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What Analytical Techniques Should Pharma Companies Implement to Estimate and Forecast COVID-19 Effects When Recovery is Geographically Uneven?

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EXECUTIVE SUMMARY

Hope for a strong and quick recovery from the COVID-19 induced U.S. recession became more uncertain with the dramatic and historic decline in Q2 2020 U.S. GDP. There are also economic signs that a full economic recovery to pre-pandemic levels is still elusive. Continued economic uncertainty remains. Further, while the resurgence of COVID-19 cases seen in many states this past June, especially in the south, seems to have abated, there still exists significant geographic variations around the country in the extent of and policies in effect to control the virus. The Federal Reserve has noted the path of the economy will depend significantly on the course of the virus. These economic and COVID-19 case developments give further credibility to an "accordion" or sustained W-shaped recovery, and that any economic recovery will be uneven across the U.S. as the control of COVID-19 cases significantly varies around the country. Thus, any national-level brand analysis will mask critical subnational variations in the economic recovery due to differences in the status of COVID-19 cases. This white paper reviews the importance of companies conducting subnational econometric analysis on drug demand estimation and forecasting. Companies need to understand these effects on brand performance given a longer and geographically uneven economic recovery and other impacts due to COVID-19.

Given the dynamic nature of this pandemic, please subscribe to the *Axtria Research Hub* (https://www.axtria.com/axtria-research-hub-pharmaceutical-industry/) for updates to this white paper and related postings.

1. Fears of a Much Longer and Uneven COVID-19 Induced Recession Recovery

1.1 Continued Economic Uncertainty Remains

Hope for a strong and quick recovery from the COVID-19 induced U.S. recession became more uncertain with the dramatic and historic decline in Q2 2020 U.S. GDP.[1] There are also economic signs that a full economic recovery to pre-pandemic levels is still elusive with no clear end in sight. Unlike the Great Recession, the current recession is virus-based, as the following quote from the Federal Reserve clearly notes.

Thus, the implementation of traditional counter-cyclical policies will likely not work as we have seen. Massive stimulus government spending programs and central banking expansionary monetary policies, as was used to counter impacts from the Great Recession, while having some positive short-term effects as seen in the COVID-19 recession, seem unable to provide a long-term fix. Even worse, increases in deficit-spending may stifle future economic growth.[2] No quick V-shaped recovery is now being touted by economists as expressed earlier in the pandemic, but rather, a W-shaped or "accordion effect" recovery, as documented in an earlier Axtria blog, is now holding the dominant view among economists.[3]

Continued economic uncertainty remains as noted by the following trends:

- Recent economic evidence suggests the economy is losing steam and even reversing on gains made earlier.[4-5]
- The U.S. base case economic outlook index from The Conference Board is projected to be 101.2 in December

> The path of the economy will depend significantly on the course of the virus. The ongoing public health crisis will weigh heavily on economic activity, employment, and inflation in the near term, and poses considerable risks to the economic outlook over the medium term.
>
> **Quote from a Federal Open Market Committee (FOMC) statement issued through a press release by the Board of Governors of the Federal Reserve System, published online July 29, 2020.[6]**

2021, still 1% lower than the 102.3 index in January 2020, just before the pandemic struck and restrictive public policies went into effect.[7]

