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Impact of foreign-listed single stock futures on the domestic underlying stock markets

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The purpose of this article is to investigate whether foreign-listed single stock futures (SSFs) would have any impact on their domestic underlying stock markets. GARCH (1,1) and GJR-GARCH (1,1) are used to analyse the data from the London International Financial Future and Options Exchange (LIFFE) in this research. Results show that the introduction of the foreign listed SSF contracts seems to have more explanatory power with respect to the higher volatility of their domestic spot markets than the announcement of the SSF contracts. Also, for two of the nine securities, the daily activity shocks of the foreign-listed SSFs are responsible for the higher conditional volatility of their home underlying stocks, while the activity that is forecastable but highly variable across days diminishes the conditional volatility of the underlying stocks.

1. INTRODUCTION

Since the trading of futures and other derivatives has become more frequent in recent years, a growing number of studies have been done to examine the influence of derivatives trading on the underlying stock markets.

However, intensive debates have been conducted with respect to this issue in the financial literature. One category of the literature has the perception that derivatives trading does result in higher underlying stock market volatility (see, for example, Conrad, 1989; Harris, 1989; Damodaran, 1990; Harris *et al.*, 1994; Antoniou *et al.*, 1998). Gulen and Mayhew (2000) found that stock index futures trading was responsible for an increase in conditional volatility in the spot markets of the USA and Japan. By showing a change in the asymmetric volatility response, McKenzie *et al.* (2000) suggested that the introduction of individual share futures (ISFs) in the Sydney Futures Exchange in Australia had an impact on the underlying security market. Rahman (2001) also reported that volatility in the 30 stocks included in the DJIA could have been increased by the introduction of futures and futures options on the DJIA.

Another category of the literature argues that the introduction of derivatives lowers (or has no significant

effect on) the volatility of the underlying stock markets (see, for instance, Ma and Rao, 1988; Edward, 1988; Choi and Subrahmanyam, 1994).

Many studies have been done on the effect of derivatives trading on the underlying spot markets. Some of them focused on the impact of stock index futures trading on the underlying asset markets (Gulen and Mayhew, 2000; Rahman, 2001). However, many macroeconomic factors other than the introduction of stock index futures may have affected the market indices. Investigating only changes in the market index volatility with the introduction of futures may be inadequate to conclude that the introduction of stock index futures influences the spot markets. With the goal to avoid this potential inference problem in mind, it may be more appropriate to use the data of single stock future (SSF) contracts to examine this controversial issue. As SSF contracts were designed for investors to manage firm-specific risk, the underlying stock markets could be more sensitive to SSF contracts. Hence, the results of this kind of study may be more reliable.

Although SSFs or ISFs have had leading roles in some studies (for example, McKenzie *et al.*, 2000), most of the studies have focused on examining the impact of the domestic listed SSFs on their underlying stock markets.

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As the internationalization of worldwide financial markets becomes ever more rapid, firms have increasingly chosen to list their securities in foreign countries. Following this trend, numerous studies have been devoted to the effect of foreign listing. Among them, the event study is the most prevalent method used to detect whether foreign-listed securities would influence the returns of their domestic stocks. Worldwide evidence has shown that the cumulated abnormal returns of the domestic firms are significantly influenced by their stocks that were listed in foreign exchanges after overseas listing (see, for example, Foerster and Karolyi, 1993, 1996; Damodaran *et al.*, 1993).

While much work has been done on the effects of foreign listed stocks on their domestic stock markets, there has been little attention given to the impact of foreign listed derivatives on their domestic underlying markets. Therefore, the purpose of this article is to determine whether the introduction of foreign-listed SSFs would affect their home underlying stock markets.

The plan of this article is as follows: the data used here are described in Section II; the methodology employed is described in Section III; the empirical results are presented in Section IV, and the conclusions of the article are presented in the final section.

II. DATA

The data used in this article are obtained from the London International Financial Future and Options Exchange (LIFFE) database. Currently, LIFFE has single stock future contracts (SSF) traded on 118 individual stocks in England, the USA, and Europe. More than 80% of the SSFs listed on the LIFFE are traded on securities outside England, and these SSFs are so-called 'foreign-listed' for their domestic stock markets. The SSFs listed on the LIFFE are also called universal stock futures (USFs). Each SSF represents 100 shares of the underlying stock in Europe (except for Italy and England), or 1000 shares of the underlying stock in Italy, the USA, and England. The contracts have delivery dates of two consecutive months or two near quarter months. The contracts are settled in cash. In addition, there are no specific daily price movement limits or position limits.

