ONTARIO SECURITIES COMMISSION

OSC ETF Study

An Empirical Analysis of Canadian ETF Liquidity and the Effectiveness of the Arbitrage Mechanism

June 2025

Ontario

Contents

Executive Summary

i. Introduction

Since their creation in the early 1990s, there has been significant growth in exchange traded funds (**ETFs**) in Canada and globally. ETFs are unique investment vehicles; they were initially intended as a cost-effective means to replicate broad market indices and have since evolved to offer exposure to a wide range of assets and investment strategies. ETFs have become a popular investment product among a broad spectrum of investors[1] and have proven resilient in the face of recent financial and macroeconomic events.[2]

In Canada, ETFs are currently regulated under a similar framework as mutual funds under NI 81-102. However, unlike mutual funds, ETFs trade on the secondary market, offering investors intraday liquidity. This liquidity is further supported by the primary market for ETFs, where ETFs transact with Authorized Participants (**APs**), typically large financial institutions such as market makers, to create and redeem ETF units. APs engage in these primary market activities mainly to facilitate large institutional trades or to capitalize on arbitrage opportunities to keep the market price of the ETF close to the value of its underlying securities, often proxied by the net asset value (**NAV**) of the ETF.[3]

Given the growing importance of ETFs, the Canadian Securities Administrators (**CSA**) began a review in 2023 to assess whether existing rules and frameworks remain appropriate to regulate ETFs. In conjunction with that review, OSC staff conducted an empirical analysis of the functioning of the Canadian ETF market, especially in relation to its distinctive features noted above and detailed in Consultation Paper 81-409.

This study summarizes the findings of OSC staff's analysis[4], which helped inform some of the policy proposals referenced in the Consultation Paper.

ii. Scope

Using a novel dataset that combines intraday quote and trade data with annual survey data from investment fund managers, we examined Canadian ETFs that traded from January 2019 to December 2023.

This study provides an overview of the Canadian ETF market, followed by a more detailed investigation into the following topics:

- **Secondary Market Liquidity of ETFs** through the lens of transaction costs as measured by quoted spread.
- **Effectiveness of the Arbitrage Mechanism** in ensuring that the market price of ETFs trades close to the value of their underlying assets.
- **Potential drivers of ETF liquidity and the arbitrage mechanism** using an impact analysis.

Due to data limitations this study does not examine:

- Primary market transactions between APs and ETFs to create new ETF units or redeem existing ETF units.
- The liquidity of ETFs' underlying assets and its impact on ETFs' liquidity.

[1] See, for instance, Hill, Nadig, and Hougan (2015), *A comprehensive guide to exchange-traded funds (ETFs)*, CFA Institute Research Foundation; or Investment Company Institute, & Strategic Business Insights (2018, September), *A close look at ETF households: A report by the Investment Company Institute and Strategic Business Insights,* Investment Company Institute, Strategic Business Insights, https://www.ici.org/pdf/rpt_18_etf_households.pdf.

[2] See Securities and Investment Management Association, (2021, December), *ETF resiliency in the COVID-19 financial crisis: A Canadian perspective,* The Investment Funds Institute of Canada, https://www.sima-amvi.ca/wp-content/themes/ific-new/util/downloads_new.php?id=26868&lang=en_CA; or Investment Company Institute (2020, October), *Experiences of US exchange-traded funds during the COVID-19 crisis*, Report of the COVID-19 Market Impact Working Group, https://www.ici.org/pdf/20_rpt_covid2.pdf.

[3] In the ETF context, arbitrage opportunities arise when the ETF's market price deviates from the value of the ETF's underlying holdings by more than the cost of transacting the underlying securities. For example, if the ETF price is lower than its underlying value and transaction costs, APs can buy the ETF units on the secondary market and redeem them for underlying securities to lock in an arbitrage profit. Conversely, if the ETF trades above its underlying value plus transaction costs, APs can do the opposite: sell short the ETF and simultaneously buy the underlying securities to create ETF units to cover their short position. See the CSA Consultation Paper 81-409 and the references therein for further details about the ETF arbitrage mechanism.

[4] The views expressed in this study are those of the authors and do not necessarily represent the official views of the Ontario Securities Commission (OSC).

iii. Key findings

The key observations from our analysis are:

- There has been considerable growth in the Canadian ETF market in terms of the number of funds, assets under management, variety of products, and secondary market activity.
- Overall, most Canadian ETFs were liquid and well-functioning as measured by tight quoted spreads and narrow price deviation from NAV.
- While generally stable, these measures widened substantially during periods of market stress. At the onset of the COVID-19 pandemic, quoted spreads and price deviation from NAV peaked to almost 10 times higher than normal levels. However, they quickly fell back to their pre-pandemic range within months.
- Almost half of the Canadian ETFs were thinly traded, however, their proportion appeared to decline over the sample period. These ETFs tended to be small, recently launched, and relatively less liquid with wider spreads and price deviation from NAV.
- Our impact analysis found some statistical evidence that a higher number of APs was associated with lower price deviation from NAV, suggesting that a greater number of APs can help improve the arbitrage mechanism.
- However, there was no statistical evidence that ETFs' portfolio disclosure practices influenced either secondary market liquidity or the arbitrage mechanism.

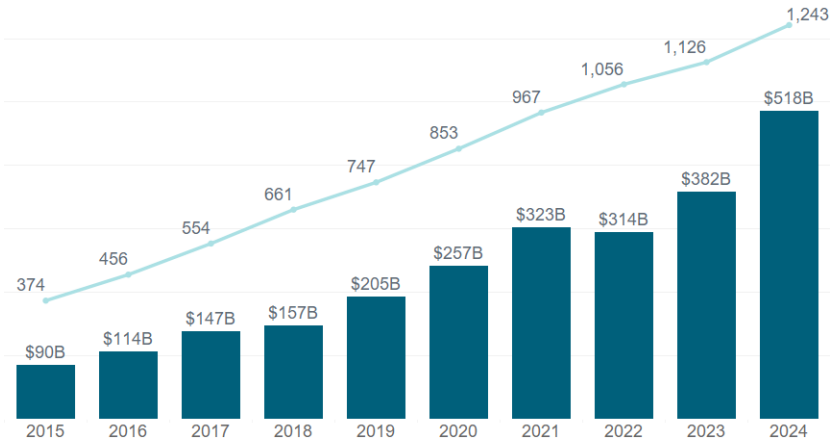
Market Overview

i. Size

ETF market size reached new heights in 2024

The Canadian ETF market has grown considerably over the last 10 years from under 400 ETFs with about $90 billion in total assets in 2015 to over 1,200 ETFs with over $500 billion in assets by the end of 2024.[5] Last year, total assets registered a record growth rate of approximately 36%, well exceeding the average annual growth rate of 22% over the last decade.

Figure 1 - ETF Net Assets and Fund Counts

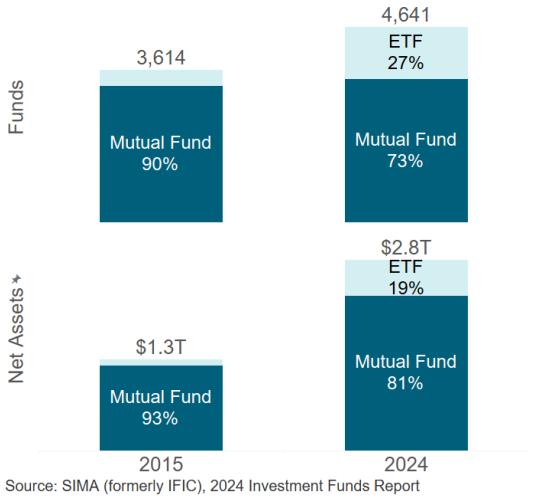


Source: SIMA (formerly IFIC), 2024 Investment Funds Report

ETF share of total investment fund assets has increased

Since 2015, ETFs have carved out a significant segment in investors' portfolio holdings, representing an increasingly larger share of the investment fund space. In 2015, ETFs represented under 10% of total public investment funds and net assets, but now account for almost 30% of funds and 20% of investment fund assets.

Figure 2 - ETF Share of Total Investment Funds



Source: SIMA (formerly IFIC), 2024 Investment Funds Report

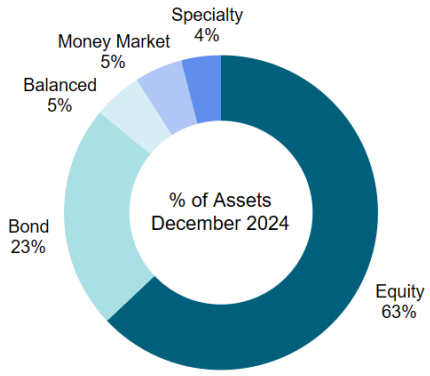
[5] See Securities and Investment Management Association (SIMA) (2024), *Investment Funds Report*.

ii. Composition

Majority of ETF assets in equity funds

According to the Securities and Investment Management Association (**SIMA**)[6], Canadian ETF assets reached $518 billion by the end of 2024. At that time, there were 45 ETF managers offering 1,243 ETFs. Equity funds comprised the largest share of total ETF assets (63%), followed by fixed income funds (23%), balanced funds (5%), money market funds (5%), and alternative or specialty funds (4%).[7]

Figure 3 - ETF Composition by Asset Class



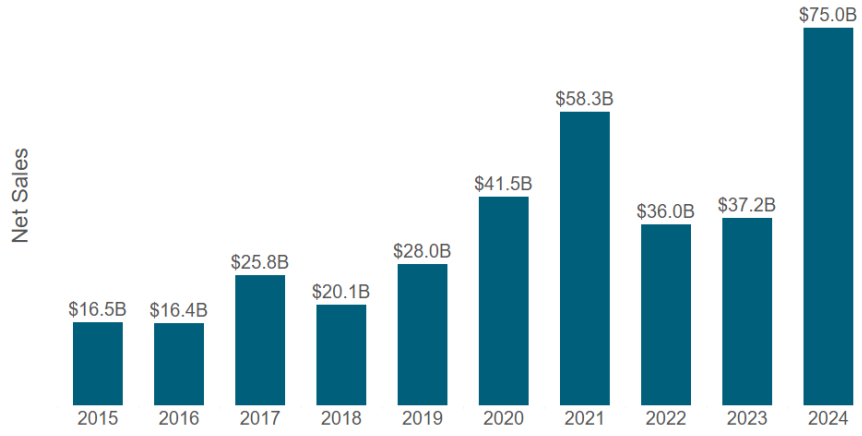
Source: SIMA (formerly IFIC), 2024 Investment Funds Report

iii. Activity

Persistent increase in net flows over the last decade

Net sales of ETFs, which represent total inflows, net of redemptions, reached a new high of approximately $75 billion in 2024, outstripping the combined net sales for the previous two years. Net sales have also continued to increase across all asset classes.

Figure 4 - ETF Net Sales



Source: SIMA (formerly IFIC), 2024 Investment Funds Report

[6] Formerly known as Investment Funds Institute of Canada (IFIC).

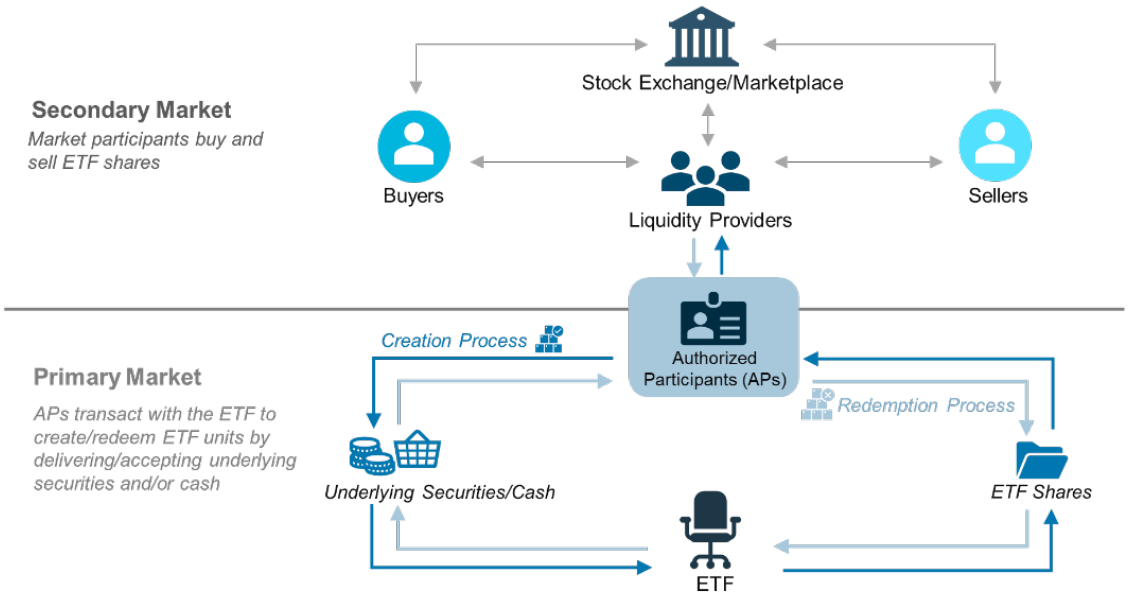
[7] See Securities and Investment Management Association (SIMA) (2024), *Investment Funds Report*.

