Using Advanced Analytics to Model, Predict and Adapt to Changing Consumer Demand Patterns Affected by COVID-19
## Contents

COVID-19's Impact on Retailers and Their Suppliers ................................................. 1
New Opportunities Created by Advanced Analytics and Predictive Modeling ................................. 1
SAS Launches COVID-19 Data Analytics Resource Hub ........................................... 2
Enabling Rapid Demand Responses to COVID-19 Driven Market Changes ............................................. 3
A Global CPG Company: Creating Accurate Sales and Production Plans ........................................ 4
Rapid Delivery of a SAS® Solution Prototype ........................................................................ 4
Why This Approach? ............................................................................................................. 5
SAS® Technology at Work........................................................................................................ 5
A European Online Grocery Retailer: Enabling a Demand Sense-and-Respond Model ........................................... 7
Investing in New Data and Advanced Analytics Capabilities........................................ 8
The SAS Approach: Enabling Short-Term Demand Sensing Capabilities ........................................... 8
Analyzing Historical Sales Data ......................................................................................... 9
Making Predictions for Future Planning ............................................................................... 10
Assessing and Improving SAS® Model Performance .................................................... 11
Delivering Real Results ........................................................................................................ 12
Learn More ............................................................................................................................. 12
Author and Content Contributor ..................................................................................... 13
Analytics Project Team Members .......................................................................................... 13
COVID-19’s Impact on Retailers and Their Suppliers

The COVID-19 pandemic is having a significant impact across all product segments, but it’s most widely visible across retail and consumer goods. Daily news and social media reporting are inundated with images of empty shelves where toilet paper, household cleaning supplies, meat and other products should be fully stocked. As a result, consumers are changing where they shop, what they purchase and how much they buy.

Retailers and consumer goods suppliers are urgently trying to determine how changes in consumer behavior will affect their regions, channels, categories, brands and products during and beyond the COVID-19 crisis and what actions they can take now. They must find new ways to adapt to shifting consumer behaviors in response to the pandemic. To succeed, they must adjust strategies immediately to improve business performance while preparing for the new normal.

New Opportunities Created by Advanced Analytics and Predictive Modeling

Prior analyses of economic recessions indicate that the companies that embrace thoughtful and immediate action can build the resilience required to weather the storm and emerge stronger. Tracking and monitoring shifts in consumer demand will signal dramatic changes in consumer behavior across many dimensions, including category consumption, channel selection, shopping frequency, brand preference and changes in demand patterns. These shifts, combined with forecasts for virus mitigation and economic recovery, are critical indicators for retrofitting new commercial strategies.

Across product categories, retailer and consumer goods suppliers are trying to understand the factors responsible for growth in demand. For example, when shelves are out of stock, are people consuming more or just pantry loading (stocking their pantries) in preparation for unforeseen changes in the pandemic? As Consumer Packaged Goods (CPG) suppliers seek insights as to why changes are unfolding, they are looking for more accurate ways to forecast demand for their products during and after the crisis.

As a result, leading retailers and CPG companies are using advanced analytics and machine learning to mine a multitude of sources to gain insights into shopper and demand patterns. To understand how demand may evolve during and after the crisis, they are analyzing point-of-sale data, syndicated scanner data and epidemiological data; using social listening; and looking at economic trends. They are also asking many questions to gain more clarity on how to revamp strategic plans for what will be the new normal – or, perhaps, what will be the new abnormal.
SAS Launches COVID-19 Data Analytics Resource Hub

In mid-March 2020, after the World Health Organization declared COVID-19 a pandemic, SAS launched the COVID-19 Data Analytics Resource Hub to begin tracking the crisis. This hub is designed to counter the pandemic through the three stages of disruption:

- **Respond:** This is the earliest stage of any disruption, when management first realizes that something is amiss. The focus is on determining how severe, widespread and fast-moving the disruption will be so you can prepare and respond appropriately. An important activity in this stage is assessing the state of supply (for example, food, medical services, consumer goods or other products).

- **Recover:** This stage focuses on economic and social recovery as companies start to emerge from isolation and businesses and governmental functions begin to resume their efforts. Organizations must address key questions, such as how manufacturers and sellers will deal with inventory that has now moved into clearance territory, as well as changing demand patterns.