The data used in this research consist of the top ten active single stock future contracts (SSF) listed on the LIFFE. However, among these SSFs, the underlying stock of the second active one (i.e. Vodafone Group plc) is listed on the London Stock Exchange. Hence, based on our criterion of foreign listing, the data of this SSF is left out. Table 1 lists the dates of announcement and introduction of the remaining nine SSF contracts.

III. METHODOLOGY

The daily returns of the underlying stock (r_t) are computed by $\ln(p_t/p_{t-1})$, where p_t and p_{t-1} are close prices at time t and time $t-1$.

To determine if the underlying stock returns are influenced by the announcement or the introduction of the SSF contracts, the samples were divided into two groups: a pre-announcement group (a pre-introduction group) and a post-announcement group (a post-introduction group) were compared. As listed in Table 2, visual examination identified that the variances of the underlying stock returns have no significant differences between the pre- and post-announcement (introduction) groups.

However, when ACF and PACF graphs of the series r_t and r_t^2 were plotted it was found that autocorrelation of r_t was very low, while autocorrelation of r_t^2 is quite high. (To save space, the ACF and PACF graphs are omitted here.) This implied that even though one could claim that r_t was serial uncorrelated, one could not jump to the conclusion that r_t was serial independent. Hence, volatility models were employed to capture such dependence in the series r_t .

Bollerslev (1986) proposed a useful extension of ARCH, known as the generalized ARCH (GARCH) model to avoid estimating too many parameters in the ARCH model. Akgiray (1989) reported that compared with various ARCH models, GARCH (1,1) performed best on estimating conditional volatility. Hence, one began with assuming that the conditional variance of daily returns of the underlying stocks has the form of GARCH (1,1). The GARCH (1,1) model used in the research is as follows:

$$h_t = \alpha + \beta r_{t-1}^2 + \gamma h_{t-1} \quad (1)$$

where h_t and h_{t-1} are the current and lagged values of conditional variance of the underlying stock daily returns and r_{t-1}^2 is the lagged value of the squared return.

After estimating the parameters in Equation 1 for the returns of pre-announcement (pre-introduction) period and the post-announcement (post-introduction) period, one adopted the statistic suggested by Harnett and Soni (1991) to test if there would be significant differences in the estimated parameters for the pre and post periods. Rahman (2001) employed this statistic and concluded that the conditional volatility in DJIA spot market exhibited no structure changes caused by the introduction of index future or futures options. The statistic is described as follows:

$$t^* = \frac{(\bar{x}_{pre} - \bar{x}_{post}) - (\mathcal{M}_{pre} - \mathcal{M}_{post})}{\sqrt{\left(\frac{((n_{pre} - 1)\hat{\sigma}_{pre}^2 + (n_{pre} - 1)\hat{\sigma}_{pre}^2)}{(n_{pre} + n_{post} - 2)} \right) \times (1/n_{pre} + 1/n_{post})}} \quad (2)$$

