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Documents de travail GREDEG
GREDEG Working Papers Series

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GREDEG WP No. 2015-21
http://www.gredeg.cnrs.fr/working-papers.html

Should dark pools be banned from regulated exchanges?

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GREDEG Working Paper No. 2015–21

Abstract

European financial markets experiment a strong competition between historical players and new trading platforms, including the controversial dark pools. Our theoretical setting analyzes the interaction between heterogeneous investors and trading services providers in presence of market externalities. We compare different forms of organization of the market, each in presence of an off-exchange and an incumbent facing a two-sided activity (issuers and investors): a consolidated exchange with the incumbent only, and fragmented exchanges with several platforms, including lit and dark pools, in competition for order flows. By capturing investors from off-exchange, dark trading may enhance market externalities and market stakeholders' welfare.

JEL Classification: G10, D62
Keywords: microstructure, *dark pools*, Over-The-Counter market, liquidity, market externalities, two-sided markets.

1 Introduction

European regulation has taken a drastic shift with Markets in Financial Instruments Directive (MIFID), implemented in 2007. The directive supports strong competition between incumbent market firms (such as Euronext Europe) and new, flexible, highly technological intensive players in trading services. Positive effects

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were expected for investors: innovation, transaction fees decrease, and differentiated trading services adapted to investors needs' heterogeneity. After MIFID enforcement, the incumbent had to deal with local competitors which can be mainly distinguished according to their transparency degree: lit and dark pools. They notably differ from their pre-trade transparency degree (*i.e.* the ability for investors to observe the size and the price of orders posted by participants). But the coexistence of numerous execution places did not produce consensual positive effects. Regulatory authorities have raised several concerns associated with order flow dispersion between players, and particularly dark pools growth. European Commission (2010) for example notes that an increased number of dark pools may ultimately affect the quality of the price discovery mechanism on the regulated market. Then, is competition on trading services really desirable? Should dark pools be banned from securities exchanges?

Microstructure theory has helped to understand that price distortions on financial markets are partly the result of rational strategic behavior of users (investors). But there is to date few analytic works and results about competition of lit and dark venues consequences. It similarly lacks from bases to elaborate practical recommendations for regulators. As Cantillon and Yin (2011) argue, microstructure toolkit is essential but not sufficient to understand trading services competition issues. Fragmentation is not only determined by strategic behavior of investors, but also by trading platforms' actions, including the elaborated two-sided market strategy of the incumbent. This last has to manage with two group of users: investors, and issuers. Our setting includes this kind of specification of trading platforms competition and captures the effect of order flow fragmentation on information distribution, on liquidity and on market intermediation quality, as recommended by Chowdhry and Nanda (1991), Colliard and Foucault (2012) or Pagnotta and Philipon (2012)

We propose to model the interactive behaviors of platforms and investors in a unified framework where each component (investors, service providers) try to adapt to environment. We suppose a basic initial form of financial market: an on-exchange (*i.e.* regulated and relevant market) composed by only on market firm in charge of issuers' admission to trading and assets'trading organization, and an off-exchange (*i.e.* the possibility to trade listed assets out of the regulated market, so-called over-the-counter market). This benchmark model is close to the historical form of European markets before MIFID enforcement. Next, we incorporate alternative platforms, only transparent in a first step, then lit and dark ones in a second step. At each stage, we consider the result of this new competition among trading services providers on the distribution of investors among platforms, market

externalities and the level of net welfare. A normative use of these results is to provide elements to regulatory initiatives related to the developments of alternative platforms.

Section 2 reviews the related literature and formulates the outline of the topic. Section 3 presents the benchmark model capturing investors and trading services before the introduction of alternative ways to make financial transactions, in competition with only off-exchange. It provides the determinants of the distribution of heterogeneous investors among trading possibilities. Section 4 analyzes the entry of k transparent alternative platforms. Section 5 adds to the previous organization dark pools. Our results are in line with a balanced regulatory struggle against dark finance. They suggest that it could be better to authorize and regulate dark trading than totally ban it from any regulated trading places. If pools are "sufficiently dark", they decrease transaction fees, and attract some investors from the off-exchange. Then, those investors benefit from an increase of trading services diversification and from liquidity externalities that lack on OTC market. Issuers benefit from a larger base of investors in the relevant marketplace and the incumbent can increase their profit on the listing segment to compensate trading fees losses. If new regulations reduce the possibility of dark trading, positive effects are less systematic.

2 Supply and demand for trading services: a literature review

As they are traditionally conceived, financial markets perform two functions: they determine the equilibrium price of assets and facilitate issuers and investors matching (Levine 1991, Bencivenga and Smith 1991). To create an environment able to promote capital mobility without decreasing investors protection, regulators must choose the adequate degree of competition in securities processing services (listing, order execution, delivery and settlement).

2.1 Trading platforms' competition and market fragmentation

Last years, there was a strong regulatory incentive to specially favor trading services competition. The Market in Financial Instruments Directive (MIFID - 2007), launched in Europe, is one of the most important examples of the changes affecting the European markets. Abandoning the historic principle of financial transaction centralization, this directive has encouraged new market players to offer alterna-

tive trading services and foster decentralization of order-execution venues. Stock markets have then shifted from an consolidated trading structure around monopolistic regulated incumbents, to a fragmented structure between these historical players and new platforms called multilateral trading facilities (MTF-156 in Europe to date). The purpose of opening up market functions to competition was to offer investors a more diversified set of services at lower cost. The switch was not so obvious in United States because of their original fragmented market structure. But the regulation took a shift, experiencing a new intensive competitive framework with the Order Handling Rule (1996) and the National Market System Regulation (Reg NMS (National Market System Regulation -2007). Both have encouraged the development of new trading players which could be distinguished by their variety of matching methods (different kinds of orders, priority execution rules and temporality), but also their pre trade opacity degree (*i.e.* the inability to observe pending orders). Indeed, new regulation trends have led to release pre transparency constraints with the help of exceptions, adapted to some types of investors' profiles.

Consequently, previous centralized and order-driven market places such as those managed by *Euronext* or *Deutsche Böerse*, have to deal with the rise of two new kinds of players : the lit pools, platforms proposing differentiated trading services with fully transparent execution (excluding investors' identity) as well as the incumbent, and the dark pools with a total pre trade opacity, allowing investors to hide their trade intentions. This is led to a fragmented order flow structure. Incumbents, have kept their listing function monopoly which determines the so-called on-exchange (*i.e.* supervised by market authorities and based on a public price discovery process). Because of their dual activity (listing/trading) and customer base (issuers/ investors), they have, unlike others players, the collective responsibility (and the economic incentive) to maintain the on-exchange safety and attractiveness. Precisely, if the new competitor fringe - with trading services diversification and fees rebates - allows to catch an extra portion of investors from the off-exchange, it could drive to an upper level of welfare for all the participants. Cross externalities arise between issuers and investors (Domowitz 1995). Because the aim of issuers is to attract trades to its securities, an additional investor will generate an issuer positive net surplus if he decide to join the platform (membership externalities). In the other hand, investors will benefit from a larger list of available securities on which to transact with additional issuers. As externalities arise as trades between investors occurred, investors' cross externalties are called usage externalities (Floreani and Polato 2014). Finaly, incumbent are able to meet a two-sided market trade-off : favor fees rebate to investors in order to attract themselves in the relevant market and compensate trading profit losses

with their listing profit, in a virtuous circle.

