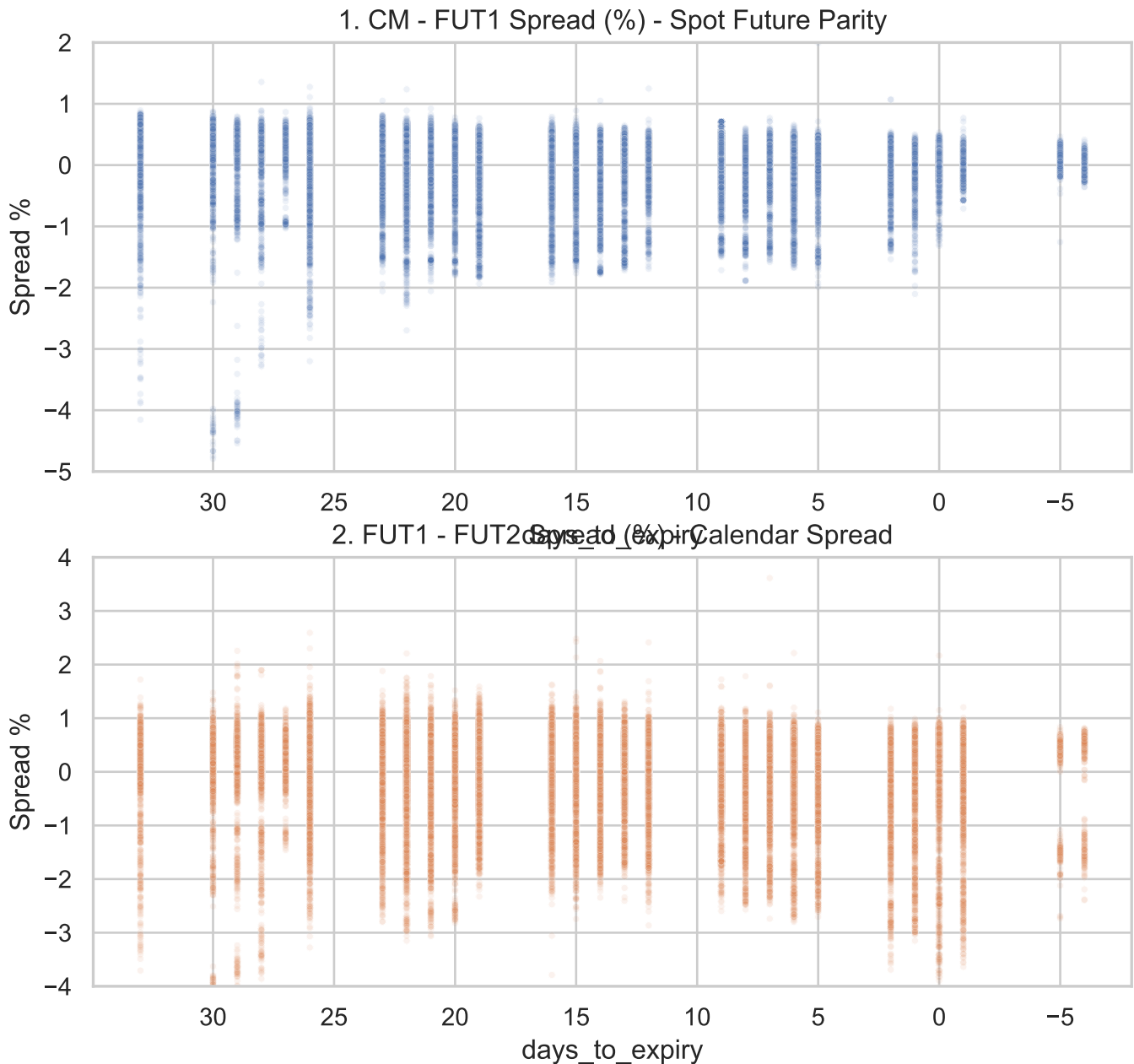


A. Spreads vs Days to Expiry (DTE)