Table 1. *The dates of announcement and introduction for the nine SSF contracts*

Name (Symbol)	Country	Listing exchange	Data period	Total observations	Announcement data	Observations pre-announcement	Observations post-announcement	Introduction data	Observations pre-introduction	Observations post-introduction
Eni SpA (ENI)	Italy	Borsa Italiana ^a	28/11/1995– 19/4/2002	1573	13/12/2000	1242	331	29/01/2001	1270	303
Telecom Italia SpA (TI)	Italy	Borsa Italiana	02/01/1995– 19/4/2002	1793	13/12/2000	1462	331	29/01/2001	1490	303
Banco Bilbao Vizcaya Argentaria SA (BVA)	Spain	Bolsa De Madrid ^b	02/01/1995– 19/4/2002	1764	02/05/2001	1527	237	14/05/2001	1535	229
Telecom Italia Mobile SpA (TIM)	Italy	Borsa Italiana	17/07/1995– 19/4/2002	1664	12/03/2001	1391	273	19/03/2001	1396	268
Nokia OYJ (NOK)	Finland	Helsinki Exchange ^c	02/01/1995– 19/4/2002	1772	20/09/2000	1389	383	29/01/2001	1475	297
Enel SpA (ENL)	Italy	Borsa Italiana ^d	02/11/1999– 19/4/2002	610	12/03/2001	337	273	19/03/2001	342	268
UniCredito Italiano SpA (UC)	Italy	Borsa Italiana	02/01/1995– 19/4/2002	1796	12/03/2001	1523	273	19/03/2001	1528	268
Telefonica SA (TEF)	Spain	Bolsa De Madrid ^e	02/01/1995– 19/4/2002	1764	13/12/2000	1437	327	29/01/2001	1465	299
Royal Dutch Petroleum Co (RD)	Netherlands	Euronext Amsterdam ^f	02/01/1995– 19/4/2002	1806	20/09/2000	1414	392	29/01/2001	1502	304

Notes: ^a ENI is also listed on the New York Stock Exchange (NYSE).

^b BVA is also listed on the NYSE.

^c NOK is also listed on the NYSE and the Stockholm Stock Exchange.

^d ENL is also listed on the NYSE.

^e TEF is also listed on the NYSE, the Buenos Aires Stock Exchange, the Lima Stock Exchange, the Sao Paulo Stock Exchange, the London Stock Exchange, the Paris Stock Exchange, the Frankfurt Stock Exchange, and the Tokyo Stock Exchange.

^f RD is also listed on the NYSE.

Table 2. *Mean and variance for the subset of all samples*

Name (Symbol)	Pre-announcement period		Post-announcement period		Pre-introduction period		Post-introduction period	
	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
Eni SpA (ENI)	0.000691	0.000319	0.000853	0.00036	0.000727	0.000318	0.00072	0.000365
Telecom Italia SpA (TI)	0.001223	0.000496	−0.00108	0.000437	0.001215	0.000494	−0.00125	0.000439
Banco Bilbao Vizcaya Argentaria SA (BVA)	0.001299	0.000442	−0.00057	0.000521	0.001303	0.0004404	−0.000632	0.0005838
Telecom Italia Mobile SpA (TIM)	0.001349	0.000567	−0.00102	0.000513	0.001336	0.000567	−0.00099	0.000512
Nokia OYJ (NOK)	0.002375	0.001006	−0.00248	0.002057	0.002082	0.001072	−0.00243	0.002039
Enel SpA (ENL)	−0.00039	0.000282	−0.00029	0.000318	−0.00072	0.000286	0.000135	0.000313
UniCredito Italiano SpA (UC)	0.001032	0.000556	0.000219	0.000313	0.000988	0.000556	0.000457	0.00031
Telefonica SA (TEF)	0.001365	0.000445	−0.00117	0.000673	0.001361	0.000456	−0.00139	0.000645
Royal Dutch Petroleum Co (RD)	0.000868	0.000262	−0.00045	0.00034	0.000732	0.000263	−0.00016	0.000359

where $\bar{x}_{pre}(\bar{x}_{post})$, $\hat{\sigma}_{pre}^2(\hat{\sigma}_{post}^2)$, and $n_{pre}(n_{post})$ are the sample mean, sample variance, and sample size of β , γ , or $(\beta + \gamma)$ for all 10 stocks for the pre and (post) period, respectively; $\mathcal{M}_{pre}$ and $\mathcal{M}_{post}$ are the respective population means. The statistic follows a t distribution with a $(n_{pre} + n_{post} - 2)$ degree of freedom.