But is there always a virtuous circle? It is not obvious that financial mechanisms that drive issuers and investors behaviors are really compatible with competition mechanisms of trading services providers. Observations and previous works are not so clear about an optimal solution. Only little studies have analyzed fragmentation's impact under MIFID on European markets quality. Among the most recent ones, Brandes and Domowitz (2010) and Gresse (2011) didn't find any evidence that European markets fragmentation has harmed liquidity and price discovery process. Degryse, De Jong and Van Kervel (2013) have showed that *"Dark trading has a detrimental effect on liquidity. Visible fragmentation improves liquidity aggregated over all visible trading venues but lowers liquidity at the traditional market, meaning that the benefits of fragmentation are not enjoyed by investors who choose to send orders only to the traditional market."* Gresse (2013) shows that multi-trading competition improves depth and spreads and that dark trading has not significantly harmed market liquidity, except for some groups of stocks like smallest ones. Regarding policy reports (Fleuriot 2010) or professional feedbacks (AMF Annual Conference 2009, AMF Risk and Trend Mapping 2012), they all depict a worrying assessment of MIFID, with no proof of a global market quality improvement, but the sentiment of a rising unfairness between investors, which led to suspect a market externality puzzle. Those mixed conclusions drive to alternative explanations based on industrial organization tools.

2.2 Heterogeneous investors and the market externalities puzzle

Consolidation and centralization principles are traditionally recommended in order to exploit scales and scope economies, improve transparency, monitoring market activity and then, offer to investors a safe and fair environment for their transactions. Mendelson (1987) and Pagano (1989) have demonstrated that a fragmented market is not viable and that securities markets are natural monopolies because of market externalities (''liquidity bedgets liquidity"). Economides (1993, 1996) has mentioned two kinds of direct externalities for investors:

- a "liquidity" externality: more investors means more chance to find a counterparty on the exchange, and improves the probability of execution of the submitted orders;
- a "price" or information externality: one of the essential components of the output produced by the exchange company is the formation and communication of a market equilibrium price. This information is crucial for users,

because it lets them evaluate the potential losses and profits related to the transaction, and offers a benchmark that enables a maximum of investors to coordinate (Economides 1993). On condition that price discovery process is publicly accessible (Admati and Pfleiderer (1991) find that transparency increases the informativeness of the price), the more users there are, the more the prices will reflect the anticipations of the majority, which helps to reach a consensus price. The relevance of the market price will thus be proportional to the size of the market itself, and an increase in prices' informational precision and content will help to improve utility for users as a whole.

Then, financial markets are by nature self-reinforcing. Malkamäki (1999) identifies significant possibilities for economies of scale in the trading and settlement and delivery functions. Considering those conclusions and the fact that numerous trading venues actually coexist, there is a market externality puzzle as mentioned by Madhavan (2000). Gehrig (1998) pointed out the substantial reduction in the cost of finding the best price for the user when infrastructures merge. But he highlighted also the tendancy of consumers to prefer larger markets for their product varieties where they are more likely to find their favorite one. Chowdhry and Nanda (1991) argued that several trading venues can coexist by corresponding to heterogeneous investors' needs of trading services. Particularly, trading platforms differ in their degree of transparency, defined as the extent to which investors can observe order flows and price discovery process. Consolidated auction markets such as pre-MIFID Euronext, are inherently transparent, while OTC and unregulated markets with no public information tape are related to their opaqueness (*i.e.* defined as the extent to which pre and post trade information stay undisplayed and do not have any involvment in the regulated market price discovery process).

Investors have differing needs and preferences which are sometimes incompatible, and this heterogeneity justifies the existence of diverse matching structures. Investors with short-lived private information will prefer, for example, opaque structures, where they will be able to hide their strategy. On the other hand, investors with higher liquidity needs are more interested in transparent markets (Bessembinder and Venkataraman 2004, Oriol 2011).

We take, as Pagnotta and Phillipon (2012) or Colliard and Foucault (2012), the position that there is no market externalities puzzle nor a consolidate of fragmented optimal structure. This, because the resulting welfare is the consequence of specific interaction between the whole market participants, it means services providers with different strategies and investors with different needs. It will then depend on investor's heterogeneity (both in their trading services needs and their sensitivity to network externalities), and to platforms behavior in response of those

different needs. One limit that could be exposed is that, in microstructure literature, actors and structures' behaviors are considered as static and exogenous. But if the competitive framework changes under regulatory decisions, it is also influenced by agents' reactions facing new rules. And those reactions are themselves relative to their profit function. It is then essential to adopt an industrial organization analysis in order to understand the characteristics of platforms' trade-offs in the new competitive game and the equilibrium (Cantillon and Yin, 2011, Oriol 2012). But we do not forget microstructure insights. Consistent with Bessembinder et *al.* (2009) findings, we consider in our model heterogeneous investors who can be distinguished by their preferences for more or less transparent market, *i.e.* possibilities to hide their trades. According to them, *investors select the optimal exposure strategies on the basis of both their private trading motives and the tradeoffs involved in selecting more aggressive prices and exposing their orders"*. Then, some investors have a strong preference for opacity, and others favor transparency to reach the accurate price and meet the maximum of investors to garantee an entire execution. Because they want to trade with the maximum of investors, both category want to choose the most liquid place to meet the crowd. But the transparency can disclose the strategy to the whole market so, some investors have naturally a tendency to prioritize opacity such as dark pools. On the most extreme form of preference for opacity, they even will prefer to trade out of any regulatory space and transparency regime, meaning off-exchange. Platforms'opacity and investors'split between them could have strong impacts on liquidity and information externalities. And, as mentioned by Gerigh in 1998 : *"[...], the role of financial centres depends delicately on their success in generating local externalities."*

The model developed in the following section does not only consider the advantages and disadvantages of alternative platforms (lit or dark) for one single category of agent (investors, issuers or intermediaries). It also considers the trading activities from the regulator point of view, taking into account the consolidated result of all interactions. We incorporate the consequences of trading platforms competition on information and liquidity externalities, and their consequences on individual investors' payoffs. If investors have a common preference for an accurate price output and the liquidity, their heterogeneous preferences for transparency degree and trading services drive them to be redistributed in a fragmented universe with potentially negative effects on market externalities.

3 The benchmark model

The benchmark model reproduces in a simplifying way the stock market listing and trading services activities before the introduction of alternative platforms in

the trading segment. Trading services are provided by an incumbent, in a position of monopoly for both activities. The incumbent's earnings are the sum of a listing profit, resulting from of the listing fees paid by issuers, and a trading profit, resulting from the fees payed by investors. Investors have the possibility to use on-exchange or the OTC market facilities. The presentation of the benchmark models details the objectives, constraints and choices of issuers, investors and intermediaries.

