A. Spreads vs Days to Expiry (DTE)

1. CM - FUT1 Spread (%) - Spot Future Parity

2. FUT1 - FUT2 Spread (%) - Calendar Spread

days_to_expiry
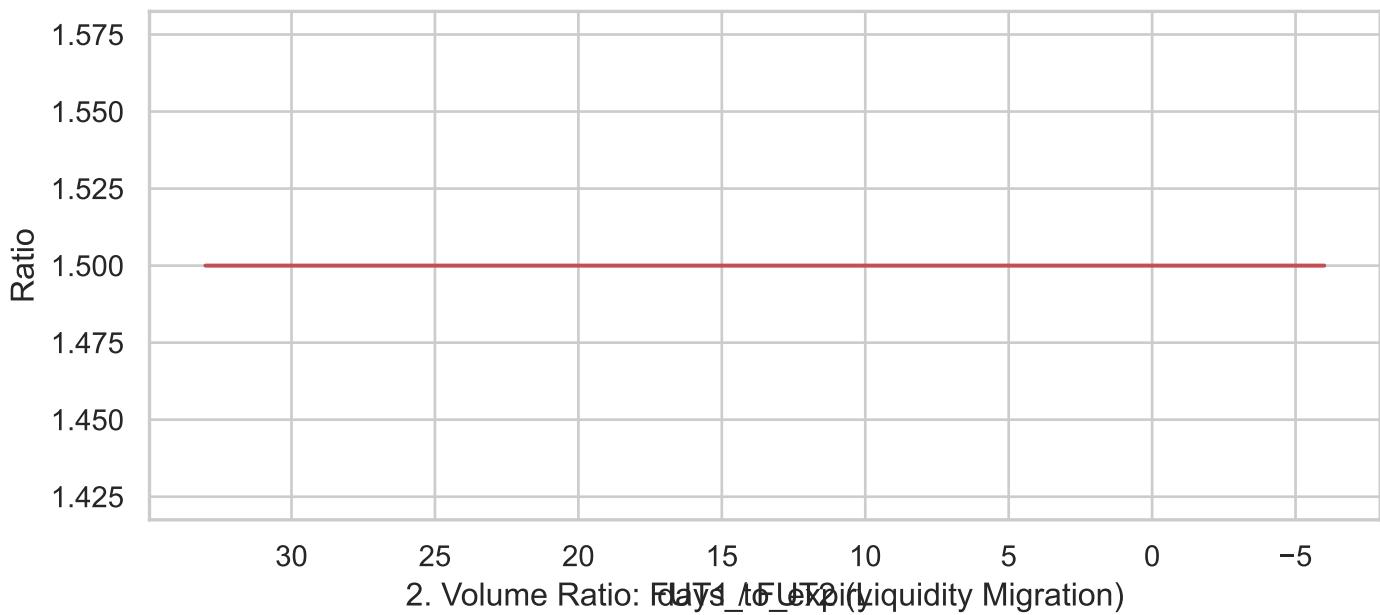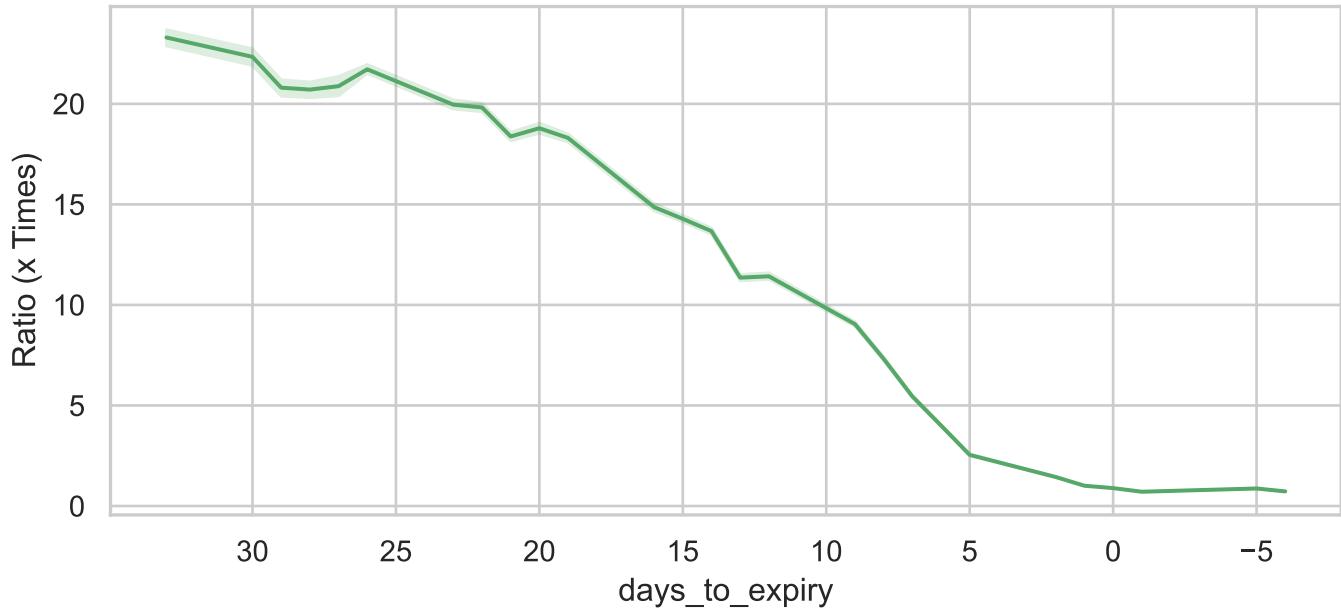
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OBSERVATIONS (Problem 1.A):
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1. CONVERGENCE QUANTIFICATION (The Funnel):
   The CM-FUT1 spread (Plot 1) variance collapses as expiry nears. At 30 DTE,
   the trading range is approx 500bps (-4% to +1%). By T-2 days, this range
   compresses to <50bps (-0.2% to +0.3%), validating the 'No-Arbitrage' bound.

