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Research Report

The Functioning of Market Products During the 2020 Market Turmoil — Are ETFs Volatility Absorbers or Amplifiers?

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SUMMARY

Exchange traded funds (ETFs) were originally designed to provide additional liquidity to securities markets, acting as “buffers” to market shocks. This includes the liquidity in the primary and secondary markets of ETFs. The liquidity of ETFs contributes to price discovery of the ETF units, which shall reflect the price of the underlying asset, and would therefore in turn contribute to the price discovery of the underlying asset. Price differences between the ETF and underlying securities can be narrowed through arbitrage activities. However, the functioning of ETFs were challenged during the market turmoil in the first quarter of 2020 (2020Q1).

During the market turmoil in 2020Q1, significant increases in the turnover of ETFs in the US and Hong Kong markets tracking indices of equities and bonds were observed, which was accompanied by active daily creation/redemption activities of ETF units in the primary market. In addition, US fixed-income ETFs experienced the widening of a price discount over the net asset value. These observations aroused market criticisms about the functioning of ETFs during market turmoils: (1) redemption activities of ETFs during market downturn amplify market volatility of the underlying equity and bond markets; and (2) flaws with the price discovery function of ETFs during market turmoils.

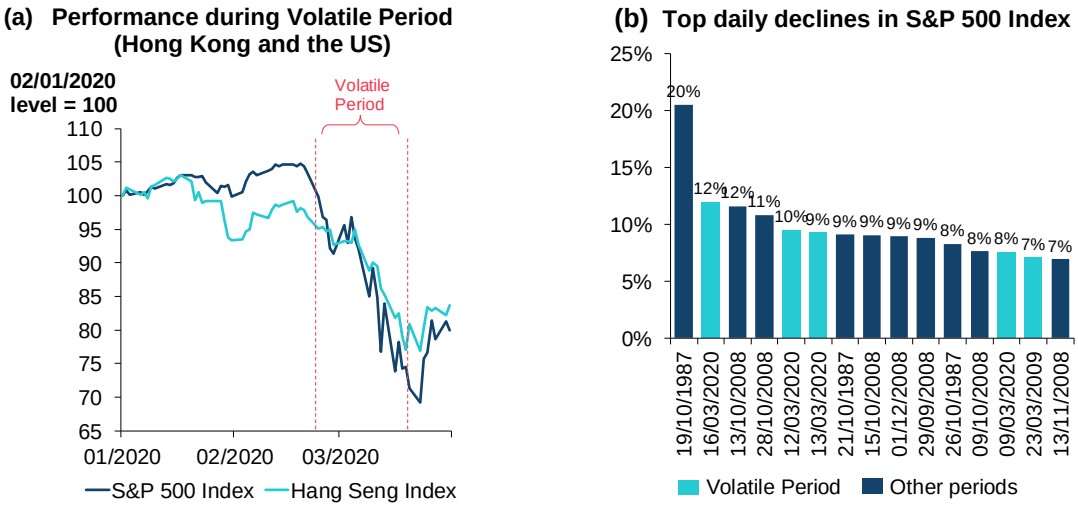
Statistical analyses were performed to examine the association of the primary and secondary market activities of ETFs with the underlying index returns and price premium/discount for ETFs in the US and Hong Kong during the market turmoil period in 2020Q1 in comparison with a benchmark period. The analysis results provide empirical evidence that there was no strong association between the primary market creation/redemption activities of ETFs and the market declines in the US and Hong Kong markets during the market turmoil in 2020Q1. In other words, there are no evidences to justify the criticism that the redemption activities of ETF units amplified price volatility in market turmoils. In the US, the reason for the persistent price discount of the US fixed-income ETFs might be the slow adjustment of the prices of the underlying securities due to the illiquidity of the underlying corporate bond market. Empirical evidences did not justify the criticism that there are of flaws with price discovery of ETFs during market turmoils. In Hong Kong, a separate examination showed that the relatively high secondary liquidity of A-share ETFs contributed to the price discovery of underlying A-share indices when the Mainland market was closed during the Chinese New Year Period.

ETFs have been popular investment tools for tracking equities and bonds, whether under normal or volatile market conditions. With efficient market mechanisms in place, the liquidity provision and price discovery functions of ETFs will continue to excel.

1. BACKGROUND: PERFORMANCE OF EQUITY AND BOND MARKETS DURING THE 2020Q1 MARKET TURMOIL

Global major equity and bond markets suffered a crash in the first quarter of 2020 (2020Q1). The peak-to-trough declines of key equity indices was about 33% and 25% in the US and Hong Kong markets respectively (see Figure 1a). In particular, the US stock market index reached a record high on 19 February 2020 and fell sharply subsequently during 24 February 2020 to 20 March 2020 (referred to as the "Volatile Period", with 20 trading days). During the Volatile Period, the maximum daily decline reached 12%, which was the highest since 1987, and 5 out of the top 15 maximum daily declines in the US stock market history took place during 2020Q1 (see Figure 1b).

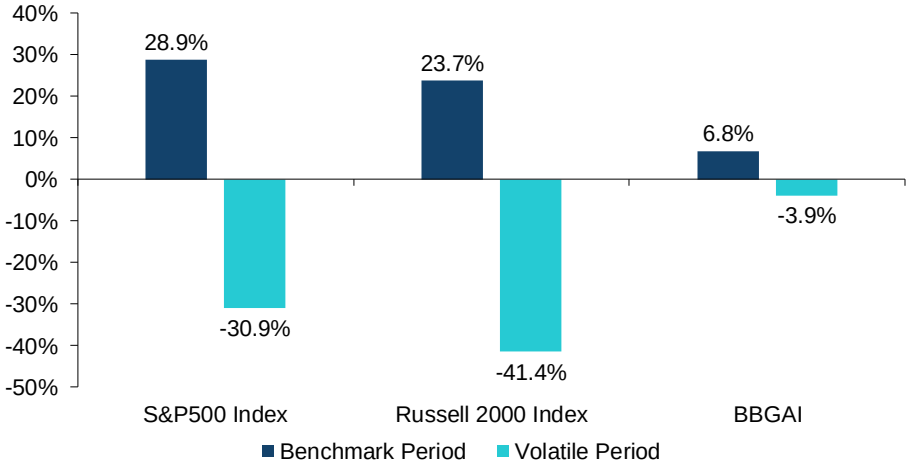
Figure 1. Market performance during the Volatile Period and other market turmoils



Source: Bloomberg.

In the US market, the major indices of large-cap stocks, small-cap stocks and corporate bonds reversed the gains in the year of 2019 (referred to as the "Benchmark Period", with 252 trading days) and fell sharply during the Volatile Period (see Figure 2). The declines were 30.9% for the S&P 500 Index (tracking US large-cap stocks), 41.4% for the Russell 200 Index (tracking US small-cap stocks) and 3.9% for the Bloomberg Barclays Global Aggregate Index (BBGAI, tracking global bonds).

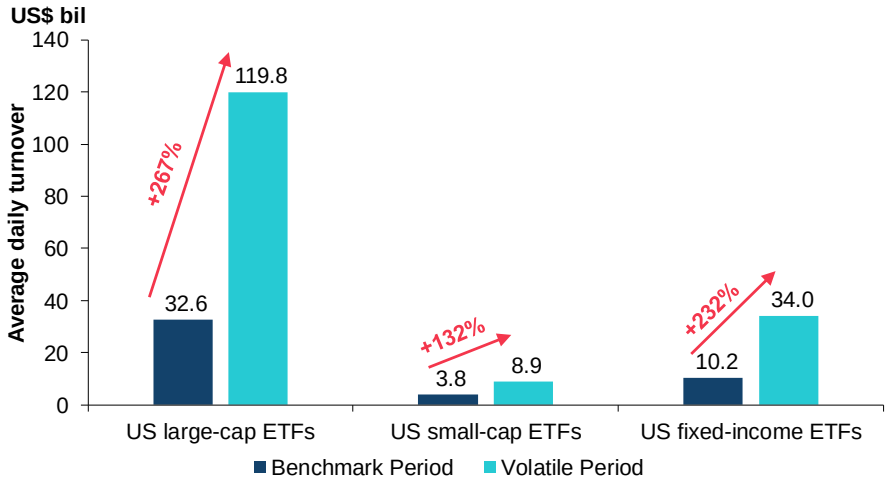
Figure 2. Returns of S&P 500 Index, Russell 2000 Index and BBGAI during the Benchmark and Volatile Periods



Source: Bloomberg.

