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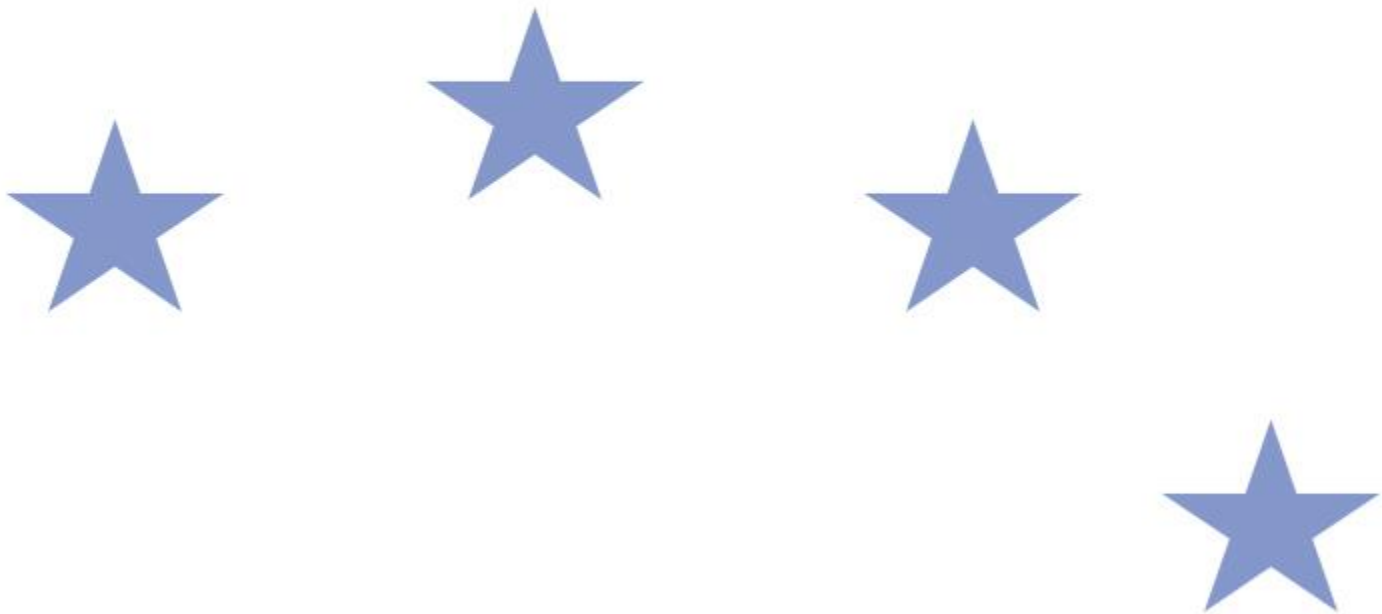

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Double Volume Cap mechanism: The impact on EU equity markets ♦

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Abstract

This paper analyses the impact of the Double Volume Cap (DVC) mechanism on European equity markets since it was introduced in March 2018. The DVC mechanism introduces limits to the amount of transactions executed under reference price and negotiated trade waivers in equity markets. For equities where DVC restrictions were applied from March 2018 onwards and for which the restriction ended in September 2018, the amount of trading on dark pools dropped from more than 7% in January 2018 to less than 1% of the total in August 2018, while the share of trading in frequent batch auctions increased over the same period from below 1% to 4% of the total. However, as the restriction on dark trading for some of these equities was lifted in September 2018, the volume of dark pool trading for these shares increased to more than 5% and the volume in frequent batch auctions declined to 2.5%. We also analyse the impact of the DVC mechanism on market liquidity in lit markets, building on a set of market liquidity indicators. The results point to an overall positive impact of the DVC measure on market liquidity in the continuous trading and auction markets (lit markets). For equities where DVC restrictions were applied from March 2018, the econometric analysis shows that market liquidity in lit markets generally improved in terms of breadth, tightness and depth. Consistently with the scope of the DVC mechanism, the turnover in continuous trading and auctions markets of the ISINs banned by the DVC mechanism is estimated to have increased significantly by about 10% following the ban compared to non-banned ISINs. Results hold when different econometric techniques are employed.

JEL Classifications: G10, G12, G18

Keywords: Equity markets, liquidity, dark trading, MiFID II.

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1 Introduction

In the last ten years European equity markets changed profoundly due to several factors, most importantly technological advances, but also changes in the regulatory environment, such as the implementation of the Markets in Financial Instruments Directive (MiFID). Following the introduction of MiFID in 2007, competition between venues in the trading of financial instruments has increased significantly. Across EU countries in 2018 the market share of the incumbent national exchange at country level is on average between 60% and 70% of total electronic order book trading in equities.[1] The rapid technological changes and, in particular, the growth of automated trading and high frequency trading (HFT) have raised concerns about possible new risks to the orderly functioning of markets. Moreover, the financial crisis highlighted the weaknesses in the functioning and the transparency of financial markets, and the need to strengthen the regulation. Against this background, MiFID II and MiFIR were published in 2014[2], triggering a major overhaul of European securities legislation.

A key goal of MiFID II/MiFIR is to ensure a higher level of transparency by imposing pre-trade and post-trade transparency requirements for both equity and non-equity instruments to market operators and investment firms operating a trading venue. As regards pre-trade transparency requirements for equity instruments – meaning shares, depositary receipts, ETFs, certificates and other similar financial instruments – trading venues should disclose information about current bid and offer prices as well as the depth of trading interests at those prices depending on the type of trading system[3]. National Competent Authorities are given the possibility to waive the obligation for trading venues to disclose this information. Four pre-trade transparency waivers have been introduced: the reference price waiver; the negotiated trade waiver; the large-in-scale waiver; and the order management facility waiver. In this paper we define dark trading as the volume of transactions executed under the reference price, negotiated trade and large-in-scale pre-trade transparency waivers.[4] In order to ensure that the use of those waivers does not prevent the proper functioning of the price formation process, the so-called double volume cap (DVC) mechanism has been introduced. It establishes limits to the amount of trading in a financial instrument executed under the reference price waiver and the negotiated trade waiver aiming to protect the price discovery process in equity markets.[5] Hence, we specify the term dark trading under the DVC mechanism as dark trading that is executed under the two mentioned waivers only.

This paper investigates the impact of the DVC mechanism on European equity markets[6] in the first six months of application (March to September 2018). The paper is based on three data sources consisting of ESMA MiFID II proprietary databases (Financial Instruments Transparency System – FITRS; Double Volume Cap – DVCAP) and Refinitiv commercial data. We find that, overall, most of the trading in equities is executed on lit markets. Based on FITRS data, for the equities banned from dark trading under the DVC mechanism in March 2018 and for which the restriction ended in September 2018, the amount of trading executed on dark pools[7] dropped as expected from more than 7% in January 2018 to less than 1% of the total in August 2018[8], while the share of trading in frequent batch auctions increased over the same period from virtually 0% to 4% of the total. However, as the restriction for a number of instruments ended in September 2018, the volume of trading executed on dark pools increased to more than 5% and the volume in frequent batch auctions declined to 2%. We run an econometric exercise to analyse the impact of the DVC mechanism on market liquidity in lit markets, building on a set of market liquidity indicators. The results point

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1 See Fidessa Fragmentation Index https://fragmentation.fidessa.com/ and FESE (2018).

2 Directive 2014/65/EU (MiFID II) https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014L0065&from=en and Regulation No. 600/2014 (MiFIR) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0600&from=EN.

3 Trading systems include: order-book, quote-driven, hybrid and frequent batch auctions.

4 MiFIR Art. 4(1) (a) to (c).

5 See section 3 for a description of the institutional details.

6 In this paper we focus on shares only while we do not consider depositary receipts, ETFs, certificates and other equity-like instruments that are under the scope of DVC mechanism (shares represent the 95% of equities in the DVC mechanism scope).

7 Dark pools refer to such markets characterised by a majority of transactions executed as dark trading which does not exclude the possibility of lit trading i.e. performed without the application of any waiver.

8 As explained in the section “Regulatory background”, the share of trading on dark pools for the affected equities is higher than 0 because for some ISINs the restriction can be applied to one trading venue or traded under the large-in-scale waiver.

to an estimated overall positive impact of the DVC measure on market liquidity in the continuous trading and auction markets (lit markets). For equities banned from dark trading under the DVC mechanism, market liquidity in lit markets generally improved in terms of breadth, tightness and depth[9]. Results hold when different econometric techniques are employed.

