

Predictive Models for Supply Chain Disruption Forecasting

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Executive Summary

This report presents PLIANT's current-generation predictive disruption modeling framework, developed and validated across a panel of 340 international logistics corridors over six years. The framework integrates geopolitical risk indicators, port throughput anomalies, weather and sea state data, and trade flow statistics to generate corridor-level disruption forecasts at 30, 60, and 90-day horizons. The report documents model architecture, data sources, performance metrics, and operational deployment considerations for credentialed government and industry partners.

1. Background and Motivation

Supply chain disruptions impose substantial costs on global trade — estimated at \$1.5 trillion annually in direct losses, with multiplier effects on downstream economic activity that are difficult to fully quantify. Despite significant industry investment in supply chain visibility tools, the capacity to anticipate disruptions before they materialize remains limited. Most commercial forecasting products operate at the shipment or lane level, providing operational visibility without the strategic foresight that continuity planning requires.

PLIANT's disruption forecasting program was established to address this gap. Beginning in 2020, the institute developed a corridor-level predictive framework designed to integrate heterogeneous data streams — geopolitical, meteorological, operational, and intelligence-derived — into actionable disruption forecasts at time horizons relevant to strategic planning. The current report documents the third generation of that framework, incorporating six years of model development and validation.

2. Modeling Architecture

The framework employs a gradient-boosted ensemble architecture as its primary modeling approach, selected for its strong performance on heterogeneous tabular data and its relative interpretability compared to deep learning alternatives. The model is trained on a rolling six-year window of corridor-level data, retrained quarterly to incorporate new observations and updated Atlas assessments. SHAP values are computed at each retraining cycle to maintain feature attribution transparency for partner reporting.

The Atlas Intelligence Database serves as the primary data infrastructure for the model's node-level inputs. Atlas currently contains profiles on 214 commercial logistics entities, 84 major node assessments across all primary trade corridors, and a seven-year incident record covering disruption events at the corridor level.

3. Performance Metrics

At the 30-day forecast horizon, the model achieves a disruption prediction accuracy of 78.4% (AUC: 0.83) on the held-out 2024–2025 validation set, representing a 22-point improvement over the persistence baseline. Performance degrades at longer horizons — AUC 0.74 at 60 days, 0.61 at 90 days — consistent with the bounded predictability of geopolitical dynamics at extended time horizons.

Geopolitical event indicators and port throughput anomalies are the strongest predictors, accounting for 41% and 28% of model explanatory power respectively. Atlas node vulnerability scores contribute 18% of explanatory power and are particularly influential for high-severity disruption event prediction.

The model's false positive rate of 18% at the 30-day horizon is operationally acceptable for most partner use cases, though high-cost pre-positioning decisions should incorporate confidence intervals rather than point forecasts.

4. Regional Performance Variation

Model performance varies meaningfully across regional corridors, reflecting differences in data quality, geopolitical predictability, and the maturity of Atlas node assessments. Asia-Pacific corridors achieve the strongest performance at the 30-day horizon (AUC: 0.87), driven by the depth and granularity of Atlas APAC node coverage. Middle East and North Africa corridors present the most challenging forecasting environment (AUC: 0.71), reflecting rapid geopolitical volatility that limits the predictive signal available in lagged indicators.

5. Data Governance and Operational Deployment

Atlas database access is governed by a tiered credentialing framework. All Atlas access is logged and reviewed quarterly under PLIANT's data governance framework. Partner access agreements specify permitted use cases, retention limitations, and breach notification obligations. The disruption forecasting model is accessible to credentialed partners through the Atlas Intelligence Database portal, with corridor-level forecast outputs updated weekly and surge updates issued within 24 hours of significant geopolitical events.

6. Limitations and Future Development

The model's strongest performance is dependent on access to proprietary terminal throughput data and high-quality Atlas node assessments. In deployment contexts where such data is unavailable, model accuracy is expected to decline by 12–15 percentage points at the 30-day horizon. Expanding open-data substitutes and deepening Atlas coverage in under-assessed regions — particularly sub-Saharan Africa and Central Asian overland corridors — are priorities for the next model generation.