- **Reimagine:** The final stage is all about reimagining and future-proofing your organization by building resilience. It's an opportunity to reconsider and reinvent how you operate, as well as to apply lessons learned during the disruption so you can be more agile and responsive in the future.

Using SAS® Viya® and SAS Visual Analytics, an innovative open visualization technology, SAS developed a robust COVID-19 dashboard, which helps global organizations combat the virus using analytics to explore COVID-19 data. The dashboard tracks the most recent global stats, accessing new COVID-19 data that's uploaded daily. SAS advanced analytics uncovers new trends and insights by location. And the dashboard also provides epidemiological and trend analysis to track the spread over time and uncover collective insight (see Figure 1).

![SAS COVID-19 dashboard for visualizing, exploring and analyzing pandemic data.](image)
SAS is also making real-time COVID-19 insights accessible with the coronavirus dashboard report. Members of the business and health care community can use it to discover and track the latest on the pandemic using a dynamic data visualization dashboard. Powered by SAS Visual Analytics, it enables users to probe the most recent statistics via interactive charts, graphs, diagrams and more. Embedded drill-down capabilities make it easy to depict the status, location, spread and trend analysis of cases around the globe.

Enabling Rapid Demand Responses to COVID-19 Driven Market Changes

Large global retailers and consumer goods suppliers are turning to SAS for help on two fronts:

- Using advanced analytics and machine learning to visualize, forecast and make more informed decisions to address changing demand patterns for their products.
- Creating a better, safer presence in a world after COVID-19.

For most companies, the length of time it takes for the demand forecasting process to incorporate rapid changes or short-term spikes in demand is a challenge. Short-term spikes can occur with retail store promotions, sudden changes in weather conditions, social media sentiment - and pandemics. Today, changes in demand are being driven by a pandemic, forcing companies to respond, recover and reimagine in a new normal. According to Larry Lapide, PhD, Research Affiliate at the MIT Center for Transportation and Logistics, “Quick response forecasting (QRF) techniques are forecasting processes that can incorporate information quickly enough to act upon by agile supply chains.” The concept of QRF (also referred to as “rapid demand response,” or RDR forecasting) is based on updating demand forecasts to reflect real and rapid changes in demand - both during and between planning cycles.

Due to the volumes of real-time data being collected as a result of the Internet of Things (IoT), it is nearly impossible to understand changing demand patterns manually using Excel spreadsheets. As retailers try to rapidly forecast changing demand patterns, they will need to automate the process and employ advanced analytics. In many cases, these short-term spikes exceed the projected baseline demand and are not always a result of planned sales promotions or marketing events, like an unforeseen pandemic.

The COVID-19 Data Analytics Resource Hub equips organizations across all industries to address these challenges by using SAS’ most advanced technology in innovative ways to combat the coronavirus outbreak. One such technology is the COVID-19 public dashboard, which uses SAS Viya to visualize key metrics and trends related to the COVID-19 pandemic. It provides continually updated stats on daily new confirmed cases, global spread by country, comparisons of selected countries and regions, and data trends to track the outbreak.

To better understand how SAS can help, let’s explore two recent customer examples where SAS helped a large global CPG company and a regional online retailer predict short-term shifts in demand patterns for their products. These predictions helped these businesses through the respond, recover and reimagine stages of the COVID-19 crisis.
A Global CPG Company: Creating Accurate Sales and Production Plans

A global CPG company needed to understand the impact of COVID-19 on its sales forecasts and production plans across key products by market. It was particularly interested in understanding which factors were affecting the markets that had already peaked and were now in the recovery stage of the COVID-19 pandemic. The process used surrogates, or “As Like” products, to predict patterns in markets that were in the earlier stages.

The senior director of demand planning and analytics for the company was interested in exploring how the SAS COVID-19 dashboard, which is available through SAS’ COVID-19 Data Analytics Resource Hub, could help. Of particular interest was how the dashboard could be combined with the company’s enterprise data to help decision makers better understand how consumer behavior in each country was being affected by the pandemic. Beyond this, the company wanted to use epidemiological predictions to forecast changes in demand for its products. This would allow the company to adjust plans and ensure the right goods were delivered to stores when they were needed to fulfill customer orders.

As a major food and beverage producer, this company needed to maintain both production sites and supply chain integrity. As a result, it needed a rapid demand response to changes in the global supply chain.

