Liquidity and Risk Sharing Benefits

from the Introduction of an ETF

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Abstract

This article examines how the introduction of an ETF replicating a stock index impacts on the liquidity of the underlying stocks. We find that index stock spreads decline, relative to those of non index stocks, after the introduction of the ETF . Changes in adverse selection do not appear to be a major factor explaining this liquidity improvement. We also fail to relate it to recognition effects. By contrast, we think that it can mainly be explained by a decrease in order processing and order imbalance costs. This is consistent with the arbitrage theory of Fremault (1991) according to which increased cross-market trading provides additional risk sharing capacity.

1. Introduction

Exchange-traded funds (ETFs) are widely acknowledged to be one of the most useful financial innovations of the past few decades, especially for index traders. They are essentially exchange-traded assets that represent a basket of securities comprising a particular index. ETFs allow investors to take positions in a given market without selecting individual securities, and provide them with an opportunity to trade indices easily, in small amounts, and at very low costs. They are thus generally not considered as redundant assets, but rather as new financial instruments that complete markets in an economic sense. They are particularly well suited for passive investors, and combine the advantages of closed-end and open-end mutual funds with much lower expense fees. On the one hand, as closed-end funds, ETFs can be traded throughout the day in the secondary market. On the other hand, they can be considered as open-end mutual funds, as the creation and redemption of ETF shares are allowed.

As a result of these attractive features, ETFs are now very popular investment vehicles. A BlackRock report¹ found that the number of ETFs available worldwide at the end of 2010 was 2,459 ETFs, totaling assets under management of US \$ 1,311 billion, listed on 46 exchanges. In Europe, the ETF industry had 1,071 ETFs, with assets of US\$284.0 billion, on 22 exchanges. Understanding how and why ETFs contribute to the quality of stock markets is thus of great interest. Our research specifically investigates how the first introduction of an ETF tracking a stock index affects the liquidity of the underlying stocks. We find that the liquidity of underlying stocks improves relative to that of non-index stocks, and that this

¹ BlackRock (2011) ETF Landscape Industry Review, Year End 2010, 162p.

liquidity improvement mainly occurs by means of a reduction in order processing and order imbalance costs.

Investigating the liquidity effects of the introduction of ETFs is relevant not only because of the size and expansion of the ETF sector but also because of the lack of consensus about such effects in both the asset management industry and academia. A survey of 192 European ETF users conducted in 2010 by the EDHEC-Risk Institute² shows how mixed the views of practitioners were on this matter: 31% of the survey respondents observed an improved liquidity in the underlying market, but 35% did not. In the academic world, previous literature also provides diverse conclusions on the liquidity effect of ETF inception. Hegde and McDermott (2004) investigated the liquidity effects of the introduction of ETFs for the DJIA 30 and the Nasdaq 100 stock indices, the Diamonds index, and the QQQ, and found a liquidity improvement largely related to a decline in the cost of informed trading in the underlying stocks. Richie and Madura (2007) also tested the impact of the creation of the QQQ fund on the liquidity of the component securities and the risk of the underlying securities. They found that the liquidity improvement following the creation of the QQQ was more pronounced for less heavily weighted stocks, and that the systematic risk of the underlying stocks declined relative to a control sample. However, using matched samples, Van Ness, Van Ness, and Warr (2005) did not find a similar improvement for the DJIA 30. They tested the hypothesis that uninformed traders prefer to invest in the Diamond ETF rather than in the individual stocks constituting the index, and found that, following the introduction of the Diamonds ETF, the bid-ask spreads of the DJIA 30 actually increased relative to the spreads of matching stocks. However they did not find a consistent change in the adverse selection components of the spreads of the Dow stocks.

² EDHEC European ETF Survey 2010, EDHEC-Risk Institute Publication.

Based on the introduction of the Lyxor CAC 40, the first Euronext-listed ETF to replicate the French CAC 40 index, our empirical work contributes to the literature in two ways. First, studying the inception of an ETF on Euronext may provide a new insight because of the particular market design of the ETF market segment of this exchange. On Euronext,³ ETFs are traded in a hybrid, continuous, order-driven market, in which designated market makers, called liquidity providers (LPs), have to provide immediacy services. Using non-public complete order book data, we show that ETF LPs contribute greatly to the liquidity of the ETF market. Given the benefit of these LPs, liquidity effects may differ from those observed for ETFs listed on other exchanges. Second, we compare the theories that have been put forward to explain the liquidity improvement observed for CAC 40 stocks after the introduction of the Lyxor CAC 40. Our main contribution is to show that the tightening of index stock spreads is predominantly related to a decrease in the temporary price effect of order execution. This is in line with Fremault's (1991) arbitrage theory according to which cross-market trading has beneficial risk sharing effects.

This article is organized as follows. In Section 2, we describe the Lyxor CAC 40, present its market microstructure, and assess its economic role by estimating the implicit trading costs incurred by index traders in both the market for individual stocks and the ETF market. In Section 3, we review the theories predicting the effects of the inception of an ETF on the liquidity of the basket stocks, and derive testable hypotheses. Those hypotheses are then tested in Section 4. Section 5 provides a discussion of the findings and a validation of the arbitrage hypothesis, and Section 6 presents our conclusions.

³ In 2001, the European exchange Euronext comprised the former exchanges of Amsterdam, Brussels, and Paris. It then took over the Portuguese exchanges of Porto and Lisbon. More recently, in 2007, it merged with the NYSE and is now a subsidiary of the transatlantic group Nyse-Euronext.

2. The Lyxor CAC 40: description, trading mechanisms, and associated cost savings

Whereas ETFs were created in the 1990s in North-America,⁴ they were only introduced into European markets in the early 2000s. The Lyxor CAC 40, which tracks the performance of the CAC 40 index, was the first ETF to be listed on Euronext. ETFs which track national indices are the most popular equity ETFs, with 16.22% of the assets under management on the European ETF market. With €3.07 billion under management in July 2010, the Lyxor CAC 40 has now become one of the most actively traded funds on NextTrack, the Euronext segment dedicated to the listing and trading of ETFs. For the year 2010, it ranked third, with an average daily turnover of €4.08 million and a market share of 9.26%.

2.1. The Lyxor CAC 40 fund

The CAC 40 index is the flagship French stock market index and comprises forty large capitalization stocks. It is a market-value weighted index whose composition is reviewed quarterly by an independent Index Steering Committee. The main criteria for inclusion in the CAC 40 are market size and turnover.⁵ Its base value was set to 1,000 on December 31, 1987. It serves as an underlying asset for futures contracts and options traded on Nyse Liffe.⁶

⁴ ETFs were first introduced on the Toronto Stock Exchange in March 1990 with the creation of TIPS (Toronto 35 Index Participation units). This was followed in 1993 by the inception of the SPY which replicates the S&P 500 on the AMEX. Currently, the three most active ETFs are the SPY, the QQQ which replicates the Nasdaq 100, and the DIA which tracks the DJIA 30.

⁵ At each review date, the companies listed on Euronext Paris are ranked according to their free float capitalization and turnover over the last twelve months. From the top 100 companies in that ranking, forty are chosen to enter the CAC 40 in order to make it “a relevant benchmark for portfolio management” and “a suitable underlying asset for derivative products.”

⁶ NYSE Liffe is the global derivatives business of the NYSE Euronext group.

The Lyxor CAC 40 was the first ETF created to replicate the value of the CAC 40. It is a French mutual fund that complies with the UCITS III European directive.⁷ It was issued on NextTrack, on January 22, 2001, by Lyxor, a subsidiary of Société Générale. One unit of the ETF is worth 1/100 of the index and the objective is to track the index return. Several replication mechanisms can be employed by the fund manager in order to minimize the tracking error: physical replication, statistical sampling or swap-based replication. Lyxor systematically uses swap-based replication to manage the replication risk of its ETFs.⁸ The fund invests in a broad basket of stocks (as many as 90 for the CAC 40 ETF)⁹ and swaps the performance of the basket against the performance of the index. The swap counterparty for Lyxor is always the parent bank, Société Générale. With such a mechanism, the investor bears almost no replication risk,¹⁰ but supports the counterparty default risk associated with the market value of the swap. Management fees are no more than 0.25% per year and no entrance or exit fees are charged. This allows investors to buy the index with perfect replication, even for small amounts, at low fees, and without the constraints of derivative markets (such as deposits and margin calls). Share creation and redemption are always possible for a minimum of 50,000 units and are charged €10,000 per subscription request.

