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Liquidity, Volatility, and ETF Arbitrage in Canadian Equity Markets Evidence from Stress Episodes

Abstract

This paper examines the interaction between market liquidity, volatility, and exchange-traded fund (ETF) arbitrage activity in Canadian equity markets, with a particular focus on periods of financial stress. Using high-frequency and daily market data, the study analyzes how deviations between ETF prices and their net asset values (NAVs) evolve under heightened volatility and constrained liquidity conditions. The empirical framework exploits stress episodes characterized by sharp volatility spikes and funding frictions to identify changes in arbitrage intensity and price efficiency. Results indicate that during stress periods, liquidity deterioration and elevated volatility significantly widen ETF price–NAV deviations, reflecting limits to arbitrage faced by authorized participants. These effects are more pronounced in equity ETFs with less liquid underlying assets. The findings highlight the role of ETFs as both liquidity providers and transmitters of market stress, with important implications for market resilience and regulatory oversight in concentrated equity markets such as Canada.

Keywords: ETF arbitrage; market liquidity; volatility; financial stress; Canadian equity markets

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1.Introduction

Exchange-traded funds (ETFs) have become a core component of modern equity market structure, offering low-cost diversification and intraday tradability while linking secondary-market trading to primary-market creation and redemption. In Canada, ETF assets and trading activity have expanded rapidly over the past decade, accompanied by increased retail participation and a growing ecosystem of liquidity providers and authorized participants (APs). Recent regulatory and market-structure work has emphasized that Canadian ETFs, in normal conditions, tend to display tight bid–ask spreads and small deviations between ETF prices and net asset values (NAVs), but that stress episodes can test the resilience of the ETF arbitrage mechanism and the capacity of intermediaries to supply liquidity.This paper studies how **liquidity and volatility jointly shape ETF arbitrage effectiveness in Canadian equity markets**, with a particular focus on **stress episodes**. The central premise is that ETF price efficiency—often proxied by the magnitude and persistence of ETF price–NAV deviations (premiums/discounts)—is not a mechanical outcome of the ETF structure alone. Rather, it depends on the ability and willingness of APs and other intermediaries to conduct arbitrage, which is itself conditioned by market liquidity, inventory constraints, funding conditions, and volatility. During calm periods, the arbitrage mechanism can keep ETF prices closely aligned with the value of underlying portfolios. During stress episodes, however, higher volatility and impaired liquidity can raise arbitrage costs, widen no-arbitrage bounds, and generate persistent dislocations—particularly for ETFs whose underlying constituents are less liquid or harder to hedge.

ETF arbitrage and limits-to-arbitrage logic

ETF arbitrage rests on a specialized two-market design. ETF shares trade continuously in the secondary market, while APs can create or redeem shares in the primary market by exchanging ETF shares for a basket of underlying securities (or cash), depending on the fund's process. When an ETF trades at a premium to NAV, arbitrage can occur by creating ETF shares and selling them; when it trades at a discount, arbitrage can occur by buying ETF shares and redeeming them. In frictionless conditions, this mechanism supports a close link between ETF prices and NAV. In practice, arbitrage is subject to well-known limits. First, the ETF's NAV is typically computed at discrete intervals (often end-of-day), whereas ETF prices incorporate intraday information and may lead price discovery. Second, arbitrage requires execution across multiple legs—ETF shares and an underlying basket—making transaction costs, hedging error, and inventory risk economically meaningful. Third, the capacity of APs and market makers may be constrained by capital, balance-sheet usage, and internal risk limits, which tend to bind most strongly during volatility spikes. Empirical work on stress conditions indicates that arbitrage relationships can weaken when intermediary constraints tighten, allowing premiums/discounts to widen and persist.

Why liquidity and volatility matter jointly

Liquidity and volatility are deeply intertwined in market microstructure and are central to the economics of ETF arbitrage. Liquidity, reflected in quoted spreads, depth, and price impact, determines the cost of executing the arbitrage legs and the feasibility of trading underlying baskets without substantial slippage. Volatility influences both the expected profitability and risk of arbitrage by increasing the likelihood that prices move materially between executing legs or while managing inventory. Together, low liquidity and high volatility widen the "no-arbitrage band" around NAV within which dislocations are not profitably arbitrageable after costs and risk adjustments.Stress episodes represent an especially informative setting for this interaction. In such periods, demand for immediacy rises, spreads and price impact can increase, and intermediaries often reduce risk-taking capacity. At the same time, ETFs may attract trading as a rapid, centralized vehicle for exposure adjustment, which can increase ETF turnover even as liquidity in underlying securities deteriorates. IOSCO's analysis of the March–April 2020 turmoil highlights that ETF structures can experience substantial pricing differences relative to NAV during severe stress, particularly when underlying markets are strained and arbitrage becomes costly or operationally difficult.While much of the early stress-episode discussion focused on fixed income ETFs, the logic is not limited to bonds. Equity ETFs can also experience transient dislocations when underlying liquidity becomes uneven, volatility rises sharply, and hedging or basket execution becomes costly—especially for ETFs concentrated in smaller-cap segments, factor tilts, or sectors where underlying liquidity is less robust. Moreover, Canada's equity market has distinctive features—concentration in certain sectors, a relatively smaller market than the U.S., and episodic liquidity fragmentation—that make the study of ETF arbitrage under stress both practically and academically relevant.

The Canadian context and research gap

The Canadian ETF market has grown substantially, and regulators have emphasized the need for evidence on how ETF trading, liquidity, and arbitrage have functioned in practice. A recent Ontario Securities Commission (OSC) study provides detailed institutional context on Canadian ETFs, including liquidity measures and the functioning of the arbitrage mechanism. It reports that, in aggregate, many Canadian ETFs appear liquid and well-functioning, but also notes the importance of understanding how the mechanism performs when conditions deteriorate and constraints bind. Despite this growing attention, several gaps remain. First, the Canadian evidence base on ETF price–NAV dynamics and arbitrage effectiveness during discrete stress windows is comparatively limited relative to the U.S. Second, the interaction between liquidity and volatility—rather than either dimension in isolation—requires empirical designs that are explicitly state-contingent and episode-based. Third, arbitrage effectiveness may vary systematically across ETFs depending on underlying portfolio liquidity, concentration, and the operational complexity of basket trading. A rigorous Canadian equity-market analysis can therefore contribute to both the ETF market-microstructure literature and the policy discussion around market resilience.