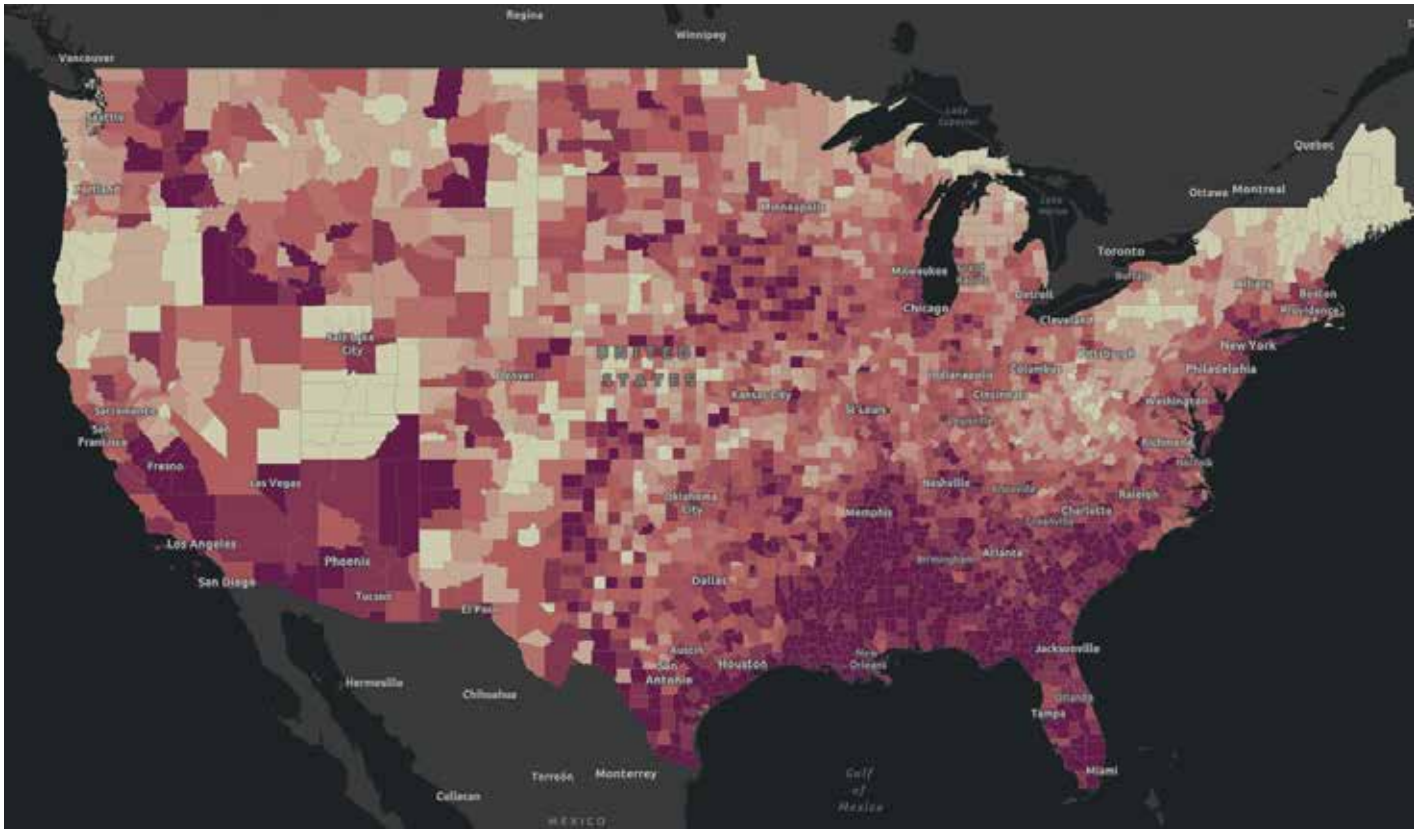
- The Organization for Economic Cooperation and Development (OECD) released fresh data on August 26, 2020 that the developed economies, though slowly turning around, face a long recovery.[8]
- While the change in U.S. GDP in Q2 2020 of -9.5% was historic, the fall in the Eurozone was even worse at 12.1%.[9]
- The economic well-being of emerging market countries is even worse, making for a tougher and longer global economic recovery.[10] These economic trends in other countries will make for a longer recovery in the U.S.
- Health and economic researchers are now measuring the significant long-term damage of lockdown policies imposed by government officials, one estimate being 400 million jobs lost worldwide and 13 million in the U.S.[11] Millions of jobs in the U.S. will likely never return,[12] and where delays in back-to-office plans by employers will cause long-term negative spillover effects to those service businesses that cater to office workers.[13]
- The reaction by state and local governments in not only laying off workers but also having to raise taxes to make up for budget deficits due to a decline in revenues (unlike the federal government, state and local governments generally must run balanced budgets), will combine for negative financial drag effects on the national recovery and stunt future economic growth.[14]
- The adverse economic effects from this recession are creating dire social consequences that are clearly distinguishing it from the Great Recession. The Census

Bureau reported that 30 million people did not have enough food to eat in the week when the survey was taken during July 2020.[15] Further, analysis of Census Bureau survey results indicated that somewhere between 30-40 million people are at risk from being evicted due to their inability to pay rent.[16] These adverse social consequences from the COVID-19 recession mean people have to choose potentially between necessities: food vs. rent vs. pharmaceuticals. Drug affordability problems will rise in prominence among people.

The U.S. passed the 6 million confirmed coronavirus case mark on August 31, 2020, about three weeks after 5 million cases were reached.[17] The U.S. death toll is now over 183,000, according to the late August 2020 data from Johns Hopkins University[17] (the U.S. number of deaths increased to over 197,000 by mid-September on almost 6.7 million cases). The increase in U.S. cases appears to be slowing, and states like California and Florida, that saw earlier spikes in cases, are also experiencing an easing of cases.[17] This does not mean however, COVID-19 is going away any time soon. Experts note the existence of COVID-19 will be in the environment for quite some time. Americans will have to contend indefinitely with this situation until there is the creation of a vaccine, generation of herd immunity, and/or the development of quick and effective treatments that minimize any serious health effects and hospitalization. This means Americans will likely have to continue adjusting their behavior to account for lowering their risk of contracting COVID-19.

Further, while the resurgence of COVID-19 cases seen in many states this past June, especially in the south, seems to have abated, there still exists significant geographic variations around the country in the extent of and policies in effect to control the virus. **Figure 1** provides a map of the COVID-19 U.S. cases by county last updated on August 31, 2020 generated by The Johns Hopkins University School of Medicine, Coronavirus Resource Center.[18] The

Figure 1. COVID-19 United States Cases by County, Updated as of August 31, 2020



Note: Darker color represents a greater number of cases by population.

Source: The Johns Hopkins University School of Medicine, Coronavirus Resource Center. Map updated as of August 31, 2020. Available at https://coronavirus.jhu.edu/us-map.[18]

map illustrates the geographic variation of COVID-19 cases around the country, but also how the southern states have seen an explosion of cases similar to the northeast corridor (e.g., around New York City), where the outbreak was initially the most severe. The map also illustrates the need for sub-national estimation of COVID-19 effects and forecasting/prediction analyses on brand utilization.

