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Does Cash Redemption Amplify the Outflows of ETFs?

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Abstract

The growing reliance on exchange-traded funds (ETFs), especially those that can be redeemed for cash (i.e., cash-redeemable ETFs), has raised concerns about their resilience to a market downturn. This study shows that abrupt redemption of cash-redeemable ETFs may occur during a market downturn. In particular, an initial redemption shock to ETFs with a low cash buffer level could lead to a downward spiral in fund performance and outflow, which could expand a downturn to the broader financial market. Given the widespread existence of cash-redeemable ETFs in Europe and emerging market economies, our results point to the potential financial vulnerability of these regions, if these ETFs are redeemed in a large scale. In regions where cash-redeemable ETFs are popular because of taxation regimes or asset liquidity, regulators should carefully scrutinise relevant policies and balance the pros and cons of this ETF redemption mechanism in terms of overall financial stability.

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1) INTRODUCTION

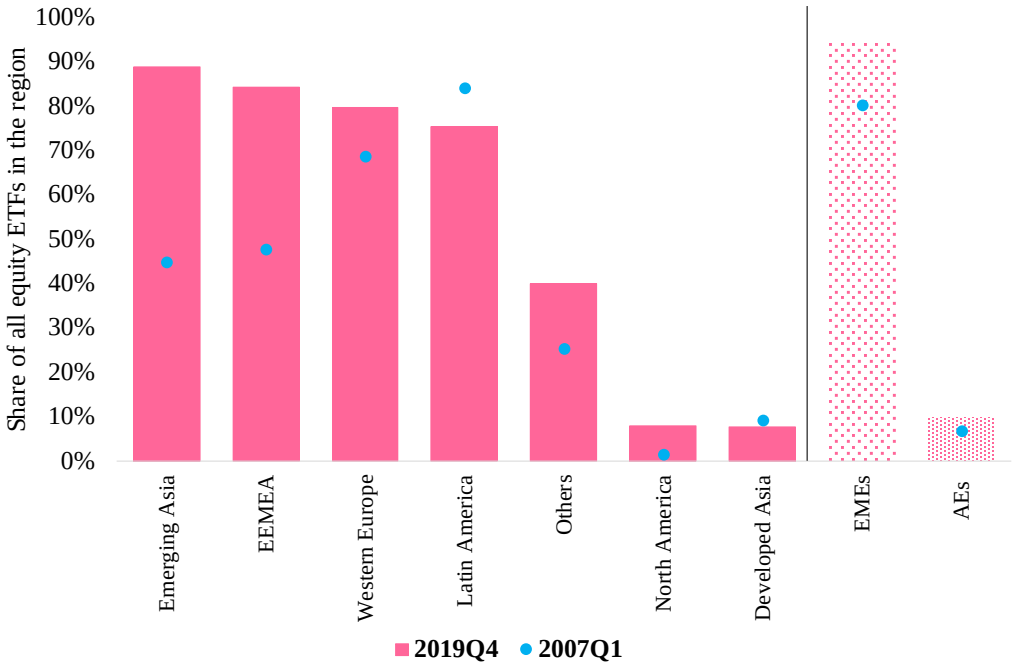
The total value of exchange-traded funds (ETFs) worldwide grew six-fold to US$4.8 trillion in assets under management (AUM) by the end of 2019, representing an increase of 7.2% since 2007Q1 and accounting for around one fourth of the AUM of all global equity funds. This growth is partly due to the advantages of ETFs, which include intra-day trading, flexible buy options (on margin or short sale), and low-cost index tracking.[2] However, such rapid growth has attracted the attention of the Financial Stability Board (FSB) and the central banks of major economies[3], leading to investigation of the resilience of ETFs to redemption and the association of this resilience with the redemption mechanism.[4] For example, if abrupt, redemption from ETFs during a market downturn would ultimately depress the prices of these funds' underlying assets and lead to negative consequences in the real economy.

For the FSB, the redemption mechanism represents a source of concern regarding the financial fragility of ETFs. Unlike traditional open-end funds, which are redeemed mainly in cash, ETF shares can be redeemed in cash, underlying securities (i.e., in kind), or a mix of both (Section 3.2 for details).[5] Despite this difference, ETFs have become more similar to traditional open-end funds over the past decade. Since the first quarter of 2007, the share of cash-redeemable ETFs in the equity ETF universe has grown across all investment markets[6] except those in developed Asia and Latin America (Figure 1). Cash-redeemable ETFs are now the dominant form in Europe and emerging market economies (EMEs), accounting for 79.5% and 94.2% of all ETFs, respectively, as of 2019Q4; these proportions represent rapid growth with respect to the 2007Q1 values of 68.7% and 80.2%,

[2] According to the findings of a survey by Greenwich Associates, in 2017, over 80% of respondents resorted to ETFs because of the speed of execution to gain diversified exposure and liquidity as institutional investors.
[3] For details, please refer to Financial Stability Board (2017), Anadu et al. (2018), Pagano et al. (2019), Arora et al. (2019) and Bank of England (2020).
[4] The potential risk to financial stability posed by cash redemption from ETFs also raised concerns among market participants. For example, during the 2013 'taper tantrum', State Street, a sponsor of several municipal bond ETFs, temporarily suspended cash redemptions of these funds to avoid adverse consequences. More recently, amid the turmoil triggered by the COVID-19 pandemic in early 2020, concerns arose that further cash redemption from some major bond ETFs would be suspended after initial cash redemption. These ETFs became highly volatile even though a suspension had yet to be implemented.
[5] Unlike traditional open-end mutual funds, redemptions of ETFs are requested by authorised participants (APs) who have contractual arrangements with the ETFs to create or redeem shares. For details, please refer to Section 3.
[6] 'Investment area' means the geographical area in which an ETF's investment is focused. Throughout this paper, the geographical location and investment area of an ETF are equivalent.

respectively.[7] Such dominance suggests a need to understand how financial stability may be affected if the share of cash-redeemable ETFs continues to increase.

Figure 1: Shares of cash-redeemable ETFs by investment area[8]



Source: Morningstar Direct and Bloomberg
Notes:

1. Figure 1 depicts the share of cash-redeemable ETFs by regions, including emerging Asia, Eastern Europe, Middle East and Africa (EEMEA), Western Europe, Latin America, North America, developed Asia and others; or by level of economic development, i.e. emerging market economies (EMEs) and advanced economies (AEs); and
2. The sample used for individual regions differs from that for EMEs/AEs, because some ETFs have an investment focus broader than the named regions, such as 'Global Emerging Markets' or 'BRIC' and thus are not included in the sample for individual regions in Figure 1.

This paper sheds light on the potential vulnerability of cash-redeemable ETFs by showing that the outflows from these ETFs could be more abrupt than those from in-kind ETFs during a market downturn. The extent of outflow abruptness may be associated with the sufficiency of the ETF cash buffer and the mechanism of redemption (i.e., cash). More importantly, the managers of these ETFs might liquidate the funds' underlying assets at a discount in response to cash redemption orders, thus depressing the future performance of the ETFs against their benchmark indices. Therefore, an initial redemption shock to these ETFs could lead to a downward spiral in fund performance and outflow and thus expand a downturn to the broader financial market.

