Reports of the Advisory Scientific Committee

No 9 / June 2019

Can ETFs contribute to systemic risk?

by
Marco Pagano
Antonio Sánchez Serrano
Josef Zechner

ESRB
European Systemic Risk Board
European System of Financial Supervision

Contents

Executive summary 2

1 Introduction 4

2 ETFs at work 10

2.1 ETFs with physical replication 10

2.2 Complex ETF structures 13

2.3 Concentration in the ETF segment 16

3 ETFs and systemic risk 18

3.1 ETF-induced changes in securities risk 18

Box 1 Procyclical trading and inverse/leveraged exchange-traded products 23

3.2 Decoupling of ETF from constituent security prices 26

3.3 ETF-induced contagion 29

3.4 Counterparty and operational risks of ETFs 30

4 Conclusions and implications for future research 32

References 34

Imprint and acknowledgements 39

Executive summary

Exchange-traded funds (ETFs) are hybrid investment vehicles that track an index or a basket of assets, combine features of open-end and closed-end mutual funds, and are continuously traded on liquid markets. They are one of the most popular financial innovations in recent decades: ETFs have grown greatly in size, diversity, scope, complexity and market significance.

Drawing on the growing literature in this area, this report assesses possible channels through which ETFs may affect systemic risk. The increasing availability of ETFs can affect investors' behaviour, by allowing them to pursue new strategies to seek return, manage risk and access new asset classes. Such changes in investors' behaviour may in turn impact the functioning of financial markets, particularly in times of market stress. Empirical research has so far identified three effects.

First, ETFs are associated with greater co-movement of asset prices: stocks tend to co-move more with their respective indices once they are included in ETF portfolios. This increase in the co-movement of asset prices may pose systemic stability issues, as it makes it more likely that many investors face losses simultaneously, therefore potentially leading to waves of insolvencies and synchronised sales.

Second, there is evidence that ETFs are associated with increased price volatility of the constituent securities: the high liquidity and continuous trading of ETFs enable investors, including noise traders, to take large short-term directional positions on entire asset baskets. The unwinding of these positions in the ETF market can eventually result in crashes. Insofar as these are transmitted to the index itself as a result of arbitrage, they can increase both the volatility of the index and the correlation of individual security prices with the index. This may become problematic especially in times of financial stress, when ETF shares tend to become less liquid, particularly ETFs with illiquid underlying securities and those traded over the counter (OTC). While some recent evidence regarding US equity ETFs contradicts the view that they transmit non-fundamental shocks to the prices of constituent securities, this view is broadly accepted for some complex ETF configurations (such as leveraged ETFs), which can amplify the volatility of security prices through their rule-based trading strategies and directly induce a procyclical trading pattern.

Third, the arbitrage mechanism between ETFs and their constituent securities may operate imperfectly: ETF prices can deviate significantly from those of the constituent securities, especially at high frequencies, for illiquid assets and during periods of financial stress. Such decoupling results from "authorised participants" (APs) and "official liquidity providers" (OLPs) not having the incentives and/or the capacity to realign ETF prices with those of the constituent securities in times of financial stress. In these situations, the order flow may have a strong adverse impact on ETF prices, which could lead investors to "lose faith" in the liquidity transformation provided by ETFs and engage in potentially destabilising fire sales. However, while the partial breakdown of arbitrage may exacerbate fluctuations in ETF prices, it may also reduce instability in the prices of constituent securities. Therefore, an amplification of ETF price swings may in principle create systemic risk insofar as leveraged financial institutions hold material ETF positions on their balance sheets, while the opposite may occur if these financial institutions are exposed mostly to the risk arising from constituent securities.

The report also considers other channels through which ETFs can raise systemic risk concerns.

First, ETFs can contribute to systemic risk by inducing investors to take correlated exposures that may trigger a chain reaction with systemic risk implications. In this case, however, the focus should be more on the ability of financial intermediaries to take correlated exposures (in the form of ETF exposures or any other financial instrument) and fund them via increased leverage, rather than on the role played by ETFs themselves.

A further issue is whether ETFs are subject to counterparty risk that may raise systemic risk concerns. Synthetic ETFs are exposed to the risk that the swap counterparty is unable to fulfil its obligation to deliver the index return, while physical ETFs are exposed to counterparty risk through securities lending transactions, with the potential, in both cases, to generate fire sales in times of financial stress. However, recent developments in both the ETF market and broader market practices and regulation seem to have mitigated concerns that the materialisation of these risks may lead to systemic consequences.

Finally, owing to the high degree of concentration observed in the ETF market, materialisation of operational risk can in principle have systemic consequences. Even though ETF providers have developed policies to mitigate operational risk and no serious operational risk event has occurred so far, such risk cannot be ruled out completely. For instance, a technical failure or a high-profile case of financial misconduct affecting a single issuer may trigger mistrust among investors for the whole segment and thus generate widespread fire sales and large ETF price drops.

In conclusion, evidence suggests that ETFs may raise systemic risk through four main channels:

1. Higher volatility and co-movement of security prices, especially at times of market stress and if the constituent securities are illiquid;

2. Decoupling of ETF prices from those of constituent securities at times of stress, with destabilising effects on financial institutions heavily exposed to ETFs or reliant on them for liquidity management;

3. Inducement of investors to take large correlated exposures, which may result in contagion in the event of sharp ETF price drops;

4. Materialisation of operational risks in a major provider of ETFs, which may generate widespread sales of ETFs owing to the sector's very high level of concentration.

To further our understanding of the systemic risk implications of ETFs, future empirical research should focus on two key areas: (i) ETF order flows in periods of stress and their impact on the volatility, co-movement and illiquidity of both ETFs and their constituent securities, considering the arbitrage mechanisms that link the ETF primary and secondary markets; and (ii) the extent to which financial institutions have significant and common exposures to ETFs and/or rely on them for their liquidity management. It would be useful if this research were to focus on the European ETF market, as most of the empirical literature has focused so far on the US ETF market, where OTC transactions, cash redemptions and non-equity ETFs are less common.

1 Introduction

Exchange-traded funds (ETFs) are one of the most popular financial innovations of recent decades. They are hybrid investment vehicles that track an index or a basket of assets, combine features of open-end and closed-end mutual funds and are continuously traded on liquid markets. In the same way as for traditional open-end mutual funds, the number of ETF units can change over time in response to changing investor demands. At the same time, ETF shares can be continuously traded on a liquid secondary market at a transparent price, like the shares of closed-end funds.[1]

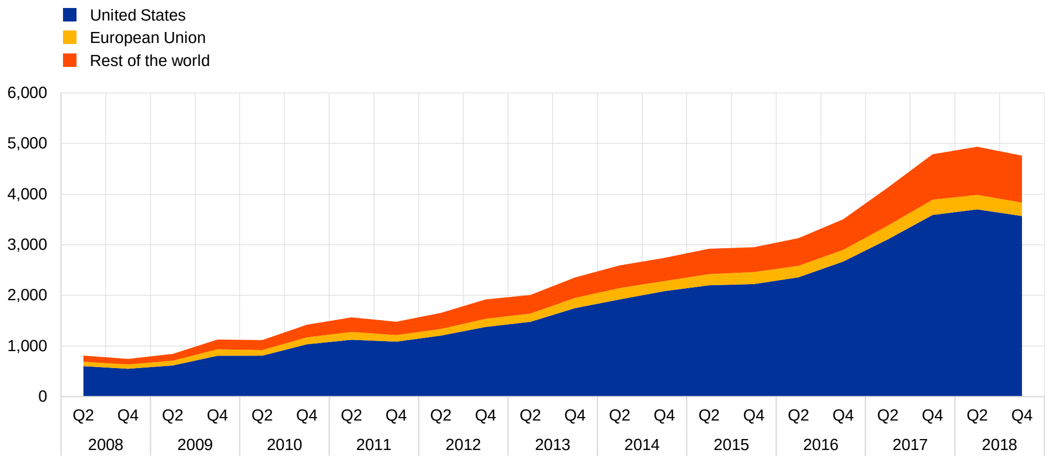
ETFs have grown substantially in size, diversity, scope, complexity and market significance in recent years (see Charts 1 and 2). The market share of ETFs has risen accordingly: even though they still account for a small portion of total market capitalisation, they represent, on average, more than 30% of the daily trading volume in US stock markets (see Charts 3 and 4). The growth of ETFs has been accompanied by an expansion in the range of underlying assets tracked by ETFs to also cover equities, bonds, commodities, currencies and even indices, such as the VIX. In Europe, around 70% of ETFs track equity indices (see Chart 5), but the share of ETFs tracking other financial assets, in particular fixed-income securities, has been growing in recent years (Morningstar, 2017).[2] More complex ETFs have also been created, which are structurally different from "simple" ETFs. These include: (i) synthetic ETFs, which use derivatives as their main instrument to track the index, (ii) smart beta ETFs, which do not replicate the relative market weights of the different component securities of the index, (iii) inverse ETFs, which take a short position on the index to deliver the inverse performance, and (iv) leveraged ETFs, which replicate a multiple of an index performance.

1 It must be noted that not all jurisdictions allow closed-end funds to be traded in secondary markets.

2 The passive nature of ETFs in that they constitute investments in fixed-income products may in principle create a moral hazard problem in the issuance of such products: anticipating that they will be bought by ETFs, bond underwriters may forgo due diligence on such instruments, as was the case in the originate-to-distribute business model before the global financial crisis (see, among others, Purnanandam, 2011).

Chart 1
Aggregate total net assets of ETFs

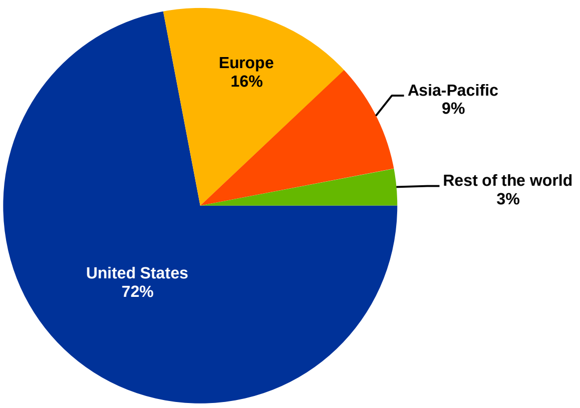
(USD billions)



Source: Morningstar and own calculations.

Chart 2
Distribution of ETFs by geographical area

(percentages)

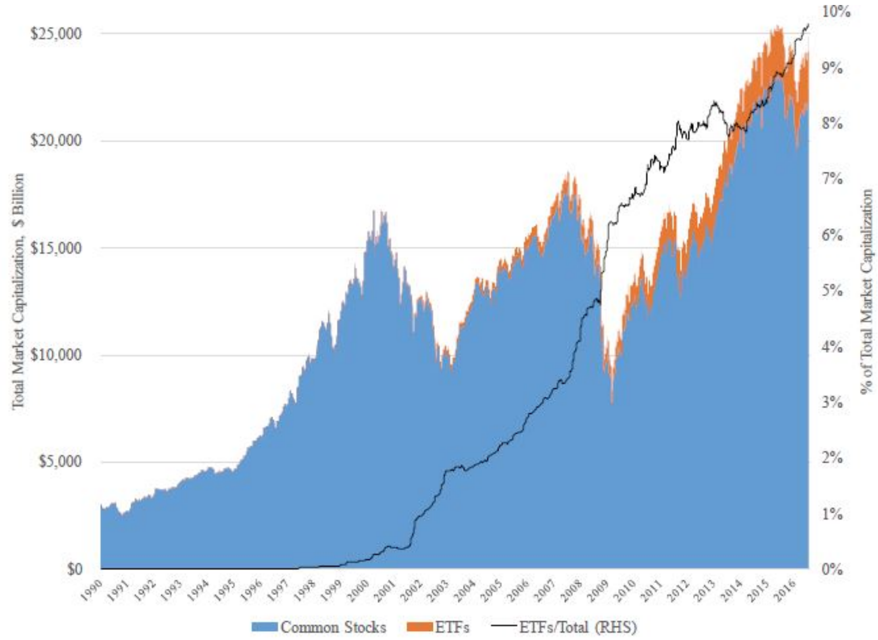


Source: Investment Company Institute (2018).
Note: According to total net assets as at 31 December 2017.