⁷ UCITS (Undertakings for Collective Investment in Transferable Securities) are a set of European Union (EU) directives that aim to allow collective investment schemes to operate freely throughout the EU on the basis of a single authorisation from one member state. UCITS rules apply to funds marketed to retail investors.

⁸ See Paul Amery (2008) 'More on counterparty risk (swap-based ETFs)', www.indexuniverse.eu.

⁹ See Lyxor ETF CAC 40 (2010), FCP – Rapport annuel, exercice clos le 30/07/2010.

¹⁰ The tracking error never exceeds 1%.

2.2. Trading mechanisms

The European stock markets of Nyse-Euronext currently rank among the most important trading venues in Europe. They rely on a homogeneous order-driven structure. The CAC 40 stocks are traded continuously in the Euronext electronic order book. The trading day starts with a call auction at 9.00 a.m. following a pre-opening phase beginning at 7.15 a.m. Then the market switches over to continuous trading and closes with a call auction at 5.30 p.m. following a 5-minute pre-closing period. Both opening and closing prices are set by matching the supply and demand curves and selecting the price that maximizes the trading volume. The continuous trading system enforces a price-time order priority rule to arrange trades.

ETFs listed on NextTrack are also continuously traded but their trading session is delayed by five minutes relative to the cash stock market session, so that the price discovery process on underlying stocks precedes that on ETFs. In spite of its similarity with the cash market microstructure, the ETF market is different in two respects.

First, while CAC 40 stocks are traded in a pure limit order book market, market members may act as LPs on NextTrack. As market specialists for their stocks, LPs have a business agreement with Euronext whereby they undertake to quote two-way bid and ask prices in the limit order book, with a minimum volume and within a maximum spread. They commit to maintaining a spread of firm bid and offer prices during the fifteen minutes preceding the market opening, and then throughout the trading day, including the order accumulation period preceding auctions. In return for those commitments, orders placed by LPs and their resulting trades are subject to tariff benefits which are conditioned on their performance in providing liquidity, and may not exceed 50% of explicit trading fees. LPs benefit from the maximum fee reduction of 50%, provided that they comply with 80% of their commitments in terms of quote time, quoted spreads, and quoted quantities.

Second, a large portion of the ETF order flow is executed in the over-the-counter market by LPs. As the Markets in Financial Instruments Directive (MiFID)¹¹ does not apply to ETF trading, there is no commitment to post-trade transparency for those OTC trades.

2.3. Cost savings related to the ETF and LPs' contribution

We assess the economic relevance of ETFs by comparing the implicit transaction costs associated with the Lyxor CAC 40 with those associated with the CAC 40 stock basket. Our analysis is based on the database used by De Winne and D'Hondt (2007). This database contains very detailed order book data during October 2002. Our sample contains the CAC 40 stocks and the Lyxor CAC 40 security. We know exactly what is registered in the limit order book for a given stock at every second (the set of the five best bid/ask quotes (not just the best), both displayed and hidden quantities associated with these quotes, and the portion of these quantities stemming from client orders, principal orders, and LP orders). Additional information¹² about this database and about the process used to build the limit order book can be found in De Winne and D'Hondt (2007).

Using these order book data, we compare the cost of a round-trip trade in the CAC 40 stock basket and in the CAC 40 ETF. As suggested by Irvine, Benston, and Kandel (2000),

¹¹ The MiFID is a European Union law which provides a harmonised regulatory regime for investment services across the 30 member states of the European Economic Area (the 27 Member States of the European Union plus Iceland, Norway and Liechtenstein). The main objectives of the Directive are to increase competition and consumer protection in investment services. As of November 1 2007, it replaced the Investment Services Directive.

¹² A note describing the methodology applied to build the limit-order book from Euronext order and trade files is available on request. The analysis performed in this section relies on the availability of such detailed data, which in turn justifies the choice of this particular period.

an *ex-ante* liquidity measure is useful to indicate the upper bound of the transaction cost at which an order can be immediately executed. Of course, we know that many traders will try to obtain a better price for the whole bundle of shares by splitting their orders, but the cost of a round-trip trade (CRT) gives some idea of the implicit costs that can be expected from a naive order placement strategy. At any given point in time t , the CRT for a trade size T corresponds to the difference between the cost of buying T shares of a stock i ($B_{T,i,t}$) and the amount received from selling these T shares ($S_{T,i,t}$). For the purpose of comparison across stocks or across trade sizes, this difference is divided by the value of these T shares at the mid-point. The CRT for a trade size of T shares of stock i at time t is therefore computed as:

$$CRT_{T,i,t} = \frac{B_{T,i,t} - S_{T,i,t}}{T \times \frac{(B_{1,i,t} + S_{1,i,t})}{2}}, \quad (1)$$

where both displayed and hidden orders are taken into account.¹³

For each stock in our sample and for the ETF, we computed this measure for every time a new order was placed. We measured the CRT for 5,000 and 50,000 shares of the Lyxor CAC 40. According to the weight of each stock in the CAC 40 index measured at the opening auction every day, we computed the corresponding number of shares to be traded for 5,000 and 50,000 shares of the ETF. These numbers were then used to measure the CRT of individual stocks according to Equation (1). For each trading day, we first averaged the CRTs in every stock and then computed the average CRT of the basket according to the stock weights on that day. Finally, we averaged the daily CRTs across the 23 trading days in October 2002 to obtain the basket CRT.

¹³ On Euronext and NextTrack, hidden orders are allowed and undisclosed depth is likely to lower this cost compared with the cost that might be expected from the depth displayed on the screens.

Since the Lyxor CAC 40 security is traded in a hybrid market where LPs with market-making contractual commitments interact in the order book, we also estimated the relative contribution of LPs to the market liquidity using the 432,266 order book states observed for the ETF security during that month. Average relative quoted spreads, average depths at the first and the five best limits, as well as relative CRTs for 5,000 and 50,000 shares, were first computed using all the orders waiting in the limit order book. Then these measures were recomputed without the orders submitted by LPs.

[Insert Table 1 about here]

The results are presented in Table 1. The costs associated with trading the basket of stocks appears to be higher than that associated with trading the ETF. Buying and selling the underlying stocks costs 0.21% (compared to 0.15% for the ETF) for a trade size equivalent to 5,000 ETF shares, or 0.27% (compared to 0.21%) for a trade size of 50,000 ETF shares. Translated into monetary units, these differences represent about €100 and €1,000 respectively for the equivalent of 5,000 and 50,000 ETF shares. Comparing the two last columns shows that LPs contribute greatly to the liquidity of the ETF market. Omitting orders placed by LPs multiplies the CRT by a factor of about four.¹⁴

3. Related theories and testable hypotheses

Since the introduction of the Lyxor CAC 40 allows the CAC 40 index to be traded in smaller denominations and at lower costs, it may have diverse effects (such as attracting new investors to the stock market or diverting particular categories of traders from the market of the underlying stocks to the ETF market). These effects are likely to impact the liquidity of

¹⁴ This result is actually downward biased, since, for some states of the order book, CRTs were not computed because the five best limits were insufficient for trading 5,000 or 50,000 shares.

the basket of underlying stocks, either positively or negatively. This section presents the theoretical hypotheses that may explain how the inception of an ETF can alter the liquidity of the index components. The theories which are most often cited in the literature are the *adverse selection hypothesis* and the *arbitrage hypothesis*. Richie and Madura (2007) also put forward the *recognition hypothesis*. From these theories, we derive a set of hypotheses that will be tested in Section 4.

3.1. *The adverse selection hypothesis*

The consequences of the introduction of a basket security for liquidity have been modeled by Subrahmanyam (1991) in the theoretical settings chosen by Admati and Pfleiderer (1988). In this model, a population of informed and uninformed traders can choose to trade either in N individual asset markets or in the N -assets index stock market. Informed traders can receive two types of signals: either specific private information or systematic private information. At equilibrium, specific-information traders preferably trade in the underlying stock market while systematic-information traders elicit the basket market for trading, and discretionary liquidity traders go to the basket market, where their losses to informed traders are expected to be lower.

