The Causal Effect of Stock Splits on Liquidity

A Propensity Score Matched Difference-in-Differences Approach

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Use Case Development Study: Causal Inference
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Outline

The Puzzle

The Phenomenon:

- Stock splits (e.g., 4-for-1) are mechanical events.
- Market Cap remains theoretically unchanged.
- Yet, we observe massive reactions in volume and volatility (e.g., Tesla, Apple).

The Research Question:

- Does the *lower price itself* cause increased liquidity?
- Or is the volume surge merely a reaction to the "Good News" implied by the split?

Competing Hypotheses

Hypothesis 1: The Liquidity Hypothesis (Causal)

Lower nominal prices reduce barriers for retail investors ("Optimal Trading Range").

- **Prediction:** Splits *cause* higher volume.

Hypothesis 2: The Signaling Hypothesis (Non-Causal)

Management splits only when they are confident about future growth.

- **Prediction:** The "Signal" drives the volume, not the split mechanics.

The Causal Challenge

We cannot simply compare splitters vs. non-splitters.

- **Selection Bias:** Firms self-select into splitting.
- **Confounder (U):** Management's private positive outlook.
- **Result:** Naive comparison is biased. ($E[Y_0|T=1] \neq E[Y_0|T=0]$)

Goal: Estimate the Average Treatment Effect on the Treated (ATT)

$$\tau_{ATT} = E[Y_1 - Y_0|T=1]$$

Identification Strategy: "Doubly Robust"

We combine two methods to isolate the effect:

1. **Propensity Score Matching (PSM):**
   - Matches treated firms with control firms based on observed probability of splitting.
   - **Covariates (W):** Momentum, Volatility, Price, Volume.
   - *Solves: Selection on Observables.*

2. **Difference-in-Differences (DiD):**
   - Compares the *change* in volume over time.
   - *Solves: Time-invariant Unobserved Confounders (e.g., Brand).*

$$\hat{\delta}_{DiD} = (\Delta \bar{Y}_{Treated}) - (\Delta \bar{Y}_{Control})$$

Data Pipeline

Data Source: `yfinance` API (S&P 500 Tickers) **Period:** 2010 – 2025

Process:

1. **Event Detection:** Identified Forward Splits (Ratio > 1.0).
2. **Control Pool:** Sampled non-splitting firms within ± 6 months.
3. **Matching:** 1:1 Nearest Neighbor Matching on Propensity Scores.

Covariate Balance (Love Plot)

Matching successfully removed selection bias. Standardized Mean Differences (SMD) dropped below 0.1 for all covariates.