[7] In both regions, the dominance of cash-redeemable ETFs is largely associated with unique local taxation regimes or asset markets. For details, please refer to Section 3.2.
[8] Cash-redeemable ETFs include those that can be redeemed only in cash or either in cash or in kind. The remaining ETFs can be redeemed only in kind. Please refer to Section 3.2 for details.

This paper makes three main contributions to the field. First, we use a novel and highly granular ETF dataset, compiled from various data vendors, that includes the details of each fund's financial status, balance sheet information and redemption mechanism. Second, this paper is the first to explore the expansion of the cash redemption mechanism among ETFs worldwide, particularly in Europe and EMEs, over the past decade. Our findings underscore the potentially destabilising impacts of these ETFs on European and EME markets if redeemed on a large scale. Third, our results provide empirical evidence favouring the in-kind redemption mechanism as a liquidity management tool. Our findings not only highlight the effectiveness of this mechanism in mitigating ETF redemptions or fire sales but also may serve as a reference for the regulators of traditional open-end funds, which are mainly redeemed in cash.

The remainder of the paper is organised as follows. In Section 2, we review the major studies included in the ETF literature, particularly those concerned with the implications of these investment funds for financial stability. We discuss the factors that have popularised cash-redeemable ETFs in Europe and EMEs in Section 3.1, and the redemption mechanisms and the channel through which cash-redeemable ETFs can affect financial stability in Section 3.2. We describe our hypotheses in Section 3.3. In Section 4, we present our novel data on equity ETFs. We describe our methodology in Section 5 and present our empirical results in Section 6. In Section 7, we conclude our analysis and discuss the implications of our findings.

2) LITERATURE REVIEW

Unsurprisingly, the tremendous growth in ETFs over the past two decades has generated widespread interest among academics, policymakers and market participants. The implications of these investment vehicles for financial stability are among the most frequently examined topics in this area. Nonetheless, the cash redemption mechanism as a potential channel for financial vulnerability appears to have been neglected in ETF research. To the best of our knowledge, no published study directly assesses the vulnerability of ETFs from this perspective, although Chen et al. (2010) and Goldstein et al. (2017) find evidence of such vulnerability in certain types of open-end mutual funds[9]. Instead, the ETF research

[9] These authors find that the flows to open-end mutual funds investing in illiquid assets are more sensitive to poor past performance than are funds investing in liquid assets. They mainly explain this phenomenon using

literature is focused on dynamic interactions between ETFs and the underlying securities. For example, Ben-David, Franzoni and Moussawi (2018) find that stocks owned by ETFs tend to have more volatile returns. More importantly, this increase in volatility is not attributable to changes in individual stock fundamentals but is associated with across-the-board buying or selling of all stocks in the indices tracked by the ETFs. These transactions lead to excessive and non-fundamental market volatility. Similarly, Krause et al. (2014) observe a significant spillover of volatility from ETFs to the underlying stocks. Da and Shive (2018) find that ETF arbitrage contributes to higher return correlations of stocks, particularly small and illiquid stocks, held by the same ETFs. Dannhauser and Hoseinzade (2017) determine that outflows from ETFs have a greater effect on underlying bond prices than outflows from open-end mutual funds, and they partly attribute this differential effect to the passive investment nature of ETFs.

In addition to the dynamic interactions between ETFs and their underlying securities, other financial stability risks of ETFs are explored in the literature; however, these are not typically related to the redemption mechanism. For example, Converse et al. (2020) find that due to rapid growth, ETFs have increasingly become a channel for international capital flows, thus amplifying global financial cycles, particularly in emerging markets. Furthermore, these amplification effects of ETFs are significantly larger than those of open-end mutual funds. In a study of ETFs invested in corporate bonds, Pan and Zeng (2017) demonstrate that bond market illiquidity imposes limits on ETF arbitrage, leading to persistent misalignments between the fund price and net asset value. During periods of market distress, such misalignments are more prevalent in bond ETFs, which, unlike equity ETFs, experience a significant decrease in arbitrage activities by authorised participants (APs), who are typically broker-dealers or market makers in the underlying securities. Baltussen et al. (2019) present evidence suggesting that passive investment products, such as ETFs, lead to excessive stock price movements even at the index level.

To analyse the role of cash redemption, we first explore the flow–performance relationship in the context of ETF fund flows. Following the seminal work of Sirri and Tufano (1998), the flow–performance relationship of investment funds is explored in many studies, such as those by Coval and Stafford (2007), Chen et al. (2010) and Goldstein et al. (2017). Nearly all of these studies analyse open-end

the concept of ‘strategic complementarities’, wherein investors have stronger incentive to take a certain action if they expect other investors to follow suit. This results in a multiplier effect that amplifies the effects of fundamentals on investors’ behaviour.

mutual funds and generally observe a positive relationship, i.e., an increase (decrease) in fund flows in response to positive (negative) fund performance, suggesting that fund investors chase fund managers perceived to have superior investment capability (often known as 'alpha' by market participants). Some studies extend this research focus to other financial institutions, such as pension funds and insurance companies (e.g., Timmer (2018)). However, very few exclusively study ETF fund flows, possibly because ETFs are predominantly passively managed, and therefore, the motivation of chasing superior fund managers appears to be irrelevant as an explanatory factor. To the best of our knowledge, only Clifford et al. (2014) exclusively analyse the drivers of ETF fund flows. However, their study does not focus on financial stability; instead, they use ETFs as a counterexample to illustrate that the pursuit of superior fund managers, as postulated by Berk and Green (2004), fails to sufficiently explain the positive flow–performance relationship.

Our study is somewhat related to liquidity management tools, as we aim to compare the ETF cash and in-kind redemption mechanisms. This comparison may highlight the effect of in-kind redemption on redemption mitigation. The findings of Zhao et al. (2020) are most relevant to our study, as the authors demonstrate that open-end funds that reserve the right to in-kind redemption experience less redemption after poor performance. However, we focus on ETFs rather than open-end funds. Alternative liquidity management tools such as swing pricing are also addressed in the literature. For example, Jin et al. (2019) and Lewrick et al. (2017) find that swing pricing can alleviate redemptions of open-end funds. Fong et al. (2021) confirm the effectiveness of swing pricing during the March 2020 turmoil and find that it is more effective when applied to open-end funds that hold fewer liquid assets or have a retail investor base.

In summary, cash redemption may be a source of financial fragility. However, the relevant literature is focused on open-end mutual funds, particularly those holding illiquid assets. In studies on the implications of ETFs for financial stability, the shock transmission channels mainly involve the effects of ETFs on underlying securities, whereas the role of cash redemption tends to be overlooked. To address this important but unexamined area, we study the ETF cash redemption mechanism as a channel for vulnerability in financial markets.

3) BACKGROUND AND HYPOTHESES

3.1 Basis of regional preference for cash-redeemable ETFs

Generally, in-kind redemption from ETFs is more common than cash redemption, as it protects ETF shareholders from any transaction costs arising from fund contraction. For example, in the cash redemption mechanism, capital gains taxes are realised once the ETF manager liquidates part of the underlying securities for cash to meet shareholders' redemption orders, and the remaining shareholders must bear the related costs. In contrast, capital gains taxes are not realised when underlying securities are used to meet in-kind redemption orders (Poterba & Shoven, 2002). However, other factors increase the attractiveness of cash-redeemable ETFs and contribute to their dominance in Europe and EMEs.