Chart 3

ETFs and total stock market capitalisation

(USD billions and percentages)

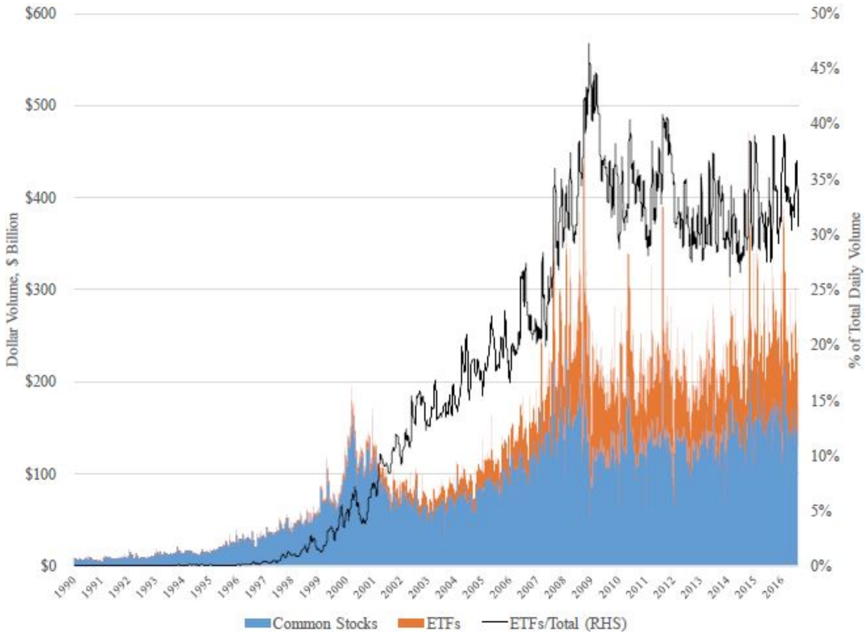


Source: Ben-David et al. (2017).

Chart 4

ETFs and total daily volume in stock market

(USD billions and percentages)

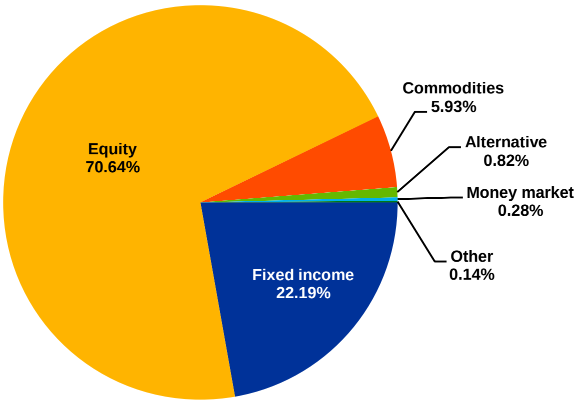


Source: Ben-David et al. (2017).

Chart 5

Distribution of ETFs in the EU according to their tracked financial assets

(percentages of assets under management)



Sources: Morningstar and own calculations.
Note: ETFs as reported in Morningstar at the end of June 2018.

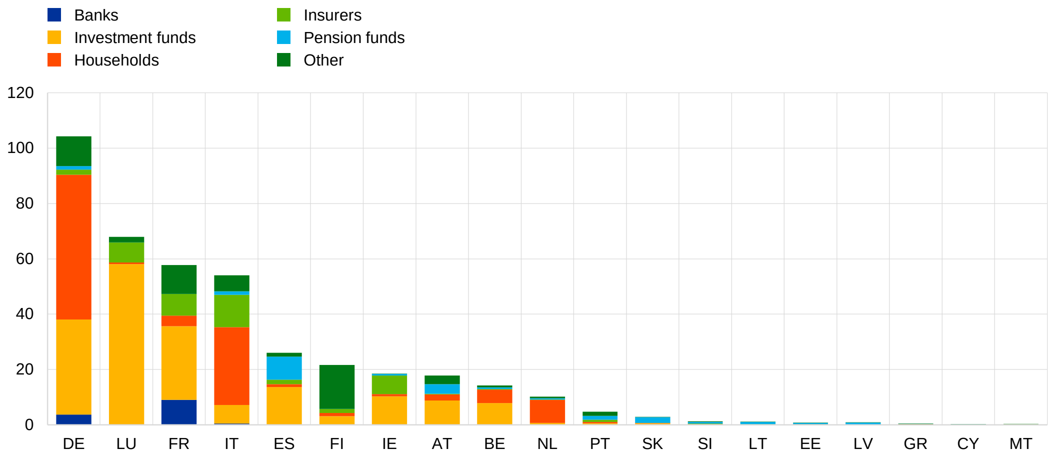
While most ETFs track liquid equity indices, one of their key features relates to their capacity to also replicate baskets of less liquid assets in the form of more liquid tradable securities, but this liquidity transformation could be subject to frictions (Deutsche Bundesbank, 2018; Turner and Sushko, 2018). ETFs that track an index of relatively illiquid assets (e.g. corporate bonds in emerging markets) create a mismatch between the expected liquidity of ETF shares and the underlying assets. There is evidence that the higher liquidity of ETFs shares vis-à-vis the underlying assets can attract investors who would not otherwise be willing to be exposed to the more illiquid underlying assets (Hamm, 2014; Broman, 2016). Deville et al. (2013) show that ETF liquidity and the liquidity of underlying assets are interdependent, with other factors, such as competition between market-makers and market fragmentation, also affecting ETF liquidity. According to the findings of Broman et al. (2018), ETFs that are more liquid than their underlying securities (i.e. positive relative liquidity), are particularly attractive to short-term investors. Accordingly, they document that relative liquidity is inversely related to the average holding duration of ETFs.

The majority of investors in ETF shares in Europe are institutional investors, with a limited direct participation of retail investors, mainly owing to the lack of distribution channels (Financial Stability Board, 2011; Morningstar, 2017; Central Bank of Ireland, 2017). Data from holdings of ETF shares in the euro area (see Chart 6) broadly confirm this fact, as the main investors in ETF shares are investment funds. In general, the direct exposure of banks to ETF shares is rather limited. Chart 6 also reveals substantial holdings of ETF shares by households in Germany, Italy and the Netherlands. In the United States, there is overall a higher participation of retail investors in the ETF market (although only 6% of US households invest in ETFs). Holders of ETFs are typically sophisticated investors, with higher levels of education and a sizable portfolio of financial assets (including similar financial products, such as stocks or mutual funds), above-average income and a higher than average appetite for risk (Investment Company Institute, 2018).

Chart 6

Holdings of ETF shares in the euro area

(EUR billions)



Sources: ECB Securities Holdings Statistics and own calculations.Holdings of Spanish banks are included in the category "other".
Note: The latest observation is for end-March 2018.

The trends seen in the ETF market may potentially affect the functioning of financial markets and merit discussion from a financial stability point of view. The trends described above can certainly affect the way in which investors participate in financial markets, as the liquidity features of ETFs allow them to pursue different strategies to seek returns, manage risk and access new asset classes (Blackrock, 2017a; Ben-David et al., 2017; Lettau and Madhavan, 2018). It is clear that ETFs have created important benefits for the investment community by lowering the costs of delegated portfolio management and improving investors' access to diversification. However, investors' behaviour may also be influenced by the availability of ETFs and by frictions in their operations, such as limits to arbitrage leading to the decoupling of the ETF price from the relevant index or the materialisation of operational risk in a major provider of ETFs. By affecting investors' behaviour, ETFs may impact the functioning of financial markets in terms of price discovery, liquidity and collateral management, among other things. As a result, regulatory authorities have recently made efforts to understand the impact of ETFs on financial markets and more specifically on financial stability (Financial Stability Board, 2011; Central Bank of Ireland, 2017; Autorité des marchés financiers, 2017; European Systemic Risk Board, 2018; European Central Bank, 2018; International Monetary Fund, 2018).

The aim of this report by the Advisory Scientific Committee is to contribute to that effort by focusing on the potential contribution of ETFs to systemic risk. Based on a review of the growing body of literature published recently in this area, this report assesses the possible channels through which recent developments in the ETF market may affect systemic risk in the financial system. Some of these channels are shared with other similar investment vehicles, like mutual funds, which are also of a larger size than ETFs in terms of assets under management. However, the rapid growth of the ETF market in the recent years, the unique characteristics of ETFs and their presence in the primary and secondary markets, warrants a focus on ETF-specific issues and how they may affect systemic risk in financial markets. This report thus contributes to the ongoing regulatory debate on ETFs, even though it does not discuss specific policy actions to address the systemic risks that they may generate or exacerbate.

The report is structured as follows. Section 2 explains the functioning of ETFs and the role of the different stakeholders involved. Section 3 describes the channels through which ETFs can contribute to systemic risk, and Section 4 concludes.

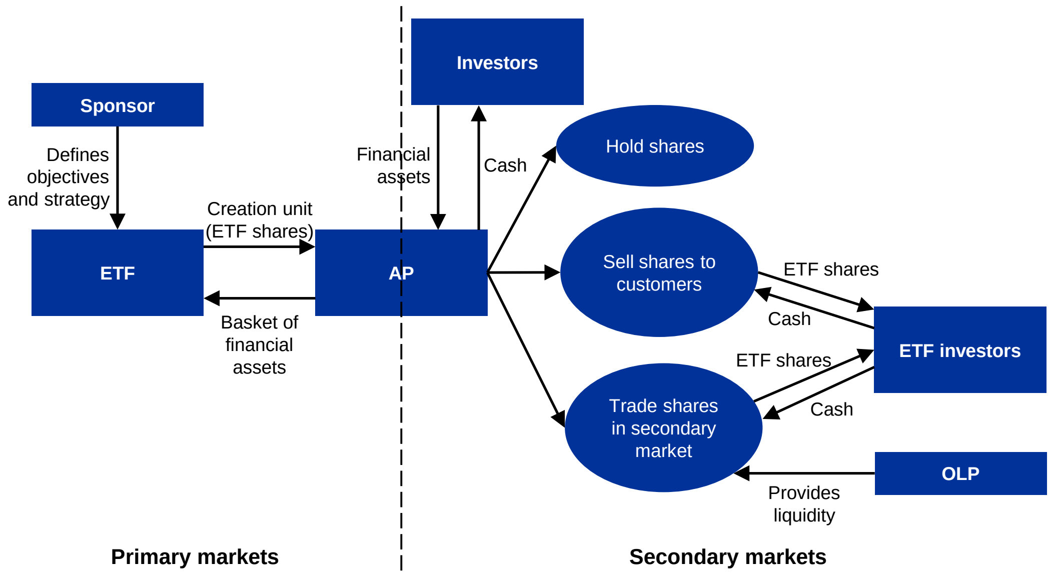
2 ETFs at work

Like all exchange-traded products (ETPs), ETFs track an index or other financial instruments, and can be traded on a secondary market. While much of the discussion below applies to the broader class of ETPs, which encompasses exchange-traded notes (ETNs), exchange-traded commodities and ETFs, this report focuses on ETFs. There is significant heterogeneity in the structures of ETFs to meet their investment objectives.[3] Before analysing the possible effects of ETFs on systemic risk, this section provides a brief description of the ETF market and of the main ETF structures.

2.1 ETFs with physical replication

The trading process for ETFs is a distinctive feature that allows them to combine features of traditional open-end funds and those of closed-end funds. The number of ETF shares can vary over time in response to investor demand, like those of open-end investment funds, and are traded on regulated secondary markets, like those of closed-end funds. Further detail is given below regarding the process of creating an ETF and how it functions (see Figure 1).

Figure 1
Functioning of an ETF with physical replication



Sources: own calculations, based on Autorité des marchés financiers (2017), Investment Company Institute (2015 and 2018) and Lettau and Madhavan (2018).
Notes: AP refers to Authorised Participants and OLP to Official Liquidity Providers. Creation units can also be delivered to the AP in exchange for cash.

3 Indeed, the expansion of ETFs beyond the "plain vanilla" configurations has led several stakeholders to call for policy work to adjust the labels of these products to make it easier for market participants to infer the inherent risks (see, for example, Fixed Income Market Structure Advisory Committee, 2018).

ETFs are originated upon the initiative of a sponsor, who also defines the objective, investment strategy and management of the ETF. Sponsors are typically (but not necessarily) financial institutions. Even if the majority of the ETFs are passively managed, it is possible to originate an active ETF: around 1.25% of ETFs traded in the European Union (EU) are actively managed, according to data from Morningstar.[4] At the time of originating the ETF, the sponsor defines not only the objective of the ETF but also how that objective will be achieved: with full physical replication of the underlying index, with a sample of the securities in the underlying index, with derivatives or with a synthetic replication (which also involves the use of derivatives).

