Agent-based Modeling vs. Market Mix Modeling

Comparison of Effectiveness
Marketers are increasingly interested in making their campaigns and media investments more effective. The industry around marketing analytics is exploding, caused in part by the push to show the Marketing ROI of social media, the tail is now wagging the dog and all marketing must show an ROI for the investment being made.

Since the turn of the 20th century, innovators have sought out ways to both measure and improve their marketing effectiveness. The industry has gone through many iterations in technology in pursuit of this goal, emerging from a flat measurement of increased sales (the truest measure) to spreadsheets to regression analysis to now, the most advanced analytics tool to date, the adoption of Agent-based Modeling (ABM).

Not all ABM is the same however. There are many significant differences between agent-based modeling implementations, whether they are built from scratch or use ProRelevant’s industry-leading ABM platform, MarketSim®.

Comparing the basic difference between ABM and statistical modeling however is the focus of this whitepaper which explores a comparison between what is seen as state-of-the-art in regression-based, statistical models (Market Mix Modeling) and industry leading ABM technology.

This paper examines six important differences and then lastly, examines how the MarketSim ABM platform extends the difference by uniquely incorporating past consumer history.
A Description of Market Mix Modeling

Marketing Mix Modeling (MMM) is known to be based on the use of statistics to correlate or regress marketing drivers of sales volume against that volume. It is a method to determine whether these drivers deliver increased or decreased volume and by how much.

In a statistical MMM, sales volume is known as the dependent variable (the Y in the formula below) and the possible drivers of sales are known as the independent variables (the x’s in the formula below).

\[ Y = \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n + \text{Constant} \]

The beta (‘\(\beta\)’ in the formula) coefficients represent the coefficient of the particular media channel or other marketing driver. The \(\beta\) coefficients are calculated to determine the best ‘fit’, that is, least error, in the model.

This is the simplest form of a statistical regression model to build an MMM. There are many variants, including multiplicative, pooled models and ARIMA models. Each of these tend to improve the level of accuracy or predictability of the models.

In addition to the modeling method, assumptions of how the marketing drivers work are also built in to the mathematical representation and modeling process. Adstocks, diminishing returns and price elasticity curves are typical enhancements used in the modeling process, however they only indirectly represent consumer behavior. Instead they are media-centric enhancements.

The regression modeling process is a fitting process, where the goal is to estimate the \(\beta\) coefficients such that the error between actual sales volume and modeled sales volume is as small as possible. There are a handful of measures of good fit, but ‘R-squared’ is probably the most well known. It is a number from 0 to 1 and represents the level of variation explained by the model. A number closer to 1 is better than a number closer to 0.

Regression Model (MMM) Example

If \(x_1\) were TV Gross Rating Points (GRPs) aired in a given period and \(Y\) were packs of diapers sold in the same period and \(\beta_1\) was 140, then for each GRP of TV advertising in a week the model would estimate that 140 packs were purchased.

If the actual GRPs were 225 in a given week, then the model would estimate that 31,500 packs of diapers would have been sold due to that advertising.
Agent-Based Modeling & Simulation (ABM)

‘Agent-based modeling’ is a generic term, like ‘statistics’, which describes the methodology to build a model of an observable process. There have been many agent-based models built to answer complex questions. These include trajectories for spacecraft, operations for the space station, and city-wide traffic patterns were some of the first ABM applications.

Each starts with some mathematical description of the key elements of the process. As computing power and speed expand, the complexity of an agent-based model can expand. Familiar examples of agent-based modeling include popular games such as the Sim- games (Sim-Ant, SimCity, etc.).

About 10 years ago ABMs were introduced for use in marketing and overwhelmingly they have received wide praise for their ability to accurately model consumer behavior and providing actionable results.

For marketing, ABMs generally start with a model of the consumer. MarketSim does this based on well-proven models that incorporate the theories of consumer behavior from Nobel-laureate Daniel Kahneman and his work on the psychology of judgment and decision-making and real world experiences from marketers such as Procter & Gamble and a host of CPG / FMCG companies from around the world.

