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More ETFs for More Efficient Markets

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Outline

• ETFs and the quality of markets
  – how the introduction of ETF might impact the quality of associated markets

• Impact on the CAC40 option markets
  “Liquidity and arbitrage in options markets: A Survival Analysis Approach”

• Impact on the CAC40 futures markets
  “Direct and Indirect Effects of Index ETFs on Spot-Futures Mispricing and Illiquidity”
ETFs and the quality of associated markets

- ETFs have become the most actively traded equity securities on U.S. stock exchanges.
- ETF trading is based on an innovative dual structure:
  - shares trade on stock markets on a continuous basis (secondary market)
  - shares can be created or redeemed directly from the fund (primary market)
- ETFs are likely to alter the mix of informed trading and liquidity-motivated trading in the markets for the basket and the underlying securities.
ETFs and the quality of associated markets

• Research on passive stock index ETFs
  – does the ETF specific structure allow for more efficient index fund pricing?
  – do ETFs represent a performing alternative to conventional index mutual funds?
  – what impact does the advent of ETFs have on trading and market quality with regard to index component stocks and index derivatives?
ETFs and the efficiency of derivatives markets

- As ETFs replicate indices accurately, they may ease the establishment of arbitrage positions at lower costs and risk
- Empirical research on US ETF suggest that the arbitrage activity between stock indices, futures and options might increase with the introduction of ETFs
  - Arbitrageurs would use index-tracking securities to establish the cash leg in arbitrage portfolios when trading the stock basket is too costly or risky
- The introduction of ETFs would result in increased arbitrage activity and tightened arbitrage relationships
ETFs and index arbitrage relationships

\[ ETF_t = \alpha I_t \]

\[ F_t^T = I_t e^{r(T-t)} - D_T \]

\[ C_t = P_t + I_t - D_T - Ke^{-r(T-t)} \]

\[ C_t = P_t + (F_t^T - K)e^{-r(T-t)} \]
No arbitrage tests on derivatives markets

- Tests of arbitrage relationships are a conventional tool for testing derivatives markets’ efficiency
  - do not require the validity of a specific pricing model
  - do not rely on the estimation of underlying parameters
- Textbook view of arbitrage
  - on an efficient market, any deviation from no-arbitrage should trigger an immediate reaction
  - deviations should therefore quickly disappear
- Empirical evidence
  - deviations are evidenced even for the main derivatives contracts
  - deviations exhibit some degree of persistence that may be explained by limits to arbitrage
No arbitrage tests on derivatives markets

- Limits to arbitrage
  - transaction costs and holding costs decrease the profitability of arbitrage trades (Tuckman and Vila, 1992; Mitchell and Pulvino, 2001)
  - short sales restrictions may prevent arbitrageurs from building appropriate portfolios (Lamont and Thaler, 2003; Ofek et al., 2004)
  - there are some risks associated with arbitrage (Campbell and Kyle, 1993; DeLong et al., 1990; Abreu and Brunnermeier, 2002)
  - along with more recent studies (Roll et al., 2007) we envision liquidity as another limit to arbitrage
- The advent of ETFs may remove some of the obstacles that prevented arbitrage trades in index derivatives markets
Empirical analysis of CAC40 index derivatives contracts

• We analyze the impact of the introduction of the LYXOR CAC 40 ETF
  – on Futures markets, with C. Gresse and B. de Séverac, "Direct and Indirect Effects of Index ETFs on Spot-Futures Mispricing and Illiquidity", working paper, 2010

• The CAC40 index offers a clean natural experiment for such studies
  – derivatives contracts are highly liquid
  – there was no competition, no previous listing and no cross listing of CAC40 ETF
Our empirical approach for the options market

• Our study is based on the deviations to the put call parity relationship
  – uses an intraday measure of the persistence time of deviations (TTNA)
  – accounts for both conventional limits to arbitrage and liquidity factors
  – uses survival analysis to model the effect of limits to arbitrage and the impact of the ETF on the quality of trading in the option market
Main results (options market)

• We evidence a process of convergence to no arbitrage
  – convergence is not immediate
  – there is substantial variation in the persistence time of deviations
• A Weibull specification along with an AFT specification fits the TTNA observations
  – TTNAs exhibit a decreasing hazard rate
  – conventional limits to arbitrage explain a significant part of the variability
  – liquidity variables have high explanatory power
• The introduction of an ETF tracking the index results in considerable gains in efficiency
  – its existence is associated with shorter durations
  – its trading activity does not affect the speed of convergence to no arbitrage
Computation of TTNA

- Identification of initial deviations with respect to put call parity
  \[ \pi_{i,t} = q_i \left[ C_t - P_t - I_t + D^* + Ke^{-r(T-t)} \right] \]
- ‘Arbitrage profit’ is re-computed with the prevailing prices when any subsequent trade or index variation occurs
- Computations stop as soon as the ‘profit’ becomes either zero or negative (if ever)