The ETF Ecosystem

ETF liquidity supported by primary and secondary market activity

An ETF is an investment vehicle that provides investors with intraday liquidity, allowing it to be bought and sold on the secondary market at market-determined prices. Similar to listed equities or stocks, ETF liquidity is supported by multiple secondary market participants, including, but not limited to, market makers that help maintain a two-sided market and voluntary liquidity providers who trade ETFs to profit from bid-ask spreads or trading fee rebates. ETF liquidity in the secondary market is further supported by the creation and redemption of ETF units in the primary market. ETFs have contractual agreements with select dealers, known as Authorized Participants (**APs**), with whom they transact exclusively to create or redeem ETF units. Once an AP creates new shares, they can be traded in the secondary market, contributing to ETF liquidity. APs may also provide liquidity in the secondary market. When an AP wants to create new ETF units, they will deliver the underlying securities, cash or a representative basket to the ETF. Alternatively, when APs want to redeem ETF units, the reverse happens (see Figure 5 for a simplified illustration). This process requires APs to transact in an ETF's underlying securities. Thus, the ETF's liquidity is also affected by the liquidity of its underlying securities.[8]

Figure 5 – ETF Ecosystem (Simplified Illustration)



AP activity primarily driven by economic incentives

Despite the contractual agreements, APs are not legally obligated to create or redeem ETF units.[9] There are numerous reasons for APs to participate in the creation/redemption process, including facilitating arbitrage when ETF market prices deviate from their NAV; executing large institutional orders; managing inventory; and securities lending. ETF managers may charge APs a fixed fee (per order), known as the creation/redemption fee, which varies by ETF and asset class. In addition to these fixed costs, APs also must consider the cost of transacting in the underlying securities. After taking these costs into account, APs are incentivized to create/redeem shares if they can realize a net economic benefit from the transaction.[10]

[8] See, for example, State Street Global Advisors SPDR (2020), *ETF liquidity: Master the mechanics of ETF trading;* or Hooper and Sharp (2025), *The ABCs of ETF liquidity,* Vanguard.

[9] Investment Company Institute (n.d.), *ETF basics and structure,* https://www.ici.org/faqs/faqs_etfs.

[10] Antoniewicz and Heinrichs (2015), *The Role and Activities of Authorized Participants of Exchange-Traded Funds,* Investment Company Institute, conducted a survey of 15 members of the ICI that sponsor two-thirds of the number of ETFs representing 90% of the industry's total net assets in the US as of November 2014, and reported that on average an ETF in their sample has 34 AP agreements, however, the number of APs that are actively creating and redeeming shares is much lower. Specifically, the average number of active APs is 9 for large ETFs with assets more than $790 million and 2 for small ETFs with assets less than $27 million.

The combination of secondary market trading and primary market activity by APs (creations and redemptions) is central to the ETF liquidity ecosystem and ensures that ETF market prices in the secondary market reflect the value of the ETF's underlying assets.

Sample Dataset and Composition

i. Sample Dataset

The empirical analysis relied on a large dataset compiled from three main sources:

1) **CSA Market Analysis Platform** (MAP)**:** Contains intraday trades and quotes on all listed securities.[11] This is our study's primary data source as it provides the most granular information on ETF secondary market trading activity.
2) **OSC Investment Fund Survey** (IFS)[12]**:** Annually compiled information from investment fund managers about the funds they manage.[13] The IFS was a key source of information on fund attributes, including but not limited to the number of APs; investment strategy; and public disclosure of full daily portfolio holdings.
3) **Third-party market data sources:** Daily, monthly and annual timeseries data (primarily closing prices, market capitalization, management expense ratio (MER), and fund net assets) from the London Stock Exchange Group (LSEG); daily NAV price data from Fundata; VIX index prices from CBOE; and interest rate data from the Bank of Canada.[14]

ETF sample represented the majority of the market

Our dataset consisted of approximately 1,100 Canadian ETFs that traded from January 2, 2019, to December 31, 2023.[15] We further restricted our sample to stand-alone ETFs that traded in Canadian dollars. As of December 2023, the final sample included 933 ETFs with total net assets (**TNA**) of approximately $361 billion, capturing the vast majority of the Canadian ETF market: about 75% of all ETFs and 95% of ETF net assets.[16] ETFs in the sample had average net assets of $387 million, which was much larger than the median net assets of $60 million, suggesting that the sample was dominated by small funds. Lastly, the sample included 40 investment fund managers (**IFMs**) with the top 5 managing more than 70% of the total net assets of our sample.

ii. Sample Composition

Like the broader market, the sample comprised a wide variety of ETFs across different sizes, asset classes and investment strategies. Figure 6 sheds light on the composition of our sample of ETFs as of December 2023, across five attributes and selected groupings. Although limited, these groupings help dissect our sample by asset size and fund counts. Most ETFs in the sample track an index, predominantly hold equities assets, have at least nine APs, and provide public disclosure of the ETF's full daily portfolio holdings.

[11] The CSA's Market Analysis Platform (MAP) provides tick-by-tick trade, order and quote data for all securities traded on Canadian equity marketplaces.

[12] The OSC IFS is an annual survey that collects fund-level data on Canadian investment funds including ETFs. For more information see https://www.osc.ca/en/industry/investment-funds/investment-fund-survey.

[13] IFS data is only available from 2020 onwards, and prior to 2023 did not capture funds that were smaller than $10 million in net assets. Additionally, some survey questions have been revised and refined over the years, which might result in slightly inconsistent interpretation of responses. Discussions with respondents suggest that when there is inconsistency in a response over the years, the latest response should prevail. Accordingly, we use the latest, 2023 IFS data to backfill responses for the same fund in prior years to address data gaps or inconsistencies.

[14] In addition, the LSEG's Lipper Investment Management (LIM) provides fund attributes including base currency, Canadian Investment Funds Standards Committee (CIFSC) category, fund of funds, etc. See more details in Appendix 1 – Variable Definitions.

[15] We obtained our sample of Canadian ETFs from the LIM using their search criteria (Asset Universe is Exchange-Traded Funds and Domicile is Canada) and the OSC Investment Fund Survey (IFS). The vast majority (87%) of ETFs were listed on the Toronto Stock Exchange, while the balance was listed on CBOE Canada (formerly NEO Exchange).

[16] The market TNA at the end of 2023 was $382 billion according to the SIMA 2024 Investment Funds Report.

Figure 6 – 2023 ETF Composition as share of Net Assets[17]

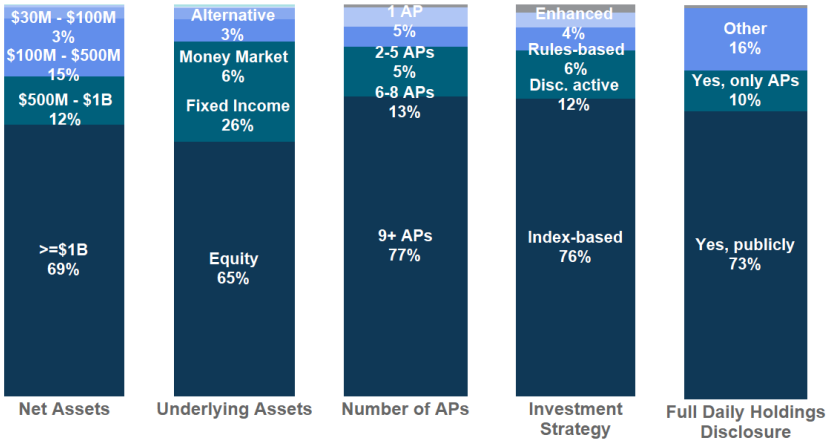
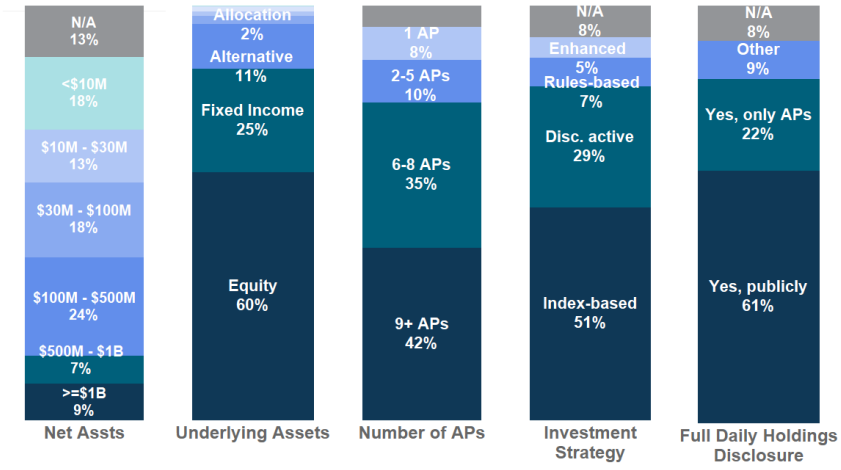


Figure 7 - 2023 ETF Composition as share of Funds



Note: N/A values in the graph indicate data points that were not available from third-party data sources.

Small proportion of ETFs held majority of net assets

ETFs with net assets under $500 million accounted for about 70% of the number of funds in our sample but represented only 20% of total net assets. In contrast, approximately 16% of the funds were large ETFs with net assets over $500 million, yet their combined size represented nearly 80% of total ETF net assets.

Equity ETFs represented the largest share by fund count and asset size

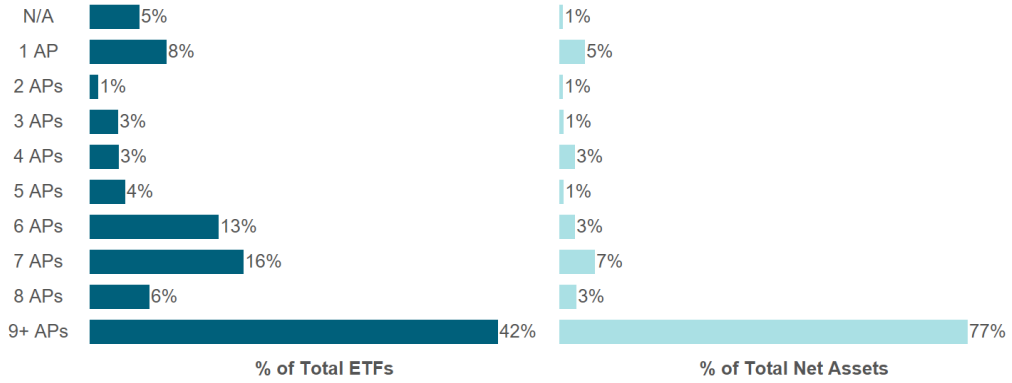
Like the broader ETF market, equity ETFs in the sample accounted for approximately 60% of total sample ETF net assets. Fixed income ETFs accounted for 26% of total sample net assets. Equity and fixed income funds together accounted for approximately 85% of the ETFs and 91% of the total net assets.

[17] Please note that the percent composition of the sample may not add up to 100% due to rounding.

Most ETFs had more than one AP

Fewer than 10% of ETFs had only one AP; these were predominantly small funds representing less than 5% of total net assets (see Figure 8). Almost half of the ETFs had at least eight APs and accounted for nearly 80% of the sample's total net assets. It is important to emphasize that we only had information about the number of APs associated with an ETF. As noted earlier, APs are not legally bound to create or redeem ETF units in the primary market; hence, they will only engage in these activities if the arbitrage opportunities justify their trading costs. Therefore, the number of APs that engage in creations and redemptions regularly may be fewer than the number of APs reported by IFMs through the IFS.[18]

Figure 8 – 2023 Distribution of AP counts by Funds and Net Assets



Index-based was the dominant investment strategy

Indexing has long been, and continues to be, the most common investment strategy for ETFs. However, more recently, ETF strategies have grown beyond broad asset class exposure to include, among other things, leveraged and inverse, rules-based, alternative beta, and active discretionary management.[19] In our sample, nearly 50% of ETFs followed an index-based strategy, while nearly 30% pursued an active discretionary management strategy. The remaining 12% of ETFs had other investment strategies.[20] The majority of ETF net assets were still allocated to index-based strategy (76%), while active and other strategies combined captured about 23% of the asset share.