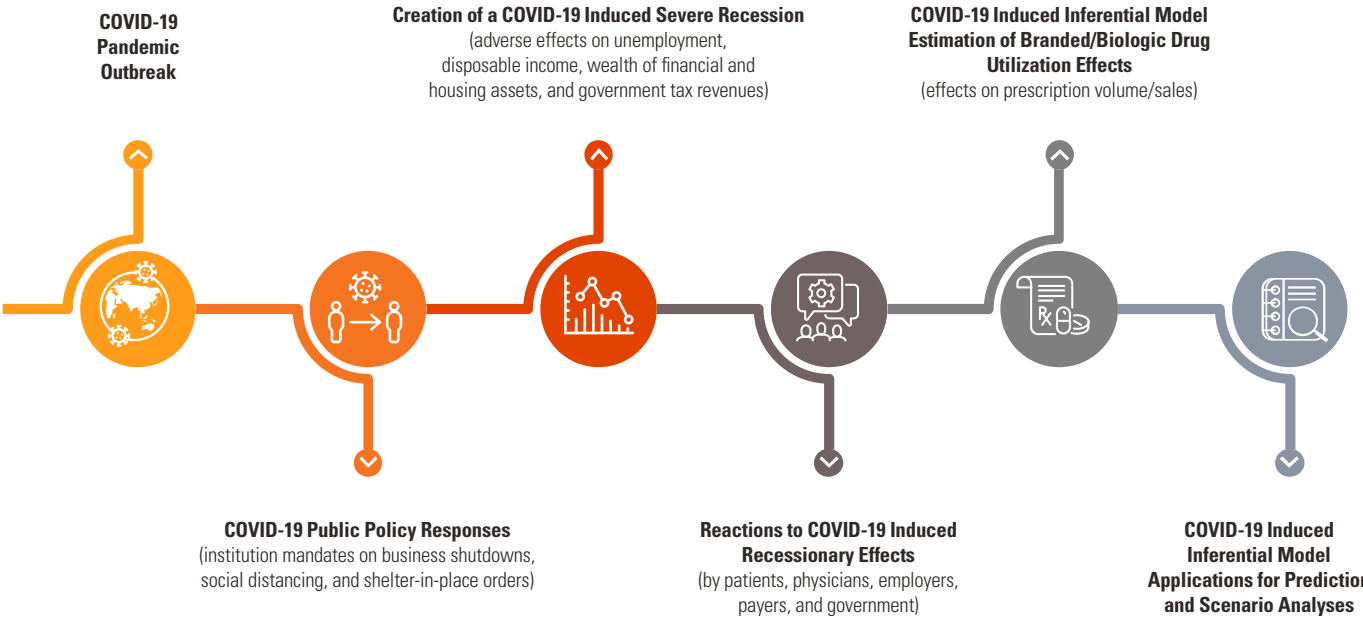
1.2 White Paper Objectives

This white paper reviews the effects of a longer and geographically sub-national uneven economic recovery and other impacts due to COVID-19. This white paper, therefore, highlights the importance of companies conducting sub-national econometric analysis on drug demand estimation and forecasting. This paper will propose frameworks and techniques to conduct both drug demand estimation and forecasting on brand utilization.

2. Sub-National COVID-19 Related Brand Econometric and Forecasting/Prediction Analyses

Geographic variations in COVID-19 cases, as shown in **Figure 1**, will create different public policy responses, which in turn will create regional differences in recession and pharma industry effects. This effect of regional differences in policies is illustrated by the following references that show which states are re-opening and closing again,[19] and the list of coronavirus restrictions by state.[20] This section provides two sets of analyses designed to measure and forecast/predict sub-national recessionary and other COVID-19 related effects on brand performance – econometric estimation for measurement of effects and forecasting/prediction analyses for future scenario planning. **Figure 2** outlines a high-level pathway analysis to measure and predict/forecast COVID-19 related effects on brand utilization.

Figure 2. High-Level Pathway Analysis to Measure and Predict COVID-19 Severe Recession and Related Effects on Brand Utilization.