Time to no arbitrage is
- the time necessary for prices to return to NA levels after a violation of PCP is identified
Data

• Our sample period
  – runs from July 2000 to August 2001
  – surrounds the inception of the CAC 40 ETF on January 21, 2001

• Our data set
  – all options transactions on the French CAC 40 index options
  – the value of the CAC 40 index disseminated every 30 seconds
  – dividends delivered by the CAC 40 constituents expressed in index points

Durations sample
  – matching call and put transactions within a one-minute interval results in 4,036 TTNA computations
The use of survival analysis

- We work with possibly right-censored duration data (10% of arbitrage opportunities do not revert to 0-profit prior to market close)
- We use an AFT specification to model the influence of explanatory variables on TTE
- Empirical modeling

\[
Y = \log(T) = \mu + \gamma'Z + \sigma U \\
Pr [T > t|Z] = S[t \exp(-\gamma'Z)] \\
\mathcal{L} = \prod_{i=1}^{n} \left[ \frac{1}{\sigma f_U \left( \frac{y_i - \mu - \gamma'Z_i}{\sigma} \right)} \right]^{\delta_i} \left[ S_U \left( \frac{y_i - \mu - \gamma'Z_i}{\sigma} \right) \right]^{(1-\delta_i)}
\]
Intuition about explanatory variables

- Conventional limits to arbitrage
  - Higher volatility (Volat) of the underlying index increases the likelihood of adverse price movements
  - Transaction costs (Costs) reduce the expected profitability of arbitrages
  - Short sale constraints (Direc) may induce additional costs
- Liquidity
  - Easiness of establishing arbitrage portfolios should foster arbitrage trades (ActivOpt, RatioOpt, Matj, Money, ActivCAC)
- ETFs
  - the existence of an ETF may facilitate and improve the construction of the index leg of the arbitrage portfolio (ETF, ActivETF)
Parameter estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intercept-only model</th>
<th>AFT specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$ (intercept)</td>
<td>6.839***</td>
<td>214.70</td>
</tr>
<tr>
<td>log $\sigma$</td>
<td>0.621***</td>
<td>51.60</td>
</tr>
<tr>
<td>ActivOpt</td>
<td>-0.008***</td>
<td>-7.05</td>
</tr>
<tr>
<td>RatioOpt</td>
<td>0.007***</td>
<td>4.55</td>
</tr>
<tr>
<td>Mat2</td>
<td>0.559***</td>
<td>5.50</td>
</tr>
<tr>
<td>Mat3</td>
<td>1.727***</td>
<td>8.13</td>
</tr>
<tr>
<td>Moneyness</td>
<td>-0.019</td>
<td>-0.79</td>
</tr>
<tr>
<td>Direc</td>
<td>0.312***</td>
<td>5.53</td>
</tr>
<tr>
<td>ActivCAC</td>
<td>-0.022***</td>
<td>-8.41</td>
</tr>
<tr>
<td>Volat</td>
<td>-0.526***</td>
<td>-6.01</td>
</tr>
<tr>
<td>ETF</td>
<td>-3.035</td>
<td>-1.51</td>
</tr>
<tr>
<td>ActivETF</td>
<td>0.095***</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Likelihood ratio test (Intercept-only vs AFT specification)

<table>
<thead>
<tr>
<th></th>
<th>Intercept-only model</th>
<th>AFT specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log-likelihood</td>
<td>-28,800.3</td>
<td>-28,240.6</td>
</tr>
<tr>
<td>$\chi^2$ (p-value)</td>
<td>1,119.5 ($&lt; 0.001$)</td>
<td></td>
</tr>
</tbody>
</table>
Incidence of the existence of the Lyxor CAC 40 ETF

- Under median market conditions
  - it takes 4:26 minutes for the market to eliminate 50% of the deviations when the ETF exists
  - against 7:31 minutes before its introduction
Direct and Indirect Effects of Index ETFs on Spot-Futures Mispricing and Illiquidity

- We test to which extent the introduction of the ETF is associated with improved efficiency for the CAC 40 Futures contract
  - pre-/post-ETF comparisons of arbitrage relationship measures
  - our results are in line with those of previous studies
- We go further in investigating whether these improvements stem from the introduction of the ETF or not
  - multivariate analysis controlling for conventional factors explaining deviations (volatility, liquidity, …)
  - our results suggest that the tightening of the index-futures price relationship is not directly attributable to the introduction of the ETF
Our empirical approach for the futures market

• Our study is based on the deviations to the cash and carry relationship
  – calculate different measures of the arbitrage profit value and persistence
  – accounts for both conventional limits to arbitrage and liquidity factors
  – uses multivariate analysis to assess the impact of the ETF on the quality of trading in the futures market
  – uses VAR analysis to test the causality links between the futures deviations, the CAC 40 stocks’ liquidity, and the ETF trading activity
Main results (futures market)

• A significant tightening of the spot index-futures price relationship is associated with the introduction of the ETF.