Once the ETF with physical replication is originated, it exchanges "creation units", i.e. a number of ETF shares, with the authorised participants (APs) for a basket of underlying securities, the creation basket, or for an equivalent amount of cash that the ETF provider uses to buy the basket. The ETF shares sold to the APs in exchange for the basket of underlying securities or a cash equivalent are typically bundled in creation units containing between 25,000 and 250,000 shares (Investment Company Institute, 2018). In Europe, currently the predominant practice is the exchange of cash for the ETF creation units (Autorité des marchés financiers, 2017; Central Bank of Ireland, 2017).[5] Typically, the sponsor of the ETF contacts different APs and offers them its originated ETF. At present, there is no regulatory restriction on the minimum number of APs that an ETF must have. Once the ETF has been created, APs can then sell the ETF shares to ultimate investors (in centralised markets or OTC) or keep them in their own inventory. The opposite process is followed when ETF shares are redeemed by APs. Based on a sample of US-based ETFs, it has been found that ETFs typically have around 30 AP agreements (Investment Company Institute, 2015; Blackrock, 2017b), although not all of them are actively trading (Turner and Sushko, 2018).[6]

Since APs are commercial investors that bear risk when trading or holding ETFs, they do not have any particular commitment to the ETF sponsors or to their customers. Indeed, they do not have any obligation to create or redeem ETFs or to provide liquidity. They do not receive any fee from ETF sponsors or investors for their role as creators and redeemers of ETF shares. Basically, APs enter into these transactions seeking arbitrage profits.[7] They can earn such profits when there is a discrepancy between the net asset value of the ETF's portfolio of securities (assuming they know the ETF's portfolio composition file, PCF) and the price at which ETF shares trade in secondary markets. If ETF shares trade at a premium compared with the net asset value, the AP can sell ETF shares in secondary markets, buy the underlying securities, and create ETF units by delivering these securities in creation baskets at the end of the day. Conversely, if ETF shares trade at a discount, the APs can buy ETF shares in secondary markets, redeem creation

---

[4] Morningstar defines as "passively managed" those funds whose investment securities are not chosen by a portfolio manager, but which are automatically selected to match an index or part of the market. Conversely, "actively managed" funds are those whose portfolio manager chooses the underlying securities.

[5] According to the Central Bank of Ireland (2017), the delivery of cash against the ETF shares typically occurs under two modalities. It can simply imply the exchange of cash for a creation unit or, in "directed cash deals", that there is a second agreement between the AP and the ETF, according to which the ETF uses the cash received from the AP to acquire the basket of underlying securities from a particular broker or channel (generally the AP's own trading desk). Most of the cash transactions seem to be on a directed cash basis, thus introducing some components of "in-kind" transactions.

[6] Currently, there does not seem to be any regulatory data collection on the relationship between ETF and APs in the EU, so information in this regard is mostly based on surveys of market participants or on anecdotal evidence.

[7] APs can create or redeem ETF shares for other reasons such as to execute client buy or sell orders of ETFs or to change their inventory of ETF shares or underlying assets. However, market intelligence suggests that this primary market activity is rather limited, as most of the transactions occur in secondary markets.

units at the end of the day, and eventually sell the underlying securities that they have thus acquired (Hill et al., 2015; Ben-David et al., 2017). Importantly, trading frictions may prevent APs from closing these arbitrage trades instantly and at no cost: if so, these arbitrage trades may create risks, which APs will be willing to bear only if they can expect a sufficiently large return.

As noted by Petajisto (2017), and Lettau and Madhavan (2018), the ETF share price may deviate substantially from the NAV at high frequencies, in particular when the underlying financial assets of the ETF are illiquid and do not trade frequently. These substantial deviations may be the result either of the stale prices[8] of the underlying assets or of the transaction costs incurred by APs when engaging in arbitrage activities. As discussed later in more detail, in situations of extreme volatility, APs and OLPs may be unable or unwilling to provide liquidity, leading to wider bid-ask spreads and to large deviations of ETF prices for the NAV (Ackert and Tian, 2008; Marshall et al., 2013).

ETF liquidity in regulated secondary markets is provided by Official Liquidity Providers (OLP), which are financial institutions (usually APs) that are committed to the exchange, not to the ETF sponsors. When ETF shares trade in regulated secondary markets, their liquidity is ensured by official liquidity providers (OLPs), who commit to provide liquidity by offering quotes to buy and sell ETF shares. There are no requirements regarding the number of OLPs that should be engaged in providing liquidity for a given ETF. However, according to data from the Investment Company Institute (2018), in the United States, ETFs had an average of 17 OLPs, with large differences across classes of ETFs. Similarly, in Ireland, the majority of equity ETFs have around 32 OLPs (Central Bank of Ireland, 2017).

A substantial part of trading with ETF shares in Europe takes place in OTC markets. According to the Autorité des marchés financiers (2017), at the end of 2016, 70% of the trading in French ETFs occurred in OTC markets. Blackrock (2016) also estimates that approximately 70% of ETF trading in Europe took place in OTC markets. Hence OLPs have a limited role in ensuring liquidity of ETF shares overall. Prior to the implementation of MiFID II, the lack of reporting obligations meant that OTC trading was more opaque than trading in regulated markets. Since January 2018, however, this has changed, as MiFiD II/MiFIR imposes a post-trading reporting obligation for OTC transactions with ETFs, thereby mitigating concerns about a lack of market transparency.[9]

Ultimate investors in ETFs do not trade directly with the ETF sponsor, but in secondary markets with the APs, OLPs or other market participants, and there could be conflicts of interest. For example, a conflict of interest may arise if the sponsor of the ETF is also an OLP in the regulated market where ETF shares are quoted (Financial Stability Board, 2011) or if a particular AP belongs to the same group as the ETF sponsor and has a vested interest there (International Organisation of Securities Commissions, 2013).

[8] A stale price of a security can be defined as a past price that does not reflect the most recent information.

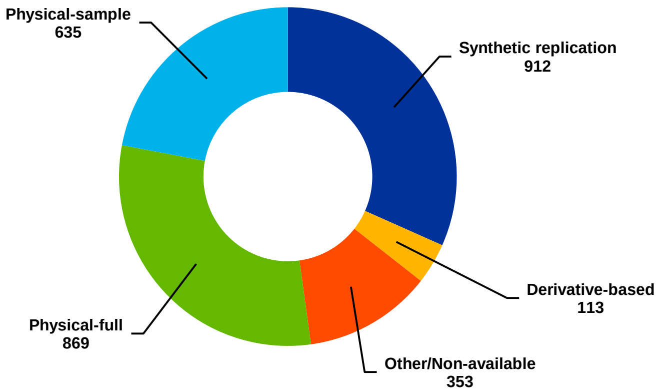
[9] Indeed, according to data from CBOE Europe, there seems to be a shift towards regulated exchanges in ETF trading, which could be explained by the introduction of MiFID II/MiFIR.

2.2 Complex ETF structures

In recent years, a sizable number of ETFs replicate an index not by investing in its constituent securities, but via more complex replication methods that rely on derivatives. As shown in Chart 7, which shows the breakdown of ETFs traded in Europe by replication method, roughly half of the ETFs in the EU currently feature complex structures. However, taking into account the total market value rather than the number of physical ETFs, they appear to dominate the EU market (see Chart 8). Synthetic ETFs have been used more prominently in Europe than in the United States (Kosev and Williams, 2011; Aramonte et al., 2017, Autorité des marchés financiers, 2017), although they have been declining in recent years (Morningstar, 2017).

Chart 7
Number of ETFs in the EU by replication method

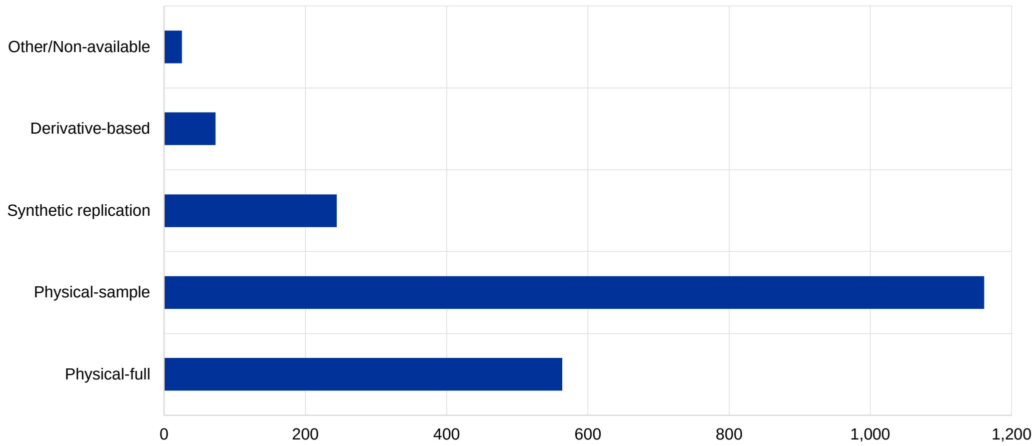
(numbers of ETFs)



Source: Morningstar.
Notes: ETFs as reported in Morningstar as at the end of June 2018. Active ETFs are included in the category "Other/Non-available".

Chart 8
Size of ETFs in the EU by replication method

(EUR billions)

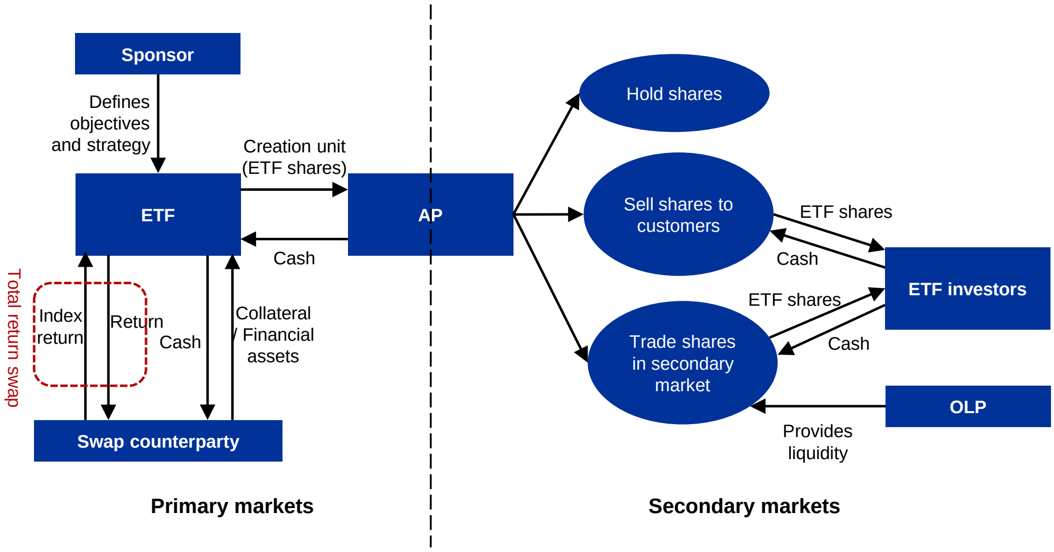


Source: Morningstar.
Notes: ETFs as reported in Morningstar as at the end of June 2018. Active ETFs are included in the category "Other/Non-available".

Synthetic ETFs replicate the performance of the underlying index with the use of derivatives, which gives rise to counterparty risk. The difference between physical and synthetic replication of an index can be understood by comparing Figure 1 with Figure 2. Figure 1 refers to an ETF that physically acquires the assets necessary to replicate the index it is tracking. Figure 2 illustrates the case of a synthetic ETF, which tracks the index via the use of derivatives, typically total return swaps (Autorité des marchés financiers, 2017, Central Bank of Ireland, 2017). In total return swaps, the ETF receives the return of its underlying index from a counterparty in exchange for an agreed return to that counterparty. That return is generated from financial assets that the synthetic ETF acquires with the cash received from APs (so that there is no transfer of financial assets in this case). Consequently, counterparty risk is present in synthetic ETFs, since the failure of the counterparty can impair the ability of the synthetic ETF to replicate the index. To mitigate this risk, synthetic ETFs usually receive collateral (to which a certain haircut is applied) or a basket of securities from the counterparty, as shown in Figure 2. By its own nature, cash redemptions are the rule in synthetic ETFs. It should be noted that the counterparty in the total return swap is usually the parent institution of the ETF (i.e., the sponsor), which also often acts as an AP (Financial Stability Board, 2011). In principle, though, a synthetic ETF should more accurately deliver the index return to investors, since it will receive, through the swap contract, the actual return of the underlying index net of swap fees. Synthetic ETFs can be used when there is no access to a certain category of financial assets, so that physical replication is impossible (Kosev and Williams, 2011).

Figure 2

Functioning of a synthetic ETF



Sources: own calculations, based on Kosev and Williams (2011), Autorité des marchés financiers (2017) and Turner and Sushko (2018).
Notes: AP refers to Authorised Participants and OLP to Official Liquidity Providers. Figure 2 shows the case of an unfunded swap agreement, where the synthetic ETF take full ownership of the collateral. In funded swap agreements, which are less frequent than unfunded, the collateral is pledged to a third-party custodian.