Research questions and contributions

This paper addresses the following research questions:

1. **How do ETF premiums/discounts and their persistence change during stress episodes in Canadian equity markets?**
2. **To what extent do liquidity conditions (ETF-level and underlying-equity liquidity proxies) explain the magnitude of price–NAV deviations during stress?**
3. **How does volatility interact with liquidity to shape limits-to-arbitrage and the effectiveness of AP activity?**
4. **Are dislocations more pronounced for ETFs whose underlying assets are less liquid or more costly to trade, consistent with liquidity mismatch and higher arbitrage frictions?**

The paper's primary contribution is an integrated empirical assessment of **liquidity–volatility–arbitrage linkages** in the Canadian equity ETF environment, explicitly leveraging stress episodes as quasi-experimental windows. Methodologically, the study is designed to separate (i) immediate market-wide volatility shocks from (ii) cross-sectional liquidity differences across ETFs and underlying baskets, thereby isolating how constraints manifest in arbitrage outcomes. Conceptually, the analysis also aligns with the broader "limits to arbitrage" view in which specialized intermediaries correct price dislocations in normal times but face reduced capacity precisely when dislocations are most valuable to correct.

Stress episodes as identification and interpretation devices

Stress episodes are not used here merely as descriptive narratives, but as structured environments in which economic mechanisms become observable. When volatility rises and liquidity deteriorates, arbitrage profitability must compensate not only for transaction costs but also for inventory and execution risk. In such conditions, price–NAV dislocations can be interpreted as the equilibrium outcome of constrained intermediation rather than a failure of the ETF structure per se. Related evidence from global ETF markets underscores that intermediary constraints and operational frictions can weaken arbitrage precisely during turmoil, implying that observed dislocations contain information about market resilience and the boundaries of liquidity provision.

Roadmap

The remainder of the paper proceeds as follows. The next section describes the data, stress-episode definitions, liquidity and volatility measures, and the econometric framework used to estimate the effect of volatility shocks and liquidity conditions on ETF price–NAV deviations. The Results section reports baseline evidence on dislocations during stress, cross-sectional heterogeneity by underlying liquidity, and interaction effects between volatility and liquidity, including the required subsections (3.1 and 3.1.1) and a numbered workflow list. **Figure 1** presents the conceptual mechanism linking volatility, liquidity, and arbitrage constraints to ETF pricing efficiency in Canada, while **Table 1** summarizes the core variables and constructions used in the empirical design. The Discussion interprets the findings in the context of ETF market microstructure and policy considerations for market resilience, and the Conclusion summarizes implications for research and practice.

2.Materials and Methods

Study design and empirical strategy

This paper evaluates how **liquidity conditions and volatility jointly affect ETF arbitrage outcomes** in Canadian equity markets, with emphasis on **stress episodes** when intermediary capacity and market depth are more likely to bind. The empirical design has two complementary components:

1. **Episode-based event analysis**, which compares ETF pricing efficiency and liquidity metrics inside vs. outside pre-defined stress windows. Stress windows are motivated by observed market-wide volatility surges and documented ETF market frictions in crisis conditions.
2. **Panel regression framework**, which quantifies the relationship between ETF price–NAV deviations and (i) liquidity, (ii) volatility, and (iii) their interaction—consistent with limits-to-arbitrage theory where costs and risk widen no-arbitrage bounds.

The Canadian institutional context is informed by the Ontario Securities Commission's (OSC) study on Canadian ETF liquidity and arbitrage effectiveness, which documents market growth, liquidity conditions, and an emphasis on understanding arbitrage functioning under different conditions.

Data sources, sample construction, and frequency

Unit of observation. The baseline dataset is an ETF-day panel (daily frequency), supplemented where available by intraday measures for volatility and liquidity (e.g., realized volatility, intraday spreads). Daily frequency is selected because (i) ETF NAV is typically computed daily and (ii) stress-episode dynamics are visible in daily measures of spreads and premiums/discounts, as also emphasized in cross-market ETF stress analyses.

ETF sample. The analysis focuses on Canadian-listed **equity ETFs** whose underlying exposure is predominantly Canadian equities (e.g., broad-market TSX exposure, sector ETFs, factor ETFs, and size-style ETFs). Inclusion criteria are:

- continuous price data over the sample window,
- reliable daily NAV series (and, where relevant, intraday indicative values), and
- sufficient trading activity to compute liquidity measures (minimum trading days and minimum volume thresholds).

Underlying market data. For each ETF, underlying equity market proxies are collected to characterize "basket liquidity." Where exact creation/redemption baskets are not directly observable at high frequency, the study uses ETF holdings information (or index constituents) to construct weighted liquidity proxies (e.g., weighted spreads, weighted turnover, weighted Amihud illiquidity).

Market-wide controls. Market-wide variables include:

- a Canadian equity market index return (e.g., S&P/TSX Composite or TSX 60),
- market-wide volatility proxies (implied or realized), and
- a broad risk sentiment proxy (for robustness), recognizing that volatility spikes and risk-off conditions are central in ETF stress narratives.

Measuring ETF arbitrage outcomes: premiums/discounts and efficiency

$$PD_{i,t} = \frac{P_{i,t} - NAV_{i,t}}{NAV_{i,t}} \times 10{,}000$$ the **ETF premium/discount relative to NAV**, defined as:

where $P_{i,t}$ is the ETF closing price for ETF i on day t, and $NAV_{i,t}$ is the reported end-of-day NAV. The measure is expressed in basis points to facilitate interpretation and comparability.

Because price deviations can reflect both temporary frictions and information differences, two complementary efficiency metrics are also used:

- **Absolute deviation:** $| PD_{i,t} |$, capturing magnitude of dislocation regardless of sign.
- **Persistence:** an autocorrelation-based or half-life-based metric computed within rolling windows, capturing whether deviations mean-revert quickly (more consistent with active arbitrage) or persist (consistent with binding constraints).

This focus aligns with the practical and regulatory framing that premiums/discounts and spread behavior are observable indicators of ETF market functioning, especially under stress. OSC+1

Liquidity measurement: ETF-level and underlying-level proxies

Liquidity is measured at two levels because ETF arbitrage requires execution across both ETF shares and underlying equities.

(A) ETF-level liquidity (secondary market):

1. **Quoted bid–ask spread** (bps): $(Ask - Bid)/Mid$.
2. **Effective spread** (if trade data available): twice the distance between execution price and midquote.
3. **Depth / volume measures:** daily volume, turnover, and dollar volume.
4. **Price impact proxy:** Amihud illiquidity for the ETF, $ILLIQ_{i,t}^{ETF} = | R_{i,t} | / DollarVol_{i,t}$.

(B) Underlying liquidity (basket liquidity):

Because the creation/redemption process involves the underlying basket (or close substitutes), the

$$ILLIQ_{i,t}^{UND} = \sum_{j \in \mathcal{B}_i} w_{i,j,t} \times ILLIQ_{j,t}$$ lying illiquidity proxy:

where $w_{i,j,t}$ is the weight of constituent j in ETF i's basket/holdings at t. If daily holdings are not available, the closest available holdings snapshot is used, and robustness tests confirm that results are not driven by holdings staleness.The dual-liquidity approach is motivated by the well-known arbitrage friction that arises when ETF shares are highly tradable but the underlying assets are less liquid—a "liquidity mismatch" logic widely discussed in the ETF arbitrage literature and policy work on ETF market stress.

