Message Traffic Restrictions and Relative Pricing Efficiency: Evidence from Index Futures Contracts and Exchange-Traded Funds

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ABSTRACT

This study examines the impact of message traffic restrictions on the relative pricing efficiency of futures market. It investigates the return correlation between index futures contracts and Exchange-Traded Funds (ETFs) against the implementation of four message traffic regulatory restrictions, namely the Cost Recovery Scheme in Australia (2012), the Integrated Fee Model in Canada (2012), and the Financial Transaction Tax in France (2012) and Italy (2013). Evidence indicates that the message traffic regulatory restrictions impose diverse impact on the relative pricing efficiency between futures and ETF markets. The cost allocation scheme based on message counts in Australia and Canada improves the return correlation, while the tax collection system based on quote value in Italy lowers the price consistency.

Keywords: Index Futures Contracts, Exchange-Traded Funds, Financial Transaction Tax, Index Arbitrage

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1. Introduction

The contemporary growth in algorithmic trading attracts the attention of market regulators, who have introduced various forms of message traffic regulatory restrictions in some countries. Prior literature reports that high order submission generally improves market quality. Those studies document that an increasing level of algorithmic trading, typically high frequency trading, is associated with improved market liquidity, faster price discovery, and lower market volatility (e.g., Brogaard, 2010; Hendershott, Jones, and Menkveld, 2011; Hasbrouck and Saar, 2013; Brogaard, Hendershott, and Riordan, 2014). In contrast, some academic studies focus on the negative externalities generated by high frequency trading. Jarnecic and Snape (2014) and Boehmer, Fong, and Wu (2015) find that high frequency trading increases short-term price volatility. Jarnecic and Snape (2014) also argue that a higher level of high frequency trading activity is associated with shorter order duration and thinner market depth. Kirilenko, Kyle, Samadi, and Tuzun (2017) suggest that high frequency traders increase price volatility by withdrawing from supplying liquidity, and even competing for liquidity, as they manage their inventory positions. It is argued that high frequency trading contributed to the extreme market stress during the “Flash Crash” in May 2010. Further, Biais, Foucault, and Moinas (2015) report that a high level of high frequency trading increases adverse selection costs of slower traders. This generates an un-level playing field among market participants. Overall, the literature documents both positive and negative effects of high frequency trading on market quality.

Two popular types of regulations over high frequency trading adopted are the market regulatory cost recovery based on message counts (e.g., Australia and Canada), and high frequency trading tax incorporated within a financial transaction tax (e.g., France and Italy). Specifically, Australian and Canadian regulators allocate their market regulatory costs to equity market participants based on their trade and message count. Those regulations raise trading costs of certain group of traders, especially high frequency trading firms. In addition, the design of modern financial transaction taxes incorporates a message traffic tax component, which levies based on the value of orders submitted, modified, or cancelled by traders. This tax component specifically targets high frequency traders, who have high order-to-trade ratios and frequent changes in trading direction. For instance, the French financial transaction tax (implemented in 2012) and the Italian financial transaction tax (implemented in 2013) impose additional high frequency trading tax on order amendments and cancellations which occur within a short time frame.

The availability of arbitrage opportunities reflects the pricing efficiency of related markets. Index arbitrageurs frequently implement their trading strategies, using index futures contracts and Exchange-Traded Funds (ETFs). Richie, Daigler, and Gleason (2008) identify the existence of mispricing between S&P 500 futures and its corresponding SPDR ETF. Further, Budish, Cramton, and Shim (2015) examine the return correlation between index futures and ETFs on the S&P 500 index. They find that the price of index futures and index ETFs is highly consistent in an efficient market, but the return correlation breaks down in high-frequency time intervals. In such situations, the price of two instruments does not move simultaneously, thereby generating profitable mechanical arbitrage opportunities for high speed traders. Message traffic restrictions, which increase the transaction costs of those traders, result in some arbitrage trading strategies becoming unprofitable. It then takes a longer time for markets to respond to mispricing. Hence, after the implementation of message traffic restrictions, the return correlation between index futures contracts and index ETFs is predicted to be lower.