Most ETFs provided full daily portfolio holdings to the public

Disclosure of portfolio holdings information enables market participants to value an ETF and facilitates the arbitrage mechanism.[21] In the 2023 IFS questionnaire, ETFs indicated whether their portfolio holding disclosure practices fell into one of three categories: 1) Daily, full disclosure to the public, 2) Daily, full disclosure to APs only, and 3) Others (includes funds that may provide only top holdings or the composition of the creation/redemption basket, instead of full daily holdings).[22] Based on the IFS data, around 61% of the ETFs provided full daily portfolio holdings to the public, and 22% of funds disclosed that information only to their APs. Although there were varying degrees of portfolio disclosure, our evidence in later sections seems to suggest that most ETFs seek to provide relevant information to APs and market participants to facilitate arbitrage.

[18] See, for example, Antoniewicz and Heinrichs (2015), *The Role and Activities of Authorized Participants of Exchange-Traded Funds,* Investment Company Institute; and BlackRock (2017), *A Primer on ETF Primary Trading and the Role of Authorized Participants,* ViewPoint, for further details.

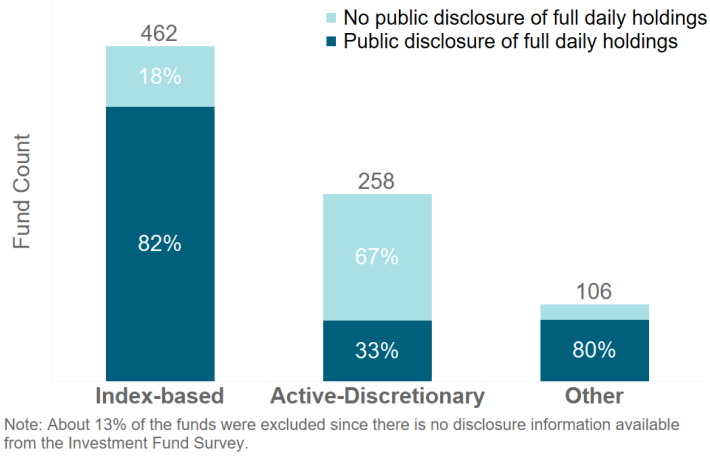
[19] See Hill, Nadig and Hougan (2015), *A Comprehensive Guide to Exchange-Traded Funds (ETFs),* CFA Institute Research Foundation; or Lettau and Madhavan (2018), *Exchange-Traded Funds 101 For Economists*, The Journal of Economic Perspectives, for more details.

[20] Based on the IFS data, the other investment strategies include "Enhanced, options or leverage (index or rules-based)" and "Rules-based, non-index tracking".

[21] The relevant information is deemed valuation information. See the CSA's Consultation Paper for details of various types of valuation information.

[22] Note that, before 2023, the IFS questionnaire provided only two response options for portfolio holdings disclosure: 1) Daily, full disclosure to the public, and 2) Others. Discussions with IFMs revealed that while some funds did not disclose their full portfolio holdings to the public, they nonetheless disclosed their holdings to the APs. As a result, the survey questionnaire in 2023 was changed accordingly.

Figure 9 - 2023 ETFs by Investment Strategy and Portfolio Holding Disclosure



Note: About 13% of the funds were excluded since there is no disclosure information available from the Investment Fund Survey.

Full portfolio transparency most common across passively managed funds

Portfolio disclosure policy is quite often influenced by an ETF's investment strategy. Providing full portfolio transparency is common for passively managed (index-based or rules-based) ETFs because their investment objective is to replicate the performance of an index with a transparent methodology or to invest in accordance with rules disclosed in their prospectus. On the contrary, active ETFs have concerns about disclosing the full daily portfolio holdings of their funds to the public, as this may reveal proprietary investment research used in their security selection. Figure 9 depicts the distribution of fund portfolio holdings disclosure policy by investment strategy. It is not surprising that over 80% of the index-based ETFs disclosed their full daily portfolio holdings to the public, while only a third of active, discretionary management ETFs chose to disclose their full daily portfolio holdings to the public.

Trading Liquidity and Arbitrage Effectiveness

i. Measures of Trading Liquidity and Arbitrage Effectiveness

Liquidity is important for investors and issuers

Trading liquidity is broadly defined as the degree to which investors can buy or sell a security without impacting its price. Securities with high liquidity can be readily traded thanks to an abundance of buyers and sellers. Conversely, securities with low liquidity may not be easily traded due to the lack of immediate buyers or sellers, which often requires greater price concessions (lower sales price or higher purchase price) or a larger price impact to execute a trade. Academic research shows that liquidity is important since it can affect investors' return on investments, the price discovery process, and an issuer's cost of capital.[23]

Liquidity of a security is typically measured by its transaction costs

Liquidity manifests itself in transaction costs with explicit and implicit components. Explicit costs include broker commissions and taxes which are incurred directly by investors; hence they are straightforward to measure. Implicit costs are the cost of trading immediacy or trading illiquidity, and they are usually measured by the spread: the difference between the bid price and ask price of a security. Other things being equal, securities with high spreads imply high transaction costs and low liquidity. Conversely, spreads are typically low for securities with low transaction costs and high liquidity.

In this study, we focus on the most-widely used liquidity measure: the quoted spread (**QS**). The QS is the difference between the best bid quote and the best offer (ask) quote at a point in time and is normalized by the midpoint of the bid and the offer. The QS reflects the cost of completing a round-trip transaction (i.e., when a buy and sell trade is executed at the quoted price).[24]

ETF liquidity is affected by both secondary and primary market activity

The literature on market microstructure identifies a number of factors that can affect liquidity, such as the supply and demand for the security, information asymmetry (due to the presence of informed traders), and market risks.[25] For ETFs, however, it is important to note that there are two distinct layers of liquidity: one in the secondary market where ETF units trade, and the other in the primary market involving the creation/redemption process. As a result, the liquidity of an ETF's shares is intimately related to the liquidity of its underlying securities.[26] Nonetheless, addressing this relationship is beyond the scope of this study, and hence our analysis focuses exclusively on the liquidity of ETFs in the secondary market.[27]

Arbitrage effectiveness is measured by the difference between ETF's price and its underlying value

As discussed earlier, the arbitrage mechanism facilitated by the creation/redemption process is designed to encourage APs and/or market makers to engage in arbitrage if the profit is large enough to justify the cost of the transactions. Therefore, the effectiveness of the arbitrage mechanism can be gauged by the difference between the ETF's price and the value of its underlying securities. While reflecting the arbitrage opportunities observed by market participants in real time, this measure is approximated by the price deviation from NAV (**PD-NAV**) measured at the

[23] Price discovery is the accuracy and speed with which relevant information is incorporated into transaction prices.

[24] See Appendix 1 for calculation details.

[25] See, for example, Foucault, Pagano, and Roell (2013), *Market liquidity: Theory, evidence, and policy,* Oxford University Press; O'Hara (1995), *Market microstructure theory,* Blackwell Publishers Inc.; and Madhavan (2002), *Market microstructure: A practitioner's guide*. Financial Analysts Journal, among others.

[26] See, for example, State Street Global Advisors SPDR (2020), *ETF liquidity: Master the mechanics of ETF trading*; or Hooper and Sharp (2025), *The ABCs of ETF liquidity,* Vanguard.

[27] Undoubtedly this is a major limitation of our study. Nevertheless, that our sample ETFs cover a wide variety of asset classes and categories including domestic and international equity and fixed income among others may help alleviate some of these concerns.

close of a trading day.[28] Similar to the QS, we normalize the PD-NAV with the ETF's NAV to obtain the price deviation relative to the ETF's NAV. [29]

Factors to consider when assessing PD-NAV

Although arbitrage effectiveness is commonly measured by the ETF's PD-NAV, there are several limitations to consider. First, as an approximation, the PD-NAV does not capture the arbitrage opportunities that might exist intraday. Second, NAV calculations may be stale, especially for ETFs with underlying securities that trade in different time zones (e.g., Europe- or Asia-based holdings) or ETFs with relatively less liquid underlying securities (e.g., fixed income), because of the uncertainty related to the valuations of underlying portfolio holdings which tends to multiply with market volatility.[30] Finally, the PD-NAV does not consider the costs of the arbitrage trade, such as transaction costs (e.g., bid-ask spreads, commissions, taxes, the creation/redemption fees charged by the ETFs, etc.) and hedging costs. Therefore, the mere existence of the PD-NAV does not necessarily indicate a viable arbitrage opportunity.[31]

ii. Trading Activity

ETF trading activity has increased

Along with the growth in ETFs, their market trading activity (traded volume, traded value, and number of trades) has also risen over the sample period. ETF trading activity as a proportion of total trading activity by all Canadian listed securities increased over the sample period (see Table 1).[32] It is worth noting that trading activity went up substantially when financial markets around the globe dealt with the shocks from the onset of the COVID-19 pandemic in 2020 and inflationary pressures induced by post COVID-19 supply-chain challenges and the Russian invasion of Ukraine during 2022.

Table 1 – ETF Daily Average Trading Statistics (Sample)

Daily Average	2019	2020	2021	2022	2023
Number of ETFs	629	706	817	896	903
Market Value ($B)	157.9	190.3	264.2	281.6	316.6
Traded Volume (M)	52.4	77.3	70.2	96.9	74.1
% of Total Traded Volume	5.4	5.7	5.0	8.9	8.2
Traded Value ($B)	1.0	1.6	1.6	2.0	1.9
% of Total Traded Value	8.6	10.2	9.3	11.0	11.4
Number of Trades (K)	65.1	116.6	140.1	158.8	139.0

Decline in average trade size consistent with increased retail participation

The average trade size per ETF both in terms of number of shares and dollar value has decreased since 2020, suggesting increased retail investor participation in ETF trading, a development broadly consistent with global trends

[28] The PD-NAV is widely used as a proxy for arbitrage profits in academic literature. See, for example, Brown, Davies, and Ringgenberg (2020), *ETF arbitrage, Non-Fundamental Demand, and Return Predictability.* Review of Finance; Madhavan and Sobczyk (2015), *Price dynamics and liquidity of exchange-traded funds*, Journal of Investment Management; Pan and Zeng (2019), *ETF arbitrage under liquidity mismatch*, Jacobs Levy Equity Management Center for Quantitative Financial Research Paper; and Zurowska (2022), *ETF primary market structure and its* efficiency, University of Pennsylvania.

[29] See Appendix 1 for computation details.

[30] See the International Organization of Securities Commissions (**IOSCO**, 2021*), Exchange Traded Funds Thematic Note – Findings and Observations during COVID-19 induced market stress*; and Financial Stability Board (2020), Holistic Review of the March Market Turmoil.

[31] According to Shim and Todorov (2021*), ETFs, Illiquid assets and fire sales*, BIS Working Paper, Bank for International Settlements; Madhavan and Sobczyk (2015), Price Dynamics and Liquidity of Exchange-Traded Funds, *Journal of Investment Management*; and State Street Global Advisors SPDR (2020), *ETF Liquidity Master the Mechanics of ETF Trading*, sometimes the PD-NAV could reflect the staleness of the NAV or ETF price overreaction rather than arbitrage profit.

[32] The ETFs' share of total trading activity based on the daily traded volume and value of all Canadian listed securities from Canadian Investment Regulatory Organization (CIRO) data.

(see Table 2).[33] While fluctuating over the years, average turnover ratios and short sales as a percentage of trading volume remained fairly stable. Furthermore, the average number of trading days increased from 190 to around 200 over the study period, indicating that the average ETF traded on around 75% – 80% of the trading days in a year.

Table 2 – Daily Average Trading Statistics per ETF

Daily Average per ETF	2019	2020	2021	2022	2023
Trade Size (shares)	849	894	723	734	621
Trade Size ($K)	19.3	20.6	18.4	16.5	13.8
Turnover Ratio (%)	1.4	1.7	2.4	2.3	1.5
Short Sales per Volume (%)	4.6	4.0	4.4	5.3	4.0
Number of Trading Days	190	197	201	200	198

Liquidity trending marginally higher since 2019 amid global macro-economic shocks

Finally, we find that average liquidity measures appeared to trend slightly higher over the sample period. Table 3 shows that the QS widened significantly in 2020 and to a lesser extent in 2022. The PD-NAV also expanded in 2020 and 2022 but reverted to pre-pandemic levels in 2023. We discuss these dynamics in more detail below.