After providing a brief review of related literature (section 2), this paper describes the regulatory background, the evolving EU market microstructure and the MiFID II data used for the analysis (section 3), the DVC mechanism impact on trading volume and market shares (Section 4) and the analysis of the impact of the DVC mechanism on market liquidity in EU regulated markets (section 5). Finally, section 6 concludes.

2 Related literature

This paper analyses the impact of the measures related to the DVC mechanism introduced by MiFID II in March 2018. In doing so, it is closest to Johann et al. (2019) that analyse the effect of the DVC mechanism focusing on the different levels of transparency characterising the trading venues available in the market. In this framework, building on commercial data, they find that the implementation of the DVC mechanism shifts investors from dark pools to other close albeit imperfect substitutes (as internalization platforms, periodic auctions and block trading venues) and increases only marginally the trading volume in lit markets. Other studies exploit the introduction of rules limiting dark trading in non-EU markets. Farley et al. (2018) study the impact of the temporary introduction of a pilot tick size regulation by the SEC, a quasi-natural experiment in the US market, and find an exogenous reduction in dark trading. The authors show that the cost of trading and price efficiency do not deteriorate and the overall trading activity, including in lit markets, only changed modestly.[10] Foley and Putniņš (2016) analyse the effects of dark trading in equity markets, using proprietary trade-level data and focusing on the restrictions of dark trading introduced in Canada and Australia. They argue that there exist two kinds of dark trading: Dark trading at the midpoint (one-sided dark trading) and dark trading with a limit order market (two-sided dark trading). The authors find that a moderate amount of two-sided dark trading is beneficial to overall liquidity and informational efficiency (spreads and price impact), while one-sided dark trading does not seem to have any substantial effect on market quality.

This paper contributes also to the literature analysing the impact of the increasing dark pool trading in equity markets. Hatheway et al. (2017), focusing on US markets, for example, provide evidence that, except for the execution of large transactions and trading in small stocks, the effects of dark-venue order segmentation are damaging to overall market quality. Liquidity providers prefer dark pools. This results in worsening liquidity provisions on lit markets, deterioration of price discovery and higher transaction costs. Comerton-Forde et al. (2015) deliver similar evidence, again for the US markets, by showing that low levels of dark trading are benign, but they harm informational efficiency when exceeding a tipping point at around 10% of total turnover for one stock. Furthermore, block trades executed beside lit markets appear to support price formation at levels below 40%. Aquilina et al. (2017) contribute to the dark pools debate by presenting first evidence on the impact of dark trading on aggregate market quality in Europe, between 2010 and 2015. They confirm the previous results and find that, at current levels, dark trading does not appear to be harmful to market quality in the aggregate UK equity market. Their results imply that there is a threshold at which dark trading may start to negatively affect market quality. They estimate this threshold to be between 10% and 17% depending on the market quality metric considered. Using a sample of LSE- and Euronext-listed equities, Gresse (2017) investigates how lit and dark market fragmentation affects liquidity. Neither dark trading, nor fragmentation between lit order books, is found to harm liquidity. Benefits are greater for large stocks and stocks with less electronic trading. From a theoretical perspective, these results are supported by Zhu (2014), that develops a theoretical model showing that dark pools improve price discovery on lit markets by absorbing uninformed investor but thereby also reduce liquidity.

By presenting new evidence on frequent batch auctions, this paper contributes also to another strand of literature, analysing discrete time trading. One seminal paper in this area is Budish et al. (2015) who show that discrete time trading may enhance

9 The sample used for the econometric analysis is based on commercial databases and includes a subset of the equities affected by DVC mechanism.

10 The narrow definitions of dark trading and dark pools within the considered literature deviate from the definitions outlined before, caused by different regulatory frameworks and data structures.

liquidity and market stability by reducing the speed advantage of certain market participants. As a result, competition on speed is replaced by competition on price.

3 Institutional details and EU market microstructure evolution

3.1 MiFID II: limiting dark trading

MiFID I introduced uniform pre- and post-trade transparency requirements for shares[11] across European equity trading venues to facilitate competition among different types of trading venues (Regulated Markets (RMs), Multilateral Trading Facilities (MTFs), Systematic Internalisers (SIs) and investment firms trading Over-The-Counter (OTC)) and to promote price formation process. Following the same rationale, MiFID II – which came into force on 3 January 2018 – expands transparency requirements to all financial instruments (other equity and non-equity instruments)[12].

Pre-trade transparency refers to the obligation for market operators and investment firms operating a trading venue to make public current bid and offer prices, as well as the depth of trading interests at those prices which are advertised through their systems for shares, depositary receipts, exchange-traded funds (ETFs), certificates and other similar financial instruments traded on a trading venue[13]. On the other hand, post-trade transparency refers to the obligation for market operators and investment firms operating a trading venue to make public the price, volume and time of the transactions executed in respect to shares, depositary receipts, ETFs, certificates and other similar financial instruments traded on that trading venue as close to real-time as is technically possible[14]. The increased level of transparency led to concerns among market participants that information regarding their orders could be detected and used by other traders before execution. To balance the interest of the wider market with the interest of individuals and to ensure that the transparency regime does not produce unintended consequences on liquidity, MiFID introduced – and MiFID II later preserved – the concept of waivers from both pre- and post-trade transparency requirements in specific circumstances.

As regards pre-trade transparency waivers for equity instruments, MiFID II allows National Competent Authorities to grant four types of waivers:

- **Reference Price Waiver** (RPW): For systems matching orders based on the midpoint within the current bid and offer process of the trading venue where that financial instrument was first admitted to trading or the most relevant market in terms of liquidity;
- **Negotiated Trade Waiver** (NTW): For systems that formalise negotiated transactions;
- **Large in Scale** (LIS): For orders that are large in scale compared with normal market size;
- **Order Management Facility** (OMF): For orders held in an order management facility of the trading venue pending disclosure.

Concerns have mounted over time that the waivers have not been implemented consistently across markets and venues, with a consequent lack of price discovery. To address this issue, MiFID II introduced the DVC mechanism to limit the amount of dark

11 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32004L0039 Articles 27, 29 and 44 of Directive 2004/39/EC provide for the general obligation of systematic internalisers, MTFs and regulated markets to make pre-trade transparency data available. Articles 29 and 44 of Directive 2004/39/EC refer to 'the size or type of orders' and 'the market model for which pre-trade disclosure may be waived', in particular transactions that are concluded 'by reference to prices established outside the systems' of the regulated market or MTF and "transactions that are large in scale". The waivers for pre-trade transparency are further defined in Articles 18 and 20 of Regulation 1287/2006.

12 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32014L0065

13 Article 3(1) MiFIR.

14 Article 6(1) MiFIR.

trading in equity and equity-like instruments allowed under the RPW and the NTW[15]. In particular, trading under both waivers is limited in the case of instruments whose percentage of this trading on a single trading venue is higher than 4% of the total volume of trading in those financial instruments across all EU trading venues over the previous twelve months, and in the case instruments whose percentage of trading across all EU trading venues under the DVC waivers is higher than 8% of the total volume of trading in that financial instrument across all EU trading venues over the previous twelve months[16]. Every month the DVC is calculated per instrument (ISIN) based on the trading executed in that instrument over a rolling period of twelve months.

When the percentage of trading in a financial instrument carried out on a trading venue under the DVC waivers has exceeded the 4% limit, the use of those waivers in the financial instrument is suspended on that venue for a period of six months. When the percentage of trading in a financial instrument carried out on all trading venues across the Union under DVC waivers has exceeded the 8% limit, the use of those waivers is suspended in all trading venues across the Union for a period of six months[17].

ESMA publishes regularly the results of the DVC mechanism on its website in the Double Volume Cap Register. While the DVC mechanism was supposed to be effective from January 2018 (along with other provisions of MiFID II), the implementation was delayed until March 2018 due to data quality and completeness issues[18]. The first publication occurred on 7 March 2018[19]. This delay allows us to separate the implementation of the DVC mechanism from other provisions introduced by MiFID II/MiFIR.

As of the beginning of September 2018[20], the application of the DVC resulted in the suspension of trading under the RPW and NTW for more than 1,300 instruments, mainly equities.

