

Business Analytics Providing Actionable Insights

With Application to

- TV Ad Optimization
- Medicine Sample Allocation Optimization

Overview

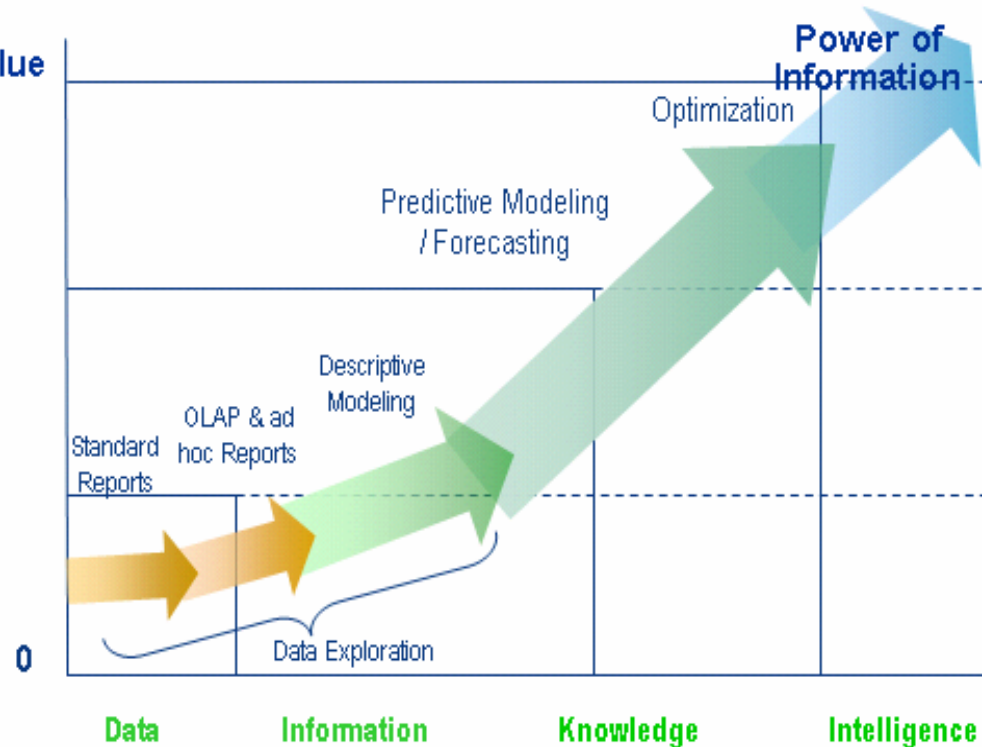
- ◆ About Business Analytics
- ◆ Current Situation in US and the World
- ◆ Statistical Techniques used in Advanced Business Analytics
- ◆ How to web-publish and run your analytics via a web-interface
- ◆ Examples of Analytics providing Actionable Insights:

About Advanced Analytics

- Analytics are tools that allows running of an analytical procedure
- Advanced Analytics
 - ◆ Use advanced Statistical and OR techniques
 - ◆ Provide Actionable Insights
- Analytics are best utilized if web-published enabling users can run them remotely via the Web
 - ◆ without having any data analytical software (e.g. SAS) on desktop
 - ◆ only with business knowledge and with no expertise in Statistics
- Developed working with experts in an organization
- Almost any business can benefit from web-based analytics