In Europe, tax efficiency arising from synthetic ETFs increases the popularity of cash-redeemable ETFs. As share transactions are taxable, ETF managers face greater costs associated with index replication when they hold all securities than when they use derivatives or swaps (i.e., are synthetic). Therefore, the majority of ETFs invested in Europe are synthetic. As derivatives or swaps cannot be transferred easily between an ETF and redeeming shareholders, redemption is always conducted in cash (Gastineau, 2010; Pagano et al., 2019).

In an EME, securities are less liquid, and therefore ETF managers cannot easily purchase the underlying securities upon receiving a creation order, leading to tracking errors. To minimise such errors, they may opt to enter derivatives or swaps for index replication without having to hold every security. Similar to the European situation, this synthetic ETF structure necessitates cash redemption (Bioy et al., 2019; Arora et al., 2019).

3.2 Channel by which ETFs affect financial stability

Unlike investors in traditional open-end mutual funds, who can redeem their shares directly from fund managers, investors in ETFs can only sell their shares in the secondary market. Indeed, the redemption of ETF shares discussed in this paper is confined to direct deals between ETF managers and APs. If investor demand for ETF shares weakens, the ETF share price will fall faster than its underlying asset value per share[10], creating a share discount. To profit from this discount, an AP can

[10] See Ben-David et al. (2018) and Brown et al. (2020) for details.

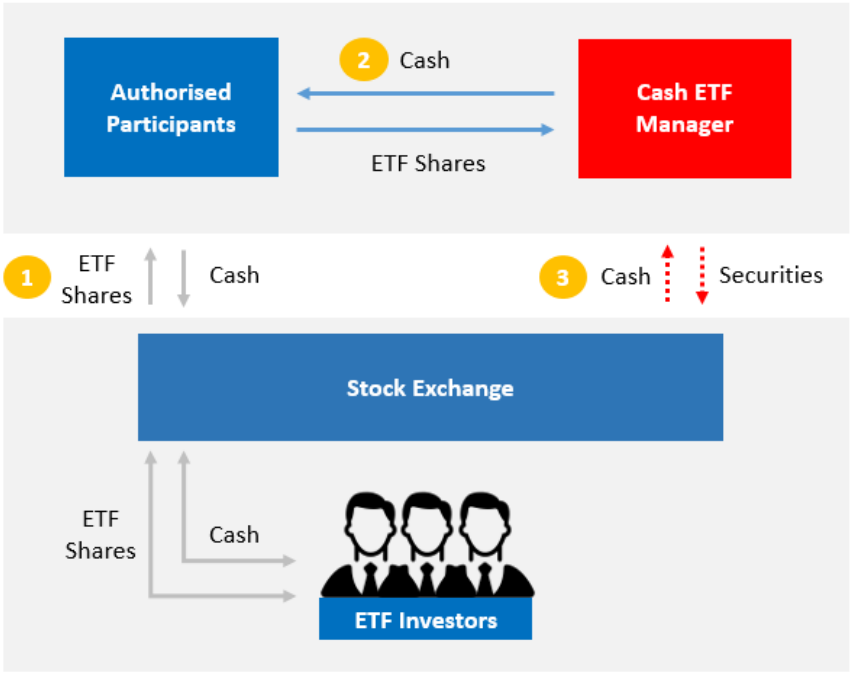
arbitrage by purchasing shares in the secondary market (Step 1 of Figures 2 and 3) and then redeeming these shares with the ETF manager for cash (i.e., cash redemption) or a portfolio of underlying securities (i.e., in-kind redemption) (Step 2 of Figures 2 and 3)[11]. These arbitrage-based ETF trades can reduce the tracking error (i.e. ensure that the market price closely tracks the net asset value).

On the one hand, the cash redemption mechanism might offer flexibility or a cost advantage to ETF managers, as discussed in Section 3.1. On the other hand, it can increase the vulnerability of the ETF to a 'fire sale'. If an ETF that uses the cash redemption method must meet massive cash redemption orders but has insufficient cash holdings, the ETF manager may be compelled to sell its underlying assets at unfavourable terms (Step 3 of Figures 2 and 3). Such a fire sale worsens the subsequent return of the ETF, widens its tracking error (i.e. ETF return minus its benchmark index return) and further weakens the demand for the ETF shares, causing another round of redemptions and thus repeating the cycle (i.e. restarting Steps 1–3). Therefore, for an ETF with a low cash level, the cash redemption method can increase the vulnerability of the flow to fund performance.

In contrast, in-kind ETFs do not have to raise cash quickly in response to massive redemption orders, thus eliminating the need for ETF managers to conduct a fire sale. Therefore, we expect that investors do not focus on in-kind ETFs as intensively as on cash ETFs during market downturns, assuming that all other variables are equal.

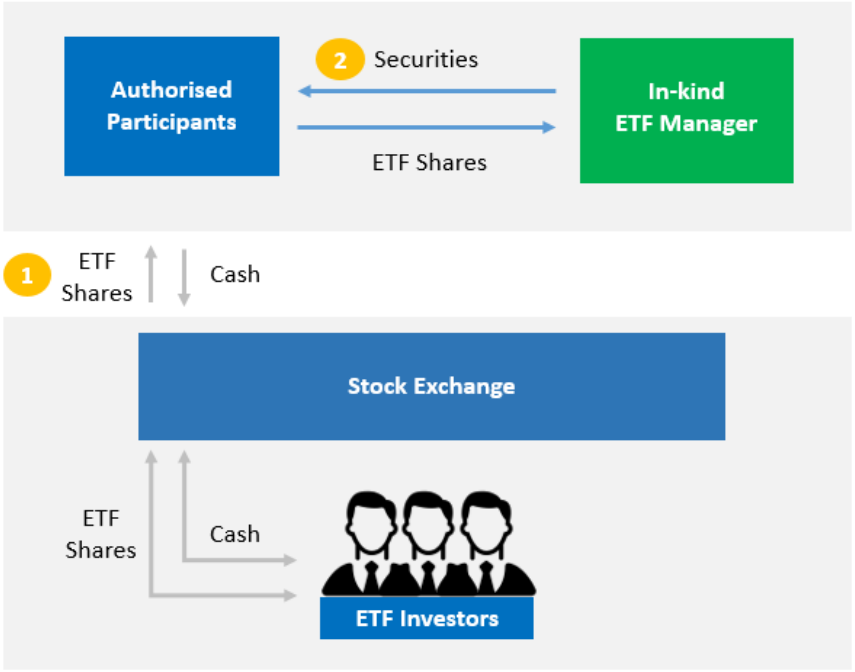
[11] If the ETF price is higher than the value of underlying securities, APs can take arbitrage the other way round, i.e. buying underlying securities and delivering them to the ETF fund managers (for in-kind ETFs), or paying the equivalent amount of cash to the manager (for cash ETFs), in exchange for ETF shares. The acquired ETF shares can then be sold for a profit.