3.2 The evolving EU market microstructure

In recent years, technology and regulation have rapidly transformed the landscape of trading in European financial markets. New trading venues and new types of traders have emerged, affecting the costs of trading for different participants. According to Petrescu and Wedow (2017), that analyse the changes in the market structures in the EU equity markets between 2004 and

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15 The Double Volume Cap mechanism shall not apply to negotiated transactions which are in a share, depositary receipts, ETF, certificate or other similar financial instrument for which there is not a liquid market.

16 According to MiFIR article 5: In order to ensure that the use of the negotiated trade waiver and of the reference price waiver [provided for in MiFIR Article 4(1)(a) and 4(1)(b)(i)] does not unduly harm price formation, trading under those waivers is restricted as follows: (a) the percentage of trading in a financial instrument carried out on a trading venue under those waivers shall be limited to 4% of the total volume of trading in that financial instrument on all trading venues across the Union over the previous 12 months. (b) overall Union trading in a financial instrument carried out under those waivers shall be limited to 8% of the total volume of trading in that financial instrument on all trading venues across the Union over the previous 12 months.

17 See MiFIR, article 5 (2) When the percentage of trading in a financial instrument carried out on a trading venue under the waivers has exceeded the limit referred to in paragraph 1(a), the Competent Authority that authorised the use of those waivers by that venue shall within two working days suspend their use on that venue in that financial instrument based on the data published by ESMA referred to in paragraph 4, for a period of six months. (3). When the percentage of trading in a financial instrument carried out on all trading venues across the Union under those waivers has exceeded the limit referred to in paragraph 1(b), all Competent Authorities shall within two working days suspend the use of those waivers across the Union for a period of six months.

18 https://www.esma.europa.eu/press-news/esma-news/esma-delays-publication-double-volume-cap-data

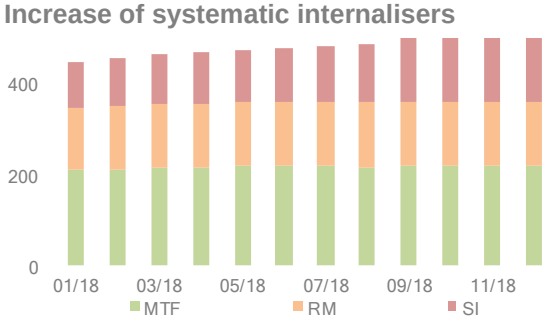
19 ESMA shall publish regularly the results of the DVCM on its website in the Double Volume Cap Register. On a temporary basis, the results of the DVCM will be published on the ESMA website in spreadsheet format. https://www.esma.europa.eu/double-volume-cap-mechanism

20 Figures refer to the beginning of September 2018, before the DVC publication on 7 September 2018.

2016, the implementation of MiFID I and the birth of algorithmic trading are the main drivers of the increase in the number and market share of dark pools.

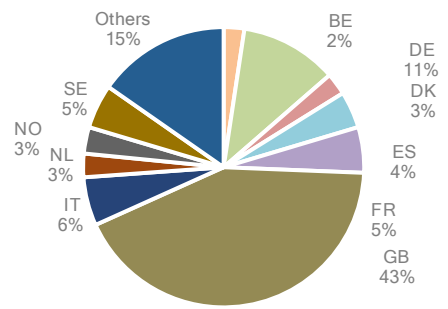
Following the entry into force of MiFID II ESMA publishes and keeps up to date a register of all EU regulated markets[21], multilateral trading facilities[22], organised trading facilities[23] and systematic internalisers[24] on its website. The newly available data at EU level allows to monitor the evolution of the EU market microstructure. Overall, in the EU in December 2018, there are 213 MTFs (they were 209 at the beginning of 2018) and 130 RMs (stable compared to January 2018). At the European level, at the end of 2018 there are 164 SIs in the ESMA register, compared to 104 in January 2018 (Chart 1)[25]. From a geographical perspective in 2018, 43% of the trading venues are located in the UK, followed by Germany (11%), Italy (6%), Sweden and France (both with 5%), while all the others are below 5% (Chart 2).

Chart 1
Trading venues in the EU
Increase of systematic internalisers



Note: number of trading venues by market type as reported in ESMA registers.
Sources: ESMA.

Chart 2
Trading venues in the EU
More than 50% in two countries



Note: Share of trading venues registered in an EU country, in %.
Sources: ESMA

Around 56% of the volume traded in equity markets in January 2018 happened in transparent order books (continuous trading, auctions and lit trading on dark pools[26]) while 30.5% of the volume traded was OTC. Frequent batch auctions at the beginning of 2018 were negligible while trading under the DVC waivers amounted to 5.2%. The share of LIS volume traded was 4.3% while SIs represented 3.7% of the total volume (Chart. 3). In October 2018, the share of volume traded in transparent order books increased to 66.1% while the volume of OTC trading decreased to 16.7%. LIS trades became more important with 8.9% of the total volume traded, while SIs remained broadly stable at 3.6% of the total.

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21 According to Article 56 of Directive 2014/65/EU (MiFID II). This register contains the Market Identifier Code (MIC) established by ESMA in accordance with Article 65(6) identifying the regulated markets for use in reports in accordance with Articles 6, 10 and 26 of Regulation (EU) No 600/2014 (MiFIR).

22 According to Article 18(10) of Directive 2014/65/EU (MiFID II). This list contains information on the services an MTF provides and entails the Market Identifier Code (MIC) established by ESMA in accordance with Article 65(6) identifying the MTF for use in reports in accordance with Articles 6, 10 and 26 of Regulation (EU) No 600/2014 (MiFIR).

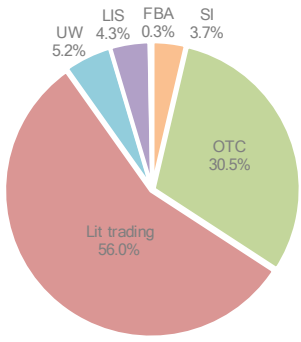
23 Article 18(10) of Directive 2014/65/EU (MiFID II). This list contains information on the services an OTF provides and entails the Market Identifier Code (MIC) established by ESMA in accordance with Article 65(6) identifying the OTF for use in reports in accordance with Articles 6, 10 and 26 of Regulation (EU) No 600/2014 (MiFIR).

24 According to Article 15(1) of Regulation (EU) No 600/2014 (MiFIR), ESMA shall establish a list of all systematic internalisers (SIs) in shares, depositary receipts, ETFs, certificates and other similar financial instruments in the Union. According to Article 18(4) of MiFIR, ESMA shall establish a list of SIs in bonds, structured finance products, emission allowances and derivatives in the Union.

25 The number of SIs under MiFID I may have been underestimated, as there was no mandatory requirement of reporting.

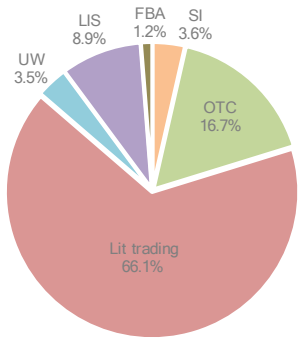
26 According to the definition in section 1, dark pools can execute trades without applying any waiver.

Chart 3
Trading volumes in the EU in January 2018
Lit trading predominant



Note: UW: Trading under RPW, NTW and in OMF. LIS: Trading under the large in scale waiver. FBA: Frequent batch auctions. Lit trading also comprises lit trading in dark pools. Share of volume traded, in %.
Sources: ESMA.

Chart 4
Trading volumes in the EU in October 2018
Increase in Frequent Batch Auction volumes



Note: UW: Trading under RPW, NTW and in OMF. LIS: Trading under the large in scale waiver. FBA: Frequent batch auctions. Lit trading also comprises lit trading in dark pools. Share of volume traded, in %.
Sources: ESMA.

Frequent batch auctions have increased from nearly 0.3% to 1.2% and trading under DVC waivers fell from 5.2% to 3.5% (Chart 4 and Box 1).

Box. 1
Focus
Frequent batch auctions

With the application of MiFID II and MiFIR on 3 January 2018, frequent batch auction (FBA) trading systems have been rapidly gaining market share, with an acceleration of this trend following the first suspensions of trading under the DVC waivers for liquid instruments on 12 March 2018. FBA accounted for only 0.3% of the total volume traded in shares in January 2018. This stake increased to 0.8% in March and up to 1.5% in June but declined to 1.2% in October after the first suspensions by the DVC mechanism expired. Sometimes also called auctions on demand, FBA trading systems for equity instruments are auctions of a very short duration triggered by market participants and occurring during the trading day[27]. MiFID II and MiFIR do not provide a definition of FBA trading systems as such.