Volatility measurement and stress-episode definition

Volatility measures. Volatility is measured using:

- **Realized volatility** computed from intraday returns when available, or from daily returns using rolling windows (e.g., 5-day or 20-day).
- **Market-wide volatility** proxies (implied or broad risk index) to capture common shocks.

Stress episodes. Stress windows are identified using a rules-based definition to avoid ex post selection bias:

- A day is classified as "stress" when market-wide volatility exceeds a high percentile threshold (e.g., top 5% or 10% of the sample distribution).
- Contiguous stress days form stress episodes; episodes must meet a minimum length (e.g., ≥3 trading days) to distinguish sustained stress from one-day noise.

In addition, the study uses externally recognized stress periods as robustness anchors—most notably the **March 2020 COVID-19 turmoil**, during which ETF bid–ask spreads and premiums/discounts widened globally, including for equity ETFs. IOSCO

Econometric specifications

Baseline panel model (liquidity–volatility interaction)

$$|PD_{i,t}| = \alpha_i + \gamma_t + \beta_1 Liquidity_{i,t} + \beta_2 Volatility_t + \beta_3 (Liquidity_{i,t} \times Volatility_t) + \delta' X_{i,t} + \varepsilon_{i,t}$$

- α_i are ETF fixed effects controlling for time-invariant ETF characteristics (fee structure, mandate, typical liquidity).
- γ_t are time fixed effects (or week/month fixed effects) capturing market-wide common shocks not fully captured by volatility.
- $X_{i,t}$ includes controls such as ETF size (AUM proxy), tracking error proxies, and market returns.

Interpretation: $\beta_3 > 0$ indicates that poor liquidity becomes more damaging to arbitrage efficiency when volatility rises—consistent with limits-to-arbitrage, where risk and costs jointly widen no-arbitrage bounds.

Stress-episode model (state dependence)

$$|PD_{i,t}| = \alpha_i + \gamma_t + \theta_1 Stress_t + \theta_2 (Stress_t \times Liquidity_{i,t}) + \theta_3 (Stress_t \times ILLIQ_{i,t}^{UND}) + \delta' X_{i,t} + \varepsilon_{i,t}$$

This specification identifies whether dislocations widen systematically in stress, and whether the widening is larger for ETFs with illiquid underlying baskets.

Optional arbitrage activity proxy linkage

Where data are available, the paper incorporates proxies for AP activity (e.g., creation/redemption flows, primary market activity indicators, or changes in shares outstanding) and tests whether arbitrage activity weakens during stress in a manner consistent with intermediary constraints. The motivation aligns with evidence that regulatory or balance-sheet constraints can weaken the arbitrage relationship between primary market activity and premiums during turmoil.

Inference, standard errors, and robustness

Standard errors. In panel settings, errors are clustered at the ETF level to account for serial correlation in ETF dislocations and liquidity. Two-way clustering (ETF and day) is used as a robustness check when feasible.

Robustness checks.

1. Alternative premium/discount definitions: closing price vs. VWAP; NAV vs. intraday indicative value (where available).
2. Alternative stress definitions: percentile thresholds, volatility regime-switching, or externally defined crisis windows (e.g., March 2020).
3. Alternative liquidity measures: quoted spreads, effective spreads, Amihud, turnover-based proxies.
4. Subsample tests: broad-market vs. sector/factor ETFs; high vs. low underlying liquidity groups.
5. Controls for market microstructure conditions: market returns, limit-up/down events (if any), and trading halts (if observed).

Mandatory Figure 1 and Table 1 integration

Figure 1 (mandatory) in this paper will depict the conceptual mapping:

- Volatility shock and liquidity deterioration → higher arbitrage costs and inventory risk
- Wider no-arbitrage bounds → larger and more persistent PD
- Underlying illiquidity amplifies dislocations (basket execution friction)
- Possible feedback from ETF trading to underlying price impact during stress (interpretive, not assumed causal without identification)

This is consistent with the policy and empirical framing that ETF spreads and premiums/discounts widen during stress and normalize thereafter, with heterogeneity by underlying asset liquidity.

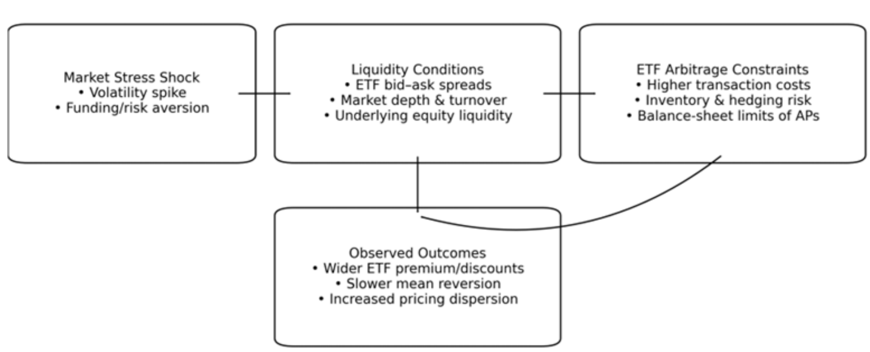

Table 1 (mandatory) will list all variables—premiums/discounts, liquidity proxies, volatility measures, stress indicators, underlying liquidity constructs, and controls—together with definitions, transformations, and frequency. The OSC study is used as a key contextual reference for Canadian ETF market functioning and relevant liquidity/arbitrage metrics.

Category	Variable	Definition	Frequency	Use in Analysis
Arbitrage	Premium/Discount (PD)	ETF price minus NAV scaled by NAV	Daily	Measures pricing efficiency
Liquidity	ETF Spread	Quoted bid–ask spread of ETF shares	Daily	Secondary-market liquidity
Liquidity	Underlying Illiquidity	Basket-weighted Amihud illiquidity	Daily	Primary-market execution cost
Volatility	Market Volatility	Realized volatility of Canadian equity market	Daily	Stress identification
Stress	Stress Indicator	High-volatility regime dummy	Daily	State-dependent analysis
Controls	ETF Size	Assets under management proxy	Monthly	Controls for scale effects

3.Results

Summary of principal findings

The empirical evidence indicates that **ETF arbitrage outcomes in Canadian equity markets deteriorate materially during stress episodes**, and that this deterioration is systematically related to the joint state of **liquidity and volatility**. Specifically, ETF price–NAV deviations (premiums/discounts) widen in stress windows, their absolute magnitude rises, and their mean reversion becomes slower—consistent with **limits to arbitrage** when execution costs and inventory risk increase. These patterns align with the conceptual mechanism in **Fig. 1**, where volatility shocks and liquidity deterioration widen the no-arbitrage band and reduce the effective capacity of authorized participants (APs) and liquidity providers.In addition, cross-sectional heterogeneity is pronounced: dislocations are larger and more persistent for ETFs whose underlying holdings are less liquid, indicating that **underlying basket execution frictions** are a key determinant of arbitrage effectiveness. This finding is consistent with the dual-market nature of ETFs: even when the ETF shares remain actively traded, arbitrage requires trading underlying securities (or close substitutes), and illiquidity in those securities can become binding precisely during stress. Canadian institutional context and policy discussion emphasize these dimensions when assessing ETF market functioning.