Figure 2: Cash redemptions of ETF shares by APs and associated sales of assets by ETF managers



Notes: The figure illustrates the cash redemption arrangement. In response to an ETF discount, APs undertake profitable arbitrage by (1) buying ETF shares from the stock exchange and (2) redeeming these shares for the equivalent market value in cash. If the ETF does not have sufficient cash holdings, the cash ETF manager might have to (3) sell the underlying assets for cash to meet the redemption orders. Discounted sales depend partly on the liquidity of the underlying assets in the secondary market.

Figure 3: In-kind redemptions of ETF shares by APs



Notes: The figure illustrates the in-kind redemption arrangement. In response to an ETF discount, APs undertake profitable arbitrage by (1) buying ETF shares from the stock exchange and (2) redeeming these shares for securities. The APs may then resell these securities in the secondary market (not shown in this chart for brevity) and bear any extra transaction costs associated with redemption.

3.3 Hypotheses

We develop the following three hypotheses based on our conjecture that cash-redeemable ETFs are more vulnerable to fire sale by fund managers during market downturns, as described in the previous sections.

Hypothesis 1. The concavity of the flow–performance relationship increases proportionally to the extent to which an ETF meets its cash redemption orders.

Hypothesis 2. The outflows of cash-redeemable ETFs with a low level of cash holdings are more sensitive to poor performance, while the outflows of in-kind ETFs are not.

Hypothesis 3. Cash-redeemable ETFs with a low level of cash holdings are more likely to underperform their indices after meeting redemption orders, while in-kind ETFs are not.

Regarding the first hypothesis, we expect that given the risk associated with cash-redeemable ETFs, investors would more abruptly redeem those that have to meet cash redemption orders in the event of poor fund performance. In econometric jargon, this is equivalent to a more concave flow–performance relationship, wherein the outflows are more sensitive to poor fund performance than are the inflows to good performance. With our second hypothesis, we further study whether such abrupt redemptions are driven by cash-redeemable ETFs with low cash levels, which themselves fuel investors' concern that the ETF managers may liquidate the underlying assets at a discount once they are unable to meet cash redemption orders. In this scenario, investors who do not redeem their ETF shares as soon as possible may have to bear the financial losses incurred by fire sales. We then seek evidence that the managers of cash-redeemable ETFs submit the underlying assets in fire sales once they run out of cash to meet redemption orders. Such fire sales would worsen the returns of these ETFs relative to the benchmark. This possibility is the foundation of our third hypothesis.

These three hypotheses are interlinked. While we find potentially abrupt redemptions from cash-redeemable ETFs during market downturn in accordance with the first hypothesis, we further explore the drivers of such abrupt redemptions using the remaining hypotheses. Furthermore, such abrupt redemptions may be accompanied by downward spirals in fund returns and outflows, as argued jointly by the second and third hypotheses.

4) DATA

4.1 Sample selection

In our empirical studies, we use equity ETF data retrieved from the Morningstar Direct investment analysis platform for the period 2007Q1 to 2019Q4. The Morningstar Direct dataset includes 12,568 equity ETFs and has worldwide coverage. We shortlist 2,293 ETFs using the following rules. First, as we manually match the characteristics of ETFs from Morningstar with their redemption mechanisms from Bloomberg via their ISINs, we exclude those for which the redemption mechanism cannot be identified through Bloomberg. Second, we exclude ETFs with less than 1 year of history, as the literature indicates that newly launched funds tend to have exponential growth. Third, we exclude actively managed ETFs, which do not track any indices and make up a negligible subpopulation of the ETF universe.[12] Fourth, to avoid survivorship bias, our sample includes both on-going and terminated ETFs.[13] Fifth, following Brown et al. (2020), we exclude ETFs with an asset size of less than US$50 million to avoid distortion of our results by tiny ETFs.[14]

Based on these rules, the asset size of our final sample totalled US$4.37 trillion at the end of 2019, accounting for 91.24% of the total assets in the equity ETF universe according to Morningstar Direct. Our sample comprises 2,293 equity ETFs, among which 910 are in-kind ETFs and the remainder are cash-redeemable. Of these cash-redeemable ETFs, 551 are redeemed in cash only (‘cash ETFs’), while 832 can be redeemed either in cash or in kind (‘hybrid ETFs’).

4.2 Measurement of key variables

The key variables in our empirical analyses are ETF flows, cash holdings and tracking errors. As a standard practice, we measure the redemptions (or subscriptions) of an ETF according to its fund flows, defined as the percentage changes in total net assets of each ETF, net of its returns. Specifically, the fund flow

[12] Since 2000, 566 actively managed ETFs have been recorded. As of December 2019, these ETFs accounted for only 0.75% of the total assets of all equity ETFs.

[13] The correction of survivorship bias is crucial, as asset management companies tend to liquidate poorly performing funds, particularly those suffering from massive redemptions. Therefore, if this bias is not corrected, the sample might over-represent funds with good performance and substantially under-represent those with poor performance.

[14] At the end of 2019, 2,108 of the 4,482 equity ETFs available in Morningstar Direct had a net asset size less than US$50 million. However, those small-sized ETFs only accounted for 0.7% of the total net assets of the equity ETF universe. The exclusion of those small-sized ETFs from our sample helps to capture the redemption risk of ETFs that are materially important to financial markets.

for ETF i in quarter t is defined as

$$\mathrm{Flow}_{i,t} = \left(\mathrm{TNA}_{i,t} - \mathrm{TNA}_{i,t-1}\left(1 + \mathrm{r}_{i,t}\right)\right) / \mathrm{TNA}_{i,t-1} \quad (1)$$

where $\mathrm{TNA}_{i,t}$ is the total net asset value of ETF i at the end of quarter t and $\mathrm{r}_{i,t}$ is the return of the ETF during quarter t.

The cash holdings of an ETF provide a comprehensive measure of the liquidity of the underlying assets; this variable includes not only the cash balance but also all other financial instruments held by the ETF with a maturity of no more than 92 days, according to by Morningstar Direct. This measure is crucial when ETFs can easily liquidate other assets without any discounts despite depleting their cash balance to meet cash redemption orders. We scale the cash holdings of ETFs by their total net assets and then create two dummy variables for our regression model. As shown in Equation (2) below, $LowCash$ is a dummy variable equal to 1 if the cash holdings of ETF i as a percentage of its total net assets, denoted by $Cash_{i,t}$, exceed the 25th percentile of its peers that adopt the same redemption method in quarter t, and 0 otherwise.[15] For Equation (3) below, $NormalCash$ is a dummy variable that takes the opposite pattern of $LowCash_{i,t}$.

$$LowCash_{i,t} = \begin{cases} 1, & Cash_{i,t} < 25th\ percentile_t \\ 0, & Cash_{i,t} \geq 25th\ percentile_t \end{cases} \quad (2)$$

$$NormalCash_{i,t} = \begin{cases} 0, & Cash_{i,t} < 25th\ percentile_t \\ 1, & Cash_{i,t} \geq 25th\ percentile_t \end{cases} \quad (3)$$

Finally, as we do not have data on asset liquidation by ETF managers, we proxy fire sales using ETFs' tracking errors, which are equivalent to the returns net of their benchmark index (or returns of the indices that they track). Theoretically, the tracking error turns to be negative (or widened) if the ETF manager sells the underlying assets at a discount because the ETF return decreases, although its benchmark index is rarely affected. For example, if an index initially decreases by 10%, investors would abruptly redeem the ETF that tracks the index to the extent that its manager has to sell the underlying assets at a discount. Although this fire sale

[15] For each quarter, we measure the bottom quartile of cash holdings for each ETF type. An ETF holds a low level of cash in quarter t if its cash holding is less than the bottom quartile of that quarter among the ETFs that have the same redemption mechanism. Our threshold is more stringent than Goldstein et al. (2017), who set the threshold at the average, instead of the bottom quartile. Our threshold benefits from capturing the ETFs for which demand for cash holdings is more pressing.

may depress the ETF return by 1%, the index return remains unchanged because the sell-off has a negligible effect on the market. Therefore, the ETF return achieved is -11%, which when compared with the -10% benchmark return leads to a -1% tracking error that serves to proxy the aforementioned fire sale.