3.1 Issuers and investors

There are two categories of agents, issuers operating in the primary market and investors operating in the secondary market. Issuers have the possibility to ask or not their admission to trading. Investors can use the incumbent platform or the OTC market.

Potential heterogeneous issuers differ according their level of motivation to make an Initial Public Offering (IPO further)[1]. The levels of motivation b_i ($i \in \{1, m\}$) of issuers are uniformly distributed on the segment $[0, \bar{b}]$, where 0 figures the smallest level and $\bar{b}$ the highest level. The listing activity is under monopoly and managed by the single incumbent.

There are n investors ($j \in \{1, n\}$). When they conclude transactions on the platform managed by the incumbent, they benefit from stocks price diffusion and liquidity of an organized platform. When they use the OTC market, they can dissimulate their transactions, including to the regulator, and avoid to diffuse information to other investors. Investors are then differentiated according to their preference for opacity, being uniformly located on a segment $[0, \bar{a}]$ where a_j measures the preference for opaque transactions of the investor located at a_j on $[0, \bar{a}]$. The OTC market is considered as the highest level of reachable opacity because information about trades is hidden from investors and from regulatory authorities.

The incumbent diffuses information to all users and provide them liquidity's access. These outputs increase with the size of the platform. The incumbent provides also specific services such as different type of orders, different tick sizes, specific priority rules or differentiated trading mechanisms (fixing and continuous auction). Investors are not only differentiated according their preference for opacity. Their second level of differentiation relates to the style of specific trading services their need. We use a Salop circle to capture this second type of differentiation. They

[1] One can consider without consequence on results that they are companies having different alternative opportunities to fund their activity.

are uniformly distributed on a circle able to integrate all possible specifications of trading services offered by potential trading platforms. When the incumbent chooses the specific service it offers to investors, it also chooses to locate its supply of intermediation service at some point on the circle. The investors located just at the point of the circle chosen by the incumbent have the ideal specification. The utility of the other investors is decreased by a parameter of inadequateness that we suppose proportional to the distance from their location on the circle and the specification chosen by the incumbent.

In the rest of the paper, the subscript l denotes the listing activity whereas the subscript t is related to trading activity. The superscript I and O are respectively associated with the Incumbent and the OTC market in the benchmark case. Hence, the fees p_l^I and p_t^I are respectively for the use of the listing and the trading services of the incumbent.

The net utility of issuer i is then given by expression (1):

$$U_i^I = \lambda n^I + \theta b_i - p_l^I \tag{1}$$

where n^I is the number of investors making transactions on the incumbent. The term λn^I with $\lambda > 0$ captures cross externalities from investors to issuers named membership externalities (see subsection 2.1). The term θb_i with $\theta > 0$ weights the preference for IPO. Potential issuers who decide not to use the primary market derive a constant utility which by simplification and without consequences on the results we suppose equal to zero.

Investors have a non-trivial choice between two possibilities, each one giving them a potentially positive net utility in transactions. They can use the services of the incumbent. Their utility is then given by (2):

$$U_j^I = (\alpha + \beta) n^I + \delta m^I - d_j - p_t^I \tag{2}$$

where m^I and n^I are respectively the number of issuers and investors using the services of the incumbent. The term αn^I where $\alpha > 0$, captures information externalities generated by all participants of the relevant market (see subsection 2.2). The term βn^I where $\beta > 0$ corresponds to the liquidity externalities generated by the same participants (see also subsection 2.2). The term δm^I, $(\delta > 0)$ corresponds to the cross externalities from issuers to investors, named usage externalities (see subsection 2.1). The term d_j measures the inappropriateness of the specific services offered by the market firm to the needs of investor j.

They can also use the OTC market facilities where their utility is then given by (3):

$$U_j^O = \alpha n^I + \gamma^O a_j + \delta m^I - p^O \tag{3}$$

where the term $\gamma^O a_j$, ($a_j \in [0, \bar{a}]$ and $\gamma^O > 0$) corresponds to the utility derived from the OTC characteristics given the preference for opaque transactions of investor j. The parameter γ^O relates to the institutional form of the OTC which may or not hide all the information diffused by investors or only one part of it. Information and usage externalities are still effective in the OTC market but not liquidity ones. The term p^O figures the transaction costs supported by investors when they use the OTC market. We suppose in this setting that these costs are given.

3.2 The Incumbent

The incumbent operates in a two-sided market. The earnings are generated by listing and trading activities and depend on the number of the participants on each segment, *i.e.* they are trivially determined by the on-exchange's number of issuers and investors. The general form of the cost function is denoted $C(n^I)$. The development of a trading platform implies fixed costs and can be an obstacle to a new player. However, the majority of new entrants after MIFID, competing on Euronext, were owned by existing global players with an already developed trading infrastructure[2]. Thus we focus only on variable costs and consider fixed costs as negligible in our model. The relevant form of variable costs is not immediate. Software license expenses, salaries, and human capital expenses more generally increase more slowly than the volume of orders. These economies of scale involve proportional or decreasing costs. They are not *a priori* compatible with perfect competition but they encourage diversification, which is a generic assumption of our setting. Other expenses evolve in the opposite direction. Trading platforms experience heavy cost constraints related to their IT-centric architecture. Orders matched to services include an extended and fault-tolerant network between the execution venue and all the trading process stakeholders (investors and post-market entities). Similarly, storage and maintenance of the entire trading database (past prices, orders and volume) involves significant hardware costs. All those services tend to generate decreasing returns to scale and increasing costs associated with

[2] *E.g.* Chi-X was launched by Instinet which is an US trading platform established in 1979. Turquoise is controlled by the London Stock Exchange and BATS launched a US stock exchange in 2006.

the trading architecture and computer maintenance.

As usually, proportional and decreasing costs have the same effect in terms of prices and quantities[3]. We then limit the analysis to the cases of proportional and increasing costs with the following specifications respectively: $C(n^I) = c(n^I)$ and $C(n^I) = c(n^I)^2$ where c is a positive parameter. The total profit Π^I of the incumbent is finally expressed as (4):

$$\Pi^I = m^I p_l^I + n^I p_t^I - C(n^I) \tag{4}$$

3.3 Results

The sequence of actions is as follows:

- At step one, the incumbent determines the nature of the specific service it offers,
- At step two, the incumbent, in a monopoly position, chooses the fees p_l^I and p_t^I maximizing its profit,
- At step three, issuers and investors choose the best way to make their transactions, according to their respective utility.

At step one, given the distribution of investors, the incumbent chooses its position on the circle of the specific characteristics. At step two, the incumbent determines the optimal level of fees expecting that at step three agents will choose the best actions given the proposed qualities and prices. At step three, issuers and investors choose the form of trading services maximizing their net utility.

The game is solved with backward induction. The choice of issuers for the incumbent is represented in Figure 1. Issuer i utility depends on the preference b_i for direct finance.