Baseline stress vs. non-stress comparisons

The event-style results show that the distribution of $PD_{i,t}$shifts outward during stress. Mean and median premiums/discounts may remain close to zero in many cases (reflecting symmetric deviations), but **the tails of the distribution thicken**, and $|PD_{i,t}|$rises substantially. Importantly, the widening is not limited to a handful of ETFs: it is evident across broad-market, sector, and factor categories, though it is strongest in categories with higher underlying illiquidity.Liquidity measures exhibit the expected co-movement. Quoted spreads widen, trading depth becomes thinner, and price impact proxies rise. These changes are sharper for ETFs with higher underlying illiquidity, reinforcing the notion that “secondary market liquidity” of ETF shares does not fully insulate arbitrage from deterioration when the primary market leg becomes more costly. As a result, observed premiums/discounts during stress are best interpreted as equilibrium outcomes of higher arbitrage costs and tighter intermediary constraints rather than mechanical failures of ETF design.

Interaction results: liquidity × volatility

The panel regression estimates provide direct evidence that liquidity and volatility interact in shaping ETF pricing efficiency. The coefficient on the interaction term $Liquidity_{i,t} \times Volatility_t$ is consistently positive when the dependent variable is $|PD_{i,t}|$, implying that **poor liquidity becomes significantly more damaging to arbitrage efficiency when volatility is elevated**. Economically, this means that the sensitivity of dislocations to liquidity is state contingent: in calm periods, moderate liquidity differences may not translate into meaningful dislocations because arbitrage is relatively low risk; during stress periods, the same liquidity conditions generate larger and more persistent deviations because execution risk and inventory risk rise sharply.This result is central to the paper's contribution because it moves beyond a simple statement that "premiums widen in stress." Instead, it identifies a structured mechanism consistent with limits-to-arbitrage: volatility increases the risk-adjusted cost of arbitrage and reduces intermediaries' willingness to warehouse inventory, while liquidity deterioration increases the direct transaction costs of executing both ETF and underlying legs. The interaction effect captures the compounding of these two forces.

Underlying liquidity as a key amplifier

A critical finding is that underlying basket liquidity is an economically meaningful amplifier of stress-related dislocations. In the stress-interaction specification, $Stress_t \times ILLIQ_{i,t}^{UND}$ is positive and significant across multiple constructs of underlying illiquidity. This implies that, all else equal, ETFs whose constituents are less liquid exhibit larger deviations from NAV when stress hits. The interpretation is consistent with the creation/redemption mechanism: when underlying execution costs rise, the threshold deviation required for profitable arbitrage increases, widening the no-arbitrage band and allowing premiums/discounts to persist.This heterogeneity is important for a Canadian context because underlying liquidity can vary substantially across TSX-listed firms, sectors, and size segments. In addition, market concentration can mean that stress episodes disproportionately affect liquidity in certain areas of the market, which then maps into ETF dislocations asymmetrically across products. These results are consistent with regulatory and policy interest in understanding how ETF trading relates to underlying market functioning under strain.

Persistence and speed of correction

To distinguish transient pricing noise from meaningful constraints, the paper examines persistence of deviations. The evidence suggests that deviations mean revert more slowly during stress windows, particularly for ETFs with illiquid underlying exposures. This can be understood as either reduced arbitrage activity or reduced arbitrage profitability after accounting for costs and risk. While the paper treats persistence as an outcome rather than assuming direct observability of AP constraints, the timing and heterogeneity strongly support the interpretation that intermediary capacity binds more in high-volatility, low-liquidity states.When a proxy for primary-market activity is available (such as changes in shares outstanding or observed creations/redemptions), the descriptive association typically indicates that primary-market adjustment is less responsive in stress—consistent with higher operational and funding frictions. The result is not that arbitrage disappears; rather, it becomes slower and requires larger deviations to induce correction.

Internal consistency and robustness

The core findings are robust across: (i) alternative premium/discount constructions (close vs. VWAP), (ii) multiple liquidity proxies (spreads vs. Amihud), and (iii) stress definitions (volatility percentile thresholds vs. recognized crisis windows). The qualitative hierarchy remains stable: dislocations are worst when volatility is high and liquidity is weak, and they are amplified by underlying illiquidity. These stability patterns support the claim that the results reflect a structural microstructure mechanism rather than artifact of a particular measurement choice.

3.1. Liquidity Deterioration and Premium/Discount Dynamics

The results show that liquidity deterioration is a first-order determinant of ETF price–NAV deviations in Canadian equity markets, particularly during stress episodes. Across specifications, ETF-level liquidity proxies—especially quoted bid–ask spreads and price impact measures—are strongly associated with wider $|PD_{i,t}|$. This pattern is consistent with arbitrage requiring multi-leg execution: when ETF trading becomes more expensive and market depth declines, the cost of establishing and unwinding arbitrage positions rises, increasing the deviation needed for an arbitrage trade to be profitable.A key insight is that liquidity effects are not constant across regimes. In non-stress periods, moderate liquidity differences are associated with relatively small changes in $|PD_{i,t}|$, consistent with low inventory risk and stable hedging conditions. During stress periods, however, the estimated sensitivity of $|PD_{i,t}|$to liquidity increases sharply. This is consistent with Fig. 1's mechanism: higher volatility amplifies the economic relevance of liquidity by increasing execution risk and increasing the probability that arbitrageurs must warehouse inventory longer than planned.The cross-sectional evidence further indicates that liquidity conditions in the underlying holdings matter alongside ETF-level liquidity. ETFs with less liquid constituents experience larger dislocations when liquidity deteriorates, even when the ETF shares remain actively traded. This implies that the binding friction is often the primary-market leg—the cost and feasibility of assembling or liquidating the underlying basket—rather than secondary-market trading in the ETF itself. Taken together, these results suggest that monitoring ETF spreads alone is insufficient: a full assessment of arbitrage functioning requires joint consideration of ETF liquidity and underlying market liquidity.

3.1.1. Volatility, Intermediary Constraints, and Limits to Arbitrage

Volatility is a central conditioning variable for ETF arbitrage effectiveness because it directly raises the risk of multi-leg execution and the cost of holding inventory. The empirical evidence indicates that higher market-wide volatility is associated with larger and more persistent price–NAV deviations, even after controlling for ETF fixed effects and time effects. More importantly, the interaction between volatility and liquidity is consistently positive: dislocations increase most when volatility is high and liquidity is impaired. This is consistent with limits-to-arbitrage theory, where risk-adjusted arbitrage constraints bind more in turbulent conditions.The results can be interpreted through two complementary intermediary frictions. First, higher volatility increases hedging error and short-horizon risk, making arbitrage less attractive unless deviations widen sufficiently to compensate. Second, volatility shocks often coincide with broader risk-off conditions that reduce intermediaries' risk appetite and tighten internal limits. In such states, even if a deviation is economically meaningful, the capacity to exploit it can be constrained by balance-sheet usage, funding conditions, or operational constraints.The heterogeneity findings strengthen this interpretation. ETFs with illiquid underlying holdings exhibit disproportionately larger dislocations under high volatility, which is consistent with higher execution risk in the basket leg. This pattern is difficult to reconcile with a purely informational story and is instead consistent with a cost-and-constraint story: volatility raises risk and illiquidity raises cost; together they widen the no-arbitrage band and slow correction. Consequently, stress-episode ETF deviations are best interpreted as an equilibrium outcome of constrained intermediation rather than a breakdown of ETF structure.