4.3 Summary statistics

Summary statistics of the variables are presented in Table 1. We winsorise the fund flows and tracking errors at the 1% level to minimise distortions caused by outliers in our sample. As shown in Table 1, the highest standard deviation of fund flows is observed for cash ETFs (46.24%), followed by hybrid ETFs (38.11%) and in-kind ETFs (22.86%). The tracking errors exhibit the same pattern, although the means are generally near zero. These preliminary findings appear to be consistent with our hypotheses. Notably, cash-redeemable ETFs hold almost no cash and thus differ little from in-kind ETFs, possibly to avoid cash drag on their returns and thus track their indices as closely as possible. This extremely low level of cash (or equivalent asset) holding by cash-redeemable ETFs is concerning, as it increases the risk of a fire sale of underlying assets to bolster insufficient liquid assets in the face of massive cash redemption orders.

Table 1: Summary statistics of variables in the study

Variable	**Mean**	**SD**	**10%**	**25%**	**50%**	**75%**	**90%**
Cash ETFs							
Fund flow (%)	10.50	46.24	-18.41	-7.42	0.68	12.68	40.59
Fund return (%)	2.21	9.24	-8.96	-2.40	2.78	7.07	12.02
Fund size (in log, US$ million)	5.49	1.12	4.16	4.58	5.30	6.21	7.04
Fund age (in log, years)	1.53	0.66	0.55	1.06	1.60	2.05	2.34
Tracking error (%)	0.01	1.93	-1.29	-0.20	-0.06	0.06	1.40
Cash ratio (%)	0.46	5.23	0.00	0.00	0.00	0.04	0.63
Hybrid ETFs							
Fund flow (%)	10.43	38.11	-13.63	-4.81	2.31	13.41	35.18
Fund return (%)	2.31	8.64	-8.11	-1.51	2.99	6.77	11.16
Fund size (in log, US$ million)	5.76	1.37	4.20	4.64	5.49	6.63	7.74
Fund age (in log, years)	1.53	0.68	0.58	1.04	1.56	2.04	2.41
Tracking error (%)	0.00	0.85	-0.38	-0.14	-0.05	0.06	0.53
Cash ratio (%)	0.47	4.10	0.00	0.00	0.08	0.40	0.95
In-kind ETFs							
Fund flow (%)	5.78	22.86	-11.85	-4.43	1.58	9.95	25.30
Fund return (%)	2.31	9.23	-9.29	-1.60	3.11	7.29	12.07
Fund size (in log, US$ million)	6.24	1.61	4.34	4.98	5.96	7.22	8.59
Fund age (in log, years)	1.95	0.67	0.97	1.54	2.06	2.45	2.71
Tracking error (%)	0.02	0.77	-0.24	-0.13	-0.05	0.04	0.50
Cash ratio (%)	0.36	1.88	0.00	0.00	0.11	0.33	0.80
Macro-variable							
VIX	19.44	8.87	11.99	13.72	16.60	22.72	29.04

5) METHODOLOGY

5.1 Sensitivity of fund flows to fund performance

Under Hypothesis 1, the concavity of the flow–performance relationship increases with the extent to which an ETF meets its cash redemption orders. To assess the concavity of this flow–performance relationship across redemption types, we estimate the sensitivity of fund flows to fund returns and differentiate the signs of the returns using the following panel regression model with a cross-sectional fixed effect across ETF types:

$$\begin{aligned}\mathrm{Flow}_{i,t} = {} & \alpha_1 r_{i,t-1} \times \mathrm{NonNegRet}_{i,t-1} + \alpha_2 r_{i,t-1} \times \mathrm{NegRet}_{i,t-1} + \alpha_3 \mathrm{Flow}_{i,t-1} \\ & + \gamma X_{i,t-1} + \sum_{T=t-1}^{t} \delta_T \mathrm{VIX}_T + \mu_t + \theta_i + \varepsilon_{i,t} \end{aligned} \quad (4)$$

where $\mathrm{NonNegRet}_{i,t-1}$ ($\mathrm{NegRet}_{i,t-1}$) is a dummy variable equal to 1 if the lagged fund return is non-negative (negative) and 0 otherwise. α_1 indicates the sensitivity of fund flows to non-negative fund returns, and α_2 estimates the sensitivity of fund flows to negative fund returns. A positive difference between α_1 and α_2 indicates a convex flow–performance relationship (i.e. inflows are more sensitive to good performance than outflows are to poor performance). In contrast, a negative difference indicates a concave flow–performance relationship (i.e. outflows are more sensitive to poor performance than inflows are to good performance). We obtain a more negative (or less positive) difference between α_1 and α_2 if the ETF has to meet cash redemption orders and test this difference using the Wald test. We run this model for each redemption type.

We include multiple control variables in the model. Lagged fund flow is introduced to control for any feedback effects. $X_{i,t-1}$ is a vector of the other lagged fund-specific control variables, such as fund size and fund age. The contemporaneous and lagged Chicago Board Options Exchange Volatility Indices, notated by VIX, are included as the control variables for risk aversion and mean reversal in the stock market. μ_t is a dummy vector of quarters that controls for seasonality. θ_i, and $\varepsilon_{i,t}$ denote the fund fixed effect and residual, respectively.

5.2 Cash holdings of ETFs and sensitivity of outflows to poor performance

According to Hypothesis 2, the outflows of cash-redeemable ETFs with a low level of cash holdings are more sensitive to poor performance. Focusing on

poor fund performance, we again estimate sensitivity but further differentiate ETFs with low and normal cash levels using the following extended model:

$$\begin{aligned}\mathrm{Flow}_{i,t} = {} & \beta_1 \mathrm{r}_{i,t-1} + \beta_2 \mathrm{r}_{i,t-1} \times \mathrm{LowCash}_{i,t-1} + \beta_3 \mathrm{Flow}_{i,t-1} + \gamma \mathrm{X}_{i,t-1} + \\ & \sum_{T=t-1}^{t} \delta_T \mathrm{VIX}_T + \mu_t + \theta_i + \varepsilon_{i,t} \qquad \forall \ \mathrm{r}_{i,t-1} < 0 \end{aligned} \tag{5}$$

where the coefficient β_1 measures the flow–performance relationship of an ETF, without taking cash holdings into consideration. β_2, the coefficient of interest, indicates the additional sensitivity of the flows of an ETF with a low cash level to poor performance. The control variables remain the same as in the previous model. We expect to obtain a positive β_2 for cash-redeemable ETFs and an insignificant β_2 for in-kind ETFs.