However, Commission Delegated Regulation 2017/587 (RTS 1) further specifies the pre-trade transparency requirements for different types of trading systems, including periodic auction (PA) trading systems. According to table 1 of Annex I of RTS 1 a PA trading system is 'a system that matches orders based on a periodic auction and a trading algorithm operated without human intervention'[28]. Trading venues operating PA systems collect offers to sell (buy) financial instruments at or above (below) a minimum (maximum) price by the selling (buying) firm. Based on those offers the trading algorithm determines a single 'uncrossing' price which maximises the volume of instruments which can be executed at that price. PA are not a new development but have been used for a long time already, either in the form of closing and opening auctions to set the price for the beginning or the closure of the trading day or, for less liquid instruments, intra-day auctions to gather sufficient liquidity to allow trading. Moreover, following a trading interruption due to market volatility, most trading venues resume normal operations via an auction. Those trading systems can be labelled as 'conventional periodic auction systems'.

Recently, with FBA systems a new type of PA trading systems has gained market share. While FBA, including auctions on demand, function in a similar way as conventional PA operated by many trading venues, it is possible to highlight two main differences. First, the duration of FBAs is very short and lasts only some milliseconds, as opposed to conventional PAs that last several minutes. Second, whereas conventional PAs are scheduled by the trading venue, for FBAs two different models for triggering an auction exist. One commonly used approach is to collect trading interest throughout the day, and to trigger a 'call period' every time a pair of opposing orders can be matched. Another frequent approach is to trigger an auction as soon as one order has been submitted.

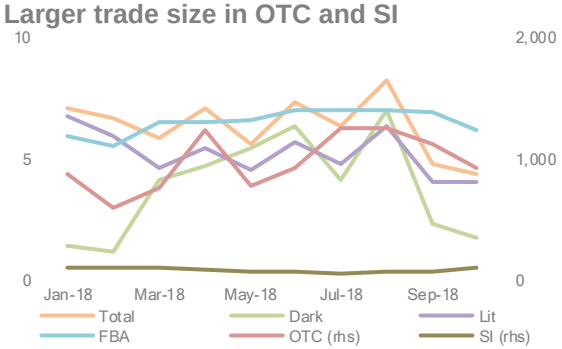
ESMA launched a call for evidence in November 2018 to better understand FBA systems and to assess whether and to which extent these systems are used to circumvent the DVC. The Final Report published on 11 June 2019 presents ESMA's assessment of four main characteristics of FBA trading systems: limited pre-trade transparency, short auction duration, price determination within the best bid and offer price, and self-matching features. ESMA, based on the evidence gathered, will focus on pre-trade transparency and the price determination process of FBAs[29].

27 Budish et al. (2015) find that when high-frequency trading is prevalent, frequent batch auctions may eliminate the mechanical arbitrage rents, enhance liquidity for investors, and stop the high-frequency trading arms race.

29 https://www.esma.europa.eu/press-news/esma-news/esma-address-regulatory-concerns-over-frequent-batch-auctions

Overall, the average trade size is between EUR 5,000 and EUR 8,000, with larger sizes characterising OTC trades and transactions in systematic internalisers. OTC trade size is particularly large, being on average slightly lower than EUR 1mln in the analysed period. For SIs the average trade size is significantly lower than for OTC transactions (EUR 80,000) but still ten times larger than in other trading venues. In lit trading the average trade size is comprised between EUR 4,000 and EUR 7,000 and for FBAs around EUR 6,000. Dark trading, comprising trading under the RPW, NTW and LIS waiver, shows augmented average trade sizes between March and August reaching between EUR 4,000 and EUR 7,000 compared to around EUR 1,500 in January and EUR 1,700 in December 2018 (Chart 5).

Chart 5
Average trade size in the EU by market type
Larger trade size in OTC and SI



Note: Average trade size in EUR thousand.
Sources: ESMA

3.3 MiFID II data: FITRS and DVCAP

This paper exploits two important proprietary databases introduced by MiFID II: Financial Instruments Transparency System (FITRS) and Double Volume Cap (DVCAP).

The FITRS database includes daily information about total trading volume and total number of transactions for both equity and equity-like as well as for non-equity instruments traded in the EU markets. The FITRS database offers the possibility to disentangle the volume (and number of transactions) executed under pre-trade transparency waivers of MiFIR Art. 4(1) (a) to (c), i.e. trading executed under the reference price waiver (RPW), negotiated trade waiver (NTW) and the Large in Scale waiver (LIS).

The DVCAP database includes information about total trading volume (and total number of transactions), trading volumes under the RPW and trading volume under the NTW only, for each ISIN-MIC-reporting period combination. Entities are required to report DVCAP data on a bi-weekly basis.[30]

4 DVC mechanism impact on trading volume and market shares

The primary objective of this research is to investigate the impact of the DVC mechanism implementation on trading volumes in EU equity markets. To perform this analysis, we employ the trading volumes data extracted by ESMA's DVCAP database[31]. By applying an additional mapping of segment MICs, we could further differentiate FBA trading volumes in the majority of cases. The DVCAP database does not include any information related to volumes of equity instruments traded on SIs, OTC or under the LIS waiver. Therefore, this analysis cannot assess the changes of the trading volumes in these market segments.

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[30] Finally, we complement the information available in ESMA proprietary databases, with data extracted from Refinitiv commercial data. In particular, mid-price, bid-ask spread, returns, return volatility and market capitalisation are extracted from Refinitiv

[31] As already mentioned, the DVCAP database includes information about total trading volume, trading volumes under the RPW and trading volume under the NTW for each ISIN-MIC-reporting period combination. Entities are required to report DVCAP data on a bi-weekly basis.

Chart 6 presents how data extracted from the DVCAP database has been filtered to create Charts 7-10. The total number of instruments in scope of the DVC mechanism was more than 27,700 from January to September 2018. We restrict our sample to shares only by excluding depositary receipts, exchange-traded funds and other equity-like instruments (21,585 ISINs)[32]. Then, we retain the instruments that were suspended by the DVC mechanism at EU level (8% limit) only following the updates of the DVC register between March and August 2018[33], allowing us to better estimate the effect of DVC mechanism[34].

Chart 6
Equity selection
Building the dataset: Multi-step process

	ISINs
Extraction from ESMA DVCAP database	27,709
Filtering instruments that are shares (Chart 7)	21,585
Of which never affected by DVC mechanism (Chart 10)	20,340
Of which affected by the DVC mechanism (Chart 9)	1,245
Of which suspended by the DVC mechanism at EU level only (8% cap)	1,116
Of which not revoked in September 2018	1,055
Of which suspended by the DVC mechanism from March to September 2018 (Chart 8)	608

Note: Number of ISINs. Data have been extracted in April 2019.
Sources: ESMA.

Overall, for the 21,585 ISINs included in the sample, volumes of continuous trading and auctions (including opening and closing auctions and post-circuit-breaker auctions) represent most of the trading, being constantly above 90% from January to September 2018. In the overall sample, FBAs increased from less than 1% at the beginning of 2018 to over 2.5% in August 2018. Trading under the DVC waivers decreased from over 6% at the beginning of 2018 to less than 2.5% in August. During the same period, the monthly total volume traded remained broadly stable, fluctuating around EUR 1tn (Chart 7).

For the 608 ISINs where the DVC restrictions were applied in March 2018 for the following six months, and for which the restriction has been removed in September 2018, volumes of continuous trading and auctions represent as well over 90% of the volumes traded. In January 2018, the volume under both DVC waivers and in FBAs amounted to 9%. It declined to less than 3% in April 2018, and then gradually increased to over 4% in August 2018 and to 7% at the end of September 2018[35]. In particular, the decline has been driven by the drop of dark trading under the DVC waivers that shrank from more than 8% to 0% of the total. Over the same period, the volume traded in FBAs increased from 0.7% to over 4% of the total between January and August 2018. When, in September 2018, the ban was removed, the RPW and NTW volumes immediately surged to almost 4% of the total, while the share of trading volume in FBAs declined to 3% (Chart 8).