Derivative-based ETFs comprise leveraged, inverse and other structured ETFs and can be characterised by the intensive use of derivatives as the main financial instruments. Even though derivative-based ETFs physically hold some of the assets they track (so that they cannot be defined as synthetic), they rely on derivatives to achieve their investment objectives: leveraged ETFs seek to increase exposure to the underlying index via derivatives such as futures to increase their leverage (although it is also possible to achieve a one-to-one replication of an already leveraged index),[10] inverse ETFs aim at generating an opposite exposure to a given market, and structured ETFs consider any other underlying index or price to track, such as volatility in a market, inflation spreads or the replication of a hedge fund (Hill et al., 2015). These features can be combined in a single ETF, which can be, for example, inverse leveraged. Derivative-based ETFs track their index on a daily basis and, therefore, must rebalance their portfolio at the end of the trading day in order to align with their investment strategy. Consequently, this rebalancing need may increase market volatility towards the end of each trading day (Cheng and Madhavan, 2009; Trainor Jr., 2010; Bai et al., 2012; Shum et al., 2016). Since they set their tracking objective on a daily basis, derivative-based ETFs may compound fluctuations in the index that they track, something which is particularly acute in volatile markets (see Box 1, which discusses the volatility spike of February 2018). This can exacerbate their gains and losses over longer time horizons.[11]

---

[10] In the EU, ETFs classified as UCITS have a leverage cap of 2x.

[11] For example, as described in Central Bank of Ireland (2017), let's consider a derivative-based ETF that delivers a two times inverse return to an index. The value of that index is 20,000 and it increases 1% in two consecutive days, reaching 20.401 at the end of those two days, with a gain of 2.01%. The value of the derivative-based ETF would then be 97 and 94.09, meaning a total decrease of -5.91% over two days, which goes beyond the daily objective of the ETF.

For this reason, derivative-based ETFs appear to be problematic for investment horizons beyond one month (Hill et al., 2015).

Finally, smart beta or factor ETFs do not replicate value-weighted indices, but focus on the replication of alternative indices which are tilted towards one or several characteristics or factors (such as size, value, growth, volatility, dividends or momentum) to achieve particular risk-return profiles. Thus, smart beta ETFs replicate an index where the weights of the constituent securities are based on one or several of the above characteristics. Some market participants have argued that smart beta ETFs are not passive investment vehicles, like other types of ETF, but active ones, as they try to differentiate themselves from the usual physical ETFs which replicate an index based on market capitalisation of the underlying securities (Vanguard, 2018). However, smart beta ETFs do not fulfil the regulatory definition of active ETFs, as the European regulatory framework considers an ETF to be active when it tries to outperform an index while smart beta ETFs actually replicate a smart beta index.[12]

2.3 Concentration in the ETF segment

Globally, the supply of ETFs is highly concentrated, possibly owing to the large economies of scale exhibited by ETFs. Chart 9 shows that the three major providers of ETFs (Blackrock, Vanguard, State Street) accounted for circa 60% of the global ETF market at the end of 2018. Similarly, a recent analysis of swap counterparties in synthetic ETFs reveals the existence of a concentrated network, where a handful of institutions act as swap counterparts for all the synthetic ETFs in the euro area (European Central Bank, 2018). This high degree of concentration may stem from the economies of scale in ETF provision (Blocher and Whaley, 2016).[13] A trend towards increased concentration, possibly as a result of the economies of scale enjoyed by passive portfolio strategies has been documented more generally for the asset management sector: Ben-David et al. (2016) estimate that the largest ten institutional investors owned 5.6% of the US equity market in 1980 and 26.5% in 2016.

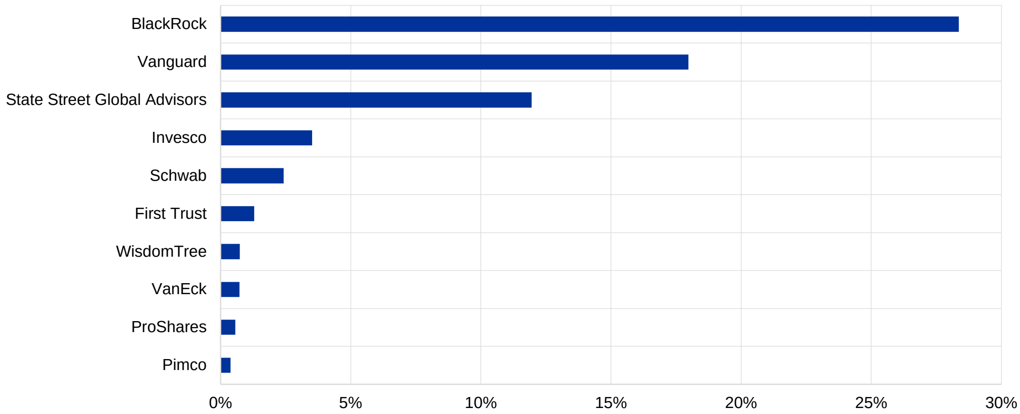
[12] See the definition of “actively-managed UCITS ETF” provided in the **ESMA Guidelines on ETFs and other UCITS issues**.

[13] On the contrary, there is strong evidence to suggest diseconomies of scale for active mutual funds (Berk and Green, 2004).

Chart 9

Market share of the ten largest providers of ETFs worldwide

(percentages)



Sources: ETF.com, Morningstar and own calculations.
Note: Market share is calculated according to assets under management at the end of 2018.

3 ETFs and systemic risk

In principle, the availability and operations of ETFs can affect the risk-return properties of securities via three different channels. They can:

1. affect the portfolio choices of investors in ways that change the risk characteristics of the underlying securities;
2. induce a decoupling of ETF prices from those of the underlying securities, which may impose substantial losses on ETF investors in times of financial stress;
3. affect the portfolio choices of investors in ways that can induce contagion across them or financial intermediaries that serve them.

These three channels are explained below with reference to the theoretical and empirical literature. Each channel is studied in order to determine whether it may be a source of systemic risk. Systemic risk can be thought of as the risk of a disruption in the financial system that leads to widespread instability in asset prices, extensive and material losses by investors and financial intermediaries, and possibly the collapse of important financial intermediaries. A first component of this definition is its scope, as it must affect a whole market or a large and significant group of institutions: episodes of losses imposed on few investors and/or financial intermediaries are excluded from this definition of systemic risk. Second, for risk to be systemic, it must threaten the solvency of key financial intermediaries and investors: situations in which ETF investors incur losses that they can absorb given their net worth do not, strictly speaking, constitute the materialisation of systemic risk.

Additionally, some ETF configurations are particularly exposed to counterparty risk, and, like all financial intermediaries, ETF issuers face operational risks: it is worth asking if such risks affect financial stability when they materialise. While these risks are not intrinsically systemic, they may take a systemic dimension in view of the highly concentrated ETF market. Therefore, this section also discusses this as a fourth possible source of ETF-related systemic risk.

3.1 ETF-induced changes in securities risk

In principle, the availability of a new financial instrument that facilitates trading an index and taking on exposure to it may affect the portfolio decisions and trading strategies of investors. In turn, these changes in investor behaviour may alter the risk characteristics of the relevant securities, especially their co-movement with each other and their volatility.

3.1.1 Increased co-movement of security prices and indices

Stocks tend to co-move more with their respective indices once they are included in ETF portfolios.[14] As found by Glosten et al. (2016), owing to their greater liquidity relative to the underlying securities, ETFs allow investors to take exposures to the systematic risk component of assets much more easily than to their idiosyncratic component. This facilitates the price discovery of the systematic component and discourages that of the idiosyncratic component. Also Da and Shive (2014) document that ETFs are associated with increased co-movement in the returns of stocks that belong to an index: they attribute it to the fact that when investors receive index-related news, they trade the corresponding ETF more intensively, and this affects the underlying securities via arbitrage, making them more responsive to index-related news than to news related to idiosyncratic factors. Another reason is that ETFs may attract sentiment-driven noise traders,[15] whose common ETF trading behaviour may affect the relevant stock index. Insofar as this is the case, the increased co-movement among security prices may be a symptom of easier propagation of noise trading shocks rather than of faster discovery of fundamental information about systematic risk.[16]

An important source of increased co-movement between ETF constituent securities is created by the arbitrage activities of APs, as shown by Shim (2019). This is because APs trade these constituent securities not according to their fundamental exposure to the underlying index or factor, but mechanically according to the portfolio weights in the creation baskets. This implies that securities with larger weights in the basket and with lower liquidity exhibit a high "arbitrage sensitivity" and therefore higher co-movement with ETF returns. Thus, these securities overreact to a repricing of the ETF. From a systemic risk perspective, it is significant that Shim (2019) documents these overreactions as being strongest in large-cap stocks, held by the most actively traded ETFs.

Excessive co-movement has been documented not only between the constituent securities of ETFs, but also between the prices of different ETFs. Broman (2016) finds that there is positive excessive co-movement between ETFs with similar styles and negative excessive co-movement between ETFs with distant styles. This is consistent with the notion that the higher liquidity of ETFs (relative to their underlying securities) attracts a clientele of short-horizon liquidity traders[17] with correlated demand for investment styles. In Section 3.2 we discuss possible effects of correlated noise trader demand on deviations between ETF share prices and NAV values.

In principle, an increased co-movement of securities prices and indices can raise systemic risk concerns. An increase in the co-movement of asset prices can make it more likely that investors experience capital losses simultaneously, therefore potentially leading to waves of insolvencies and synchronised fire sales. This effect may be reinforced by feedback effects

---

[14] There is evidence that, more generally, inclusion of a security in an index (see, for example Barberis et al 2005); Sushko and 2018a) or increased index trading (see, for example Sullivan and Xiong, 2012) leads to increased co-movement. In this report, we abstain from any historical analysis of co-movements and focus on ETF-specific channels, potentially leading to increased co-movement.

[15] Noise traders are characterised as not using fundamental data, having poor timing in their investment decisions, following market trends and overreacting to news about the market.

[16] On the contrary, according to Madhavan and Morillo (2018), the rise in cross-stock correlations is caused mainly by the macroeconomic environment and not by the development of the ETF segment.

[17] In contrast to informed traders, liquidity traders trade for reasons other than private information (for example, financial institutions may trade to meet the liquidity needs of their customers or for portfolio-balancing reasons).

between market and funding illiquidity similar to those modelled by Brunnermeier and Pedersen (2009).

3.1.2 Increased volatility of securities prices

In this subsection, we discuss the effect of ETFs on the risk characteristics of the constituent securities' returns, such as their volatility, assuming that the arbitrage mechanism between the ETF and constituent securities works perfectly. In the following subsection, we explore the additional effects on ETF volatility resulting from frictions that may trigger a de-coupling of ETF share prices and constituent securities.

The high liquidity and continuous trading of ETFs enable investors to take large short-term directional positions on entire asset classes, which, if driven by market sentiment, may have adverse consequences for market stability.[18] These positions tend to be correlated across a number of market participants, who change their index exposure based on past performance. Indeed, Bhattacharya and O'Hara (2018) present a model where ETFs can exacerbate herding, because they allow speculators to trade similarly across markets, unhinged from fundamental value. Insofar as there is arbitrage between the ETF and the basket of constituent securities, the demand shocks arising from such traders can increase the volatility of these securities and thus of the index underlying the ETF. In fact, Ben-David et al (2018) find that a one standard deviation increase of ETF ownership[19] leads to a 16% increase in the standard deviation of the stock price. Similarly they document that the increase in ETF ownership coinciding with a firm's reassignment from the Russell 1000 to the Russell 2000 index moves a stock that initially exhibits median volatility up to the 65th percentile of the volatility distribution. Finally, an increase in ETF ownership seems to go along with more left-skewed return distributions and larger downside risks, especially in stress situations when the VIX index is high or ETF redemptions are high. These findings suggest that large short-term directional bets in the ETF market can eventually result in market crashes, and thus exacerbate the volatility of the index itself, as well as the sensitivity of security prices to market crashes. Conceptually, this point is not really separate from that made in Section 3.1.1 on ETFs enabling non-idiosyncratic information to increase price co-movement: it just focuses on their effect on the volatility and skewness of the constituent securities and the index itself, rather than on co-movement.