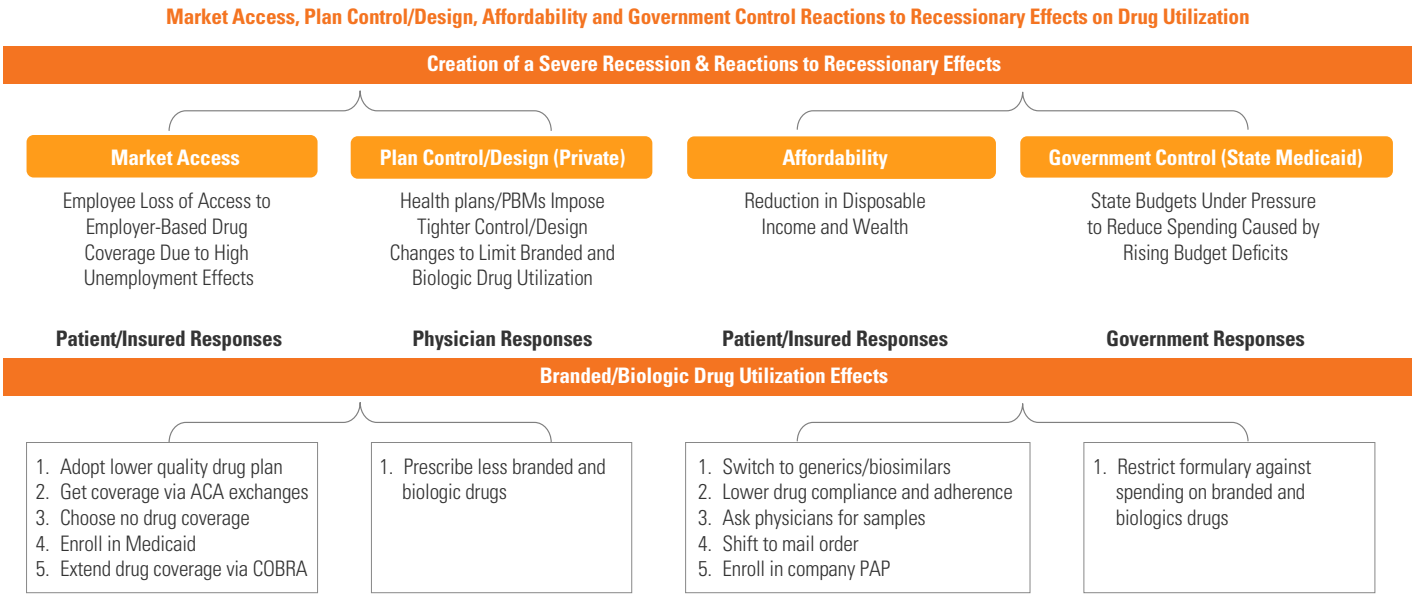


Source: Axtria Inc.

2.1 Measurement of Sub-national COVID-19 Effects through Econometric Estimation

Figure 3 provides the four pathways of analysis to measure COVID-19 related recession effects on brand utilization. These pathways will provide the foundation for the econometric model specification of the recessionary effects caused by COVID-19 and related public policy responses that create sub-national variations around the country.

Figure 3. Market Access, Plan Control/Design, Affordability, and Government Control Reactions to Recessionary Effects on Drug Utilization



Source: Axtria Inc.

Figure 4 outlines the general econometric framework that is very versatile for the following important business analyses:

1) Estimating sub-national recession, internal promotion, and COVID-19 related effects on brand utilization. Model estimates on promotional variables can be used to derive marketing-mix optimization at the brand-Metropolitan Statistical Area (MSA) level of analysis.

2) Implementing a random coefficients model approach (allowing the parameter estimates to vary by MSA geography) will generate MSA-specific estimates on the independent variables.[21] The seminal reference is cited here by Hildreth and Houck, though other subsequent references that are frequently cited are from Swamy[22-24] and Hsiao[25] for further explanations of this useful econometric technique. Applying this method does require advanced econometric training, but the payoff is the creation of MSA-specific parameter estimates that can drive local sales, marketing, and payer tactical decisions.

3) Applying the inferential model for forecasting/prediction analyses for scenario planning. Forecasted recessionary economic variables, along with internal management control and COVID-19 related variables, can be inserted into the model to make future predictions on brand utilization. Unlike "naive" forecast models built without any formal theoretical foundational structural, applying inferential models for forecasting/prediction analysis allows pharma executives to understand how future changes in salient variables affect the dependent variable. The pharma company can then determine how to alter variables under their control to mitigate future adverse sub-national recessionary effects by MSA.

4) Using Principal Components Analysis (PCA) to determine sub-national forecasts/predictions by an entire scenario set of variables on the dependent variable, without generating multicollinearity issues in the model. PCA results per scenario can then be compared to determine which action a pharma company wishes to take.

5) Leveraging the sub-national future predictions can also be applied to determine insights on financial drag brand impacts due to recessionary effects. This means the pharma company can understand by brand how future financial targets could be at risk (and by how much) due to recessionary effects. Further, since the underlying model is inferential-based, management can determine how variables can be changed to mitigate adverse financial effects and measure the ROI on spending by promotional channel to reduce the financial risk of not making the target.

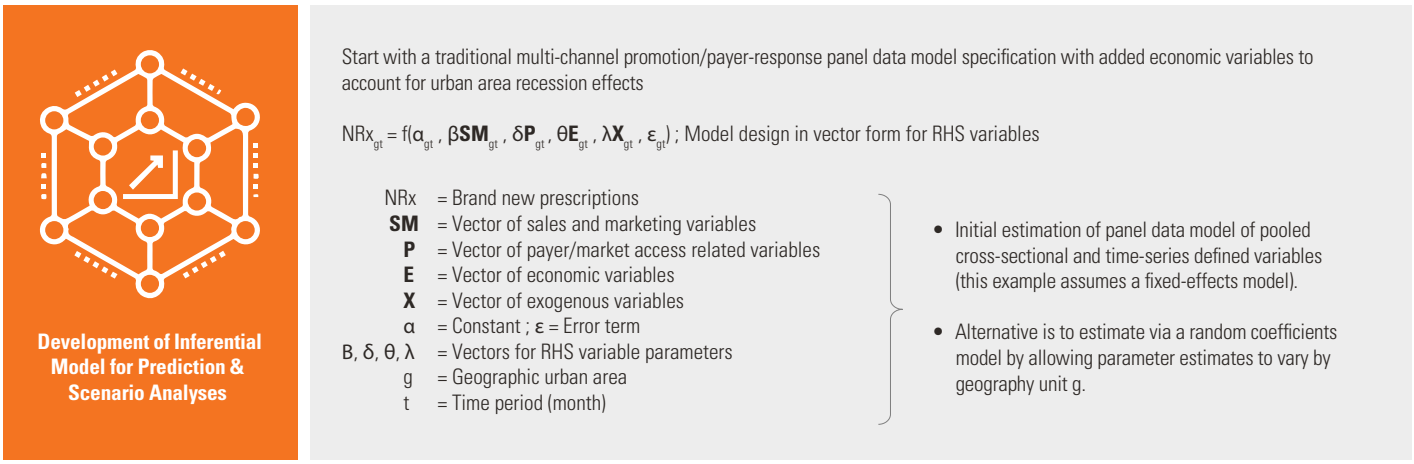
6) Modifying the model to look at sub-national recessionary effects on drug adherence (as a leading indicator of health outcomes) or patient health outcomes as the dependent variable.