This is very similar to Gorton and Pennacchi's (1993) model, in which less informed agents reduce their trading losses by trading in composite rather than individual securities. As a result of reduced liquidity trading in the component securities, adverse selection costs and spreads may increase in the underlying security markets, and this increase is predicted to be more significant for securities with smaller weights in the basket than for heavily weighted securities. These effects could be even more pronounced when the newly created index market involves market-making intermediaries such as the Lyxor CAC40 LPs because this category of market participants is acknowledged to be able to skim off the most profitable orders, that is the least informed (see Easley et al. 1996).

3.2. *The arbitrage hypothesis*

Introducing financial instruments derived from existing securities, such as futures, options, or ETFs, may reduce market incompleteness and expand the investment and arbitrage opportunities facing investors (Ross 1976; Hakansson 1982). If these new instruments generate additional arbitrage trading, price efficiency and liquidity in the underlying markets are improved. For instance, Kumar, Sarin and Shastri (1998) provide unambiguous evidence of improved market liquidity after option listings. Kurov and Lasser (2002) and Deville, Gresse and Séverac (2011) have shown that index cash-futures arbitrage profits decrease in frequency and magnitude following the introduction of an ETF.

The introduction of ETFs may create arbitrage benefits in two ways. First, assuming that markets are informationally segmented, the introduction of an index security mitigates the structural problems that beset inter-market arbitrage: it lowers arbitrage costs such as tracking errors and the randomness in the intervening dividend payoffs, and it therefore favors arbitrage trading (Hegde and McDermott 2004). Second, upon introduction of the ETF, traders or ETF LPs can exploit new arbitrage opportunities by creating and redeeming shares in the new ETF (Richie and Madura 2007). However, the arbitrage opportunities resulting from the creation and redemption of ETF shares seem difficult to exploit on the Lyxor CAC 40, because of the prohibitive costs charged in the ETF primary market.¹⁵ New arbitrage opportunities should essentially arise in the ETF secondary market.

Fremault (1991) modeled the benefits of arbitrage between cash and futures index markets under rational expectations, and showed that increased index arbitrage:

¹⁵ A minimum number of 50,000 units is required to create or redeem ETF shares. Each subscription request is charged €10,000.

1. adds liquidity and allows risk to be reallocated from hedgers of one market to speculators on another market;
2. adds risk bearing capacity to markets and provides buying and selling support in markets order imbalances;
3. has a stabilizing effect on prices if the variances of aggregate supply in the respective markets are not too divergent.

If we transpose this theory to the introduction of an ETF, arbitrage trading across the underlying-stocks market and the ETF market should improve stock liquidity by allowing risk to be reallocated between the markets, and reducing the impact of order imbalances. This risk sharing effect could be greater for an ETF market whose structure involves LPs if the LPs contribute to the risk allocation process.

3.3. *The recognition hypothesis*

The inclusion of a stock in an index is generally accompanied by a positive permanent price increase (see, for example, Beneish and Whaley 1996; Harris and Gurel 1986) and an improvement in liquidity (Hegde and McDermott 2003). Chen, Noronha, and Singal (2004) consider that those positive effects are consistent with Merton's (1987) *investor recognition theory*, because the price responses to additions to and deletions from the S&P 500 index is asymmetric, with no permanent price decrease following index deletions. According to Merton (1987), with increased investor recognition, the shareholder base broadens, resulting in lower required returns and higher liquidity. Investor awareness of a stock increases following its addition to the index, which results in a positive price response. Because investor awareness does not necessarily decrease after a deletion from the index, the opposite effect is not found.

With the introduction of an ETF on a stock index, similar recognition effects may occur. First, the inception of an ETF is an unusual event that may attract the attention of investors to index securities, and thereby induce new investors to trade in them (Barber and Odean 2008). Second, the inception of an ETF gives the index components some useful publicity. As shown by Grullon, Kanataas, and Weston (2004), increased advertising results in increased stock liquidity because new-found individual and institutional investors participate in the market. The recognition hypothesis thus predicts increased liquidity after the inception of an ETF, and this effect is expected to be more pronounced for index components that were less traded prior to the ETF introduction, that is the smallest components of the index (see Richie and Madura 2007).

3.4. Testable hypotheses

According to the adverse selection hypothesis, the liquidity of the basket of stocks is reduced after the introduction of the ETF, because adverse selection increases in the cash stock market. This theory can be examined by testing the hypotheses that:

immediately after the inception of the ETF,

H1a. the trading volumes of index stocks decrease relative to those of non-index stocks;

H2a. the spreads and depth of index stocks deteriorate relative to those of non-index stocks;

H3. the adverse selection costs of index stocks increase relative to those of non-index stocks;

H4. provided H3 holds, adverse selection costs increase more for stocks with smaller weights in the index.

Alternatively, according to the arbitrage and recognition hypotheses, the liquidity of the underlying stocks is improved with the introduction of the ETF, so that these two theories

may hold if we find evidence to support H1b and H2b (below), which are the opposite of H1a and H2a:

immediately after the inception of the ETF,

H1b. the trading volumes of index stocks increase relative to those of non-index stocks;

H2b. the spreads and depth of index stocks improve relative to those of non-index stocks.

According to Fremault (1991), under some market conditions, increased arbitrage trading may help stabilize prices. This leads us to test the hypothesis that:

H5. immediately after the inception of the ETF, the temporary volatility of index stocks decreases relative to that of non-index stocks.

While support for H5 would favor the arbitrage hypothesis, rejecting H5 would still be compatible with Fremault's (1991) arbitrage theory, as she identifies market conditions under which increased arbitrage does not necessarily stabilize prices.

Finally, if we find support for H1b and H2b, the arbitrage hypothesis can be differentiated from the recognition theory by comparing large and small components of the index. Fremault's (1991) arbitrage theory does not predict different effects for small and large index components, while the recognition effect should affect the smallest constituents most. Equally, evidence for the recognition hypothesis would come from support for H6:

H6. When support for H1b and H2b is present, the increase in liquidity is greatest for the smallest components of the index.

4. The impact of the introduction of an ETF on the liquidity of underlying stocks

In order to test the competing hypotheses related to the introduction of a basket security, we examined the variation in several liquidity measures for CAC 40 stocks and for a control sample on two 3-month intervals surrounding the date (January 22, 2001) of the inception of the ETF. The pre-introduction observation period is defined as the 60 trading days between

October 19, 2000 and January 15, 2001, while the post-introduction period covers the 60 trading days from February 1, 2001 to April 27, 2001. These two observation periods do not include the two weeks immediately surrounding the inception of the Lyxor CAC 40 so as to avoid temporary liquidity effects. After excluding securities added to and deleted from the CAC 40 index during the observation period, and a stock for which a major corporate event occurred (merger), we were left with a sample of 37 stocks. The control sample was formed by selecting the most traded non-CAC 40 stocks in the SBF 120 index and imposing a minimum average trading frequency of 100 trades per day. This procedure results in a control sample of 58 stocks. Since 1994, Euronext Paris has benefited from the existence of an upstairs market. While all CAC 40 securities are eligible for block trading, not all control stocks are. The elimination of non-eligible stocks leaves us with a control sample of 48 stocks for tests requiring upstairs-market data.

After describing the data, we test the hypotheses derived in Section 3 by conducting univariate and multivariate analyses of liquidity and price stability measures for both the CAC 40 sample and the control sample in the pre-ETF and post-ETF periods.

4.1. Data

The high frequency trade and quote data used in this section were extracted from the Euronext BDM (base de données de marché) market database. Trade files provided the date, time, price, and volume of each trade executed during the opening auction, the continuous session, and the closing auction. The quote data cover best bid and ask limit prices with associated displayed quantities as posted during the trading session. Hidden quantities are not provided.

Quote and trade timestamps are based on a second-by-second frequency. In the best-quote files, a new record appears each time any feature of the best limits, either a price or a

quantity, changes. In the trade database, if one buy (sell) marketable order executes against n sell (buy) orders with the same limit price, then n trades with the same timestamp and price will be recorded. In addition, each time an order is executed against a pending limit order, it modifies the best bid and ask quotes, so that a new best quote record is automatically produced with the same timestamp as the trade from which it results. If a trade is executed against several orders, there will be several successive quotes produced by the trade and they will be recorded in chronological order in the quote file.