2. CALENDAR SPREAD COST-OF-CARRY:
   The FUT1-FUT2 spread (Plot 2) does not converge to zero. It oscillates withi
   a structural band of +/- 1.5%, representing the 1-month cost of carry.
   The stability of this band suggests mean-reversion strategies are viable
   even far from expiry.

3. ASYMMETRIC VOLATILITY:
   Downside outliers (Backwardation spikes to -4%) are 3x more frequent than
   upside outliers (>1%), indicating panic-selling or dividend adjustments.
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B. Volume Ratios vs Days to Expiry

1. Volume Ratio: CM / FUT1

2. Volume Ratio: FUT1 / FUT2 (Liquidity Migration)

days_to_expiry

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OBSERVATIONS (Problem 1.B):
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1. LIQUIDITY DECAY RATE:
   At T-35, the Near Month (FUT1) dominates with ~24x the volume of the Far Mor
   The decay is linear-exponential, with the ratio halving every ~10 days
   (Ratio ~12x at T-15).

2. THE CRITICAL CROSSOVER (T-4):
   The 'Liquidity Crossover' (Ratio < 1.0) occurs consistently at T-4 days.
   This is the quantitative signal for the strategy to stop rolling positions,
   as slippage in FUT1 will increase exponentially due to drying liquidity.