7) Implementing propensity modeling to look at resulting effects from each explanatory variable can then be undertaken to measure recession effects. An analysis of drug adherence will require another structural model to connect changes in the dependent variable with patient health outcomes.

8) Adjusting this general framework to look at other sub-national recessionary effects, such as on brand-to-generic substitution, biologic-to-biosimilar substitution, total treatment costs, and cost-effectiveness. Additional analysis can be instituted for sub-national effects by payer channel (e.g., commercial, Medicare Part D, Medicaid).

9) Adding COVID-19 specific metrics to track sub-national trends in social distancing guidelines and the evolution of infections. Obtaining coefficients on region-specific indicator variables on COVID infections and hospitalizations, the current phase (1-3) of re-opening, and other pandemic metrics would provide better forecasts in case of future regional COVID-19 resurgences.

Figure 4. Inferential Brand-Urban Level Model Development and Estimation Requiring Advanced Econometric Methods

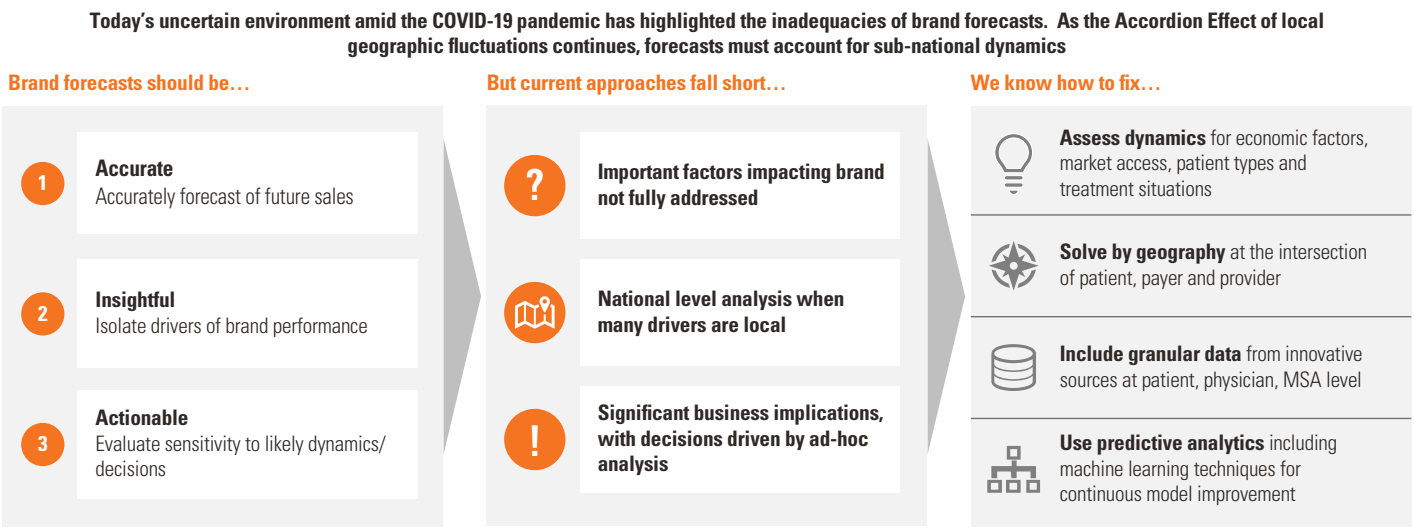


Source: Axtria Inc.

2.2 Forecasting/Predicting Sub-National COVID-19 Effects on Future Brand Utilization

The current resurgence of COVID-19 and its uneven spread around the country has highlighted the need for a new brand forecasting paradigm. **Figure 5** illustrates the need to analyze sub-national fluctuations that are missed when doing national brand utilization forecasts. Moreover, the conduct of sub-national forecasts that assess and factor in local dynamics is consistent with the business decisions and actions taken to affect brand utilization and other outcomes at the local level. The forecasting paradigm outlined here is much more detailed than the previous discussion.