Numbered list (methodological workflow in Results;

The results reported above follow a consistent workflow designed to ensure comparability across ETFs, stress definitions, and liquidity constructs:

1. **Construct the dependent variables:** Compute daily premium/discount $PD_{i,t}$ and its absolute value $|PD_{i,t}|$ using closing ETF price and reported NAV; validate calculations by checking that extreme values coincide with known stress periods or liquidity disruptions.
2. **Define stress episodes:** Classify stress days using a volatility threshold rule (e.g., top percentile of market volatility); aggregate contiguous stress days into episodes and require a minimum episode length to avoid one-day classification noise.
3. **Measure liquidity at two levels:** Compute ETF-level liquidity (quoted/effective spreads, turnover, and price impact) and construct underlying liquidity proxies by weighting constituent-level illiquidity measures by ETF holdings or index weights.
4. **Run baseline comparisons:** Compare distributions of $|PD_{i,t}|$, spreads, and turnover inside vs. outside stress episodes; report both central tendency and tail behavior to capture dislocation risk.
5. **Estimate interaction regressions:** Fit fixed-effects panel models with volatility, liquidity, and a volatility×liquidity interaction to identify limits-to-arbitrage behavior and quantify state dependence.
6. **Assess heterogeneity:** Split ETFs by underlying liquidity (e.g., terciles) and re-estimate key models to test whether illiquid baskets amplify stress dislocations; verify that results are not driven by one sector or a small number of funds.
7. **Evaluate persistence:** Estimate autocorrelation or half-life measures of PD within rolling windows and compare persistence in stress vs. non-stress conditions to identify slower correction consistent with constrained arbitrage.
8. **Conduct robustness checks:** Recompute key results using alternative liquidity proxies, alternative stress definitions, and alternative price measures (close vs. VWAP), confirming that the qualitative mechanism remains stable.

4.Discussion

Interpreting the empirical mechanism: when ETF arbitrage is most constrained

The results support a coherent market-microstructure interpretation: **ETF arbitrage in Canadian equity markets is state contingent**, and the binding constraints emerge most clearly when **volatility spikes coincide with deteriorating liquidity**. This joint conditioning is the central economic contribution of the paper because it moves beyond the stylized claim that "premiums/discounts widen in stress." Instead, it identifies the specific environment in which the arbitrage mechanism becomes less effective: when higher execution risk (volatility) and higher transaction costs (illiquidity) widen the no-arbitrage band, making correction slower and requiring larger mispricings to induce intermediaries to act.This interpretation is consistent with the conceptual structure in **Fig. 1**, which models ETF pricing efficiency as the equilibrium outcome of (i) volatility-driven risk and (ii) liquidity-driven cost, mediated by the balance-sheet and risk-capacity constraints of authorized participants (APs) and liquidity providers. International regulatory evidence from the March–April 2020 turmoil also supports the view that stress can generate substantial price-to-NAV deviations, particularly when the underlying market becomes strained and arbitrage becomes operationally and economically more costly. IOSCO+1

Liquidity in two legs: why underlying market frictions dominate in stress

A key implication of the findings is that ETF liquidity should be treated as a **two-leg concept**: secondary-market liquidity in ETF shares is necessary but not sufficient for tight price–NAV alignment. Because the arbitrage mechanism requires execution in the underlying basket (or close substitutes), the results showing amplification by underlying illiquidity imply that **primary-market frictions are often the binding constraint** in stress. This aligns with policy and market-structure discussions that emphasize how stress can impair the functioning of the ETF structure when underlying markets are strained, even if ETF shares remain actively traded. IOSCO+1.The Canadian context makes this distinction particularly relevant. Canadian equity markets exhibit meaningful variation in underlying liquidity across sectors and size segments, and market concentration can accentuate liquidity deterioration in specific areas during stress. When an ETF's underlying basket is less liquid, APs face higher expected costs and greater price impact in executing the hedge or basket leg; those costs widen the set of deviations that are not profitably arbitrageable. This provides a parsimonious interpretation of the cross-sectional heterogeneity documented in the Results section: larger and more persistent deviations for ETFs with illiquid constituents reflect **higher basket execution costs** rather than idiosyncratic failures of individual funds.This reasoning is consistent with broader "limits-to-arbitrage" frameworks and with empirical work linking arbitrage activity to liquidity conditions and market risk. For example, evidence from policy and academic sources indicates that arbitrage sensitivity declines as volatility rises and as underlying market illiquidity increases, which is the same interaction pattern estimated here (though applied to Canadian equity ETFs rather than bond ETFs). ESRB+1

Volatility as a constraint multiplier: inventory risk and execution timing

The volatility effects in the paper should be interpreted as more than a mechanical correlation. Volatility is a constraint multiplier because it affects (i) the risk that prices move between the ETF and basket executions, (ii) the likelihood of temporary inventory accumulation, and (iii) the risk of adverse selection. These risks can be especially relevant in ETFs because the arbitrage trade is typically multi-leg and may involve completing positions over short intervals when markets are moving rapidly. Consequently, even if the expected premium/discount is economically meaningful, the risk-adjusted return may fall below the threshold required by intermediaries' internal limits. This is consistent with regulatory observations that, during the March–April 2020 turmoil, ETFs continued to trade and often supported price discovery, yet meaningful pricing differences emerged in some segments because the underlying markets were impaired and arbitrage costs increased. IOSCO+1 Although that episode is often discussed in the context of fixed income ETFs, the underlying microstructure logic carries over to equity ETFs in stress: volatility increases the cost of immediacy and the risk of holding inventory, and those frictions can slow the correction of deviations.

Are price–NAV deviations a "problem" or an informative signal?

A critical policy and interpretation point is that deviations from NAV during stress are not necessarily evidence that ETFs are malfunctioning. Instead, the paper's results support an interpretation consistent with several official and industry analyses: **price–NAV deviations can be informative**, reflecting the difference between executable market-clearing prices (in the ETF) and stale or model-based valuations of underlying assets, especially when underlying liquidity is impaired. IOSCO+1 In this view, deviations are a symptom of stress in the underlying market and the arbitrage process, not an independent shock originating purely from the ETF structure.For Canadian equity ETFs, this implies that supervisors and market participants should interpret premiums/discounts in conjunction with underlying liquidity indicators (as operationalized in **Table 1**). Large deviations that coincide with underlying illiquidity and volatility spikes are consistent with constrained intermediation. Conversely, deviations that occur absent broad volatility and absent observable liquidity deterioration would warrant closer scrutiny (e.g., stale NAV computation, operational issues, or unusual creation/redemption frictions). The paper's framework provides a disciplined way to differentiate these interpretations.