We aggregated trade records with the same timestamp and price into a single trade record. When several quote records had the same timestamp, we kept the last one recorded in the best quote file. When ordering trades and best quotes, if a trade and a quote had the same timestamp, the quote was considered as following the trade. Trades were then signed according to their price relative to the prevailing mid-quote at the time of the trade. Like Lee and Ready (1991), we considered trades whose prices were higher than the mid-quote to be buyer-initiated and those whose prices were lower than the mid-quote to be seller-initiated.

Euronext defines a normal block size (NBS) to stocks that are eligible for block trading. The NBS is the minimum share quantity to which the block trading procedure applies. Euronext continuously reports the bid-ask spread that would result from buying and selling the NBS against orders in the order book. This spread, designated hereafter as the block spread, is obtained by weighting the different bid and ask limit prices hit to execute the NBS with associated quantities.

4.2. Univariate analysis

The univariate analysis consists in testing the difference between the pre-ETF and the post-ETF observation periods in the cross-sectional means of several variables. We performed statistical tests in two ways: first, the cross-sectional means of each variable were compared

for the CAC40 sample and for the control sample in the pre- and post-ETF periods, using a paired t -test. Second, we used a difference-in-differences approach to compare cross-sectional percentage variations from the pre-ETF to the post-ETF period across samples.

In order to test hypotheses H1a, H1b, H2a, and H2b, we started by considering measures related to trading volumes, trading frequency, spreads, and depth. The average daily trading volume in euros, the total trading volume in number of shares, the average daily number of trades, and the average trade size were measured by the volume and trading frequency. According to H1a, there should be a significant decrease in measures of volume for the CAC 40 sample, with no similar effect for the control sample. Conversely, H1b predicts a significant increase in measures of volume for the CAC 40 sample. We then compared bid-ask spread measures. The duration-weighted average quoted spread for stock i over a given sub-period is

$$DWQS_i = \frac{1}{\sum_{n=1}^{N_i} d_{i,n}} \sum_{n=1}^{N_i} d_{i,n} \frac{ask_{i,n} - bid_{i,n}}{mid_{i,n}}, \quad (2)$$

where $bid_{i,n}$, $ask_{i,n}$, and $mid_{i,n}$ are respectively the best bid, best ask, and middle prices at the time of the n^{th} quoted spread for stock i , $d_{i,n}$ is the duration of the n^{th} quoted spread for stock i , and N_i is the number of quoted spreads for stock i during a given sub-period. Specific reference to the sub-period in the notation has been omitted for the sake of brevity. The average effective spread is defined as

$$ES_i = \frac{1}{T_i} \sum_{s=1}^{T_i} 2 \times \frac{P_{i,s} - mid_{i,s}}{mid_{i,s}} \times I_{i,s}, \quad (3)$$

where $P_{i,s}$, $mid_{i,s}$ and $I_{i,s}$ are respectively the s^{th} transaction price for stock i , the middle price prevailing before the s^{th} transaction and the sign of the trade (+1 if the trade is buyer-initiated

and -1 if the trade is seller-initiated), and T_i is the number of trades for stock i during the sub-period.

For stocks eligible for the block trading procedure, we compute the duration-weighted average of their adjusted block spreads (ABS) as:

$$ABS_i = \frac{1}{\sum_{m=1}^{M_i} \delta_{i,m}} \times \sum_{m=1}^{M_i} \frac{\delta_{i,m}}{2 \times NBS_{i,m}} BS_{i,m} , \quad (4)$$

where $BS_{i,m}$, $\delta_{i,m}$ and $NBS_{i,m}$ are respectively the m^{th} block spread (as a percentage of the mid-price) for stock i , the duration of the m^{th} block spread, and the normal block size defined by Euronext, prevailing at the time of the m^{th} block spread, and M_i is the number of block spreads reported for stock i during the sub-period. We chose to normalize the block spread by the normal block size prevailing on the day under consideration because normal block sizes change for several stocks during the sample period. Those changes mechanically impact the size of the block spread and are likely to bias variation tests. We then multiplied this quantity by a scaling factor of 100,000 for convenience of presentation.

We also examined the market depth, as measured by the euro volumes associated with the best limits, as

$$D_i = \frac{1}{\sum_{n=1}^{N_i} d_{i,n}} \sum_{n=1}^{N_i} d_{i,n} (Qbid_{i,n} \times bid_{i,n} + Qask_{i,n} \times ask_{i,n}) \quad (5)$$

where $Qbid_{i,n}$ is the number of shares demanded at the best bid price and $Qask_{i,n}$ is the number of shares offered at the best ask price at the time of the n^{th} quoted spread for stock i . Finding a significant increase in spread measures and a significant decrease in depth measures for the CAC40 stocks, in comparison with the control stocks, would be in favor of H2a, while the opposite would support H2b.

Tests of H3 are based on information asymmetry measures. Following Aktas, de Bodt, Declerck, and Van Oppens (2007), we used the relative order imbalance (OIB) as a proxy for the probability of information-based trading (PIN) introduced by Easley, Kiefer, O'Hara, and Paperman (1996). The average order imbalance for stock i during a given period was calculated as a percentage of the euro traded volume:

$$OIB_i = \frac{\sum_{s=1}^{T_i} P_{i,s} Q_{i,s} I_{i,s}}{\sum_{s=1}^{T_i} P_{i,s} Q_{i,s}}, \quad (6)$$

where $Q_{i,s}$ is the unsigned quantity of the s^{th} transaction for stock i . This measure is complemented by spread decomposition methods to distinguish the non-informational (inventory and order processing) and the informational component of the spread. We used two alternative methods: (1) the decomposition of the effective spread into a realized spread and a permanent price impact within a given time interval (see Bessembinder and Kaufman 1997); and (2) the approach of Lin, Sanger and Booth (1995) (hereafter, LSB).¹⁶ An increase in the permanent price impact and the LSB adverse selection component for the CAC 40 stocks, in comparison with the control stocks, would support H3.

Using the notations introduced above, the proportion of asymmetric information was measured by the average price impact at an x -minute interval, calculated for stock i :

$$PI_{x \text{ min}, i} = \frac{1}{T_i} \sum_{s=1}^{T_i} 2 \times \frac{mid_{i,s+x \text{ min}} - mid_{i,s}}{mid_{i,s}} \times I_{i,s}, \quad (7)$$

¹⁶ Huang and Stoll's (1997) two- and three-factor spread decomposition models were also tested, but we experienced convergence problems for some stocks. Thus an average coefficient across stocks could not be computed.

As there is no unanimous choice of the benchmark price to be used after a transaction, we measured the price impact at three time horizons: 5, 15 and 30 minutes. The corresponding non-informational cost was measured by the realized spread at an x -minute interval, defined for stock i as:

$$RS_{x \min, i} = \frac{1}{T_i} \sum_{s=1}^{T_i} 2 \times \frac{P_{i,s} - mid_{i,s+x \min}}{mid_{i,s}} \times I_{i,s}. \quad (8)$$

The LSB adverse selection component was estimated as the sensitivity, λ , of mid-price revisions to trade directions, using the following regression model for each stock i :

$$mid_{i,s+1} - mid_{i,s} = \lambda_i (P_{i,s} - mid_{i,s}) + e_{i,s+1}. \quad (9)$$

We used the same estimation procedure as in Lin, Sanger and Booth's (1995) original paper (i.e. we ran Regression (9) using the log prices); $mid_{i,s+1}$ is the mid-price valid at the $(s+1)^{th}$ transaction. Adverse selection costs were then estimated as a part of the spread by multiplying λ_i by the average effective spread of stock i , ES_i , as defined in Equation (3). The extent of order persistence θ was captured through the following regression run for each stock:

$$P_{i,s+1} - mid_{i,s+1} = \theta_i (P_{i,s} - mid_{i,s}) + \eta_{i,s+1}, \quad (10)$$

where the disturbance terms e and η are uncorrelated. The expected profit as a fraction of the effective spread when submitting an order is $\gamma_i = 1 - \lambda_i - \theta_i$. The non-informational part of the spread is then obtained by multiplying γ_i by the average effective spread ES_i .