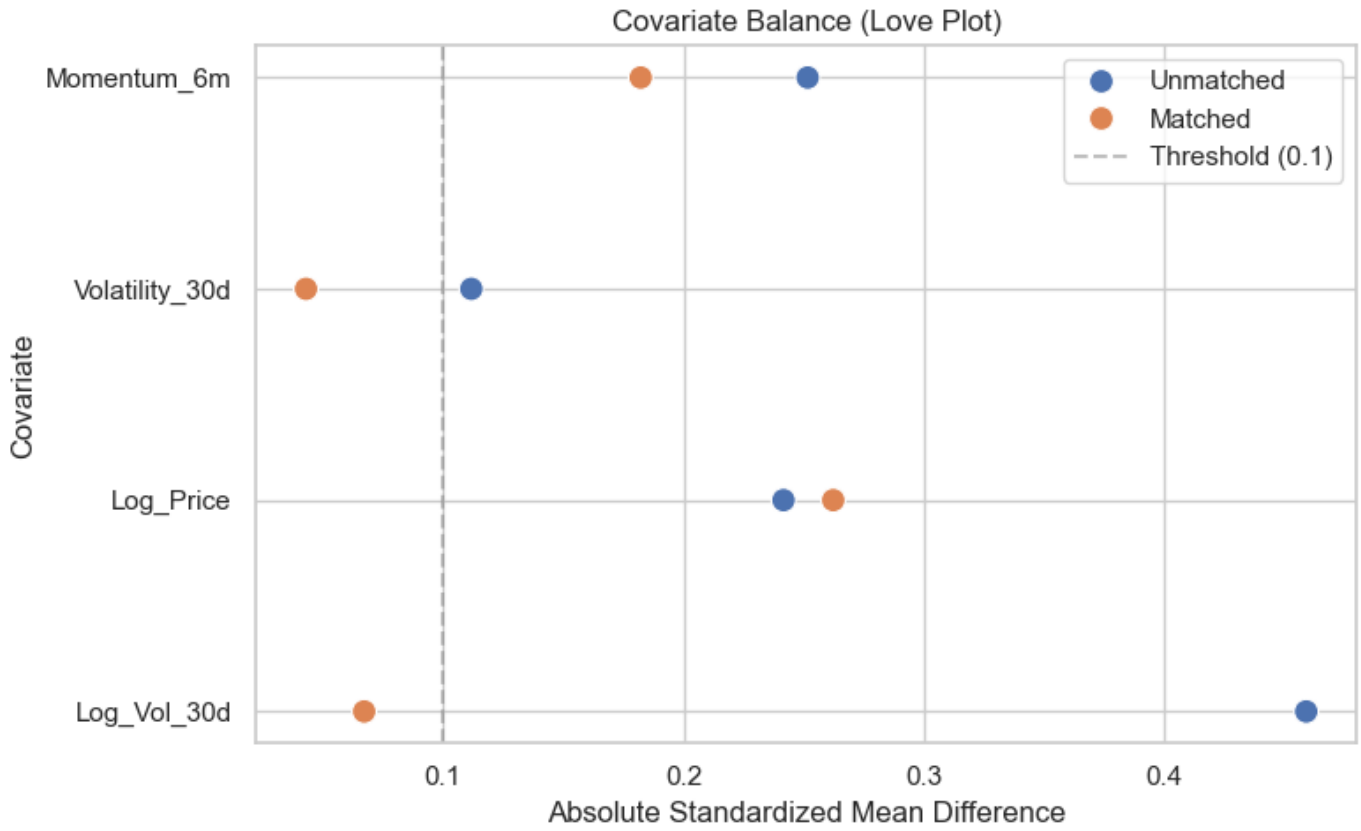

Figure 1: Covariate Balance: Before (Red) vs. After (Blue)

Parallel Trends Assumption

Pre-treatment trends for Treated and Control groups are parallel, validating the DiD design.

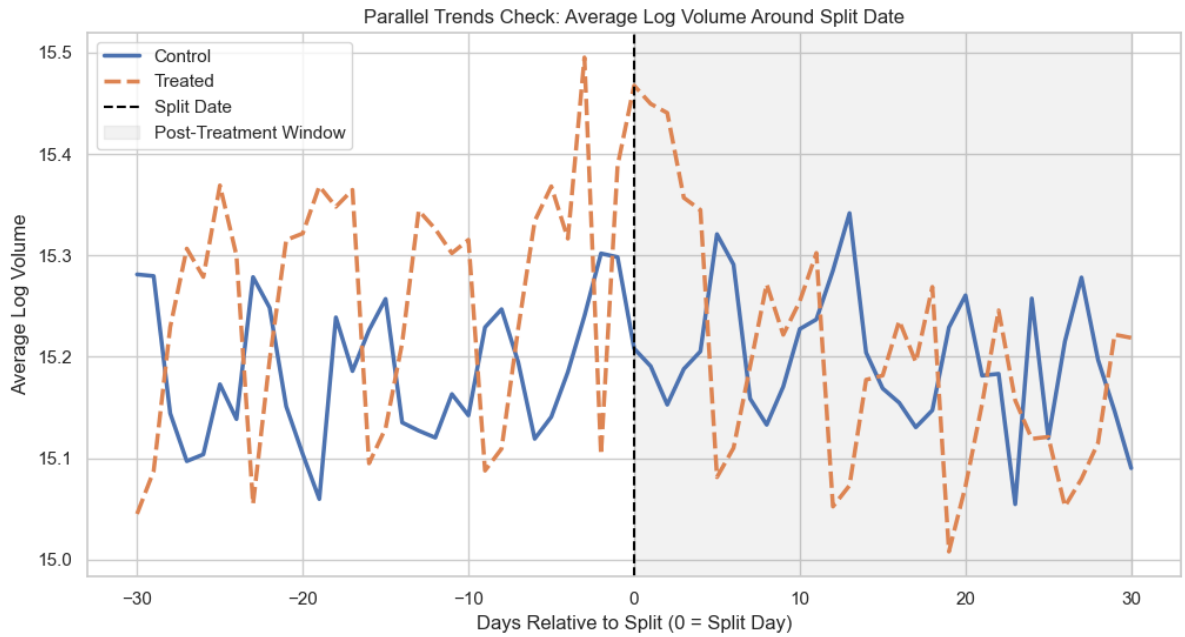

Figure 2: Average Log Volume around Split Date ($t = 0$)

Main Causal Result (The Surprise)

Dependent Variable: Change in Log Volume ($\Delta \ln Y$)

Variable	Coef.	Std. Err	P-value
Intercept	0.021	0.019	0.252
Treated	**-0.094**	**0.026**	**0.000**

Unexpected Finding

On average, stock splits cause a **9.4% decrease** in volume relative to the counterfactual.