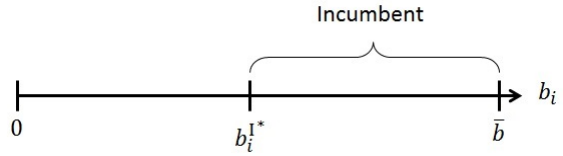

Figure 1: Distribution of issuers on the incumbent primary market

[3]We have verified that the results obtained are the same with proportional and decreasing costs in our model.

The distribution of investors between on and off-exchange is the result of a rational decision. Figure 2 represents in dimension 2 the choices of investors. Those last are uniformly distributed in the rectangle. Horizontally, they are located following their position on Salop circle, *i.e.* according to the specific services they expect from the incumbent. Vertically, they are located according to their preference for opacity. The Salop circle circumference has been cut in such a way that the location of the incumbent, *i.e.* the specific service that it offers, is situated at the center of the rectangle basis. The white and checkered zones then represent respectively the subsets of investors choosing respectively the incumbent and the OTC market.

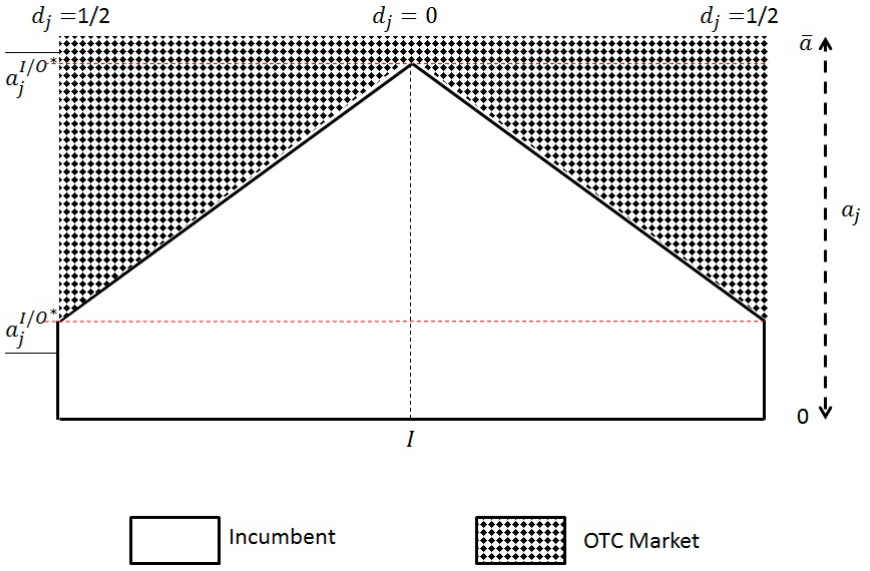

Figure 2: Distribution of investors on the incumbent secondary market and the OTC market

We derive from the study of the benchmark model the following Lemma 1 where m^{I^*}, n^{I^*}, $p_l^{I^*}$ and $p_t^{I^*}$ figure respectively the number of issuers, investors using the services of the regulated trading platform, and the equilibrium amount of fees on the listing and trading segments.

Lemma 1. *There exists a Nash perfect equilibrium* $\{p_l^{I^*}, m^{I^*}, p_t^{I^*}, n^{I^*}\}$ *determining mutually compatible choices of the incumbent, issuers and investors.* [4]

[4]The optimal values of fees and population (which are available on request) with proportional and increasing cost functions are not written to lighten the presentation of the results but are used for following comparative studies.

Proof: All relations between variables are continuous. In particular, the numbers of issuers and investors that choose to participate decrease, all things equal, continuously respectively with p_l^I and p_t^I until the values that vanish these numbers. From this, profit of the incumbent is also continuous on these numbers m^I and n^I directly, and on prices p_l^I and p_t^I indirectly. Given the restriction of prices definition interval on those that could make at least one demand positive, all variables are defined in compact sub-sets. As a result, there exists at least one perfect equilibrium.
As the two sided player, the incumbent first determines the listing fees to charge to issuers according to the number of issuers and investors on this market and second the level of trading fees. The population m^{I^*} depends on the value of the threshold $b_i^{I^*}$, obtained by equalizing U_i^I to 0, such that $m^{I^*} = m\frac{\bar{b}-b_i^{I^*}}{\bar{b}}$ according to Figure 1. The population n^{I^*} depends on the value of the thresholds $\overline{a_j^{I/O^*}}$ and $\underline{a_j^{I/O^*}}$ which are obtained by comparing the utility derived from lit and dark pools for the investor j respectively when $d_j = 0$ and when $d_j = 1/2$. Given Figure 2, n^I expresses as: $n^I = \frac{n}{\bar{a}}\left(\underline{a_j^{I/O^*}} + \frac{1}{2}(\overline{a_j^{I/O^*}} - \underline{a_j^{I/O^*}})\right)$. We verify that $\overline{a_j^{I/O^*}} - \underline{a_j^{I/O^*}} = 1/2\gamma^O$. Then substituting m^I and n^I into the incumbent profit 4 provides after maximization the optimal value of fees $p_l^{I^*}$ and $p_t^{I^*}$ ■

Whatever the type of costs, some conditions on parameters should be verified to ensure positive profits for the incumbent and non negative fees and population. For instance, the utility derived from the highest preference for opacity $\bar{a}\gamma^O$ should be greater than the utility derived from the highest level of liquidity in the regulated trading platform $n\beta$. Another necessary condition is about the level of the OTC market's transactions costs p^O which should be not too low compared to the negative effect of diversification d_j in the utility function of the investor j choosing the regulated market. In the following comparative statics, we only consider such states of the world.

4 Lit Pools

From the initial conditions depicted by the benchmark, we then consider the introduction of alternative platforms. There are two possible types of alternative platforms: transparent platforms (or lit pools) and opaque platforms (or dark pools). In this section, we consider the entry of $(k-1)$ lit pools, competing with the incumbent on the transparent segment.

The superscript L is now associated with lit pools, including the incumbent.

The listing fees for the incumbent is p_l^L and the trading fees of lit pools are denoted p_t^L. The number of issuers and investors using the lit pools services are now respectively denoted by m^L and n^L.

4.1 Agents' utility and profits with lit pools

There are now $(k-1)$ lit pools which aim to compete with the incumbent to provide standard and specific trading services to investors. Listing services remain under monopoly and are still provided by the incumbent. The net utility of potential issuers remains the same but the superscript I becomes L such that:

$$U_i^L = \lambda n^L + \theta b_i - p_l^L \tag{5}$$

In the competitive trading segment, the optimal locations of lit pools is such that the incumbent I and the $(k-1)$ lit pools are now located at equal distance to their two closest competitors on the Salop circle of the investors characteristics (see Figure 3).