Rapid Delivery of a SAS® Solution Prototype

The company worked with SAS to quickly develop a solution prototype. Management provided SAS with data from retailers in China, France, Italy and Germany. Over the next three weeks, SAS worked closely with the company, holding daily calls to share progress. As shown in Figure 2, the result was an end-to-end solution that has been made available to the company’s supply chain analysts to evaluate incorporating the approach in their demand forecasting process.

![Figure 2: An end-to-end, interactive dashboard.](image)
The new solution predicts the spread of the epidemic using a SEIR (Susceptible, Exposed, Infectious or Recovered) model and employing machine learning algorithms (trained using data on the reference market) to determine expected sales predictions for each target market. Figure 3 summarizes the key capabilities of the SAS solution.

![Figure 3: The SAS approach to addressing key challenges.](image)

**Why This Approach?**

The company found that the response to COVID-19 is reflected in the sales patterns from market to market and product group to product group. For example, some items will see increased sales when people prepare for quarantine living by stocking up their pantries. During isolation, sales may drop and then recover as quarantine measures are relieved. There are many of these patterns simply within different product groups, let alone when considering different industries, markets and regions.

This approach to understanding buyer behavior and demand patterns is similar to predicting outcomes for a new product launch. By comparing the characteristics and attributes of new products with similar, existing products that share similar characteristics, the company can use information across markets as the epidemic spreads through those regions at different times. The assumption built into this approach is that markets in earlier stages of the epidemic can learn from the patterns in markets that are in the recovery to reimagining stages of the epidemic.

**SAS® Technology at Work**

The SAS solution finds varying patterns from prior pandemic stages and applies those patterns to predict sales in markets that have not yet experienced those stages. Demand planners and brand managers can then learn from preceding markets what the probable sales patterns are for the next phase of COVID-19.

For example, the solution revealed that China and Korea (reference markets) were mostly at the stabilization phase or approaching the recovery phase of COVID-19. Their POS (point-of-sale) patterns had already gone through highs, lows and outbreak phases and were starting to stabilize. In contrast, Italy (the target market) was still at the outbreak stage, or restricted living phase, of COVID-19 - fully three to four weeks behind China and Korea (see Figure 4). If the sales patterns of a given product category in Italy so far closely resemble a cluster of time series in China and Korea leading up to their outbreak phase, one could assume that the sales patterns in Italy will likely continue to follow the same time series cluster seen in China and Korea.
As these examples illustrate, the SAS statistical forecast is based on replicating historical behavior into the future as the forecast. In this case, it linked the historical behavior in one country (i.e., what has happened already) in the COVID-19 period to understand what is likely to happen in another country.

Figure 4: The four pandemic stages for demand.

From a modeling process perspective, the SAS approach had similarities with new product forecasting: It was based on reviewing demand patterns in a reference market (in this case, China) and applying those same patterns to a target market. Figure 5 overviews the steps used in the SAS modeling process and their sequence:

**Step 1. Reference markets:** Cluster the time series for the reference market to produce anywhere between three and six representative time series models. These show the relative growth or decline throughout the epidemic phases, including the recovery phase (post-lockdown).

**Step 2. Target markets:** Match all the time series in the target market (about 40 series) to the time series from Step 1. This requires matching phase by phase so as not to ignore the recovery phase in the reference market at any point.

**Step 3. Employ an epidemic model:** Use epidemic models to predict when the recovery phase in the target market is likely to occur.

**Step 4. Adjust pantry stock:** Using the sales pattern for the recovery phase from the closest cluster of reference markets, apply that to adjust the forecast for the target market.

**Step 5. Forecast adjustments:** Estimate the household pantry stock due to stocking up at the beginning of the epidemic. This can be separately applied as a forecast adjustment.

**Step 6. View results via a dashboard:** Show results in an interactive dashboard.
A European Online Grocery Retailer: Enabling a Demand Sense-and-Respond Model

COVID-19 has dramatically changed normal consumer patterns. Activities like a trip to the grocery store or dining out with friends are difficult at best – and even prohibited in some locations. While the hospitality industry has been hit hard, sales for online retailers haven’t been slowing down in the short term, and this is expected to continue as we move from respond to recover, and finally reimagine the new normal.