- Contradicts the naive "Liquidity Hypothesis."
- Suggests a "Sell the News" effect for the average firm.

Heterogeneity Analysis (The Resolution)

Does the effect depend on pre-split Momentum?

$$\Delta Y \sim T + \text{Mom} + (T \times \text{Mom})$$

Variable	**Coef.**	**P-value**
Treated (Main)	-0.055	0.298
Momentum (6m)	-0.148	0.020
Treated $\times$ Momentum	**+0.197**	**0.031**

Insight: The "Superstar" Effect

The interaction is positive and significant.

- **Low Momentum:** Splits decrease volume.
- **High Momentum:** Splits significantly **increase** volume.

Robustness: Fisher's Permutation Test

We ran 1,000 simulations shuffling treatment labels to ensure the result wasn't noise.

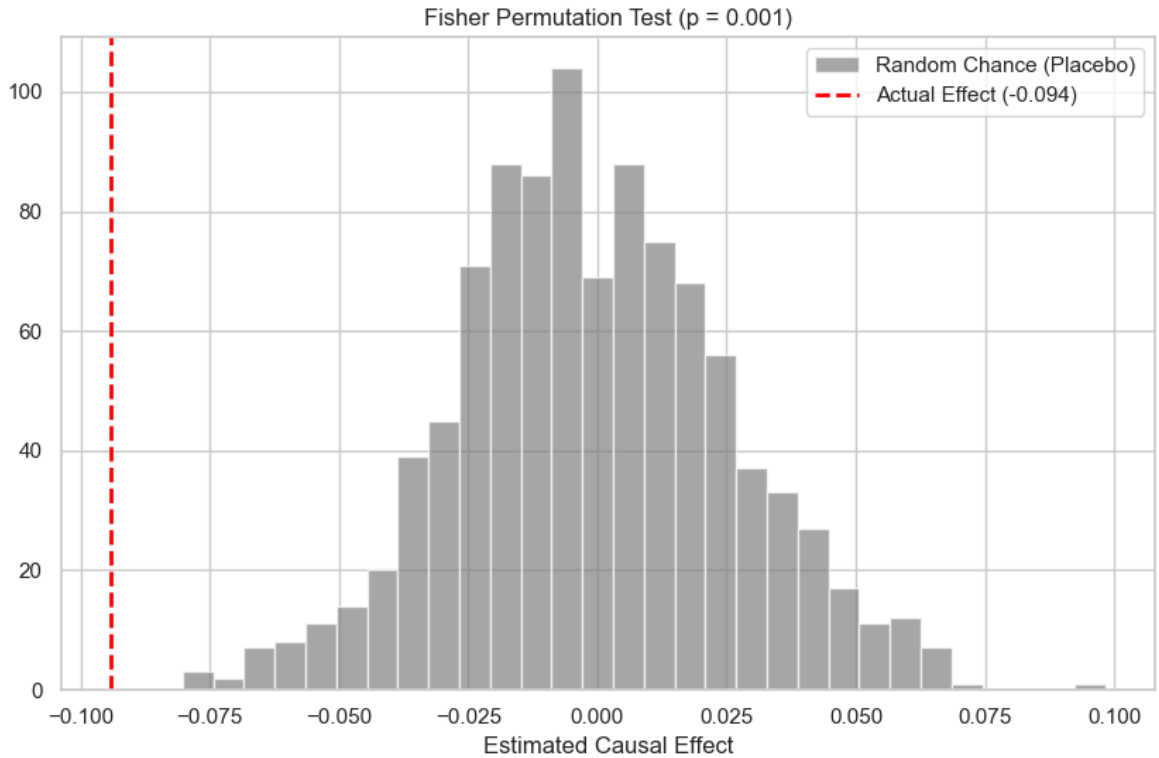

Figure 3: Empirical P-Value: 0.0010 (Highly Significant)

Conclusion

Summary of Findings:

1. **Average Effect:** Negative (-9.4%). Splits alone do not guarantee liquidity; they often act as a cooling event.
2. **Heterogeneity:** Strongly positive interaction with Momentum.
3. **Implication:** Splits are effective *accelerants* for high-growth firms but ineffective for stagnant ones.

Contribution:

- Applied rigorous Causal Inference (PSM-DiD) to Finance.
- Disproved the universal "Liquidity Hypothesis."
- Identified the specific condition (Momentum) under which splits work.

Thank You