



e2open®

EXECUTIVE BRIEF

2021 Forecasting and Inventory Benchmark Study

Supply Chain Performance During the Covid-19 Pandemic

Executive Summary

2020 was a particularly challenging year. A year of human tragedy with loved ones lost, it was also a year of heroics with frontline personnel working tirelessly to care for people that fell ill and keep the rest of us healthy, fed and safe. Manufacturers and supply chain professionals boldly rose to the challenge to meet the basic needs of a world in lockdown. Businesses closed and sent non-essential employees home, impacting global economies. The day-to-day activities of virtually everyone around the world changed in an instant.

Wholesale changes in consumer buying patterns, swings in demand and reduced supply capacity from restrictions aimed at preventing coronavirus transmission led to widespread stockouts and shortages. The Covid-19 pandemic affected not just what consumers bought but when and how they bought. Stay-at-home orders, infection concerns and fears of scarcity led consumers to purchase weeks' worth of goods at a time. Practices like e-commerce, fulfillment through dark stores, and curbside pickup grew exponentially, compressing changes that would typically take years into weeks or months.

As the single largest disruption in modern history, the pandemic was also the most extensive stress test of economies, businesses and supply chains worldwide. It is important to note that the pandemic did not create new weaknesses. Rather it accentuated existing fractures within organizations, processes and systems — often to the point of failure.

E2open's tenth annual Forecasting and Inventory Benchmark Study was in the right place at the right time to capture the full impact of the pandemic on supply chain performance. As the largest fact-based analysis of its kind, the study is unique. It aggregates data directly from e2open's planning applications for a true apples-to-apples comparison against a range of metrics. It encompasses over \$200 billion in annual sales from global manufacturers across industries, including consumer packaged goods, food and beverage and animal care. The public version of the study reports on the current state of forecasting, inventory and supply chain performance in North America.

This year is unique because the study also reveals the state of supply chain performance during the Covid-19 pandemic. This primary research will be a helpful resource to corporations, economists, analysts and any other party interested in a fact-based assessment of the impact of the pandemic on businesses. It provides a baseline by which leaders can compare the performance of their organization and consider successful strategies adopted by some of the world's largest manufacturers.

Perhaps most importantly, understanding what actually happened during the pandemic helps leaders prepare for other large-scale disruptions in the future — from new variations of this disease, other global health crises, a rise in weather and climate extremes, geopolitical tensions and even terrorist activities or cyber-attacks. Being better prepared is a key factor in helping organizations build resilient processes to weather these disruptions, support the communities they serve during trying times and emerge stronger than before.

Key Findings

1. The pandemic made business structurally harder than ever. Data from the study reveals three stages of the pandemic, defined by service. Service levels during the first two months of the year were consistent with the pre-pandemic baseline. In March, the World Health Organization (WHO) officially declared a pandemic, and governments instated global lockdowns. During this “Onset” period of the pandemic, service dropped to 83%, an all-time low and a significant decline from the pre-pandemic baseline of 99%. Service levels stabilized in June for the remainder of the year, averaging 86%. While this was a slight improvement to the prior months, service in the second half of 2020 was 13 percentage points lower than the pre-pandemic baseline. The “New Normal” that emerged from the lockdowns and stay-at-home orders was one where it was harder to do business than before.

2. Sales increased, yielding a banner year driven by a rise in demand for essential goods. The impact of the pandemic varied considerably by industry. Some experienced demand shocks, supply shocks or a combination of both. For the most part, the companies participating in this study manufacture essential goods to keep people healthy, fed and safe. Demand for these products was especially strong, resulting in the largest sales growth in the history of the study. However, there were unrealized revenue opportunities. Sales growth could have been even higher if service remained at pre-pandemic levels.

3. There was a shift in strategy from “growth through innovation” to “growth through efficiency.” Historically, manufacturers of fast-moving consumer goods stimulate demand through a steady stream of introductions, with roughly one-third of items being replaced each year. 2020 was different. It was a time of need, and demand for essential goods was high. The challenge for companies was less about creating new demand than filling orders for existing demand. In response, manufacturers adopted strategies to maximize production efficiencies, cutting the rate of introductions in half to focus on existing products trusted by consumers. Furthermore, priority shifted to higher-volume items to reduce changeovers and maximize output. The rapid change in strategy to focus on efficiency and assure supply in this time of need reflects strong corporate commitment to social responsibility.

4. Businesses became structurally harder to forecast.

Not only is doing business tougher, but sales are also now inherently harder to forecast too. Every business decision and every win or loss starts with a prediction of what customers will buy. The quality of each decision starts with the quality of the forecast. Unfortunately, forecastability — how easy or hard business is to predict — reached an all-time low during the Onset of the pandemic. In the New Normal, supply chain forecastability stabilized at 65%, a 7% drop from the pre-pandemic baseline. The good old days are gone. Today’s environment is inherently more difficult to forecast than it was a decade ago, or even a year ago.

5. Forecast performance dropped to an all-time low.

Traditional forecasting is predicated on the assumption that history repeats itself. Forty years ago, when businesses and supply chains were more stable, this was a reasonable approximation — and was the best option available when demand planning was introduced. With each passing year, this premise grew less relevant, but it was rendered virtually meaningless in the face of a major disruption such as the pandemic. Planning error rose by one-third during the Onset of the pandemic and stabilized at 54%, a 21% rise from the baseline. The assumption that history repeats itself was accepted as “good enough” for years but is simply no longer good enough now that risk from major disruptions has become commonplace.

6. Value from demand planning investments fell to an all-time low.

Large companies invest millions of dollars in the people, processes and systems to predict demand. Each year, the study measures the value of these investments compared to a simple naïve forecast accomplishable at little to no cost. In 2020, the value from demand planning investments was cut in half. The root cause for this loss in value is that demand planning is still fundamentally disconnected from the current realities on the ground. This calls for a re-evaluation of strategy and a new way of thinking about planning.

7. The volume of business exposed to extreme error rose to an all-time high. Supply chains are inherently designed to work in an uncertain environment, with the flexibility to tolerate normal daily error with little impact. Extreme error — the most disruptive and costly error — is when shipments exceed or fall short of forecasts by two times or more. This kind of extreme error exceeds the normal tolerances for supply chains and leads to disproportionate costs or lost revenue. During the pandemic Onset, 46% of all business was exposed to extreme error, up 72% from the baseline. The new normal going into 2021 is a business environment where 36% of volume is exposed to costly and disruptive extreme error — 33% higher than before the pandemic.

8. AI and real-time data are a pandemic game-changer. If planning systems and processes were connected to current realities and could sense changes in buying behavior in real-time, would that help companies manage major disruptions? The answer is yes — even when the disruptions are at pandemic scale. Companies that used AI and real-time data to “sense” demand reduced forecast error by one-third, performance that was effective at all stages of the pandemic. With demand sensing, the volume exposed to extreme error was also cut in half. Perhaps most importantly, companies that sensed demand realized six times more value in their demand planning investments, underscoring the importance of using AI and real-time data to enhance traditional planning approaches.

9. Safety stock grew, and the best way to control it remains inventory optimization combined with demand sensing. In 2020, more capital was invested in safety stock to buffer against volatility and cycle stock decreased as production shifted to higher-volume items. The use of multi-echelon inventory optimization helped reduce safety stock by 23%. When combined with better forecasts created by AI and real-time data, this reduction increased to 42%. Data confirms that anyone serious about maximizing return on capital investments in inventory should consider inventory optimization combined with demand sensing.

Key Questions for Decision Makers

The purpose of this study is to give back to the industry by offering a data-driven baseline to help companies in the pursuit of forecasting and supply chain excellence. Two top-level considerations relate to improving performance and resilience.

- **Performance:** How was your supply chain performance during the pandemic? What strategies did your organization adopt, and how did those strategies compare to the leaders in this study? What are your plans to use AI and real-time data to connect forecasts to current market realities and make better business decisions?
- **Resilience:** What is your plan to be prepared and more resilient for the next disruption? In 2020, the Covid-19 pandemic created a new standard for best practices in managing disruptions at scale. As variants of the virus spread around the globe at an alarming rate, the threat of a next wave of disruption is all too real. The droughts, fires, floods and damage from rising sea levels across all regions are a reminder that we live in an increasingly volatile world where 100-year storms are now routine. Geopolitical tensions and concerns about cyber-attacks threaten to destabilize economies and global commerce. These all combine to create increased risk for businesses and nations. The one certainty in this increasingly uncertain world is that the pandemic of 2020 is neither the last — nor possibly the largest — disruption coming our way.

There is no single answer to these questions, and what is right for you depends on the nature and purpose of your business. One thing that is true across the board is that the road to resilience starts by asking these kinds of questions and using the knowledge gained from major disruptions like the pandemic to guide future decisions. We hope the data and insights on what actually happened provide a helpful reference on your journey to improving performance and becoming more resilient.

New and Tougher Business Reality

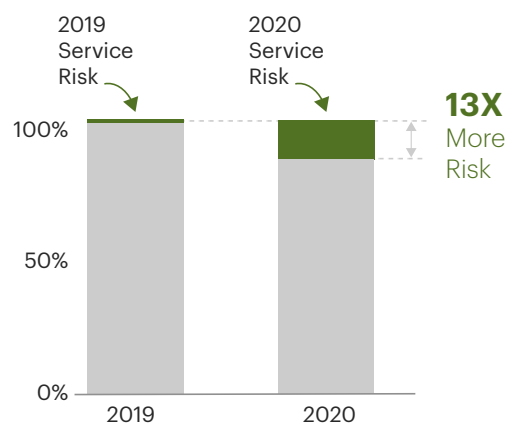
The pandemic caused the single greatest drop in service in the ten-year history of this study.

Companies spend a lot of effort to meet service-level commitments. Manufacturers of fast-moving consumer goods tend to have high service levels. The pre-pandemic baseline for service in this study was 99%. It varied little year-over-year, and for good reason. Service is a key business metric related to customer satisfaction, brand loyalty and revenue realization. It is also related to profitability and the avoidance of costly on-time in-full (OTIF) penalties. Shortfalls in service reflect insufficient supply to meet demand and are caused by issues in demand management or supply constraints.

In 2020, as Covid-19 evolved from a series of local epidemics to official pandemic status, everything changed. Lockdowns and government stay-at-home orders impacted the way people around the world lived, worked and cared for each other. The result was a series of demand and supply shocks that cascaded around the world at the same time — with the supply chain at the epicenter. Normal labor ceased, factories shut and frontline workers became unsung heroes. Global just-in-time supply chains, which drove efficiencies and value for the past two decades, were put under tremendous stress. The pandemic did not create the new weaknesses in the supply chain, but rather accentuated and revealed them. Systems that were “good enough” for years were subjected to the largest natural stress test all at once. Inherent flaws and structural fractures pushed organizations and processes to the breaking point. Approaches that companies relied upon for years were proven insufficient and, in some cases, no longer relevant.

As the pandemic shut down global economies, service predictably declined in many sectors. For the manufacturers in this study, service levels for the year fell 12 percentage points to 87%. This represents a 13X increase in service risk for the year as a whole. To put this in context, for a \$100 billion company, a 12 percentage point drop in service translates to lost sales opportunities of roughly \$12 billion. Given the additional overhead of operating during the pandemic, capturing any of these missed revenue opportunities would have created a sizeable rise in net earnings and shareholder value.

Pandemic-Related Disruptions Created 13-Times More Service Risk in 2020



KEY TAKEAWAY

Service levels in 2020 fell to 87%. For a \$100 billion company, this drop translates to roughly \$12 billion in lost sales opportunities.

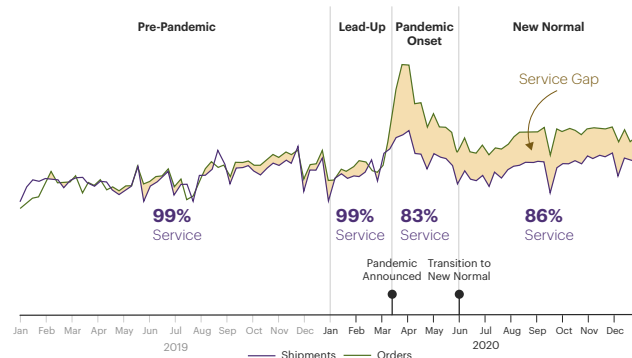


Three Distinct Stages of the Pandemic Defined by Service

Analysis of the supply chain data reveals three distinct stages of the pandemic during 2020, based on customer service levels.

