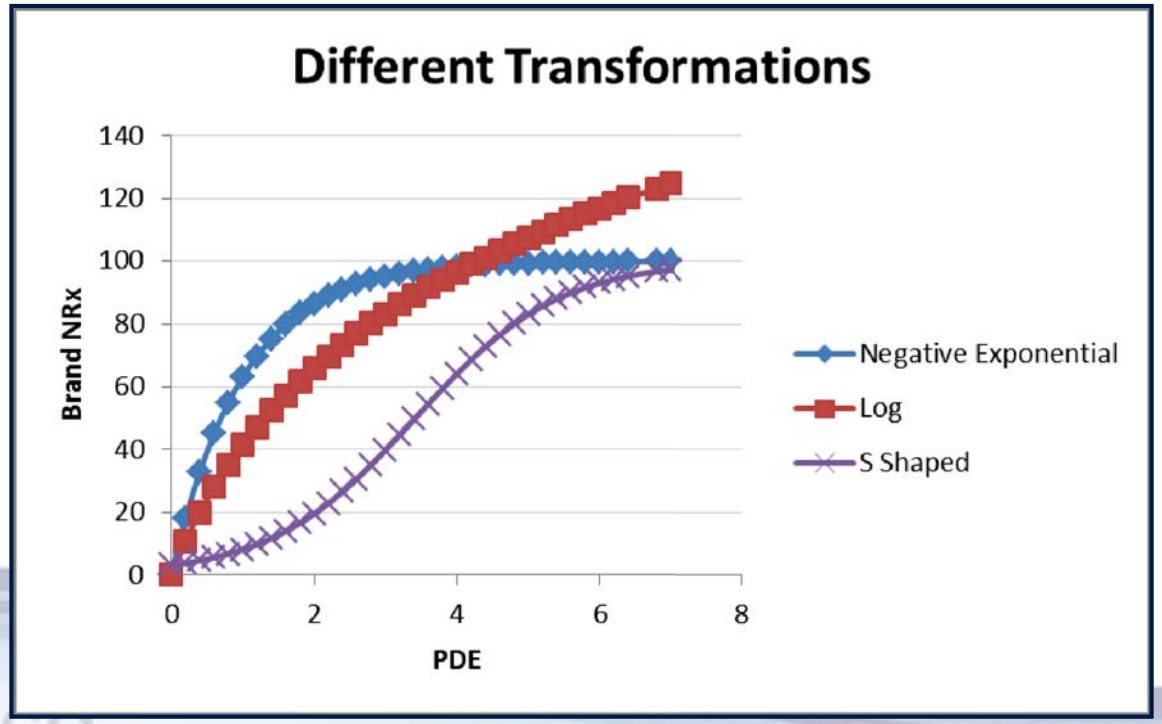
Standard Transformations types

Transformation	Parameters	Equation
Negative Exponential	A,C	A * [1 – Exp(-C*X)]
Log	A	A*LN(1+X)
S Shaped	A,C	A*[1/{1+Exp(-C*(X-$\bar{X}$))}]



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