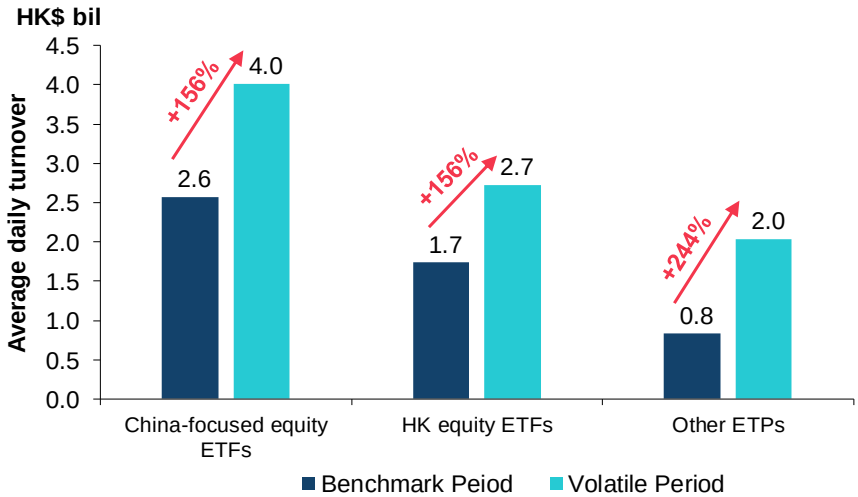
At the same time, significant increases in the turnover of exchange traded funds (ETFs) tracking these indices were observed during the Volatile Period. The average daily turnover (ADT) of US ETFs was more than doubled or tripled during the Volatile Period compared to that in the Benchmark Period for US large-cap ETFs, US small-cap ETFs and US fixed-income ETFs[1] (see Figure 3). In Hong Kong, the ADT of China-focused equity ETFs and Hong Kong equity ETFs increased significantly in the Volatile Period (see Figure 4). Trading of these ETFs was dominated by Tracker Fund (stock code: 2800) and Hang Seng Chinese Enterprises Index (HSCEI) ETF (stock code: 2828)[2], which track the Hang Seng Index (HSI) and the HSCEI respectively.

Figure 3. ADT of US large-cap ETFs, US small-cap ETFs and US fixed-income ETFs during the Benchmark and Volatile Periods



Source: Bloomberg.

Figure 4. ADT of China-focused equity ETFs, Hong Kong equity ETFs and other ETPs in Hong Kong during the Benchmark and Volatile Periods



Note: Other ETPs are other exchange traded products, which include fixed-income and currency ETFs, commodity ETFs and leveraged and inverse (L&I) products.

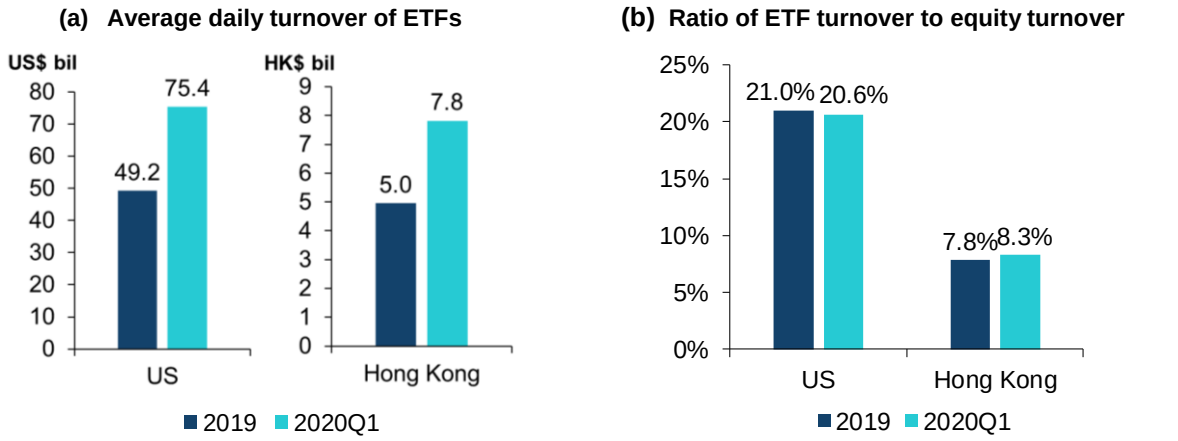
Source: Bloomberg.

[1] The three types of ETF are classified using Morningstar, Inc. (Morningstar)'s definitions.

[2] Tracker Fund and HSCEI ETF were the most actively traded ETFs in the market, together accounting for about 40% of total ETF turnover in Hong Kong in 2019 (source: Bloomberg).

In a broader sense, the ADT of all ETFs in the US market rose by 53% from US$49.2 billion in 2019 to US$75.4 billion in 2020Q1 (see Figure 5a). Alongside, the ADT of ETFs in the Hong Kong market also increased, by 56% from HK$5.0 billion in 2019 to HK$7.8 billion 2020Q1. The total turnover of ETFs was about 21% of total equity turnover in the US market, and about 8% in the Hong Kong market (see Figure 5b) during both periods of 2019 and 2020Q1.

Figure 5. ADT of ETFs and ratio of total ETF turnover to total equity turnover in the US and Hong Kong markets



Note: Data of the US market comprise NYSE and NASDAQ. Equity turnover did not include ETF turnover.

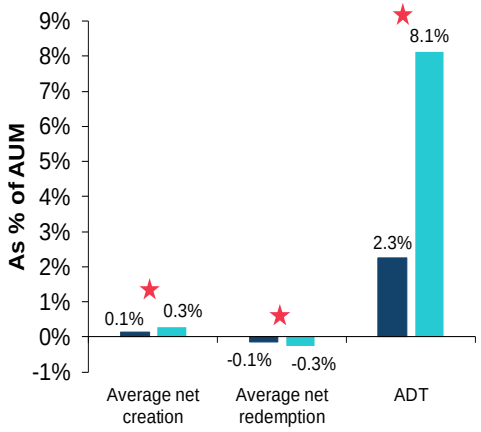
Source: Statistics database on World Federation of Exchanges' website.

The active ADT of ETFs during the market turmoil was accompanied by active daily creation/redemption activities of ETF units in the primary market. The net funds flow in the primary market is referred to as the net primary flows (NPF), which is the creation amount subtracting the redemption amount. For analysis purpose, the daily net creation/redemption activities of ETFs in the primary market is measured by the ratio of daily NPF to assets under management (AUM) (referred to as the "Net Primary Flow Ratio" or NPFR). In the US, the magnitudes of average net creation (positive NPFR)/net redemption (negative NPFR) of ETFs during the Volatile Period were larger than those during the Benchmark Period for large-cap and fixed-income ETFs, and the ADT (as percentage of AUM) of ETFs was much bigger in the Volatile Period than in the Benchmark Period for all three types of ETF. In Hong Kong, both the ADT and the average net creation/redemption of Tracker Fund (2800) and HSCEI ETF (2828) were bigger during the Volatile Period compared to the Benchmark Period[3]. The increases in ADT and average net creation/redemption of ETFs in the US and Hong Kong, both measured in terms of percentage of AUM, were found to be statistically significant in most cases. (See Figure 6.)

[3] HSCEI ETF (2828) can be traded through its RMB counter with a ticker 82828 but the trading of its HKD counter dominated which accounted for over 99% of the total turnover of the ETF in 2019. The omission of the RMB counter (82828) in the analysis is considered to have little impact on the observations. Tracker Fund (2800) has no RMB counter for trading. Funds flow in the primary market do not have separate counters.

Figure 6. Average daily NPF and ADT as percentage of AUM of the main types of ETFs in the US and key ETFs in Hong Kong during the Benchmark and Volatile Periods

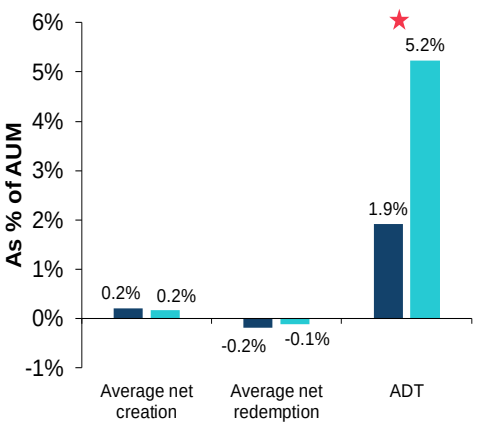
(a) US large-cap ETFs



Number of trading days:

Benchmark Period	155	97	252
Volatile Period	10	10	20

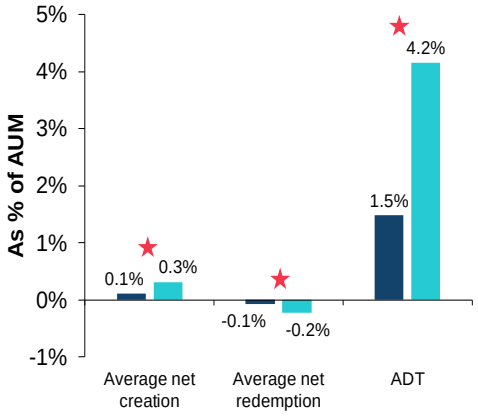
(b) US small-cap ETFs



Number of trading days:

