Environmental Demand Signals

Testing whether weather adds predictive value after controlling for recurring seasonality

STUDY QUESTION

Do temperature, dew point, precipitation, wind, and lagged environmental conditions improve genuine forward forecasts, or are they mostly tracking the same annual cycle as demand?

Executive Summary

Environmental conditions were plausible demand drivers, but the analysis treated that hypothesis as something to test rather than assume. Raw relationships, lagged values, rolling windows, seasonality-adjusted relationships, and incremental rolling-origin forecast performance were examined.

Temperature and dew point showed strong raw correlation with demand, but much of that relationship weakened after the annual seasonal pattern was removed. Precipitation retained some lagged signal in early specifications, yet its incremental gain also weakened after the adaptive seasonal level was modeled correctly. No weather variable improved the revised adaptive baseline enough to justify inclusion in the final frozen model.

Why This Question Matters

For a seasonal outdoor-service business, weather and customer demand naturally move together. That creates a modeling risk: a weather variable can look highly predictive simply because both weather and demand rise and fall during the same part of the year.

The relevant forecasting question is not whether weather correlates with demand. It is whether weather adds information beyond what a well-specified seasonal and adaptive demand model already knows.

Testing Framework

- Screen current environmental values, lags, and rolling windows.
- Compare raw relationships with seasonality-adjusted relationships.
- Evaluate candidate features in chronological rolling-origin forecasts rather than by in-sample fit alone.
- Retain an external variable only if it improves genuine forward accuracy enough to justify additional complexity.

The First Frozen Weather-Enhanced Model

An early frozen specification combined annual seasonality, prior-week demand, and precipitation hours lagged three weeks. The model ranked 2025 demand well, but it failed the forecasting standard because a simpler recent-level benchmark had lower error.

2025 holdout	Weather-enhanced first model	Recent 4-week mean
MAE	2.90	2.43
RMSE	3.89	3.70
Actual vs. predicted correlation	0.855	0.846

DECISION RULE

High correlation was not enough. Because the simpler four-week benchmark produced lower forecast error, the first weather-enhanced Demand Score was classified as not validated.

What the Feature Tests Showed

- Temperature and dew point had strong raw relationships with demand, but most of the apparent signal disappeared after removing the annual seasonal cycle.
- Precipitation variables showed some lagged signal in earlier specifications, but the gain weakened after the adaptive seasonal level was modeled correctly.
- The final model became smaller, not larger, because the evidence suggested that much of the external-variable signal was shared seasonality or short-term demand momentum.

Business Interpretation

The study changed the way environmental data should be used. Weather may still be useful for explanation, scenario analysis, or operational context, but the supplied evidence does not support treating it as a required component of the final weekly demand forecast.

This distinction protects the model from a common analytics failure: confusing a plausible causal story with demonstrated incremental predictive value.

Key Takeaways

Core finding	Raw weather correlation overstated the independent forecasting value of environmental variables.
Strongest lesson	Feature inclusion should be based on out-of-sample lift beyond seasonality, not on correlation alone.
Model decision	Weather variables were excluded from the final frozen model.
Portfolio value	The negative result demonstrates disciplined feature selection and willingness to reject a plausible hypothesis.

Limitations and Future Test

Current-week realized weather can explain what happened, but it is not automatically safe for forward forecasting unless historical forecast vintages are available. A future study could use forecast-safe weather inputs captured as they were known at each forecast origin and retest incremental value without leakage.

Portfolio-Ready Summary

SUGGESTED HEADLINE

Does weather predict demand beyond seasonality?

I tested environmental variables using lags, rolling windows, seasonality adjustment, and rolling-origin forecasts. Several variables looked strong in raw relationships, but they did not add enough forward predictive value after the seasonal and adaptive demand structure was modeled correctly. I therefore excluded weather from the final model rather than rewarding correlation that did not survive validation.