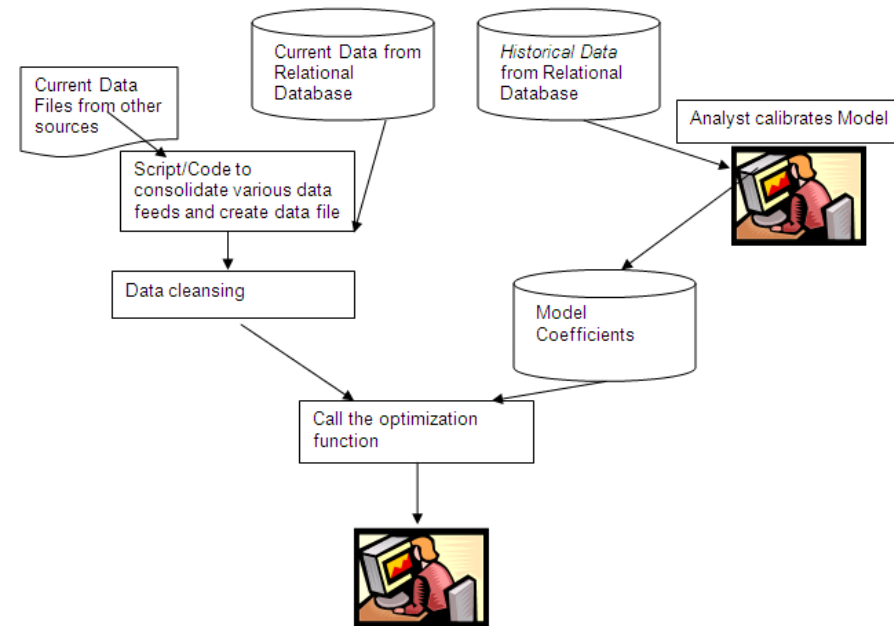
Advanced Business Analytics: Leveraging the power of analytics

- To get full benefit of your models, go beyond ROI estimation
 - Optimize ROI
 - Provide Business Insights to take specific actions
- Possible when model parameters are estimated at lowest level of decision making
- Use calibrated model to Optimize Promotional Tactics and Business Operations
- Web-publish analytics so that
 - Marketing/Sales can run models
 - No need to know Stats Techniques or Programming



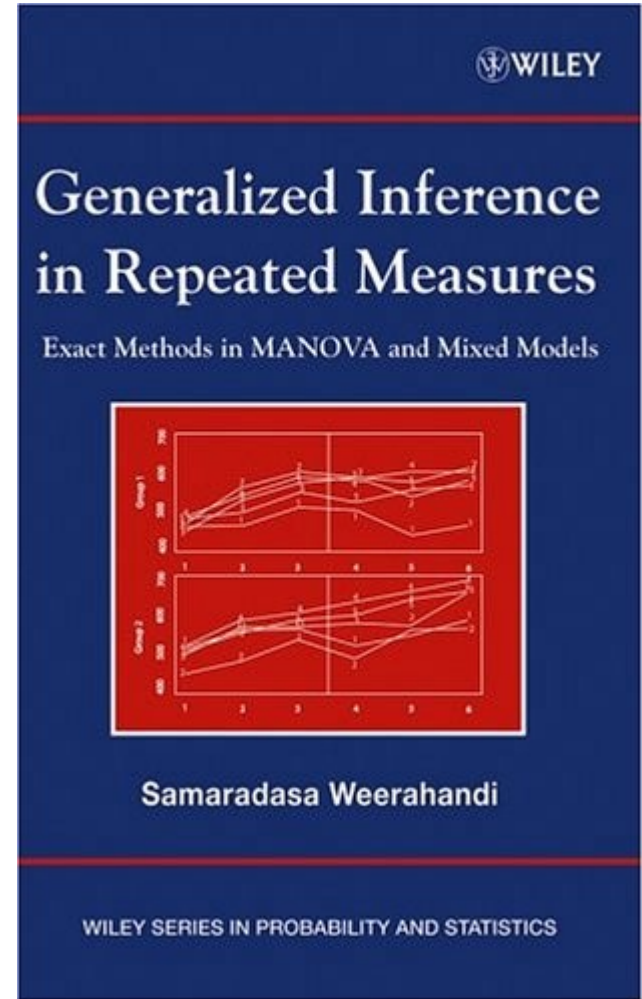
Current Situation in US and the World

- US Companies are leading in Analytics
- Mostly Technology companies (e.g. Google, Yahoo, Amazon, NetFlix) used to lead in Analytics
- Now most companies use Analytics, but many lack analytical value
- In-depth Business Analytics require
 - Statisticians
 - BI Developers with analytical knowledge
- Many companies perform simple Business analyses such as Trend, ROI calculations, Market Share
- Such analyses are of limited use
- Use Analytics providing Actionable Insights