- **Lead-Up (Jan-Feb):** In the first two months of 2020, service hovered around the pre-pandemic baseline of 2019.
- **Pandemic Onset (Mar-May):** The WHO officially classified Covid-19 as a global pandemic on March 11th. Lockdowns and stay-at-home orders to control transmission of disease changed demand patterns overnight. Reports of scarcity and stockouts led to periods of panic buying and hoarding, exemplified by the infamous run on toilet paper. Inventory was quickly depleted, and new production struggled to keep up. During this initial phase of the pandemic, service dropped 16 percentage points to an average of 83%.
- **New Normal (June-Dec):** After the initial Onset, service levels settled to a new normal for the remainder of the year. Instead of returning to pre-pandemic levels, service stabilized at 86%, 13 percentage points below the baseline set in 2019. This, in turn, creates the new baseline going forward into 2021.

Dramatically Reduced Service Since Pandemic was Declared



KEY TAKEAWAY

The stark reality is that business is now fundamentally harder than it was before, urging a re-evaluation of time-tested business strategies that fell short during the pandemic.

While the turbulence of the Pandemic Onset period is striking, the New Normal that occurred afterward is perhaps more important because this reveals the basis for business going forward and is still defining service norms today.

The stark reality is that business is now structurally harder than it was before the pandemic. This calls for a re-evaluation of time-tested business strategies, the shortcomings of which became evident under the stress of the pandemic.

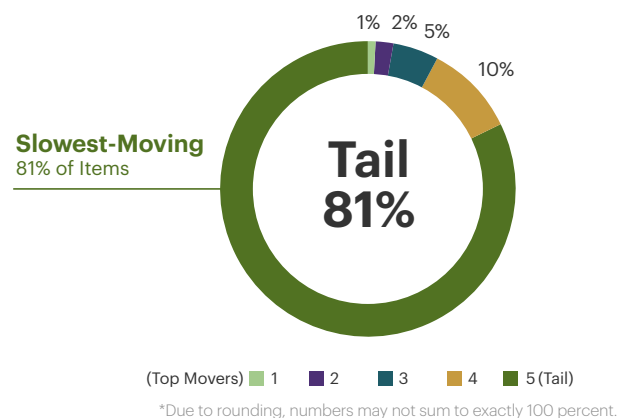
Not All Products Are Created Equal

Did all products in the portfolio face the same service challenges, or did some fare better? How did the performance of the core staples compare to items that make up the long tail? What strategies did manufacturers employ to deal with the sudden service shortfall?

To gain insight, the study segments items into five groups based on sales velocity, with each group representing one-fifth of sales. The fastest-moving Super A products are referred to as top movers, while the slowest-moving items form what is commonly known as the long tail. Top movers make up only 1% of the items, whereas the long tail consists of 81% of all items.

In pre-pandemic times, service for top movers is essentially 100%, compared to 91% for items in the tail. This service differential is understandable since top movers are essential to a company's financial performance. A reduction in service for a single top-mover has the same impact as a decline to hundreds or thousands in the tail.

The Long Tail Comprises the Vast Majority of Items in the Portfolio



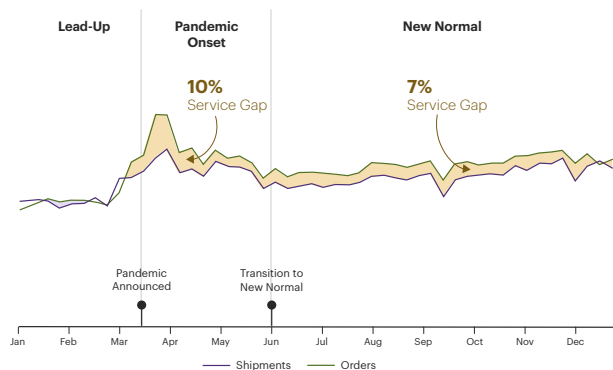
KEY TAKEAWAY

A drop in service for a single top-selling item can have the same or even greater impact as a similar drop to hundreds or thousands of long-tail items.

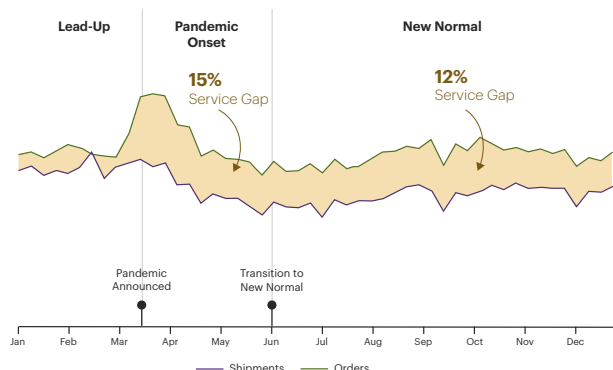
During the pandemic, service was reduced for both of these groups. Top movers had an overall service of 94% for the year — a drop of six percentage points compared to the pre-pandemic baseline. Items in the tail had 80% service, representing a decline of 11 percentage points. These are historic drops, and while the reduction is greater for items in the tail, the service gap for top movers is even more profound.

A revealing cut of the data shows service across the different phases of the pandemic for fast- and slow-moving items. During the Onset, service for top movers and items in the tail dropped to 90% and 75% respectively, as consumers purchased weeks' worth of goods at a time and engaged in panic buying. Service levels stabilized in the New Normal to 93% and 78% respectively. While better than the Onset period, this new reality reveals the pandemic has made business harder for fast items, slow items and everything in between.

Service for Top Items Dipped to Historic Lows



Service for Tail Items Dropped Dramatically and Remained Low in the New Normal

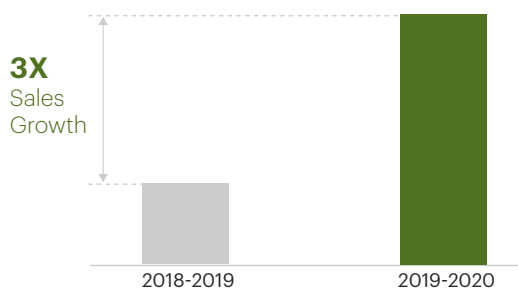


Surge in Sales of Essential Goods

So what happened to sales during this period? To channel Charles Dickens, “It was the best of times, it was the worst of times.”

The stay-at-home orders and lockdowns put in place to limit exposure to disease fundamentally altered consumer behavior. The impact on businesses was somewhat a tale of two cities. For industries such as travel, entertainment and events, demand essentially evaporated overnight, causing financial hardship, furloughs and even bankruptcies. In contrast, high demand drove record sales within industries that provide essential goods. The manufacturers included in this study fall into the essential goods category. Despite the drop in service, rising demand for products in 2020 led to a banner year in sales. In fact, year-over-year sales growth in 2020 totaled 8%, an exponential increase from the 1-3% yearly range during the preceding five years.

Year-Over-Year Sales Growth Nearly Tripled During the Pandemic



KEY TAKEAWAY

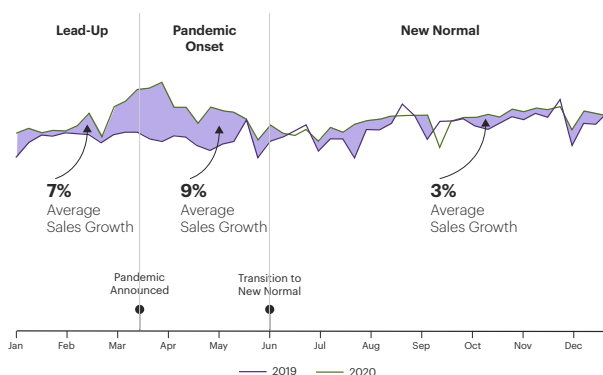
Despite the drop in service, rising demand for essential goods led to record sales growth compared to prior years.

Much of this growth came in the first half of the year. In the months before the WHO officially declared Covid-19 a pandemic, sales rose by 7% compared to the same period in the prior year. Even while the outbreak was still

labeled an epidemic, many consumers were concerned something bigger was at play. Sales data show that consumers had begun stocking up in the face of an increasingly uncertain future. Service remained flat during this period, indicating sufficient supply through production and inventory reserves.

In March, the pandemic was officially declared, and lockdowns were imposed across the world. Consumers prepared for extended stays at home by stocking up on staple goods. Fears of supply shortages for essential goods led to panic buying in certain product categories and widespread stockouts. Overall sales were 9% higher in the Onset period than the same time the prior year. Weekly sales peaked in early April, up 32% over the pre-pandemic baseline.

Sales Growth Was Especially Significant in the Pandemic Onset



Some of the sales growth was driven by demand from panic buying. However, real demand actually increased for goods such as personal protective equipment (PPE), disinfectants and wipes as people started wearing masks in public and wiping surfaces for safety. However, for most products, underlying demand remained unchanged. For example, each person only uses so much toothpaste, and pets only eat so much food.

Regardless of whether the additional purchased goods were actually consumed, the shortages were real, driven primarily by the fear of a shortage itself. This fear of losing out was amplified by reports in both social and traditional media and became self-fulfilling as stockouts in one item fueled hoarding of others. The result was a dramatic change in buying behavior.

In parallel, demand for many commercial goods collapsed as workplaces were shuttered and people worked from home. While some of this demand was transferred to consumer markets, manufacturing capacity is often challenging to interchange. For example, it can be difficult to reconfigure a line from giant cafeteria-sized cans of soup to the small cans required for use at home.

As inventory buffers were depleted, production was unable to react fast enough to replenish, and service was negatively impacted, leaving retail shelves and even entire aisles bare — like a scene from a post-apocalyptic movie.

In June, consumer buying stabilized, with sales growth for the rest of 2020 at 3% compared to the pre-pandemic baseline. It is interesting to note that the growth rate for the prior year was also 3%. On the surface, this would indicate that, from a sales perspective, the New Normal is not very different from the old normal. However, while sales returned to baseline levels, service declined. If the actual demand had been fulfilled, sales would have been considerably greater. Now that business is tougher in the New Normal, companies face more uncertainty and revenue risk than before.

From “Growth Through Innovation” to “Growth Through Efficiency”

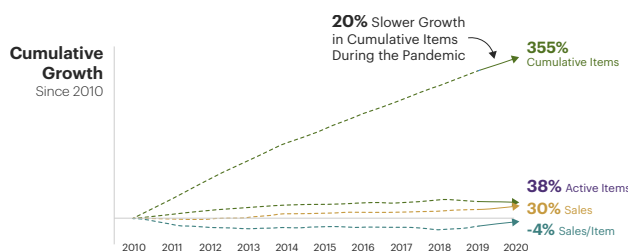
Throughout the pandemic, essential personnel worked tirelessly to keep people healthy, fed and safe. We would like to extend our gratitude to frontline workers and all of those behind the scenes that risked their personal well-being. This includes the manufacturers participating in this study, their staff and trading partners that put forth the herculean effort required to keep global supply chains running and goods flowing in this time of need.

A pressing question for the study this year is, “What strategies did manufacturers adopt to manage the sharp rise in demand from the pandemic?” This question is especially interesting because Covid-19 stressed demand and supply simultaneously, as social distancing restrictions and plant closures impacted production capacity, and driver shortages made it hard to secure transportation. The study finds a clear shift in strategy from growth through innovation to growth through efficiency.

Each year the Forecasting and Inventory Benchmark Study measures item productivity in terms of new product introductions, discontinuations and sales per item across the dataset. Since the onset of this study in 2010, companies pursued a growth through innovation strategy to offer consumers more products to choose from as well as to differentiate their offerings through line extensions, new packaging, bundles and entirely new categories. This adds significant supply chain complexity, with roughly one-third of items being discontinued each year.