Figure 5. The Need for a New Brand Forecasting Paradigm

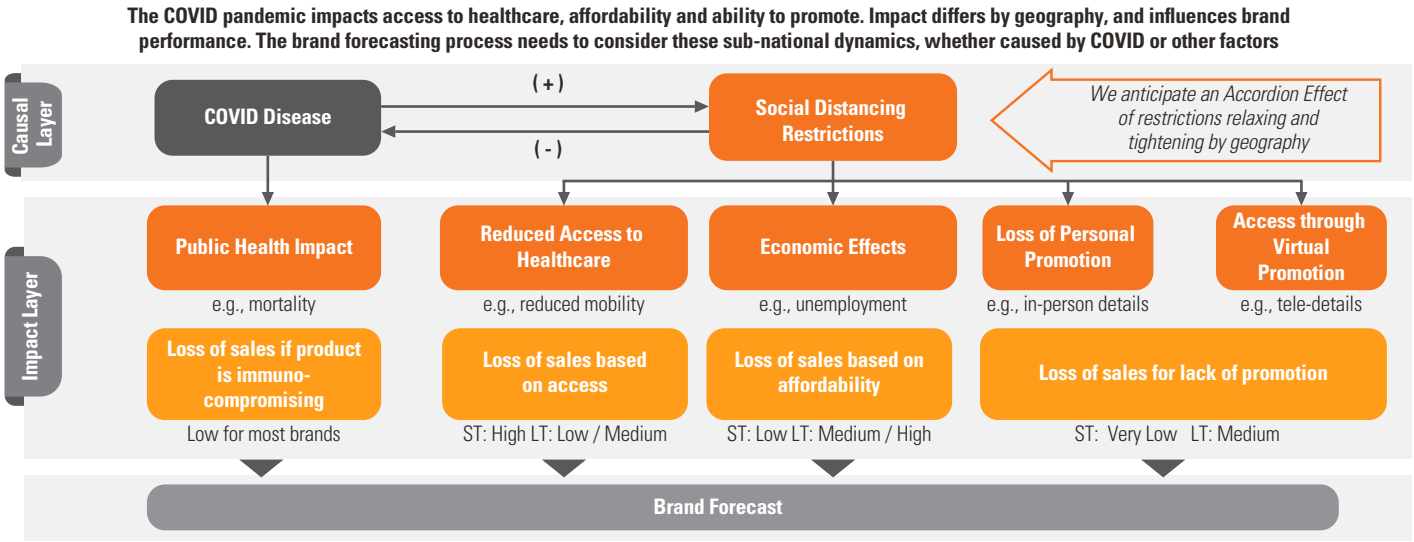


Source: Axtria Inc.

The COVID-19 pandemic illustrates sub-national effects on patient access to healthcare, affordability, and the ability to promote by pharma companies. These impacts differ by geography and influence brand performance. The brand forecasting process needs to consider these sub-national dynamics, whether caused by COVID-19 or other factors.

Figure 6 provides an illustration of how the COVID-19 disease and the public policy reactions to it, such as social distancing restrictions, produce multiple effects that ultimately impact brand forecasts. The key is that these effects vary by geography and must be accounted for by a sub-national forecasting paradigm.

Figure 6. Sub-National Dynamics in Forecasting COVID-19 Example



Source: Axtria Inc.

Figure 7 provides a solution to this sub-national forecasting problem, featuring four steps:

1) Developing a robust framework that captures all key dynamics impact brand utilization, accounting for geographic variation, and providing internal consistency between sub-national forecasts with the national view.

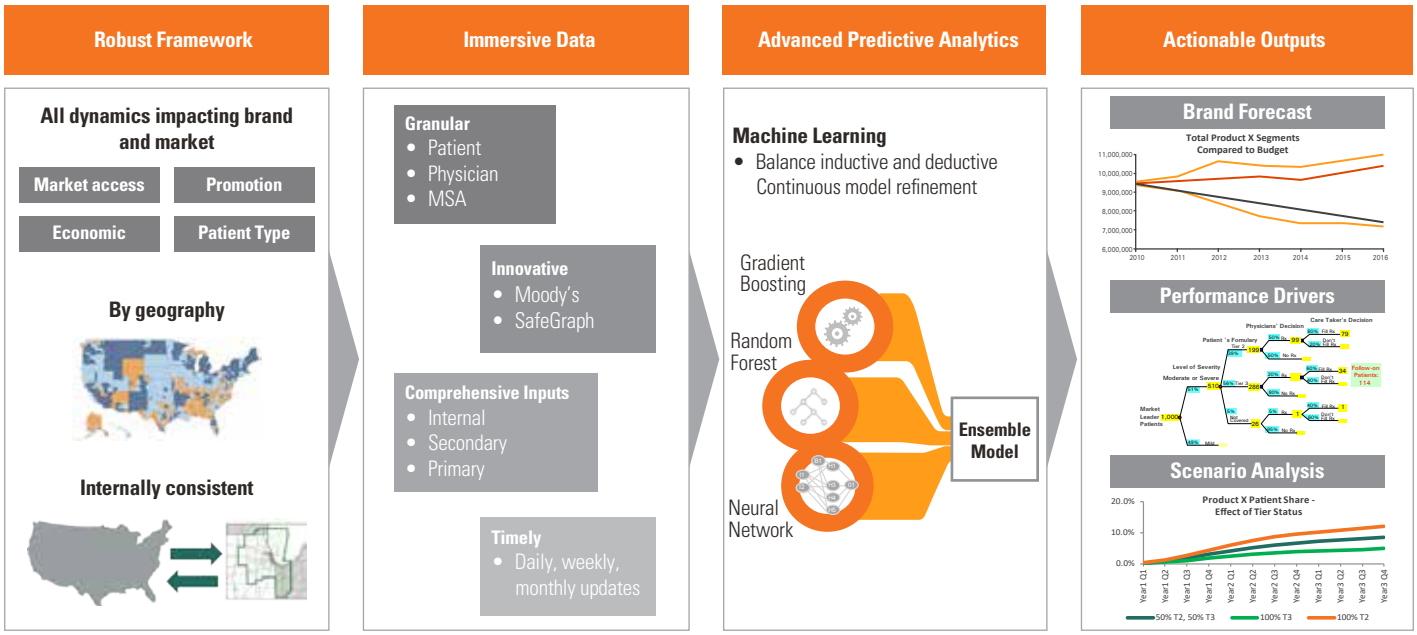
2) Applying immersive data that is granular, innovative, comprehensive, and timely. Important innovations are using economic data at the MSA level from Moody's Analytics and mobility data from SafeGraph.