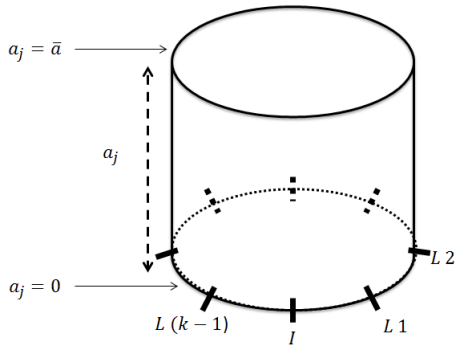

Figure 3: The optimal location of lit pools in the circle of trading services specifications

Given the uniform distribution of investors on the Salop circle, they are now distributed uniformly between the k lit platforms which leads their net utility to change into equation (6):

$$U_j^L = (\alpha + \beta/k)n^L + \delta m^L - d_j - p_t^L \tag{6}$$

where $(\beta/k)n^L$ are the liquidity externalities which depend only on investors using the services of the same platform. The other terms remain unchanged excepting the superscript L instead of I.

Only the superscript of issuers and investors populations change in the utility of investors on the OTC market, which expresses as (7):

$$U_j^O = \alpha n^L + \gamma^O a_j + \delta m^L - p^O \tag{7}$$

The profit of the incumbent is now given by (8)

$$\Pi^I = m^L p_l^L + \frac{n^L}{k} p_t^L - C(n^L/k) \tag{8}$$

while the profit of each lit is limited to (9):

$$\Pi^L = \frac{n^L}{k} p_t^L - C(n^L/k) \tag{9}$$

We still study the cases of proportional and increasing costs with the following specifications respectively: $C(n^L) = c(n^L/k)$ and $C(n^L) = c(n^L/k)^2$.

4.2 Results

The sequence of actions is now as follows:

- At step one, lit pools in competition choose their location on the Salop circle.
- A step two, the incumbent, in a monopoly position, determines the listing fees p_l^L.
- A step three, all lit pools choose the trading fees and p_t^L maximizing their trading profit,
- At step four, issuers and investors choose the best way to make their transactions, according to their respective utility.

The game is still solved with backward induction, each player expecting that at further stages the other players will take the best actions given the previous choices made by the others. It is straightforward to verify that at Nash perfect equilibrium, each lit pool chooses a location on the circle such that the distance between each two subsequent platforms is uniform around the circle.

After the introduction of alternative platforms, Figure 4 shows that investors are still uniformly located horizontally according to the specific services they expect from lit pools, and vertically according to their propensity to use the OTC market. While only one location on the Salop circle was compatible with the specific services offered by the incumbent in the benchmark, now there are k positions on the Salop circle where investors may find the appropriate, specific service they expect ($\overline{a_j^{L/O^*}}$). Consequently, the maximal distance between the investor j and one of

the k lit pool is reduced from $d_j = 1/2$ (without fragmentation) to $d_j = 1/2k$. The white and checkered zones still represent the subsets of investors choosing respectively transparent and the OTC market.

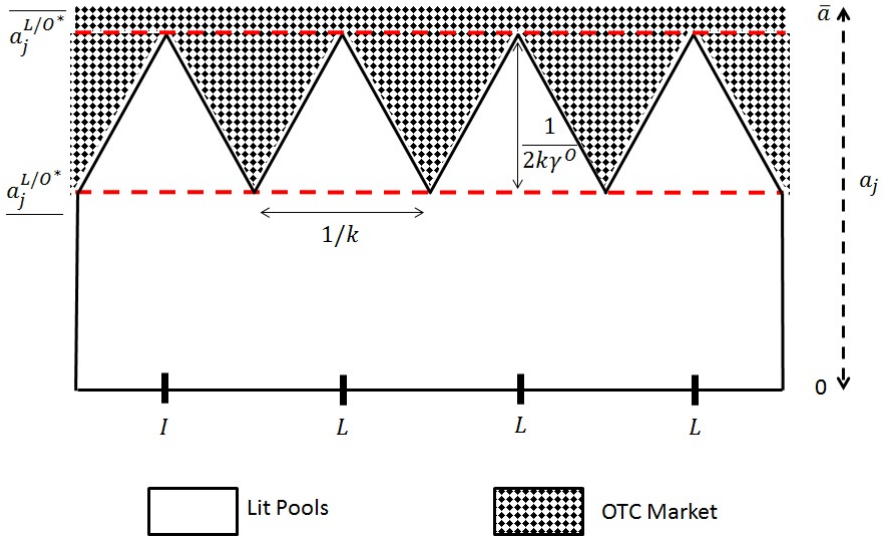

Figure 4: Distribution of investors on lit pools and the OTC market

We are now able to determine new listing p_l^L and trading fees p_t^L, the number of issuers m^L and investors n^L using lit pools, and the market shares and profit for each platform on the transparent market.

Lemma 2. *If $k > 1$, there still exists a Nash perfect equilibrium $\{p_l^{L*}, m^{L*}, p_t^{L*}, n^{L*}\}$ determining mutually compatible choices from platforms, issuers and investors.*

Proof: All relations between variables are still continuous, for the same reasons than in lemma 1 proof. All variables are still defined in compact sub-sets, with the same limitations thna vefor for the prices set of definition. It then results the existence of at least one equilibrium.
In the benchmark case, the incumbent maximizes simultaneously listing and trading profits while in the fragmentation case with lit pools, the incumbent plays leader only on the listing segment and therefore determines sequentially listing and trading profits. This last sequence of events is always less efficient than a simultaneous determination of both amounts of fees in such two-sided market. Consequently, if the incumbent is the only provider in the market, *i.e.* $k = 1$, the optimal values of fees and populations are the same as in the benchmark case.

The population m^{L^*} still depends on the value of the threshold issuer $b_i^{L^*}$, obtained by equalizing U_i^L to 0, and with $m^{L^*} = m\frac{\bar{b}-b_i^{L^*}}{\bar{b}}$. The population n^{L^*} depends now on the value of the thresholds $\overline{a_j^{L/O^*}}$ and $\underline{a_j^{L/O^*}}$ which are obtained by comparing the utility derived from the two trading markets of the investor j respectively when $d_j = 0$ and when $d_j = 1/2k$. Given Figure 4, n^L expresses as: $n^L = \frac{n}{\bar{a}}\left(\underline{a_j^{L/O^*}} + \frac{1}{2}(\overline{a_j^{L/O^*}} - \underline{a_j^{L/O^*}})\right)$. We verify that $\overline{a_j^{L/O^*}} - \underline{a_j^{L/O^*}} = 1/2k\gamma^O$. Then substituting m^L and n^L into the lit pool profit 8 provides after maximization the optimal value of trading fees $p_t^{L^*}$. Finally, the maximization profit of the incumbent given the optimal trading fees $p_t^{L^*}$ determines the listing fees $p_l^{L^*}$ ■

We can deduce from the values of fees and populations in Lemmas 1 and 2 the following propositions.