To keep the thinking in the model current, we work with some of the sharpest minds in consumer behavioral modeling. MarketSim changes as your audience changes.
Agent-based Modeling vs. Market Mix Modeling

Last touch attribution v. consumer behavior

A statistical MMM looks at understanding how media works and looks at the response it delivers in terms of sales. To build a statistical MMM time-series data of the sales and the marketing activities over a certain amount of time are gathered. This time period is typically 3 years, or 156 weeks.

There are a number of data transformations that can be done to improve the predictive power of the statistical MMM. These include Adstocks, diminishing returns and price elasticity curves as mentioned before. But beyond these transformations, the model fundamentally looks at the sales volume in a given week and regresses that against the dependent variable of unit sales. An MMM ignores any past consumer behavior and consumer perceptions or state of mind. It is essentially an enhancement to a last touch attribution model.

Agent-based models are very different. They build in past consumer behavior as well as activities in the current period.

MarketSim specifically does this in a number of ways. Here are three:

- MarketSim includes the impact of all past purchases on the consumer
- MarketSim incorporates the value of all past advertising from all brands in the category
- MarketSim incorporates the value of the brand for the consumer to determine their brand choice
Modeling the future

Because of the way statistical modeling works, there are a number of limitations that are inherent when using a MMM to make predictions into the future. Statistical MMMs work best when the category is relatively **static** and there are generally **no major changes**.

Statistical MMMs have difficulty however in delivering robust answers to support critical marketing decision making for a product launch, a new marketing campaign or a major shift in some external driver (e.g., weather, a tax increase, or technical innovation).
Agent-based Modeling vs. Market Mix Modeling

**Modeling a product launch**

Because ABMs, in general, and MarketSim, in particular, can accurately model consumer behavior and therefore the major dynamics in the category can be readily modeled.

A great example is a new product launch, which is anything but certain for many companies.

When a new product is launched, the awareness, the purchase intent, the brand relevance and distribution are zero. There has been no product trial, repeat purchase, purchase or intent. There is no consumer experience with the brand.

Here are typical, real life assumptions related to a product launch:

- The product will be launched at some targeted price at the consumer level
- There will be some level of reasonably known and controllable build up in distribution
- We can test various media plans based on expected creative quality, reach and frequency
- We can estimate how brand equity will grow based on past experience
- We can estimate the trial and repeat process for the new brand based on the model’s experience in a category

MarketSim can simulate future sales based on these factors. The marketer can then make adjustments to the investments in price promotions to spur trial, in increased distribution and in media, to balance and optimize the overall spending plan to drive the most volume in the shortest amount of time, as well as grow brand equity or drive penetration.

Each of these can then be simulated against a handful of scenarios, depending on how the marketer perceives competitive response to their initiative in order to build a well thought-out risk portfolio of the first six to twelve months of the product launch.

**Single brand v. category model – One Apple or the Whole Basket of Fruit**

A marketing mix model is typically built using sales volume of a single brand as the dependent variable.
Methods are available to model more than a single brand, but the complexity coupled with the inherent uncertainty of the outcomes make MMM a poor choice for this kind of work. The complexity of the entire category further implies that the interactions of competitive advertising, pricing and distribution are only partially included in the model. This has an advantage for MMM practitioners - less data is required.

Agent-based modeling and simulation using MarketSim models the complete category. All major SKUs (typically 50 to 90) are included in the model. MarketSim includes all data from sales, brand and advertising in the model, making the model much more comprehensive and therefore more predictive and robust.
Agent-based modeling is simulation based

Statistical MMM is based on a time-series regression analysis. It looks simply at the ups and downs (the variance) in each of the inputs (the independent variables) and correlates them against the variance in the output (the single, dependent variable.)

The beta coefficients are calculated to minimize the error between the modeled sales and the actual sales. This is called a ‘fitting’ process. Building a simulator based on these results can be difficult and the model is often not predictive, especially where there are significant changes or dynamic aspects in the category.

An agent-based model using MarketSim is, from the beginning, a simulation-based approach. This means that the deviations and variations that are a part of the natural world are properly considered within the model from the outset.

The outputs are simulated starting from the first day of the modeling period and run to the last day of available data. It simulates the outputs – the sales volumes for all SKUs in the category – and compares them against real sales. The parameters in the model are adjusted in order to calibrate the model, such that the difference between real sales and simulated sales are as small as possible. This fitting process is called ‘calibration’.