Table 3 – Daily Average QS and PD-NAV per ETF[34]

Daily Average per ETF		2019	2020	2021	2022	2023
Quoted Spread (bps)	*Median*	15	23	16	20	17
	95th Pct.	55	114	55	75	67
	5th Pct.	5	6	4	5	5
Price Deviation to NAV (bps)	*Median*	7	14	8	11	7
	95th Pct.	50	106	54	80	50
	5th Pct.	1	1	1	1	1

iii. Trading Liquidity

During the sample period, most Canadian ETFs were liquid with an average median QS of 18 basis points (**bps**).[35] Note that the average median spread is calculated as the average over the study period of the daily median spreads across our sample of ETFs.

Quoted spreads recovered to pre-pandemic levels within a few months

At the height of market volatility in March and April 2020 (as seen in at the peak of the VIX and total trading volume in Figure 11), spreads widened significantly and jumped to almost 10 times above their historical average.[36] Widening spreads at times of market stress or volatility reflects the increased liquidity costs of ETFs and their underlying securities, which may also cause frictions in the arbitrage mechanism.[37] Nonetheless, after the policy interventions

[33] See, for example, State Street Global Advisors (2024), *ETFs on the Rise: The Investment Choice Revolutionizing Portfolios,* https://www.ssga.com/us/en/intermediary/insights/etfs-on-the-rise-the-investment-choice-revolutionizing-portfolios; or BlackRock (2022), *Towards More Transparent and Resilient Securities Markets: A Framework to Support Retail Investor Participation*, https://www.blackrock.com/corporate/literature/whitepaper/spotlight-a-framework-to-support-retail-investor-participation-october-2022.pdf.

[34] The statistics in this table are computed by first calculating the median, the 5th and 95th percentiles of the QS and PD-NAV across all sample ETFs for each trading day and then averaged across each year in our sample period.

[35] The medians are reported (as opposed to the means) to represent the typical value of our sample ETFs, which is less sensitive to extreme values.

[36] At its peak, the median QS reached 1.2%. Nonetheless, this was within the range (1% – 2.5%) reported by the IOSCO (2021), *Exchange Traded Funds Thematic Note – Findings and Observations during COVID-19 induced market stress*; and Financial Stability Board (2020), *Holistic Review of the March Market Turmoil.*

[37] Respondents to the IOSCO survey on how ETFs fared during the COVID-19 volatility suggested that frictions in the arbitrage mechanism driven by higher transaction costs, uncertainty related to valuation of underlying assets, and costlier hedging costs may translate to wider ETF spreads in the secondary market. See the IOSCO (2021), *Exchange Traded Funds Thematic Note – Findings and Observations during COVID-19 induced market stress*, for more details.

by central banks around the world to address the COVID-19 impact on the economy, spreads gradually reverted toward their normal historical ranges by June 2020.[38]

Liquidity impacted by US holidays and global macro-economic shocks

Aside from the COVID-19 event, we noticed a systematic pattern of slightly elevated spreads on US market holidays. In tandem, the average trading volume was much lower than usual on trading days that coincide with US holidays. This trend is not unique to ETFs, as it was also observed for listed Canadian equities, indicating that there is a significant decline in trading activity and hence liquidity during US holidays. Lastly, rising spreads in 2022 were induced, in part, by elevated market volatility associated with the onset of inflationary pressures caused by, among other things, post-COVID-19 supply chain issues and the Russian invasion of Ukraine.

Figure 10 – Daily Median Quoted Spread

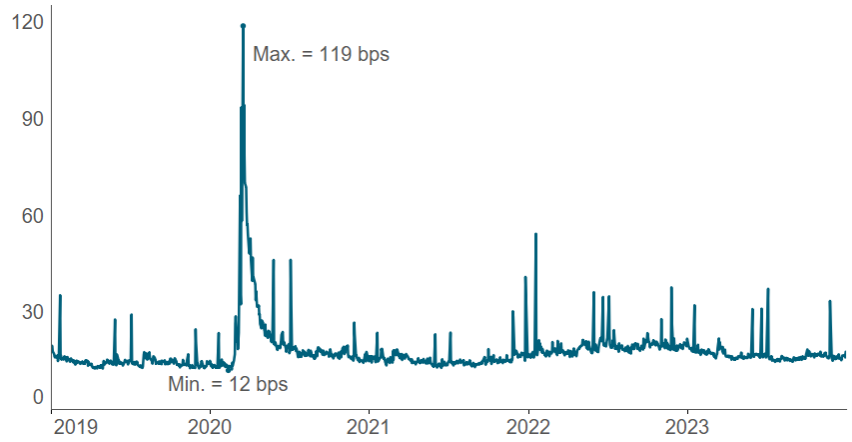
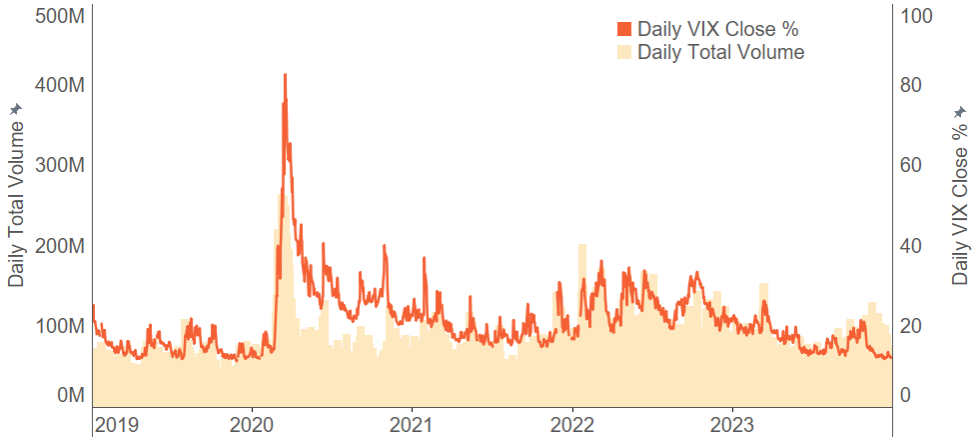


Figure 11 – Daily VIX and Daily Total ETF Trading Volume



[38] See Bank of Canada (2025), *Review of the Bank of Canada's Exceptional Policy Actions During the Pandemic: Executive summary*, https://www.bankofcanada.ca/2025/01/review-of-the-bank-of-canadas-exceptional-policy-actions-during-the-pandemic-executive-summary.

iv. *Trading Liquidity by Fund Attribute*

Liquidity for equity ETFs recovered faster than fixed income ETFs

To further dissect ETF liquidity, we compared the QS by asset class, primarily between equity and fixed income ETFs in Figure 12. The difference between them was most pronounced during the COVID-19 period, when the spreads of fixed income ETFs were two to three times wider than that of equity ETFs. Moreover, fixed income ETF spreads took longer than equity ETFs spreads to recover to their historical levels.[39] This could be attributable to more challenging liquidity conditions of the underlying fixed income assets.

Figure 12 - Daily Median QS by Asset Class

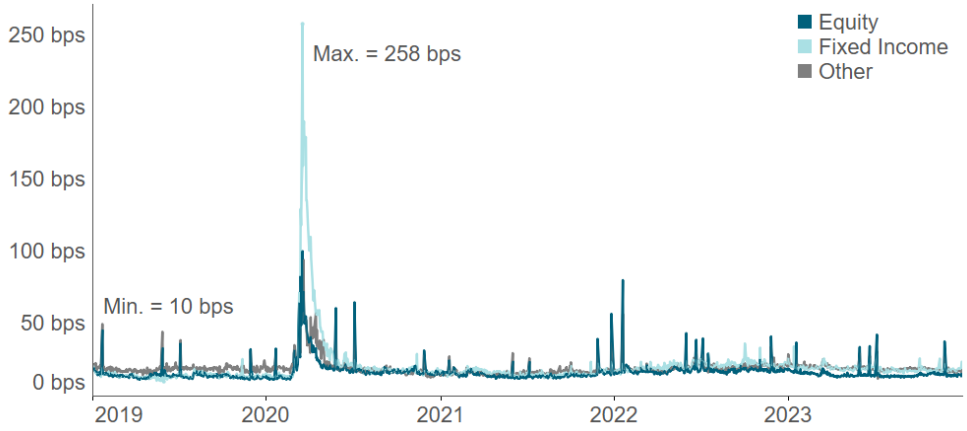
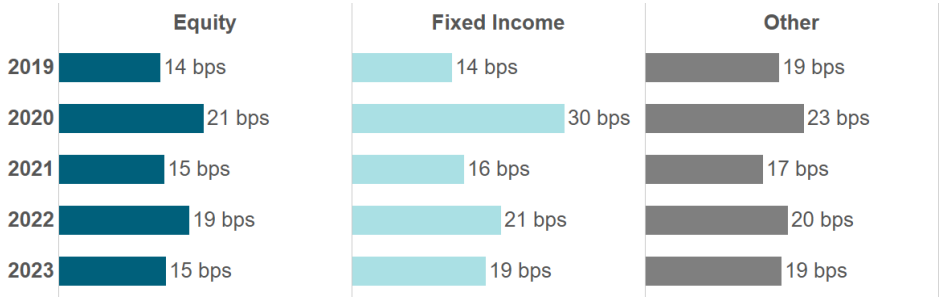


Figure 13 - Annual Average of The Daily Median QS by Asset Class



Number of APs may not reflect AP Involvement

Figure 15 indicates that median spreads tended to have a negative correlation, albeit imperfect, with the number of APs. For example, the median QS in 2023 was 26 bps for ETFs with only 2-5 APs compared to 13 bps for ETFs with 9 or more APs. However, the median QS of the ETFs with only 1 AP was 22 bps, which is lower than the median QS of ETFs with 2-5 APs. This inconsistency is not surprising since the number of APs may include those that are not actively participating in either primary or secondary market transactions.[40] Additionally, it is worth noting that ETFs' secondary market trading can be supported by "voluntary" market makers or liquidity providers, such as high frequency traders (HFTs), who may not be an AP, but support an ETF's liquidity.[41]

[39] The spreads of equity ETFs reverted to pre-pandemic levels by the end of April 2020, whereas those of fixed income ETFs only normalized by the end of June 2020.

[40] See Gorbatikov and Sikorskaya (2022), *Two APs are Better Than One: ETF Mispricing and Primary Market Participation*.

[41] See, for example, Anand and Venkataraman (2016), *Market conditions, fragility, and the economics of market making*, Journal of Financial Economics; Banerjee and Roy (2023), *High-Frequency Traders' Evolving Role as Market* Makers, Pacific-Basin Finance Journal; Hagstromer and Norden (2013), *The diversity of high-frequency* traders, Journal of Financial Markets; and Menkveld (2013), *High-frequency trading and the new market makers*, Journal of Financial Markets, for more details about the evolving role of HFT as market makers.

Figure 14 – Daily Median QS by Number of AP Group

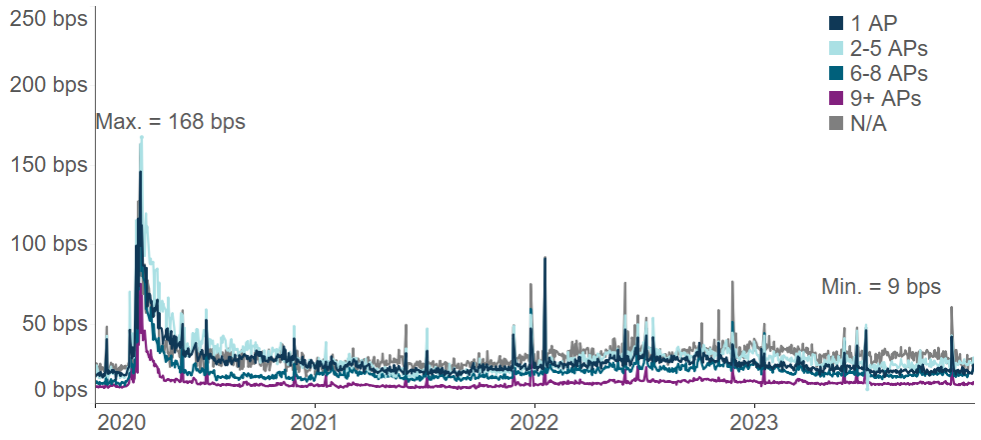


Figure 15 - Annual Average of The Daily Median QS by Number of AP Group

	1 AP	2-5 APs	6-8 APs	9+ APs	N/A
2020	34 bps	40 bps	23 bps	15 bps	33 bps
2021	22 bps	22 bps	18 bps	11 bps	26 bps
2022	27 bps	31 bps	23 bps	14 bps	34 bps
2023	22 bps	26 bps	20 bps	13 bps	31 bps

Note: Data on the number of APs from the IFS dataset is available starting in 2020.

