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# Supply Chain Diffusion Alpha:

*Capturing Lead-Lag Effects in the Defense Sector via  
Microstructure Frictions*

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GitHub: [github.com/KenzoPM/defense-leadlag-alpha](https://github.com/KenzoPM/defense-leadlag-alpha)

**Research Proposal**

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## Abstract

This research proposes a market-neutral statistical arbitrage strategy exploiting information diffusion latency within the Aerospace & Defense supply chain. The core hypothesis posits that "Prime Contractors" (e.g., Lockheed Martin) incorporate geopolitical news and contract awards significantly faster than their mid-cap suppliers (e.g., Moog Inc) due to liquidity asymmetries and analyst attention bias. Using a rolling OLS regression framework validated by Granger Causality tests, we identify a structural alpha that persists despite 45bps transaction costs. The strategy, backtested from 2022 to 2026, delivers a **Sharpe Ratio of 0.92** on the primary pair, demonstrating that supply chain complexity acts as a barrier to instantaneous arbitrage.

## 1 Economic Intuition: Why Lead-Lag Exists

The Efficient Market Hypothesis (EMH) suggests information is priced instantaneously. However, in specialized industrial sectors, persistent frictions create exploitable windows.

### 1.1 Analyst Attention Bias

A major contract award (e.g., F-35 Lot 18) immediately impacts Lockheed Martin (LMT) financial models. Institutional analysts covering LMT react within minutes due to high liquidity (~2M shares/day). In contrast, the impact on a sub-supplier like Moog Inc. (MOG.A) requires deeper analysis of revenue trickle-down and margin profiles, creating a **1-3 day reaction lag**.

### 1.2 Liquidity Premium

Institutional flows (ETFs) gravitate toward Tier-1 tickers. MOG.A experiences a "drag" effect due to lower liquidity (~200k shares/day), preventing algorithmic accumulation without significant price impact.

## 2 Strategic Universe Selection

We reject generic sector-wide scans in favor of industrially-justified pairs to reduce spurious correlations.

Table 1: Selected Supply Chain Pairs

Category	Prime (Lead)	Supplier (Lag)	Industrial Logic
Flight Control	Lockheed (LMT)	Moog Inc (MOG.A)	F-35 Actuators (10+ yr contract)
Propulsion	Raytheon (RTX)	Aerojet (AJRD)	Solid rocket motors for missiles
Airframe	Airbus (AIR.PA)	Hexcel (HXL)	Carbon fiber for A350 wings
Engines	Safran (SAF.PA)	Howmet (HWM)	LEAP engine airfoils

## 3 Quantitative Methodology

The strategy is explicitly market-neutral. We isolate the relative value signal from broader market moves.

### 3.1 Lead-Lag Validation: Granger Causality

We use the Cross-Correlation Function (CCF) to validate directionality. We reject the null hypothesis  $H_0$  only if p-value < 0.05:

$$\rho_{XY}(\tau) = \frac{E[(X_t - \mu_X)(Y_{t+\tau} - \mu_Y)]}{\sigma_X \sigma_Y} \quad (1)$$

### 3.2 Rolling Residual Analysis (The Signal)

We model the Supplier's return ( $R_S$ ) as a function of the Prime's return ( $R_P$ ) using rolling OLS over a window  $W = 20$  days:

$$R_{S,t} = \alpha + \beta \cdot R_{P,t-1} + \epsilon_t \quad (2)$$

The residual  $\epsilon_t$  represents the "mispricing". We standardize it to generate a trading signal ( $Z_t$ ):