This year saw a marked change. The growth in cumulative items dropped from 33% last year to 26% this year — the lowest level in the history of the study. This represents a 20% reduction in the growth number of cumulative items compared to the prior year. The lower churn rate and smaller base of active items in 2020 helped manufacturers maximize production efficiencies by reducing changeovers.

Shift From Growth Through Innovation to Growth Through Efficiency



The shift to a growth-through-efficiency strategy was pragmatic, responsible and respectful. It was pragmatic in that revenue realization was no longer constrained by consumer demand but by limited production capacity. It was responsible in that many of these goods are deemed essential, so ensuring basic availability is more important than providing multiple options for consumer preference. It was respectful in that marketing campaigns for a “new and improved” offer could be perceived as tone-deaf when consumers are struggling to meet basic needs.



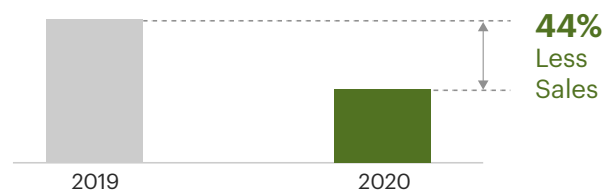
New Product Introductions Take the Back Seat

Data on item counts and sales of new and existing items reinforced the adoption of a growth-through-efficiency strategy. Sales from new items dropped by roughly half, from a pre-pandemic baseline of 9% to only 5%. Correspondingly, sales of existing items grew to a new high of 95% in 2020.

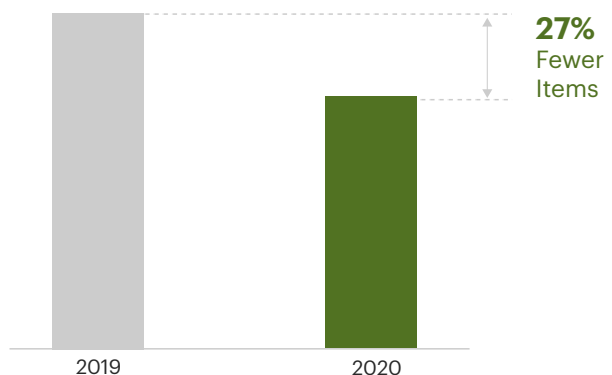
The number of new items in the portfolio dropped by more than one-quarter, from 21% to 15% over the same period. Meanwhile the mix of existing items rose to 85%, another all-time high.

Launching new products requires a lot of time and effort from multiple functional groups such as marketing, manufacturing, packaging, etc. In the midst of a pandemic, it makes sense that companies would be reticent to spend a lot of resources on marketing activities especially when there is unfulfilled demand for existing items. Furthermore, successful introductions often rely on store presence for exposure to consumers, which was all but eliminated when stay-at-home orders forced the switch from in-store shopping to online ordering and curbside pickup.

New Product Sales Halved During the Pandemic in Favor of Existing Items



Less Reliance on New Products Due to the Pandemic

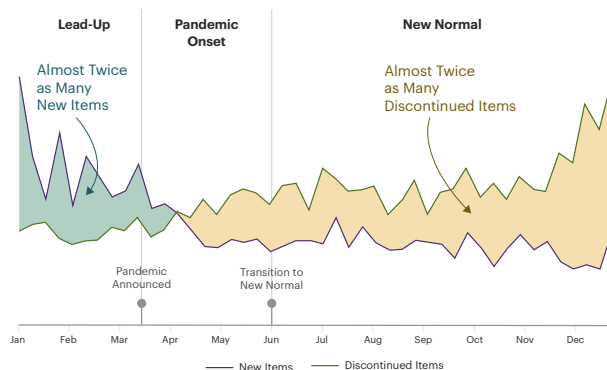


Product innovation is also a risky business. Prior Forecasting and Inventory Benchmark Studies have reported that only 1 in 1,000 introductions becomes a top seller, and the vast majority of new items are discontinued within two years. Traditionally, this risk is accepted as necessary to create new demand and capture share from competitors. The pandemic upended these dynamics in a matter of months, flipping from constrained demand to constrained supply; from the pursuit of specific segment desires to the needs of the market as a whole; from consumers' desire for something new to something trusted and, most importantly, something available. In response, manufacturers adopted a strategy to focus on existing items to ensure availability, raise manufacturing efficiency and convert orders to realized revenue.

There were roughly twice as many introductions as discontinuations in the Lead-Up to the pandemic. This pattern inverted mid-year, with almost twice as many discontinuations as introductions in the New Normal period.



The Number of New Introductions to Discontinuations Flipped Mid-Year as Manufacturers Shifted Strategies



KEY TAKEAWAY

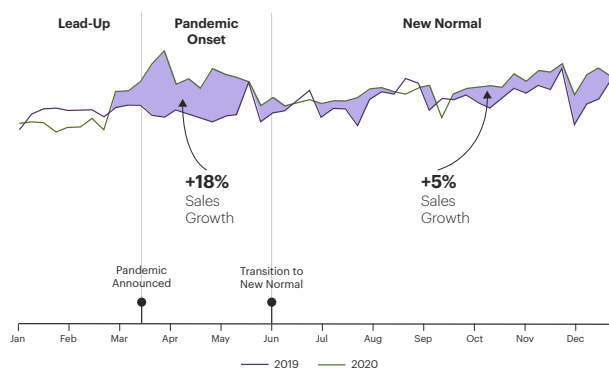
In just a few months, the pandemic upended established dynamics around new product introductions, as manufacturers directed limited resources toward maximizing production efficiencies of essential goods to keep consumers healthy, fed and safe during this time of need.

The shift to grow the business by assuring supply of existing staples lifted the sales productivity of existing items by 7%, compared to a decline of 16% for new items. As such, existing items became both the main revenue engine and main engine for growth in 2020.

Item Rationalization and Strategy Shift to Produce Fast-Moving Products

At the Onset of the pandemic, sales of top-moving items grew by 18%, fueled by consumers stocking supplies and hoarding goods. In the New Normal period, sales of top movers stabilized around 5% above the pre-pandemic baseline. In short, top movers performed well in 2020 and came out ahead in the New Normal.

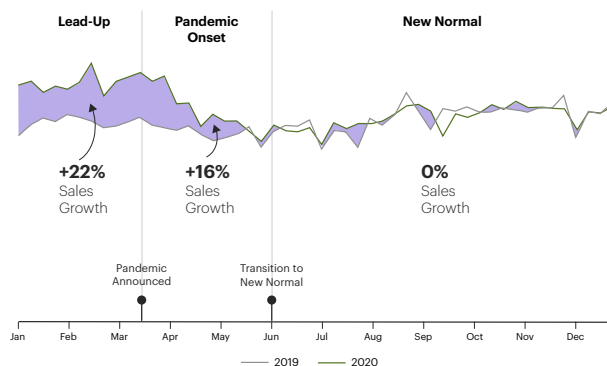
Growth in Sales From Top Sellers Spiked in the Onset and Remained Greater in the New Normal



Items in the tail saw a significant lift in sales starting in January, with a growth rate of 22% for the first two months of the year. This is likely related to purchases of new must-have goods — such as cleansers, disinfectants and wipes — to combat the virus as governments around the world instructed citizens to thoroughly wash hands and disinfect surfaces. These products tend to be slow sellers in normal times, but items like rubbing alcohol were already being hoarded long before the epidemic was reclassified as a pandemic. During the Onset, as lockdowns were imposed, growth rates for items in the tail experienced the same kind of lift as top movers.

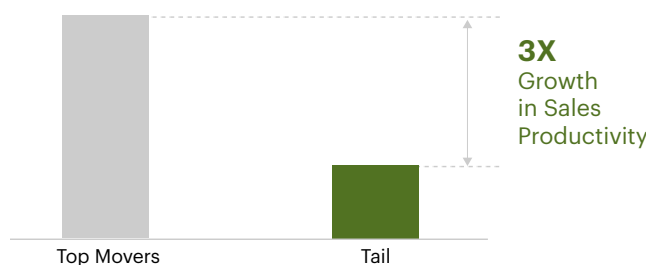
The big difference occurred in the New Normal, where sales of slow-moving items flattened to pre-pandemic levels. This aligns with factors such as the confirmation by epidemiologists that the virus spreads primarily through the air rather than through contact with surfaces. At this point, demand for historically tail goods such as cleansers and disinfectants naturally softened.

Sales Growth for Tail Items Was Highest in the Lead-Up Period



The takeaway is that the change in strategy to prioritize production efficiency, reduce changeovers and raise product assurance meant that A and Super A items were the big winners in terms of sales volumes. This is reinforced by the growth in sales productivity, which was three-times greater for fast-moving items than for those in the tail.

Top Movers Had 3-Times More Annual Growth in Sales Productivity Than Tail Items

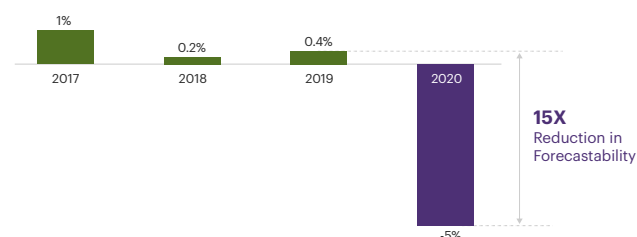


Forecasting Is Now Structurally Harder Than Before the Pandemic

With business becoming inherently harder, what happened to companies' ability to accurately forecast demand? The answer is that the pandemic also made it harder to forecast. Traditional forecasting is based on the presumption that history repeats itself. Even in the best of times, this method has limitations. During the pandemic, it completely failed. For companies trying to predict demand in March of 2020 as the world was descending into lockdown and everything was being turned upside down, what happened in March of 2019 had little to no relevance.

The first step in analyzing the performance of demand planning is to establish whether the business itself has become structurally easier or harder to forecast. The pandemic created seismic changes in consumer behavior, resulting in a record 5% drop in forecastability compared to positive annual growth ranging between 0.2% and 0.9% in prior years.

Annual Change in Forecastability Dropped by 15-Times, Making it Harder Than Ever to Forecast



EXECUTIVE TIP

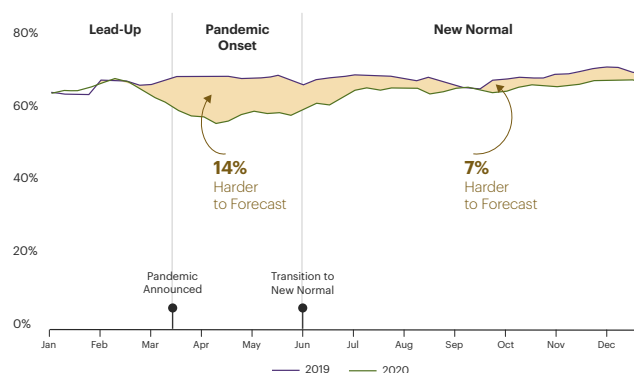
Are Some Businesses Easier To Forecast Than Others?

Yes. High forecast accuracy is always good, but it doesn't necessarily mean you are doing an especially great job of predicting demand. It could be that the forecastability of your business is structurally easier than your peers or others in different industries. The reverse is true too.

Forecastability is the degree to which demand for a particular business can be accurately predicted, and it provides the baseline on which to assess planning. To determine forecastability, companies use what is referred to as a naïve forecast, which is based on what sold during the prior three months and adjusted for seasonality. A rise in naïve forecast error for an item or the business as a whole indicates a drop in forecastability, making it inherently harder to forecast.

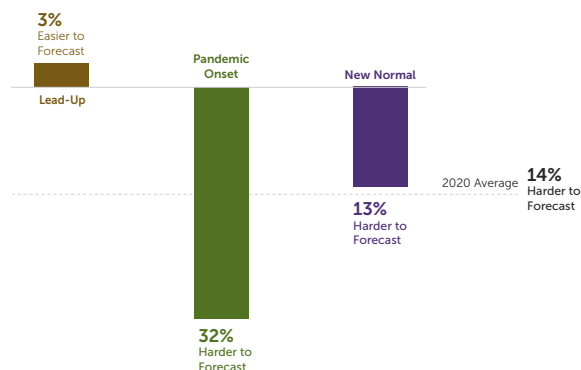
Similar to service levels, the drop in relative forecastability was most acute during the panic buying of the Onset stage. During this period, forecastability fell nine percentage points to 60%. It recovered somewhat as the New Normal set in but remained 7% lower than the same period in the prior year.

