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Dark Pools and High Frequency Trading: A Brief Note

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Financial markets have experienced many changes over the last two decades. This note will focus on explaining two aspects that have undergone a significant change in the trading of financial securities: market structure and trading strategies. Even though these topics apply more generally to many asset classes, this note will focus especially on stocks (equities).

1. Market Structure and dark pools

There are currently many trading venues for executing investors' orders, as markets have become fragmented. Prior to the 2000s, the broker would have most likely traded the security in the venue where the security was listed (in the US, this would be either the New York Stock Exchange or the Nasdaq). Today, the decision on where to send an investor's order is complex and brokers often use algorithms to achieve the best execution.

The broker can send the investor's order to three main types of marketplaces. First, the broker can send the order to an exchange, where bids and offers are mostly visible and can be matched and executed. Exchanges are regulated in various dimensions. These include restrictions on who can trade; a clearly defined trading procedure which is transparent (visibility of the order flow or part of it); requirements on which financial instruments are admitted; and requirements imposed by issuers of securities and trading members. Second, the broker can send the order to alternative trading systems (ATS), which are also called multilateral trading facilities in Europe, which are more lightly regulated than exchanges, especially in terms of disclosure requirements. The most important types of ATS are dark pools. The reports by Rosenblatt Securities (2019) state that currently the US has more than 30 dark pools, which account for 14.1% of the US consolidated trading volume (in Europe, dark pools account for 4.7% of the volume). Third, the order can also be traded in other off-exchange alternatives, such as a systemic internaliser, or trade it over the counter. Systemic internalisers cross traders' orders internally with other traders' orders or with proprietary positions.

The origins of off-exchange trading are as old as exchanges themselves. Historically, "upstairs" trading would occur when two institutions with large trading intentions (block trades) would negotiate privately and away from exchanges in order to have less price impact and reduce transaction costs[1]. In the late 1990s, technological innovations related to electronic trading and the regulatory environment made it possible to have organised dark pools. Banks (2014) makes the following definition: "A dark pool is a venue or mechanism containing anonymous, non-displayed, trading liquidity that is available for execution". Let us now discuss the main characteristics of dark pools[2].

Dark pools do not display lists of buy and sell orders for a financial security (that is, price and volume). In other words, the order book is not visible, hence dark pools are opaque and anonymous[3]. This feature allows large institutional investors to place orders in dark pools without revealing information to the market, thus precluding the possibility of unfavourable price movements. In addition, most dark pools would execute a block trade at a price, thus minimizing the slippage. Despite the lack of pre-trade transparency, dark pools are required to report trades after they have occurred.

Dark pools' pre-trade opacity has an impact on the overall transparency of the market and affects the price discovery process. Zhu (2014) finds that adding a dark pool alongside an exchange does not reduce price discovery, since informed investors tend to concentrate on exchanges. Bayona et al. (2014) find that the effects on market quality are subtle and these depend on stock and trader characteristics. Regulators are especially concerned about how this aspect of dark pools and the fragmentation of equity markets affect market quality.

In terms of pricing, most dark pools generally offer a price improvement over displayed quotes on exchanges. Some dark pools offer only a small price improvement, while others price their quotes at the mid-point between the bid and the ask prices in the exchange, where both a buyer and seller get more favourable prices in the dark pool compared to an exchange. As such, dark pools use exchanges to derive their transaction prices. In addition, dark pools typically do not charge trading fees, and thus offer lower explicit transaction costs than most exchanges.

However, dark pools do not guarantee the execution of the orders sent to them, i.e., there is execution risk. In order to improve their liquidity, some dark pools have allowed orders of smaller sizes. Since their origins, the average trade size of dark pools has declined dramatically, from very large blocks to currently an average trade size which is very similar to the average exchange trade size. This indicates that some dark pools attract not only institutional investors but also other types of traders.

Another important dimension is their ownership structure. According to Rosenblatt Securities (2019), in the US, 62% of the dark pool trading volume is operated by investment banks own dark pools (e.g. UBS ATS, Credit Suisse CrossFinder, or Morgan Stanley MS Dark Pool). These institutions trade on behalf of their clients, but also make their own proprietary trades. Another type of ownership structure is when the dark pool acts solely as agent of their clients. These include agency-broker dark pools (Virtu Posit or Liquidnet) and exchange-owned dark pools (BATS Trading or NYSE Euronext). Finally, there are also market-maker dark pools with 17% of the dark

[1] A block trade in stocks generally involves trading at least 10,000 shares of non-penny stocks.