Statistical Techniques Used in Advanced Analytics

- ◆ Mixed models are now heavily used
 - in Business Analytics
 - In analysis of data from Clinical Trials
- ◆ In Corporate America performing advanced business analytics Hierarchical Mixed Models are heavily used
- ◆ You can read more about Mixed Models from freely distributed Book www.x-techniques.com
- ◆ The most widely used Statistical Techniques in Business Analytics was used to be LSE (Least Squares Estimator)!
- ◆ What is the Most widely used business analytical technique today?
- ◆ **It is BLUP, the Best Linear Unbiased Predictor**



Statistical Techniques Used in Analytics (ctd.)

- ◆ In Corporate America performing advanced business analytics
 - **BLUP has replaced LSE as the most widely used statistical technique**
- ◆ Why? In estimating by large number of segments, estimates you get using
 - BLUP provides more accurate estimates than by LSE
 - BLUP yields shorter prediction intervals
 - Chance of getting wrong sign diminishes
- ◆ Example: Suppose you were asked to estimate consumer Response to TV campaign by Market (DMA). Then
 - Ad-stock TV GRPs
 - Model sales by market as a function of ad-stocked GRP and other drivers of sales
 - **If you model all covariates as “fixed effects” and use LSE you will not even yield the right sign for some markets**
 - So, model response to TV Ad as a random effect around the national average
 - USE BLUP instead of LSE

Overview of the BLUP



- Suppose certain groups/segments distributed around their parent
- Assumption in Mixed Models: Random effects are Normally distributed around the mean, the parent estimate, say M
- Suppose Regression By Groups yield estimate M_i for Segment i
- Let V_s be the between segment variance and V_e be the error variance, which are known as Variance Components
- It can be shown that the BLUP of Segment i effect is

$$\frac{V_e M + k V_s M_i}{V_e + k V_s}$$

a weighted average of the two estimates, and k is a known constant that depends on sample size and group data

- The above is a shrinkage estimate that move extreme estimates towards the parent estimate

The BLUP (ctd): Some Inference Issues



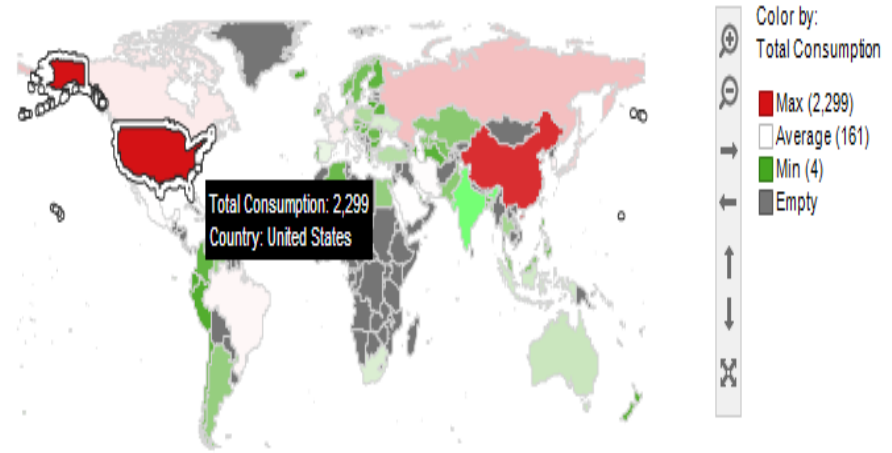
- Recall that BLUP of Segment i effect is
$$\frac{V_e M + k V_s M_i}{V_e + k V_s}$$

is a function of variance components (two or more)
- MLE based methods frequently yield 0 (or negative) variance estimates, a drawback of
- Generalized Estimator (GE) and Bayesian Estimator (BE) do not suffer from such drawbacks
- Areas requiring further research:
 - ◆ Extending GE/BE to more complicated mixed models
 - ◆ Improving upon GE/BE using Stein type approach