Benchmark Period	123	129	252
Volatile Period	10	10	20

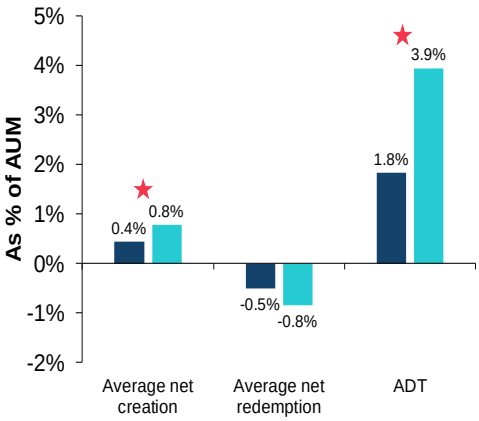
(c) US fixed-income ETFs



Number of trading days:

Benchmark Period	189	63	252
Volatile Period	5	15	20

(d) 2800 and 2828 in Hong Kong



Number of trading days:

Benchmark Period	127	119	246
Volatile Period	15	5	20

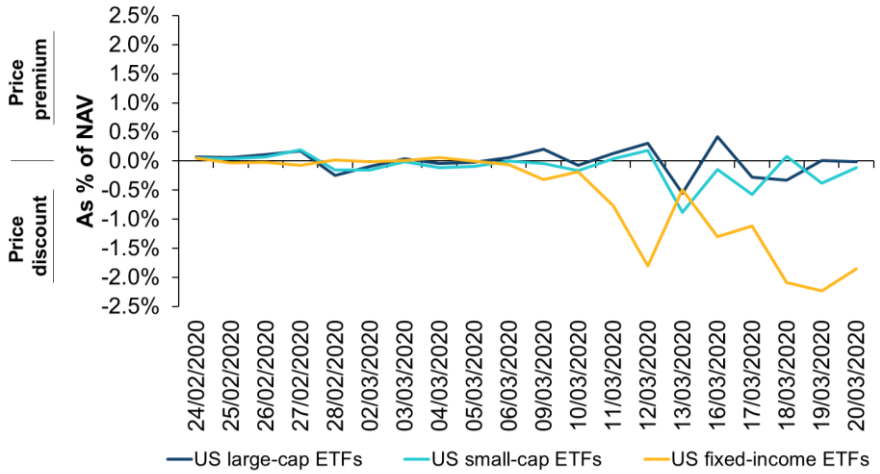
★ Statistically significant difference at 5% level.

Note: Average net creation refers to the average daily NPFR for trading days with positive NPF. Average net redemption refers to the average daily NPFR for trading days with negative NPF.

Source: Morningstar for primary funds flows; Bloomberg for secondary market turnover.

During the Volatile Period, it was also observed that US fixed-income ETFs experienced the widening of a price discount over the net asset value (NAV) (see Figure 7). Under normal market conditions, any price premium/discount of ETF units can be narrowed through arbitrage activities between the primary and secondary markets, contributing to the price discovery function of ETFs (see Section 2). Therefore, it was alleged that the price discovery function of ETFs had failed during the Volatile Period.

Figure 7. Average price premium/discount of US ETFs during the Volatile Period



Source: Bloomberg.

The above observations have aroused market criticisms about the functioning of ETFs during market turmoils:

(1) Redemption activities of ETFs during market downturn amplify market volatility of the underlying equity and bond markets; and

(2) Flaws with the price discovery function of ETFs during market turmoils.

This paper aims at assessing whether these criticisms are justified based on the experience in the 2020Q1 market turmoil in the US and whether these apply to the Hong Kong ETF market.

2. THE DESIGNED FUNCTIONS OF ETFS IN LIQUIDITY PROVISION AND PRICE DISCOVERY

The main reason for the increased popularity of ETFs is that ETFs provide low-cost options to invest in a wide range of asset classes for diversification[4]. These include equities, fixed income, commodities and other assets. ETFs track the performance of the underlying indices of these asset classes and may adopt various investment strategies (e.g. smart beta or active strategies). As ETF units are traded in the secondary market during normal market hours, additional liquidity and better price discovery of the underlying assets are also benefits of ETFs offered to the market.

ETFs were originally designed to provide additional liquidity to securities markets, acting as "buffers" to market shocks[5]. There are three layers of liquidity for ETFs[6], these are: (1) on-screen liquidity of visible amount of ETF units in the secondary market; (2) hidden liquidity in the secondary market from inventories of market makers or other sources[7]; and (3) underlying liquidity in the primary market. In the primary market, authorised participants (APs), which are principally large banks, brokers/dealers and professional trading firms, can apply to the issuer for creation and redemption of ETF units in large blocks based on prevailing market demand. These ETF units are traded in the secondary market by all types of investor. Market makers

4 See HKEX research paper, "Hong Kong's ETF market as a door to global investment", published on HKEX's website, 12 September 2019.

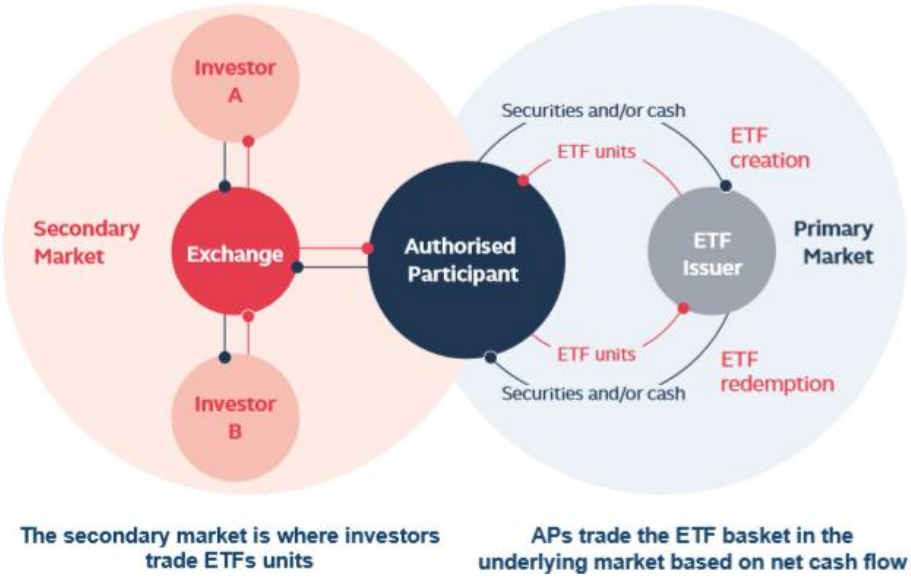
5 See Division of Market Regulation of the US Securities and Exchange Commission (SEC). (1988) "Chapter 3: The effects of derivative products", *The October 1987 market break*, pp.3-1–3-34, US SEC.

6 See "ETF Handbook: A practical guide to Exchange Traded Funds", published on HKEX's website, viewed on 21 August 2020.

7 Hidden liquidity can also be sourced from inventories available through over-the-counter (OTC) platforms and securities borrowing.

are obliged to provide bid-ask quotes of ETF units in the secondary market. Market makers and other APs can trade in both the primary and secondary markets. (See Figure 8.)

Figure 8. Illustration of liquidity provision in the ETF primary and secondary markets



Source: "ETF Handbook: A practical guide to Exchange Traded Funds", published on HKEX's website.

In Hong Kong, market making in ETFs is encouraged by policy incentives. These incentives include the exemption of trading fee and transaction levy for market making transactions in the secondary market and the wavier of stamp duty for creation/redemption of ETF units in the primary market in Hong Kong[8]. Besides, a pilot programme of "buy-in" exemptions for ETFs was launched by HKEX in July 2019[9] to provide more flexibility to market makers. Under the programme, market makers of eligible ETFs can apply for a one-day buy-in exemption on short positions that resulted from market making activities to allow the settlement of ETF units on T+3, instead of T+2. Underpinned by a sudden surge in demand for ETFs, the number of buy-in exemptions rose during the Volatile Period[10]. Buy-in exemptions for market makers help reduce market structure constraints when liquidity is tight. This was exemplified by the widening of trading spreads of certain ETFs after the "buy-in" exemption of these ETFs was suspended in early March 2020[11]. On 9 March 2020, three ETFs, including Global X China Consumer Brand ETF (2806), Global X China Clean Energy ETF (2809) and Global X China Electric Vehicle ETF (2845), were suspended for buy-in exemptions. Subsequently, the trading spreads of these ETFs widened, which might be attributable to less active market making activities (see Figure 9). This highlighted the importance of market makers to provide liquidity of ETFs.