5.3 Effect of outflows on the future performance of ETFs

According to Hypothesis 3, an ETF manager with a low level of cash holdings can be compelled by cash redemption orders to liquidate the ETF's underlying assets at a discount, and the resulting fire sale can worsen the ETF's future performance relative to its benchmark index. Accordingly, a negative association is established between the outflows and tracking errors of a cash-redeemable ETF. We test this association using the following extended model:

$$\begin{aligned}\mathrm{TrackError}_{i,t} = {} & \pi_1 \mathrm{Outflow}_{i,t-1} \times \mathrm{NormalCash}_{i,t-1} \\ & + \pi_2 \mathrm{Outflow}_{i,t-1} \times \mathrm{LowCash}_{i,t-1} + \pi_3 \mathrm{TrackError}_{i,t-1} + \gamma \mathrm{X}_{i,t-1} \\ & + \sum_{t-1}^{t} \delta_T \mathrm{VIX}_T + \mu_t + \theta_i + \varepsilon_{i,t} \end{aligned} \tag{6}$$

where $\mathrm{Outflow}_{i,t-1}$ is a dummy variable to indicate the redemption event that is equal to 1 if the fund flow is negative and 0 if non-negative. The coefficient π_2 is negative for a cash-redeemable ETF with a lower level of cash holdings if its subsequent investment return is worse than its benchmark index return after outflows.

6) EMPIRICAL RESULTS

6.1 Increase in flow–performance relationship concavity for cash-redeemable ETFs

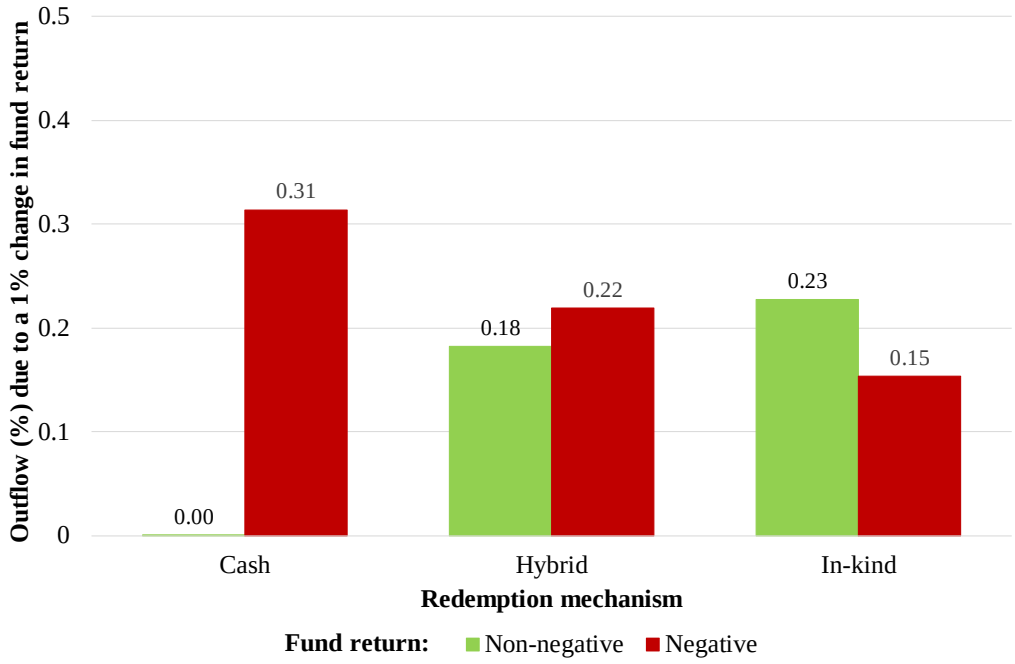
We show that the concavity of the flow–performance relationship

increases with the extent to which an ETF meets its cash redemption orders. Table A2 presents the estimations generated by Equation (4), and Figure 4 depicts the estimated sensitivities of ETF flows to non-negative returns (green bars) or negative returns (red bars). For cash ETFs, the inflows are insensitive to good fund performance; however, the outflows intensify as the fund returns become negative. Specifically, a 1% return induces a near-zero inflow, whereas a 1% loss induces an outflow of around 0.31%. The difference between these estimates is negative at a 1% level of significance (Wald test; Column 1, Table A2), showing that the flow–performance relationship is concave for cash ETFs.

The flow–performance relationships of hybrid ETFs and in-kind ETFs are relatively less concave. For hybrid ETFs, the flow–performance relationship is neither concave nor convex; the estimated sensitivity of hybrid ETF flows to fund returns increases insignificantly from 0.18 to 0.22 as the returns shift from positive to negative (Wald test; Column 2, Table A2). In-kind ETFs exhibit a convex flow–performance relationship: a 1% positive return induces an inflow of around 0.23%, whereas a 1% loss induces an outflow of 0.15%, and the difference between these estimates is positive at 10% level of significance (Wald test; Column 3, Table A2).

In summary, for a cash-redeemable ETF, a more concave flow–performance relationship reflects investors' tendency to redeem shares in these funds abruptly in response to poor fund performance. At a large scale, such redemptions could potentially amplify financial market turbulence.

Figure 4: Sensitivity of ETF flows to fund returns by redemption mechanism (Equation 4)



Note: (1) Solid bars denote statistical significance at the 10% level.
(2) The green and red bars represent α_1 and α_2, respectively.