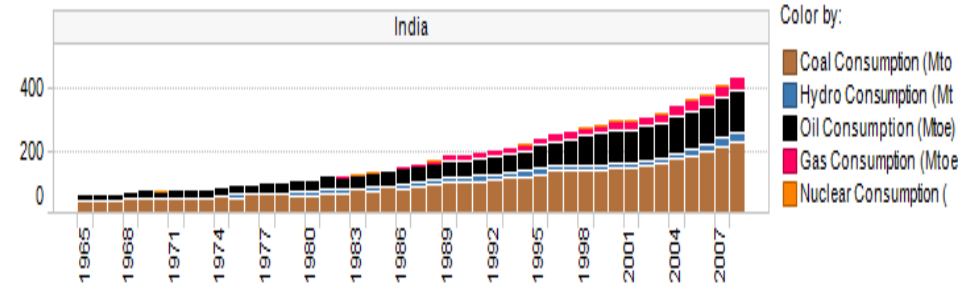
How to Web-Publish Your Desktop Analytics: BI Software

- ◆ Use BI Software to web publish your analytics
- ◆ They provide Drilldown capabilities, Interactive capabilities, etc.
- ◆ BI software for reporting: **Cognos, Business Objects, MicroStrategy, SAP, etc.**
- ◆ **SpotFire (see Image) and Microsoft Power BI allow any analysis with R**
- ◆ Few other BI software allow programming in SAS and SPSS

2008 energy figures



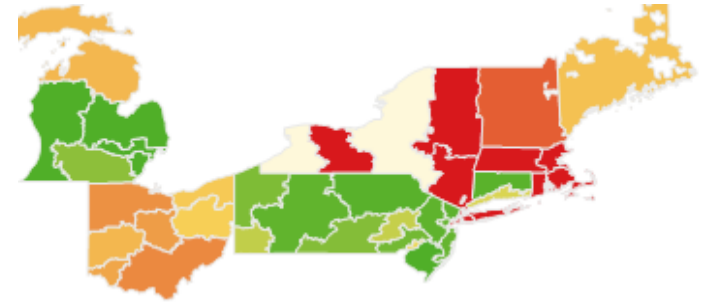
Yearly consumption by energy type (Click on a country to see)



Advanced Analytics Example 1: Estimating and Optimizing TV Ads

■ Problem:

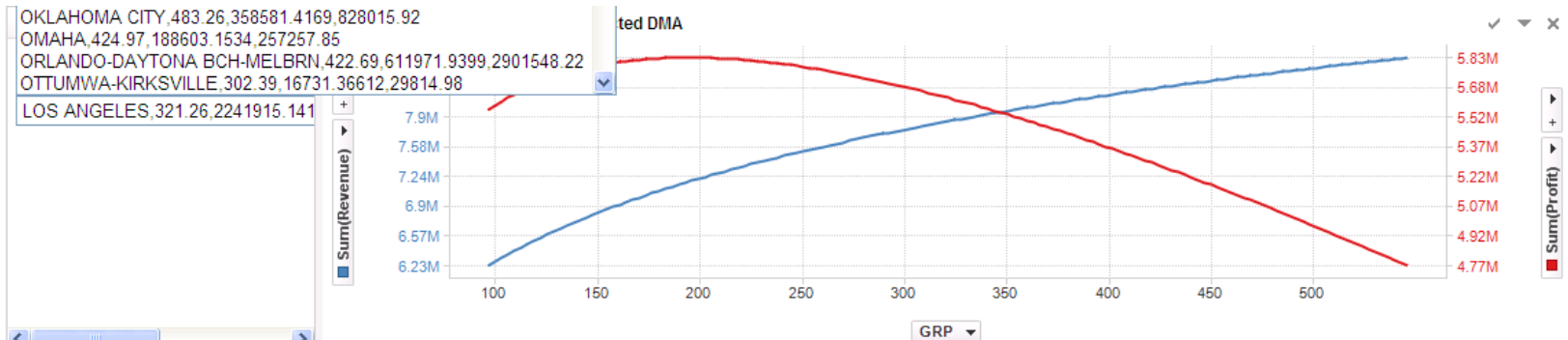
- Estimate Response to a TV Ad by Market
- Optimize TV exposure by Market