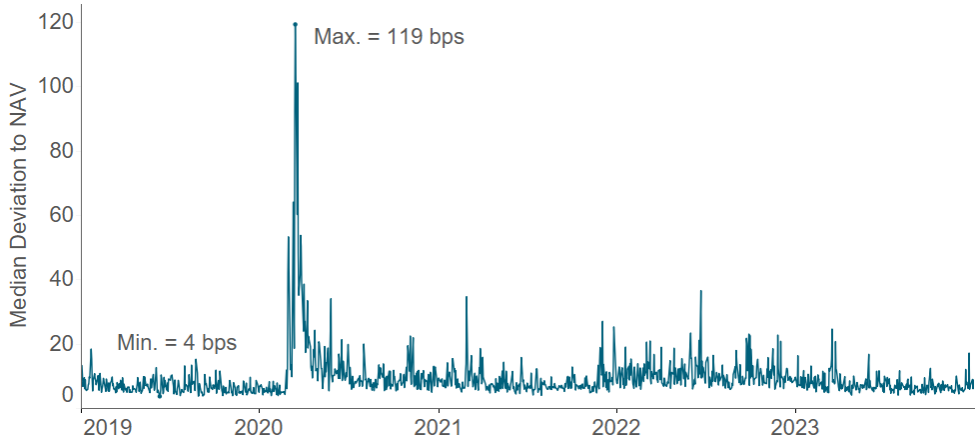
Although not discussed here, we also analyzed the QS by portfolio disclosure policy and investment strategy. In short, passively managed ETFs and ETFs that provide full portfolio transparency tended to have smaller QS than their corresponding cohorts (see Appendix 3 for details).

v. Arbitrage Effectiveness

Most ETFs traded close to NAV

Overall, we find the arbitrage mechanism functioned well for most Canadian ETFs. The average daily median PD-NAV during the entire study period was very low at about 9 bps. The dynamics of PD-NAV largely mirrored that of the QS trends discussed above. During the COVID-19 volatility, the median PD-NAV reached a peak of 119 bps. As noted earlier, differences between an ETF's market price and NAV may reflect frictions in the arbitrage mechanism that could be attributed to higher transaction costs, hedging costs, and heightened valuation uncertainty for the ETF and its underlying securities. Under these circumstances, larger price deviation from NAV may be necessary for arbitrage trades to be profitable from the AP's perspective.

Figure 16 – Price Deviation from NAV



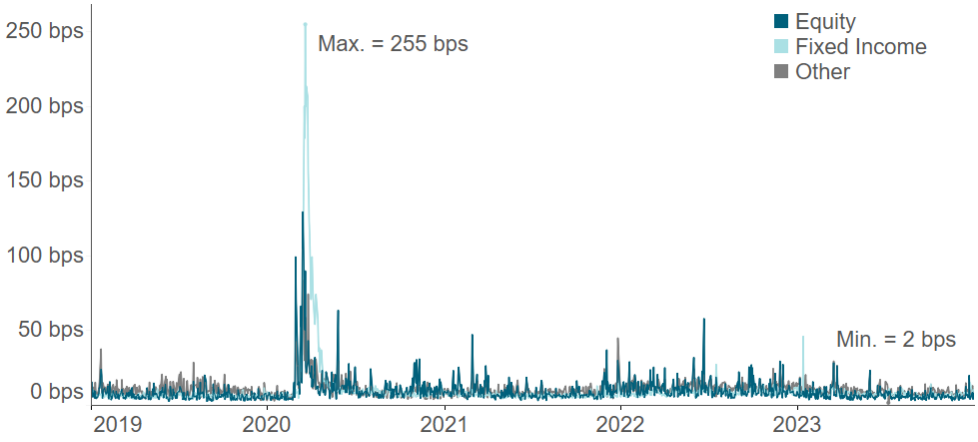
vi. Arbitrage Effectiveness by Fund Attribute

PD-NAV for fixed income ETFs took longer to recover

The wide difference in PD-NAV for equity and fixed income ETFs during the COVID-19 period highlights the impact of the illiquidity of underlying assets on the ETF arbitrage mechanism. At its peak, the median PD-NAV for fixed income ETFs was almost 2.6%, about 2 times larger than that of equity ETFs. Moreover, the extreme levels of PD-NAV for fixed income ETFs took noticeably longer to return to pre-pandemic levels than that for equity ETFs.

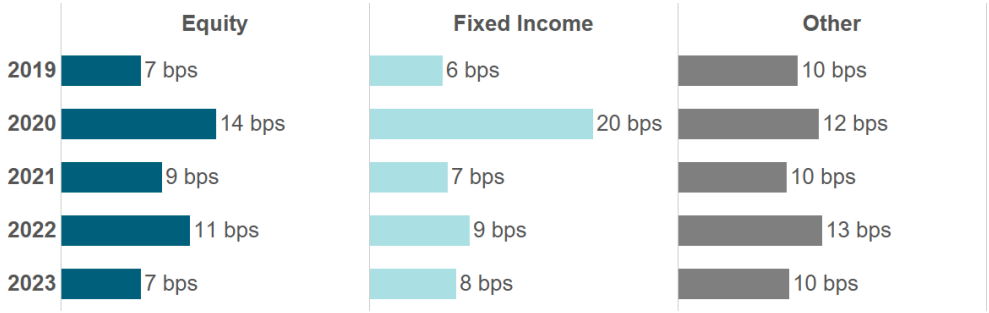
The IOSCO (2021) report suggested that the elevated and extended level of PD-NAV for fixed income ETFs during the COVID-19 period was partly attributed to the illiquidity in the underlying bonds.[42] However, fixed income ETFs continued to trade and the ETFs' market price reflected information more rapidly than the price of their underlying assets. As a result, the ETFs' market price continued to diverge from their NAV over an extended period until information was fully incorporated in the underlying asset valuations.

Figure 17 - Price Deviation from NAV by Asset Class



[42] See the IOSCO (2021), *Exchange Traded Funds Thematic Note – Findings and Observations during COVID-19 induced market stress*; and Financial Stability Board (2020), *Holistic Review of the March Market Turmoil*, for more details.

Figure 18 - Annual Average of the PD-NAV by Asset Class



Number of APs correlated weakly with arbitrage effectiveness

Our analysis also showed an imperfect correlation between the PD-NAV and the number of APs used by an ETF. In 2023, the median PD-NAV for ETFs with 2-5 APs (9bps) was higher than for ETFs with 9 or more APs (6bps). However, the median PD-NAV for ETFs with 1 AP (7bps) was lower than that of ETFs with 2-5 APs. Notably, the differences in the median PD-NAV among these ETF groups were quite negligible, suggesting that other factors may be influencing the arbitrage mechanism.

Figure 19 - Price Deviation from NAV by Number of AP Group

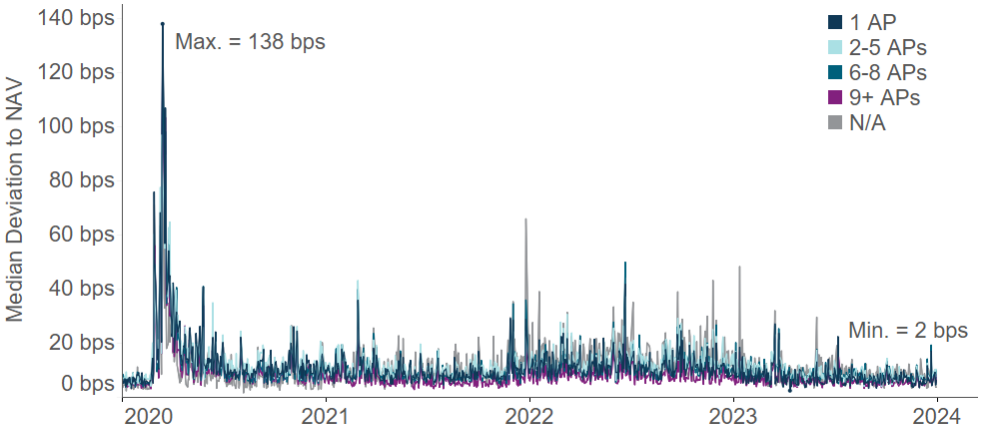
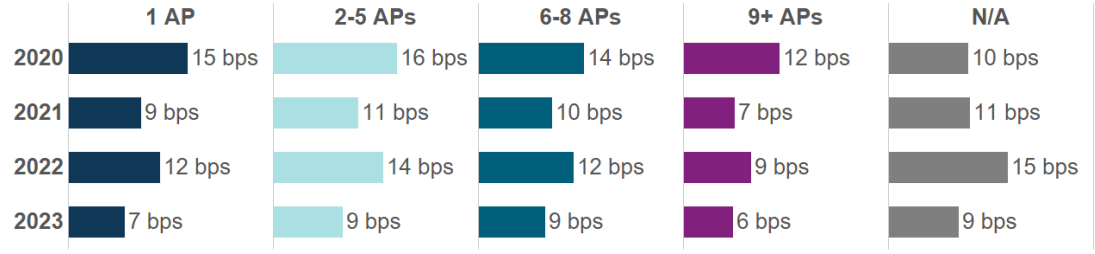


Figure 20 - Annual Average of the PD-NAV by Number of AP Group



Note: Data on the number of APs from the IFS data is available starting in 2020.

Finally, our analysis of PD-NAV by portfolio holdings disclosure policy and investment strategy, not discussed here, showed that ETFs with full portfolio transparency or passively managed ETFs tended to have smaller PD-NAV than their corresponding cohorts (see Appendix 3 for details).

vii. ETF Liquidity vs Underlying Securities' Liquidity

To further assess the liquidity of Canadian ETFs, we focused on ETFs that invest predominantly in Canadian equities (Equity ETFs)[43] and compared their average spreads with those of the constituents of the S&P/TSX Composite Index (Equities) in Table 4. For consistency, we only included Equity ETFs and S&P/TSX Composite Index constituents that remained in the index over the full sample period from 2019 to 2023.[44]

Table 4 - Average Daily Trading Activities of Equity ETFs and S&P/TSX Composite Constituents

	2019		2020		2021		2022		2023	
	Equity ETFs	Equities	Equity ETFs	Equities	Equity ETFs	Equities	Equity ETFs	Equities	Equity ETFs	Equities
Number of issuers	55	163	63	163	70	163	68	163	67	163
Market Cap. ($B)	0.7	14.0	0.6	14.0	0.8	17.7	0.9	17.9	1.0	18.1
Trade Volume (M)	0.2	1.3	0.3	1.8	0.2	1.5	0.2	1.5	0.2	1.3
Trade Value ($M)	5.7	41.8	6.6	52.5	5.5	55.2	7.4	60.8	5.1	51.7
Num. of Trades (K)	0.2	6.1	0.3	8.5	0.3	7.3	0.3	7.7	0.3	6.8

Equity ETF liquidity comparable to liquidity of S&P/TSX Composite Constituents

As shown in Table 4, the Equity ETFs, on average, exhibited notably less trading activity than the index constituents across all metrics considered. Nonetheless, the spread comparisons in Table 5 show that Equity ETFs and the composite index constituents had comparable QS. Overall, these results seem to suggest that despite ETFs having less trading activity than the securities they track, the ETFs were supported by a comparably competitive quoting environment (i.e., there were sufficient liquidity providers).