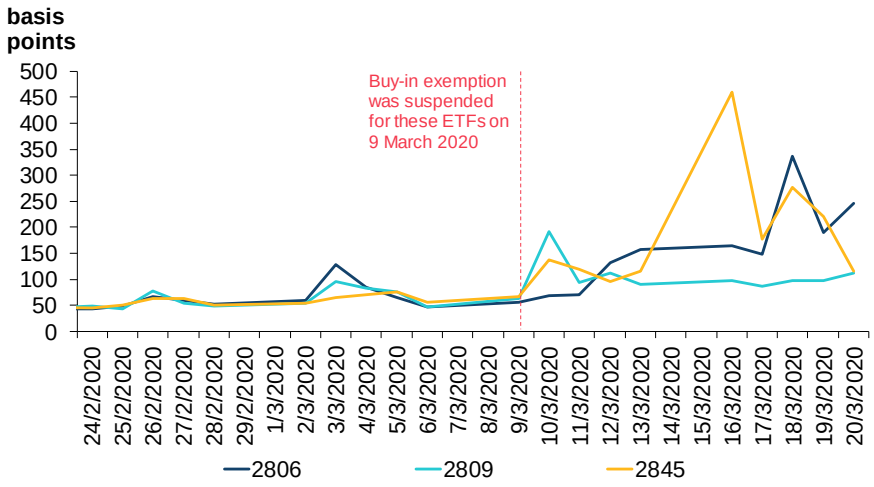
8 Source: "Market making arrangements of exchange traded products", published on HKEX's website, viewed on 3 September 2020.

9 Source: HKEX circular, "Introduction of new buy-in exemption for Exchange Traded Funds and Leveraged and Inverse Products transactions", HKEX's website, 26 June 2019; HKEX circular, "Extension of buy-in exemption for Exchange Traded Funds and Leveraged and Inverse Products transactions", HKEX's website, 26 June 2020.

10 Source: HKEX.

11 Hong Kong Securities Clearing Company Limited will review the Programme from time to time and may suspend the availability of the ETP buy-in exemption for any Clearing Participant and any ETP at any time and for such period in its absolute discretion. Source: HKEX circular, "Introduction of new buy-in exemption for Exchange Traded Funds and Leveraged and Inverse Products transactions", HKEX's website, 26 June 2019.

Figure 9. Trading spreads of selected ETFs in Hong Kong during the Volatile Period



Source: HKEX.

Liquid primary and secondary markets of ETFs contribute to price discovery of the ETF units, which shall reflect the price of the underlying asset, and would therefore in turn contribute to the price discovery of the underlying asset. Any price difference between the primary and secondary markets of ETF units will be narrowed by arbitrage activities of APs. If an ETF on securities is traded at a premium over the NAV of the underlying securities, an AP can purchase the underlying securities to create ETF units in the primary market with the issuer[12] and sell ETF units in the secondary market. If an ETF is traded at a discount to the NAV of the underlying securities, an AP can redeem the ETFs for underlying securities in the primary market and sell these securities in the market[13].

3. HOW ETFS PERFORM AT TIMES OF MARKET TURMOIL?

At times of market turmoil, there would be panic sell-offs of securities and the price level of indices on these securities would fall, possibly to below their fair values. This would induce arbitrage trading in the ETFs on these underlying securities, apart from the trading in the ETFs for profit-taking or loss-avoidance induced during the market turmoil. In the event that the price of an ETF falls less than the underlying index, ending up with a price premium over the NAV, an AP would short sell the ETF units, purchase the underlying securities to create ETF units in the primary market to make up for the short sale. In the event that the price of an ETF falls more than that of the underlying index, ending up with a price discount to its NAV, an AP would short sell the underlying securities and redeem the ETF units to get the underlying securities to make up for the short sale. Such activities would help restore the equilibrium fair pricing of the underlying assets. However, if these are excessive redemption of ETFs, the resultant sale of the underlying assets may further push down the price of the underlying assets.

For exploration and illustration purposes, the case of the functioning of the US and Hong Kong ETF markets during the market turmoil in 2020Q1 (the Volatile Period identified) was examined. As presented in Section 2 above, both the primary and secondary market of ETFs in the US and Hong Kong became more active in the Volatile Period. Were there excessive

[12] Certain ETFs only allow creation and redemption in the primary market through cash only, but not using the underlying securities. In other words, an AP may not need to buy or sell underlying securities before/after the creation/redemption. Nevertheless, creation and redemption through cash will still affect the outstanding number of ETF units, and the creation/redemption process will still involve related trading activities in the underlying securities taken up by issuers of physical ETFs (vis-à-vis synthetic ETFs).

[13] In certain cases, a market maker may short sell the ETF units (underlying securities) first, then submit an application for creation (redemption) of ETF units when there is a price premium (discount) of ETF units.

ETF redemption activities that had amplified market volatility of the underlying equity and bond markets? Were there disruption of arbitrage activities leading to flaws with the price discovery function of ETFs during the market turmoil?

To examine these two questions, we looked into the association between the primary and secondary market activities of ETFs and the underlying index returns and price premium. In our study, the daily primary market activities are measured by NPFR (see Section 1 for definition), and the daily secondary market activities of ETFs are measured by the ratio of daily turnover value to AUM (referred to as the "Secondary Market Liquidity Ratio", or SLR). Analyses were undertaken to test (1) whether the returns of the underlying index had positive association with NPFR and SLR; and (2) whether the price premium of ETF units had a positive association with NPFR and SLR. Tests (1) and (2) are meant to provide insights for the two questions respectively.

Each analysis was conducted for US large-cap ETFs, US small-cap ETFs and US fixed-income ETFs in the US as well as for Tracker Fund (2800) and HSCEI ETF (2828) in Hong Kong. The corresponding underlying indices of the ETFs are respectively S&P 500 Index, Russell 2000 Index and BBGAI (a global index as a proxy of overall bond market performance) in the US case, and the HSI and HSCEI in the Hong Kong case.

The analysis results are presented in the following sub-sections.

3.1 Volatility absorber or amplifier?

If there are more net redemption activities of ETF units (net redemption means a negative value in NPFR) when the underlying index falls more (a negative value in index return), the association between the underlying index return and NPFR will be positive. The association between the underlying index return and NPFR during the Volatile Period was examined and compared with that during the Benchmark Period.

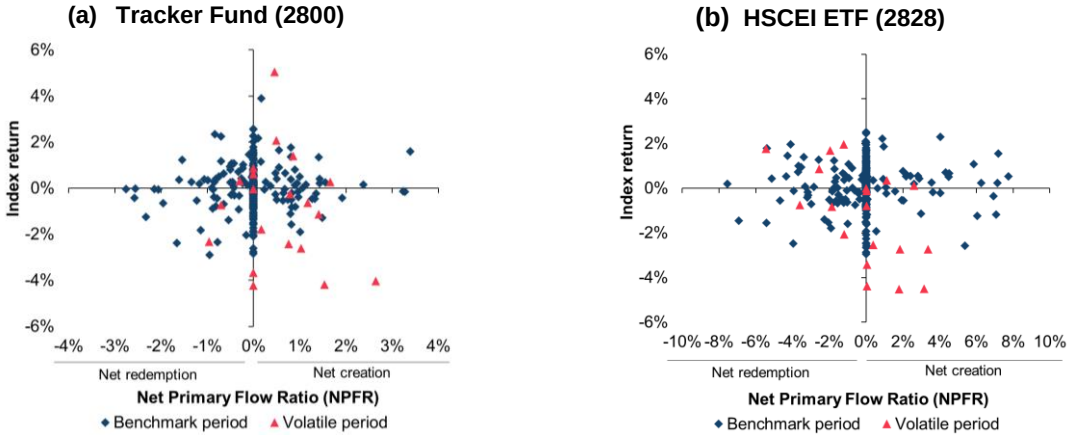
Figure 10 presents the scatterplots of index returns against NPFR for the three main types of US ETFs during the Benchmark and Volatile Periods. The directional association between index returns and NPFR was not definite in both the Benchmark and Volatile Periods for all three types of ETFs. Compared with the Benchmark Period, the Volatile Period had days of bigger positive and negative index returns. A large degree of net creation (positive NPFR) on days of a big rise in index level (positive index return) and a large degree of net redemption (negative NPFR) on days of a big fall in index level (negative index return) were observed during the Volatile Period for US large-cap ETFs and US fixed-income ETFs. However, cases where small degrees of net creation/redemption were also observed on days of large price declines for US large-cap ETFs and US fixed-income ETFs, and these small degrees of net creation/redemption were comparable to those during the Benchmark Period when the price level changes were small. Interestingly, these were the typical cases for US small-cap ETFs at times of large price declines during the Volatile Period.

Figure 10. Scatterplot of daily index returns against daily NPFR of the main types of US ETFs during the Benchmark and Volatile Periods

Source: Morningstar for primary funds flows and Bloomberg for AUM for calculating the NPFR; Bloomberg for daily index closings for calculating daily index returns.

Figure 11 presents the scatterplots of index returns against NPFR for Tracker Fund and HSCEI ETF in Hong Kong during the Benchmark and Volatile Periods. No directional association between index returns and NPFR was observed during the Benchmark Period for both ETFs. Compared to the Benchmark Period, there tended to be more net creations than net redemptions of ETF units on days with big price declines during the Volatile Period.

Figure 11. Scatterplot of daily index returns against daily NPFR of selected ETFs in Hong Kong during the Benchmark and Volatile Periods



Source: Morningstar for primary funds flows and Bloomberg for AUM for calculating the NPFR; Bloomberg for daily index closings for calculating daily index returns.