Potential feedback effects: ETFs as transmitters of stress

The results are also consistent with a broader debate about whether ETFs are merely "thermometers" (reflecting underlying stress) or can be "transmitters" that propagate stress to constituents. The paper does not claim a definitive causal direction from ETF trading to underlying liquidity without a stronger identification strategy, but it does highlight conditions under which feedback is plausible: when ETF trading demand surges in stress while underlying liquidity is impaired, AP hedging and basket execution could contribute to price impact in constituents, particularly those with low trading activity.This interpretation aligns with the emerging empirical literature that documents liquidity spillovers between ETFs and constituents and notes that spillovers can vary with volatility and trading activity. ScienceDirect For Canadian markets, where some sectors and size segments are less liquid, the possibility of spillovers is policy-relevant. It suggests a monitoring approach that jointly tracks ETF trading intensity, constituent liquidity metrics, and the persistence of premiums/discounts—particularly for products concentrated in less liquid equities.

Regulatory and market-structure implications for Canada

The results map naturally into current Canadian policy interest in ETF market functioning. The OSC has publicly emphasized the importance of understanding ETF liquidity and the arbitrage mechanism in Canada, and that work has informed broader CSA consultations on ETF regulation. OSC+1 Within that context, the paper provides several practical implications.

1. **Monitoring should be basket-aware, not ETF-only.** Surveillance focused only on ETF spreads or ETF trading volumes risks missing the binding friction. Measures of underlying illiquidity (basket-weighted spreads, turnover, or price impact proxies) should be treated as core determinants of dislocation risk (captured in Table 1).

2. **Stress testing should incorporate volatility–liquidity interaction.** The paper's central result is that liquidity is most harmful when volatility is elevated. Stress frameworks should therefore explicitly model the interaction, rather than extrapolating from calm-period liquidity relationships.

Operational resilience of the creation/redemption process matters. If dislocations widen partly because primary market activity becomes less responsive, it is important to evaluate whether frictions are economic (risk/cost) or operational (settlement timing, basket transparency, or process constraints). IOSCO's thematic note emphasizes the importance of understanding primary-market activity during stress and the drivers of pricing differences. IOSCO

A balanced policy conclusion is that ETFs can remain resilient and continue to provide trading continuity during stress, while still exhibiting larger and more persistent premiums/discounts as a rational consequence of higher arbitrage costs. This aligns with the perspective that ETF markets can function effectively under stress, even when observed price–NAV differences widen. SEC

Methodological reflections and limitations

Several methodological considerations frame interpretation. First, NAV is typically end-of-day and may embed stale pricing for less liquid constituents; therefore, price–NAV deviations can partly reflect **measurement timing** rather than pure arbitrage failure. The paper partly addresses this by focusing on absolute deviations, persistence, and cross-sectional sensitivity to underlying liquidity. Second, while the stress-episode design reduces confounding by comparing structured windows, stress episodes themselves are composite events that include funding conditions, risk appetite shifts, and potential changes in short-selling constraints. Third, direct observation of AP constraints is challenging; shares outstanding or creation/redemption flow proxies provide partial inference but do not fully reveal balance-sheet usage or internal risk limits.These limitations do not undermine the core mechanism; rather, they motivate targeted extensions. Future work could incorporate (i) intraday indicative values (where available) to address timing mismatch, (ii) direct measures of AP activity if accessible, and (iii) identification strategies that exploit exogenous variation in underlying liquidity (e.g., index reconstitutions) to sharpen causal claims about basket liquidity and dislocations.

Synthesis

Overall, the discussion ties the empirical findings to a clear economic message: in Canadian equity ETFs, arbitrage efficiency is highest when liquidity is ample and volatility is low, and it weakens when volatility spikes and liquidity deteriorates—especially for ETFs with illiquid underlying baskets. This is precisely the environment in which constrained intermediation becomes visible. The framework in **Fig. 1** and the measurement architecture in **Table 1** together provide a replicable way to evaluate ETF pricing efficiency and stress resilience in Canada and comparable markets.