Proposition 1. *If profits, population and fees are positive and*
(i) if trading services are proposed at increasing costs, on-exchange competition

- *decreases the trading fees, such that $p_t^I > p_t^L$, if the transaction costs of the OTC market are sufficiently high, i.e. if $p^O \geq p^{O^*}[p_t^*]$ and increases them if $p^O < p^{O^*}[p_t^*]$*
- *increases the number of investors in the transparent market, such that $n^I < n^L$, if the transaction costs of the OTC market are sufficiently high, i.e. if $p^O \geq p^{O^*}[n^*]$ and decreases them if $p^O < p^{O^*}[n^*]$*

(ii) if trading services are proposed at non increasing costs, on-exchange competition

- *always increases the trading fees such that $p_t^I < p_t^L$*
- *always decreases the number of investors in the transparent market such that $n^I > n^L$*

Proof: (i) We define the term $p^{O^*}[p_t^*]$ as $p^{O^*}(p_t^{I^*} = p_t^{L^*})$, *i.e.* as the value of p^O equalizing the optimal values of the trading fees on the transparent market before and after fragmentation. In the same way, the term $p^{O^*}[n^*]$ can be obtained by equalizing the optimal values of the number of investors on the transparent market before and after fragmentation such that $p^{O^*}(n^{I^*} = n^{L^*})$. Note that since all the optimal values of fees and population are linear with p^O, there is only one threshold of p^{O^*} in each case. According to the values of the parameters, $p^{O^*}[p_t^*]$ may be greater or lower than $p^{O^*}[n^*]$. For example, if liquidity externalities are particularly low, then $p^{O^*}[n^*] < p^{O^*}[p_t^*]$ and conversely if they are high, then

$p^{O*}[n^*] \geq p^{O*}[p_t^*]$
(ii) In this case, the trading fees decrease if $p^O < p^{O*}[p_t^*]$ and the number of investors in the transparent market increases if $p^O < p^{O*}[n^*]$. Note that the values of $p^{O*}[p_t^*]$ and $p^{O*}[n^*]$ differ from (i) in respect with their analytical expression but not their definition). Since $p^{O*}[p_t^*]$ and $p^{O*}[n^*]$ are always strictly negative, we deduce that $p_t^I < p_t^L$ and $n^I > n^L$ ■

These results can be commented. They point out the role of two critical values of p^O (equalizing respectively the fees and the population on regulated trading platforms before and after competitors entry on the trading segment), especially when the costs are increasing. When the OTC market transactions costs are higher than the first of these critical values, entry decreases the fees on the regulated trading segment. In this case competition has a positive effect on prices on regulated segment. The opposite result is observed when transactions costs are low on the OTC market. In a sense, with low transaction cost, the OTC market is able to counterbalance the competitive effect of entry. The same effect is observed with the redistribution of investors among trading market segments. Entry attracts new investors when transaction costs are not competitive but drive them back to the OTC market when they are too high.

If marginal costs are constant or decreasing, trading fees always increase with competition, because the cost effect is here negative and then cannot compensate the negative effect of liquidity fragmentation with an increase of the number of transparent competitors.

Proposition 2. *If fragmentation attracts more investors in the transparent market, i.e.,* $n^{I*} < n^{L*}$,
(i) the number of issuers increases $m^{I*} < m^{L*}$
(ii) the listing fees increases $p_l^{I*} < p_l^{L*}$
Conversely, if fragmentation attracts more investors in the OTC market, i.e., $n^{I*} \geq n^{L*}$*:*
(i) the number of issuers decreases $m^{I*} \geq m^{L*}$
(ii) the listing fees decreases $p_l^{I*} \geq p_l^{L*}$

Proof: One can find that the same threshold of p^{O*} leads to increase (decrease) the population of issuers and investors and listing fees such that $p^{O*}(n^{I*} = n^{L*}) = p^{O*}(m^{I*} = m^{L*}) = p^{O*}(p_l^{I*} = p_l^{L*})$. In the increasing cost case this threshold equals to $p^{O*} = \frac{mn(8\bar{b}(c-\beta)\theta-\lambda)\lambda+4\bar{a}\bar{b}\gamma^O\theta(1+k(2m\lambda-1))}{4n(4\bar{b}(k-1)(c-\beta)\theta-km\lambda^2)}$ whereas in the non increasing case it equals to $p^{O*} = \frac{mn\lambda^2(1+4ck)+4\bar{b}\theta(4c(k-1)n\beta+2mn\beta\lambda+\bar{a}\gamma^O(-1+k-2km\lambda))}{4n(4\bar{b}(k-1)\beta\theta+km\lambda^2)}$ ■

This result is associated with the two-sided market incumbent environment. When there are an increase of the on-exchange's number of investors, crossed externalities generate an incentive on potential issuers to choose IPO instead of other forms of funding. This tension on the listing segment push up fees on this side of the market. Note that these results hold whatever the type of production costs (increasing or not).

5 Dark pools

This section studies the entry of another kind of alternative platform, usually named "dark pools". We now use the superscript T for transparent platforms (incumbent and lit pools), D for dark pools and still O for the OTC market.

5.1 Agents' utility and profits with dark pools

They are k' dark pools. Investors joining these opaque platforms diffuse as other investors membership externalities λ on issuers. Listing services remain under monopoly and their fees are then still determined by the incumbent and denoted p_l^T. The net utility of potential issuers is now depicted by equation (10):

$$U_i^T = \lambda n^T + \theta b_i - p_l^T \tag{10}$$

From investors' side, dark pools are opaque but less than the OTC market. Investors joining these platforms then diffuse few information externalities denoted $\alpha_D\, n^D$ on the other investors but less than those of the lit pools such that $\alpha_D < \alpha$. They also diffuse liquidity externalities $\beta/k'\, n^D$ to investors who invest on the same dark pool and they benefit from the usage externalities of issuers joining the incumbent δm^T. Investor j also has an advantage $\gamma^D a_j$ to make opaque transactions on the dark pools (with $\gamma^D < \gamma^O$). The investor j's net utility on a dark pool is then given by expression (11):

$$U_j^D = \alpha n^T + (\alpha_D + \beta/k')n^D + \gamma^D a_j + \delta m^T - p^D \tag{11}$$

where n^D the number of investors joining dark pools and p^D the fees paid for dark pools access.

The entry of dark pools slightly changes the other investors utility functions.

For the investor j, the net utility on a transparent platform located at a distance d_j from them, and the net utility associated with the OTC market becomes (12) and (13):

$$U_j^T = (\alpha + \beta/k)n^T + \alpha_D n^D + \delta m^T - d_j - p_t^T \tag{12}$$

and

$$U_j^O = \alpha n^T + \alpha_D n^D + \gamma^O a_j + \delta m^T - p^O \tag{13}$$

The profits of the incumbent and lit pools remain unchanged and those of dark pools have the same form such that:

$$\Pi^D = \frac{n^D}{k'} p_t^D - C(\frac{n^D}{k'}) \tag{14}$$

As in previous sections, we still study the cases of proportional and increasing costs with the following specifications respectively: $C(n^D) = c(n^D/k')$ and $C(n^D) = c(n^D/k')^2$.

5.2 Results

The sequence is still the same.