In order to examine more precisely the influence of the introduction of SSFs on the spot markets, one investigated whether there is a relationship between the conditional volatility of the underlying stock and the magnitude of the SSF trading activity. Another model suggested by Bessembinder and Seguin (1992) was employed and data after the introduction of SSF contracts were used. In Bessembinder and Seguin's opinion, trade volume and open interest are two important trading activity variables, influencing the conditional volatility. They suggested that the trading activity variables should be detrended at first, and then the detrended series should be divided into expected and unexpected components using ARIMA specifications. According to them, 'The unexpected component of the detrended series is interpreted as the daily activity shock. The expected component of the detrended series ... reflects activity that is forecastable but highly variable across days.' They reported that the expected components of trade volume and open interest had negative effects on the conditional volatility, while the unexpected components had opposite effects. Following Gulen and Mayhew (2000), after applying the Augmented Dicky-Filler test (ADF) to check if the trading activity variables

have a unit root, we used models smaller than ARIMA (5,1,5) to partition the series with a unit root into two parts, and used models smaller than ARMA (5,5) to divide the series without a unit root into two parts. Then the additional four explanatory variables – the unexpected trading volume, the expected trading volume, the unexpected open interest, and expected open interest – were added to the GJR-GARCH (1,1) model as follows:

$$r_t = c + \varepsilon_t \quad (3)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 I_{t-1} \varepsilon_{t-1}^2 + \alpha_3 h_{t-1} + \alpha_4 Unexp Vol + \alpha_5 Exp Vol + \alpha_6 Unexp OI + \alpha_7 Exp OI \quad (4)$$

where Equation 3 is the mean equation of the underlying stock returns (r_t); the dummy variable I_{t-1} in Equation 4 takes the value of one when ε_{t-1} is negative, otherwise it takes the value of zero, reflecting the asymmetry effects of bad and good news on the conditional volatility in the GJR-GARCH model (i.e. leverage effect).

IV. EMPIRICAL RESULTS

The estimated coefficients on r_{t-1}^2 and h_{t-1} (i.e. β and γ) in Equation 1 for the nine stocks for the pre-announcement and post-announcement period (pre-introduction and post-introduction period) are reported in Table 3 (Table 4). The report of α is omitted due to its exceedingly small value and relative insignificance.

Table 3. Estimates for the announcement case from the following variance equation $h_t = \alpha + \beta r_{t-1}^2 + \gamma h_{t-1}$

Name (Symbol)	Pre-announcement period		Post-announcement period	
	β	γ	β	γ
Eni SpA (ENI)	0.113112* (0.0000)	0.796738* (0.0000)	0.067301 (0.1758)	0.795375* (0.0000)
Telecom Italia SpA (TI)	0.080625* (0.0000)	0.885708* (0.0000)	0.101047* (0.0137)	0.836687* (0.0000)
Banco Bilbao Vizcaya Argentaria SA (BVA)	0.136621* (0.0000)	0.851847* (0.0000)	0.134303* (0.0369)	0.836446* (0.0000)
Telecom Italia Mobile SpA (TIM)	0.066357* (0.0000)	0.908380* (0.0000)	0.076868 (0.0566)	0.858846* (0.0000)
Nokia OYJ (NOK)	0.096286* (0.0000)	0.879968* (0.0000)	-0.017888* (0.0329)	0.927999* (0.0000)
Enel SpA (ENL)	0.144801* (0.0001)	0.827821* (0.0000)	0.129729* (0.0052)	0.788963* (0.0000)
UniCredito Italiano SpA (UC)	0.134052* (0.0000)	0.783408* (0.0000)	0.113359* (0.0047)	0.849718* (0.0000)
Telefonica SA (TEF)	0.088051* (0.0000)	0.908845* (0.0000)	0.080419* (0.0464)	0.822002* (0.0000)
Royal Dutch Petroleum Co (RD)	0.081990* (0.0000)	0.904634* (0.0000)	0.138284* (0.0003)	0.791281* (0.0000)

Notes: 1. Figures in parentheses are p -values

2. Figures marked with* are statistically significant at the 5% level.

Table 4. Estimates for the introduction case from the following variance equation $h_t = \alpha + \beta r_{t-1}^2 + \gamma h_{t-1}$