In many places around the world, retail grocers are among the few businesses that have remained open, as they provide essential services to their communities. This has resulted in unprecedented increases in sales – not just in stores, but also online. According to Progressive Grocer, e-commerce grocery sales for home delivery and/or store pickup reached $5.3 billion in April 2020. This represents a 37% increase over March 2020 sales, which were already a new record.

COVID-19 thrust online retail grocers into the position of trying to fulfill urgent demand while meeting customers’ needs without interruption. The estimated percentages vary, but more consumers are turning to online grocery purchases as they stay at home and try to avoid brick-and-mortar stores out of fear of contracting COVID-19.

Given these trends, a regional online grocer in the EU – and SAS customer – experienced growth of online grocery purchases by more than 200% virtually overnight. This demand spike generated substantial supply chain bottlenecks and product substitution challenges, which in turn created order cancellations as consumers turned to digital channels to purchase food and other goods.
Analysts believe it’s very likely that this shift to digital consumer shopping and delivery experiences will persist and even grow, even after the coronavirus subsides. As a result, companies that act quickly to modernize their delivery models in ways that help consumers navigate the pandemic safely and effectively today will have a long-term advantage over their competitors.

Investing in New Data and Advanced Analytics Capabilities

Management realized that looking at sales orders alone would not help forecast the changing demand patterns resulting from the COVID-19 pandemic. This would require investing in new data, advanced analytics and predictive technology that could turn historical sales data into accurate forecasts of shifts in consumer grocery spending. Understanding true demand – and the disruptive events affecting demand for each product and location – would be vital to accurately align products and categories with shoppers’ needs. In addition, management believed that grocers that adapt to effectively plan to meet shifting online consumer demand will rise above the crisis as community lifelines – ready to handle spikes in online sales as needed.

The SAS Approach: Enabling Short-Term Demand Sensing Capabilities

SAS consultants worked with management to understand its business processes and challenges and how to best solve them. The SAS team also explored affected KPIs, categories, products and departments and identified the data necessary to solve the problem.

SAS recommended the company establish a short-term forecasting process using advanced analytics and machine learning. The solution would model internal and external data to predict detailed weekly demand across the product portfolio. Figure 6 overviews the data used in the models.

Figure 6: Data summary.
Analyzing Historical Sales Data

When the organization used the solution to model historical sales data, management could see that demand for most grocery categories increased, as consumers hoarded goods out of fear of shortages and public health concerns. In addition, inflationary effects due to rising exchange rates and COVID-19 related government actions led to further increases in consumption within the region - increases that are expected to continue into recovery. Subsequently, as the availability of goods decreased, it created low availability across many categories of products.

Consumers reacted to the fear of a shortage by initially purchasing more goods, such as pet food and toilet paper. However, the SAS model showed how consumption eventually returned to previous levels after recovery, resulting in the post-crisis volume declines. Work-from-home and shelter-in-place policies forced consumers to shift from visiting food-service outlets to ordering from online retailers. The result was increased consumption of these products during and potentially after the crisis. Figure 7 shows examples of the trend analysis reporting provided by the solution.

Figure 7: Uncovering insights from the data.
Making Predictions for Future Planning

Forecasting demand for grocery products is hard enough during normal conditions, let alone during a pandemic. Simple time series models that take historical demand for a product and extrapolate those patterns (for example, trend and seasonality patterns) into the future no longer work well under these conditions. As a result, SAS employed more advanced time series and machine learning models that could integrate additional information – such as epidemiological data, exchange rates, Google Trends and a stringency index – that can influence future demand or improve model predictability.

Fortunately, public health organizations have a good understanding of how pandemics spread. SAS combined this information with other key data sources to take full advantage of its advanced analytics and machine learning models. The data was readily available to estimate the various parameters in the models and then run what-if simulations to determine what will happen under various scenarios. Some of the parameter estimates, while not as significant in terms of predictability, enabled the grocer to test what happens to demand forecasts by varying future values within a likely range. The SAS solution also verified that a simpler model using only demand history alone would be misleading unless it could reflect various actions by local governments, the medical community and changing consumer demand patterns in reaction to the pandemic.