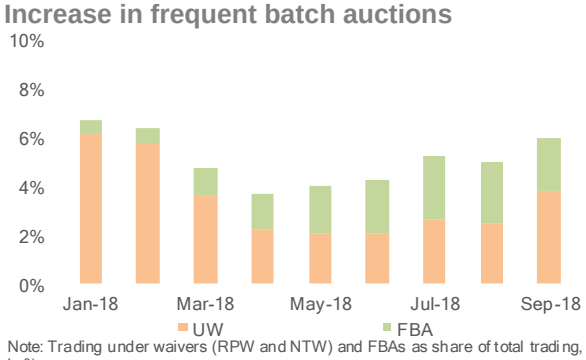
[32] Since our empirical analysis studies liquidity dynamics, we restrict our sample to shares only in order to consistently study their dynamics that could differ from the other types of equity and equity-like instruments (depositary receipts, exchange-traded funds and others).

[33] The publication dates are: 7 March, 10 April, 8 May, 7 June, 6 July and 7 August 2018.

[34] As mentioned in Section 3.1, there are two different restrictions introduced under the DVC mechanism: 4% cap (single trading venue suspension) and 8% cap (EU level suspension). Since investors could still trade the relevant share in dark pools if the instrument is suspended by the DVC mechanism at TV level, it would be difficult to identify any economic effect of the DVC mechanism. More than 89% of the suspensions published by ESMA were due to the breach of the 8% threshold.

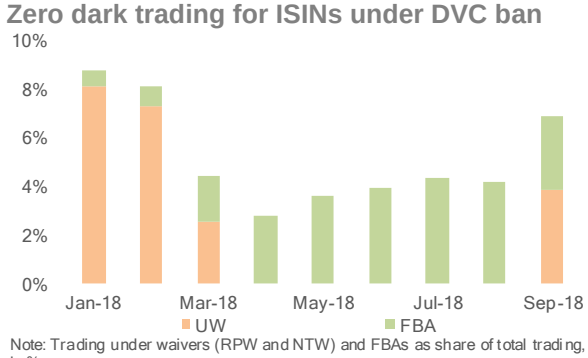
[35] Volumes traded under the LIS waiver are excluded from the analysis as they are out of scope of the DVC mechanism.

Chart 7
Trading volumes for all ISINs in DVC scope



Note: Trading under waivers (RPW and NTW) and FBAs as share of total trading, in %.
Sources: ESMA.

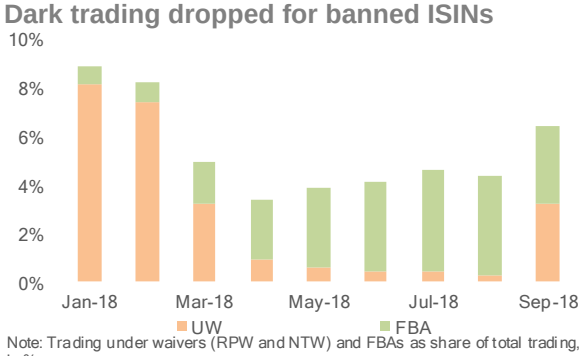
Chart 8
Trading volume for ISINs constantly banned from dark trading between March and September 2018



Note: Trading under waivers (RPW and NTW) and FBAs as share of total trading, in %.
Sources: ESMA.

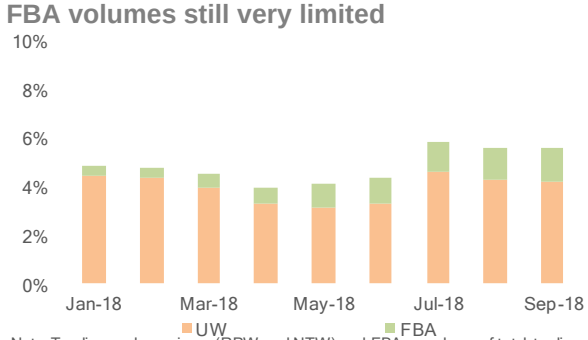
The number of ISINs where the DVC restrictions were applied between March and September 2018 was 1,245 (i.e. around 6% of ISINs in scope)[36]. Volumes of continuous trading and auctions in these instruments represent constantly above 90% of their total volumes. They experienced a decline in volumes under DVC waivers, similarly to the ISINs banned by the DVC mechanism in March 2018[37]. In particular, volumes shrank from almost 8% to 3% of the total between January and September 2018, while volume traded in FBAs increased from below 1% to over 3% of the total in the same period (Chart 9).

Chart.9
Trading volume for ISINs banned from dark trading at any time between March and September 2018



Note: Trading under waivers (RPW and NTW) and FBAs as share of total trading, in %.
Sources: ESMA.

Chart 10
Trading volumes for non-banned ISINs



Note: Trading under waivers (RPW and NTW) and FBAs as share of total trading, in %.
Sources: ESMA.

Finally, for the ISINs where the DVC restrictions have not applied over the considered period (20,340 ISINs), trading volumes remained broadly stable in relative terms and no structural changes in trading can be identified. Continuous trading and auctions represent around 95% of total trading, while volumes traded in FBAs slightly increased from less than 0.4% to around 1.3% of the total. Trading volumes under the RPW and the NTW remained broadly stable around 4% (Chart 10).

36 The large majority of suspensions interested equities for which their percentage of trading across all trading venues under the waivers goes beyond 8% of the total volume of trading in that financial instrument across all EU trading venues over the previous twelve months. Less than 1% of suspensions concerned equities for which their percentage of trading on a single trading venue under the waivers goes beyond 4% of the total volume of trading in those financial instruments across all EU trading venues over the previous twelve months.

37 The decreasing share of trading under DVC waivers derives directly from the increasing number of ISINs getting banned by the subsequent DVC publications.

5 DVC mechanism impact on market liquidity

This paper investigates market liquidity in EU equity markets in the period between 1 January 2018 and 12 September 2018. In particular, this paper analyses the impact of the DVC mechanism on market liquidity in continuous trading and auction markets from 12 March 2018 up to 12 September 2018.

It is widely recognised that liquidity is not directly observed or uniquely defined and cannot be captured by one single metric. The existing literature identifies generally the following five dimensions of market liquidity: tightness, depth, breadth, immediacy and resilience. In this paper we analyse the first three dimensions building on liquidity proxies that can be developed without the availability of order level data. Tightness identifies the possibility of executing transactions at a low cost. It can be measured by bid-ask spreads. Depth refers to the existence of enough orders at prices above or below the market price. It can be meaningfully proxied by looking at volumes of trades. Breadth can be defined as the ability to transact large volumes with a minimum impact on prices: it can be proxied by the Amihud illiquidity index, by the turnover ratio and by the average trade size. Immediacy is considered an order's time to execution and resilience refers to the availability of liquidity in periods of higher volatility and market stress, both require order level data and are therefore not investigated.

The primary source of data for this analysis is ESMA's FITRS[38] database, which includes both reference (i.e. intrinsic characteristics of the instruments) and quantitative data (i.e. information related to their trading activity) of all instruments under the transparency scope. The FITRS database includes variables such as issuance size, number of outstanding instruments, close price, total number and total volume of transactions, as well as the number and volume of transactions under pre-trade transparency waivers and deferred trade-publication separately.

As described in Chart 11, a filtering process has been developed, in order to obtain from the data extracted from FITRS a sample of shares that has been employed in the analysis. More specifically, the initial database includes 27,976 distinct ISINs that fall under the DVC scope. First, instruments that were not classified as liquid[39] for the purpose of MiFID II were excluded, since this status is a pre-requisite for the application of rules concerning pre-trade and post-trade transparency. After proceeding with this filtering, the remaining sample is composed of 1,934 equity and equity-like instruments. Furthermore, shares for which trading price information is not available in Refinitiv DataStream have been eliminated. The matching of these two data sources and the removal of outliers and instruments not formally classified as *shares* (i.e. depositary receipts, ETFs, certificates and other categories) leads to a further reduction in sample size. In addition, to analyse the impact of the DVC mechanism on market liquidity in the EU markets only those ISINs that do not change their treatment status after the first application of the DVC mechanism on 12 March 2018 were included (that is, only instruments either banned or not banned for the whole duration of the analysis). Finally, ISINs that were misclassified (for which the ban was lifted) and those few ISINs that were subject, during the period considered, to a suspension at the trading venue level (i.e. referring to the 4% "local" threshold) were removed from the sample, since their behaviour is affected by the partial ban and, thus, they are not clearly classifiable as treatment or control in our framework. As a result, the final sample of analysis contains 473 ISINs, including 209 banned ISINs and 264 non-banned ISINs under the DVC mechanism.[40]

Chart.11
Equity selection
Building the dataset: Multi-step process

	ISINs	MICs[41]	Observations
Filtering instruments that are under DVC scope	27,976	203	39,736,724

38 https://www.esma.europa.eu/policy-activities/mifid-ii-and-mifir/transparency-calculations

39 An equity instrument is classified as having a liquid market if it has (i) a free float of at least EUR 100 mln; (ii) at least 250 average daily number of transactions; (iii) and an average daily turnover of EUR 1 mln. https://www.esma.europa.eu/policy-activities/mifid-ii-and-mifir/transparency-calculations

40 The share of banned ISINs (by the DVC mechanism) in the sample used for the econometric analysis is much larger than in the sample of ISINs included in the DVC scope (44% vs less than 1%).