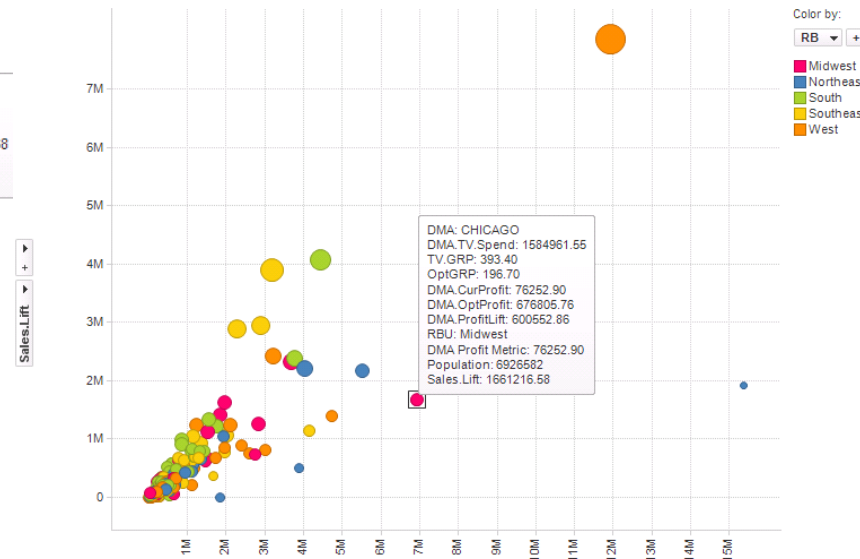
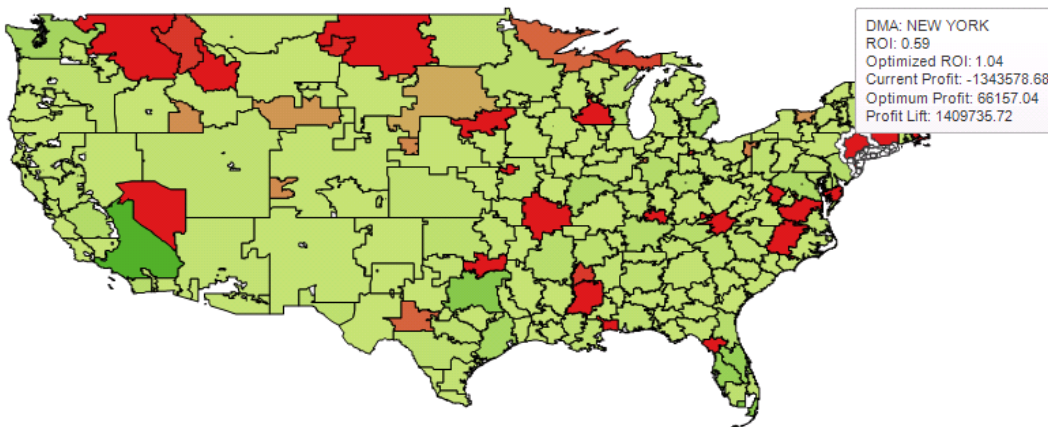
■ Approach to Modeling:

- Model Sales or log sales on **ad-stocked GRP** as random effects around the national average, with other covariates such as Trend
- Estimate the parameters by REML (if converges) or GE
- Use estimated responses to TV and write down the profit function
- Do parameter estimation on desktop
- Do Optimization and Visualization Real-Time via a Web-based Analytic

Estimating and Optimizing TV Ads (ctd.)