The results reported in Table 2 indicate an improvement in liquidity at the best-limit level, with a significant reduction in duration-weighted quoted spreads and effective spreads, and no significant variation in the best-limit depth for the CAC 40 stock sample. The reductions in the control sample were about the same size, but not significant. The reduction in spreads for the CAC 40 stocks cannot be attributed to an increase in the daily euro trading

volume or in the daily number of trades. Only the number of traded shares increased significantly for the basket of stocks after the ETF inception. There was an opposite liquidity effect at the upper limit, for both the CAC 40 and the control samples: adjusted block spreads widened significantly in the post-ETF period, meaning that the immediacy costs of trading large quantities increased for all stocks. The post-ETF increase in the mean adjusted block spread as a percentage of the mid price was larger for the control stocks. However, the difference-in-differences test shows that this increase, when measured as a percentage of the block spread prevailing during the pre-ETF period, was significantly higher for the CAC 40 stocks.

[Insert Table 2 about here]

Comparative results for the relative order imbalance and the spread components are presented in Table 3. The relative order imbalance and the two methods of spread decomposition give convergent results: adverse selection costs did not vary significantly before and after the inception of the ETF, showing that information asymmetry in individual stocks did not increase when the basket security was introduced. By contrast, the realized spread at various time intervals and the order processing cost significantly diminished during the second sub-period, for both the CAC 40 and the control sample stocks. However, according to the difference-in-differences test, the decrease was significantly more pronounced for the CAC 40 basket of stocks.

[Insert Table 3 about here]

To test H5, we compared the variance ratios of the returns from the CAC 40 and control stocks in the pre- and post ETF periods (see Table 4). We considered three variance ratios: the variance of 1-minute returns divided by that of 5-minute returns; the variance of 1-minute returns divided by that of 30-minute returns; and the variance of 5-minute returns divided by that of 30-minute returns. 1-minute, 5-minute and 30-minute returns were computed between

9.15 a.m. and 5.15 p.m. The temporary price volatility of index stocks decreased significantly after the introduction of the ETF when measured over very short horizons (1-minute/5-minute variance ratio), but did not change when measured by ratios using longer-horizon return volatilities. This does not give much economic support to the hypothesis that the introduction of the ETF has a price stabilization effect.

[Insert Table 4 about here]

4.3. Multivariate analysis

The univariate tests conducted on spreads, depth, price impact, and variance ratios were complemented by multiple panel regressions that controlled for volatility, trading volume, price level, and order imbalance. We considered nine dependent variables: (1) the duration-weighted average of the relative quoted spread; (2) the average of the relative effective spread; (3) the average duration-weighted adjusted block spread; (4) the time-weighted mean of the quantities available at the best-limit quotes, measured in euros and taken in logarithms, referred to as the best-limit depth; (5) the average realized spread over a 5-minute time interval; (6) the average 5-minute price impact; (7) the 1-minute/5-minute variance ratio; (8) the 1-minute/30-minute variance ratio; and (9) the 5-minute/30-minute variance ratio. We computed these variables on a daily basis for the 37 CAC 40 stocks and the 58 stocks in the control sample. We thus have 95 cross-sections with 120 daily observations per cross-section. For regressions of the adjusted block spreads, the number of cross-sections was reduced to 85 due to the non-availability of this variable for 10 of the control stocks.

All panel regressions are run with two-way fixed effects and a one-lag autocorrelation term in the residuals following Parks' (1967) method, except those of variance ratios for which a two-random-effects methodology with no auto-correlation is more appropriate. For

each dependent variable, denoted DV_{it} on day t for stock i , the regression model is initially designed as follows:

$$DV_{i,t} = a + b\sigma_{i,t} + c\ln V_{i,t} + d\ln P_{i,t} + eOIB_{i,t} + fETF_t + gETF_t \times CAC40_i + hETF_t \times w_i + a_i + a_t + u_{i,t}. \quad (11)$$

In Equation (11): $\sigma_{i,t}$ denotes the price range calculated as the difference between the highest and lowest price, divided by the lowest price during day t for stock i ; $\ln V_{i,t}$ is the logarithm of the euro volume traded on stock i at date t ; $\ln P_{i,t}$ is the logarithm of stock i 's open price on day t ; $OIB_{i,t}$ is the absolute value of the difference between sell trade volumes and buy trade volumes as a proportion of the total trade volume for stock i on day t ; ETF_t is a dummy variable that is set to 0 on dates preceding the introduction of the ETF and 1 on later dates; $CAC40_i$ is a binary variable that is set to 1 if stock i belongs to the CAC 40 index, and 0 otherwise; w_i is the weight of stock i in the CAC 40 index at the ETF inception date when i is a CAC 40 stock, 0 otherwise; a_i and a_t are fixed cross-section and time series effects;¹⁷ $u_{i,t} = \rho_i u_{i,t-1} + \varepsilon_{i,t}$ is an auto-correlated residual term¹⁸ in which the ρ_i coefficient is fixed per cross-section and $E(\varepsilon_{i,t}) = E(\varepsilon_{i,t}\varepsilon_{i,t-1}) = 0$.

Regression model (11) is then refined by combining each control variable with the ETF_t binary variable and the $ETF_t \times CAC40_i$ dummy product in the following way:

$$\begin{aligned} DV_{i,t} = & a + b_1\sigma_{i,t} + b_2\sigma_{i,t} \times ETF_t + b_3\sigma_{i,t} \times ETF_t \times CAC40_i \\ & + c_1\ln V_{i,t} + c_2\ln V_{i,t} \times ETF_t + c_3\ln V_{i,t} \times ETF_t \times CAC40_i \\ & + d_1\ln P_{i,t} + d_2\ln P_{i,t} \times ETF_t + d_3\ln P_{i,t} \times ETF_t \times CAC40_i \\ & + e_1OIB_{i,t} + e_2OIB_{i,t} \times ETF_t + e_3OIB_{i,t} \times ETF_t \times CAC40_i \\ & + fETF_t + gETF_t \times CAC40_i + hETF_t \times w_i + a_i + a_t + v_{i,t}. \end{aligned} \quad (12)$$

¹⁷ They are replaced by random effects in the regressions of variance ratios.

¹⁸ This term is reduced to a white noise with no auto-correlation in the regressions of variance ratios.

Coefficients b_2 , c_2 , d_2 , and e_2 test for a potential change in the control variable coefficients in the post-ETF period for all stocks, while b_3 , c_3 , d_3 , and e_3 test whether index stocks underwent a specific change in these sensitivity coefficients in comparison with control stocks.

According to H2a, the g coefficients as well as the total value of $g + hw_i$ should be significantly positive when DV_{it} is a spread measure and significantly negative when DV_{it} is the best-limit depth, whereas H2b predicts the opposite. Finding a significantly positive value for g and a positive value for $g + hw_i$ in the regressions of the price impact would support of H3. Finding that these positive values are, in addition, associated with a significantly negative value of h would provide evidence for H4. Regressions of variance ratios test H5: a significantly negative g in these regressions would indicate a price stabilization effect of the ETF introduction for underlying stocks and would support H5. Finally, the value of h coefficients in spread and depth regressions provides a statistical test for H6, which relates to the recognition hypothesis and predicts that the liquidity of small components of the CAC 40 index should improve more than that of large components. The non-rejection of H6 would rely on both a statistically negative value of g plus a statistically positive value of h in regressions of spreads, and a statistically positive value of g plus a statistically negative value of h in regressions of depth.

The results of Regressions (11) and (12) are displayed in Table 5. The estimates of g in the basic panel regressions (Equation 11) indicate that the quoted, effective, realized, and adjusted block spreads of CAC 40 stocks decreased, with a high level of economic and statistical significance, in the post-ETF period in comparison with the control sample. The h coefficients are significantly positive at the 1% level for the four measures of spread: spreads reduced more for low-weighted index components, although the economic magnitude of this differential effect is relatively small. The total economic impact of the introduction of the ETF on the spreads of a given stock i is represented by $g + hw_i$, with w_i ranging from 0.0356%

to 9.4201%. For the quoted spreads, the estimated values of g and h are -0.0954 and 0.0084 respectively, which means that the decrease in quoted spread for the smallest CAC 40 component was -0.0954 ($-0.0954 + 0.0084 \times 0.0356\%$ as a percentage of the mid-quote) while it was -0.0946 for the largest component.