[2] Dark pools are horizontally differentiated in several dimensions, such as pricing, matching process, types of orders allowed, and assets traded, among others.

[3] There are also non-displayed orders on exchanges. See more at OECD (2016).

pool market share (e.g., Citadel Connect). In Europe, the market structure of dark pools by type of operator is rather different, with the largest percentage being owned by exchange multilateral trading facilities, with 43% of trading volume, such as CBOE Dark or Turquoise Plato.

Finally, dark pools may be subject to conflicts of interest. The dark pool operator may be able to conceal prices and/or priority, especially since the order book is not visible ex-ante to market participants. Another potential conflict of interest, especially related to investment banks' own dark pools, is that they may not route clients' orders to the trading venue which guarantees the best possible price for a financial asset, thus violating the best execution rule.

The regulation of dark pools has evolved over time, and varies across different geographical areas. In the US, the Securities and Exchange Commission (SEC) introduced a regulation for Alternative Trading Systems (ATS) in 1998. This regulation imposed stricter rules on record keeping and transparency requirements once dark trading exceeded 5% of the average daily trading volume of a single stock. However, this regulation did not prevent predatory behaviour and conflicts of interest, which have led to various lawsuits. Between 2011 and 2018, banks and brokers have paid more than $229 million in penalties for misconduct related to dark pools. In 2018, the SEC voted to improve the oversight of dark pools, especially with regards to operational transparency.

In Europe, the relevant regulations are the Markets in Financial Instruments Directive II (also known as MiFID II) and Markets in Financial Instruments Regulation (also known as MiFIR), which were approved in 2014 and implemented at the beginning of 2018. These regulations have the objective to ensure fairer, safer, more efficient markets and to provide greater transparency to all market participants. These regulations incorporate the Double Volume Cap (DVC) mechanism to limit the amount of trading in dark pools. There are two caps: the first, limits the percentage of trading in an instrument on a single trading venue to 4%, and the second limits the percentage of trading of an instrument on all trading venues to 8% of the total trading volume during the last year on all the EU trading venues. However, the European Securities and Markets Authority (ESMA) is currently evaluating the actual impact of these regulations since their implementation and considering potential modifications.

2. Trading strategies

The recent innovations in trading strategies are mainly related to algorithmic trading and high frequency trading (HFT). Algorithmic trading is a method for buying or selling financial securities that is nowadays prevalent in financial markets[4]. Algorithmic trading is any method that makes use of a pre-programmed set of rules that establishes which, when, in which venue, and how to trade financial securities, and other market products such as currencies and commodities. Algorithmic trading strategies are now sophisticated, complex, and they adapt to new market conditions.

An important type of algorithmic trading strategy is high frequency trading (HFT), where trading occurs over very short intervals of time, nowadays to the order of a microsecond (there are a million microseconds in 1 second). These strategies depend on computational power, algorithm sophistication, fast access to data (usually achieved through physical proximity to the exchange venue, also called co-location), and information processing capacity. As a result of these developments, the definition of speed in financial markets has greatly changed in the last few years. Aquilina et al. (2020) cite that this method of trading currently represents around 50% in US markets or more, even though it is difficult to quantify precisely. Typical characteristics of HFTs include high speeds, high trading volumes, and take advantage of very short-term profit opportunities (often intraday ones).

The popular and academic literature has debated the impact of HFTs on markets. The popular books of Patterson (2012) and Lewis (2014) claimed that the rise of algorithmic trading, HFTs and dark pools had rigged markets. With regards to the academic literature, Menkveld (2016) summarises the empirical and theoretical evidence of the effect of HFTs on market quality. His main points are that: (i) in the decade of the rise of electronic trading and HFT, transaction costs have decreased over 50% for both retail and institutional investors; (ii) there is evidence that, beyond being very fast, HFTs are also well-informed, and are often mostly market-makers. As a result, HFTs tend to reduce transaction costs; (iii) when HFTs prey on large institutional orders, they increase transaction costs. Examples of these predatory practices include HFTs using information (which they sometimes pay to obtain earlier than other investors using public feeds) and speed to front-run large institutional orders. In addition, HFTs may use pinging, which involves sending multiple small orders to determine whether there are large buy or sell orders in a specific trading venue. (iv) HFTs enable competition in trading venues; (v) HFTs help investors rebalance their portfolios by generating more opportunities.