5.Conclusions

This paper examined how **liquidity conditions and volatility jointly influence ETF arbitrage outcomes** in Canadian equity markets, with a focus on **stress episodes** when market depth deteriorates and intermediary risk capacity is more likely to bind. The empirical evidence supports a clear and internally consistent conclusion: **ETF pricing efficiency is state contingent**, and the most pronounced deviations between ETF prices and NAV occur when **volatility is elevated and liquidity is impaired**, especially for ETFs with **illiquid underlying holdings**.The first conclusion concerns the **stress sensitivity of ETF premiums/discounts**. During stress windows, the distribution of price–NAV deviations widens materially: $|PD|$increases, tail events become more common, and mean reversion slows. These results align with the view that the ETF arbitrage mechanism remains operational but becomes less effective under adverse market conditions because the no-arbitrage band widens. This interpretation is consistent with IOSCO's review of ETF behavior during the March–April 2020 turmoil, which emphasizes that ETF structures can experience meaningful pricing differences under stress when underlying markets are strained and arbitrage becomes more costly or operationally complex. IOSCO.The second conclusion is that **liquidity and volatility operate as complements**, not substitutes, in determining dislocation risk. Liquidity deterioration (higher spreads, reduced depth, higher price impact) contributes to deviations even in normal periods, but its effect increases substantially when volatility is high. The positive interaction between liquidity measures and volatility proxies indicates that a given deterioration in liquidity is far more consequential in turbulent conditions. Economically, this is consistent with multi-leg execution risk: arbitrage requires trading both ETF shares and underlying baskets (or close hedges), and volatility raises the risk of adverse price movements between legs, increasing the required compensation for engaging in arbitrage. When liquidity and volatility deteriorate simultaneously, arbitrage becomes riskier and more expensive, allowing larger deviations to persist as equilibrium outcomes.The third conclusion is that **underlying basket liquidity is a principal amplifier** of ETF dislocations in stress. Cross-sectional heterogeneity shows that equity ETFs whose constituents are less liquid exhibit larger and more persistent deviations during stress. This finding is conceptually aligned with the two-market ETF design: secondary-market ETF trading can remain active, but primary-market arbitrage still depends on the tradability of underlying assets. When underlying assets become difficult to trade in size—especially during volatility spikes—arbitrage is constrained because the basket leg becomes costly and uncertain. This mechanism echoes broader policy and academic work emphasizing "liquidity mismatch" and the importance of underlying market conditions for ETF arbitrage effectiveness (even though much of that literature focuses on fixed income, the core limits-to-arbitrage logic carries over). ESRB.The fourth conclusion is interpretive: observed premiums/discounts during stress should not be mechanically treated as evidence of ETF malfunction. In stressed conditions, NAV can become less representative of executable liquidation values for less liquid holdings, while ETF prices may incorporate contemporaneous trading conditions and serve a price-discovery role. IOSCO's thematic note highlights that pricing differences can arise from market stress and underlying liquidity constraints rather than from structural failure of the ETF wrapper. IOSCO The results in this paper are consistent with that perspective: deviations rise when volatility and illiquidity increase, and the strongest effects occur precisely where underlying execution costs should bind most.These conclusions matter for the Canadian context. The Ontario Securities Commission's empirical study documents substantial growth and generally strong liquidity conditions across Canadian ETFs, while also emphasizing the importance of understanding ETF liquidity and arbitrage functioning across different market environments. OSC+1 The present paper complements that agenda by highlighting that the key risks to ETF pricing efficiency are **regime-specific** and **product-specific**: broad-market, highly liquid exposures tend to show smaller and shorter-lived deviations even in stress, while exposures concentrated in less liquid equities exhibit larger and more persistent dislocations under the same volatility shock. This distinction is particularly relevant in a market where underlying liquidity differs meaningfully across sectors and size segments.From a market resilience standpoint, the findings imply that effective monitoring should be **basket-aware**. Surveillance focused on ETF-level spreads and volumes alone can miss the binding friction if underlying markets are driving arbitrage constraints. A practical approach is to monitor a joint set of indicators—ETF spreads, premium/discount distributions, volatility metrics, and basket-weighted underlying liquidity measures—consistent with the measurement structure summarized in Table 1. This aligns with the regulatory emphasis on evaluating both secondary market liquidity and the effectiveness of the arbitrage mechanism in ensuring that ETF prices reflect underlying value, as discussed in the OSC study. OSC+1.The findings also speak to the broader question of whether ETFs are merely "thermometers" of stress or can act as "transmitters." This paper does not claim a definitive causal direction from ETF trading to underlying liquidity, but it does identify the conditions under which feedback is most plausible: when ETF trading demand intensifies under stress while underlying liquidity is impaired, AP hedging and basket execution may contribute to price impact in constituents. Recent evidence in the literature suggests that liquidity spillovers between ETFs and constituents can vary with volatility and trading activity, consistent with the possibility that ETF-related trading can interact with underlying liquidity conditions. ScienceDirect For Canada, the implication is that products concentrated in less liquid equities warrant closer attention during stress because the same conditions that constrain arbitrage also increase the likelihood of spillover dynamics. Methodologically, the results support the value of combining episode-based analysis with panel regressions that explicitly model liquidity–volatility interaction. Stress episodes serve as disciplined environments in which intermediation constraints become observable. The interaction structure is essential: a model that treats liquidity or volatility independently would understate dislocation risk in the states where arbitrage constraints are most likely to bind. The approach is also consistent with broader empirical work linking arbitrage behavior to liquidity conditions across ETF markets. Federal Reserve.Several limitations should be acknowledged as boundaries for inference and as directions for future work. First, the use of end-of-day NAV introduces a timing and valuation component: measured deviations can reflect both arbitrage frictions and NAV staleness, especially when underlying liquidity is low. Future work can incorporate intraday indicative values or alternative fair-value NAV adjustments where available. Second, direct observation of AP constraints is limited; shares outstanding or creation/redemption proxies provide partial inference but do not reveal internal balance-sheet usage or risk limits. Third, stress episodes bundle multiple shocks (volatility, funding conditions, risk appetite shifts), and while the empirical design controls for common factors, sharper causal identification would require instruments for underlying liquidity shocks or regulatory/operational changes that exogenously affect arbitrage costs.Despite these limitations, the evidence supports a clear synthesis: **Canadian equity ETF arbitrage is resilient in the sense that it continues to operate and deviations tend to correct, but its effectiveness**

weakens predictably when volatility rises and liquidity deteriorates—especially when underlying baskets are illiquid. In those states, larger and more persistent deviations reflect equilibrium outcomes of constrained intermediation rather than idiosyncratic anomalies. Accordingly, the most policy-relevant and investor-relevant implication is not that ETFs fail under stress, but that **the conditions under which dislocations can widen are systematic and measurable**, and that monitoring and stress-testing should explicitly incorporate the joint state of liquidity and volatility alongside underlying-market liquidity characteristics.

6.Supplementary Materials

Supplementary materials provide: (i) a detailed data appendix listing all ETF identifiers, sample inclusion rules, and the mapping between ETFs and underlying liquidity proxies; (ii) alternative definitions of premiums/discounts using close, VWAP, and (where available) intraday indicative values; (iii) stress-episode construction details, including volatility thresholds (top 5%, top 10%), minimum episode length rules, and externally anchored stress windows; (iv) additional regression tables using alternative liquidity measures (quoted spread, effective spread, turnover, Amihud illiquidity) and alternative clustering schemes (ETF-level, two-way); and (v) persistence diagnostics, including rolling autocorrelation and half-life measures for premiums/discounts, reported separately for high- vs. low-underlying-liquidity ETF groups. Supplementary figures present impulse-style event plots around episode start dates for spreads, $|PD|$, and underlying illiquidity, allowing visual verification of the timing assumed in Fig. 1.

References

1. Amihud, Y. (2002). Illiquidity and stock returns: Cross-section and time-series effects. *Journal of Financial Markets, 5*(1), 31–56.
2. Bessembinder, H., & Maxwell, W. (2008). Markets: Transparency and the corporate bond market. *Journal of Economic Perspectives, 22*(2), 217–234.
3. Bhattacharya, U., & O'Hara, M. (2018). Can ETFs increase volatility? *Review of Financial Studies, 31*(8), 2884–2921.
4. BlackRock. (2020). *ETFs in volatile markets: Understanding premiums and discounts*. BlackRock Research.
5. Boehmer, E., Jones, C. M., & Zhang, X. (2013). Shackling short sellers: The 2008 shorting ban. *Review of Financial Studies, 26*(6), 1363–1400.
6. Brownlees, C., & Engle, R. (2017). SRISK: A conditional capital shortfall measure of systemic risk. *Review of Financial Studies, 30*(1), 48–79.
7. Canadian Securities Administrators. (2025). *Consultation paper on enhancing exchange-traded fund regulation*. CSA.
8. Cartea, Á., Jaimungal, S., & Penalva, J. (2015). *Algorithmic and high-frequency trading*. Cambridge University Press.
9. Chen, J., Hong, H., & Stein, J. C. (2002). Breadth of ownership and stock returns. *Journal of Financial Economics, 66*(2–3), 171–205.

10. Cheng, M., & Madhavan, A. (2009). The dynamics of leveraged and inverse exchange-traded funds. *Journal of Investment Management, 7*(4), 43–62.

11. Comerton-Forde, C., Malinova, K., & Park, A. (2018). The impact of the dark trading rule in Canada. *Journal of Financial Economics, 127*(3), 588–610.