The liquidation of these short-term directional bets may be problematic in times of financial stress, when ETF shares tend to become less liquid than in normal times, particularly for ETFs with illiquid underlying securities and traded OTC. In times of financial stress, APs may be confronted with a large number of investors selling ETF shares, thus depressing their price. If APs react to the price drop by buying ETF shares, they can then redeem them according to the mechanism illustrated above for physical ETFs (see Figure 1): APs deliver ETF shares back to the ETF and receive either the constituent securities (in-kind redemptions) or the equivalent amount of cash (cash redemptions). In the first case, they will sell the securities to flatten their inventories; in

---

18 Compared with other financial instruments, such as derivatives, ETFs allow the placement of bets on asset classes for which no derivatives (or any other similar financial instrument) exist, such as corporate bonds or leveraged loans.

19 ETF ownership is defined as the share of the dollar value of all ETFs investing in the stock, divided by the total stock's capitalisation.

the second, the ETF sponsor will sell a slice of the constituent portfolio to recover the cash paid to the AP. In both cases, the redemption results in the sale of the corresponding fraction of underlying securities, which may affect their price and liquidity, potentially creating negative spillovers (Central Bank of Ireland, 2017; European Central Bank, 2018). In the dynamic equilibrium model by Malamud (2016), large demand shocks in the primary ETF market may lead to spillovers in the market of the underlying securities. This spillover would become particularly relevant if the underlying securities are relatively illiquid. Indeed, Dannhauser and Hoseinzade (2016) find that a one-standard-deviation increase in corporate bond ETF outflows in the summer 2013 (related to ETF primary market activities) led to a subsequent 12.6 basis point increase in the yield spread of corporate bonds.

In contrast to open-end mutual funds, physical ETFs should be less likely to experience investor runs if they operate exclusively via in-kind redemptions. Physical ETFs are obliged to always disclose the basket of constituent securities. The composition of this basket does not change in response to redemption requirements, so there is no first-mover advantage in the sense of entitling those who ask for redemption first to the most liquid assets, as is possibly the case in some open-ended mutual funds (Autorité des marchés financiers, 2017; Turner and Sushko, 2018).[20] It is worth considering whether a first-mover advantage may still be present in the case of cash redemptions of ETFs with illiquid underlying securities (Anadu et al., 2018); however, as discussed above, cash redemptions will have to be funded by subsequent or contemporaneous sales of the constituent assets by the ETF sponsor, and thus should reduce the potential for significant decoupling of NAV and ETF prices. This should mitigate investors incentives to run. The existence of first-mover advantages cannot be completely excluded for synthetic ETFs, for which redemptions are always in cash, but current market practices and regulation enable ETFs to substantially mitigate them.[21]

There is intense debate as to whether the liquidity transformation operated by ETFs may backfire in situations of market stress, generating system-wide fire sales and negative feedback loops (International Monetary Fund, 2018; DTCC, 2018; Su, 2018).[22] Particularly for ETFs tracking more illiquid securities, the additional liquidity that investors expect from ETFs may evaporate at times of market stress, when widespread selling pressure results in increased volatility of both ETFs' and underlying securities' prices. This can occur even if the arbitrage mechanism functions perfectly under these conditions (see the following section for a discussion of possible malfunctions in the arbitrage mechanisms under stressed market conditions). Given the current size of the illiquid ETF market segment, these risks are currently limited, although they may become more serious if the growth of ETFs with illiquid constituent securities continues at the current pace.

Clearly, the implicit assumption in the above argument is that, if there were no ETFs, traders would not place equally aggressive short-term directional bets. The main reason for it is that

---

[20] Chen et al. (2010) and Goldstein et al. (2017) provide further evidence on first-mover advantages in open-ended mutual funds.

[21] As noted by the Central Bank of Ireland (2018) and Deutsche Bundesbank (2018), ETFs that operate as UCITS in the EU can impose gates when faced with liquidity shortages, and, if necessary, suspend ETF shares redemptions.

[22] See also "**CDS Creativity Is Everywhere**", by Matt Levine (Bloomberg 23 May 2018), "**Who's buying leveraged loans anyways?**", by Colby Smith (FT Alphaville, 20 November 2018), "**ETF Liquidity Trap Will Get You**", by Tautvydas Marciulaitis (Seeking alpha, 26 July 2017), and "**Gumby, Space Stations, And Things That Make No Sense**", by Thornton McEnery (Dealbreaker, 31 October 2017).

placing directional bets on the index would be far more expensive owing to the lower liquidity of the basket of underlying securities. The above-mentioned study by Ben-David et al. (2018) provides the most convincing evidence of ETFs having a causal impact on the volatility of the underlying securities, because the arbitrage mechanism transmits noise trade shocks generated by ETF investors to the underlying securities. Baltussen et al. (2019) find that indexation increases negative serial correlation in stock prices[23], consistently with the view that index products such as ETFs transmit mean-reverting, non-fundamental shocks into security prices. Moreover, the evidence that investment flows tend to chase ETFs' returns (Clifford et al., 2014; Broman, 2016) would suggest irrational behaviour by investors, since by definition ETFs do not feature any managerial skill and therefore their performance should not trigger investment flows if investors were rational.[24]

It should be noted that not all of the available evidence agrees with the view that shocks in the demand for ETFs introduce noise in the prices of constituent securities as a result of arbitrage trades. Madhavan (2016) argues that, while ETF trading volumes are highly correlated with volatility, ETF trading does not necessarily lead to spillover effects to the underlying stocks. A recent study by Box et al. (2019) examines this proposition directly by identifying intraday arbitrage opportunities between 423 US equity ETFs and the portfolios of their constituent stocks from 2006 to 2015, and find that "mispricing of the ETF relative to the underlying is typically preceded by a permanent price shock in the constituent portfolio, and is then corrected through quote adjustments, not through arbitrage trading". This evidence clearly contrasts with that in the above-discussed studies that the ETF order flow transmits non-fundamental shocks to the prices of constituent securities. In fact, the evidence put forward by Box et al. (2019) indicates that by taking positions in ETFs, market-makers in the constituent securities are able to offer greater liquidity. Thus, on the whole, this study offers a far more benign view of ETFs than previous ones.

Some complex ETF configurations are, however, robustly associated with an amplification of the volatility of securities prices, because these ETFs' rule-based trading strategies directly induce a procyclical trading pattern in the underlying securities' markets. For example, leveraged ETFs provide returns that are multiples of index returns. Thus, even when there are no ETF fund flows, i.e. when no new ETF shares are created or redeemed, these funds must dynamically buy or sell the underlying index or derivatives, for example futures, written on the index. They must buy index shares when the index return is positive and sell when the index return is negative. Such procyclical trading behaviour may in turn impact the prices of the underlying assets (see Box 1). Bai et al. (2015) analyse real-estate related leveraged ETFs and find that they have a significant impact on the prices of component stocks, increase their volatility and contribute to price momentum. Shum et al. (2016) also find that end-of-day volatility is positively and statistically significantly correlated with the ratio of potential rebalancing trades of leveraged ETFs to total trading volume. These effects are found to be particularly large on the most volatile days.

---

[23] Baltussen et al. (2019) use the term "negative serial correlation" to refer to the fact that first-order autocorrelation coefficients from daily returns have been declining continuously since 1951 and turned negative in the 2000s. That would imply more frequent index return reversals that cannot be explained by fundamental factors.

[24] The increase in volatility may also arise from index investing by (rational) institutional investors subject to performance-based compensation contracts, as argued by Basak and Pavlova (2013, 2016). They show that, as the performance of fund managers is benchmarked against an index, they must overweight assets included in the index, leading to an increase in their price level, price volatility and correlation with other indices.

Box 1

Procyclical trading and inverse/leveraged exchange-traded products[25]

A striking recent example of the effects of procyclical trading by leveraged and inverse ETFs occurred at the time of the "volatility blow-up" of 5 February 2018.[26] On that date trading by volatility-related exchange-traded products (ETPs) generated adverse price responses in the underlying markets, eventually leading to the implosion of one of the ETPs, the Velocity Shares Daily Inverse VIX Short Term (XIV). The perverse feedback loop between volatility ETPs and the VIX was triggered by the sudden jump in the VIX on that day, following a long period during which the VIX had been extremely low.[27] This led to substantial losses in short VIX ETPs, especially those providing exposure to the VIX based on short-term futures contracts (see Chart A).[28] Two ETPs (tickers XIV and SVXY, issued by Credit Suisse/Velocity Shares and Pro Shares respectively) lost roughly 95% of their value on that day. Conversely, leveraged long VIX ETPs, such as TVIX and UVXY, more than doubled their values on 5 February 2018.

Issuers of leveraged volatility ETPs take long positions in VIX futures to multiply returns relative to the VIX. These products are designed to track the performance of a rolling 1-month duration VIX futures contract portfolio with a leverage factor of x, and must rebalance daily by buying or selling VIX futures in order to maintain their target exposure to the VIX. For example, a 2x VIX ETP such as the UVXY builds notional positions in VIX futures that are twice as large as its asset value. Inverse volatility products are designed to track the performance of a rolling 1-month duration VIX futures contract portfolio with an inverse factor of -1, and must rebalance daily by buying or selling VIX futures in order to maintain their target exposure to the VIX. Rebalancing of portfolios usually takes place in the last hour of the trading day.

---

25 Since there are both ETFs and ETNs (exchange-traded notes) on volatility indices, the term ETPs (exchange-traded products) is used throughout this box. The rebalancing needs of ETNs resemble those of ETFs and can thus serve to illustrate the impact of the procyclical behaviour of leveraged ETFs on the underlying assets.

26 See **here** for a broader discussion of this episode.

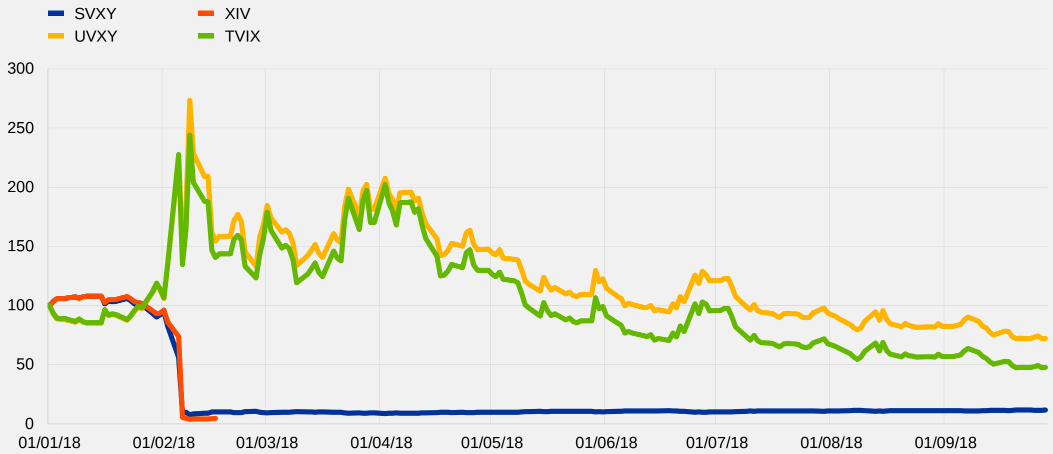
27 In total, the VIX increased by more than 100% on 5 February 2018, the largest daily increase since the 1987 stock market crash.

28 Since the VIX and other volatility measures are not directly investable assets but are synthetically constructed on the basis of stock index options, ETPs use futures contracts on the VIX as the underlying. For example, VIX short-term futures funds replicate the return from a rolling position in the first and second nearby VIX futures contracts, maintaining a constant one-month maturity. VIX medium-term funds maintain a rolling position in VIX futures with a constant maturity of typically five months. See Whaley (2013) and Alexander et al. (2015) for an overview of the main features of volatility ETPs.