Name (Symbol)	Pre-introduction period		Post-introduction period	
	β	γ	β	γ
Eni SpA (ENI)	0.110516* (0.0000)	0.799542* (0.0000)	0.072073 (0.1551)	0.774387* (0.0000)
Telecom Italia SpA (TI)	0.077432* (0.0000)	0.890021* (0.0000)	0.113404* (0.0292)	0.819254* (0.0000)
Banco Bilbao Vizcaya Argentaria SA (BVA)	0.140819* (0.0000)	0.845117* (0.0000)	0.116841* (0.0341)	0.853460* (0.0000)
Telecom Italia Mobile SpA (TIM)	0.066208* (0.0000)	0.908498* (0.0000)	0.077092 (0.0666)	0.849148* (0.0000)
Nokia OYJ (NOK)	0.098373* (0.0000)	0.883250* (0.0000)	-0.003237 (0.9329)	0.640056 (0.8712)
Enel SpA (ENL)	0.178085* (0.0001)	0.794890* (0.0000)	0.125322* (0.0039)	0.788202* (0.0000)
UniCredito Italiano SpA (UC)	0.133847* (0.0000)	0.782976* (0.0000)	0.102581* (0.0055)	0.869125* (0.0000)
Telefonica SA (TEF)	0.085773* (0.0000)	0.909836* (0.0000)	0.138526 (0.0698)	0.680863* (0.0000)
Royal Dutch Petroleum Co (RD)	0.036586* (0.0000)	0.960101* (0.0000)	0.170286* (0.0008)	0.777228* (0.0000)

Notes: 1. Figures in parentheses are p -values

2. Figures marked with* are statistically significant at the 5% level.

The statistics for β and γ both for the announcement case and the introduction case are computed. Table 5 displays the results. From Table 5, it is concluded that within the research samples, γ is significantly different between the pre- and post-introduction periods rather than between the pre- and post-announcement periods, and that β is not significantly different in either the announcement or the introduction cases. That is, the volatility of the spot market changes may be due to the introduction of the SSF, while the announcement of introduction may have fewer effects.

In order to examine the influence of SSF introduction on the spot markets more accurately, we introduce Equations 3 and 4 into the methodology. Because we are interested in the relationship between the conditional volatility of the underlying stock and the magnitude of the SSF trading activity, we just report the estimates of the Equation 4 in Table 6. As shown in Table 6, the coefficient (α_2) on the dummy variable I_{t-1} in Equation 4 is positive in eight of the nine securities and statistically significant in three, reflecting that bad shocks indeed impact conditional volatility more than good news in our researched data. In addition, as one focuses on the influence of SSF trading activity, one finds that the estimated parameters in Eni SpA and UniCredito Italiano SpA have the same sign suggested by Bessembinder and Seguin (i.e. α_4 and α_6 should be positive; α_5 and α_7 should be negative). Of the nine securities, the coefficient (α_4) on the unexpected trading volume is positive in six, although it is statistically significant only in Enel SpA. As for the coefficient (α_5) on the expected trading volume, it is slightly negative in all nine but not

Table 5. The statistic t for β and γ

Bases	β	γ
Announcement date	0.700682	1.22830263
Issuing date	0.075101	2.41919083*

Note: An asterisk marks statistical significance at the 5% level.

statistically significant. Four of the nine securities have a positive coefficient (α_6) on the unexpected open interest, but this was only statistically significant in Eni SpA. Of the nine securities, the coefficient (α_7) on the unexpected trading volume is slightly negative in three, but insignificant in all nine.

The significance of the coefficients for the explanatory variables depends on the security. For example, the unexpected open interest has a significantly positive effect on the conditional volatility in Eni SpA. As for Enel SpA, the unexpected trading volume has a significantly positive effect on the conditional volatility.

V. CONCLUSION

This article used data obtained from the London International Financial Future and Options Exchange (LIFFE) database to determine whether the introduction of SSF contracts listed on the LIFFE would influence the volatility of their domestic underlying stock returns. It began by employing the GARCH (1,1) model suggested by Akgriray (1989) and the statistic suggested by Harnett

Table 6. Estimates from the following variance equation:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 I_{t-1} \varepsilon_{t-1}^2 + \alpha_3 h_{t-1} + \alpha_4 \text{Un exp Vol} + \alpha_5 \text{Exp Vol} + \alpha_6 \text{Un exp OI} + \alpha_7 \text{Exp OI}$$