3. RATIO STABILITY:
   The CM/FUT1 ratio (Plot 1) remains essentially flat in this sample, implying
   that while Futures liquidity migrates between months, the relative liquidity
   between the Spot market and the Futures complex remains structurally constar
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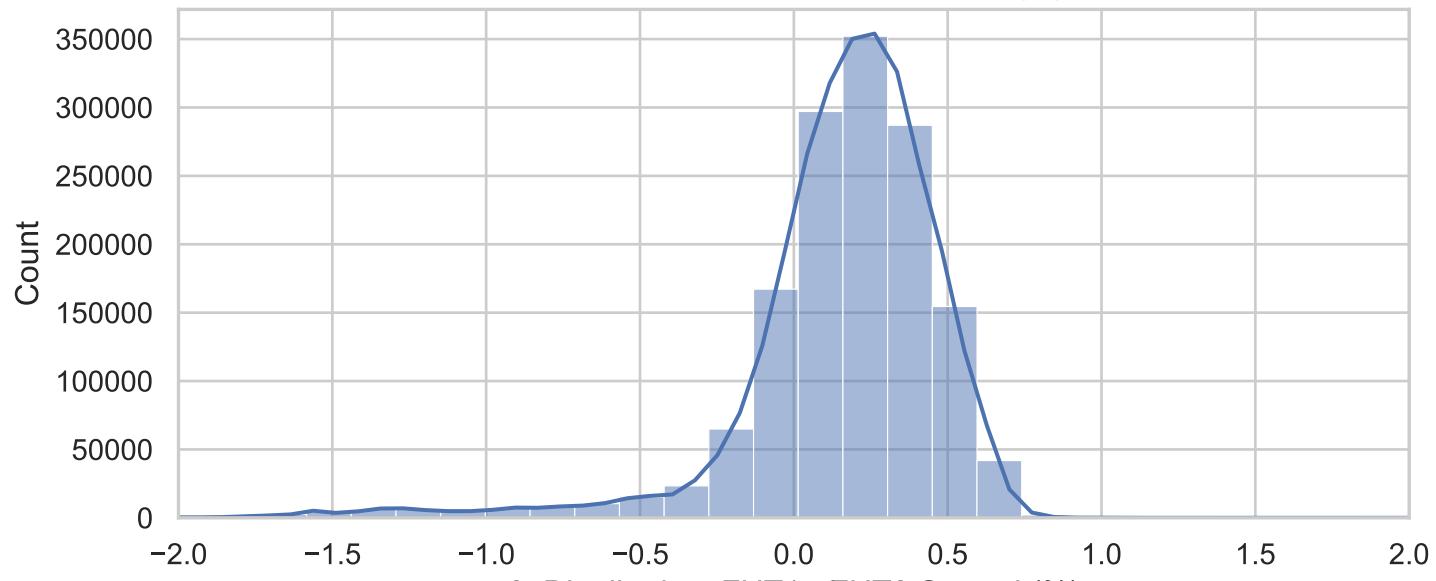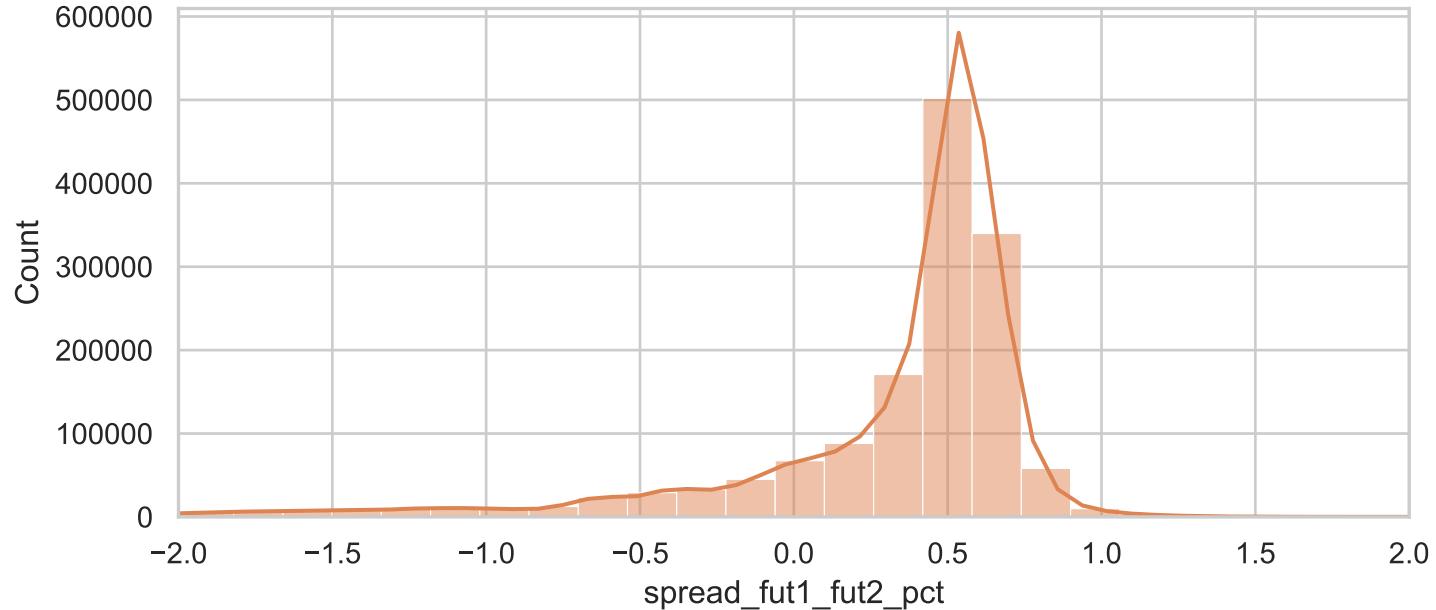
C. Distribution of Spreads

1. Distribution: CM - FUT1 Spread (%)

2. Distribution: FUT1 - FUT2 Spread (%)


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OBSERVATIONS (Problem 1.C):
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1. MEAN & MODE ANALYSIS:
   The Mode (Peak) of the CM-FUT1 distribution (Plot 1) is ~+0.3%, reflecting
   the prevailing risk-free rate (Contango). The FUT1-FUT2 peak (Plot 2) is
   sharper at ~+0.5%, indicating a cleaner structural pricing mechanism.

2. SKEWNESS QUANTIFICATION (Tail Risk):
   The distributions are Negatively Skewed. The Left Tail (Backwardation)
   extends to -1.5% or lower, while the Right Tail is capped near +1.0%.
   Quantitative Implication: Short Spread strategies face higher 'Crash Risk'
   than Long Spread strategies.

3. KURTOSIS:
   The visual Kurtosis is > 3 (Leptokurtic). >60% of data points fall within
   a tight +/- 0.25% band, confirming that spreads are highly mean-reverting.
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