Table 5 - Average Daily Liquidity Metrics Activities of Equity ETFs and S&P/TSX Composite Constituents

		2019		2020		2021		2022		2023	
		Equity ETFs	Equities	Equity ETFs	Equities	Equity ETFs	Equities	Equity ETFs	Equities	Equity ETFs	Equities
Quoted Spread (bps)	*Median*	8	7	11	10	8	8	8	9	8	9
	5th Pct.	4	2	5	3	3	2	4	2	4	2
	95th Pct.	16	23	25	30	17	24	17	30	16	29

Finally, as a further case study, we benchmarked the spreads of one of the largest Equity ETFs, iShares S&P/TSX 60 ETF (**XIU**), against those of its underlying securities – the 60 largest and most liquid stocks in Canada.[45] During the sample period, XIU traded with spreads on par or slightly better than the average spreads of its underlying securities. This is broadly consistent with the results documented by several academic researchers (e.g., Pham et al. (2021), Browman and Shum (2018), Calamia et al. 2016, and Hedge and McDermott (2004), who found that passively managed ETFs had better liquidity than their underlying securities.[46] However, during the height of COVID-19 volatility, XIU started to trade with a QS around 10 bps higher than the average of its constituents, showing that

[43] Equity ETFs comprise of ETFs that are classified under the "Canadian Equity" or "Canadian Dividend & Income Equity" CIFSC categories. See CIFSC fund category definitions at https://www.cifsc.org/fund-category-definition/.

[44] Although a comparison between each of these ETF and its own underlying securities would be more appropriate, such as analysis is beyond the scope of our study.

[45] See Appendix 3 for details.

[46] See Pham, Marshall, Nguyen, and Visaltanachoti (2021), *The Liquidity of active ETFs*, Global Finance Journal; Broman and Shum (2018), *Relative Liquidity, Fund Flows and Short-Term Demand: Evidence from Exchange-Traded Funds*, The Financial Review; Calamia, Deville, and Riva (2016), *The Provision of Liquidity in ETFs: Theory and Evidence from European Markets*; and Hede and Marshall (2004), *The Market Liquidity of DIAMONDS, Q's, and their Underlying Stocks*, Journal of Banking and Finance.

even for the most liquid underlying assets, frictions in the arbitrage mechanism can arise under extreme market stress.

In summary, this section dissects the measures of liquidity and arbitrage for ETFs across various fund attributes and characteristics. While many of these results were intriguing, we would caution against the temptation to draw patterns from them because they could reflect correlations driven by some common factors rather than causal relationships between the measures and fund attributes.

Impact Analysis of ETF Liquidity and Arbitrage

i. Approach

Correlation is not causation

In the previous section, we examined the relationships between liquidity/arbitrage and each of the five fund attributes (fund size, asset class, the number of APs, disclosure policy, investment strategy) separately. However, this singular examination fails to account for the cross correlations among these attributes. For example, most large ETFs are within the equity asset class, have more than eight APs, follow a passive investment strategy, and publish portfolio holdings to the public daily.

Beyond dissecting key trends in Canadian ETF liquidity and the effectiveness of the arbitrage mechanism, we are also interested in understanding the factors that influence them. We attempt to answer this question by using a regression analysis to estimate the relationships between liquidity/arbitrage measures and select fund attributes. Regressions allow us to isolate the individual effects of various factors on liquidity/arbitrage by controlling the different characteristics across the funds. Therefore, we can identify which factors likely have a true effect on liquidity/arbitrage as opposed to a correlation by chance.

Data selection affects reliability of regression estimates

Regression analysis, like any other data modeling techniques, is sensitive to the quality and consistency of data inputs. Therefore, the selection of input data – in our case, the selection of ETFs – is important to obtain reliable estimates. In essence, the characteristics of each selected ETF, including how long the ETF stayed in the sample and how often it traded during its stay, will be used as the weights in the estimation. Since many ETFs in our sample did not trade on a daily basis, their inclusion would adversely affect the reliability of our estimates. Therefore, we further refine our sample ETFs to include only those that traded at least 95% of the trading days in a year. We label these ETFs as “continuously traded ETFs” for the regression analysis.

ii. Regression Subsample

Some ETFs were thinly traded

In each year of our study period, we divided the sample ETFs into continuously traded and non-continuously traded subsamples based on the count of trading days. Table 6 below provides the summary statistics for these subsamples.

Table 6 – Continuously Traded ETFs

		2019	2020	2021	2022	2023
Fund Count	*Cont. Traded ETFs*	326	362	469	536	547
	Non-Cont. Traded ETFs	316	358	366	382	377
Avg. Daily Market Value ($B)	*Cont. Traded ETFs*	141	170	233	255	292
	Non-Cont. Traded ETFs	10	10	17	10	10
Avg. Daily Traded Value ($B)	*Cont. Traded ETFs*	0.94	1.32	1.32	2.01	1.79
	Non-Cont. Traded ETFs	0.07	0.26	0.28	0.03	0.06
Avg. Daily Volume (M)	*Cont. Traded ETFs*	49.4	58.1	51.2	95.0	72.1
	Non-Cont. Traded ETFs	3.0	19.2	18.9	1.9	2.0
Median Quoted Spread (bps)	*Cont. Traded ETFs*	12.2	15.8	13.1	15.6	14.5
	Non-Cont. Traded ETFs	19.0	26.2	20.5	31.9	26.7
Median Prem. Disc. NAV (bps)	*Cont. Traded ETFs*	0.8	0.6	2.5	0.2	0.8
	Non-Cont. Traded ETFs	1.7	1.5	2.5	1.8	1.6

Notably, we observe that the ratio between the number of continuously traded and non-continuously traded ETFs started at about 1:1 in 2019 and rose to 1.5:1 in 2023. In other words, the proportion of ETFs that trade daily increased over the study period.[47]

Continuously traded ETFs exhibited better liquidity and arbitrage effectiveness

Examining the trading statistics shows that continuously traded ETFs tended to be the largest, most active and liquid ETFs with lower spreads and price deviations from NAV. Finally, dissecting the continuously traded ETFs also reveals that its composition largely mirrored the broader sample.

iii. Empirical Model

Relying on recent academic literature on ETF arbitrage, we formulated our empirical models to estimate the impact on QS and PD-NAV as follows[48]:

Equation 1 - Liquidity Spread Model

$$Spread_{ijt} = \alpha_i + N\_AP_{ij} + Disclosure_{ij} + Deviation_{ijt} + MarketControls_t + FundControls_{ijt} \quad (1)$$

Equation 2 - Arbitrage Effectiveness Model

$$Deviation_{ijt} = \alpha_i + N\_AP_{ij} + Disclosure_{ij} + Spread_{ijt} + MarketControls_t + FundControls_{ijt} \quad (2)$$

where

$Spread_{ijt}$ is the QS for an ETF j in CIFSC category i on trading day t,

and

$Deviation_{ijt}$ is the PD-NAV for an ETF j in CIFSC category i on trading day t.

N_AP_{ij}, the number of APs, is our proxy for AP participation in the primary market or secondary market. As noted earlier, this may reflect the potential, rather than actual, level of AP activity. $Disclosure_{ij}$ is a dummy variable to indicate whether an ETF provides full daily portfolio transparency. $MarketControls$ include daily market variables to capture market conditions, while $FundControls$ comprise of fund attributes and characteristics to account for the heterogeneity of ETFs in our sample.[49]

Equations (1) and (2) attempt to explain the measures of liquidity and arbitrage in terms of the number of APs and the choice of public portfolio holdings disclosure while controlling for market conditions, and other fund characteristics. We estimate these equations for each year from 2020 – 2023 using the fixed-effects (**FE**) estimation method for panel data.[50]

[47] Note that the proportion of non-continuously traded ETFs may be attributable, in part, to the strong growth of the ETF market during the sample period as highlighted in Section II. Newly launched ETFs usually take time to gain traction from investors and establish regular trading status.

[48] See, for example, Gorbatikov and Sirkoskaya (2022), *Two APs are Better Than One: ETF Mispricing and Primary Market Participation*; Pan and Zeng (2019), *ETF Arbitrage under Liquidity Mismatch*; and Zurowska (2022), *ETF Primary Market Structure and Its Efficiency*.

[49] See Appendix 1 for details.

[50] See, for instance, Greene (2018), *Econometric Analysis*, Pearson; or Wooldridge (2010), *Econometric Analysis for the Cross Section and Panel Data,* The MIT Press, for textbook treatment of panel model methodology.

iv. Estimation Results for Liquidity Spread

Number of APs had no impact on liquidity

First, the coefficient for the number of APs, our proxy for primary or secondary market activity by APs, was not statistically significant (except for 2021 when it was only statistically significant at the 10% level). This might reflect the fact that the number of APs is a poor proxy for AP participation because an AP acting strictly on economic incentives will not participate in creating or redeeming or market-making activity unless it is profitable.

Portfolio holdings disclosure policy had no impact on liquidity

Second, public portfolio disclosure appears to have no consistent relationship with spreads. The coefficient was not statistically significant, which seems to suggest that an ETF's policy to disclose its daily holdings to the public may not affect liquidity providers' quotations on the secondary market. As indicated earlier, ETFs may disclose holdings to their APs or designated brokers even if they do not publish portfolio holdings to the public concurrently.

Passively managed ETFs had better liquidity than active ETFs

Third, there is some evidence that passive investment strategy had a negative relationship with spreads, suggesting that, other things being equal, passively managed ETFs have better liquidity than active ETFs.

Additional ETF characteristics that had a statistically significant impact on spreads, at least for some years during the study period, include intraday return volatility, short sales, dollar turnover, average daily volume per trade, and MER. Among the market variables, the COVID-19 pandemic had a highly statistically significant impact on spreads in 2020.

See Table A3 in Appendix 2 for detailed estimation results for trading liquidity for each year in our sample period (2020 to 2023).

v. Estimation Results for Price Deviation from NAV

Some evidence that number of APs affects the arbitrage mechanism

We observe that the coefficient on the number of APs was negative and statistically significant at the 5% significance level in 2021 and 2023. This points to some evidence that the number of APs was negatively associated with PD-NAV, a result, to some extent, consistent with Gorbatikov and Sikorskaya (2022) who reported that, the number of APs had weaker negative relationship with the PD-NAV compared with the number of active APs.[51] However, there was no evidence that the public portfolio disclosure or the investment strategy had any impact on the PD-NAV.

Secondary market liquidity and certain fund attributes impacted the arbitrage mechanism

Certain fund characteristics were found to influence the arbitrage mechanism. Firstly, there was some evidence that the QS is positively associated with the PD-NAV, highlighting the importance of ETF liquidity in the secondary market to the arbitrage mechanism. Secondly, there was little evidence that the MER has significant impact on the PD-NAV, except for in 2023, where it was statistically significant at the 5% significance level. Third, there was weak evidence that ETF size is negatively associated with its PD-NAV. Lastly, the VIX index, proxied for market volatility, was the only market variable that consistently had a significant impact on the PD-NAV. See Table A4 in Appendix 2 for detailed estimation results for PD-NAV for each year in our sample period (2020 to 2023).

[51] See Table 3, p.23, in Gorbatikov and Sikorskaya (2022), *Two APs are Better Than One: ETF Mispricing and Primary Market Participation* for more details. Note that this paper examines the US market which has regulatory data on ETF primary market activity allowing the identification of active APs.

Conclusion

The Canadian ETF trading ecosystem appears to operate with adequate liquidity to support the market's substantial growth in assets, number of funds and product proliferation during the period analyzed.

Overall, quoted spreads and price deviations from NAV remained tight and stable, reflecting low transaction costs and an efficient arbitrage mechanism. More importantly, the market was able to withstand the extreme volatility induced by the global shock associated with the COVID-19 pandemic or the Russian invasion of Ukraine in 2022.

However, not all ETFs behave the same. Nearly half of Canadian ETFs were small, relatively less liquid and thinly-traded, although their proportion declined over time. Additionally, quoted spreads appeared to trend slightly higher since 2022 amid increased market volatility and global macroeconomic events. This trend may require further market monitoring to ensure that it is not a result of deteriorating liquidity conditions.

Our impact analysis indicated that the number of APs, a proxy for AP primary market activity or secondary market activity, may influence arbitrage effectiveness (i.e. ETFs with more APs had narrower PD-NAV). Additionally, we found some evidence to suggest that passively managed ETFs have better liquidity than actively managed ETFs. However, there was no evidence to suggest that public disclosure of full portfolio holdings impacts either liquidity or arbitrage effectiveness. Among the selected fund attributes and market variables, only a few provided strong statistical evidence that they influenced either liquidity or arbitrage effectiveness.

Last, it is worth emphasizing the limitations of our study. We acknowledge that the number of APs is an imperfect proxy for the participation of APs in either primary or secondary markets. To better inform our analysis, we would require data that reliably measures AP participation in the creation/redemption process. Market volatility, which occurred intermittently during our sample period, can make our measures for trading liquidity and arbitrage mechanism less precise, and thereby limit the inference of our empirical models. Further, the inference may depend on the specific period of our study. Finally, as with most empirical studies, we cannot rule out the possibility that there might be other confounding factors that we did not consider.