Name (Symbol) Vol / OI	α_0	α_1	α_2	α_3	α_4	α_5	α_6	α_7
Eni SpA (ENI) $10^3/10^5$	0.000197 (0.73430)	0.081417 (0.2105)	-0.018770 (0.8039)	0.779947* (0.0000)	6.94E-05 (0.0811)	-0.000262 (0.8159)	0.000178* (0.0420)	-1.72E-05 (0.4440)
Telecom Italia SpA (TI) $10^3/10^4$	7.27E-05 (0.6913)	-0.053221 (0.0525)	0.162719* (0.0000)	0.966161* (0.0000)	2.17E-05 (0.7514)	-0.000256 (0.7080)	3.95E-05 (0.5116)	2.83E-07 (0.9290)
Banco Bilbao Vizcaya Argentaria SA (BVA) $10^3/10^4$	1.52E-05 (0.2774)	-0.058679 (0.3517)	0.190039* (0.0268)	0.952755* (0.0000)	-3.57E-06 (0.9348)	-2.98E-05 (0.2339)	8.88E-05 (0.5612)	2.34E-05 (0.3908)
Telecom Italia Mobile SpA (TIM) $10^3/10^4$	0.000238 (0.9497)	0.025802 (0.7040)	0.029424 (0.6943)	0.776000* (0.0000)	4.23E-05 (0.2177)	-0.000576 (0.9640)	-0.00026* (0.0000)	4.63E-05 (0.1430)
Nokia OYJ (NOK) $10^3/10^4$	0.000447 (0.1516)	-0.084967 (0.0835)	0.074332 (0.2003)	0.885431* (0.0000)	-1.79E-05 (0.7597)	-0.000245 (0.3721)	-0.000600 (0.1928)	-4.89E-05 (0.4595)
Enel SpA (ENL) $10^3/10^4$	2.13E-05* (0.0002)	-0.11948* (0.0006)	0.224035* (0.0000)	0.926538* (0.0000)	5.42E-05* (0.0029)	-1.13E-05 (0.6810)	-0.00013* (0.0263)	3.69E-06 (0.7640)
UniCredito Italiano SpA (UC) $10^3/10^4$	0.000305 (0.9893)	0.180868* (0.0354)	0.043454 (0.7123)	0.695399* (0.0000)	2.23E-05 (0.4654)	-0.002220 (0.9907)	0.000119 (0.4971)	-4.94E-05 (0.2201)
Telefonica SA (TEF) $10^3/10^4$	0.000131 (0.1007)	0.066938 (0.4393)	0.156840 (0.2128)	0.65705* (0.0001)	-4.48E-05 (0.5383)	-8.73E-05 (0.6974)	-0.000362 (0.2629)	3.77E-05 (0.6729)
Royal Dutch Petroleum Co (RD) $10^3/10^3$	3.17E-05* (0.0006)	0.129717 (0.0878)	0.131113 (0.2341)	0.70574* (0.0000)	0.000122 (0.2872)	-0.000123 (0.3412)	-5.83E-05* (0.0000)	1.71E-05 (0.2298)

Notes: 1. Figures in parentheses are *p*-values.

2. An asterisk marks statistical significance at the 5% level.

3. For computational reasons, we standardized the trading volume and open interest series to be of a mean less than one, following Gulen and Mayhew (2000). Scaling units are listed under the security name.

and Soni (1991) to determine if there would be a change in the volatility of underlying stock returns before and after the announcement (introduction) of the SSF contracts. It concluded that within the research samples, the introduction of the foreign listed SSF contracts induced structure changes in the conditional variances of their domestic spot markets, while the announcement of the SSF contracts had no significant effect.

In order to examine more accurately the influence of SSF contracts on the spot markets after their introduction, it then included four additional variables – the unexpected trading volume, the expected trading volume, the unexpected open interest, and expected open interest – into the GJR-GARCH (1,1) model suggested by Gulen and Mayhew (2000). The findings support the leverage effect. In addition, as one considered the effects of the SSF trading activity, it appears that the daily activity shocks of the foreign listed futures raise the conditional volatility of their home underlying stocks, while the activity that is forecastable but highly variable across days lessens the conditional volatility of the underlying stocks.

Based on the samples of the SSF contracts and their underlying stock returns, the findings provide evidence that the foreign-listed derivatives trading has an effect on the volatility of their home underlying spot markets. Moreover, the results suggest that even though the SSFs are designed for investors to easily and cheaply hedge firm-specific risk of stocks, the high conditional volatility

of the underlying stock returns arising from SSFs trading in the highly interactive foreign financial markets may be a dissatisfactory by-product.

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