Relative Forecastability Dropped Sharply During the Onset and Remained Considerably Lower Than the Pre-Pandemic Baseline



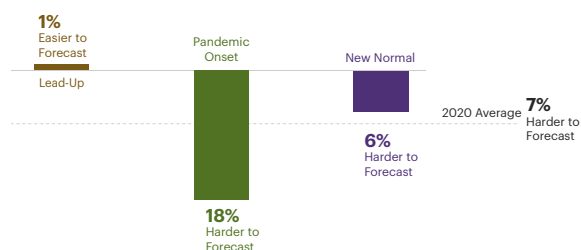
Relative forecastability was more pronounced for items in the tail than top movers. As shelves emptied during the Pandemic Onset, consumers were less picky about particular preferences and searched for any product at all. Fear of scarcity in one item reinforced hoarding across the board. Consumer behavior turned upside down, and forecastability for the tail dropped by one-third compared to the pre-pandemic baseline. Though items in the tail are always more challenging to forecast, they are now 13% more difficult to forecast in this New Normal.

Forecastability of Tail Items Became One-Third Harder During the Onset and Eased to 13% in the New Normal



While higher than items in the tail, forecastability for top movers also dropped significantly during the Onset, down 18% from the same time the prior year and settled into a new normal that is 6% lower than last year. Regardless of how the data is sliced, sales became harder to forecast.

Forecastability of Top-Moving Items Became 18% Harder During the Onset, Easing to 6% in the New Normal



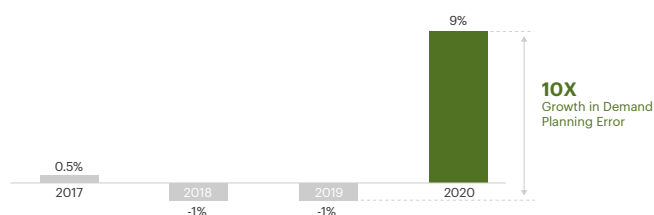
Planning Performance Hit an All-Time Low

While forecastability is a measure of how hard business is to predict, demand planning accuracy is a measure of an organization's skill at predicting. This is an important distinction because ineffective planning teams may create accurate forecasts if the business has high forecastability. Most organizations, however, would like to independently assess the quality of their planning teams and processes to drive continuous improvement. In prior iterations of this study, demand planning accuracy has been essentially

stable year-over-year. This pattern holds true for the Lead-Up period of 2020 as well, with average demand planning error at roughly 46%.

When the pandemic was declared, however, this trend was upended, creating the first step-change in the history of the study. Forecast error rose by one-fifth in 2020 to 54%. The rate of change increased ten-fold compared to the prior year when error was down 1%. Given the structural decrease in forecastability, a significant rise in error during the pandemic is expected.

Growth in Demand Planning Error Rose Sharply During the Pandemic, Up Ten-Fold



KEY TAKEAWAY

When the pandemic was declared, demand planning accuracy fell sharply, creating the first ever step-change in the history of this study.

The observed error during the pandemic is higher than the historical ratios of forecastability to demand planning error would suggest. This too is expected because traditional demand planning depends on history repeating itself. While this premise becomes less relevant every year, it was rendered meaningless during the pandemic given the massive scale of change imposed on global economies.

EXECUTIVE TIP

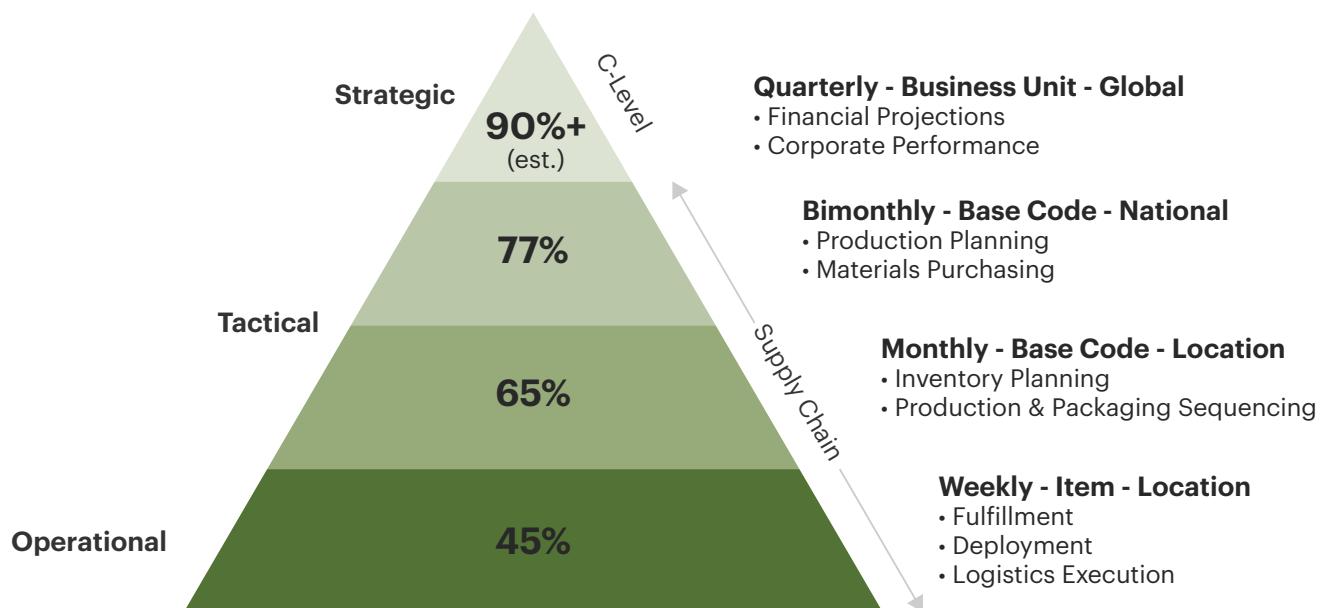
Forecast Accuracy Varies by Business Decision

Accuracy matters. Predictions about future demand are used to plan every aspect of business. However, what does “good” look like when it comes to forecast accuracy? The answer is it depends on where you sit in the organization and the decision you are about to make.

At the C-suite, executives use forecasts to manage corporate performance and give quarterly guidance. For this kind of decision, forecasts are aggregated to a quarterly-business unit level and typically exceed 90% accuracy. It is a principle of mathematics that higher aggregation provides higher accuracy, and this makes it easier to forecast the business as a whole.

The flipside to this mathematic principle is that the more granular you get, the harder things are to accurately predict. Deep at the core of the supply chain, customer fulfillment, replenishment and logistics execution make decisions based on the quantities of specific products at specific locations. Accuracy of granular weekly-item location forecasts for these kinds of decisions fell to 45% in the pandemic, compared to a 55% pre-pandemic baseline.

It's harder to get it right at this granular level, but the payoffs are enormous. Accurate forecasts for fulfillment and replenishment are essential for meeting service targets. Any drop in accuracy at this level exposes companies to more inventory shortages or excesses, missed revenue opportunities, erosion of profitability, lower return on capital and service risk.



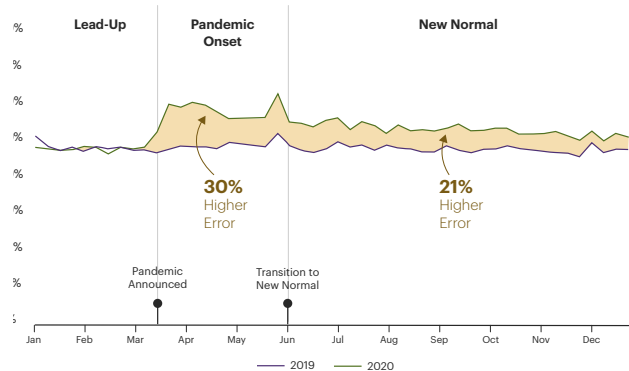


Demand Planning Performance by Phase

At the Onset of the pandemic, demand planning error jumped to 59%, up 14 percentage points from the baseline. Perhaps the bigger takeaway is to understand the scale of the rise in error resulting from a major disruption such as the pandemic — essentially a 30% rise in error. The events of 2020 serve as a valuable reference for assessing the impact of future major disruptions and the level of risk exposure executives and investors are willing to accept by sticking with the status quo.

Demand planning error improved slightly during the New Normal period, stabilizing at 54% for the second half of the year. This new reality is 21% higher than the baseline, presenting a challenge for businesses going forward. Not only did the pandemic make running a business harder and forecasting more difficult, but it also reduced the effectiveness of the organization's demand planning apparatus.

Significant Rise in Demand Planning Error for All Items During the Pandemic Onset and New Normal



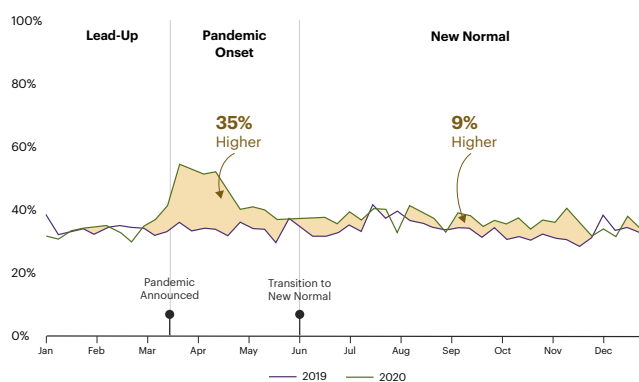
KEY TAKEAWAY

Not only did the pandemic make running a business harder and forecasting more difficult, but it also reduced the effectiveness of organizations' demand planning apparatus.

Error for Top-Movers and Tail Items Was Starkly Different

The impact of the pandemic on forecast performance was different for tail items than for top movers. As people stocked up on staple goods, forecast error for Super A items rose by more than one-third to 45%, up 12 percentage points from the pre-pandemic baseline. However, the error stabilized in the New Normal period, dropping to 37% — just three percentage points above the baseline.

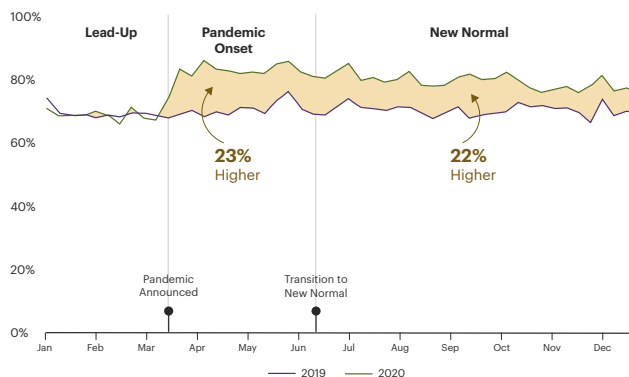
Planning Error for Top Movers Jumped During the Lockdown as Consumers Scrambled to Get Goods



The change in performance for items in the tail tells a very different story with a different ending. As the nation went into lockdown, consumers bought whatever was available. When a category's top-movers sold out, consumers purchased similar but less popular versions. Pandemic purchasing was less about preference and more about need. During the Onset, tail-item error was up 16 percentage points to 82%. And unlike top movers, which recovered in June, forecast error for items in the tail remained at an average of 82% for the rest of 2020. With items in the tail accounting for 81% of the portfolio, operating with error that is 22% higher than the pre-pandemic baseline as the new normal has considerable impacts across a range of decisions related to manufacturing capacity, inventory investments, fulfillment costs and service penalties.

This reality makes it all the more urgent for manufacturers to rationalize items and carefully assess the true – and now much higher – cost of maintaining a long tail.