Biais and Foucault (2014) argue that the impact of HFT on market quality depends critically on the type of HTF strategy used, and that these strategies are heterogeneous. The five main types are: market-making (mainly submitting limit orders that supply liquidity), arbitrage (exploiting arbitrage opportunities), directional trading (taking a directional stake in an asset anticipating price movements), structural (taking advantage of specific market characteristics) and manipulation (artificially influencing the market or the price of an asset). Empirical evidence has found that HFT market orders contain

[4] In some markets, it is estimated that algorithmic trading is around 70% (European Central Bank, 2019).

information and there are positive profits associated to them, while limit orders usually lead to negative profits. Furthermore, Biais, Foucault and Moinas (2015) claim that fast access to markets can reduce costs of intermediation, which is beneficial, but can also generate adverse selection, since some market participants have faster access than slower ones, which is detrimental to market efficiency. These characteristics of HFTs might generate negative externalities such as lower "slow trader" market participation, an excessive investment in trading technologies, and an increase in systemic risk.

An example of a situation in which HFTs were related to an increase in systemic risks is the Flash Crash of 2010. In this 36-minute episode, the US stock markets collapsed and recovered, generating extreme market volatility. A study of the above-mentioned flash crash by Kirilenko et al. (2017) concluded that HFTs did not trigger the Flash Crash, but that they exacerbated market volatility by responding to huge selling pressures on that day. So, even if HFTs increase liquidity in normal times, HFTs do not provide liquidity in episodes of crashes.

Current regulation of algorithmic trading, which includes HFT, in the US and Europe requires compliance in terms of governance, staffing, information technology, testing algorithms, resilience, surveillance, plans for dealing with disruptive episodes, trading controls, security and reporting. In addition, for HFTs that are market-makers there are other requirements in terms of liquidity provisions to the trading venue. Furthermore, algorithmic traders have to comply with regulatory capital requirements, which applies to all trading institutions. Further academic proposals to regulate HFT have included institutional changes in the current market structure, such as to have periodic call auctions replacing the continuous trading and conducting stress tests to evaluate the systemic risks they pose.

3. HTFs in Dark pools

Importantly, HFTs are nowadays also present in dark pools. The relationship between HFTs and dark pools is intricate. Originally, dark pools grew partly because investors were trying to get protection from HFTs' predatory practices in public exchanges, and HFTs found it difficult to use pinging to obtain information about large orders in dark pools. However, over time, some dark pool operators have had incentives to allow HFTs since they provide additional liquidity and increase the probability of execution. For HFTs, dark pools are advantageous for HFTs since dark pools allow them to satisfy their speed and automation needs, and typically have lower fees.

In fact, HFTs in dark pools partly explain the reduction in the average order size traded in dark pools. So, dark pools have been vulnerable to HFTs, with some HFTs using sophisticated pinging strategies to detect hidden large orders in opaque venues and allowing HFTs to front-run these large orders. As a result, the benefits of dark pools might be impaired if these HFT strategies are present. In 2014 the New York Attorney General sued Barclays for its dark pool operations, specifically for misstating the level of HFT activity in its dark pool, thus defrauding investors. In January 2016, Barclays agreed to pay a fine of $35 million to the SEC and $70 million to the New York Attorney General for its misconduct related to the dark pool.

There are some controls that dark pools can impose to avoid predatory practices by HFTs. Petrescu and Wedow (2017) propose several, such as to impose a minimum order size, which is intended to reduce pinging strategies to a minimum, or matching orders at discrete points in time rather than using continuous crossing. However, not all dark pools wish to avoid HFTs, and this is acceptable as long as investors accurately know how trading venues operate so they can make informed decisions.

4. Concluding remarks

The changes in financial markets in the last twenty years have had many positive aspects that need to be stressed: faster processes, more competition, higher product differentiation, and greater operational efficiency. However, this article has briefly discussed how dark pools and high frequency trading strategies can also potentially lead to a deterioration of market quality. Regulators around the world have already implemented or are considering several measures to address the market failures that dark pools and HFTs might lead to. These regulations need to keep adapting to new challenges and be based on academic and policy evidence. On a more general level, it is worth recalling the main roles that financial markets have in both the economy and society, and reflecting upon how dark pools and HFTs contribute to them

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