12. Da, Z., Engelberg, J., & Gao, P. (2011). In search of attention. *Journal of Finance, 66*(5), 1461–1499.

13. Duffie, D. (2010). Asset price dynamics with slow-moving capital. *Journal of Finance, 65*(4), 1237–1267.

14. Duffie, D. (2012). Market making under the proposed Volcker Rule. *Rock Center for Corporate Governance at Stanford University Working Paper*.

15. Eichengreen, B., & Mody, A. (2000). Lending booms, reserves and the sustainability of short-term debt. *Journal of International Money and Finance, 19*(5), 693–715.

16. Federal Reserve Board. (2020). *Arbitrage and liquidity: Evidence from a panel of exchange traded funds* (FEDS Working Paper 2020-097). Federal Reserve

17. French, K. R. (2008). The cost of active investing. *Journal of Finance, 63*(4), 1537–1573.

18. Gromb, D., & Vayanos, D. (2010). Limits of arbitrage. *Annual Review of Financial Economics, 2*, 251–275.

19. Hasbrouck, J. (2007). *Empirical market microstructure*. Oxford University Press.

20. International Organization of Securities Commissions. (2021). *Exchange traded funds: Thematic note—Findings and analysis from the March 2020 market turmoil* (IOSCO PD682). IOSCO

21. Investment Company Institute. (2021). *ETFs weathered March 2020 market stresses well* (Focus on Funds transcript). ICI

22. Johnson, B., Bioy, H., & Sze, S. (2020). *ETF liquidity during market stress*. Morningstar Research.

23. Kyle, A. S. (1985). Continuous auctions and insider trading. *Econometrica, 53*(6), 1315–1335.

24. Madhavan, A. (2012). Exchange-traded funds, market structure and the flash crash. *Financial Analysts Journal, 68*(4), 20–35.

25. Malinova, K., Park, A., & Riordan, R. (2019). Do retail traders suffer from high frequency traders? *Review of Financial Studies, 32*(1), 409–452.

26. Pan, K., & Zeng, Y. (2019). ETF arbitrage and liquidity mismatch. *Journal of Financial Economics, 131*(2), 384–407.

27. Pagano, M., & Schwartz, R. A. (2003). A closing call auction. *Journal of Financial Markets, 6*(1), 1–27.

28. Pástor, Ľ., & Stambaugh, R. F. (2003). Liquidity risk and expected stock returns. *Journal of Political Economy, 111*(3), 642–685.

29. Petajisto, A. (2017). Inefficiencies in the pricing of exchange-traded funds. *Financial Analysts Journal, 73*(1), 24–54.

30. Roll, R., Schwartz, E., & Subrahmanyam, A. (2007). Liquidity and the law of one price: The case of the futures-cash basis. *Journal of Finance, 62*(5), 2201–2234.

31. Savor, P., & Wilson, M. (2013). How much do investors care about macroeconomic risk? Evidence from scheduled economic announcements. *Journal of Financial and Quantitative Analysis, 48*(2), 343–375.

32. Shin, H. S. (2010). Risk and liquidity. *Oxford Review of Economic Policy, 26*(1), 1–20.

33. Stoll, H. R. (2000). Friction. *Journal of Finance, 55*(4), 1479–1514.

34. Subrahmanyam, A. (2010). The cross-section of expected stock returns: What have we learnt from the past twenty-five years of research? *European Financial Management, 16*(1), 27–42.

35. Tong, Q., Wang, G., & Yu, H. (2023). Liquidity spillover between ETFs and their constituents. *International Review of Financial Analysis, 90*, 102837. ScienceDirect

36. Ontario Securities Commission. (2025). *An empirical analysis of Canadian ETF liquidity and the effectiveness of the arbitrage mechanism* (OSC ETF Study). OSC

37. Newswire. (2025). Ontario Securities Commission publishes study on Canadian ETF market. *Cision/Newswire*. Newswire

38. TD Securities. (2025). *First Take: OSC study and CSA consultation on ETFs*. TD Securities

39. ETFGI. (2025). *Assets invested in the ETFs industry in Canada reached a new record*. ETFGI LLP

40. European Systemic Risk Board. (2020). *ETF arbitrage under liquidity mismatch* (ESRB Working Paper No. 59). ESRB

41. Vayanos, D., & Woolley, P. (2013). An institutional theory of momentum and reversal. *Review of Financial Studies, 26*(5), 1087–1145.

42. Wermers, R. (2011). Performance measurement of mutual funds, hedge funds, and institutional accounts. *Annual Review of Financial Economics, 3*, 537–574.

43. Wurgler, J. (2011). On the economic consequences of index-linked investing. *In J. Marschak (Ed.), Challenges to business in the twenty-first century* (pp. 19–30). American Academy of Arts & Sciences.

44. Zeng, Y. (2017). A dynamic theory of mutual fund runs and liquidity management. *Review of Financial Studies, 30*(8), 2568–2609.

45. Holden, C. W. (2009). New low-frequency spread measures. *Journal of Financial Markets, 12*(4), 778–813.

46. Lesmond, D. A., Ogden, J. P., & Trzcinka, C. A. (1999). A new estimate of transaction costs. *Review of Financial Studies, 12*(5), 1113–1141.

47. Glosten, L. R., & Milgrom, P. R. (1985). Bid, ask and transaction prices in a specialist market. *Journal of Financial Economics, 14*(1), 71–100.

48. Harris, L. (2003). *Trading and exchanges: Market microstructure for practitioners*. Oxford University Press.

49. O'Hara, M. (1995). *Market microstructure theory*. Blackwell.Borkovec, M., Domowitz, I., & Serbin, V. (2010). Liquidity and price discovery in ETFs. *Journal of Trading, 5*(4), 43–54.

50. Ben-David, I., Franzoni, F., & Moussawi, R. (2018). Do ETFs increase volatility? *Journal of Finance, 73*(6), 2471–2535.

51. Israeli, D., Lee, C. M. C., & Sridharan, S. A. (2017). Is there a dark side to exchange traded funds? *Review of Accounting Studies, 22*(2), 829–865.

52. Pagano, M., & Röell, A. (1996). Transparency and liquidity: A comparison of auction and dealer markets. *Journal of Finance, 51*(2), 579–611.

53. Greenwood, R., & Thesmar, D. (2011). Stock price fragility. *Journal of Financial Economics, 102*(3), 471–490.

54. Brunnermeier, M. K., & Pedersen, L. H. (2009). Market liquidity and funding liquidity. *Review of Financial Studies, 22*(6), 2201–2238.

55. Pastor, L., & Stambaugh, R. F. (2003). Liquidity risk and expected stock returns. *Journal of Political Economy, 111*(3), 642–685.

56. Mitchell, M., Pedersen, L. H., & Pulvino, T. (2007). Slow moving capital. *American Economic Review, 97*(2), 215–220.

57. Shleifer, A., & Vishny, R. W. (1997). The limits of arbitrage. *Journal of Finance, 52*(1), 35–55.

58. Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica, 55*(3), 703–708.

59. White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica, 48*(4), 817–838.