Forecast Error in the Tail Rose in the Onset and Never Fully Recovered



KEY TAKEAWAY

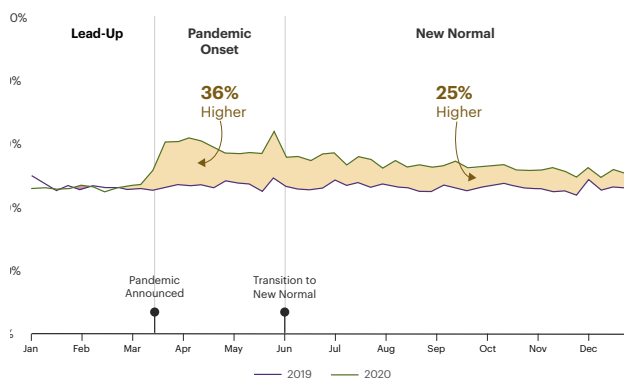
The markedly higher error in this new normal has considerable implications for manufacturing capacity, inventory investments, fulfillment costs and service penalties, making it all the more urgent for manufacturers to carefully assess the true — and now much higher — cost of maintaining a long tail.

Error Was Primarily Driven by Existing Items

How did the pandemic impact the performance of new and existing items? The shift in manufacturers' strategy to focus on efficiency instead of innovation meant fewer introductions and sales of new items. In a normal year, this would improve the overall forecast accuracy of the portfolio, but 2020 was far from a normal year. While error was indeed greater for introductions, it turns out that existing items are the primary driver of the overall lift in demand planning error. Forecast error for existing items jumped 15 percentage points during the Onset to 58%, a relative rise of 36%. It recovered slightly starting in June and normalized at 53% but remained 25% above the pre-pandemic baseline.

In response to the pandemic, some companies considered forecasting demand as if there were no supply constraints to ensure that all available capacity was used to its full extent. This is referred to as unconstrained demand. When service levels are at the normal 99% level, a shift to forecasting unconstrained demand would have little effect on the error metrics. However, when service falls below 90% as it did in the pandemic, the inherent gap between orders and shipments results in a rise in error. This likely contributed to some of the observed rise in forecast error in 2020.

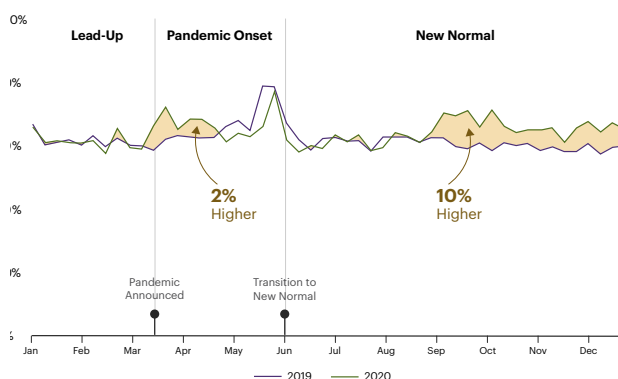
Forecast Error for Existing Items Spiked in the Onset and Remained 25% Higher in the New Normal



The error profile for new items was quite different than for existing products. During the Onset, introductions were considerably fewer than in prior years, and while there were ups and downs during these few months, the average error was only 64% compared to the baseline of 63%. Error continued to hover around the baseline until it diverged in September. From this point on, error for new items averaged 67%, up 11 percentage points from the same period in the prior year.

An 11 percentage-point spread coming out of the New Normal is concerning because it sets a higher baseline going forward for future introductions. Just as the pandemic has made business harder, it has made innovation harder.

Forecast Error for New Products Is 10% Higher in the New Normal



KEY TAKEAWAY

Just as the pandemic has made business harder, it has made prediction and the launch of introductions harder.

AI and Real-Time Data Changed the Game

Each year, the study includes a fact-based analysis of the value realized by companies that use real-time data and artificial intelligence (AI) in forecasting. With the term AI being used indiscriminately as a cure-all by vendors, this study provides a way to cut through the noise with hard data on the actual benefits of deploying AI at scale in production by some of the world's largest manufacturers. This year, the stakes are even higher because the pandemic turned everything upside down, yielding the largest and most abrupt change in consumer behavior in modern history.

Some expressed concern that since AI had never “seen” a pandemic before, it would be ineffective and that it might even be reckless for companies to use it. This study provides the definitive, fact-based answer to the question on everyone's mind: “Can AI work in major disruptions?” The answer is an unqualified “Yes!” Data from global demand sensing deployments confirm that the use of AI and real-time information to sense demand and understand what is happening right now in your supply chain is a game-changer for managing disruptions — even when the disruptions are at pandemic scale.

EXECUTIVE TIP

What is Demand Sensing?

There is a lot of buzz about demand sensing, and for good reason. It is an essential part of building a more agile and resilient supply chain and an important step in the journey to forecasting excellence. The term demand sensing is used liberally by vendors, which can make it challenging to understand the actual performance to expect. A benefit of this study is that the underlying data comes directly from e2open's Demand Sensing application, providing a true apples-to-apples comparison. To avoid false equivalencies when comparing to findings outside this study, it is important that the demand sensing solution matches all the following criteria:

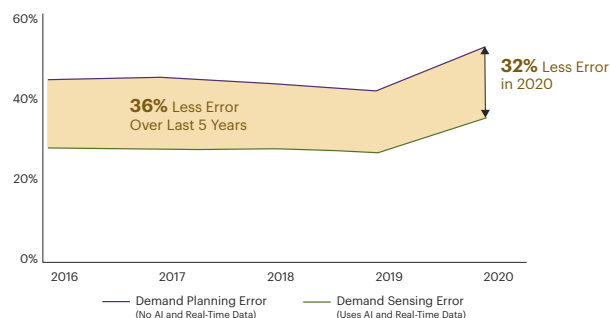
- Use of multiple, real-time signals to create daily forecasts reflecting current market realities (instead of relying on historical sales which are, by definition, disconnected from present conditions)

- Use of AI and machine learning (ML) pattern recognition technology to process masses of big data and extract meaningful information (beyond traditional time series analysis methods)
- Fully automated system with self-tuning algorithms that learn from data without human interaction and publish daily forecasts directly to the supply system for execution

When evaluating vendors, be sure to look for production deployments at scale with years of proven performance in the field. Speak directly to their customers to learn just how effective it really is and the benefits they have realized. This is the only reliable way to cut through all the marketing hype around AI and distinguish what is real.

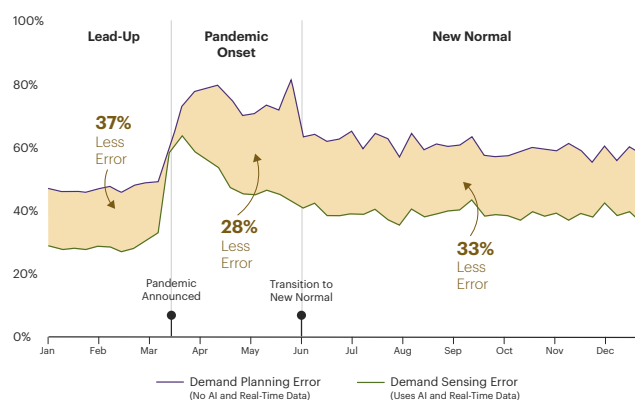
Demand sensing provides a solid advantage year-over-year regardless of what comes its way, with an average of 36% lower forecast error over the past five years compared with demand planning. Despite the dramatic change in consumer behavior from lockdowns and stay-at-home orders, companies using demand sensing technology cut forecast error by 32% during the pandemic. It is important to note that these figures are not carefully curated to highlight categories where performance is strong. Rather they reflect all items stored at all locations for all companies participating in the study. There is no cherry-picking in this report — what you see is what you get.

Demand Sensing Consistently Cuts Forecast Error Year-Over-Year — Even During the Pandemic



Furthermore, the use of real-time data and AI to sense demand helped at every stage of the pandemic, cutting error by 28% during the panic buying of the Onset and 33% in the New Normal period.

Solid Demand Sensing Performance Advantage Across All Three Phases of the Pandemic



Effective Across the Entire Portfolio

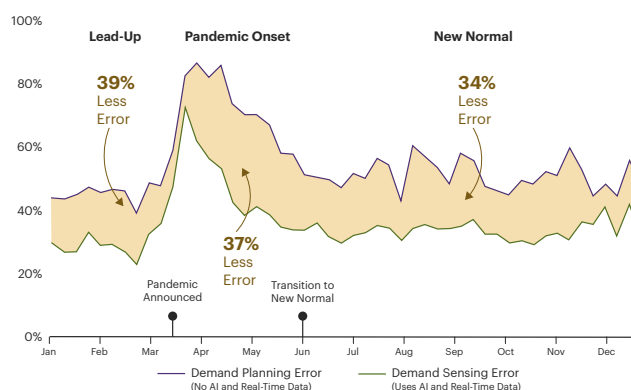
Each year, this study reports how demand sensing improves the performance of the entire portfolio, including the fastest- and slowest-moving items as well as new and existing products. While the same holds true in this year's study, the big question is how well did it perform in each of these segments during the pandemic? The short answer is that it did not skip a beat.

Top Movers

While comprising only roughly 1% of items in the portfolio, Super A items represent 20% of sales, so they are essential to get right. Even a minor improvement in forecasting performance for these all-important products provides outsized returns. In terms of accuracy, top movers have an inherent advantage because their high turnover rate makes them mathematically easiest to forecast. Furthermore, organizations pay special care to top-moving items, with a disproportionate time allocated to adjusting and tuning forecasts.

Even with all this attention and the inherent mathematical advantage, the use of AI and real-time data to sense demand provided a step-change in forecasting performance for top movers at every stage of the pandemic. After a sharp spike in March, forecast error was cut by 37% during the Onset — from 50% to 32%. This correction brought the error level back down essentially to pre-pandemic levels. In the New Normal phase, error with demand sensing fell to 24%, 34% less than demand planning.

Demand Sensing Cut Error for Top Movers by More Than One-Third at All Stages of the Pandemic



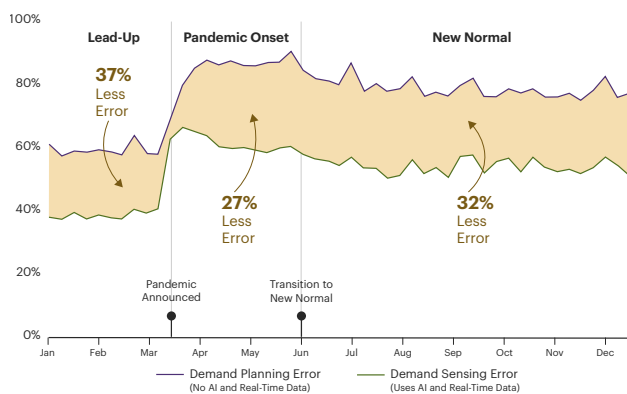
KEY TAKEAWAY

The use of AI and real-time data to sense demand provided a step-change in forecasting performance for all items, across all stages of the pandemic.

Items in the Tail

What about the items in the long tail, where demand planning error spiked to record-high levels during the pandemic? Demand sensing provided similar performance here as it did with top movers, reducing error for items in the tail by 27% during the Onset and by 32% during the New Normal. With hundreds or thousands of items to manage, planners are routinely forced to make trade-offs regarding which items to spend precious time on. One of the many benefits of demand sensing is that there are never too many items for an algorithm. AI provides the same care and attention to tens of thousands of slow-moving items in the tail as it does to the top 100 Super A items. This is demonstrated in the results.