• After controlling for conventional limits to arbitrage and liquidity factors, we show that
  – index-futures mispricing does decrease after the introduction of the ETF
  – the ETF turnover poorly explains that improvement

• The impact of the ETF may rather be indirect, formed through the mediation of indirect liquidity effects.
Data

- 2 years of intraday transaction data from 1 Jan 2000 to 31 Dec 2001
  - CAC40 futures
  - CAC40 index and CAC40 stocks
  - Lyxor CAC 40 ETF

- Trading activity for the Lyxor CAC 40 ETF
  - small number of trades
  - very large trades

<table>
<thead>
<tr>
<th>Trading activity in the LYXOR ETF CAC 40</th>
<th>Mean</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily traded volume (in €)</td>
<td>36,750,977</td>
<td>28 upon 43</td>
</tr>
<tr>
<td>Average daily number of trades</td>
<td>233</td>
<td>last</td>
</tr>
<tr>
<td>Average trade size (in €)</td>
<td>157,818</td>
<td>first</td>
</tr>
</tbody>
</table>
Computation of arbitrage profit

- More than 4 millions futures-spot index price pairs are matched within 1 minute
- Arbitrage profit is computed as
  - ex post
    \[
    \pi_{t,T,\tau}^{\text{ex post}} = \left( I_{t,\tau} - D_{t,T} \right) e^{r_{t,T}(T-t)} - F_{t,T,\tau} - C_{t,T,\tau}
    \]
  - after a δ-minute delay
    \[
    \pi_{t,T,\tau+\delta}^{\text{ex ante}} = \frac{F_{t,T,\tau+\delta}^{*} - F_{t,T,\tau+\delta}}{I_{t,\tau+\delta}} - C_{t,T,\tau+\delta}
    \]
Univariate results

- Ex post, only the strongest deviations persist
  - deviation frequencies decrease with the introduction of ETFs
  - but deviation values increase
- Ex ante, arbitrage profits turn negative

<table>
<thead>
<tr>
<th>Lag</th>
<th>1mn Pre-ETF</th>
<th>1mn Post-ETF</th>
<th>2mn Pre-ETF</th>
<th>2mn Post-ETF</th>
<th>3mn Pre-ETF</th>
<th>3mn Post-ETF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-period</td>
<td>Percentage of completed portfolios</td>
<td>90.47</td>
<td>78.62</td>
<td>90.01</td>
<td>74.95</td>
<td>89.74</td>
</tr>
<tr>
<td></td>
<td>Percentage of positive ex ante profit</td>
<td>54.55</td>
<td>28.20</td>
<td>48.56</td>
<td>25.32</td>
<td>45.92</td>
</tr>
<tr>
<td></td>
<td>Mean ex ante profit</td>
<td>.008</td>
<td>-.173</td>
<td>-.004</td>
<td>-.188</td>
<td>-.011</td>
</tr>
</tbody>
</table>
Multivariate results

- We control for conventional limits to arbitrage and factors linked to liquidity in a multivariate setting
  - conventional factors explaining deviations are significant
  - the period binary variable is associated with a significantly smaller arbitrage profits
- The level of trading in the ETF is not significant
  - this undermines the argument according to which joint price efficiency improves because ETF securities are used in arbitrage strategies when single stocks cannot be
Causal relations between arbitrage opportunities and liquidity

- We examine the causality links between
  - the joint cash-futures price efficiency
  - the CAC 40 stocks’ liquidity
  - the ETF trading activity
- Consistent with the ETF introduction indirectly strengthening the spot-future price linkage
  - a new regime in causality between liquidity and index-futures price efficiency appears after the ETF introduction
  - index-futures mispricing does not invite arbitrage activity using ETF shares in the cash leg
Conclusions

• The introduction of an ETF improves the link between the associated cash and derivatives markets
• This impact essentially stems from the associated reduction in the liquidity risks and costs of the arbitrage portfolios
• If the speed of reversion to no arbitrage values or the size of arbitrage opportunities are considered a measure of efficiency
  – ETFs appear to be a valuable lever for increasing the degree of efficiency the market can achieve
Research perspectives

• The liquidity of ETFs
  – liquidity is key to understanding modifications in derivatives market quality
  – liquidity of ETF has specificities that are not yet tackled

• The impact of subsequent introductions of ETFs
  – most studies focus on the first introduction for a given index
  – increased competition may result in significant impact on market quality
Panel Discussion

Chairman:
Scott Stark, Director, Russell Indexes Europe

Speaker:
Laurent Deville, Affiliate Professor, Edhec Business School

Panel:
Nizam Hamid, Global Head of ETFs, Lyxor AM

Daniele Tohmé-Adet, Head of Business Development, ETF & Indexed Funds, BNP Paribas Asset Management

Sidi Kleefeld, ETF Sales, Deutsche Bank