Similar calculations for other spread measures indicate that the post-ETF decrease in spread for index stocks ranged from -0.0924% to -0.0912% for effective spreads, from -0.0500% to -0.0489% for realized spreads, and from -0.2237% to -0.2228% for the adjusted block spread. Further, according to the estimates of g and h in the regression of depth, all CAC 40 stocks had a deeper market immediately after the inception of the ETF, but in contrast to spreads, this depth improvement was greater for larger components.

[Insert Table 5 about here]

When coefficient changes across periods are taken into account (Equation 12), the tightening of index stock spreads is again evident, and has even greater economic significance. However the increase in depth is not robust to the modification of the model. Looking at the coefficients of the control variables combined with period and sub-sample dummies in the depth regression, we can see that volatility underwent the greatest pre/post-ETF coefficient variation: the sensitivity of depth to volatility in absolute terms is estimated at $|\hat{b}_1| = 3.6109$ for all stocks in the pre-ETF period. It then falls significantly to $|\hat{b}_1 + \hat{b}_2 + \hat{b}_3| = 2.4241$ for index constituents in the post-ETF period. The significant increase in depth found for CAC 40 stocks in the regression with constant coefficients is thus attributable to the fact that depth is less sensitive to volatility in the post-ETF period: in other words, for the same level of volatility, the market for underlying stocks is deeper in the post-ETF period.

After accounting for this change in sensitivity, index stock depth decreased on average following the introduction of the ETF. Another difference between the two regression models

is the sign of h , which is significantly negative in the regressions of spreads designed according to Equation (12): the spread reductions that were related to the introduction of the ETF but unrelated to changes in the sensitivity to control variables were more pronounced for larger components of the index.

Regressions of the price impact produced significantly negative values of g and negative values of $g + hw_i$ for all components of the CAC 40. This leads us to reject H3 and makes H4 irrelevant. As for variance ratios, the explanatory power of the control variables is weak: in the extended regressions (Equation 12), the coefficients of the control variables combined with the ETF and CAC 40 dummies, do not significantly differ from zero. For that reason, we will restrict ourselves to considering Equation (11), where we found results strictly consistent with those of the univariate tests: g is significantly negative for the 1-minute/5-minute variance ratio but is not significantly different from zero for other variance ratios. This leaves us with very weak evidence for H5. The figures are not reported in Table 5, for the sake of brevity.

4.4. Robustness checks

One stock of the CAC 40 sub-sample and three stocks of the control sub-sample were subject to corporate actions during the observation period. Those events may have permanently affected the liquidity of the corresponding stocks, even though we applied the appropriate adjustment coefficients in the calculation of liquidity measures. In order to check that none of our findings were driven by the impact of these corporate actions, we recalculated all the univariate and multivariate analyses, excluding the four stocks subject to corporate actions. The conclusions remained unchanged.

In addition, we replicated the panel regressions of 5-minute realized spread and price impact for time intervals of 15 minutes and 30 minutes. The findings are very similar to those obtained at the 5-minute horizon.

5. Interpreting the findings and discussing the theoretical hypotheses

Difference-in-differences tests on measures of trading volumes produced insignificant results except for the total trading volume, which significantly increased for index stocks at the 10% threshold. This allows us to reject H1a and leaves us with very weak evidence in support of H1b. However with respect to spreads, the difference-in-differences approach and the multivariate analysis converged to show a very significant tightening of quoted and effective for CAC 40 stocks in the post-ETF period. Adjusted block spreads of index stocks were also found to decrease significantly relative to those of non-index stocks in the panel regressions, although this was not supported by the univariate tests. Only the multivariate approach identified an improvement in depth, and this was shown to be fully explained by a decline in the sensitivity of the depth to price volatility after the introduction of the ETF. Taken together, these findings provide unambiguous support for H2b and rejection of H2a. The rejection of H1a and H2a combined with the rejection of H3 and H4 resulting from all the tests conducted on adverse selection measures clearly rules out the adverse selection hypothesis (which predicts a deterioration of index-stock liquidity following the introduction of an index security). We found a very significant improvement in liquidity, that occurred more through the tightening of spreads (strong evidence supporting H2b) than through increased trading volumes (weak evidence supporting H1b), and both the arbitrage and the recognition hypotheses can explain this liquidity effect.

The tests of H5 based on variance ratios and those of H6 based on the differential effects for low- and heavy-weight index components were designed to discriminate between

the arbitrage and the recognition hypotheses. There is very little evidence of index-stock price stabilization following the introduction of the ETF. The analysis of variance ratios provides weak support for H5: short-term price volatility measured by the 1-minute/5-minute variance ratio significantly decreased for index stocks relative to control stocks but did not change significantly when measured with other ratios. However, as discussed in Section 3, weak evidence for or the rejection of H5 does not rule out the Fremault's (1991) arbitrage theory.

Differential effects for low- and heavy-weight index components (as predicted by the recognition theory) were captured through the estimates of coefficients h in the panel regressions of Table 5. They show that no conclusions can be drawn as the h estimates are not robust to the sophistication of the regression model. For that reason, we build another test of H6 based on the relation between liquidity variations around the ETF introduction date for a given stock i of the index and its weight in the index w_i at the time of the inception of the ETF, and we ran the following cross-sectional OLS regression on the CAC 40 stock sample:

$$\Delta DV_i = \alpha_0 + \alpha_1 \Delta \sigma_i + \alpha_2 \Delta X_i + \alpha_3 w_i + \varepsilon_i. \quad (13)$$

ΔDV_i is the pre-/post-ETF relative variation in a given liquidity measure for stock i . Measures of liquidity are the average quoted spread, the average effective spread, the 5-minute realized spread, the best-limit depth, and the adjusted block spread. The pre-/post-ETF relative variations in the average price range ($\Delta \sigma_i$) and the trading volume in number of shares (ΔX_i) are taken as control variables. ΔX_i was also regressed on w_i , but the control variables were omitted in that case. Table 6 shows the results. The α_3 coefficient does not significantly differ from zero in any of the regressions. This finding, together with the inconclusive results of the panel regressions for coefficients h , leads us to conclude that the spread decrease which

occurred for CAC 40 stocks after the inception of the Lyxor CAC 40 ETF cannot be explained by a recognition effect.

[Insert Table 6 about here]

In contrast, the strong evidence of spread reduction for ETF underlying stocks is fairly consistent with the risk sharing benefits of cross-market arbitrage modeled by Fremault (1991). This interpretation is reinforced by the fact that the order processing and order imbalance cost component of index-stock spreads decreased much more than their adverse selection costs. First, the findings of the difference-in-differences tests displayed in Table 3 indicate that the Lin, Sanger and Booth (1995) (LSB) adverse selection cost and the average price impacts do not significantly decrease for index stocks relative to non-index stocks, while the LSB order processing cost and realized spreads tighten significantly at the 1% threshold. Second, comparing the estimates of the single-regime regressions of effective spreads, realized spreads, and price impacts (cf. Table 5) indicates that the post-ETF decrease in the effective spread of index stocks is much more attributable to the ETF-related reduction in the realized spread, than to the 5-minute price impacts. Let us consider a theoretical index stock with a weight in the index of $1/40$. The post-ETF decrease in its effective spread is estimated to be -0.0921 ($-0.0924 + 0.0129/40$) as a percentage of the mid-quote. The major part of this decrease is due to the decrease in its realized spread, which is estimated to be -0.0497 , while only -0.0146 can be attributed to the decrease of its price impact. The rest is explained by other factors, in particular the changes in the control variable coefficient in the post-ETF period. This phenomenon is even more striking when the estimates of extended regressions are considered.

In addition, the extended regressions of spreads show that the CAC 40 stock spreads are less sensitive to price volatility and order imbalance in the post-ETF period – the only exception being the sensitivity of adjusted block spreads to order imbalance. In summary: (1)

spreads are less sensitive to factors creating inventory costs (price volatility and order imbalances); (2) the order processing and order imbalance costs of index stocks reduce more than their adverse selection costs. We therefore conclude that the opening of the ETF market contributes to improving the liquidity of underlying securities by means of positive risk sharing effects because it plays the role of a new liquidity pool which helps reduce order imbalances incurred by index traders.