Chart A

Price performance of leveraged long and short VIX ETPs (1 January 2018 = 100)

(index)



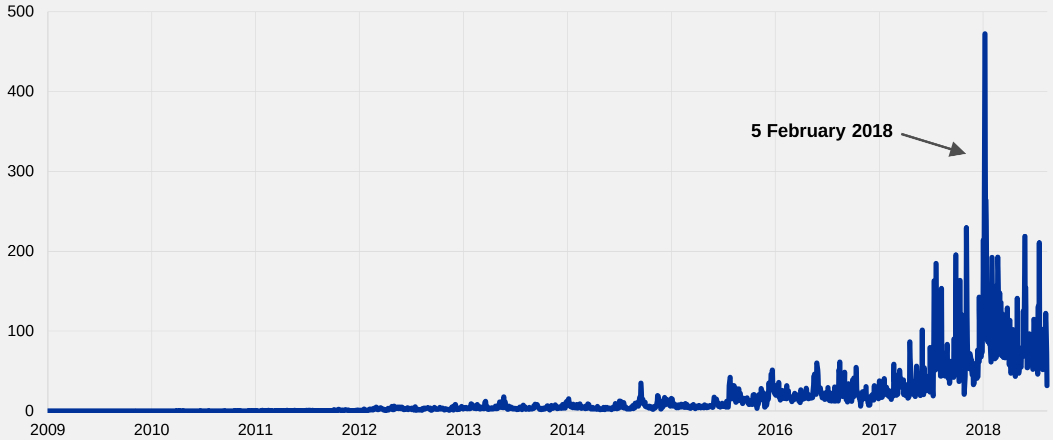
Sources: Bloomberg and own calculations.
Note: XIV denotes the Velocity Shares Daily Inverse VIX Short Term (-1 inverse exposure); TVIX is the Velocity Shares Daily 2x VIX Short Term ETN (2x leveraged exposure); SVXY: Pro Shares Daily 2x VIX Short Term ETN (-1 inverse exposure until 27 February 2018, -0.5 thereafter); UVXY: Pro Shares Daily 2x VIX Short Term ETN (2x leveraged exposure until 27 February 2018, 1.5x leverage thereafter).

The large-scale trading activities of ETP issuers on the CBOE VIX futures markets have the potential to substantially influence market dynamics in volatility markets. Using intra-day data, Bollen et al. (2017) find that VIX ETPs and VIX futures are linked contemporaneously: on many days VIX ETPs lead underlying futures markets. The turmoil in VIX markets on 5 February 2018 was accompanied by unprecedented levels of trading volume in volatility ETP markets (see Chart B), suggesting that ETPs might have played an important role as amplifiers in the volatility spike. Furthermore, issuers of ETPs publish their daily net asset value each trading day at 4:15 p.m., meaning that issuers typically rebalance their hedging positions as close as possible to this time so as to avoid biasing their hedging account. Since the number of shares outstanding on each ETP is public, speculative investors cannot only predict the timing of trades (shortly before 4:15 p.m.), but also the approximate size of hedging trades by ETP issuers on VIX futures markets, thus creating an opportunity for speculators to front-run these trades (Alexander and Korovilas, 2013).

Chart B

Aggregate daily trading volume in volatility ETPs

(contracts in millions)



Sources: Bloomberg and own calculations.
Note: The figure shows the combined trading volume of the 15 largest volatility-index related ETPs (according to asset value).

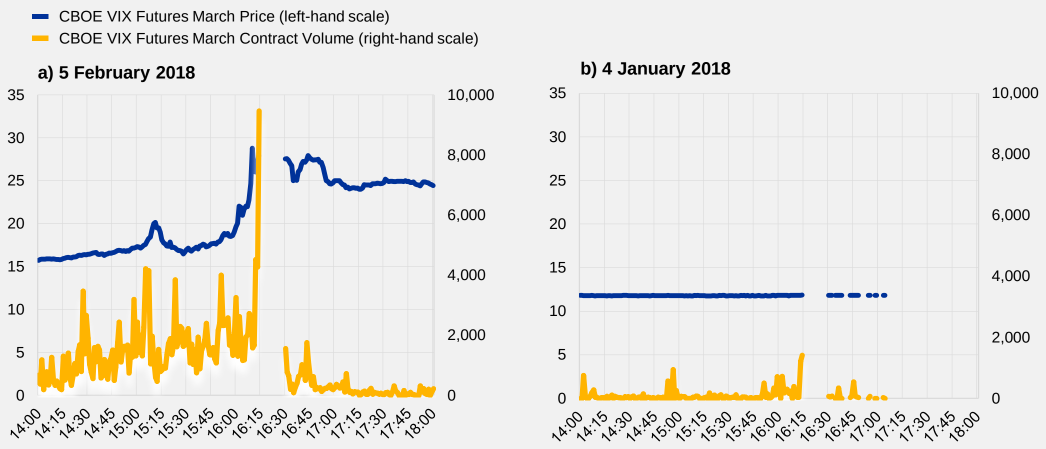
The systematic trading strategies of ETP issuers and the behaviour of speculative investors appear to have been a key driver of the spike in volatility on 5 February 2018 (Sushko and Turner, 2018). The VIX had been rising early on in the day of 5 February 2018, meaning that market participants knew that both leveraged long volatility ETPs and inverse ETPs had to buy VIX futures to rebalance their portfolios (the former to maintain their target daily exposure, the latter to cover losses on short positions). These circumstances created an adverse feedback loop that led to the spike in volatility on that day. At 4:00 pm, prices of near month VIX futures had already increased almost 30% with respect to prices at 2:00 pm. In doing so, given the size of the combined VIX ETPs and those price dynamics, leveraged and inverse ETPs collectively had to buy approximately 275,000 VIX futures contracts shortly before 4:15 p.m., in order to maintain their daily leverage.[29] By doing so, they pushed the price of VIX futures even higher and then more contracts were needed, generating a perverse feedback loop of losses and rebalancing. The market did not have enough liquidity to absorb such a large demand of contracts over a short time horizon without materially increasing prices. Chart C shows the market developments in VIX futures on 5 February, illustrating the differences compared with a "normal" trading day one month earlier (4 January 2018). While a jump in trading volume shortly before 4:15 p.m. appears to be a common feature of each trading day, the jump was materially larger on 5 February. High trading volume in the front-month VIX contract, in turn, led to substantial price increases in the VIX and corresponding price drops in inverse volatility ETPs. The sudden loss of value in these ETPs caused Credit Suisse to announce the closure of its short-term inverse VIX ETN.

[29] That amount was about 50% of the average traded volume of VIX futures for the previous five days.

Chart C

Intra-day market developments in VIX futures and ETP markets on 5 February 2018 (left panel) and 4 January 2018 (right panel)

(prices and numbers of contracts)



Sources: Bloomberg and own calculations.

3.2 Decoupling of ETF from constituent security prices

The previous discussion is predicated on the effectiveness of arbitrage between the ETF and constituent securities. In fact, ETF prices can deviate significantly from those of the constituent securities, especially at high frequencies, for illiquid assets and during periods of financial stress. Petajisto (2017) finds that, especially for illiquid assets, this deviation is very small on average, but varies substantially over time. As such, the tracking error may become an additional source of risk. Ben-David et al. (2017) report a number of intriguing episodes of market turmoil in which ETFs displayed large price fluctuations, also relative to the underlying basket.[30]

Such decoupling of ETF and constituent securities prices can originate from APs and OLPs not having the incentives and capacity to realign them in times of financial stress. APs engage in the creation and redemption of ETF shares in pursuit of profit and have no commitment to ETF sponsors or investors. Thus, in stressed conditions, APs could simply decide not to engage in ETF redemptions (Autorité des marchés financiers, 2017).[31] Indeed, these deviations are often larger at times of market stress, when APs face abnormally high risk in arbitraging ETFs and underlying securities. While there is some evidence that these deviations are partly due to the staleness of the NAV (as it is based on the last available price), there is also evidence that APs

[30] Examples of these episodes are the Flash Crash of 6 May 2010 and the decline in stock prices of several emerging markets on 20 June 2013.

[31] There are even situations in which the constituent securities become so illiquid that it becomes impossible to perform arbitrage trades between the relevant security basket and the ETF. For example, during the closure of the Greek stock exchange between 29 June and 3 August 2015, the Lyxor ETF FTSE Athex 20 suspended its primary and regulated secondary market activity, but was traded in OTC secondary markets. However, a second ETF (Global X FTSE Greece 20 ETF) continued to trade in secondary markets while the Greek stock market remained closed.

tend to withdraw from arbitraging activity when the VIX is high (Nagel, 2012; Pan and Zeng, 2016; Ben-David et al., 2018). APs may also be deterred from their arbitrage activity by impaired secondary market liquidity: for example, Fulkerson et al. (2018) show that both secondary market liquidity and the liquidity of the underlying assets determine the likelihood of an AP arbitraging a premium or a discount between ETFs and the NAV of underlying assets. This dependence is stronger when the liquidity mismatch between the ETF shares and underlying assets is higher.[32]

When the arbitrage mechanism between the ETF share prices and their NAV is impaired, ETF investors, who may initially have had unrealistically high expectations about their investment's liquidity ("liquidity illusion"), may be unable to cancel their positions without incurring substantial discounts from the NAV (Deutsche Bundesbank, 2018). Such a scenario may not be unrealistic, considering the gradual withdrawal of banks as APs and market-makers in the ETF market and the growing role played by high-frequency traders (HFT) in the provision of ETF liquidity (Autorité des marchés financiers, 2017; European Central Bank, 2018). Indeed, the related literature finds that HFT firms can be consumers, rather than providers, of liquidity in times of financial stress (Easley et al., 2012; Cespa and Foucault, 2014). Thus, when investors conjecture that the liquidity transformation provided by APs and OLPs will become impaired, this could lead to fire sales, creating a negative feedback loop that may worsen the de-coupling and create price pressure in the market for the underlying securities.[33]

The decoupling of ETF share prices from their constituent securities can be exacerbated if the APs of an ETF are also the liquidity providers trading ETF shares in the secondary market. This dual role can potentially create a conflict of interest, since the arbitrage trades required to bring the ETF price in line with the prices of the constituent securities may impose losses on APs that can subsequently drain their capital and thus limit their liquidity provision, potentially creating a negative spiral. Pan and Zeng (2017) find that this is the case in ETFs that track more illiquid underlying securities. In practice, the relevance of this potential conflict of interest may be limited insofar as other secondary market investors, rather than APs, are willing to perform some of the trading activity to realign the prices of ETFs with those of the constituent securities.

The partial breakdown of arbitrage between ETFs and constituent securities implies that ETF trading may have two opposite effects: it may exacerbate fluctuations in ETF prices and reduce instability in those of constituent securities. On the one hand, an imperfect arbitrage is likely to exacerbate the effect of demand shocks on ETF prices: when arbitrage works without frictions, excess demand (supply) in the ETF market leads to an instantaneous increase (decrease) in the number of ETF shares outstanding, thereby reducing ETF price swings. If this arbitrage process does not work smoothly, then the effects of supply or demand shocks on ETF prices will be larger. On the other hand, the more continuous the arbitrage activity between ETFs and their constituent securities, the more rapidly and effectively the shocks to ETF prices are transmitted to the underlying basket of securities. So, frictions in the arbitrage process may to some extent insulate the markets from the underlying assets and reduce their volatilities. Thus, it is not *prima*

[32] See also Rappoport and Tuzun (2018).

[33] However, the Investment Company Institute (2018) states that the primary market trading volume is only a small fraction of the trading volume in the secondary markets, even during times of stress. iShares (2015) also shows that traded volumes of one high-yield corporate bond ETF tended to increase during periods of volatility in credit markets, while activity in primary markets (creation and redemption of ETF shares) remained stable over time.

facie clear whether a decoupling of ETF prices from those of the underlying securities due to "limits to arbitrage" slowing down the activity of APs should exacerbate or mitigate systemic risk concerns.

Insofar as the ETF discounts and premia amplify swings in the underlying, such deviations tend to make the ETF itself riskier than the underlying. If ETFs on average trade at a discount on days when the underlying index experiences a sharp drop and trade at a premium when the market rallies, then this introduces excess volatility for those investors who take their index exposure via ETFs and could potentially lead to increased market fragility.[34] The evidence presented by Brown et al. (2018) appears consistent with this: they investigate whether the frictions that limit arbitrage activities of APs eventually leading to a decoupling of NAVs from ETF share prices show up in ETF returns. If, due to transactions costs or other sources of limits to arbitrage, ETF share creations or redemptions by the APs only take place when ETF share prices are too high or too low relative to their constituent securities, then such arbitrage activities should predict ETF returns. Brown et al. (2018) find that ETFs with large creation activity subsequently underperform ETFs with redemption activities, consistent with a view that ETF investors collectively mistime their investments.

Large swings in ETF prices may create systemic risk insofar as financial institutions hold large ETF positions on their balance sheets or rely heavily on ETF shares in their liquidity management operations.[35] In such circumstances, this excess volatility of ETFs relative to their constituent securities will translate into a more volatile net worth of financial intermediaries, which may trigger additional selling pressure in the ETF positions, thereby exacerbating ETF price drops, similar to the mechanism described as liquidity spirals in Brunnermeier and Pedersen (2009). In times of financial stress, when liquidity in financial markets is in general more valuable, financial intermediaries that use ETF shares as near-substitutes for cash in their liquidity management operations may theoretically also be subject to frictions when primary market activities between APs and ETFs are impaired and ETF shares are traded with substantial discounts from the NAV.