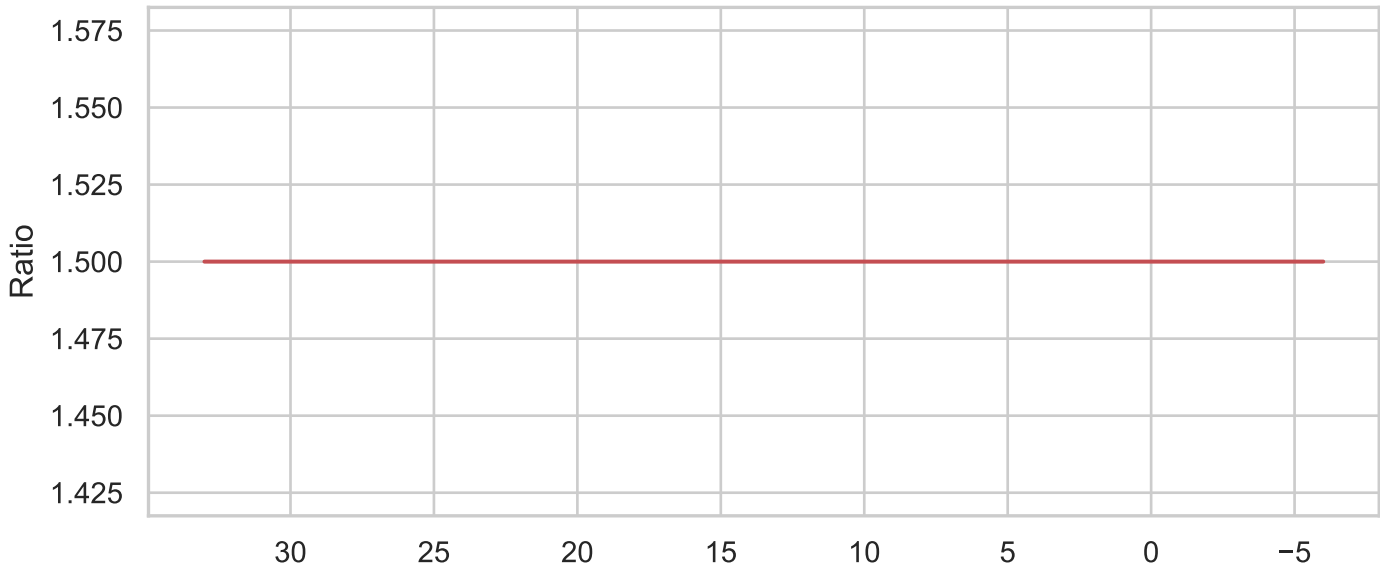


OBSERVATIONS (Problem 1.A):