Demand Sensing Improved Forecast Accuracy for Tail Items Across All Stages of the Pandemic



Existing Items

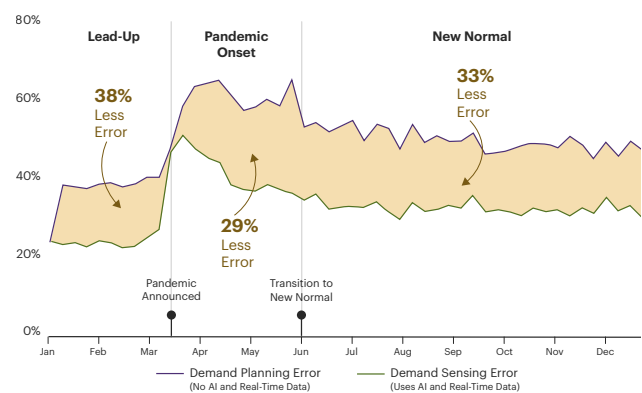
With the shift in corporate strategy to emphasize efficiency over innovation, how important did the combination of AI and real-time data prove to be for the existing items that the world depended on during the pandemic to keep people healthy, fed and safe? Put simply, it proved to be vital.

Vital because near-term forecasts are the foundation for replenishment decisions. During the pandemic, good replenishment decisions meant the difference between continued or interrupted supply of essential goods such as PPE to protect frontline workers, medicines for those who fell ill and food to keep people from going hungry.

As the virus spread and economies were disrupted, demand sensing ensured that forecasts were connected to the realities on the ground. Real-time signals helped manufacturers get ahead of demand and better assess what products would be required — and at what time and place. Granted, demand sensing forecasts still contained errors, but they were far more accurate than relying on prior sales trends and gut feel.

Forecast error for the replenishment of existing items was cut by 29%, from 58% error to only 41%, as lockdowns were imposed. It is worth repeating that existing items made up 95% of sales in 2020 and included the staples that kept the world healthy, fed and safe during the pandemic. In the New Normal period, demand sensing cut error for these items by 33% — from 53% to 35%.

Demand Sensing Improved Forecast Accuracy for Existing Items



KEY TAKEAWAY

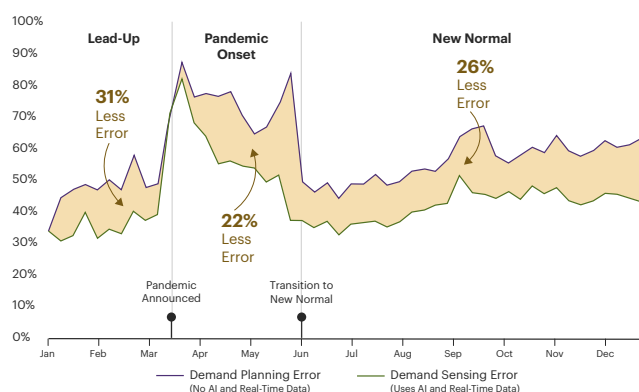
Existing items made up 95% of sales in 2020 and included the staples that kept the world healthy, fed and safe during the pandemic. In the New Normal period, demand sensing cut error for these items from 53% to 35%.

New Items

While there were fewer introductions during the pandemic, understanding the role of AI and real-time data to improve the performance of new items provides an important data point to prepare in advance of the next major disruption. It turns out that systematically using real-time signals to understand current market conditions is enormously helpful for new items — even in the midst of the largest disruption in modern history.

Demand sensing cut forecast error for new items 22% during the Onset, from an average of 68% to 53%. In the New Normal period, error was reduced by 26%, from 57% to 42%. For context on how effective the combination of AI and real-time data is in sensing demand, forecast error for new items during the pandemic was lower than pre-pandemic baselines for existing items.

Demand Sensing Delivered a Step-Change in Forecast Error for New Items

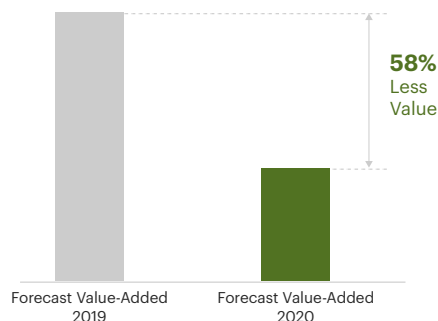


Business Value From Demand Planning Investments Was Significantly Eroded

Companies invest millions of dollars in people, processes and technology to plan demand. The way to measure the value of these investments is through a metric called forecast value-added. It compares the forecast accuracy after people, processes and technology to a simple naïve forecast that requires no investment. In 2019, forecast value-added for the companies in the study was 15%, meaning that investments across all departments to better forecast sales produced a relative improvement of 15% in the quality of predictions.

As reported earlier, the pandemic made forecasting fundamentally harder than before, and forecast accuracy dropped. The big question is, “Did investments aimed at improving forecasting gain or lose value during the pandemic?” The short answer is that more than half of the value delivered in 2019 was lost in 2020.

The Pandemic Reduced the Value of Forecasting Investments by More Than Half



KEY TAKEAWAY

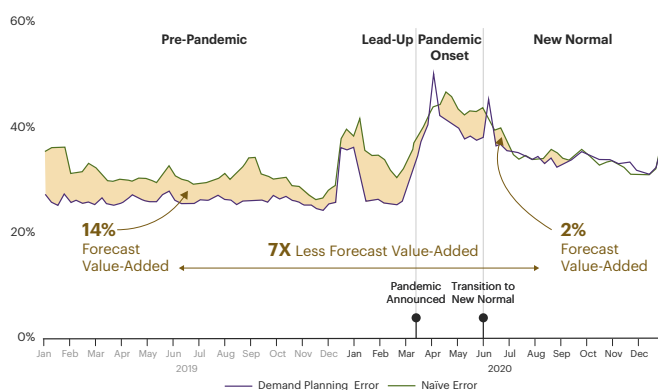
The pandemic erased more than half the value of investments in people, processes and technology aimed at improving planning accuracy.

As the pandemic progressed, the change in forecast value-added can be visually depicted by the difference in spread between the demand planning and naïve forecast error. In the chart below, this spread is shaded in green, where more green indicates more value. Unshaded areas reflect periods of a negative value-added, where the planning process degraded the quality of the forecast.

The pre-pandemic baseline shows a healthy spread for 2019 and the first two months of 2020. The rise in error and convergence between the two lines just before the December holidays is a seasonal phenomenon that can be ignored for the purposes of analyzing the pandemic impact. In the Onset period, purchase patterns were thrown off as consumers were hoarding goods, so error in both metrics understandably rose. The main point of interest is the convergence of both lines in the New Normal period. The forecast value-added delivered by demand planning for this period is only 2%. This is seven times lower compared to the same period in the prior year.

This is especially concerning because this New Normal figure of 2% forecast value-added is the new baseline for business going into 2021, a year in which many of the same conditions that prevailed in the New Normal are still present.

Forecast Value-Added by Phase Reveals That Business Has Become Harder



Six-Fold Increase in Value by Sensing Demand

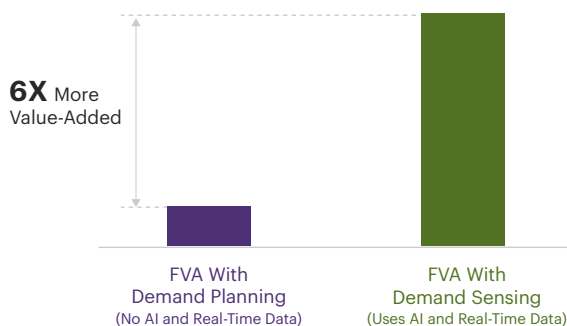
The drop in value of the investments made in planning is because demand planning processes and technology are predicated on the assumption that history will repeat itself. However, just as the Securities and Exchange Commission

requires mutual funds to warn investors that “past performance is no guarantee of future results,” the same holds true for demand planning. Economic uncertainty, shifts in consumer behavior and the continued rise of e-commerce mean predicting what customers will order next week is increasingly disconnected from what they ordered this time last year — let alone half a decade ago. Furthermore, what happened at this time last year is essentially irrelevant during a pandemic with lockdowns and stay-at-home orders.

Real-time data and AI were helpful in overcoming this disconnect to create more accurate forecasts that are aligned to current market realities. What was the impact on the value of investments in planning demand? The answer is significant.

Demand sensing provided six times the forecast value-added during the pandemic compared to demand planning alone. Please note that demand sensing augments existing demand planning investments — it does not replace them.

Demand Sensing Increased the Forecast Value-Added by 6-Times

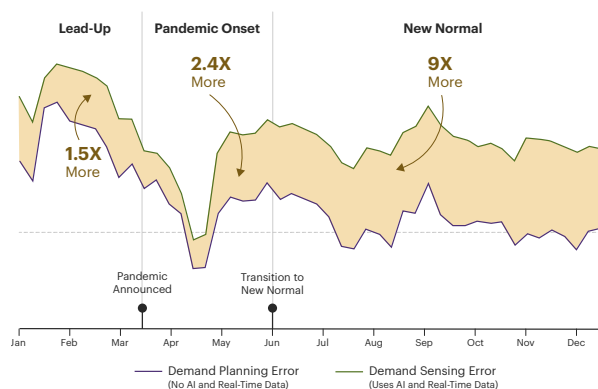


KEY TAKEAWAY

Demand sensing augments traditional demand planning by connecting forecasts with current realities. This led to a six-fold increase in forecast value-added.

As each stage of the pandemic progressed, the effect of demand sensing on forecast value-added became more pronounced. In the first two months of the year, forecast value-added with demand sensing was 50% greater than with demand planning alone. In the Onset period, people started to panic-buy, and overall forecast value-added dropped as consumer behavior became more unpredictable. However, added value from demand sensing increased to two times. In the New Normal period, both metrics stabilized, with demand sensing adding nine times more value than demand planning alone.

Demand Sensing Significantly Improved Forecast Value-Added Across All Stages of the Pandemic



KEY TAKEAWAY

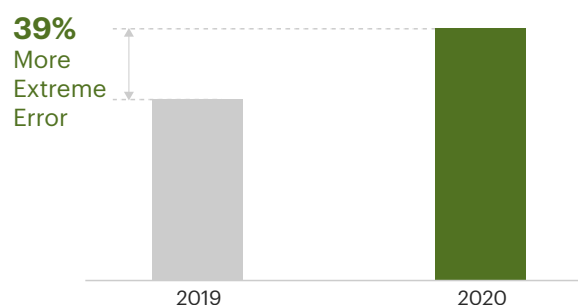
Demand sensing consistently delivered more value than demand planning alone — nine-times more in the New Normal period.

Volume Exposed to Extreme Error During the Pandemic

Simply put, 2020 was a year of disruptions like no other. While supply chains are flexible in nature and designed to adapt to deviations from the plan, instances of extreme error — where forecasts exceed or fall short of sales by two times or more — are the most costly and disruptive to businesses. Forecasts are always wrong to some extent. Small deviations are easily absorbed by the flexibility built into supply chain processes, with little financial effect. However, the supply chain gets a shock whenever deviations of forecasts and sales are significant, resulting in an asymmetric impact to costs, service and revenues. These shocks ripple upstream and downstream as well, affecting suppliers and distribution partners. The flipside is that reducing the volume of sales exposed to extreme error leads to asymmetric gains in revenue and profitability. This makes extreme error an especially relevant metric to understand the business impact of major disruptions such as the pandemic.

During the pandemic, the volume of business exposed to extreme error was 38%, up more than one-third from the baseline of 27%. To put this in context, for a manufacturer with an annual turnover of \$100 billion, this means that \$38 billion of its sales were exposed to higher levels of disruption — impacting growth, eroding profits and reducing return on invested capital.

Volume Exposed to Extreme Error Jumped by 39% in 2020 to an All-Time High



EXECUTIVE TIP

Extreme Error: Most Problematic for the Supply Chain

Supply chains are designed to operate in an uncertain environment and accommodate minor daily error with little impact. As an analogy, consider driving to a nearby town and predicting the journey will take one hour. Normal events like stoplights or unexpected traffic might slow you down a little but won't materially affect how long it takes to get there. However, if the highway is closed or a bridge is washed out, this means serious delays that impact not just when you'll arrive but all your plans once when you get there. These sorts of delays — comparable to extreme forecasting error for organizations — are the most disruptive and costly to recover from. For example,

if the detour around the closed bridge delays you by three hours, you might miss your flight, need to stay overnight and pay for rebooking; be late for an important appointment; or rush to get there only to find the store has closed and you'll need to repeat the journey tomorrow.