Statistical analysis was performed to examine the correlation between NPFR of the ETFs under study and the daily returns of their corresponding indices during the Volatile Period in comparison with that during the Benchmark Period. Tables 1 and 2 present the correlation coefficients between NPFR and the daily return of the underlying index for ETFs in the US and Hong Kong respectively. A positive correlation coefficient means that there tends to be more creation than redemption activities (positive NPFR) as the index level rises more (positive index return) and more redemption than creation activities (negative NPFR) as the index level falls more (negative index return). A negative correlation coefficient means that there tends to be more redemption than creation activities (negative NPFR) as the index level rises more (positive index return) and more creation than redemption activities (positive NPFR) as the index level falls more (negative index return).

Table 1. Correlation coefficients between NPFR and index returns during the Benchmark and Volatile Periods for US ETFs

Period	US large-cap ETFs	US small-cap ETFs	US fixed-income ETFs
Benchmark Period (2/1/2019 – 31/12/2020)	-0.04 (252)	0.05 (252)	**0.13* (252)**
Volatile Period (24/2/2020 – 20/3/2020)	0.42 (20)	-0.15 (20)	0.26 (20)

* Correlation coefficient is statistically significant at 5% level.

Note: Number of trading days are given in brackets.

Source: Calculated based on primary flows from Morningstar, and AUM and daily index closings from Bloomberg.

In the US, the correlation between NPFR of ETFs and index returns was found to be mildly to weakly positive in the Volatile Period for US large-cap ETFs (a correlation coefficient of +0.42) and US fixed-income ETFs (+0.26) but slightly negative for US small-cap ETFs (-0.15) (see Table 1). In other words, there tended to be more net redemptions of ETFs as prices declined more, and more net creation as prices rose more for US large-cap ETFs and US fixed-income ETFs; and there tended to be more net creations of ETFs as prices declined more, and more net redemptions as prices rose more for US small-cap ETFs. However, all these correlations during the Volatile Period were not statistically significant[14]. In comparison, the correlation between NPFR and index returns was found to be slightly positive (+0.13) and statistically significant for US fixed-income ETFs during the Benchmark Period.

Table 2. Correlation coefficients between NPFR and index returns during Benchmark and Volatile Periods for selected ETFs in Hong Kong

Period	Tracker Fund (2800)	HSCEI ETF (2828)
Benchmark Period (2/1/2019 – 31/12/2020)	0.06 (246)	0.03 (246)
Volatile Period (24/2/2020 – 20/3/2020)	-0.19 (20)	**-0.50* (20)**

* Correlation coefficient is statistically significant at 5% level.

Note: Number of trading days are given in brackets.

Source: Calculated based on primary flows from Morningstar, and AUM and daily index closings from Bloomberg.

In Hong Kong, the correlation between NPFR and index returns during the Volatile Period was weakly negative (a correlation coefficient of -0.19) without statistical significance for Tracker Fund and mildly negative (-0.50) with statistical significance for HSCEI ETF. In other words, there tended to be more net creation of ETF units when prices declined more during the

[14] Given the small number of trading days in the Volatile Period, a relatively high correlation coefficient may not be statistically significant due to the small number of observations.

Volatile Period. In comparison, there was almost no correlation found between NPFR and index returns during the Benchmark Period.

In summary, during the Volatile Period, there tended to be more net redemption activities for US large-cap ETFs and US fixed-income ETFs as prices declined more but less net redemption or even more net creation activities for US small-cap ETFs as well as for the two key index ETFs in Hong Kong as prices declined more.

Statistical analysis was also performed to examine the correlation between the SLR of the ETFs under study and the daily returns of their corresponding indices during the Volatile Period in comparison with the Benchmark Period. Separate observations were made for trading days when the index level rose (up market) and for trading days when the index level fell (down market). For easy interpretation, the absolute values of the negative index returns in a down market were used to calculate the correlation coefficient with SLR. In an up/down market, a positive correlation coefficient means that there tends to be more ETF trading (higher SLR) as the index rises/falls more, and a negative correlation coefficient means that there tends to be less ETF trading (lower SLR) as the index rises/falls more. Tables 3 and 4 present the results for ETFs in the US and Hong Kong respectively.

Table 3. Correlation coefficients between SLR and index returns in the Benchmark and Volatile Periods for ETFs in the US

Period	Up market			Down market		
	US large-cap ETFs	US small-cap ETFs	US fixed-income ETFs	US large-cap ETFs	US small-cap ETFs	US fixed-income ETFs
Benchmark Period (2/1/2019 – 31/12/2020)	**0.43* (150)**	**0.46* (141)**	**0.46* (141)**	**0.74* (102)**	**0.63* (111)**	**0.63* (111)**
Volatile Period (24/2/2020 – 20/3/2020)	0.29 (6)	**0.83* (6)**	**0.73* (12)**	0.38 (14)	**0.48* (14)**	0.48 (8)

* Correlation coefficient is statistically significant at 5% level.

Note: Number of trading days are given in brackets.

Source: Calculated based on secondary market turnover, AUM and daily index closings from Bloomberg.

In the US ETF market, the correlation between the daily SLR and index returns was positive in an up market and a down market during both the Benchmark and Volatile Periods. In other words, ETF turnover tended to be larger when the underlying index rose or fell more. In an up market during the Volatile Period, the correlation coefficients were strongly positive with statistical significance[15] for US small-cap ETFs (0.83) and US fixed-income ETFs (0.73), even stronger than the correlations during the Benchmark Period, but was only mildly positive without statistical significance for US large-cap ETF (0.29). When prices fell during the Volatile Period, the correlation coefficients were mildly positive for all types of equity and fixed-income ETFs; such correlations were less strong than in the Benchmark Period and was statistically significant only for US small-cap ETFs (0.48). As the correlation between the net creation/redemption and index returns was not strong and/or statistically significant, there are no implications of directional trading in the ETFs during the down market.

[15] It has to be noted that the number of trading days in the Volatile Period was small, especially after splitting into up and down markets. The small number of observations would affect the degree of statistical significance found in the correlation coefficient, for analysis results reported throughout this paper.

Table 4. Correlation coefficients between SLR and index returns in the Benchmark and Volatile Periods for selected ETFs in Hong Kong

Period	Up market		Down market	
	Tracker Fund (2800)	HSCEI ETF (2828)	Tracker Fund (2800)	HSCEI ETF (2828)
Benchmark Period (2/1/2019 – 31/12/2020)	**0.19*** **(135)**	0.15 (134)	0.13 (111)	**0.31*** **(112)**
Volatile Period (24/2/2020 – 20/3/2020)	**-0.83*** **(7)**	-0.23 (8)	0.11 (13)	0.05 (12)

* Correlation coefficient is statistically significant at 5% level.

Note: Number of trading days are given in brackets.

Source: Calculated based on secondary market turnover, AUM and daily index closings from Bloomberg.

In Hong Kong, the association between SLR and index returns of the ETFs during the Volatile Period was weak and statistically insignificant, except for Tracker Fund in an up market. In an up market, for Tracker Fund, the correlation was strong with statistical significance (a correlation coefficient of -0.83) during the Volatile Period, compared to a very weak and positive correlation (+0.19, with statistical significance) during the Benchmark Period; for HSCEI ETF, there were no strong association during both the Volatile Period and the Benchmark Period. This implied that in an up market there were no strong directional creation/redemption activities for both ETFs during the Benchmark Period and for HSCEI ETF during the Volatile Period, and that there tended to be less net creation or more net redemption activities of Tracker Fund when the index moved up more during the Volatile Period. In a down market, for Tracker Fund, there were not much association between SLR and index returns during both the Volatile Period and the Benchmark Period; for HSCEI ETF, there was virtually no association during the Volatile Period compared to a positive but weak correlation (+0.31, with statistical significance) during the Benchmark Period. In other words, ETF turnover did not tend to surge more in a down market during the Volatile Period than it would be in the Benchmark Period, while they might tend to trade less in an up market during the Volatile Period probably because of a loss of trading direction during market turmoil. These observations did not reflect strong directional trading activities in ETFs associated with redemptions in the primary market that could possibly amplify market volatility.

The above analysis results provide empirical evidence that there is no strong association between the primary market creation/redemption activities of ETFs and the market declines in the US and Hong Kong markets during the market turmoil in 2020Q1. In other words, there are no evidences to justify the criticism that the redemption activities of ETF units amplified price volatility in market turmoils.

3.2 Flaws with the price discovery function?

For the criticism that there are flaws with the price discovery function of ETFs during market turmoils, the case of the ETF market in the US during the Volatile Period was studied.