If investors anticipate a breakdown in the liquidity transformation operated by ETFs, this could lead to market fragility: large deviations of ETF prices from the value of the underlying securities may induce investors to lose faith in the market valuation of those securities as well. This may occur when investors believe that the "smart money" trades the ETF, causing them to pull out of the underlying market. If so, large fluctuations of ETF prices due to limits to arbitrage may end up amplifying also the price fluctuations of the underlying securities. This mechanism is similar to that modelled by Cespa and Foucault (2014), who show that when investors rely on the price of one asset (in our case, the ETF) to price another (say, one of the underlying securities), an increase in the noise of the price of the first may make investors wary of trading the second, also making the second less liquid.

In conclusion, we see two potential channels via which decoupling could create systemic risk: (i) the breakdown of the arbitrage mechanism may lead to excessive swings in the ETF price, and these may create market fragility if institutions are adversely affected, and (ii) the decoupling may affect the pricing of the underlying assets. This second effect could occur if

---

[34] The concept of market fragility typically refers to the possibility of disproportionately large effects resulting from small and routine economic shocks.

[35] For example, in a survey by Greenwich Associates (2018), 56% of the respondents indicated the use of ETFs for liquidity management purposes.

the decoupling leads investors to expect deteriorations of the liquidity transformation offered by ETFs, thereby triggering sales also in the underlying markets. Hence, this points to the need to: (i) establish whether the exposures of financial intermediaries to ETFs are so important (owing to their size or to their role in the liquidity management of these intermediaries) that they may be destabilised by the decoupling of ETF prices from those of their constituent securities, and (ii) to investigate whether the decoupling may indeed lead to a broader loss of faith in the functioning of the market.

3.3 ETF-induced contagion

The liquidity of ETFs may induce investors to take very large, short-term and correlated positions, with the potential to trigger a chain reaction with systemic risk implications. If these large, short-term and correlated positions produce large losses to leveraged investors such as banks, the latter may end up defaulting on other investors. Through contagion, these losses could thus trigger a chain reaction with systemic risk implications. The model by Bhattacharya and O'Hara (2018) shows that the availability of ETFs may induce investors to take correlated exposures but, in their model, traders are not subject to default risk. In practice, for example, an investor such as a hedge fund may take huge leveraged positions using ETFs and may become insolvent if ETF prices collapse. The investor's default on the banks that have funded such positions may then trigger a chain reaction.

Given the material role that ETFs play in the liquidity management of financial institutions, disruptions in the ETF market may spread through the financial system. As highlighted in the previous section, the assumption that ETF shares are highly liquid (more than their underlying securities) makes them attractive for use by other financial institutions for cash or liquidity management purposes (European Central Bank, 2018). Therefore, beyond direct exposures to ETFs, this makes ETFs indirectly interconnected to other parts of the financial system. Through this channel, malfunctions in the redemption mechanism of ETF shares in times of stress may spread to other segments of the financial system and have an impact on overall financial stability.

However, it is not clear whether the problem is the availability (or liquidity) of ETFs any more than, say, the availability (or liquidity) of derivatives that allow hedge funds to take large risks. Of course, insofar as ETFs themselves increase volatility, as argued previously, the risk that such a chain reaction may start is greater. Yet, derivatives trading may also, in some circumstances, increase the volatility of their underlying securities and lead to a similar chain reaction. This would not, thus, be a unique feature of ETFs in comparison with other financial assets.

In conclusion, while the availability of ETFs may facilitate contagion, the same can be said of other financial instruments. The focus should rather be on the ability of financial intermediaries to take correlated exposures (in the form of ETF exposures or any other financial instruments) and fund them via increased leverage. This is an issue affecting financial markets more generally, not only via ETFs, and which should probably be addressed via a comprehensive approach.

3.4 Counterparty and operational risks of ETFs

Synthetic ETFs are exposed to the risk that the swap counterparty is not able to fulfil its index return obligation and typically hold collateral as protection against that risk, with the potential to generate fire sales in times of financial stress. In the case of a synthetic ETF, the swap counterparty must deliver the index return to the ETF and there is a risk that it fails to fulfil that obligation. To mitigate that risk, swap counterparties typically post collateral to the synthetic ETF. Hurlin et al. (2017) find that the synthetic ETFs in their sample are over-collateralised by around 8%, while Aramonte et al. (2017) also document overcollateralisation in synthetic ETFs across asset classes. However, there are three particular factors that may still render counterparty risk relevant from a financial stability point of view. First, in Europe, the swap counterparty is usually the sponsor of the synthetic ETF, raising issues about potential conflicts of interest, including the provision of the index return swap under non-economic conditions (European Central Bank, 2018; Turner and Sushko, 2018). Second, assets posted as collateral are usually taken from the inventory of the swap counterparty and, therefore, synthetic ETF may allow the swap counterparty to raise funding against a portfolio of illiquid assets (Financial Stability Board, 2011; Ramaswany, 2011). The use of illiquid assets as collateral may also impair the ability of the synthetic ETF to sell them, particularly in times of financial stress, with the possibility of creating a downward price spiral in the prices of those illiquid assets (Turner and Sushko, 2018). Using liquid assets as collateral may also be problematic in periods of financial stress if the performance of these assets is linked to the performance of the swap counterparty (European Central Bank, 2018).

Physical ETFs may be exposed to counterparty risk through securities lending transactions, potentially creating vulnerabilities in times of financial stress. In order to obtain an additional source of income, physical ETFs may use the purchased basket of financial assets in securities lending transactions (Autorité des marchés financiers, 2017; European Central Bank, 2018; Turner and Sushko, 2018). According to Morningstar data, around 40% of ETFs report that they enter into securities lending transactions, although no additional details are available on the proportion of the basket of financial assets effectively used in these transactions or on the financial assets involved.[36] Entering into these transactions implies an exposure to counterparty risk, which in the case of ETFs must be adequately managed to account for possible redemptions of ETF shares. The ETF should ensure that it holds sufficient financial assets to face the expected flow of redemptions, also taking into account the unpredictability of moves in market sentiment that may trigger these redemptions. Additionally, the collateral obtained in the securities lending transaction may be mismatched with the basket of financial assets and their prices may evolve differently in times of financial stress.

However, the recent evolution of the ETF market as well as broader market practices and regulation seems to have mitigated concerns regarding the systemic consequences of these risks materialising. After reaching their peak in 2009, the share of synthetic ETFs over the total ETF market in Europe stood only slightly above 20% at the end of 2016 (Morningstar, 2017). The entry into force of several pieces of regulation on swap counterparties (usually banks) as well as on

---

[36] According to data from IHS Markit, US-based ETFs seem to make more intensive use of securities lending transactions than European ETFs (European Systemic Risk Board, 2018). Hurlin et al. (2017) find that more liquid financial assets (government bonds) are more frequently used in securities lending transactions by physical ETFs than other financial assets, like corporate bonds.

OTC derivatives has also contributed to limit counterparty risk from synthetic ETFs.[37] Therefore, authorities seem not to be particularly concerned about the adverse financial stability effects of a materialisation of counterparty risks in synthetic ETFs (European Central Bank, 2018). In the case of physical ETFs entering into securities lending transactions, current market practice is to have multiple counterparties, attenuating counterparty risk and the possibility of facing a shortage of financial assets to meet investor redemptions (Central Bank of Ireland, 2018).

Usually, if operational risks arise, they do not generate significant systemic consequences; however, in a highly concentrated segment like that of ETFs, this can occur by triggering mistrust among investors towards the whole segment and thus widespread sales. As mentioned in Section 2.3, in the ETF market segment, there are three main suppliers, which are leveraged and which manage assets, not limited to ETFs, in excess of USD 10 trillion.[38] In this situation, events like a serious technical failure or a high-profile issue of financial misconduct affecting only one of the three ETF issuers may instil mistrust towards the whole segment and lead to massive sales of ETFs, and hence large drops in their prices, with the destabilising effects discussed in Section 3.2. Even though ETF providers have enacted policies to manage operational risk and so far no serious operational risk events have occurred, the materialization of such risks cannot be ruled out completely and can therefore not be ignored from a systemic risk perspective. Indeed, the financial stability impact of the observed concentration in the asset management industry has received increased attention in the last years (Office of Financial Research, 2013; Elliott, 2014; International Monetary Fund, 2015). Given the observed concentration levels, the ETF segment warrants further attention in this respect.

---

37 For example, as noted in Central Bank of Ireland (2017), ESMA’s Guidelines on ETFs and other UCITS issues require UCITS ETFs to ensure that collateral received meets certain qualitative and quantitative criteria, including liquidity.

38 The three main ETF providers (Blackrock, Vanguard and State Street) each have balance sheets of around €200 billion, making them comparable in size to that of medium-sized European banks.

4 Conclusions and implications for future research

The rapid growth of ETFs and their underlying structure can explain the increased attention they have received from regulators and supervisors around the world. ETFs and similar forms of passive investment have grown substantially in recent years, particularly in the United States, but to some extent also in the EU. Given their low cost and high liquidity in normal times, ETFs have become a popular investment alternative for many investors. At the same time, there is growing evidence that the increased use of ETFs may affect the risk characteristics of securities markets, possibly reinforced by new and more complex types of ETFs that have been developed, such as leveraged and synthetic ETFs. It is on these grounds that ETFs have attracted the attention of regulatory institutions around the world (Financial Stability Board, 2011; International Organisation of Securities Commissions, 2013; Autorité des marchés financiers, 2017; Central Bank of Ireland, 2017; International Monetary Fund, 2018).

This report focuses on the potential systemic risks that may be associated with the spread of ETFs and highlights four main reasons why ETFs could pose systemic risks:

1. **In normal times, the high liquidity of ETFs encourages investors to place large short-term directional bets on entire asset classes, which affect the prices of the underlying securities, increasing their volatility and their co-movement.** The liquidation of these short-term directional positions may be especially problematic in times of financial stress, particularly for ETFs with illiquid underlying securities and traded OTC. Moreover, leveraged ETFs have built-in procyclical trading strategies that occasionally exacerbate securities price volatility.

2. **During times of market stress, ETF prices may decouple from those of their constituent securities and, insofar as financial institutions have large exposures to ETFs or rely heavily on ETF shares in their liquidity management operations, this may destabilise them.** Moreover, if investors expect a deterioration in ETF liquidity, this may lead to fire sales and exacerbate the volatility increase described in (i). However, this decoupling may also decrease the effect of market stress on constituent securities. If financial institutions are exposed mainly to the risk from these securities, the decoupling between ETF and constituent securities' prices may then reduce rather than increase systemic risk.

3. **ETFs allow investors to take correlated exposures; insofar as these exposures are leveraged, they may generate contagion at times of market stress**, with potential systemic risk consequences.

4. **Given the high levels of concentration in the ETF market, a large event leading to the materialisation of operational risks in one of the providers may generate massive fire sales of ETFs**, resulting in large price movements of their constituent securities (as under i) or of the ETFs themselves (as under ii).

Hence, to further sharpen our understanding of the systemic risk implications of ETFs, empirical research should focus on two key, yet still under-researched, areas:

1. **a more detailed analysis of ETF order flows in stress periods and their impact on the volatility, co-movement and illiquidity of both ETFs and their constituent securities,** taking into account the arbitrage mechanisms that link the ETF primary and secondary markets and the potential effects of conflicts of interest when the same financial institution performs multiple roles, such as ETF sponsor, AP, OLP and/or swap counterparty;

2. **the extent to which financial institutions have significant and common exposures to ETFs (rather than to their constituent securities) and/or rely on them for their liquidity management.**

The above-mentioned analyses would need to be performed with reference to the European ETF market, given its specificities relative to the US ETF market, on which most of the empirical literature has focused so far. In contrast to US ETFs, which are mostly equity-based and traded on centralised exchanges, European ETFs more often track fixed-income securities, trade on OTC markets and rely on cash redemptions in the primary market. On the two latter points, it would be important to exploit as much as possible the post-trading reporting obligation in MiFiD II/MiFiR.

References

Ackert, L. F. and Tian, Y. S. (2008), “Arbitrage, liquidity, and the valuation of Exchange Traded Funds”, *Financial Markets, Institutions & Instruments*, Vol. 17(5), pp. 331-362.

Alexander, C. and Korovilas, D. (2013), “Volatility Exchange-Traded Notes: curse or cure?”, *Journal of Alternative Investments*, Vol. 16(2), pp. 52-70.

Alexander, C., Kapraun, J. and Korovilas, D. (2015), “Trading and investing in volatility products”, *Financial Markets, Institutions and Instruments*, Vol. 24(4), pp. 313-347.

Anadu, K., Kruttli, M., McCabe, P., Osambela, E. and Shin, C. H. (2018), “The shift from active to passive investing: potential risks to financial stability?, *Finance and Economics Discussion Series* No 2018-060, Board of Governors of the Federal Reserve System.