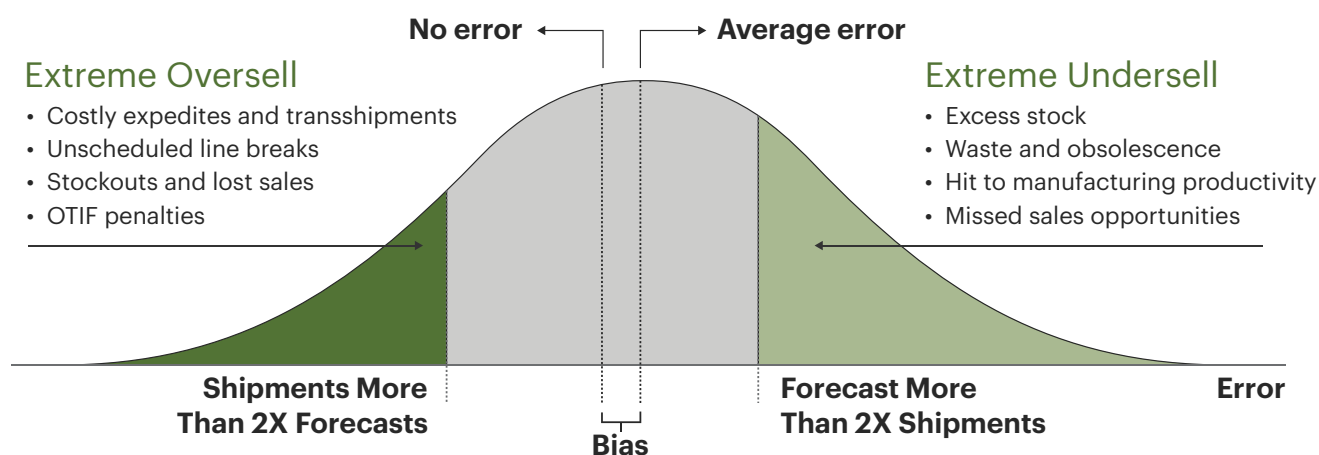
Cases of extreme error — when forecasts exceed or fall short of shipments by two times or more — are the supply chain equivalent of the highway washout or bridge closure. These are the most disruptive and costly to supply chains, and have an asymmetrical impact on revenue and costs, significantly reducing profitability and hindering long-term goals. There are two types of extreme error in supply chain:

Extreme oversell error

Sales are more than double the forecast. This imposes hardships on human resources, erodes margins through transshipments, expediting and/or unplanned production changes, and risks service levels.

Extreme undersell error

Sales are less than half the forecast. This results in high levels of excess inventory, poor use of working capital and ongoing finance and carrying costs. This is of special concern for revenue realization in times of constrained supply, such as during the pandemic, where production of items that fail to sell consumes valuable capacity and materials that could otherwise generate sales.

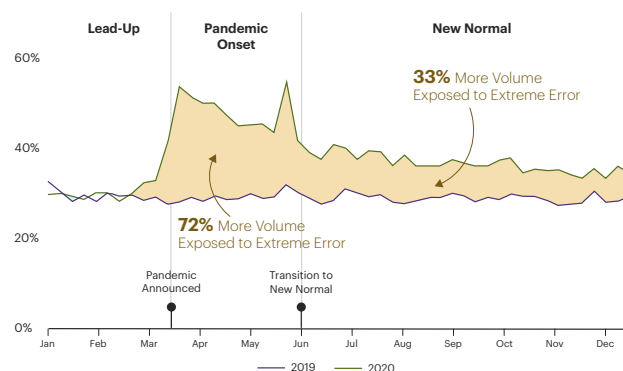




The annual measures only tell a portion of the story. For the first two months of the year, extreme error was essentially on par with the pre-pandemic baseline. In the Onset period, as lockdowns were imposed, consumer behavior quickly changed, with people shopping for several weeks' worth of goods at a time. Fears of scarcity sparked hoarding. During this three-month period, volume exposed to extreme error jumped by 72% to a record high of 46%. That means almost half of all trade was exposed to costly and disruptive extreme error during this period. As context, for a company with \$100 billion in annual sales, roughly \$12 billion in sales would have been exposed to extreme disruption in these three months alone, putting revenue and profits at risk. It also disrupts upstream and downstream partner operations, impairing the health of the overall ecosystem organizations rely on to support their business.

With the transition to the New Normal period, the volume exposed to extreme error fell to 36%. While lower than the prior three months, it was still nine percentage points or 33% higher than the pre-pandemic baseline. Not only did the pandemic make business and forecasting harder, organizations were contending with one-third of their volume exposed to extreme error. This is a fundamental change that will shape economic performance going forward.

Volume Exposed to Extreme Error at Each Phase of the Pandemic



KEY TAKEAWAY

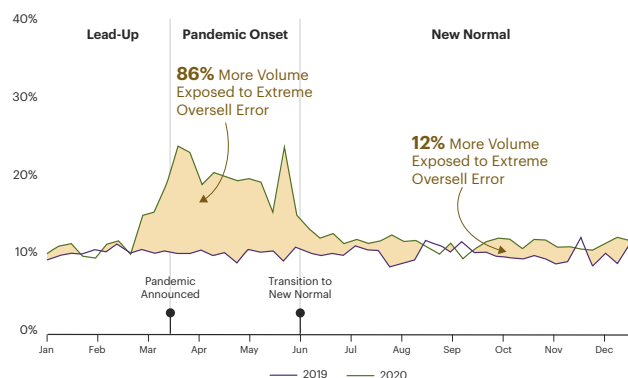
In the New Normal, sales volumes exposed to the risk of extreme error were one-third higher than before the pandemic. This is a fundamental change that will shape economic performance going forward.

Extreme Oversell Error

The widespread stockouts that occurred in the spring of 2020 were driven by rational forces of supply and demand, combined with irrational human nature. People rushed to stock pantries with several weeks of goods at once, creating what is perhaps the world's largest simultaneous build-up of personal safety stocks in history. According to behavioral economic theory, the fear of loss outweighs the prospect of gains. This was in full display as stockouts in one item or category spurred consumers to buy more than necessary for other items "just in case." This is exemplified by shelves empty of toilet paper and disinfectants in March. Fear of losing out extended across industries, causing waves of human-driven shortages.

During the Onset period, hoarding by consumers almost doubled the volume exposed to extreme oversell error — where demand exceeded what was expected to sell by two times or more. With personal safety stocks full, buying stabilized, and extreme oversell error dropped to almost pre-pandemic levels during the New Normal stage.

Extreme Oversell Error Nearly Doubled as People Hoarded Goods During the Onset Period



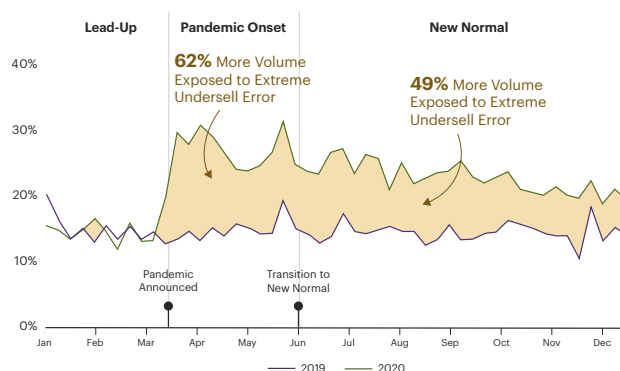
KEY TAKEAWAY

The early weeks of the pandemic were characterized by perhaps the largest simultaneous build-up of personal safety stocks in history. The unpredictable nature of the bulk-buying led organizations to significantly underestimate sales.

Extreme Undersell Error

The effect of the pandemic was noticeably different for extreme undersell error. As stay-at-home orders were enforced, everything got turned upside down, and it was understandably hard to predict what would sell. Extreme undersell error — when planners expected to sell at least twice what consumers actually purchased — rose by 62% from March through May. However, it failed to recede in the New Normal period, remaining at a level that is 49% higher than the pre-pandemic baseline.

Extreme Undersell Error Rose at the Pandemic Onset and Remained at Higher Levels in the New Normal



While consistent with the observation of positive bias by demand planners, the rise in extreme undersell error is at odds with the service gap of 17% during this time. A closer examination of the ratio of extreme undersell to oversell during each stage of the pandemic finds that there was far more extreme undersell error in the second half of the year.

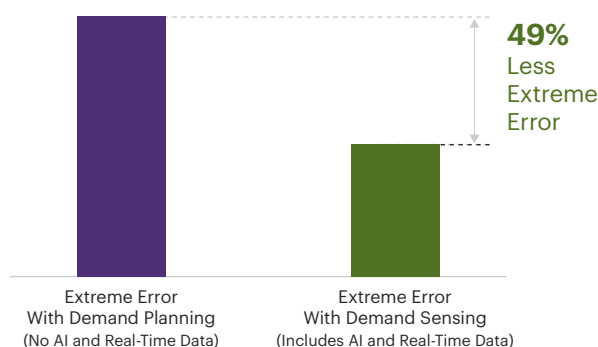
This exposes a costly consequence of persistent overoptimism. The new reality is that businesses are faced with eight percentage points more of volume exposed to extreme undersell error. As context, for a \$100 billion company, this represents \$8 billion more of sales exposed to extreme disruptions because of over-optimism.

The final financial implications include a corresponding rise in excess stock, carrying costs and waste. Furthermore, the service gap in the New Normal period suggests limited supply capacity. In times of constrained supply, it is especially important to focus plant capacity on building products that people will buy, not just what planners hope they will buy. Hope is not a strategy. The higher rate of extreme undersell error that stabilized in the New Normal period represents a significant loss of revenue and growth potential.

Changing the Game With AI and Real-Time Data

Prior versions of the study have repeatedly shown that the use of AI and real-time data to sense demand is proven to reliably reduce the volume exposed to extreme error. This year, the million-dollar question is, “Can AI and real-time data reduce the volume exposed to extreme error even in a major disruption like the pandemic?”

Demand Sensing Halved the Volume Exposed to Extreme Error During the Pandemic

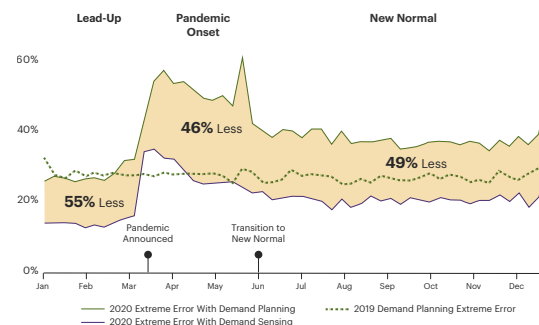


The answer is yes. Using AI and real-time data to sense demand cuts the volume exposed to extreme error in half.

With the sharp rise in demand at the Onset, demand sensing — a technology based on the use of AI and real-time data — cut the volume of extreme oversell error in half, from 46% to 24%. In the New Normal phase, demand sensing continued to provide a 49% advantage, cutting the volume exposed to extreme error from 36% to 18%.

It is interesting to note that the level of extreme error with demand sensing is even lower during the pandemic than demand planning technology alone achieved even in the baseline period before the pandemic. This clearly demonstrates the value of using AI and real-time data to get closer to the customer and make decisions based on current market realities.

Demand Sensing Reduced Extreme Error During All Phases of the Pandemic



KEY TAKEAWAY

The level of extreme error with demand sensing is lower during the pandemic than the pre-pandemic baseline with demand planning alone. This highlights the value of using AI and real-time data to get closer to the customer and make decisions based on current market realities.