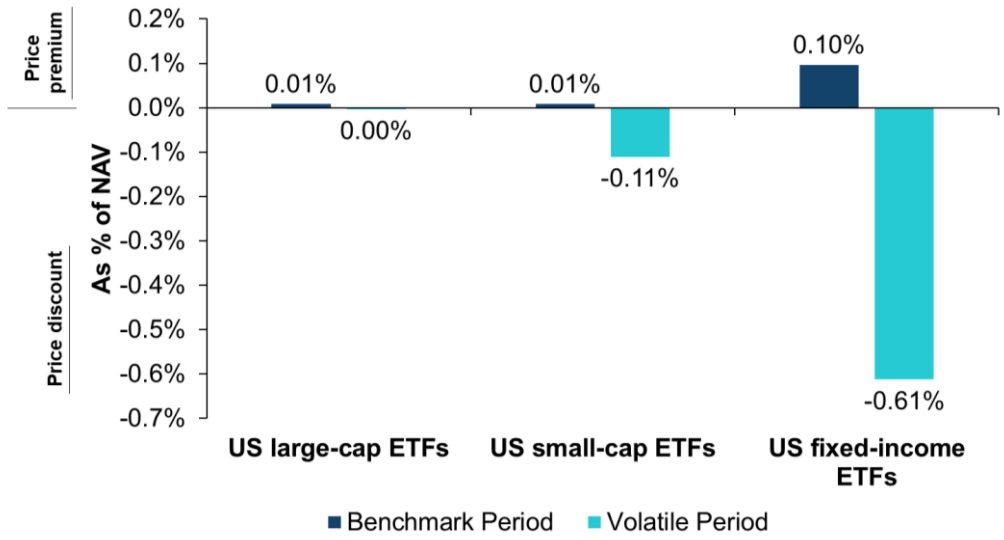
During market turmoil, there may be rapid sell-offs of ETF units in the secondary market such that the price decline of ETF units would be larger than that of the underlying securities resulting in a price discount of the ETF relative to its NAV, which will trigger arbitrage activities between the ETF's primary and secondary markets, i.e. redeeming the ETF units in the primary market and selling the underlying securities in the secondary market (see Section 2). If there are not enough arbitrage activities to restore fair pricing, the ETF price discount will persist and the price discovery function of the ETF may be interpreted to have failed.

Statistical analyses were performed to examine the association between the net creation/redemption activities (measured by NPFR) and the ETF price premium/discount for US large-cap ETFs, US small-cap ETFs and US fixed-income ETFs in the US, and for Tracker Fund and HSCEI ETF in Hong Kong. As a separate examination of the price discovery function, the case of A-share ETFs in the Hong Kong market during the Chinese New Year holidays in the Mainland market in 2020 (CNY Period) was studied.

3.2.1 US ETF market

During the Volatile Period, major indices of equities and fixed-income securities fell sharply. The prices of ETFs fell more than that of their NAV. The average daily price as a percentage of NAV across ETFs of each type of US ETF turned from a price premium during the Benchmark Period to a price discount during the Volatile Period. The degree of price discount of particularly US fixed-income ETFs was much larger (-0.61%) than those of US large-cap ETFs (-0.003%) and US small-cap ETFs (-0.11%). (See Figure 12.)

Figure 12. Average premium/discount of US ETFs during the Benchmark and Volatile Periods



Source: Calculated based on the price premium of each ETF from Bloomberg.

Table 5 presents the correlation coefficients between NPFR and the daily price premium/discount of the ETFs under study during the Volatile Period in comparison with the Benchmark Period. There was virtually no correlation between NPFR and the daily premium/discount for the ETFs during the Benchmark Period. During the Volatile Period, the correlation between NPFR and price premium/discount was positive for US small-cap ETFs and US fixed-income ETFs, which implies more redemption activities as price discount widened or more creation activities as price premium widened. Such correlation was strongly positive and statistically significant for US fixed-income ETFs. In contrast, the correlation was weakly negative in the Volatile Period for US large-cap ETFs, which implies less redemption activities as price discount widened, but this was not statistically significant.

Table 5. Correlation coefficients between NPFR and average price premium/discount in the Benchmark and Volatile Periods for US ETFs			
Period	**US large-cap ETFs**	**US small-cap ETFs**	**US fixed-income ETFs**
Benchmark Period (2/1/2019 – 31/12/2020)	0.04 (252)	-0.03 (252)	0.02 (252)
Volatile Period (24/2/2020 – 20/3/2020)	-0.14 (20)	0.28 (20)	**0.70* (20)**

* Correlation coefficient is statistically significant at 5% level.

Notes: Number of trading days are given in brackets.

Source: Calculated based on primary flows from Morningstar, and AUM and price premium from Bloomberg.

Statistical analysis was also performed to examine the correlation between SLR and the daily price premium/discount of the ETFs under study during the Volatile Period in comparison with the Benchmark Period. Separate observations were made for trading days with price premium and for trading days with price discount. For easy interpretation, the absolute values of price discounts were used to calculate the correlation coefficient with SLR. During trading days with price premium/discount, a positive correlation coefficient means that there tends to be more ETF trading (higher SLR) as the price premium/discount increases, and a negative correlation coefficient means that there tends to be less ETF trading (lower SLR) as the price premium/discount increases. Table 6 presents the analysis results.

Table 6. Correlation coefficients between SLR and average price premium/discount in the Benchmark and Volatile Periods for US ETFs						
Period	**Trading days with price premium**			**Trading days with price discount**		
	US large-cap ETFs	**US small-cap ETFs**	**US fixed-income ETFs**	**US large-cap ETFs**	**US small-cap ETFs**	**US fixed-income ETFs**
Benchmark Period (2/1/2019 – 31/12/2020)	**0.19* (147)**	**0.27* (145)**	**-0.19* (251)**	**0.28* (105)**	0.18 (107)	— (1)
Volatile Period (24/2/2020 – 20/3/2020)	0.53 (11)	0.54 (7)	-0.29 (5)	0.54 (9)	0.36 (13)	0.27 (15)

* Correlation coefficient is statistically significant at 5% level.

Note: The US fixed-income ETFs had an average price discount during the Benchmark Period for one trading day only and no correlation coefficient can be calculated. Number of trading days are given in brackets.

Source: Calculated based on secondary market turnover, AUM and price premium from Bloomberg.

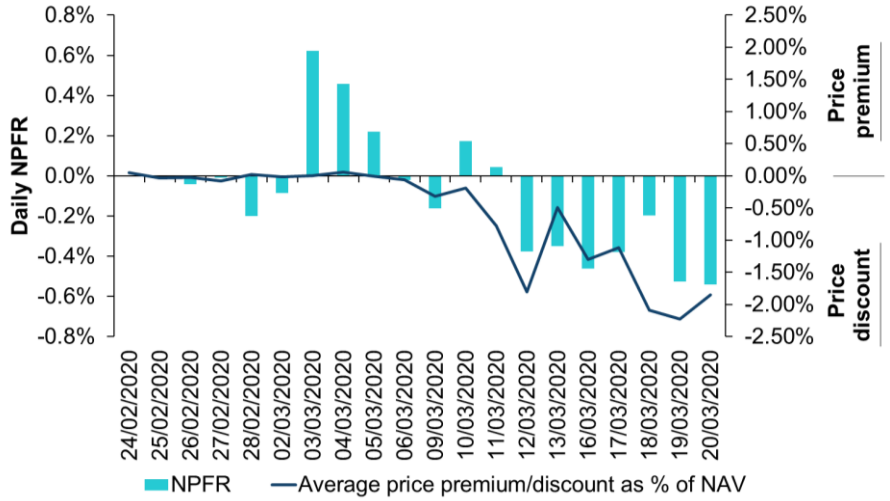
For US large-cap ETFs and small-cap ETFs, the turnover tended to be larger when price premium/discount widened in both the Benchmark Period and Volatile Period. Such positive correlation was stronger in the Volatile Period but without statistical significance[16], while that in the Benchmark Period was relatively weak but statistically significant (except US small-cap ETFs for trading days with price discount for which the correlation was not statistically significant). For US fixed-income ETFs, they were notably traded at a price premium in all except one trading day during the Benchmark Period but were mostly traded at a price discount (75% of the trading days) during the Volatile Period. The correlation between their SLR and price premium was negative (though weakly) during the Benchmark Period (with statistical significance) and the Volatile Period (without statistical significance),

[16] As in the correlation analysis for the Volatile Period split into up and down markets, the small number of observations in the Volatile Period split into days with price premium and days with price discounts would affect the degree of statistical significance found.

and the correlation between their SLR and price discount was positive (similarly weak without statistical significance) during the Volatile Period. In other words, the turnover of US fixed-income ETFs during the Volatile Period tended to be larger when the price discount widened but smaller when the price premium widened.

The above findings on US fixed-income ETFs shows that there had possibly been more redemption activities for arbitrage purposes during the Volatile Period. However, it appeared that the net redemption of the ETFs did not reduce their price discount to NAV during the Volatile Period (see Figure 13). Their average discount to NAV remained large since 12 March 2020 and even got bigger despite net redemptions during 12-20 March 2020.

Figure 13. Daily average price premium/discount and NPFR of US fixed-income ETFs in the Volatile Period



Source: Calculated based on primary flows from Morningstar and AUM and price premium from Bloomberg.