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Appendices

i. Appendix 1. Measures and Variable Definitions

Liquidity Measures

We use quoted spread (QS) as our measures of liquidity. The QS measures the cost of completing a round trip (buy and sell). The following table summarizes its definition.

Table A1 - Liquidity Measures[52]

Liquidity Measure	Definition
Dollar Quoted Spread (DQS)	$Ask_t - Bid_t$
Percent Quoted Spread (PQS)	$\frac{(Ask_t - Bid_t)}{2M_t}$

Where the quotes, Ask_t and Bid_t, are the National Best Offer (NBO) and National Best Bid (NBB), respectively; M_t is the midpoint of the quotes.

In this study, we use the percent (proportional) quoted spread and simply refer to it as QS.

We construct the daily QS by aggregating their intraday values, specifically, by time-weighted averaging the QS of all valid quotes in a trading day using the interval between the quotes as weight. Valid quotes are quotes within regular trading hours (from 9:30 AM – 4:00 PM) with non-negative spread ($Ask_t \geq Bid_t$) and positive bid size and ask size.

To evaluate the effectiveness of the ETF arbitrage mechanism, we employ a commonly used measure defined as the absolute value of price deviation from net asset value (PD-NAV) scaled by NAV. Specifically,

$$PD\_NAV_t = \frac{|P_t - NAV_t|}{NAV_t}$$

where P_t is the share price of a fund.

The PD-NAV is calculated daily using the ETF's closing price and NAV. Due to concern over thin trading of some Canadian ETFs and the resulting potential for stale prices, TMX Group Limited (TMX) implemented a new methodology of calculating the closing price for ETFs listed on Toronto Stock Exchange (TSX) in 2021 after public consultation.[53] Following their approach, we calculate the closing price for all ETFs in our sample as the time-weighted average of the mid-quote during the last 10 minutes of trading.

[52] See Bessembinder and Venkataraman (2010), *Bid – Ask Spreads: Measuring Trade Execution Costs in Financial Markets*, Encyclopedia of Quantitative Finance; or Holden and Jacobsen (2014), *Liquidity Measurement Problems in Fast, Competitive Markets: Expensive and Cheap Solutions*, The Journal of Finance for more details.

[53] See TMX (2022) "TSX Calculated Closing Price Bid Ask for ETFs Research Paper" and TSX (2021) "Notice of Proposed Amendments and Requests for Comments" for details.

Variable Definitions

Table A2 - Variable Definitions

Variable	Definition	Source
Portfolio Disclosure	A dummy variable with value equal to 1 if an ETF discloses daily its full portfolio holdings to the public and 0 otherwise.	IFS
Strategy	A dummy variable with value equal to 1 of an ETF follows a passive (index-based or rules-based) strategy and 0 otherwise.	IFS
MER, %	Management Expense Ratio of an ETF	LSEG Lipper
Ln(Size)	Natural logarithm of an ETF's TNA	LSEG Lipper & OSC calculation
Ln(Age)	Natural logarithm of an ETF's age measured in years from the inception date.	LSEG Lipper & OSC calculation
Ln (Avg. Daily Volume)	Natural logarithm of average daily volume per trade	MAP & OSC calculation
Ln (Avg. Daily Value)	Natural logarithm of average daily value per trade	MAP & OSC calculation
Ln (Turnover, $)	Natural logarithm of the dollar turnover per day per ETF	MAP & OSC calculation
# Trades	The number of trades per day per ETF	MAP & OSC calculation
Volume HHI	The Herfindahl-Hirschman index based on venue share of total trading volume calculated as follows, $\sum\left(\frac{V_j}{\sum V_j}\right)^2$ Where V_j is the total trading volume on venue or marketplace j.	MAP & OSC calculation
Intraday Volatility, %	Intraday return volatility calculated as follows, $\ln\left(\frac{Hi}{Lo}\right)$ where Hi, Lo are the intraday High and Low of an ETF price.	MAP & OSC calculation
Short Sales/Volume, %	Ratio of short sales volume to trading volume	MAP & OSC calculation
Ln(VIX)	Natural logarithm of the VIX index value	CBOE & OSC calculation
CORRA, %	The Canadian Overnight Repo Rate	Bank of Canada
Yield Spread (2/10), %	The yield spread between the 10-year and 2-year Government of Canada Bond	Bank of Canada & OSC calculation
TSX Return, %	The return on the S&P/TSX Index	LSEG & OSC calculation
COVID	The dummy variable for the COVID-19 outbreak in 2020, equal to 1 from February 20 – April 6, 2020, and 0 otherwise.	OSC Calculation

ii. Appendix 2. Estimation Results

Table A3 - Estimation Results for the QS

This table reports the annual results of the panel regression for Equation (1) where the dependent variable is the QS measured in bps; the independent variables include the number of APs, Portfolio Disclosure (1 if Yes, 0 otherwise), Investment Strategy (1 if Passive, 0 otherwise) and fund and market controls. Fund controls include MER, natural logarithm of fund size, natural logarithm of fund age, natural logarithm of average daily volume, natural logarithm of average daily value, natural logarithm of dollar turnover, number of trades, the HHI for volume share by venue, intraday return volatility, and short sales to trading volume ratio. Market controls are the market volatility index (VIX), the Canadian Overnight Repo Rate (CORRA), the yield spread between the 10-year and 2-year Government of Canada Bond, the return on the S&P/TSX Composite Index, and, in 2020, the dummy for the COVID-19.

*All regressions include CIFSC Category as fixed-effects. The notations ***, **, *, and . denote statistical significance levels of 0.1%, 1%, 5%, and 10%, respectively.*

	2020	2021	2022	2023
# of AP	-.2004	-0.3189.	-.3179	-.4187
Portfolio Disclosure: Yes	.3636	-.0339	-.1435	-.3808
Strategy: Passive	-4.4620	-2.009*	-2.870.	-4.119.
Deviations from NAV, bps	0.1177***	.0331	.0046	.0119
MER, %	9.659*	3.054***	1.872.	.3704
Ln(Size)	1.1820	-0.8670.	-.7975	-1.018.
Ln(Age)	-.8702	.5095	.4048	1.0420
Ln(Avg. Daily Volume)	3.7450	4.086**	4.667**	2.950***
Ln(Avg. Daily Value)	-.1659	-.0787	-0.7513*	0.1421**
Ln(Turnover, $)	-4.679.	-4.022**	-5.072**	-3.568***
# of Trades	-3.8810	1.0410	1.1660	0.0012***
Volume HHI	-.0379	.0079	.0123	.0051
Intraday Volatility, %	8.876***	6.388**	4.915***	3.830***
Short Sales/ Volume, %	0.0984.	0.0734***	.0326	0.0656*
Ln(VIX)	13.84**	1.8170	.2124	-1.778*
CORRA, %	3.4530	-3.1860	0.6057**	-3.475***
Yield Spread (2/10), %	6.4960	-.2332	.5954	-.4418
TSX Return, %	-0.5152.	0.2560**	0.1678*	-.0682
COVID	5.701***			
Fixed-Effects	CIFSC	CIFSC	CIFSC	CIFSC
Observations	88011	109310	123220	139257
# of Funds	362	452	506	573
Adj R2	.4327	.4213	.3646	.4568

Table A4 - Estimation Results for the PD-NAV

This table reports the annual results of the panel regression for Equation (2) where the dependent variable is the PD-NAV measured in bps; the independent variables include the number of APs, Portfolio Disclosure (1 if Yes, 0 otherwise), Strategy (1 if Passive, 0 otherwise) and fund and market controls. Fund controls include MER, natural logarithm of fund size, natural logarithm of fund age, natural logarithm of average daily volume, natural logarithm of average daily value, natural logarithm of dollar turnover, number of trades, the HHI for volume share by venue, intraday return volatility, and short sales to trading volume ratio. Market controls are the market volatility index (VIX), the Canadian Overnight Repo Rate (CORRA), the yield spread between the 10-year and 2-year Government of Canada Bond, the return on the S&P/TSX Composite Index, and, in 2020, the dummy for the COVID-19.

*All regressions include CIFSC Category as fixed-effects. The notations ***, **, *, and . denote statistical significance levels of 0.1%, 1%, 5%, and 10%, respectively.*

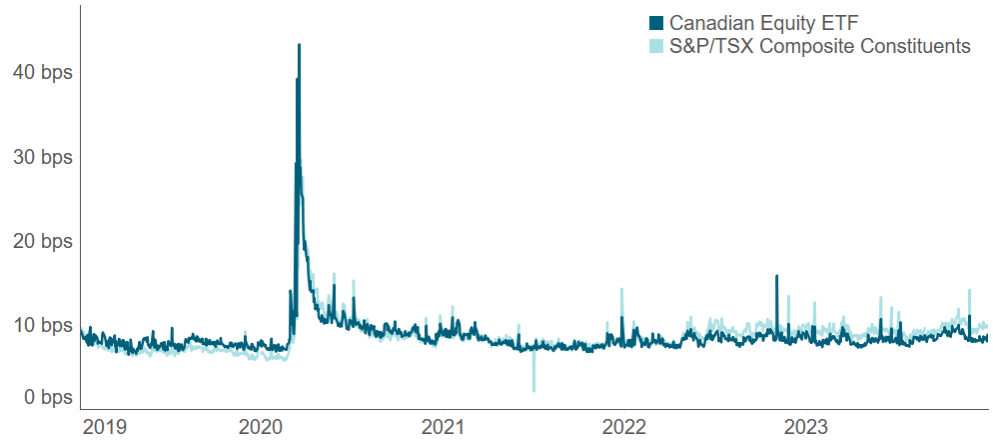
	2020	2021	2022	2023
# of AP	-.0137	-0.4392*	-1.4950	-2.909*
Portfolio Disclosure: Yes	3.6280	.4122	3.4080	4.1390
Strategy: Passive	-1.3620	.8857	5.2130	13.33.
Quoted Spread, %	0.3722***	0.1433.	.0604	0.3316.
MER, %	3.5320	1.3790	5.0420	23.19*
Ln(Size)	-1.7610	-0.9808.	-6.080.	-6.631.
Ln(Age)	1.0490	.1783	5.962.	6.202*
Ln(Avg. Daily Volume)	.9453	-.2057	-7.6460	-5.088.
Ln(Avg. Daily Value)	1.015*	.0839	1.4950	0.4048***
Ln(Turnover, $)	-2.6710	.0223	4.7960	3.374.
# of Trades	4.4560	.1903	-3.0240	.0019
Volume HHI	.0317	.0120	.2959	0.2135*
Intraday Volatility, %	4.751.	1.655*	2.6380	1.5060
Short Sales/ Volume, %	-.0425	0.1054**	.0140	-.0285
Ln(VIX)	21.91***	6.525***	10.51*	4.770*
CORRA, %	14.92**	-13.81***	1.102.	.1996
Yield Spread (2/10), %	27.64**	2.857**	-1.4390	-.4900
TSX Return, %	0.9164**	-.3001	1.172*	0.4668.
COVID	3.9990			
Fixed-Effects:	CIFSC	CIFSC	CIFSC	CIFSC
Observations	88011	109310	123220	139257
# of Funds	362	452	506	573
Adj R2	0.2003	0.0852	0.07889	.0800

iii. Appendix 3. Additional Analysis

Canadian Equity ETFs and the constituents of the S&P/TSX Composite Index

The following chart compares the quoted spread between Canadian equity ETFs that tracked the S&P/TSX Composite Index and the spreads of S&P/TSX Composite index's constituent securities.