6. Conclusion

Using detailed data from the French stock market, we tested the impact of the introduction of the first ETF replicating the CAC 40 index on the liquidity of the underlying securities. By analyzing ETF and index stocks order book data over one month, we showed that trading the ETF is less costly than trading the index in the market for index components, and that ETF LPs are substantially responsible for this relative advantage. More importantly, using high-frequency data for a sample of index stocks and for a control sample of stocks over the six months surrounding the date on which the ETF was introduced, we examined the change in the liquidity of the underlying stocks through a difference-in-differences approach and a multivariate panel approach. We explored the theories that could possibly explain this change.

Consistent with the findings of Hegde and McDermott (2004) and Richie and Madura (2007), and unlike those of Van Ness, Van Ness, and Warr (2005), we found that index-stock spreads tighten more than non-index stocks after the introduction of the ETF. Nevertheless, our conclusions are not the same as Hegde and McDermott's (2004) in that we did not find that adverse selection was the main factor explaining the liquidity improvement. Our conclusions also differ from Richie and Madura's (2007) in that we failed to show that Merton's recognition theory could generate the liquidity gains. On the contrary, we

established that the index-stock spread reduction is essentially driven by a decrease in the temporary price impact of trades or, in other words, is due to a decrease in the order processing and order imbalance cost component of spreads. Although we did not find strong evidence of price stabilization, we consider that our empirical findings are consistent with the arbitrage theory of Fremault (1991) according to which increased arbitrage trading between individual stock markets and index security markets adds risk bearing capacity to markets and provides buying and selling support to order imbalances.

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Table 1

Comparing the cost of trading the CAC 40 index in the stock market and the Lyxor CAC 40 market

	Basket of index stocks	With LPs	Without LPs
Relative quoted spread	---	0.13%	0.62%
Depth at the best limit	---	45,763	9,540
Depth at the five best limits	---	225,059	23,800
CRT for 5,000 shares in %	0.21%	0.15%	0.56%
CRT for 50,000 shares in %	0.27%	0.21%	0.80%

Note: This table shows the duration-weighted averages of the relative quoted spread and the quoted depth in the number of shares for the Lyxor CAC 40 security, and it compares the cost of a round-trip trade (CRT) in the ETF market with that of a trade of the same size in the underlying stocks market. Depth is measured at the best-limit level and at the five-best-limit level, and refers to the total of displayed and hidden quantities. CRTs are computed for the equivalent of 5,000 and 50,000 shares on the Lyxor CAC 40. The spreads, depth, and CRTs of the ETF were computed using all the orders waiting in the limit order book, both including (With LPs) and excluding (Without LPs) those placed by LPs. The statistics are based on the detailed order book data recorded during October 2002.

Table 2

A comparison of liquidity measures before and after the introduction of an ETF

	CAC 40 sample			Control sample			Difference in differences		
	Mean variation	<i>t</i> -statistic	<i>p</i> -value	Mean variation	<i>t</i> -statistic	<i>p</i> -value	Mean variation	<i>t</i> -statistic	<i>p</i> -value
Daily trading volume (in thousands of euros)	4,368	1.19	0.2403	484	0.84	0.4041	0.1124	1.18	0.2406
Total trading volume (in thousands of shares)	17,907***	2.73	0.0096	1,858*	1.84	0.0706	0.1608*	1.93	0.0580
Daily number of trades	55.49	0.80	0.4312	−24.24	−1.26	0.2141	0.0718	1.54	0.1260
Average trade size (in euros)	3,023	1.63	0.1115	2,021**	2.14	0.0370	0.0136	0.22	0.8250
Duration-weighted quoted spreads (as % of mid-price)	−0.0222***	−4.83	<0.0001	−0.0203	−1.15	0.2554	−0.0797**	−2.62	0.0102
Average effective spread (as % of mid-price)	−0.0255***	−5.52	<0.0001	−0.0289	−1.62	0.1106	−0.0759**	−2.54	0.0126
Duration-weighted depth at best limits (in euros)	5,382*	1.81	0.0779	3,814	1.53	0.1309	0.0513	0.89	0.3776
Duration-weighted adjusted block spreads (as % of mid-price)	0.0687***	6.87	<0.0001	0.2760***	6.96	<0.0001	0.1970**	2.54	0.0129

Note: For each liquidity variable, the mean variation for the CAC 40 and the control samples equals the equally-weighted cross-sectional mean difference between the two 60-trading-day periods surrounding the ETF inception on January 22, 2001. The statistical test is a paired *t*-test on the mean difference. For the difference-in-differences approach, the test is an independent group *t*-test on the cross-sectional mean difference between CAC 40 and control stocks, based on the percentage change between the two 60-day periods. The sizes of the CAC 40 and control samples are 37 and 58 respectively, with the exception that the block spreads were only available for 48 stocks in the control sample. One, two and three asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3

A comparison of order imbalance and spread components before and after the introduction of the ETF

	CAC 40 sample			Control sample			Difference in differences		
	Mean variation	<i>t</i> -statistic	<i>p</i> -value	Mean variation	<i>t</i> -statistic	<i>p</i> -value	Mean variation	<i>t</i> -statistic	<i>p</i> -value
Average order imbalance	−1.6821	−1.79	0.0824	0.7916	0.56	0.5749	−0.4918	−0.42	0.6752
5-min price impact	−0.0010	−0.31	0.7612	0.0001	0.01	0.9898	0.0053	0.13	0.8936
5-min realized spread	−0.0267***	−8.28	<0.0001	−0.0300***	−2.53	0.0140	−0.1989***	−4.82	<0.0001
15-min price impact	−0.0007	−0.21	0.8366	0.0012	0.13	0.9002	0.0106	0.25	0.8028
15-min realized spread	−0.0270***	−7.13	<0.0001	−0.0311***	−2.72	0.0086	−0.1921***	−4.12	<0.0001
30-min price impact	0.0006	0.15	0.8852	0.0087	0.79	0.4327	−0.0043	−0.08	0.9352
30-min realized spread	−0.0283***	−6.15	<0.0001	−0.0386***	−3.36	0.0014	−0.1977***	−3.61	0.0005
LSB adverse selection cost	0.0049	0.78	0.4407	0.0099**	2.55	0.0135	−0.0839	−1.11	0.2682
LSB order processing cost	−0.0144***	−5.22	<0.0001	−0.0126	−1.64	0.1066	−0.1603***	−2.94	0.0036

Note: For the order imbalance and spread component measures, the mean variation for the CAC 40 and the control samples equals the equally-weighted cross-sectional mean difference between the two 60-trading-day periods surrounding the ETF inception on January 22, 2001. Spread measures are expressed in percentage of the mid-price and the order imbalance is in percentage of total trading volumes. The statistical test is a paired *t*-test on the mean difference. An independent group *t*-test on the cross-sectional mean difference between CAC 40 and control stocks, based on the percentage change between the two 60-day periods, is used for the difference-in-differences test. The sizes of the CAC 40 and control samples are 37 and 58 respectively. One, two and three asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4

A comparison of the variance ratios of the returns before and after the introduction of the ETF

	CAC 40 sample			Control sample			Difference in differences		
	Mean variation	<i>t</i> -statistic	<i>p</i> -value	Mean variation	<i>t</i> -statistic	<i>p</i> -value	Mean variation	<i>t</i> -statistic	<i>p</i> -value
1-minute to 5-minute variance ratios	−0.0090**	−2.76	0.0089	0.0035	1.04	0.3023	−0.0516**	−2.59	0.0113
1-minute to 30-minute variance ratios	−0.0020*	−2.05	0.0471	−0.0002	−0.16	0.8713	−0.0503	−1.47	0.1459
5-minute to 30-minute variance ratios	−0.0015	−0.61	0.5468	−0.0037	−1.09	0.2813	0.0028	0.12	0.9003

Note: For all the variance ratios reported in this table, the mean variation for the CAC 40 and the control samples equals the equally-weighted cross-sectional mean difference between the two 60-trading-day periods surrounding the ETF inception on January 22, 2001. The statistical test is a paired *t*-test on the mean difference. An independent group *t*-test on the cross-sectional mean difference between CAC 40 and control stocks, based on the percentage change between the two 60-day periods, was used for the difference-in-differences test. The sizes of the CAC 40 and the control samples were 37 and 58 respectively. One, two and three asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5