- With estimated Consumer Response, we can perform real-time analyses using R
- Running one market time is Inefficient
- But, we can run all markets and optimize in background and visualize to provide insights, as shown below



Advanced Analytics

Example 2: Inventory Optimization

- Analysts estimate Model parameters periodically; e.g. Demand Model for consumer products of a Supermarket Chain; e.g. Interface below
- Other parameters and scenarios are specified by users
- Model is applied real-time with latest data
- Results are displayed or exported in desired format
- Optimization is done real-time:
 - ◆ Note: Average Demand is NOT the Optimum Inventory
 - ◆ Optimum Inventory is a Quantile, a function of the Mean and Variance Both:
Opt Inventory = $\mu + \sigma \Phi^{-1}(1-c/p)$, where c is the unit cost and p is the unit price

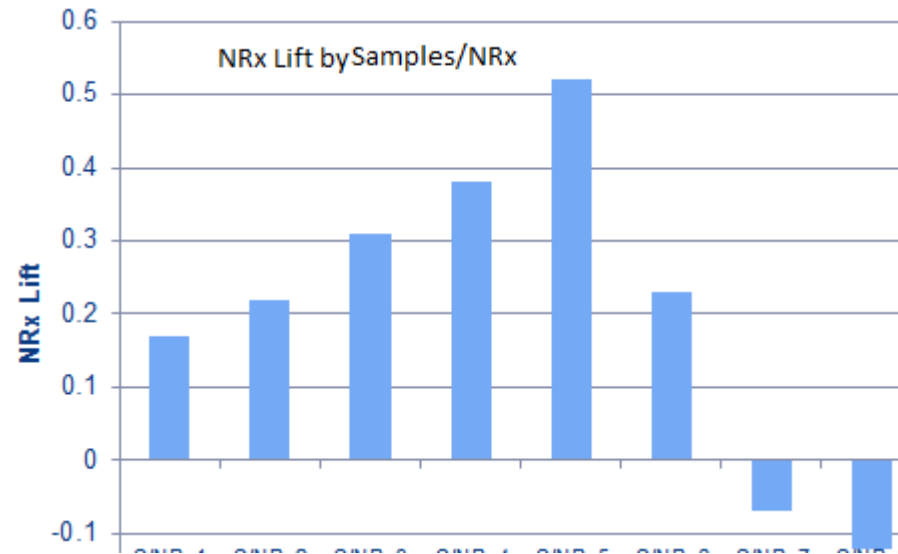
The screenshot shows a web interface for 'Fresh Grocer Mart' titled 'Inventory Optimization'. The interface is divided into two columns of input fields. The left column includes: 'Item:' with a dropdown menu showing 'Apple Juice' (selected) and other options like 'Orange Juice', 'White Bread', and 'Wheat Bread'; 'Start Date:'; 'Price Per unit:' with a text box containing '2.00'; 'Sale Price Per unit:' with a text box containing '1.00'; and 'Week of the Year:' with a text box containing '20'. The right column includes: 'County:' with a dropdown menu showing 'Middlesex'; 'End Date:' with a text box containing '09/22/2011'; 'Cost Per unit:' with a text box containing '0.50'; and 'Min units Allowed:' with a text box containing '5'. At the bottom left is a 'Home' link, and at the bottom right is a 'Run Analysis' button.