- At step one, lit pools in competition choose their location on the Salop circle.
- A step two, the incumbent, in a monopoly position, determines the listing fees p_l^T.
- A step three, lit and dark pools choose simultaneously their trading fees and p_t^T and p_l^D maximizing their trading profit,
- At step four, issuers and investors choose the best way to make their transactions, according their respective utility.

The game is still solved with backward induction. After the entry of dark pools, Figure 5 shows how the distribution of investors is modified. Horizontally, the maximal distance between the investor j and one of the k lit pool is still $d_j = 1/2k$. But vertically there are three new thresholds relative to the investors' preference for opacity. For the most distant investors j from a lit pool, we have the threshold $\underline{a_j^{T/D^*}}$ and for those who find exactly the specific trading services they search, we have $\overline{a_j^{T/D^*}}$. Lastly, for the investors who have the highest preference for opacity, whatever their position on the circle, we have the threshold a_j^{D/O^*}.

The white and the black checkered zones still represent the subsets of investors choosing respectively transparent and OTC market, and we have now in the middle a gray zone for those who choose dark pools.

Then, we derive the following result:

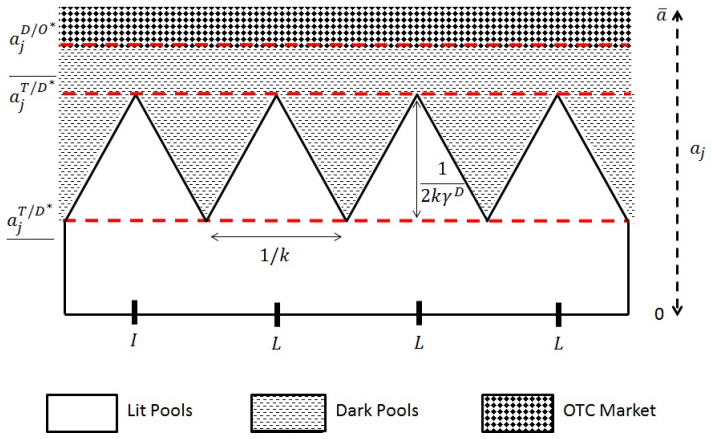

Figure 5: The distribution of investors among the different types of platforms

Lemma 3. *After the entry of dark pools, there still exists a Nash perfect equilibrium* $\{p_l^{T*}, m^{T*}, p_t^{T*}, n^{T*}, p^{D*}, n^{D*}\}$ *determining mutually compatible choices from platforms, issuers and investors.*

Proof: All expressions are still continuous from variables p^D, n^D which are definite in compact sub-sets when whe limit prices to the range of variation compatible with positive number of issuers and investors in each platform. It then results the existence of at least one equilibrium. The incumbent still plays leader only on the listing segment. Like in the previous sections, the number of issuers m^{T*} still depends on the value of the threshold b_i^{T*}, obtained by equalising U_i^T to 0, and such that $m^{T*} = m(\frac{\bar{b}-b_i^{T*}}{\bar{b}})$. The population n^{T*} depends now on the value of the thresholds $\overline{a_j^{T/D^*}}$ and $\underline{a_j^{T/D^*}}$ which are obtained by comparing the utility derived from lit and dark pools for the investor j respectively when $d_j = 0$ and when $d_j = 1/2k$. The number of investors joining dark pools n^{D*} could be determined by deducing populations n^{T*} and n^{O*} from the total number of investors n. Following Figure 5, we have to solve the following equation system:

$$\begin{cases} n^T &= \frac{n}{\bar{a}}(\overline{a_j^{T/D^*}} - \frac{1}{4k\gamma^D}) \\ n^O &= \frac{n}{\bar{a}}(\bar{a} - a_j^{D/O^*}) \\ n^D &= n - n^T - n^O \end{cases}$$

Then, substituting n^T into the lit pool profit and n^D into dark pool profit, provides after simultaneous maximization the optimal value of trading fees p_t^{T*} and p^{D*}. Finally, the maximization profit of the incumbent given the optimal trading fees p_t^{T*} determines the listing fees p_l^{T*} ■

The exact values of the important variables are too complex to be written. Despite this complexity, a static comparative study is possible. We can then deduce from these values the following proposition:

Proposition 3. *If coexistence of lit pools, dark pools and the OTC market is possible, the entry of dark pools in the competitive trading market,*
(i) always decreases trading fees in the transparent market, i.e., $p_t^{T^*} < p_t^{L^*}$
(ii) decreases the number of investors on the OTC market either if the number of investors on lit pools increases ($n^{T^*} \geq n^{L^*}$) *or if the number of investors on lit pools decreases* ($n^{T^*} < n^{L^*}$) *but if and only if the opacity of dark pools* γ^D *is sufficiently high.*

Proof: The coexistence is viable if all fees and populations are positive, *i.e.* $\{n^{T^*}, n^{D^*}, p_t^{T^*}, p^{D^*}\} > 0$ and if some investors still join the OTC market such that $n^{T^*} + n^{D^*} < n$.
(i) Consider the value of p^O equalizing the optimal values of the trading fees on the transparent market before and after the entry of dark pools: $p^{O^*}[p_t^*]$ as $p^{O^*}(p_t^{L^*} = p_t^{T^*})$. Whatever the type of costs (increasing or not), and since all the optimal values of trading fees are linear with p^O, we find that $p_t^{L^*} > p_t^{T^*}$ (the trading fees decrease) only if $p^O > p^{O^*}(p_t^{L^*} = p_t^{T^*})$ and conversely. But, since this threshold is always negative (notably because $\gamma^D < \gamma^O$), we conclude that the trading fees always decrease.
(ii) Before the entry of dark pools, the number of investors using the OTC market is given by $n - n^{L^*}$ whereas after the entry of dark pools they are $n - n^{T^*} - n^{D^*}$. The number of investors on the OTC market decreases $n - n^{T^*} - n^{D^*} < n - n^{L^*}$ if $n^{T^*} \geq n^{L^*}$. Analytical and numerical simulations show that such case occurs if the liquidity parameter β is particularly low. If not, *i.e.* if $n^{T^*} < n^{L^*}$, the entry of dark pools decreases the number of investors joining lit pools but even decreases the number of investors on the OTC market if γ^D sufficiently high since we have: $\delta n^{T^*}/\delta\gamma^D > 0$ and $\delta n^{D^*}/\delta\gamma^D > 0$ ■

Proposition 3 shows that the entry of dark pools reduces fees in the transparent market. This kind of result is not guaranteed when fragmentation occurs without dark pools (see Proposition 1) because of the ambiguous role of fragmentation, even with increasing costs. The decrease of fees in the transparent market may then attract more investors from the OTC market when the liquidity externalities reduce too much. Nevertheless, even in this case, this decrease of fees does not prevent some investors to leave transparent platforms if liquidity on these platforms has declined. In such case, if dark pools are sufficiently opaque, they are able to attract some investors otherwise interested in using the OTC market and their effect is then to enhance the number of investors using the regulated market.