6.2 Low cash level as a driver of abrupt redemption from cash-redeemable ETFs

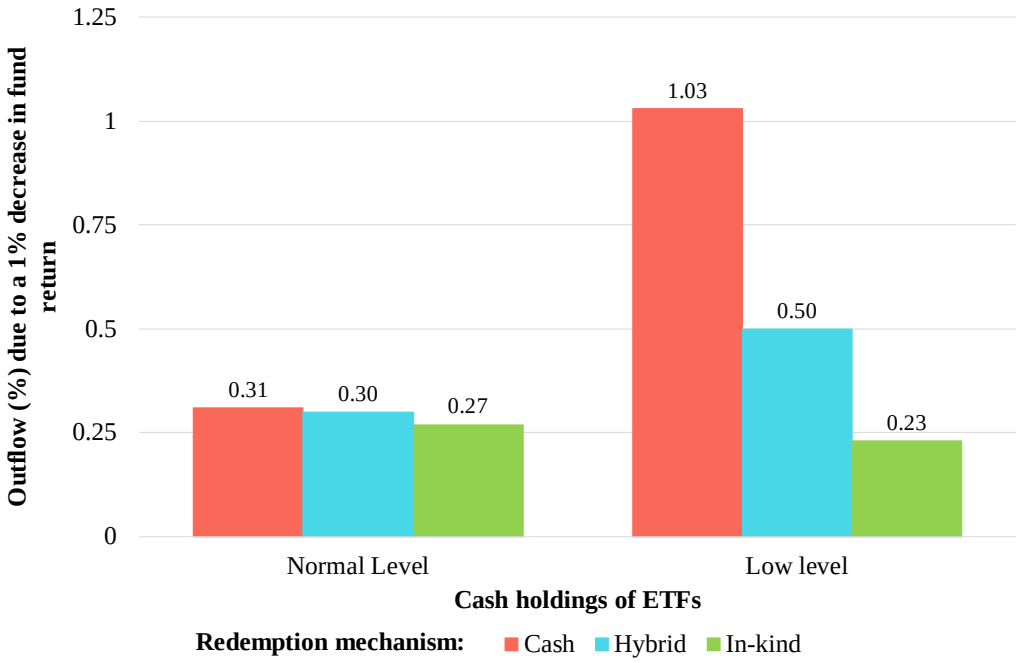
We further show that abrupt redemptions from cash-redeemable ETFs (as described in Section 6.1) are driven by a low cash level. Table A3 presents the results of Equation (5), and Figure 5 depicts the sensitivities of fund flows in response to fund performance for an ETF with a normal (bars at left) or low level (bars at right) of cash holdings. For ETFs with a normal level of cash holdings, the redemption type has little effect. Specifically, a 1% decrease in the return on ETF investment is associated with an outflow of around 0.3% at no more than 5% level of significance (β_1, Table A3), regardless of redemption type, suggesting that the redemption method does not prompt investors to redeem shares of cash-redeemable ETFs more intensively than those of in-kind ETFs, when these ETFs have adequate cash holdings.

However, for ETFs with a low level of cash holdings, the cash redemption method increases the sensitivity of the fund outflow to poor fund performance. Specifically, a 1% decrease in the return on ETF investment is associated with an outflow of 1.03% from cash ETFs at a 5% significance level ($\beta_1+\beta_2$, Column 1, Table A3) by Wald test, which is more than triple the outflow of cash ETFs with a normal level of cash holdings (β_1, Column 1, Table A3). For other

types of ETFs with a low level of cash holdings, the estimated outflows decrease to the extent at which they meet redemption orders in kind. A 1% decrease in the return on ETF investment is associated with a significant outflow of around 0.5% for hybrid ETFs (or 0.2% more than that for hybrid ETFs with a normal level of cash holdings) and 0.23% for in-kind ETFs. In the event of poor fund performance, investors appear to more intensively redeem the shares of ETFs that meet cash redemptions to a greater extent but hold a low level of cash.

Our findings that abrupt redemptions from cash-redeemable ETFs (as described in Section 6.1) appear to be driven by a low level of cash holdings may be attributable to investors' concern that the managers of such funds are likely to liquidate the ETFs' underlying assets at a discount. Therefore, if the investors do not sell their ETF shares as early as possible, then they must bear the financial losses incurred by forced liquidation.

Figure 5: Sensitivity of ETF flows to fund returns by the level of cash holdings (Equation 5)



Note: (1) Solid bars denote statistical significance at the 10% level.
(2) The three left-hand bars represent β_1, and the right-hand bars represent $\beta_1 + \beta_2$.

6.3 Association of lower cash-redeemable ETF future performance with a low level of cash holdings

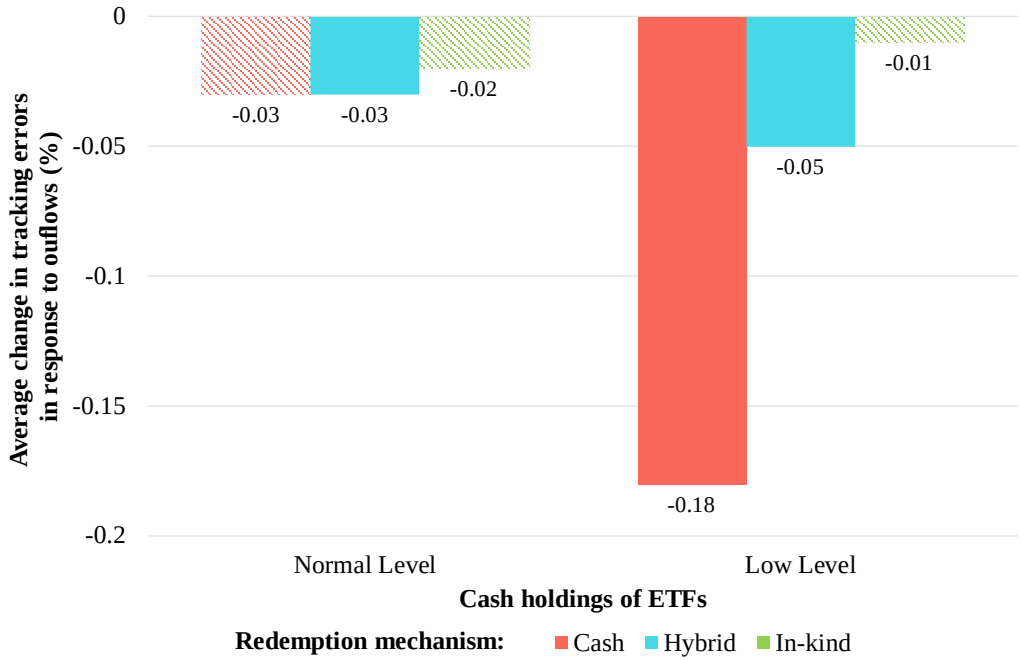
Finally, we present evidence that in response to cash redemption orders, managers of cash-redeemable ETFs with a low cash level liquidate the fund's assets

at a discount, which depresses the future fund performance against the benchmark index returns. Table A4 presents the results of Equation (6), and Figure 6 depicts the tracking errors relative to the benchmark indices of ETFs with normal (bars at left) and low levels of cash holdings (bars at right). We find that for ETFs with a normal cash level and any redemption method, the estimated tracking errors in response to outflows are immaterially small (i.e., -0.02 to -0.03), although the estimate for the hybrid ETFs is statistically significant at 10% level (π_1, Column 2, Table A4). Therefore, outflows do not materially depress the future performance of an ETF with a normal cash level against its benchmark index.

However, for a cash-redeemable ETF with a low level of cash holdings, outflows significantly depress the future fund performance. In this analysis, outflows widened the tracking errors in quarterly returns by an average of 0.18% for cash ETFs and 0.05% for hybrid ETFs. In other words, these two ETF types significantly underperform their own benchmark indices after recording outflows. In contrast, outflows do not have a statistically significant effect on tracking errors for in-kind ETFs.

The results in this section have three implications. First, we provide indirect evidence that managers of cash-redeemable ETFs with a low cash level undertake fire sales, as reflected in the wider tracking errors. Second, we observe a downward spiral in the ETF returns and outflows of cash-redeemable ETFs. Specifically, poor fund performance induces outflows, as described in Sections 6.1 and 6.2, and these outflows worsen fund performance. Third, the worse future performance of cash-redeemable ETFs arguably explains the greater sensitivity of these funds' outflows to poor performance, as shown in Section 6.2. Specifically, investors should redeem their shares in cash-redeemable ETFs with a low cash level as soon they anticipate a fire sale prompted by outflows; otherwise, other investors' redemptions will decrease the value of their shares.