3) Implementing advanced predictive analytics through machine learning that balances inductive and deductive reasoning, and allowing for continuous model refinements in real-time as the data changes.

4) Generating actionable outputs that create brand forecasts, understand performance drivers, and develop useful scenario analysis.

Figure 7. The Solution: Framework, Data, and Analytics

Our framework is designed to address full range of factors that can influence brand performance, solve at a level of granularity needed to quantify, and provide outputs that deliver on need for accuracy, insights and actionability



Source: Axtria Inc.

Figure 8-10 provide more details on the new forecasting paradigm requiring immersive data, implementing advanced predictive analytics, and generating outputs aligned with business needs that are required to produce and apply sub-national forecasts.

Figure 8. Immersive Data

Moody's Economic Data

- Data needed to capture varying economic impact at local level
- Moody's provides high quality econometric forecasts of future economic conditions

Moody's

- **Historical data** for over 3,400 variables, varying levels of geographic granularity
- **Econometric forecasts**, updated monthly, **at MSA level. 165 forecast variables** including:

Employment (by sector)	Births
Labor: Unemployment Rate	Birth rate
Labor Force Participation	Deaths
CPI: Total - All Urban Consumers	Death rate
Housing Starts: Single-Family	Housing completions: Single-family
Housing Starts: Multifamily	Real estate: FHFA House Price Index
Home Sales: Existing Single-Family	Quarterly Deposits at All Banks
Sales Price Existing Single-Family Homes	Population (by age cohort)
Housing Affordability Index	Income: Average Household
Permits: Nonresidential (by building type)	Disposable Personal Income
Permits: Residential (by type)	Bankruptcies (by type)

SafeGraph Mobility Data

- Accordion Effect will continue, with geographies opening and closing
- Mobility data can be used to track access to providers and impact on healthcare utilization

SafeGraph

- **Geofencing of individual address** locations, with identification of all healthcare provider locations across US
- Ability to select specific **locations of HCP targets** of interest for brand
- Data captured from mobile devices measures **traffic volume by day** for each location
- Ongoing reporting of traffic with **2 day lag**
- Provides ability to assess degree to which local geographies are **open or closed**, and measure **impact on brand**

Source: Axtria Inc.

Figure 9. Advanced Predictive Analytics

Building on the existing national forecast process, we solve at a sub-national level while maintaining alignment with the national level forecast, using a thoughtful balance of deductive (hypothesis driven) and inductive (data driven) techniques.

DEDUCTIVE AND INDUCTIVE LEARNING

Deductive

- *Deterministic*... certain conclusions!
- Theory ⟶ Data *test* hypotheses

Hypothesis ▶ Test with Data ▶ Accept or Reject

- Answer pre-defined questions
- Explain the past
- Parametric methods
- Static model

Inductive

- *Probabilistic*... plausible findings
- Data ⟶ Theory *let* the data speak

Gather Dta ▶ Look for Patterns ▶ Develop theory

- Identify the questions to ask
- Predict the future
- Non-parametric techniques
- Continuous model refinement

RANGE OF METHODOLOGIES

Primary/Secondary Research	Moving Average	Neural Networks
Competitive Intelligence	Regression	Ensemble Methodologies
Patient Flows	ARIMA / Box Jenkins	Forecast Accuracy
Markov Chain Models	Simple Exponential Smoothing	Holdout Period
Patient-Based Forecasting	Holt's	Trend Selection
New Product Analogs	Additive Winter's (& Damped)	Event Assessment
Sensitivity Analysis, Monte Carlo Simulation	Multiplicative Winter's (& Damped)	Event Analogs

SOLVE BY GEOGRAPHY

- Solve at sub-national level using granular data to isolate local market dynamics
- Single model to ensure internal consistency across geographic levels

CONTINOUS LEARNING

- Train on multiple years of historical data for accuracy
- Operational process allowing access to forecasts based on latest data
- Ability to re-tune models, identify changes in drivers of performance at national and sub-national level

Source: Axtria Inc.