Inventory Optimization: Leveraging to non-flat Demand models

- Preceding Inventory model for “Flat Demand” is called “Newsboy Model”
- Appropriate for ‘Rent-a-Car’ type inventory management, but not for such problems as Medicine Sample Allocation to Doctors
- Many pharmaceutical companies use a Vendor developed Newsboy type model for Sample Allocation
- Not appropriate even for Magazine Inventory Management

Newsboy model

- Not appropriate due to the shape of Demand function, a piece-wise curve as shown in figure
- cannibalize brand sales due to over-sampling
- We develop customized Demand models and Optimize for any type of logistics problems



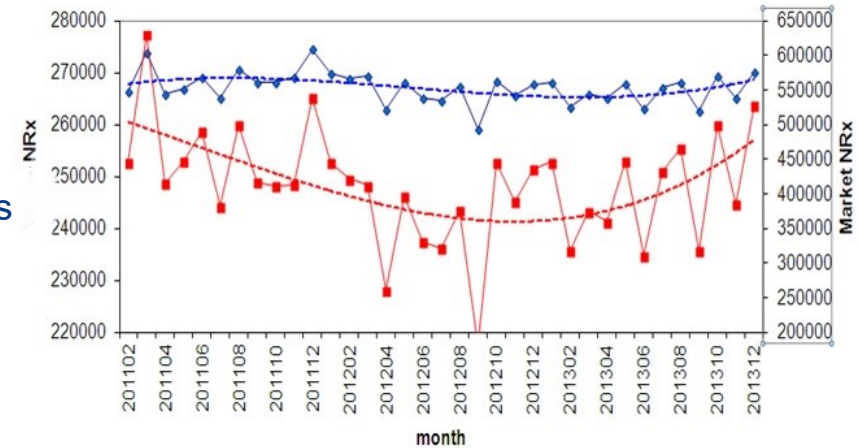
Sample Allocation Optimization Model: Does the Model work?

- A Model was developed in 2012 for a particular pharmaceutical company
- Implemented in 2013
- Year 2012 was a bad year
 - ◆ Major brands all had a negative trend
 - ◆ Ads (e.g. TV) were down due to budget cuts
 - ◆ So, all marketing strategy was down
- Only major change happened end of 2012 was implementation of New Medicine Sample Allocation model
- Model Performance was evaluated by a third party

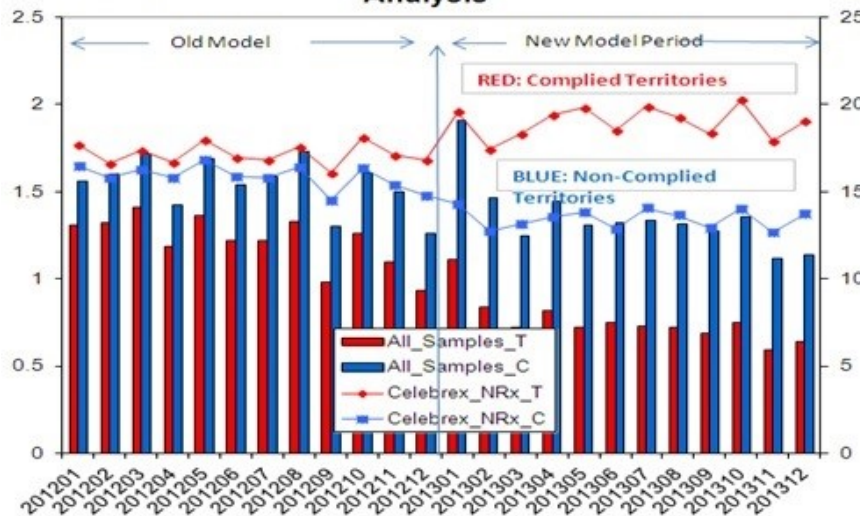
Starter Allocation Optimization: Did the Model work?

- New Model was implemented in January 2013
- After 4+ years of negative trend, Brand 1 Trend became positive
- After 18 months of negative trend, Brand 2 Trend became positive in 2013, and hit an all time high in Sales
- If Trend continue to be positive or negative
Compare Territories Complied vs less-Complied: e.g. Brand 3:
 - ◆ Complied territory sales Trend became positive
 - ◆ Non-complied territory sales Trend continued to be negative

Brand 1 : NRx (Red) vs Market NRx (Blue)



Brand 3: Test (complied) Vs. Control (not-complied) Analysis



Brand 2: NRx (Red) vs Market NRx (Blue)