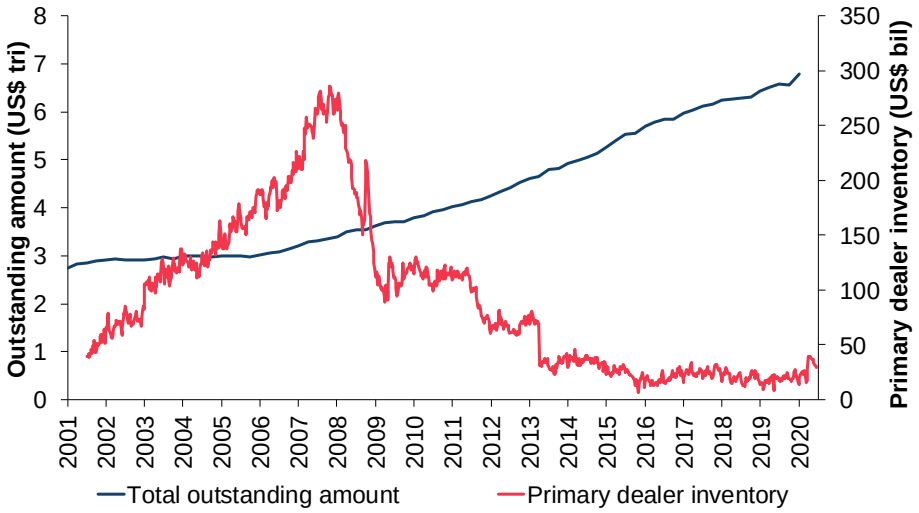
Does it mean there were "flaws" in the price discovery function of US fixed-income ETFs vis-à-vis the US equity market? This may relate to the liquidity of the US bond market, particularly for corporate bonds. Corporate bonds in the US are mainly traded in the over-the-counter (OTC) market intermediated by primary dealers, who may underwrite new government debt and act as market makers for the US Federal Reserve. A study[17] showed the positive association between primary dealers' inventories and corporate bond market liquidity in the US. In fact, primary dealer inventory of corporate bonds has dropped significantly since the Global Financial Crisis in 2008 while the outstanding amount of corporate bonds has grown steadily in the US (see Figure 14). Under this situation, US corporate bonds have likely become less liquid than in the pre-crisis period before 2008. In comparison, US fixed-income ETFs are more liquid than their underlying bonds. Another study[18] noted that secondary market trading was an important source of liquidity for US fixed-income ETFs, which was about four times of their transaction amount in the primary market, and the trading tended to increase at times of volatile market. The same study found that the trading spreads of US fixed-income ETFs were much smaller than those of their underlying bonds during January 2017 to October 2018, even so (0.02% for ETFs versus 0.49% for the underlying bonds) during the period with the largest market sell-offs. Given the liquidity, the price adjustment of ETF units would be faster in reflecting investors' views on the values of the underlying bonds. In other words, the reason for the persistent

[17] Ivanov, P., A. Orlov and M. Schil. (2020) "Bond liquidity and dealer inventories: Insights from US and European regulatory data", Occasional Paper published by the Securities and Exchange Commission (SEC)'s Division of Economic and Risk Analysis (DERA), No. 52.

[18] "Debunking myths about bond ETF liquidity", published on Vanguard's website, 20 September 2019.

price discount of the US fixed-income ETFs during the Volatile Period might be the slow adjustment of the NAV due to the illiquidity of the underlying bond market. The active US fixed-income ETFs are believed to have actually contributed to the price discovery of the US bonds.

Figure 14. Quarter-end total outstanding amount and weekly primary dealer inventory of US corporate bonds (2011 – 2020Q2)

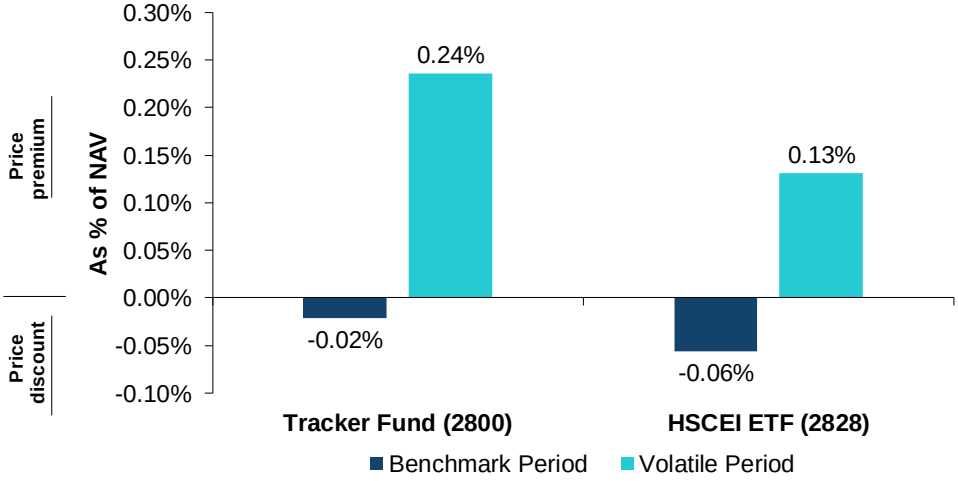


Source: Federal Reserve Bank of New York for data of primary dealer inventory; Federal Reserve Bank of St. Louis for data of total outstanding amount.

3.2.2 Hong Kong ETF market

The Tracker Fund and HSCEI ETF had price discounts relative to their NAVs (-0.02% and -0.06% respectively) during the Benchmark Period. These turned into price premiums during the Volatile Period (+0.24% and +0.13% respectively) (see Figure 15), the opposite of the behaviour of the US ETFs examined in Section 3.2.1 above. The price premiums of these ETFs implied that the price declines of these ETFs were smaller than those of their respective underlying indices during the market turmoil.

Figure 15. Average price premium/discount of Tracker Fund (2800) and HSCEI ETF (2828) during the Benchmark and Volatile Periods



Source: Calculated based on the premium of each ETF from Bloomberg.

Table 7 presents the correlation coefficients between the daily NPFR and the daily price premium/discount of the two ETFs during the Volatile Period in comparison with the Benchmark Period. The association between NPFR and price premium/discount for the two ETFs was not obvious (correlation coefficient close to zero, with no statistical significance) during the Benchmark Period when market prices fluctuated within confined ranges. During the Volatile Period, the correlation coefficients turned weakly or mildly positive — relatively strong for HSCEI ETF, with statistical significance. In other words, there tended to be more net creation of ETF units as the price premium widened (ETF price rose more than the underlying securities) and/or more net redemption of ETF units as the price discount widened (ETF price fell more than the underlying securities). This reflects that the price discovery function of the ETFs in Hong Kong performed as expected during the Volatile Period when there were large price fluctuations.

Table 7. Correlation coefficients between NPFR and price premium/discount in the Benchmark and Volatile Periods for Tracker Fund and HSCEI ETF

Period	Tracker Fund (2800)	HSCEI ETF (2828)
Benchmark Period (2/1/2019 – 31/12/2020)	0.07 (246)	-0.03 (246)
Volatile Period (24/2/2020 – 20/3/2020)	0.14 (20)	**0.57*** **(20)**

* Correlation coefficient is statistically significant at 5% level.

Note: Number of trading days are given in brackets.

Source: Calculated based on primary flows from Morningstar, and AUM and price premium from Bloomberg.

In respect of trading in the secondary market, Table 8 presents the correlation coefficients between daily SLR and price premium/discount for Tracker Fund and HSCEI ETF during the Benchmark and Volatile Periods. Notably, Tracker Fund traded at a price premium throughout the Volatile Period (compared to only 42% of the trading days during the Benchmark Period). HSCEI ETF also traded at a price premium for most of the trading days (75%) during the Volatile Period (compared to only 32% during the Benchmark Period).

Table 8. Correlation coefficients between SLR and price premium/discount in the Benchmark and Volatile Periods for Tracker Fund and HSCEI ETF

Period	Price premium		Price discount	
	Tracker Fund (2800)	HSCEI ETF (2828)	Tracker Fund (2800)	HSCEI ETF (2828)
Benchmark Period (2/1/2019 – 31/12/2020)	**0.23*** **(103)**	0.02 (79)	0.12 (143)	0.00 (167)
Volatile Period (24/2/2020 – 20/3/2020)	-0.01 (20)	0.45 (15)	— (0)	**0.57*** **(5)**

* Correlation coefficient is statistically significant at 5% level.

Note: Tracker Fund (2800) did not trade at a discount during the Volatile Period and no correlation coefficient can be calculated; Number of trading days are given in brackets.

Source: Calculated based on secondary market turnover, AUM and price premium from Bloomberg.