41 ISO 10383 defines codes for exchanges and market identification (MIC code). This international standard specifies a universal method of identifying exchanges, trading platforms, regulated or non-regulated markets and trade reporting facilities as sources of prices and related information in order to facilitate automated processing.

Filtering instruments that are liquid	1,934	146	10,518,504
Filtering rows that have both FITRS quantitative and Refinitiv data	537	131	144,451
Removing outliers & instruments suspended by the DVC mechanism at TV level (4% threshold)	533	130	143,222
Filtering instruments that are shares	523	130	140,955
Removing instruments for which the DVC suspension has been revoked	481	130	130,412
Keeping instruments that were never banned by the DVC as control only	473	127	94,285

Note: Data have been extracted from FITRS in December 2018.
Sources: Refinitiv, ESMA.

The sample covers 130 trading venues between 1 January 2018 and 12 September 2018. All trading venues on which trades occurred for the ISINs in the sample during the observation period are included. For each ISIN, information is available about the relevant trading types: continuous trading and auction including opening and closing auctions and post-circuit breaker auctions (Lit), trading on dark pools (Dark), OTC[42], FBA and SI trading. Over the analysed period, continuous trading and auction markets accounted for 84% of the trades and 75% of the turnover (Chart 12).[43]

Chart.12
Summary statistics
The dataset: Trading venue information

	Number of trading venues	Turnover	Number of trades
Lit	66	293	63,052
SI	34	14	187
Dark	15	42	10,587
FBA	10	6	922
OTC	-	31	65

Note: Number of trading venues per each type. Turnover in EUR bn, computed as a monthly average. Number of trades in thousands, computed as a monthly average.
Sources: ESMA.

For each share *i* in the sample, the variables included in Chart 13 have been analysed.

Chart.13
Variable description
The dataset: ISIN level information

Variable	Currency	Source	Frequency	Definition
Volume	EUR	ESMA FITRS	d	Total volume of transactions
Volume Pre	EUR	ESMA FITRS	d	Volume of transactions reported under pre-trade transparency waivers
Volume Post	EUR	ESMA FITRS	d	Volume of transactions reported under post-trade transparency waiver
Number of trades	-	ESMA FITRS	d	Total number of transactions
Average trade size	-	Computed	d	Volume divided by the total number of transactions
Price	EUR	ESMA FITRS, TR Eikon	d	Eikon mid-price where available, otherwise FITRS close price
Returns	-	Computed	d	Percentage variation in price
Return volatility	-	Computed	w	Standard deviation of returns
Market capitalisation	EUR	Refinitiv	d	

42 OTC is identified by the Market Identifier Code (MIC) 'XOFF' corresponding to financial instruments admitted to trading, or traded on a trading venue or for which a request for admission was made, where the transaction on that financial instrument is not executed on a trading venue, SI or organised trading platform outside of the Union, or where an investment firm does not know it is trading with another investment firm acting as an SI.

43 Volumes traded and transactions in all categories except lit markets may be underestimated. The bias may be particularly relevant for frequent batch auctions (one trading venue available), dark pools (two trading venues) and OTC (five trading venues).

Amihud ratio	-	Computed	d, w	Absolute value of returns divided by volume (at ISIN-MIC level in daily and weekly frequencies)
Bid-ask spread	-	Refinitiv	d	Relative spread: (ASK-BID)/((ASK+BID)/2)
Share of Non-transparent trading	-	Computed	d	Share of OTC and SI trading, computed at ISIN level
Fragmentation	-	Computed	d	Calculated, at ISIN level, as the inverse of the HHI index on the regulated markets

Note: d = daily; w = weekly
Sources: Refinitiv, ESMA.

At ISIN level, daily information about mid-price, bid-ask spread, returns, return volatility and market capitalisation (Chart 14) is retrieved from Refinitiv database.

The latter chart displays summary statistics for bid-ask spreads, returns and market capitalisation for those ISIN affected by the DVC ban and for those that are not affected by the DVC ban (treated and control group as defined in the following section) in the time span prior to the policy intervention, with the purpose of investigating their comparability. Overall, before the publication of the first DVC measures in March 2018, the ISINs banned by the DVC mechanism seem to be characterised by tighter bid-ask spreads compared to the ISINs that were not banned in the same period. Market performance, slightly negative for both categories in the first two months of 2018, was better for the ISINs banned by the DVC mechanism. Finally, the treatment group is characterised on average by a lower market capitalisation, even though it seems that the high mean value for the control group is driven by extreme tail observations.

Chart.14
Summary statistics
The dataset: ISIN level information

Banned ISINs	**P25**	**P50**	**Mean**	**P75**
Bid-ask spread	0.0006	0.0015	0.0024	0.0031
Returns	-0.88%	-0.10%	-0.04%	0.72%
Market capitalization	1.3609	3.1201	7.7161	7.4445
Number of ISINs	209	209	209	209
Non-banned ISINs	**P25**	**P50**	**Mean**	**P75**
Bid-ask spread	0.0008	0.0021	0.0033	0.0048
Returns	-0.98%	-0.14%	-0.08%	0.71%
Market capitalization	0.7377	1.9112	8.5344	7.0350
Number of ISINs	264	264	264	264

Note: The summary statistics represent 25th percentile, median, mean and 75th percentile of each variable referring to the months of January and February 2018, before the implementation of DVC. Bid-ask spread in basis points; Market capitalization in EUR billion. Returns are first computed averaging on a weekly basis and are expressed in percentage.
Sources: Refinitiv database, ESMA.

5.1 Empirical approach

The impact analysis of the DVC mechanism on market liquidity in continuous trading and auction markets employs a difference-in-difference approach, a standard econometric methodology in the policy evaluation field[44]. The baseline regression model is the following:

[44] Gertler et al (2016).

$$Y_{it} = \alpha_i + \beta Treatment_i + \gamma Event_t + \delta Treatment_i * Event_t + \theta ISIN_{it} + \epsilon_{it}$$

where:

— i represents the respective ISINs included in the analysis and t is a time index for each trading day between 1 January 2018 and 12 September 2018.

— Y_{it}, the dependent variable, is one of the liquidity measures described in Section 5. To obtain a comprehensive assessment of the impact on market liquidity and on its different dimensions, the following range of measures has been included: Turnover, Bid-ask spreads, Turnover ratio, Average trade size and Amihud illiquidity index.

— α_i indicates ISIN fixed effects.

— $Treatment_i$ is a dummy variable equal to one over all trading days for ISINs that were suspended by the DVC mechanism.

— $Event_t$ is a dummy variable equal to one for all ISINs after the first DVC suspensions on 12 March 2018.

— $Treatment_i * Event_t$ is the interaction variable which isolates the effect of the intervention on the treated ISINs. In other words, the interaction represents the treatment and its coefficient δ reflects the average effect of DVC suspensions. It is, hence, the most important coefficient of this regression.

— $ISIN_{it}$ includes the other relevant controls at ISIN level.

The control variables included at ISIN level are:

— A fragmentation index, calculated as the inverse of the Herfindahl-Hirschman Index, which is a widely used measure to determine the concentration of a market.[45] As shown by Degryse et al. (2015), fragmentation may have a significant impact on market liquidity. In particular, fragmentation improves liquidity aggregated over all trading venues but may lower liquidity in the traditional market. The index is defined as:

$Fragmentation_{it} = \frac{1}{HHI_{it}}$, where, for each t, $HHI_{it} = \sum_{j=1}^{M} \left(marketshare_{ij}\right)^2$

with *M* being the total number of MICs/Trading Venues that displayed trading in that ISIN.

In the empirical analysis, the index was calculated considering only the volumes traded across the regulated markets (thus, disregarding trading on dark pools, OTC and SI platforms).

— Market capitalisation, used to control for firm size. As larger firms generally benefit from larger coverage by financial analysts, they tend to have larger trading volumes and possibly higher market liquidity.