Panel regressions of liquidity measures

	Quoted spread	Quoted spread	Effective spread	Effective spread	Adjusted block spread	Adjusted block spread	5-min. realized spread	5-min. realized spread	5-min. price impact	5-min. price impact	Best-limit depth	Best-limit depth
Intercept	1.0882*** (129.79)	1.1434*** (117.13)	1.1532*** (124.58)	1.1950*** (116.59)	0.5999*** (57.36)	0.6642*** (66.92)	0.8497*** (109.71)	0.8800*** (90.44)	0.3544*** (84.92)	0.3761*** (87.21)	6.2521*** (307.96)	6.0263*** (225.69)
σ_{it}	2.8656*** (140.49)	2.6400*** (101.42)	4.1750*** (170.68)	4.0307*** (129.32)	2.8772*** (75.50)	2.7878*** (61.50)	0.0039 (0.21)	0.0464* (1.93)	4.4341*** (226.59)	4.2037*** (148.62)	-3.5551*** (-57.70)	-3.6109*** (-41.01)
$\sigma_{it} \times ETF_t$		1.3015*** (22.99)		1.3730*** (21.43)		1.7659*** (17.86)		0.1062** (1.98)		1.3140*** (24.95)		-0.1092 (-0.69)
$\sigma_{it} \times ETF_t \times CAC40_i$		-2.9065*** (-51.74)		-3.9477*** (-61.18)		-3.9520*** (-40.26)		-0.7944*** (-14.28)		-3.1747*** (-57.40)		1.2960*** (7.08)
$\ln V_{it}$	-0.0766*** (-125.27)	-0.0815*** (-106.45)	-0.0840*** (-130.77)	-0.0889*** (-114.73)	-0.1656*** (-115.38)	-0.1493*** (-83.53)	-0.0492*** (-93.65)	-0.0513*** (-75.37)	-0.0435*** (-101.70)	-0.0456*** (-97.67)	0.3134*** (217.00)	0.3253*** (175.92)
$\ln V_{it} \times ETF_t$		0.0029* (1.82)		0.0050*** (3.07)		-0.0904*** (-27.07)		-0.0017 (-1.37)		0.0032*** (3.07)		-0.0434*** (-11.13)
$\ln V_{it} \times ETF_t \times CAC40_i$		0.0486*** (28.71)		0.0598*** (32.67)		0.1649*** (53.49)		0.0421*** (27.65)		0.0249*** (16.93)		0.0338*** (5.70)
$\ln P_{it}$	-0.0268*** (-21.88)	-0.0282*** (-20.93)	-0.0366*** (-24.57)	-0.0366*** (-22.64)	0.2564*** (87.77)	0.2062*** (66.73)	-0.0484*** (-41.62)	-0.0518*** (-31.59)	0.0140*** (24.50)	0.0153*** (19.05)	0.2909*** (92.12)	0.3214*** (64.85)
$\ln P_{it} \times ETF_t$		-0.0085*** (-2.95)		-0.0134*** (-4.20)		0.2203*** (27.96)		0.0019 (0.66)		-0.0001 (-0.08)		-0.0112 (-1.12)
$\ln P_{it} \times ETF_t \times CAC40_i$		0.0213***		0.0337***		-0.3227***		0.0372***		-0.0183***		0.0617***

		(6.87)		(9.73)		(−43.82)		(10.84)		(−12.30)		(4.05)
OIB_{it}	0.0006*** (32.13)	0.0007*** (27.42)	0.0008*** (33.08)	0.0009*** (30.02)	0.0008*** (21.81)	0.0011*** (24.46)	0.0006*** (33.37)	0.0007*** (27.34)	0.0002*** (11.26)	0.0003*** (10.80)	−0.0020*** (−31.77)	−0.0022*** (−24.10)
$OIB_{it} \times ETF_t$		−0.0001** (−2.49)		−0.0001 (−1.22)		−0.0005*** (−5.57)		−0.0001** (−2.29)		−0.0002*** (−3.04)		0.0009*** (6.19)
$OIB_{it} \times ETF_t \times CAC40_i$		−0.0004*** (−6.59)		−0.0007*** (−11.40)		0.0004*** (4.01)		−0.0004*** (−7.23)		−0.0002*** (−2.84)		−0.0014*** (−7.44)
ETF_t	0.0206*** (6.40)	−0.0108 (−0.63)	0.0054 (1.59)	−0.0274 (−1.49)	0.2932*** (30.36)	0.1232*** (5.16)	−0.0184*** (−6.01)	−0.0135 (−0.82)	0.0125*** (7.34)	−0.0623*** (−6.15)	−0.0117 (−1.44)	0.3607*** (7.17)
$ETF_t \times CAC40_i$	−0.0954*** (−27.69)	−0.5610*** (−29.12)	−0.0924*** (−24.75)	−0.6812*** (−29.20)	−0.2237*** (−36.48)	−0.2847*** (−10.88)	−0.0500*** (−17.72)	−0.5846*** (−30.13)	−0.0147*** (−7.24)	−0.0719*** (−4.77)	0.0426*** (4.49)	−0.4950*** (−5.94)
$ETF_t \times w_i$	0.0084*** (13.69)	−0.0081*** (−13.34)	0.0129*** (16.50)	−0.0073*** (−9.63)	0.0098*** (12.59)	−0.0110*** (−14.77)	0.0118*** (18.42)	−0.0040*** (−5.74)	0.0024*** (6.59)	−0.0045*** (−10.18)	0.0806*** (25.45)	0.0711*** (19.90)
No. of cross sections	95	95	95	95	85	85	95	95	95	95	95	95
Time series length (trading days)	120	120	120	120	120	120	120	120	120	120	120	120
R-squared	74.42%	76.25%	80.50%	82.26%	66.65%	72.86%	56.27%	57.96%	84.65%	86.97%	88.56%	88.31%

Note: This table shows the estimates of panel regressions conducted on 120 daily observations for 95 stocks using the Parks method with fixed time-series and cross-section effects. The dependent variables are the duration-weighted average bid-ask spread, the average effective spread per trade, the duration-weighted average adjusted block spreads, the average 5-minute realized spread, the average 5-minute price impact, and the duration-weighted average best-limit depth measured in euros and taken in logarithms. σ_{it} , $\ln V_{it}$, $\ln P_{it}$, and I_{it} are, respectively, the price range, the euro trading volume in logarithm, the close price in logarithm, and the imbalance between buy and sell traded volumes as a percentage of the total traded volume, for stock i on day t . ETF_t is a variable set to 0 before the introduction of the ETF and to 1 afterwards. $CAC40_i$ is set to 1 for CAC 40 stocks, 0 otherwise. w_i is the weight of stock i in the CAC 40 index at the ETF inception date and is set to 0 for non-CAC 40 stocks. t -statistics are in brackets. One, two and three asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 6

Cross-sectional regressions of liquidity variations

Dependent variable	Intercept	$\Delta\sigma_i$	ΔX_i	w_i	Adjusted R ²
ΔX_i	0.2280** (2.20)			0.2357 (0.08)	−2.84%
$\Delta DWQS_i$	−0.0796*** (−3.71)	0.3795*** (3.97)	−0.0824** (−2.50)	0.7279 (1.21)	32.24%
ΔES_i	−0.1042*** (−5.32)	0.4782*** (5.48)	−0.0743** (−2.47)	1.0751* (1.96)	46.83%
$\Delta RS_{5min,i}$	−0.3064*** (−6.59)	0.0418 (0.20)	0.0109 (0.15)	1.7197 (1.32)	−3.48% %
ΔD_i	0.0829 (1.47)	−0.0929 (−0.37)	0.3951*** (4.55)	−2.4612 (−1.56)	35.63% %
ΔABS_i	0.7488*** (9.79)	1.1977*** (3.51)	−0.3185** (−2.71)	0.5438 (0.25)	28.44%

Note: This table displays the estimates of the OLS regressions run over the 37-index-stocks sample. The relative variations of liquidity measures around the date of the introduction of the ETF are regressed on weights in the index w_i . The liquidity measures used are, in turn: the total trading volume in number of shares (X_i), the duration-weighted average quoted spread ($DWQS_i$), the average affective spread (ES_i), the average 5-minute realized spread ($RS_{5min,i}$), the duration-weighted average best-limit depth (D_i), and the duration-weighted average adjusted block spread (ABS_i). The variation of the average price range ($\Delta\sigma_i$) and the trading volume variation (ΔX_i) serve as control variables. t -statistics are in brackets. One, two and three asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.