By applying machine learning to product attribute data and other external data in combination with historical demand, the SAS approach proved to be the most accurate way to predict demand by product and location – particularly where there was sparse sales history or if sales history was disrupted. Implementing a hierarchical forecasting approach allowed additional external data and causal factors to be deployed at different levels of data aggregation, including category and store levels. Additionally, it allowed the estimation of internal cannibalization effects from product out-of-stocks at various levels of the hierarchy, as well as the capture of halo effects across categories and products.

In addition, the SAS approach to solving the problem made it possible to estimate and predict the impact of disruptive events influencing future demand using advanced causal modeling. The company can also flexibly configure various event occurrences, as well as duration and recurrence factors. The strategy of modeling the impact of the disruptive event at the product and location level and then testing multiple algorithms to determine the best fit was significantly more accurate than using a one-model-fits-all approach. SAS technology was able to estimate event impacts and quantify the unique effects for each product and location up and down the hierarchy. In addition, using robust, real-time, what-if capabilities, the retailer was able to evaluate multiple scenarios regarding the outcome of the disruptive events on future demand.
Assessing and Improving SAS® Model Performance

This grocery retailer used SAS to model and forecast demand for several pasta categories and product groups, including noodles and nests, buckwheat grain, horns, shells, and butterflies and bows. To test the accuracy of the models, it used a four-step process:

1. Only use internal historical demand data.
2. Include Google Trends.
3. Include epidemiological data.
4. Include exchange rates.

By adding various causal factors, the retailer determined which factors improved the predictability of the models using MAPE (Mean Absolution Percentage Error) as the default performance metric. In other words, the lower the MAPE, the more accurate the model performed with those additional factors incorporated. Figure 8 overviews the entire process used to assess model performance and reduce forecasting errors.

Starting with just historical demand data, the models’ average MAPE was anywhere between 20% and 60% – a very high forecast error (indicating low forecast accuracy). However, as additional causal factors were added, the forecast accuracy improved significantly. MAPE decreased significantly to between 4% and 9%.

Figure 8: SAS modeling and forecasting results.
Delivering Real Results

SAS delivered a real-time feed and automation of data, providing the demand planners with an up-to-date view of global and regional patterns. SAS also delivered additional what-if scenarios to adjust product forecasts based on key consumer sentiment.

SAS can replicate this capability on any dedicated public cloud environment the customer uses, or as a Software as a Service solution in the SAS Cloud environment, using standard SAS software; SaaS solutions deploy in days. It also includes an interactive end-to-end COVID-19 dashboard, as shown in Figure 9.

Figure 9: Short-term, end-to-end interactive COVID-19 forecasting solution.

This advanced analytics approach is a proven methodology and straightforward way to adopt and implement short-term forecasting across a product portfolio. It is also a valuable practice to have in place for demand planning agility and execution.
Learn More

The COVID-19 crisis is challenging retailers and CPG companies to adjust pricing plans and promotional budgets to align with the projected demand curve across their portfolio. New promotional tactics, such as bundling higher demand and lower demand SKUs, will support products with higher demand curves, as well as those products negatively affected by the pandemic.

But wherever possible – and based on changing consumer demand patterns – companies need to build in a mix of actions, such as assortment adjustments, reduced promotions, and support for higher demand categories and products. These tactical changes can help counter the negative impact of the pandemic across their product portfolio.

Retail and CPG executives should plan to rapidly adapt their marketing and demand plans to reflect changing consumer demand patterns and sentiment. Additionally, they should quickly optimize their e-commerce channels – for example, by recalibrating product volumes with the new demand patterns and emphasizing the fastest-selling SKUs. Retailers should expect daily resets to their demand forecasts, which will require shifting online assortments accordingly and adjusting supply chain logistics and distribution centers to meet online consumer demands.

Learn more about how SAS can help at SAS Retail and Consumer Goods Solutions in the Age of COVID-19.

Author and Content Contributor
Charles Chase
Charlie.Chase@sas.com

Analytics Project Team Members
Sherrine Eid
Sherrine.Eid@sas.com

Sudeshna Guhaneogi
Sudeshna.Guhaneogi@sas.com

Pasi Helenius
Pasi.Helenius@sas.com

Matteo Landrò
Matteo.Landro@sas.com

Valentina Larina
Valentina.Larina@sas.com

James Ochiai-Brown
James.Ochiai-Brown@sas.com