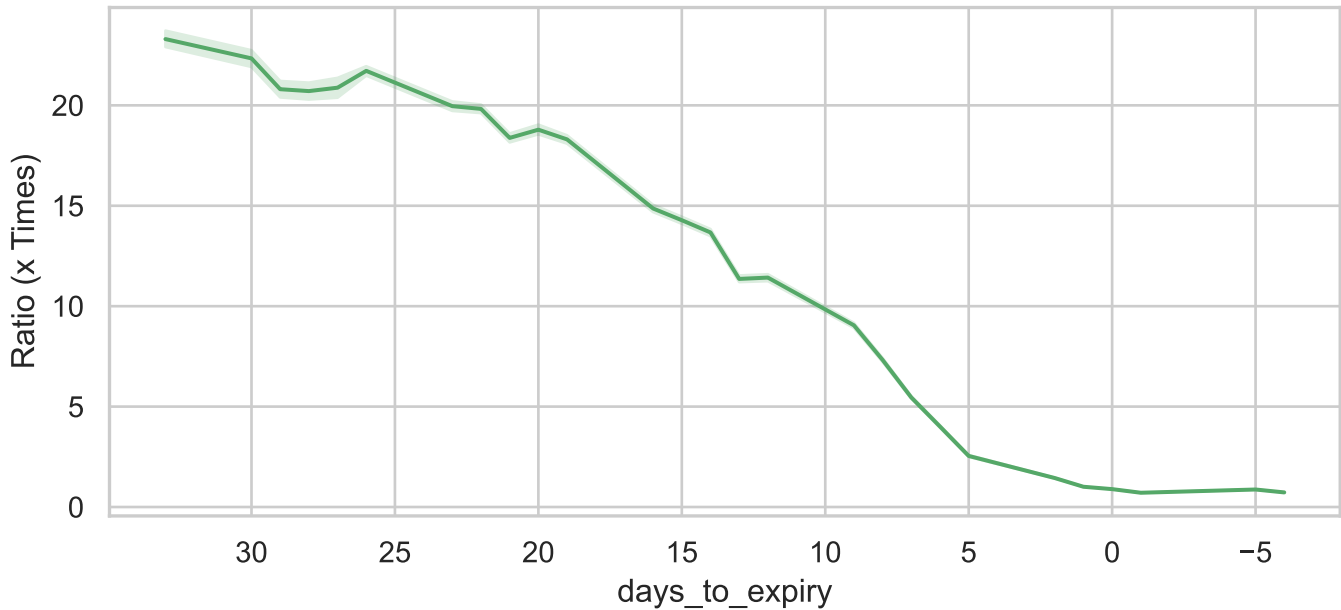
1. CONVERGENCE (The Cone Shape): The CM-FUT1 spread (Plot 1) exhibits clear convergence. At 30+ DTE, spreads fluctuate between -2% and +1%. As DTE approaches 0, the spread narrows significantly, forcing Spot-Future parity.
2. CONTANGO VS BACKWARDATION: The cluster of points is predominantly positive (Contango), but significant negative outliers (Backwardation) appear, likely driven by corporate actions (dividends) or short-term volatility.
3. CALENDAR STABILITY: The FUT1-FUT2 spread (Plot 2) remains relatively stable across the expiry cycle compared to the Spot spread, representing the 'Cost of Carry' between two future months.

