Problem 1C: Distribution Analysis of Spreads

1. Cash vs. Near Future (CM-FUT1) - Convergence & Leptokurtosis

The distribution of the Basis narrows significantly as expiry approaches, but extreme "Fat Tails" persist.

- **Core Compression:** The Interquartile Range ($p75 - p25$) collapses from **5.23** (DTE 10) to **2.25** (DTE 0). For 50% of the market, the basis converges into a very tight window at expiry.

- **Fat Tail Risk:** Despite the tight core, extreme negative outliers remain (e.g., **-130.00** at DTE 0). This is driven by specific stocks like **SHREECEM**, which exhibits a standard deviation of **94.0** and massive dislocations (-310 to +355), distorting the Index Mean.

2. Near Future vs. Far Future (FUT1-FUT2) - Skewness & Expansion

Unlike the Basis, the Roll Spread distribution **expands** and exhibits positive skewness.

- **Widening Dispersion:** The IQR widens from **10.55** (DTE 10) to **12.80** (DTE 0), indicating market bifurcation. "Easy-to-roll" stocks remain cheap, while "Hard-to-roll" spreads blow out.

- **Positive Skew:** At DTE 0, the Mean (**8.25**) exceeds the Median (**5.10**). This "Right Tail" (Max **210**) creates asymmetric risk for sellers, as a few stocks trade at massive premiums while the majority remain moderate.

3. Constituent Heterogeneity (Stability vs. Chaos)

The aggregate data hides distinct regimes:

- **Regime A (Convergers):** Stocks like **SBIN** behave theoretically perfectly (Mean Basis **-0.12**, Std Dev **0.69**).

- **Regime B (Dislocations):** Stocks like **SHREECEM** show chaotic behavior with high volatility (Basis Std Dev **43.3**) and backwardation, defying normal convergence models.

Conclusion for Risk Management

1. **Filter by Volatility:** Mean-reverting strategies must exclude Regime B stocks (High Std Dev) to avoid immediate stop-outs.

2. **Median over Mean:** Use **Median** spreads for expected returns in backtesting, as the **Mean** is inflated by high-priced outliers.

3. **Tail Risk Hedging:** Capped leverage is essential given the statistical frequency of 3-sigma spikes (Leptokurtosis) in the basis.