During trading days with price premium, for Tracker Fund, there was almost no correlation between SLR and price premium during the Volatile Period but weakly positive (+0.23, with statistical significance) during the Benchmark Period; for HSCEI ETF, the correlation was mildly positive (a correlation coefficient of +0.45, without statistical significance) during the Volatile Period but almost absence during the Benchmark Period. During trading days with price discount, for HSCEI ETF, the correlation between SLR and price discount was mild (a correlation coefficient of 0.57, with statistical significance) during the Volatile Period,

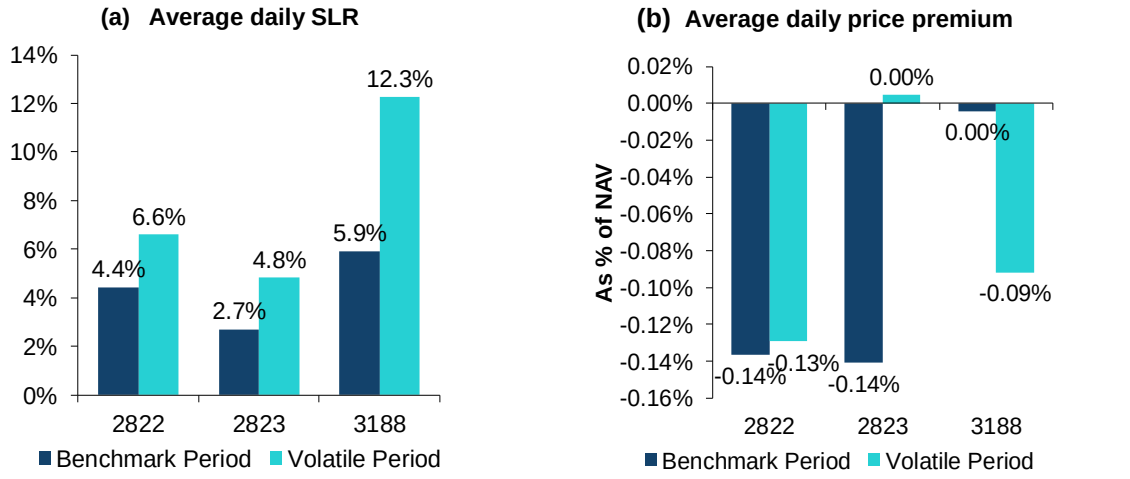
compared to no correlation found during the Benchmark Period; for Tracker Fund, the correlation was also very weak during the Benchmark Period. In other words, the turnover of HSCEI ETF during the Volatile Period tended to be higher when the price premium/discount widened.

The above results of correlation analysis of ETF activities in the primary and secondary markets might suggest a certain degree of active arbitrage activities during the Volatile Period to realise the price discovery function of HSCEI ETF. For Tracker Fund, its daily voluminous trading in the secondary market irrespective of market conditions might have shadowed its arbitrage trading to reveal any significant correlations[19].

Another case for illustration would be the price discovery function of A-share ETFs in Hong Kong. A-share ETFs are ETFs tracking indices on A shares listed in the Mainland market. Those actively traded in Hong Kong include CSOP FTSE China A50 ETF (stock code: 2822), iShares FTSE China A50 ETF (stock code: 2823) tracking FTSE China A50 Index and ChinaAMC CSI 300 Index ETF (stock code: 3188) tracking CSI 300 Index[20].

During the Volatile Period, the three A-share ETFs recorded an increase in SLR relative to the levels during the Benchmark Period (see Figure 16a). Alongside, price discounts, if any, remained low during the Volatile Period (see Figure 16b).

Figure 16. Average daily SLR and average price premium/discount of the most actively traded A-share ETFs in Hong Kong in the Benchmark and Volatile Periods



Source: Calculated based on secondary market turnover, AUM and price premium from Bloomberg.

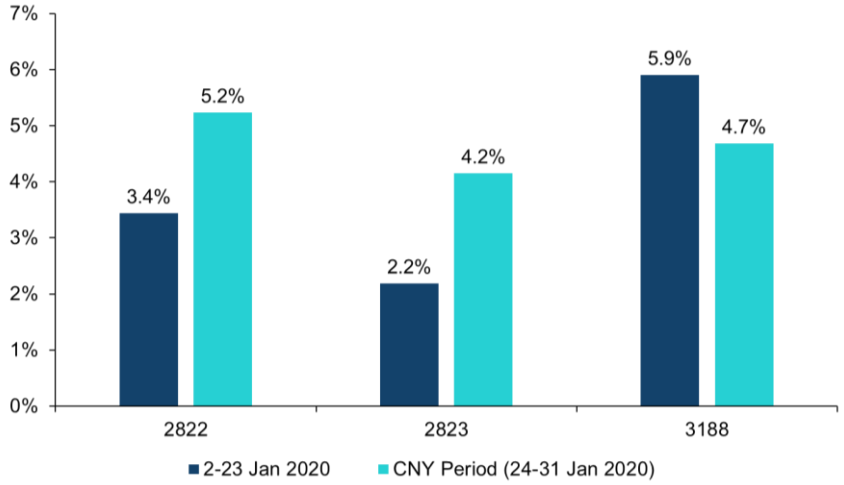
A separate examination of the price movements of the A-share ETFs in comparison with their underlying indices during the CNY Period (24 to 31 January 2020) showed some evidence of their price discovery function. Despite the closure of the A-share market in the Mainland during the CNY Period, the secondary liquidity (measured by SLR) of these A-share ETFs remained relatively high during the CNY Period or even higher than that during the prior trading days in January before the CNY Period (see Figure 17). As the Hong Kong market resumed trading while the Mainland market was still closed during the CNY Period, global investors could still trade A-share ETFs listed in Hong Kong to reflect their

[19] Tracker Fund has been the most actively traded ETF in Hong Kong and accounted for about 35% and 28% of total ETF turnover during the Benchmark and Volatile Periods respectively. For comparison, the second most active ETF accounted for only 17% and 16% respectively during the two periods. Source: Wind.

[20] The turnover of these three A-share ETFs accounted for about 44% of total ETF turnover value in Hong Kong in 2019, most of which contributed by trading through their HKD counters (counters with the above stock codes) (over 99% of turnover). Source: Bloomberg. The creation and redemption of these A-share ETFs are cash-settled only, without involving any transactions in the underlying securities.

views on A-share indices and the ETFs continued to perform their price discovery function, as shown in Figure 18. The price of ETFs moved during the CNY Period and tracked quite closely the A-share index levels upon re-opening of the Mainland market on 3 February 2020. This provides empirical evidence that, being supported by the liquid ETF secondary market in Hong Kong, the price discovery function of A-share ETFs in Hong Kong continued to function well during closure of the Mainland market.

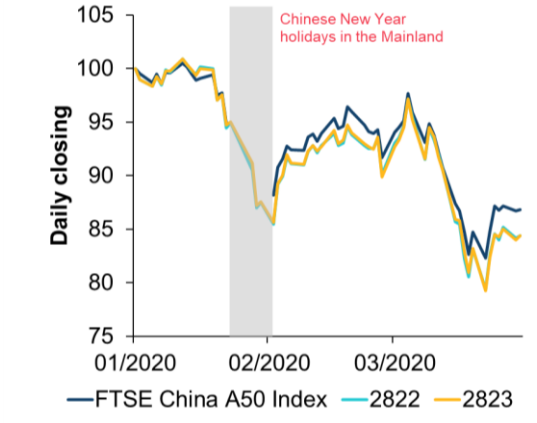
Figure 17. Average daily SLR of ETFs (2822, 2823 and 3188) in Hong Kong during January 2020 and the CNY Period



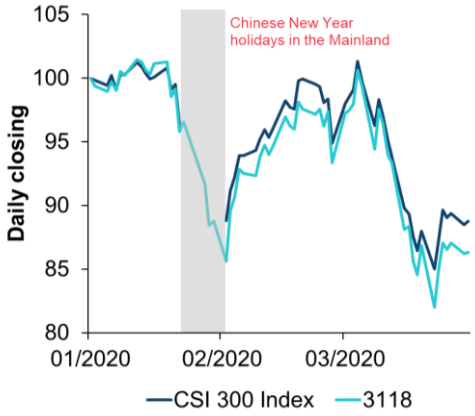
Source: Calculated based on secondary market turnover and AUM from Bloomberg.

Figure 18. The price performance of A-share indices and A-share ETFs in 2020Q1

(a) FTSE China A50 Index (Rebased on 02/10/2020 at 100)



(b) CSI 300 Index (Rebased on 02/10/2020 at 100)



Source: Bloomberg.

4. CONCLUSION

ETFs have been popular investment tools for tracking equities and bonds, whether under normal or volatile market conditions. However, the market turmoil in 2020Q1 has aroused market criticisms about ETFs being volatility amplifier and the functioning of ETFs in price discovery during market turmoils. The results of statistical analyses, exemplified by the cases of ETFs in the US and Hong Kong, showed that daily creation/redemption activities of ETFs did not increase market volatilities during the market turmoil in 2020Q1 and there were also some signs of active trading of ETFs to support the price discovery of the underlying securities.

With efficient market mechanisms in place, the liquidity provision and price discovery functions of ETFs will continue to excel.

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