Numerical simulations of the model highlight that the decrease of the number of investors using the OTC market appears for a wide range of variation of relevant parameters whatever the type of cost. We have only found few counter examples for particular values of parameters. More precisely, a low level of opacity in the dark pools is a necessary but not sufficient condition, some particular values of $\bar{a}$, β and k' are also necessary to find a case where the number of investors using the regulated market decreases.

Proposition 4. *If the entry of dark pools decreases the number of investors in the OTC market and if cross externalities are sufficiently high, the net utility of issuers and investors increases and the incumbent profit's increases too. As a consequence, global welfare unambiguously improves.*

Proof: Consider issuers' utility. At each increase of the number of investors on the regulated market, gross utility of issuers increases as a consequence of the increase of membership externalities. Given Proposition 1 and after the expression of the optimal amount of fees and populations with dark pools, one can find that the same threshold of combination of parameters X^* leads to increase (decrease) the population of issuers and investors on lit and dark pools and listing fees such that $X^*(n^T + n^{D^*} = n^{L^*}) = X^*(m^{T^*} = m^{L^*}) = X^*(p_l^{T^*} = p_l^{L^*})$. Therefore, if the number of investors in lit and dark pools increases $n^T + n^{D^*} > n^{L^*}$, then the number of issuers also increases $m^{T^*} > m^{L^*}$. Then, a greater number of issuers necessarily means that they are better off despite the increase of listing fees.
Consider now investors' utility. The role of cross externalities is crucial. All things equal, the more the number of issuers m^T increases, the more utility associated with usage externalities δm^T increases for all investors. If $n^T > n^L$, a greater number of issuers necessarily means that they are better off. Otherwise, if $n^T < n^L$, the decrease of liquidity $\beta/kn^{T^*} < \beta/kn^{L^*}$ and the potential decrease of information externalities (if $\alpha n^{T^*} + \alpha_D n^{D^*} < \alpha n^{L^*}$) have to be overcome by the decrease of fees $p^{T^*} < p^{L^*}$ and increasing usage externalities $\delta m^{T^*} > \delta m^{L^*}$. The same kind of reasoning could be applied to investors' utility on the OTC market: the potential decrease of information externalities (if $\alpha n^{T^*} + \alpha_D n^{D^*} < \alpha n^{L^*}$) have to be more than compensated by higher usage externalities $\delta m^{T^*} > \delta m^{L^*}$. Consider now the investors' utility on dark pools : if they leave lit pools and the OTC market where other investors are better off comparing to the situation without dark pools, they are also necessarily better off.
Last, we consider the incumbent situation. Total profits split into listing services profits and trading services profits. If the number of investors in lit and dark pools increases $n^T + n^{D^*} > n^{L^*}$, the number of issuers $m^{T^*} > m^{L^*}$ and the level of listing fees also increase. Then, the part of the profit linked to listing activities always increases. Trading services fees always decrease $p_t^{T^*} < p_t^{L^*}$ but the number of customers may increase or decrease. If $n^{T^*} \leq n^{L^*}$, the profits linked

to trading should decline except if increasing costs increase very sharply. Finally, in the case where dark pools attract investors from the OTC market, the profit of the incumbent increases whatever the profits linked to trading if the number of issuers m^{T^*} is sufficiently high. This case corresponds to strong cross externalities ■

Proposition 4 sheds new light on the role of dark pools. For a wide range of parameters, dark pools help to maintain investors in the regulated market and then may enhance agents welfare including the incumbent. With dark pools, even if information and liquidity externalities between investors are less important, they can be largely overcome by the positive effect of cross-externalities between issuers and investors. By diverting some investors from off-exchange, the listing services of the incumbent become more attractive and the issuers' welfare improves through membership externalities and the investors' welfare through usage externalities and lower fees.

6 Concluding remarks

Implemented on 2007, the Markets in Financial Instruments Directive became a core pillar in the European financial markets regulation. One of its main objectives was to increase trading services competition. The incumbent has to manage with local competitors such as Bats Chi-X or Turquoise which can be divided between lit and dark pools. However, expected benefits from the new competitive landscape have not flowed equally to all market participants, especially end-users. The trading environment has become more fragmented and dark pools were particularly accused to decrease the market quality. But the rising complexity is not only the consequence of trading services competition, but also of the social interaction between all trading stakeholders - players and heterogeneous users (investors and issuers) - and of specific market externalities. Our paper, in a theoretical setting, combine all those features in a model. The main issue of our results is to determine if competition between trading platforms, and especially the presence of dark competitors, is desirable for all the market stakeholders.

We compare three forms of trading services structure. Initially a single market firm, in charge of issuers' admission to trading and trading services, competes with an OTC segment. Then, we consider the entry of new lit trading platforms and finally dark ones. Our final results point out that on-exchange dark trading systematically generate positive effects on trading participants' welfare. This result may seem surprising: the usual opinion is to consider that dark pools increase market opacity and decrease in average market quality. Our setting attests that this view must be challenged. When they compete mainly with the OTC market,

dark pools decrease transaction fees, and overall, their opacity - even limited - is sufficient to attract some investors from the off-exchange. Then, investors benefit from an increase of trading services diversification and from liquidity externalities that lack on the OTC market. Issuers benefit from a larger base of investors in the relevant marketplace and the incumbent can increase its profit on the listing segment to compensate trading fees losses. If new regulations exclude the possibility of dark trading and authorize only lit players to compete the incumbent, positive effects could be less systematic. They would be highly dependent on determinants such that liquidity externalities, diversification benefits or intermediation costs structure. Precisely, if the lit entry decreases transaction fees, a rise of the participant's welfare depends on the capacity of the market place to divert investors from the off-exchange. In other words, the effect of entry on welfare depends on the ability of the financial center in generating local externalities. For instance, with strong liquidity externalities, entry reduces incumbent trading revenue, as a consequence of the decrease of trading fees (due to the competition) and of listing fees (to stop the issuers' departure to other marketplaces) with a two-sidedness scissors effect. In this case, the increasing competition is detrimental without dark pools. Conversely, with poor externalities and increasing platforms management costs, an increase of the number of platforms can decrease the fees on the lit trading segment and on the listing, and enhance the number of investors on organized market. In this case, an entry of new competitor has positive effects on welfare and can be Pareto improving.

Our results are in line with a balanced regulatory struggle against dark finance. They suggest that it could be better to authorize and regulate dark trading than totally ban it from any regulated trading places. Some practical insights arise from our work, especially if we make a comparison between the virtuous circle modelled in this paper with dark platforms entry, and the actual European post-MIFID landscape with ambivalent consequences. According to Fleuriot report (2010), MIFID effects are based on three main characteristics: an observed decrease of trading fees, a significant fragmentation of order flows, and a rising dissatisfaction of investors with major concerns about market liquidity. In our paper, positive effects generated by dark regulated services is closely dependent on their attractiveness contrasted with OTC possibilities, and our implicit hypothesis of a free access for investors to the whole marketplace matching possibilities and a public consolidated tape. Both are the prerequisite to benefit from information and liquidity externalities. And the actual lack of platforms and real time public information accessibility could explain less positive results in practical of MIFID impact.

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