Figure 6: Sensitivity of ETF tracking errors from the benchmark index to redemption (Equation 6)



Note: (1) Solid bars denote statistical significance at the 10% level.
(2) The three LHS bars represent π_1, and the RHS bars represent π_2.

7) CONCLUSION

Despite rapid growth in the ETF market since the 2007–08 Global Financial Crisis, the risk associated with the ETF redemption mechanism has not been well examined. This paper fills this gap by showing that an initial shock to an ETF could lead to a downward spiral in both fund performance and flows, depending on the redemption mechanism. At a large scale, such a downward spiral could even magnify a downturn in the broader financial market.

Our results have several implications. First, this paper underscores the financial vulnerability of Europe and EMEs if cash-redeemable ETFs in those markets are redeemed on a large scale. Although cash redemption mechanisms may be more practical or tax-efficient for ETF managers in those economies, regulators should carefully scrutinise related policies and balance the pros and cons of this mechanism to ensure overall financial stability.

Second, the growing popularity of the cash redemption mechanism in ETF markets may conflict with a deduction by some researchers that the shift to ETFs from traditional open-end funds over the past decade could reduce the redemption

risk as more mutual funds become redeemable in kind (Anadu et al., 2019). This deduction assumes that most ETFs are redeemable in kind. However, our findings reveal that ETFs have become increasingly similar to traditional open-end funds in terms of redemption mechanism, and this shift may therefore be less ideal than expected.

Finally, our empirical results suggest that in-kind redemption could protect the fund performance and flows of an ETF from entering a downward spiral. Therefore, this redemption mechanism warrants regulators' attention as a liquidity management tool not only for ETFs but also for traditional open-end funds, which may react similarly to cash-redeemable ETFs to massive cash redemption orders. Our paper thus provides a reference for regulators who review existing liquidity management tools for the mutual fund industry.

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APPENDIX

Table A1. Data sources of variables

Variable	Definition	Unit	Data Source
Fund flow	Percentage change in the total net assets of the ETF, net price change	%	Morningstar Direct and HKMA estimates
Fund return	Total return of the ETF	%	Morningstar Direct
Fund size	Logarithm of the total net assets of the ETF (in million USD)	--	Morningstar Direct and HKMA estimates
Fund age	Logarithm of the age of the ETF (in years)	--	Morningstar Direct and HKMA estimates
VIX	The quarter-end Chicago Board Options Exchange Volatility Index	--	Bloomberg
Tracking error	Return of the fund minus return of the index that the ETF is tracking	%	Morningstar Direct, Bloomberg and HKMA estimates
Cash ratio	Cash holdings as a percentage of the total net assets of the ETF	%	Morningstar Direct

Table A2. The ETF flow–performance relationship by redemption type, based on Equation (4):

$$\mathrm{Flow}_{i,t} = \alpha_1 \mathrm{r}_{i,t-1} \times \mathrm{NonNegRet}_{i,t-1} + \alpha_2 \mathrm{r}_{i,t-1} \times \mathrm{NegRet}_{i,t-1} + \alpha_3 \mathrm{Flow}_{i,t-1} + \gamma \mathrm{X}_{i,t-1} + \sum_{T=t-1}^{t} \delta_T \mathrm{VIX}_T + \mu_t + \theta_i + \varepsilon_{i,t}$$

Conditional on fund return (t-1) < 0	Dependent variable: Fund flow (t)		
	Cash ETFs	Hybrid ETFs	In-kind ETFs
	(1)	(2)	(3)
Non-negative fund return (t-1)	0.00	0.18***	0.23***
Negative fund return (t-1)	0.31***	0.22***	0.15***
Fund size (t-1)	-10.98***	-8.53***	-4.77***
Fund age (t-1)	-4.37***	-1.77***	-1.49***
Fund flow (t-1)	0.02***	0.05***	0.06***
VIX (t)	-0.24***	-0.12***	-0.22***
VIX (t-1)	0.10*	0.06	0.05**
Wald test: $\alpha_1 - \alpha_2$	-0.31*** (Concave)	-0.04 (Neither concave nor convex)	0.07* (Convex)
Fund fixed-effect	Yes	Yes	Yes
Seasonality controls	Yes	Yes	Yes
R-squared	0.09	0.11	0.08
Funds	490	750	870
Observations	8209	11530	23908

Note: ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

Table A3. The ETF flow–performance relationship by redemption type, based on Equation (5):

$$\text{Flow}_{i,t} = \beta_1 r_{i,t-1} + \beta_2 r_{i,t-1} \times \text{LowCash}_{i,t-1} + \beta_3 \text{Flow}_{i,t-1} + \gamma X_{i,t-1} + \sum_{T=t-1}^{t} \delta_T \text{VIX}_T + \mu_t + \theta_i + \varepsilon_{i,t}$$

Conditional on fund return (t-1) < 0	Dependent variable: Fund flow (t)		
	Cash ETFs	Hybrid ETFs	In-kind ETFs
	(1)	(2)	(3)
Fund return (t-1)	0.31**	0.30***	0.27***
Fund return (t-1) x Low cash (t-1)	0.72**	0.20**	-0.04
Fund size (t-1)	-17.71***	-10.43***	-6.58***
Fund age (t-1)	-8.38***	-2.63**	-1.34**
Fund flow (t-1)	-0.24*	-0.15**	-0.23***
VIX (t)	0.15	0.17*	0.12***
VIX (t-1)	0.00	0.06**	0.05**
Fund fixed-effect	Yes	Yes	Yes
Seasonality controls	Yes	Yes	Yes
R-squared	0.125	0.111	0.076
Funds	337	622	804
Observations	1766	3310	7455

Note: ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

Table A4. The effect of ETF outflows on tracking error by redemption type, based on Equation (6):

$$\text{TrackError}_{i,t} = \pi_1 \text{Outflow}_{i,t-1} \times \text{NormalCash}_{i,t-1} + \pi_2 \text{Outflow}_{i,t-1} \times \text{LowCash}_{i,t-1} + \pi_3 \text{TrackError}_{i,t-1} + \gamma X_{i,t-1} + \sum_{T=t-1}^{t} \delta_T \text{VIX}_T + \mu_t + \theta_i + \varepsilon_{i,t}$$

	Dependent variable: Tracking error (t)		
	Cash ETFs	Hybrid ETFs	In-kind ETFs
	(1)	(2)	(3)
Fund outflow (t-1) × Normal cash (t-1)	-0.03	-0.03*	-0.02
Fund outflow (t-1) × Low cash (t-1)	-0.18*	-0.05*	-0.01
Fund size (t-1)	-0.07	0.02	-0.02*
Fund age (t-1)	0.08	0.04*	0.08***
Tracking error (t-1)	0.03***	0.00	0.01**
VIX (t)	0.00	0.01***	0.00
VIX (t-1)	-0.04	-0.14***	-0.12**
Fund fixed-effect	Yes	Yes	Yes
Seasonality controls	Yes	Yes	Yes
R-squared	0.011	0.027	0.018
Funds	410	728	857
Observations	5419	10255	21920

Notes: ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.