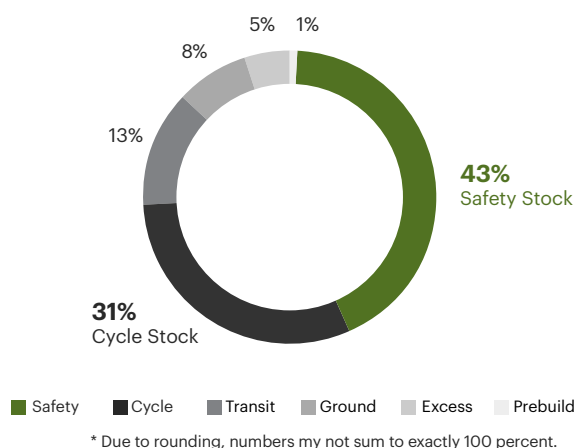
State of Inventory During the Pandemic

Inventory is the lubricant that keeps the supply chain working and goods flowing by buffering stock at different points in the network. This includes stock held at internal operations such as plants and distribution centers, downstream partners such as retailers and distributors and upstream stakeholders such as contract manufacturers or mixing centers. Too much inventory hurts financial performance, with capital tied up in unproductive goods and excess carrying costs, plus the increased risk of waste. However, too little inventory also hurts financial performance, with missed revenue opportunities, costly expedites and unplanned production breaks or all-out line stoppages. Achieving the right balance provides a distinct competitive advantage, especially for just-in-time manufacturing, where disruptions pose a significant risk.

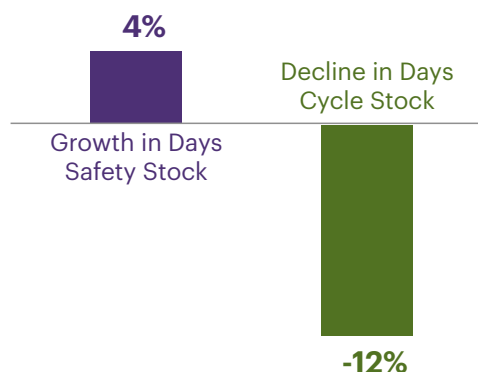
Each year, the Forecasting and Inventory Benchmark Study analyzes finished goods inventory and the value of multi-echelon inventory optimization technology to reduce excess inventory.

Finished goods inventory serves many functions. The two largest segments are safety stock to protect against uncertainty and cycle stock to meet normal demand. In 2020, safety stock represented 43% of inventory, up 4% from the pre-pandemic baseline. The degree of safety stock is related to the levels of demand and supply volatility — both of which were higher than normal due to the pandemic.

Finished Goods Inventory by Function in 2020



Safety Stock Grew While Cycle Stock Dropped



Cycle stock was 31% of finished goods inventory, down 12% from the prior year. This aligns with the shift to an efficiency-driven growth strategy during the pandemic. Focusing on a smaller number of faster-moving goods meant fewer line changes and higher output. For the same sales, faster-moving items lead to faster inventory turnover, reducing the amount of cycle stock.

Value of Inventory Optimization

Since the beginning of commerce, people have used rules of thumb to determine how much safety stock to carry. Segmentation is a popular methodology, grouping products with similar characteristics — such as whether items are more stable or volatile — and setting targets for each group. While better than a one-size-fits-all approach, segmentation still applies rules of thumb to various clusters of products based on high-level characteristics. The advent of multi-echelon inventory optimization (MEIO) technology replaces rules of thumb with unique models for every item at every stocking location, even for large networks with hundreds or thousands of item-locations.

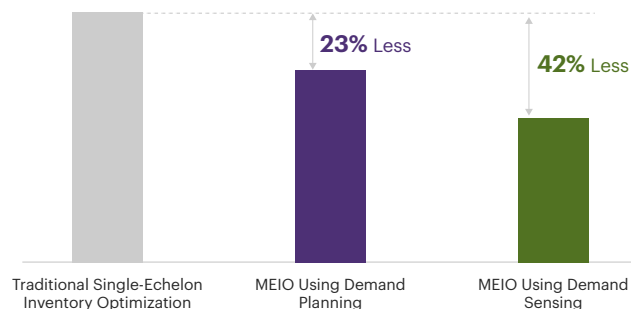
Multi-echelon inventory optimization considers volatility, service requirements and fulfillment strategy to define optimal stocking levels of every node of the supply chain. Instead of segmentation into one of a handful of groups, each item stocked at each location becomes its own group. For large companies with many items and complex distribution, it would take months for planners to model these manually, but just minutes for an algorithm.

More advanced solutions include multi-enterprise optimization to include upstream and downstream inventory outside of the organization, pre-integration with demand sensing to leverage daily forecasts and automatic self-tuning every week to reflect changes in market conditions. Weekly tuning is essential in times of volatility to ensure that levels stay connected and relevant to what is happening on the ground.

In 2020, MEIO technology using standard demand planning forecasts was able to reduce safety stock by 23% compared to the traditional single-echelon inventory management included in enterprise resource planning (ERP) systems. MEIO was even more effective when combined with the accurate daily forecasts from demand sensing, cutting safety stock by 42% in 2020.

The takeaway is that inventory optimization works. Advanced MEIO works even better.

MEIO Significantly Reduced Safety Stock Levels but MEIO Combined with Accurate Forecasts from Demand Sensing Provided the Most Value



KEY TAKEAWAY

If you are serious about reducing inventory, then it's time to revisit multi-echelon inventory optimization and combine it with accurate forecasts from demand sensing.

Key Takeaways for Decision Makers

It is tempting to act as if the disruptions in 2020 are an anomaly and that the most extreme risk is behind us. While no one can predict with certainty what the future holds, the task of looking at the facts and assessing business risk falls to decision makers. This study aims to help leaders do this task well by providing a data-driven baseline of the actual supply chain performance of some of the world's largest manufacturers during the pandemic. Data from 2020 reveals that virtually every aspect of business is now structurally harder than before the pandemic.

Demand became harder to forecast as long-established patterns in consumer buying behavior changed overnight. Consumers not only bought different types of goods, but also began buying greater quantities of many of these goods, leading to record sales and widespread stockouts

and gaps in service across almost every segment of the portfolio. Many factories, upstream suppliers and logistics providers were pushed past their normal operating thresholds, further complicated by stay-at-home orders and health concerns restricting capacity. In the face of strong but unpredictable demand mixed with supply and transportation shortages, companies focused capacity on high-volume, essential goods for greater manufacturing efficiency and expanded safety stock buffers to help mitigate volatility.

In a world of globalized just-in-time manufacturing, these are the sorts of impacts and ripple effects we can expect to confront during major disruptions in the future. Supply chain processes span internal operations, multiple tiers of upstream and downstream trading partners, and reach down to the end consumer. These processes and the inherent dynamics of demand, supply and transportation are all connected, interdependent and highly reactive. Data and insights from this study find there are key steps decision makers can take to proactively manage these risks, better achieve corporate goals and emerge stronger after major disruptions:

- **Use real-time data and AI to sense demand, understand the impact of current market realities and better predict what customers will actually order — even in a major disruption like the pandemic.** 2020 proved without a doubt that history no longer repeats itself, and demand planning was ill-equipped to manage this scale of disruption. The study found that the use of AI and real-time data to sense demand cut forecast error by more than one-third across all stages of the pandemic; reduced the volume exposed to extreme error by half; and drove a six-fold increase in realized value from investments in people, processes and technology related to planning.
- **If you are serious about rightsizing inventory levels and costs, consider multi-echelon inventory optimization combined with demand sensing.** This study reveals that the use of multi-echelon inventory optimization helped reduce safety stock by 23%. When combined with better forecasts from sensing demand, this number increased to 42%.

Glossary of Terms

Active items	Items with sales in a particular calendar year are considered active items in that year.
Base code	Base code refers to a set of items that share a Universal Product Code (UPC) or Global Trade Item Number (GTIN), for example, all types of a manufacturer's six-roll-per-pack, 100-sheet regular paper towels regardless of the pattern.
Bias	Bias is calculated by dividing the difference between total forecasts and shipments by total shipments. Positive and negative bias represent over- and under-forecasting respectively.
Cumulative items	This is the number of items that was for sale at any time in the current and prior years. It includes both active and discontinued items.
Cycle stock	The portion of inventory that is replenished in a warehouse periodically for fulfilling downstream orders is considered cycle stock.
Cycle time	A key driver in the safety stock calculation. The average time between replenishments for warehouses and distribution centers, or the average time between manufacturing runs for plants.
Demand planning	This refers to traditional demand planning solutions employed by participating companies to create forecasts using a time-series analysis of historical data and augmented to reflect promotions as well as planner insights.
Demand sensing	This advanced forecasting technique uses machine learning to predict near-term daily demand based on current demand signals. Demand sensing is automated and self-tuning. All companies participating in this study use e2open's Demand Sensing application.
Discontinued items	Items that were last shipped in the prior calendar year are considered discontinued.
Excess stock	This is extra inventory carried due to over-forecasting actual demand. Excess stock is calculated based on historical forecast bias measured over total lead time.
Extreme oversell error	This is calculated as the percentage of volume for which shipments exceed forecasts by more than two times.
Extreme undersell error	This is calculated as the percentage of volume for which forecasts exceed shipments by more than two times.

Forecast value-added (FVA)	Forecast value-added, also known as FVA, is the difference in mean absolute percentage error (MAPE) between a planning system forecast and a naïve forecast, divided by the naïve forecast. Forecast value-added represents the percentage forecast improvement attained from investments in people, processes and technology.
Forecastability	Forecastability is the degree to which demand can be accurately predicted. A rise in the naïve forecast error indicates a drop in forecastability.
Ground stock	Inventory on hold due to quality assurance, order picking time, aging time and similar reasons is considered ground stock.
Item	The lowest level of the product hierarchy, an item constitutes a unique product. For example, a brand of six-roll-per-pack, 100-sheet paper towels might come in different design patterns all sharing the same UPC or GTIN. Each specific design pattern would constitute a separate item.
Lead-Up	The first two months of 2020 (January and February) before Covid-19 was declared a pandemic.
Lead time	A key driver in the safety stock calculation. Total replenishment lead time representing the average amount of time required to replenish inventory when an unexpected need arises.
Multi-echelon inventory optimization (MEIO)	Also known as MEIO, multi-echelon inventory optimization is an advanced technique that reduces inventory by mathematically determining the minimum amount of safety stock required at all stocking echelons in the extended supply chain to achieve customer service targets. All companies participating in the inventory portion of this study use e2open's Multi-Echelon Inventory Optimization application.
Naïve forecast	This simple forecast is based on a seasonally-adjusted moving average. The naïve forecast provides a means to measure forecast value-added.
New item	Any item with less than 12 months of history is considered a new item. This includes items with changes in product size, short-lived items such as displays, line extensions and entirely new products.
New Normal	The period beginning in June 2020 and continuing through the end of the year, as economies, corporations and supply chains found new operating norms to adapt to ongoing disruptions from the Covid-19 pandemic.
Pandemic Onset	The period beginning on the 11th of March 2020, when the World Health Organization officially classified Covid-19 as a pandemic, and continuing through the end of May 2020, when stay-at-home orders began to expire and a new normal began.

Pre-Pandemic Baseline	The period including calendar year 2019, which serves as the baseline for assessing business performance in 2020.
Safety stock	Inventory maintained to mitigate the risk of stock-outs due to uncertainties in demand and supply is considered safety stock.
Service	Service is calculated as the difference between orders and shipments, divided by shipments. Shortfalls in service reflect insufficient supply to meet demand and are caused by issues in demand management or by supply constraints.
Shipments	This is the quantity of items shipped in physical cases.
Transit stock	Inventory in transit from one location to another is considered transit stock.
Velocity	An item's rate of sale is its velocity. Sales velocity separates top movers from the tail. In the study, base codes are parsed into five quintiles by velocity. Velocity 1 refers to the fastest-moving products (also called top sellers or top movers), and velocity 5 items make up the tail.

About e2open

At e2open, we're creating a more connected, intelligent supply chain. It starts with sensing and responding to real-time demand, supply and delivery constraints. Bringing together data from customers, distribution channels, suppliers, contract manufacturers and logistics partners, our collaborative and agile supply chain platform enables companies to use data in real time, with artificial intelligence and machine learning to drive smarter decisions. All this complex information is delivered in a single view that encompasses your demand, supply and logistics ecosystems. E2open is changing everything.

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