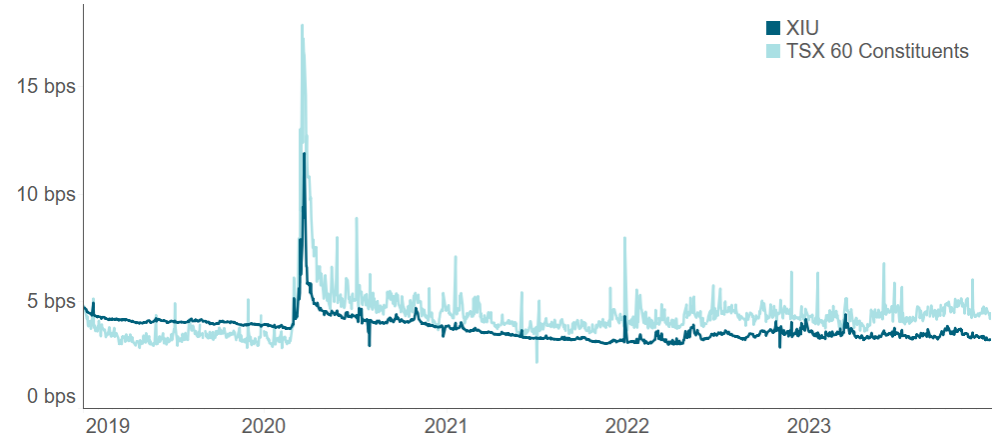
Figure 21 – Median Quote Spread of TSX Composite Constituents and Canadian Equity ETFs



The iShares S&P/TSX 60 Index ETF, XIU, and the constituents of the S&P/TSX 60 Index

The following charts show the trading liquidity comparison between the iShares S&P/TSX 60 Index ETF (XIU) and the constituents of TSX 60.

Figure 22 - Median Quoted Spread of TSX 60 Constituents and XIU



Additional Trading Liquidity Time Series

Figure 23 – The Daily Median Quoted Spread by Investment Strategy

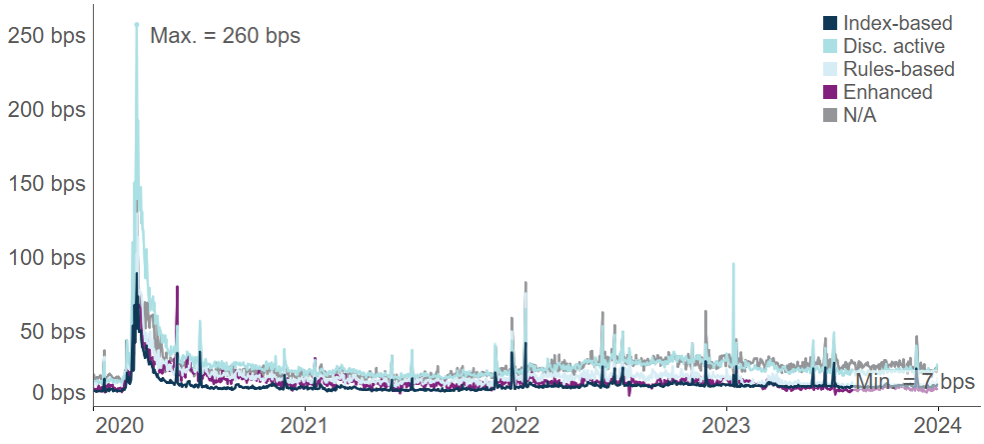


Figure 24 - Annual Average of the Daily Median Quoted Spread by Investment Strategy

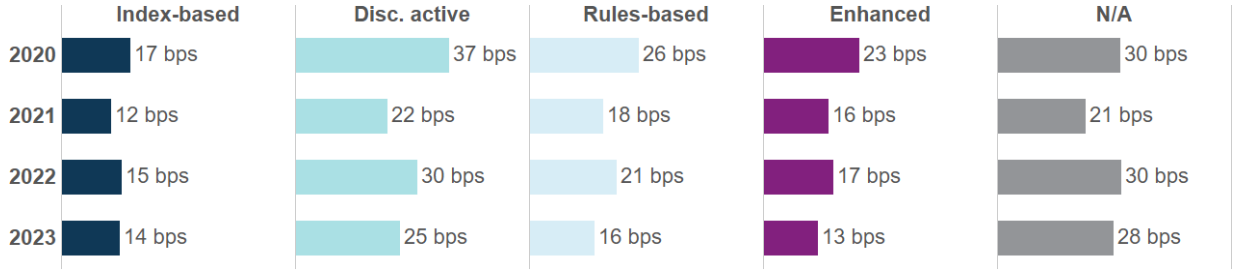


Figure 25 - Daily Median Quoted Spread by Holdings Disclosure Policy

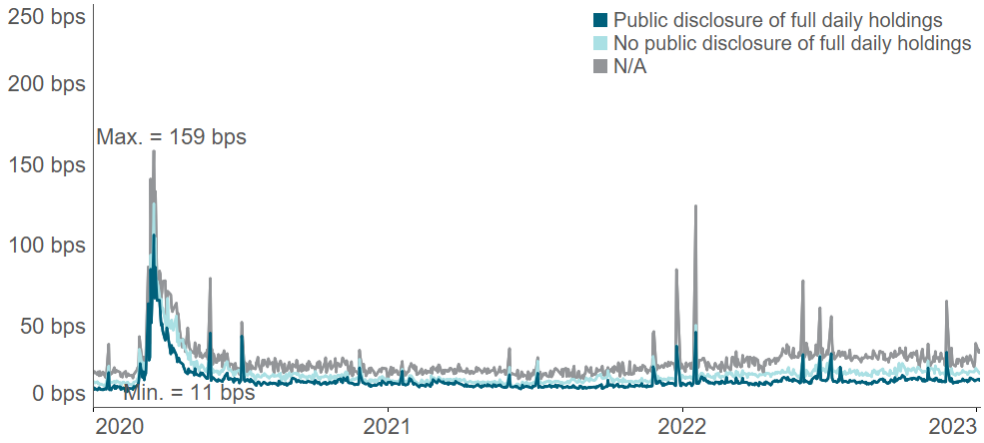


Figure 26 - Annual Average of The Daily Median Quoted Spread by Holdings Disclosure Policy

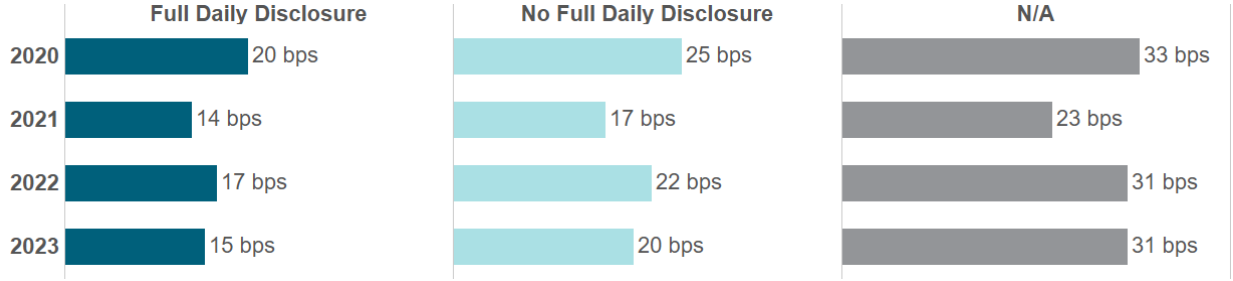


Figure 27 – The Daily Median PD-NAV by Investment Strategy

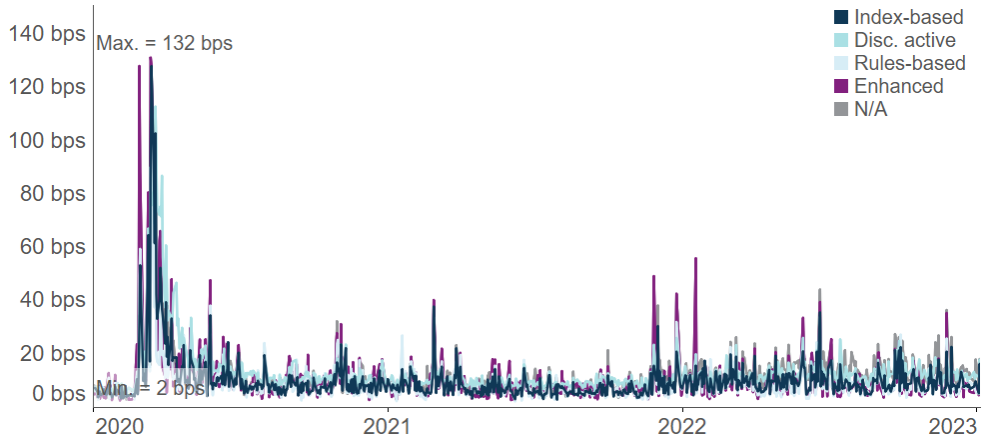


Figure 28 - Annual Average of the Daily Median PD-NAV by Investment Strategy

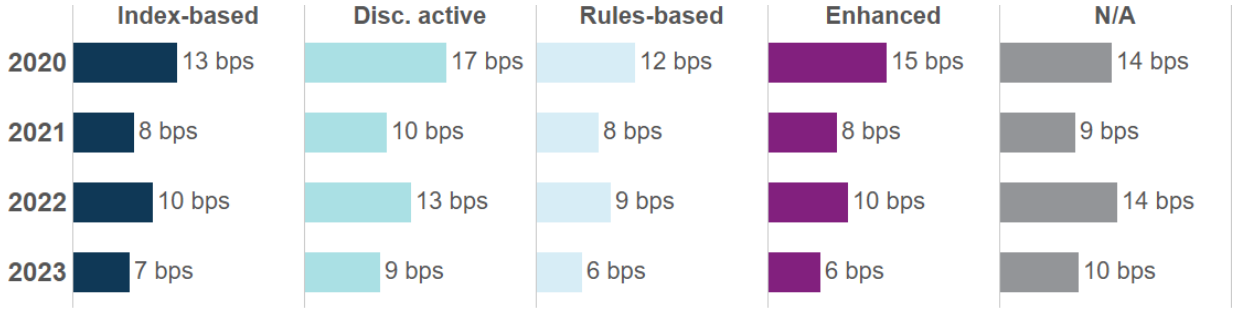


Figure 29 - The Daily Median PD-NAV by Holding Disclosure Policy

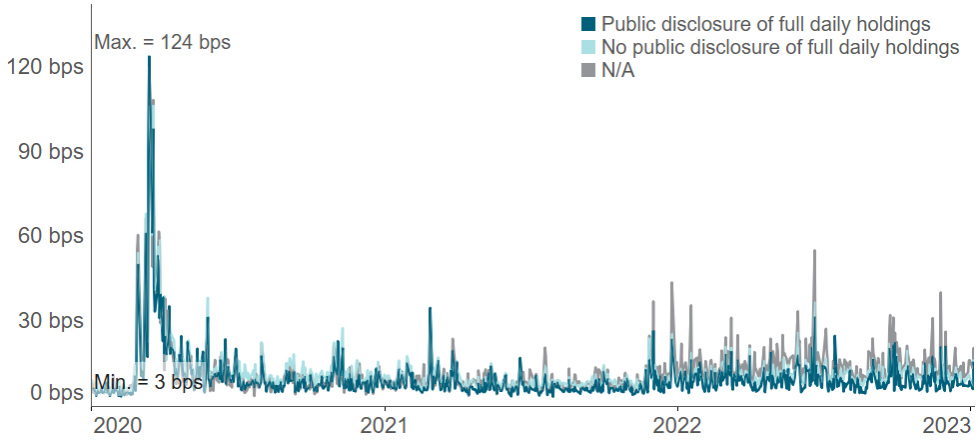
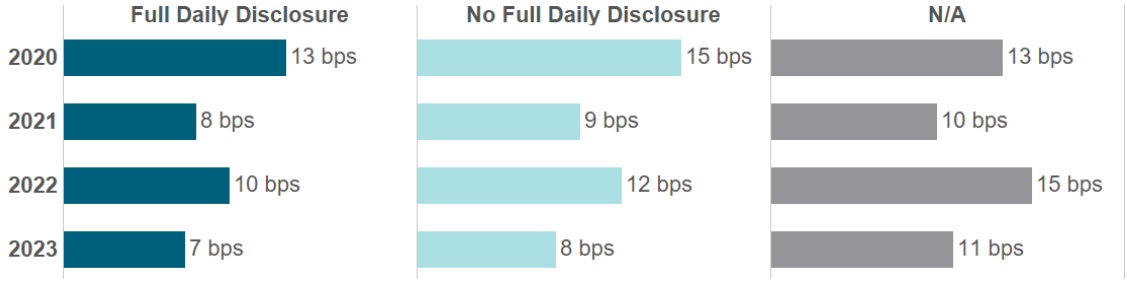


Figure 30 - Annual Average of the Daily Median PD-NAV by Holding Disclosure Policy



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Acknowledgements

Staff are grateful to the various industry stakeholders who provided helpful comments and insights into the Canadian ETF market. Special thanks to Marcos Jean Cortes, former OSC staff, for his contributions during the initial phase of this research and Ella Corkum for her editorial assistance.