— The lagged volatility of weekly returns: on ISIN level, it has been added to consider market developments and uncertainty in the market.

Finally, time (monthly) and country fixed effects have been included the model specification (where possible).

5.2 Results

The effect of the ban on market liquidity appears to be positive for the suspended ISINs, as indicated by the sign and the statistical significance of the main variable of interest in the regression: the interaction between *Treatment* and *Event* (Chart 15).[46] This result holds for all the different indicators of market liquidity, with the exception of the Amihud ratio - where the relation is not statistically significant. Specifically, following the ban and consistently with the scope of the DVC mechanism, the turnover in continuous trading and auction markets of the ISINs banned by the DVC mechanism increased significantly by about 10% compared to non-banned ISINs. This indicates that a portion of trading is likely to have shifted from dark pools to continuous trading and auctions markets. This result is interesting if contrasted with the overall negative impact on trading volume following

[45] This is in line with the Fidessa Fragmentation Index.

[46] We have picked the most representative specification, but the results are consistent across different ones.

the DVC publication in March 2018 for the whole sample (as underlined by the sign and the statistical significance of the coefficient of the *Event* variable). Similar results are found when market liquidity is measured by the turnover ratio. Furthermore, instruments banned by the DVC mechanism experienced a decrease in the bid-ask spread compared to the control ISINs, reflecting lower tightness in the market. The DVC ban seems to affect the average trade size in a positive way, and this as well points to an improvement of market liquidity. As mentioned, the effect on price responsiveness to trading, measured by the Amihud illiquidity index, is not statistically significant, exhibiting however a negative (liquidity enhancing) sign.

Chart. 15

Regression results

	Log Amihud	Log trade size	Bid ask spread	Log turnover	Turnover ratio
Treatment	-0.110	-0.236***	-0.000555	0.0752	-0.000753
	(0.0824)	(0.0415)	(0.000592)	(0.0963)	(0.000535)
Event	0.128***	-0.0935***	0.000473***	-0.168***	-0.000908***
	(0.0216)	(0.0154)	(0.000104)	(0.0200)	(0.000217)
Treatment*Event	-0.0551	0.0924***	-0.000276**	0.108***	0.000644***
	(0.0354)	(0.0205)	(0.000120)	(0.0279)	(0.000249)
Fragmentation	0.258***	0.808***	0.000209**	-0.0872***	-0.000912***
	(0.0222)	(0.0370)	(8.70e-05)	(0.0179)	(0.000118)
Log capitalization	-0.830***	0.262***	-0.00157***	0.946***	
	(0.0307)	(0.0121)	(0.000263)	(0.0331)	
Lagged volatility	0.000630	0.000587	1.92e-05*	0.00404	2.82e-05*
	(0.00132)	(0.00105)	(1.14e-05)	(0.00286)	(1.66e-05)
OTC share	-0.288***	0.00525	-0.000279	0.125***	0.000445**
	(0.0584)	(0.0518)	(0.000174)	(0.0272)	(0.000178)
SI share	-0.179*	-0.568***	-0.000735**	-0.0230	-0.000159
	(0.0962)	(0.0637)	(0.000313)	(0.0657)	(0.000369)
FB auction share	-0.558***	-1.479***	-0.000204	-0.376***	-0.00179***
	(0.174)	(0.119)	(0.000462)	(0.115)	(0.000662)
Constant	0.0204	2.464***	0.0400***	-7.823***	0.0132***
	(0.664)	(0.249)	(0.00535)	(0.684)	(0.00337)
Observations	74,163	74,609	74,335	74,609	74,609
Number of ISINs	473	473	473	473	473

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Sources: ESMA.

It is worth noting a few considerations regarding the control variables included in the analysis. Fragmentation is related to lower market liquidity in lit markets across all liquidity dimensions but average trade size. As expected, larger market capitalization seems to be positively correlated with market liquidity: as capitalization increases, turnover and trade size improve as well, while price responsiveness and the bid-ask spread decrease[47]. In addition, a rise in the share of FBA trading negatively affects liquidity in continuous trading and auctions markets, as shown by the negative and significant coefficients on turnover, turnover ratio and

[47] As the turnover ratio is calculated as total turnover divided by market capitalization, log capitalization is omitted as regressor in column 5.

average trade size. However, it positively influences liquidity in the sense that it reduces price impacts (notice the negative coefficient linked to the Amihud illiquidity index).

Overall, the results point to a positive impact of the DVC measure on market liquidity in lit markets. When considering the individual variables of interest, it is possible to state that bid-ask spreads, turnover and turnover ratio have improved, and average trade size increased. However, a significant impact of the policy on price responsiveness to volumes could not be identified.

5.3 Market liquidity impact: Robustness checks

To further assess the robustness of the results, two additional and complementary methodologies have been implemented:

- First, a staggered difference-in-difference regression, which allows for the inclusion of the ISINs that were periodically banned by the DVC mechanism after its first application in March 2018. Results from this technique indicate short-term effects on liquidity of DVC bans (6.3.1).
- Second, two sample matching techniques, with the purpose of assigning to each treatment observation a comparable (in terms of individual characteristics) counterpart of the control group. This methodology controls for differences between treatment and control groups which may be correlated to their status (banned or non-banned by the DVC mechanism) and could therefore impair the parallel trends hypothesis. Thus, the matching process contributes to improve the robustness of the estimates. The results confirm the evidence from the baseline specification (6.3.2).

The magnitudes of the outcomes vary depending on the applied methodology, suggesting that they should be interpreted with caution and represent directional rather than precise effects. However, the directions of the coefficients are largely consistent and suggest overall increased market liquidity.

5.3.1 Staggered difference-in-difference

The staggered set-up consists of six event windows around the DVC mechanism publication dates in March, April, May, June, July and August 2018. Each event window comprises of 40 trading days – starting from 20 days prior to the ban and 20 days after it, hence capturing short-term liquidity effects. This methodology allows for the consideration of all interventions in the observation period (and not only the ban that took place in March 2018), thus increasing the robustness of the results. For each event, mutually independent control and treatment groups are selected. For instance, with reference to the first event (12 March 2018), the ISINs that will later be banned by the DVC mechanism between April and August are included in the control group, along with the equities that are never affected the policy. This increases the number of observations, reduces the selection bias and improves the statistical power. However, it is necessary to remark that the effect of the DVC mechanism will be heavily influenced by the suspensions mandated on 12 March 2018, which account for 84% of the bans imposed during the 6 events considered (Chart 16).

Chart. 16
Distribution of imposed bans

Date	Frequency	Percent
12 March 2018	211	84.06
13 April 2018	12	4.78
14 May 2018	17	6.77
12 June 2018	3	1.20
11 July 2018	4	1.59
10 August 2018	4	1.59
Total	251	100

Sources: ESMA.

The econometric exercise follows a similar empirical approach as outlined in section 5.2.:

$$Y_{it} = \lambda_t + \beta Treatment_i + \delta Treatment_i * Event_t + \theta ISIN_{it} + \epsilon_{it}$$

where:

— Y_{it} is one of the dependent liquidity measures;

— λ_t are event window fixed effects;

— $Treatment_i$ is a dummy variable equal to one if ISIN i is in the treatment group at day t.;

— $Treatment_i * Event_t$ is a dummy variable equal to one for the 20 days of an event window during which an instrument i from the treatment group is banned by the DVC mechanism;

— $ISIN_{it}$ captures the relevant control variables;

— ϵ_{it} is the error term.

In contrast to the baseline regression in Section 6.2, the results show a positive significant impact of the policy (*Treatment*Event*) on the Amihud measure of price responsiveness, suggesting deteriorated liquidity in this dimension within the first 20 days following a suspension. However, compared to other control variables, the magnitude of the coefficient is rather small. The DVC ban seems to have a positive and significant effect on the average trade size and the turnover ratio – these results match previously observed effects, while the impacts on the bid-ask spread as well as on turnover remain below significance. The staggered set-up uses the same control variables as the baseline regression[48] (Chart 17).