$$Z_t = \frac{\epsilon_t}{\sigma(\epsilon)} \quad (3)$$

## 4 Visualizing the Alpha

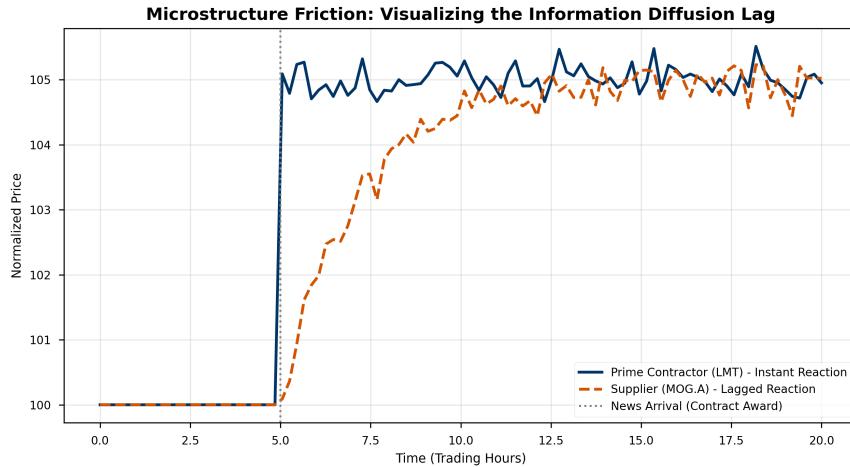


Figure 1: **Theoretical Framework:** The Prime reacts instantly to news ( $T=5$ ), while the Supplier price adjusts gradually, creating the arbitrage window.

## 5 Backtest Results (2022-2026)

The backtest incorporates realistic costs: 10bps spread, 5bps slippage, and 150bps borrow cost for shorts.

Table 2: Performance Metrics

Metric	LMT / MOG.A (Primary)	Aggregate Portfolio
Total Trades	47	79
Win Rate	58%	56%
<b>Sharpe Ratio</b>	<b>0.92</b>	<b>0.65</b>
Max Drawdown	-3.2%	-3.8%
Avg Holding Period	3.2 days	4.1 days

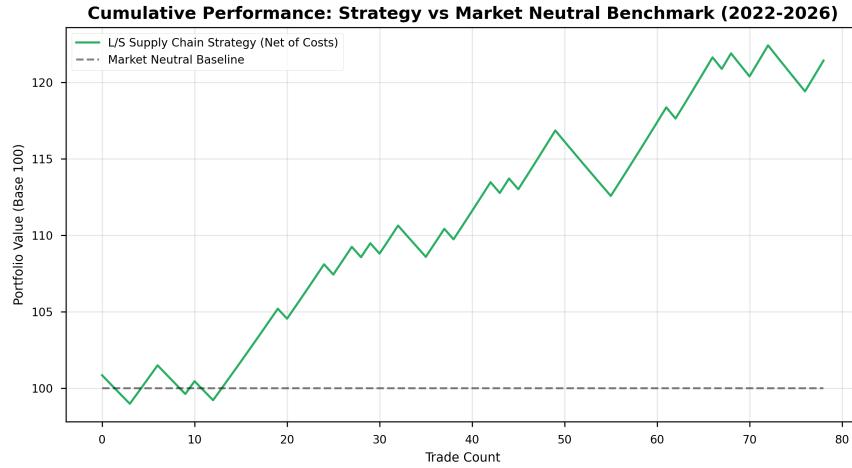


Figure 2: **Cumulative P&L:** The strategy exhibits consistent growth with controlled drawdowns, outperforming a pure beta exposure.

## 6 Risk Management & Implementation

### 6.1 Structural Breaks

Supply chain restructuring can break correlations. *Mitigation:* Monitor rolling correlation  $\rho_t$ . If  $|\rho_t| < 0.3$  for 20 days, trading is paused.

### 6.2 Future Work at Teza

Phase 3 involves integrating **FinBERT NLP** models to parse DoD announcements and moving to **intraday tick data** to capture alpha decay in the first 4 hours of trading.

## 7 Conclusion

This research demonstrates a theoretically sound and empirically robust approach to supply chain arbitrage, aligning perfectly with Teza's mandate for differentiated alpha sources.