Aramonte, S., Caglio, C. and Tuzun, T. (2017), “Synthetic ETFs”, *FEDS Notes*, Board of Governors of the Federal Reserve System.

Autorité des marchés financiers (2017), “ETFs: characteristics, overview and risk analysis – the case of the French market”, February.

Bai, Q., Bond, S.A. and Hatch, B. C. (2015), “The Impact of leveraged and inverse ETFs on underlying stock returns”, *Real Estate Economics*, Vol. 43(1), 37-66.

Baltussen, G., van Bekkum, S. and Da, Z. (2019), “Indexing and stock market serial dependence around the world”, *Journal of Financial Economics*, Vol. 132(1), pp. 26-48.

Barberis, N., Shleifer, A. and Wurgler, J., (2005), "Comovement", *Journal of Financial Economics*, Vol. 75(2), pp. 283-317.

Basak, S. and Pavlova, A. (2013), “Asset prices and institutional investors”, *American Economic Review*, Vol. 103(5), pp. 1728-1758.

Basak, S. and Pavlova, A. (2016), “A model of financialization of commodities”, *Journal of Finance*, Vol. 71(4), pp. 1511-1555.

Ben-David, I., Franzoni, F. and Moussawi, R. (2017), “Exchange-Traded Funds”, *Annual Review of Financial Economics*, Vol. 9, oo. 169-189.

Ben-David, I., Franzoni, F. and Moussawi, R. (2018), “Do ETFs increase volatility?”, *Journal of Finance*, Vol. 73(6), pp. 2471-2535.

Ben-David, I., Franzoni, F., Moussawi, R. and Sedunov, J. (2016), “The granular nature of large institutional investors”, *NBER Working Paper,* No 22247.

Berk, J. and Green, R. (2004), “Mutual fund flows and performance in rational markets”, *Journal of Political Economy*, Vol. 112, pp. 1269-1295.

Bhattacharya, A. and O’Hara, M. (2018), “Can ETFs increase market fragility? Effect of information linkages in ETF markets”, *Cornell University Working Paper*.

Blackrock (2016), *Addressing current liquidity concerns*, May.

Blackrock (2017a), *Index investing supports vibrant capital markets*, October.

Blackrock (2017b), *A primer on ETF primary trading and the role of Authorized Participants*, March.

Blocher, J. and Whaley, R. (2016), "Two-sided markets in asset management: Exchange-Traded Funds and securities lending", *Vanderbilt Owen Graduate School of Management Research Paper,* No 2474904.

Bollen, N. P. B., O'Neill, M. J. and Whaley, R. E. (2017), "Tail wags dog: intraday price discovery in VIX Markets", *Journal of Futures Markets*, Vol. 37(5), pp. 431-451.

Box, T., Davis, R., Evans, R. and Lynch, A. (2019), "Intraday arbitrage between ETFs and their underlying portfolios", **available at SSRN**.

Broman, M. (2016), "Liquidity, style investing, and excess comovement of Exchange-Traded Fund returns", *Journal of Financial Markets*, Vol. 30, pp. 27-53.

Broman, M. and Shum, P. (2018), "Relative liquidity, fund flows and short-term demand: evidence from Exchange-Traded Funds", *Financial Review*, Vol. 53(1), pp. 87-115.

Brown, D., Davies, S.W. and Ringgenberg, M. C. (2018), "ETF arbitrage and return predictability", **available at SSRN**.

Brunnermeier, M. K. and Pedersen, L.H. (2009), "Market liquidity and funding liquidity", *Review of Financial Studies*, Vol. 22(6), pp. 2201-2238.

Central Bank of Ireland (2017), "Exchange Traded Funds", discussion paper, May.

Central Bank of Ireland (2018), "Feedback statement on DP6 – Exchange Traded Funds", September.

Cespa, G. and Foucault, T. (2014), "Illiquidity contagion and liquidity crashes", *Review of Financial Studies*, Vol. 27(6), No 1615-60.

Chen, Q., Goldstein, I. and Jiang, W. (2010), "Payoff complementarities and financial fragility: evidence from mutual fund outflows", *Journal of Financial Economics*, Vol. 97(2), pp. 239-262.

Cheng, M. and Madhavan, A. (2009), "The dynamics of leveraged and inverse exchange-traded funds", *Journal of Investment Management*, Vol. 7(4).

Clifford, C.P., Fulkerson, J.A. and Jordan, B.D., (2014), "What drives ETF flows?", *Financial Review*, Vol. 49(3), pp. 619-642.

Da, Z. and Shive, S. (2018), "ETFs and asset return correlations", *European Financial Management*, Vol. 24(1), pp. 136-168.

Dannhauser, C. and Hoseinzade, S. (2016), "The transformation of corporate bond investors and fragility: evidence on mutual funds and ETFs", working paper.

Deutsche Bundesbank (2018), “The growing importance of exchange traded funds in the financial markets”, *Monthly Report*, October.

Deville, L., Calamia, A. and Riva, F. (2013), “Liquidity in European equity ETFs: What really matters?”, *Bankers Markets & Investors: an academic & professional review*, pp. 60-73.

DTCC (2018), “The next crisis will be different: opportunities to continue enhancing financial stability 10 years after Lehman’s insolvency”, September.

Easley, D., Lopez de Prado, M. M. and O’Hara, M. (2012), “Flow toxicity and liquidity in a high-frequency world”, *Review of Financial Studies*, Vol. 25(5), pp. 1457-1493.

Elliott, D. (2014), *Systemic risk and the asset management industry*, The Brookings Institution, May.

European Central Bank (2018), “Counterparty and liquidity risks in exchange-traded funds”, *Financial Stability Review*, Special Feature C, November.

European Systemic Risk Board (2018), *Shadow Banking Monitor*, September.

Financial Stability Board (2011), *Potential financial stability issues arising from recent trends in Exchange-Traded Funds (ETFs)*, April.

Fixed Income Market Structure Advisory Committee (2018), *Recommendation for an Exchange-Traded Product Classification Scheme*, October.

Fulkerson, J. A., Jordan, S. D. and Travis, D. H. (2018), “Equity ETF arbitrage and daily cash flow”, paper presented at FMA conference, 8 January 2018.

Glosten, L. R., Nallareddy, S. and Zou, Y. (2016), “ETF trading and informational efficiency of underlying securities”, *Columbia Business School Research Paper,* No 16-71.

Goldstein, I., Jiang, H. and Ng, D. (2017), “Investor flows and fragility in corporate bond funds”, *Journal of Financial Economics*, Vol. 126, pp. 592-613.

Greenwhich Associates (2018), *ETFs: valuable versatility in a newly volatile market*, April.

Hamm, S. (2014), “The effect of ETFs on stock liquidity”, **available at SSRN**.

Hill, J., Nadig, D., Hougan, M. and Fuhr, D. (2015), A comprehensive guide to Exchange-Traded Funds (ETFs), CFA Institute Research Foundation, May.

Hurlin, C., Iseli, G., Pérignon, C. and Yeung, S. (2017), “The counterparty risk exposure of ETF investors”, **available at SSRN**.

International Monetary Fund (2015), “The asset management industry and financial stability”, *Global Financial Stability Report*, Chapter 3, April.

International Monetary Fund (2018), “A bumpy road ahead”, *Global Financial Stability Report*, Chapter 1, April.

International Organisation of Securities Commissions (2013), Principles for the regulation of Exchanged-Traded Funds, final report, June.

Investment Company Institute (2015), *The role and activities of Authorized Participants of Exchange-Traded Funds*, March.

Investment Company Institute (2018), *2018 Investment Company Fact Book*, May.

iShares (2015), *High yield ETFs in stressed markets*, December.

Kosev, M. and Williams, T. (2011), "Exchange-traded funds", *Bulletin of the Reserve Bank of Australia*, March.

Lettau, M. and Madhavan, A. (2018), "Exchange Trade Funds 101 for economists", *Journal of Economic Perspectives*, Vol. 32(1), pp. 135-154.

Madhavan, A. (2016), "ETFs and the new dynamics of investing". Oxford University Press.

Madhavan, A. and Morillo, D. (2018), "The impact of flows into Exchange-Traded Funds: volumes and correlations", *Journal of Portfolio Management*, Vol. 44(7), pp. 96-107.

Malamud, S. (2016), "A dynamic equilibrium model of ETFs", *CEPR Discussion Paper Series,* No DP11469.

Marshall, B. R., Nguyen, N. H. and Visaltanachoti, N. (2013), "ETF arbitrage: Intraday evidence", *Journal of Banking & Finance*, Vol. 37(9), pp. 3486-3498.

Morningstar (2017), *A guided tour of the European ETF marketplace*, February.

Nagel, S. (2012), "Evaporating liquidity", *Review of Financial Studies*, Vol. 25(7), pp. 2005-39.

Office of Financial Research (2013), *Asset management and financial stability*, September.

Pan, K. and Zeng, Y. (2017), "ETF arbitrage under liquidity mismatch", *European Systemic Risk Board Working Paper*, No 59, December.

Petajisto, A. (2017), "Inefficiencies in the pricing of Exchange-Traded Funds, *Financial Analysts Journal*, Vol. 73(1), 24-54.

Purnanandam, A. (2011), "Originate-to-distribute model and the subprime mortgage crisis*", Review of Financial Studies*, Vol. 24(6), pp. 1881-1915.

Rappoport, D. E. and Tuzun, T. (2018), "Arbitrage and liquidity: Evidence from a panel of Exchange Traded Funds", **available at SSRN**.

Ramaswany, S. (2011), "Market structures and systemic risks of exchange-traded funds", *BIS Working Paper Series,* No 343.

Shim, J.J. (2019), "Arbitrage Comovement", working paper.

Shum, P., Hejazi, W., Haryanto, E. and Rodier, A. (2016), "Intraday share price volatility and leveraged ETF rebalancing", *Review of Finance*, Vol. 20(6), pp. 2379-2409.

Su, E. (2018), “Exchange Traded Funds (ETFs): issues for Congress”, *Congressional Research Service Report,* No R45318, September.

Sullivan, R. and Xiong, J. (2012), “How index trading increases market vulnerability”, *Financial Analysts Journal*, Vol. 68(2), pp. 70-84.

Sushko, V. and Turner, G. (2018a), “The implications of passive investing for securities markets”, *BIS Quarterly Review*, March 2018.

Sushko, V. and Turner, G. (2018b), “The equity market turbulence of 5 February – the role of Exchange-Traded Volatility Products”, *BIS Quarterly Review*, March 2018.

Trainor, Jr W. (2010), “Do leveraged ETFs increase volatility”, *Technology and Investment*, No 2010(1), pp. 215-220.

Turner, G. and Sushko, V. (2018), “What risks do exchange-traded funds pose?”, *Banque de France Financial Stability Review*, April.

Vanguard (2018), “The case for low-cost index-fund investing”, April.

Whaley, R. E. (2013), “Trading volatility: at what cost?”, *Journal of Portfolio Management*, Vol. 40(1), pp. 95-108.

Imprint and acknowledgements

This report has benefited from extensive discussions at the Advisory Scientific Committee (chaired by Marco Pagano, Richard Portes and Javier Suárez). Comments by members of the Joint Expert Group on Shadow Banking (co-chaired by Steffen Kern and Richard Portes), of the Analysis Working Group (co-chaired by Carsten Detken and Thomas Schepens) and of the General Board (chaired by Mario Draghi) are gratefully acknowledged. Christian Gross, Christoph Kaufmann and Paulina Zlatkute provided outstanding research assistance.

Marco Pagano
University of Naples Federico II, Naples, Italy; e-mail: **marco.pagano@unina.it**

Antonio Sánchez Serrano
European Systemic Risk Board, Frankfurt am Main, Germany; e-mail: **antonio.sanchez@esrb.europa.eu**

Jozef Zechner
Vienna University of Economics and Business, Vienna, Austria; e-mail: **josef.zechner@wu.ac.at**

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website **www.esrb.europa.eu**

Note: The views expressed in the Reports of the Advisory Scientific Committee are those of the authors and do not necessarily reflect the official stance of the ESRB or its member organisations. In particular, any views expressed in the Reports of the Advisory Scientific Committee should not be interpreted as warnings or recommendations by the ESRB as provided for in Art. 16 of Regulation No 1092/2010 of 24 November 2010, which are subject to a formal adoption and communication process.

The cut-off date for the data included in this report was 15 March 2019.

ISBN 978-92-9472-121-1 (pdf)
DOI 10.2849/45983 (pdf)
EU catalogue No DT-01-19-521-EN-N (pdf)