Chart. 17

Staggered regression results

	Log Amihud	Log trade size	Bid ask spread	Log turnover	Turnover ratio
Treatment	-0.290**	-0.244***	-0.000332***	-0.0179	-0.000718***
	(0.0858)	(0.0392)	(8.05e-05)	(0.0497)	(0.000123)
Treatment*Event	0.0436**	0.0693***	7.44e-05	-0.00342	0.000290**
	(0.0125)	(0.00838)	(7.32e-05)	(0.0138)	(7.58e-05)
Fragmentation	0.125***	0.589***	3.64e-05	0.512***	0.000664***
	(0.0239)	(0.0321)	(9.12e-05)	(0.0169)	(8.52e-05)
Log capitalization	-0.799***	0.306***	-0.00105***	0.908***	
	(0.00849)	(0.00383)	(3.96e-05)	(0.00812)	
Lagged volatility	0.0125**	0.000599	2.23e-05***	0.000215	1.59e-05***
	(0.00333)	(0.00193)	(1.72e-06)	(0.000349)	(3.44e-06)
OTC share	-0.531**	0.127	0.000334	0.946***	0.00243***
	(0.157)	(0.112)	(0.000432)	(0.0535)	(0.000272)
SI share	-0.316	-0.743***	-0.00256**	0.896***	-0.000566
	(0.201)	(0.0681)	(0.000723)	(0.109)	(0.000314)
FB auction share	-4.137***	-3.255***	-0.00684***	1.013***	-0.00286**
	(0.343)	(0.193)	(0.00107)	(0.188)	(0.000803)
Constant	-1.852***	0.672***	0.0262***	-4.983***	0.0149***
	(0.198)	(0.0622)	(0.000917)	(0.178)	(0.00141)
Observations	113,581	114,278	113,851	114,278	114,278
R-squared	0.439	0.339	0.073	0.647	0.013

[48] Additionally, a number of alternative controls has been taken into consideration, including variables such as equity prices, their lags and their lagged returns, as well as dummies which capture the top and bottom tails of the instruments with regards to their market capitalization levels. These additional control variables do not alter our main findings and are therefore not shown.

Number of events	6	6	6	6	6

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Sources: ESMA.

5.3.2 Sample matching

As a second robustness check, sample matching techniques are introduced in order to better select an appropriate control group. In particular, two different matching approaches are applied to the baseline analysis. The first approach is carried out through Propensity Score Matching (PSM), while the second one relies on the so-called Nearest Neighbour Matching. These methodologies match actively treated observations with non-treated ones having similar individual properties. This assures that treatment and control groups are homogeneous and that a random sampling assumption holds. In accordance with the baseline regression, ISINs suspended by the DVC mechanism in March 2018 are compared to ISINs that have not been banned during the whole observation period.

In a first estimation, a propensity score – which estimates the probability of being treated – is computed for each observation. The estimation is based on a logistic regression of the treatment dummy variable on a set of covariates. Each treatment observation is matched to the one observation in the control group with the closest propensity score. The average treatment effect is then determined by comparing means of treatment and control groups. The results show a substantial negative impact on the Amihud measure of price responsiveness, which contrasts with our previous results but suggests a positive impact of the policy on liquidity. In addition, no significant effect on trade size has been uncovered, whereas the bid-ask spread seems to tighten as a result of the policy. When comparing these results with the baseline outcomes, the effect on turnover is more pronounced in the PSM setting, while the positive impact on the turnover ratio is weaker (Chart 18).

In the second estimation, the matching is based on a different methodology. The nearest neighbour matching framework is applied: this method, instead of using a propensity score, selects the closest counterpart according to a weighted function of a set of covariates (Mahalanobis distance). After this step, the analysis is thus repeated using the updated control group. The results for the Amihud measure, the bid-ask spread, turnover and the turnover ratio are similar to the outcomes resulting from the PSM matching. However, trade size seems in this instance to be affected negatively. This effect is significant, even though rather reduced in magnitude.

Overall, both methods confirm the findings from the baseline regression. In particular, the outcomes related to the Amihud measure and to turnover reflect a larger improvement of market liquidity compared to the simple difference-in-difference estimations, indicating potential downward sample selection bias in these approaches.

Chart. 18

Propensity Score Matching results

	Log Amihud	Log trade size	Bid ask spread	Log turnover	Turnover ratio
			Propensity score matching		
Treatment*Event	-0.379***	0.00993	-0.000360***	0.172***	0.000204**
	(0.0176)	(0.00918)	(5.02e-05)	(0.0154)	(9.19e-05)
			Nearest neighbor matching		
Treatment*Event	-0.327***	-0.0225***	-0.000259***	0.217***	0.000438***
	(0.0195)	(0.00335)	(9.15e-05)	(0.0133)	(0.000102)
Observations	95,680	96,170	95,644	96,170	96,170

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Sources: ESMA.

6 Conclusion

In this article, the authors focus on the impact of the DVC mechanism on European equity markets in the first six months of its application (March to September 2018). After providing a review of the regulatory background, empirical evidence related to the changed trading patterns in EU equity markets is presented. Results indicate that overall, most of the trading in equities is executed on lit markets. For equities where the DVC restrictions were applied from March 2018, the amount of trading on dark pools dropped, as expected, from more than 7% in January 2018 to less than 1% of the total in August 2018 while the share of trading in FBAs increased over the same period from virtually 0% to 4% of the total. However, as the restrictions ended in September, the volume of trading executed on dark pools rose to more than 5% and the volume in FBAs declined to 2%.

In addition, the impact of the DVC mechanism on market liquidity in lit markets has been analysed through a Difference-in-Differences regression model. The outcomes from this analysis point to a general improvement of liquidity for ISINs banned by the DVC mechanism in March 2018, and for which the ban has been revoked in September 2018. In particular, following the intervention and consistently with the scope of the DVC mechanism, the econometric analysis points to an estimated increase of 10% in turnover in continuous trading and auctions markets for banned ISINs if compared to non-banned ISINs. Results are robust to different econometric specifications – including a staggered version of the DiD allowing for the impact evaluation of multiple DVC mechanism publications, without limiting the analysis to the first publication (i.e. in March 2018 only) - and to supplementary analyses undertaken as validity checks.

References

Aquilina, M., Diaz-Rainey, I., Ibikunle, G. and Sun, Y. (2017). Aggregate market quality implications of dark trading. Financial Conduct Authority, Occasional Paper, 29.

Budish E., P. Cramton and J. Shim (2015) “The high-frequency trading arms race: frequent batch auctions as a market design response”, The Quarterly Journal of Economics, Vol.130, Issue 4, pp.1547-1621.

Comerton-Forde, Carole and Tālis J. Putniņš (2015) "Dark trading and price discovery", Journal of Financial Economics 118 (1) 70-92.

Degryse, H., F. De Jong, V. Van Kervel (2015) “The impact of dark trading and visible fragmentation on market quality”, Review of Finance, 19 (4), pp.1587-1622.

De Renzis, T., C. Guagliano and G. Loiacono (2018), “Liquidity in EU fixed income markets – Risk indicators and EU evidence”, ESMA working paper No. 1, 2018.

Farley, R., E. K. Kelley and A. Puckett (2018): “Dark Trading Volume and Market Quality: A Natural Experiment", working Paper.

FESE (2018) European Equity Market Report. http://www.fese.eu/statistics-market-research/european-equity-market-report.

Fidessa (2017) Fidessa Fragmentation Index: Making sense of global fragmentation.

Foley, S., & Putniņš, T. J. (2016): “Should we be afraid of the dark? Dark trading and market quality”, Journal of Financial Economics, 122(3), 456-481.

Gertler et al (2016) Impact Evaluation in Practice, Washington, DC: World Bank, Ch 7.

Gomber, P., B. Clapham, J. Lausen, and S. Panz (2018) “The MiFIR Trading Obligation: Impact on Trading Volume and Liquidity”, https://ssrn.com/abstract=3133161.

Gresse, C. (2017): “Effects of lit and dark market fragmentation on liquidity", Journal of Financial Markets 35, 1-20.

Hatheway, F., A. Kwan and H. Zheng (2017): “An Empirical Analysis of Market Segmentation on U.S. Equity Markets", Journal of Financial and Quantitative Analysis, 52 (6), pp. 2399-2427.

Johann, T., T.J. Putnins, S. Sagade, and C. Westheide (2019) “Quasi-Dark Trading: The Effects of Banning Dark Pools in a World of Many Alternatives”. SAFE Working Paper No. 253.

Petrescu, M. and M. Wedow (2017) “Dark pools in European equity markets: emergence, competition and implications” ECB Working Paper No 193 / July 2017.

Zhu, H. (2014): “Do dark pools harm price discovery?”, The Review of Financial Studies, 27(3), 747-789.

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