Figure 10. Outputs Aligned with Business Needs

Outputs address the need for accuracy, insights and actionability. Clear line of sight from data, to drivers of performance, to impact on forecast, to rationale behind chosen actions and investments

Brand Forecast

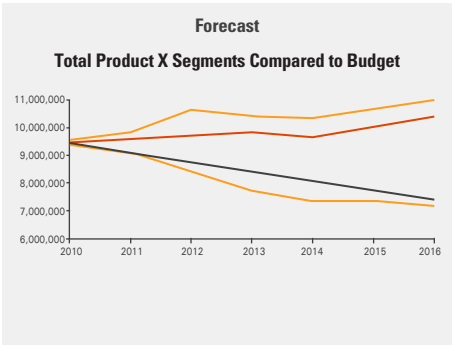
- Generate forecast over near term or long term horizons; National level or for geography of choice; current state assumptions or for defined scenario; confidence intervals based on fit with historical data

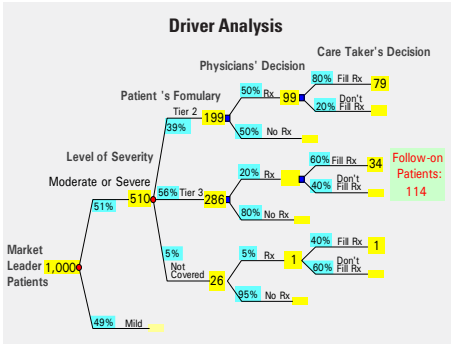
Performance Drivers

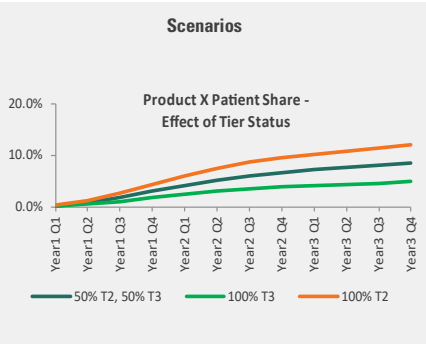
- Data-driven identification of drivers; quantification of impact; ability to include expert input; multiple lenses including market access segment, geography, competitor landscape, patient segment

Scenario Analysis

- Define and manage scenarios; apply probabilities and create probability weighted forecast; test sensitivity to events; dynamically update with latest data and latest model results







Source: Axtria Inc.

3. Concluding Remarks

The U.S. continues to experience significant exposure to COVID-19 cases around the country at varying degrees. States have a plethora of varying policies to contain the virus in their region, creating variations in economic effects as a result consistent with high-level pathway analysis outlined in **Figure 2**. The geographic variation of this exposure has called into question the usefulness of national-level analyses, which will not pick up the sub-national effects needed by pharma companies to make appropriate strategic and tactical decisions. This white paper reviewed the importance of and proposed frameworks/techniques for companies conducting sub-national econometric analysis on drug demand estimation (inferential model) and forecasting (for scenario analysis) on future brand utilization.

While many unknowns still exist regarding the future of COVID-19, there is likely universal agreement on the following statements as it pertains to understanding and analyzing the effects from geographic variability of the virus resurgence around the country:

1) The resurgence of COVID-19 cases and its geographic variability around the country require pharma companies to develop new models and apply different analytical techniques to gain sub-national insights into the effects of the spread of the virus and what can be done to mitigate and anticipate pandemic effects.

2) The resurgence of COVID-19 cases means that the economic recovery from the induced-recession caused by the pandemic and the public policy mandates employed to control its spread will take much longer than previously anticipated and be geographically uneven around the country.

3) A new future brand utilization forecasting paradigm is required to gain insights into the sub-national effects of a geographically uneven and resurging COVID-19 virus.

4) Pharma companies will need to rely on different databases to give them insights and solutions into future sub-national effects caused by a resurging COVID-19.

5) Advanced predictive analytics will be required that utilize machine learning (ML) platforms that derive updates in forecasts in real-time with changes in the data.

6) The new paradigm adopted by pharma companies must produce outputs that are aligned with business needs in developing brand forecasts, understanding performance drivers, and generating scenario analyses that improve strategic and tactical decision-making.

7) The focus in this white paper has been on sub-national recessionary effects on brand utilization. It is also very plausible that adverse declines in drug adherence due to market access and affordability effects will have downstream impacts on patient health outcomes.[26] Ongoing research from the Great Recession has revealed these effects and should be of concern to pharma companies, especially in an environment with a growing prevalence of outcomes-based payer contracts. The good news is that the model designs and empirical methods outlined here to analyze brand utilization effects can be extended and modified to investigate patient health outcomes effects.

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Founded in 2010, Axtria is a global provider of cloud software and data analytics to the Life Sciences industry. We help Life Sciences companies transform the product commercialization journey to drive sales growth and improve healthcare outcomes for patients. We continue to leapfrog competition with platforms that deploy Artificial Intelligence and Machine Learning. Our cloud-based platforms - Axtria DataMAx™, Axtria SalesIQ™, Axtria InsightsMAx™ and Axtria MarketingIQ™ - enable customers to efficiently manage data, leverage data science to deliver insights for sales and marketing planning, and manage end-to-end commercial operations. We help customers in the complete journey from Data to Insights to Operations.

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