Once these parameters have been fit, they no longer need to be recalculated when new data is available. Only the new marketing activities need to be entered. New activities don’t need to be calibrated, unless there is a new creative concept or some new marketing channel in use.
Agent-based models can use data with varying granularity

Typical marketing mix models are built using time-series data at a weekly level. Unfortunately, many data sets are often at a monthly level. Monthly data sets include billboards, print media and brand tracking data. Brand tracking data is sometimes available at a monthly level, but is often only available at a quarterly or even 6-monthly level. It is difficult for a statistical model to perform well using a mix of weekly, monthly and quarterly data.

An agent-based model can use all data types. In MarketSim, data is parsed down to a daily level in order to simplify the alignment of the data types. Because the model is built on a consumer purchase behavior framework, the model is much more robust.

In addition, the model accuracy is validated across multiple dimensions. Some of these include: time periods (e.g., 1, 4 and 12 weeks), classes of trade (e.g., food, drug or mass), SKUs and brands. With this level of cross validation of the model, the predictive power of the model is significantly higher than a simple statistical model.

Finally, because the model is based on a detailed consumer purchase behavior framework, the statement ‘correlation does not equal causation’ does not apply. If it does calibrate in ABM, it is the cause.
MarketSim® ABM incorporates past consumer history

Statistical models do not take past consumer history into account. They cannot.

They only regress the sales and independent variables for each week of the modeling period. They totally ignore how consumers make purchase decisions based on their past experiences with the brands.

In the real world, as each consumer uses a product or sees advertising, their future behavior is changed.

1. **Awareness** - If they aren’t aware, they can’t have purchase intent or brand equity. Once they are aware, then they can build purchase intent and brand equity. Only then can they purchase a product.

2. **Prior purchase** - The next purchase made by a consumer is dependent on their most recent past purchases. For a new product launch, this trial and repeat process is modeled in a detailed way within MarketSim allowing marketers to very accurately model the launch of a new brand.

Statistical MMMs ignore any level of awareness, as well as many other critical consumer-centric data known about the category. MMM ignores past use and *only* looks at the inputs (independent variables) and the outputs (dependent variables).
Media centric v. consumer centric modeling

Statistical MMMs are essentially regression models of how media explains variance in sales. The assumption is that media drives consumer purchase (it does) but it ignores the underlying actions taken by a consumer.

There is a ‘black box’ between media and sales volume. This means that the connection between media and consumer behavior is at best, indirectly modeled and based on how well it regresses against sales volume in a given period.

On the other hand ABM in a MarketSim model accurately portrays the connections directly for all media; including traditional media, instore media, sponsorships, and digital and social media. It opens the black box, so that brand managers can fully understand the drivers of consumer behavior in their categories.

Consumer behavior is based on where the brand is in the purchase funnel, how they perceive the brand, whether the brand can be found in distribution and many other key elements that go into a consumer’s purchase decision at the moment of truth at the shelf.

MarketSim is designed to use the latest theories, grounded in experience, to model consumer purchase behavior. This requires the analyst to have a more robust understanding of consumer behavior not just media.

Modeling using MarketSim includes transaction data (i.e.; Nielsen or IRI), media data from any source and brand tracking data (i.e.; Millward Brown). Additionally, Usage and Attitudes studies can be used to provide category background data to enhance the construction of the model.

Because a statistical MMM is media centric the marketing analyst makes the assumption that correlation is causation. With MarketSim, the analyst just needs to understand how consumers make purchase decisions. The outcomes developed by MarketSim are more robust and predictive because they are grounded in validated, fundamental consumer behavior theory.
Summary

MarketSim is in a special class of ABM. It has a highly detailed consumer purchase behavior model at its core and is built around a simulation technique that makes it possible to very accurately model dynamic consumer markets.

This document highlights major differences between MarketSim ABM and statistical MMMs. There are many other differences not discussed here and if you’d like more information on how MarketSim can work for your organization, visit our website at ProRelevant.com and request a live demonstration.

We’ll set up a time where we can illustrate these differences and others in much more detail to see how they could apply to your business.

MarketSim from ProRelevant Marketing Solution. New ideas in a new age of marketing.

*Don’t Guess. Know. Act. Win* with MarketSim from ProRelevant