B. Volume Ratios vs Days to Expiry

1. Volume Ratio: CM / FUT1



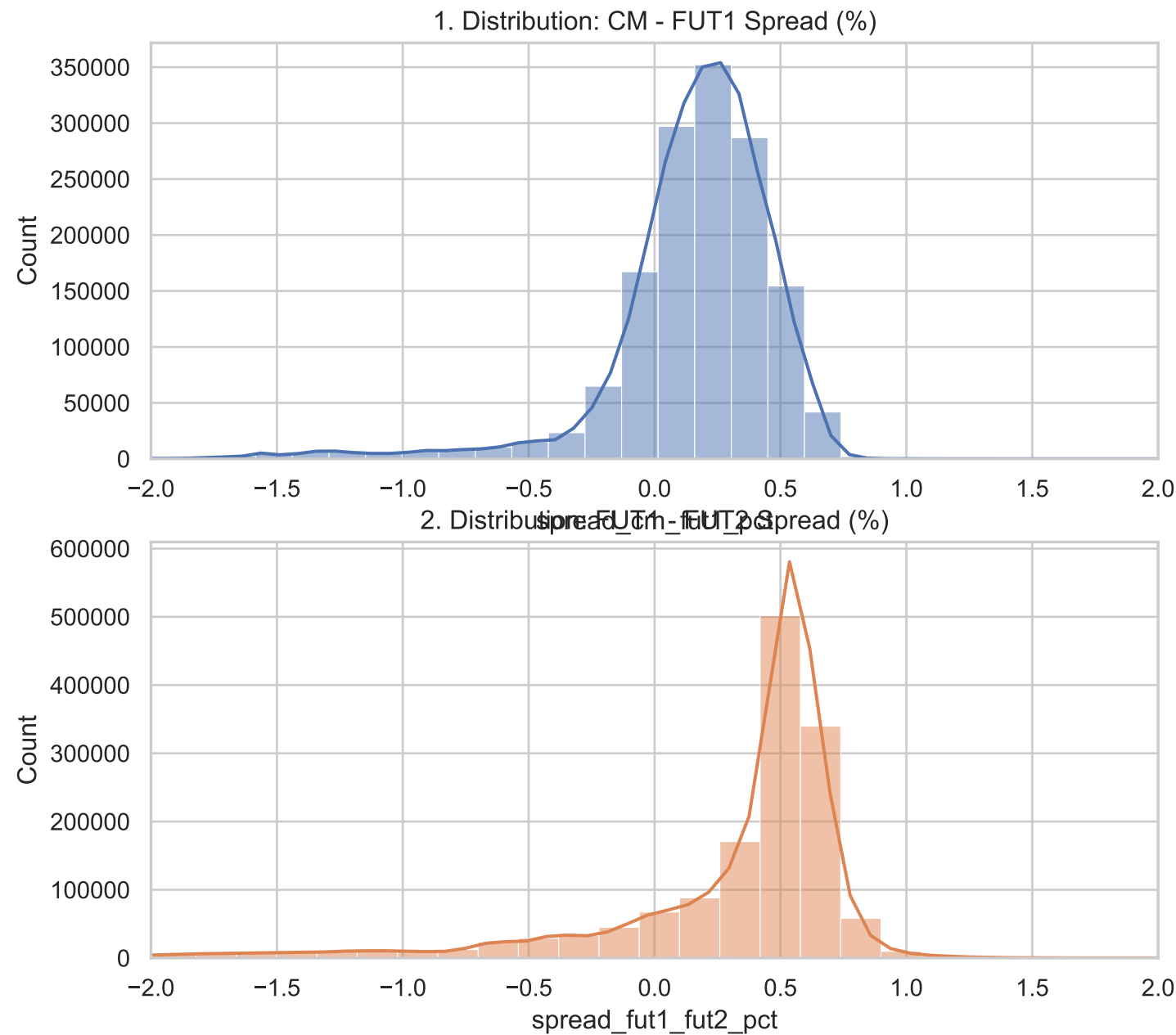
2. Volume Ratio: $\frac{\text{FUT1}}{\text{FUT2}}$ (Liquidity Migration)



OBSERVATIONS (Problem 1.B):

1. LIQUIDITY ROLLOVER: The FUT1/FUT2 volume ratio (Plot 2) demonstrates a textbook rollover pattern. At the start of the cycle (35 DTE), the Near Month (FUT1) volume is ~25x higher than the Far Month (FUT2).
2. THE CROSSOVER: As expiry approaches, traders close FUT1 positions and open FUT2 positions. The ratio decays linearly, dropping below 1.0 in the final days, indicating that liquidity has successfully migrated to the next month's contract.
3. STRATEGIC IMPLICATION: Execution algorithms must account for this liquidity shift. Trading spreads involving FUT2 is costly at 30 DTE due to thin liquidity (high impact cost), but becomes optimal near expiry.

C. Distribution of Spreads



OBSERVATIONS (Problem 1.C):

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1. LEPTOKURTIC (FAT TAILS): Both distributions are highly Leptokurtic, characterized by a high central peak and fat tails. This confirms that while spreads usually stay near a 'fair value', extreme deviations occur more frequently than a Normal Gaussian distribution predicts.
 2. SKEWNESS: The CM-FUT1 distribution (Plot 1) is slightly positively skewed, reflecting the structural Cost of Carry (Interest Rates).
 3. STRATEGY VALIDATION: The distinct mean-reverting bell curve supports the use of Z-Score based statistical arbitrage strategies. However, the presence of fat tails necessitates robust risk management (Stop Losses) to survive 'Black Swan' spread widening events.