However, some research finds that the frequency and duration of arbitrage opportunities increases when high frequency trading increases in the market (Frino, Mollica, Webb, and Zhang, 2016; Kozhan and Tham, 2012). Frino, Mollica, Webb, and Zhang (2016) point out that a higher level of high frequency trading activity can increase the execution risks of arbitrage trading, which drives index futures mispricing. In this situation, the relative pricing efficiency will improve with message traffic restrictions. Therefore, it is an empirical question whether the overall impact of message traffic restrictions on the relative pricing efficiency between index futures and ETF markets is significant or not.

This study incorporates the implementation of four message traffic regulations, which are the Cost Recovery Scheme in Australia (2012), the Integrated Fee Model in Canada (2012) and the Financial Transaction Tax in France (2012) and Italy (2013). These transitions provide an opportunity to investigate the market impact of high frequency trading regulations. This essay utilises an order-level data set and creates daily return correlation based on the paired securities' prices every one second. Regression analysis is undertaken to perform the event study.

The multivariate analysis reveals that the message traffic restrictions impose a significant impact on the return correlation between index futures contracts and index ETFs, after controlling for the effects of futures market volatility and trading volume. However, the direction of changes varies across markets. Specifically, the return correlations in Australia and Canada increase after the transition, while a decrease in correlation is observed in Italy. Further, the return correlation between those two instruments in France does not experience a significant change. This is because the French high frequency trading tax, implemented in the underlying equities market, excludes transactions in financial derivatives and exchange-traded products.

Additional analysis is performed incorporating the effect of introducing the Australian co-location services, as a robustness test. In early 2012, Australian Securities Exchange (ASX) provided co-location services for equities and derivatives trading. This infrastructure improvement allows faster trading for market participants and provides a wider playground for high frequency trading firms. Results suggest that the introduction of the co-location services improves the return correlation between those two instruments. After controlling the effect of this factor, the message traffic restriction still exerts a positive impact on the relative pricing efficiency. In Italy, the financial transaction tax extends to the derivatives market six months after its implementation in the equity market. We observe that the return correlation increases after both markets implement the message traffic restriction.

This paper is structured as follows. Section 2 reviews the existing literature. Section 3 provides institutional details of stocks indices and their corresponding futures contracts and ETFs in four countries, as well as the message traffic restriction policies. Section 4 presents the data sample and descriptive statistics. Section 5 summarises the research design. Section 6 reports the empirical results. Section 7 provides a robustness test. Section 8 concludes.

2. Literature Review

The literature suggests that the market impact of high frequency trading is mixed. Prior research widely demonstrates a positive relationship between high frequency trading and market quality. High frequency trading activity can reduce bid-ask spreads, increase market depth, lower price volatility, and improve price discovery (e.g., Brogaard, 2010; Hendershott, Jones, and Menkveld, 2011; Hasbrouck and Saar, 2013). In contrast, negative effects generated by high frequency trading are also documented. Jarnecic and Snape (2014) and Boehmer, Fong, and Wu (2015) find that high frequency trading increases short-term price volatility. Jarnecic and Snape (2014) also argue that a higher level of high frequency trading activity is associated with shorter order duration and thinner market depth. Kirilenko, Kyle, Samadi, and Tuzun (2017) suggest that high frequency traders increase price volatility by withdrawing from supplying liquidity, and even competing for liquidity, as they manage their inventory positions. It is argued that high frequency trading contributed to the extreme market stress during the "Flash Crash" in May 2010. Consistently, Brogaard, Hendershott, and Riordan (2017) examine the impact of high frequency trading activity on market liquidity during the period of the 2008 short sale ban in the US. They conclude that some high frequency traders' activities are detrimental to liquidity during the extremely volatile period. Further, Biais, Foucault, and Moinas (2015) recognise that high frequency traders can profit from their speed advantage. A high level of high frequency trading activity increases adverse selection costs of the slower traders. This generates an un-level playing field among market participants. Overall, the literature documents both positive and negative effects of high frequency trading on market quality.

Along with the proliferation of high frequency trading in global markets, regulations are proposed and implemented by many market authorities. Financial transaction taxes are a prevalent method designed to curb excess market volatility, as well as collecting revenue for governments (e.g., Tobin, 1978; Schwert and Seguin, 1993). However, past studies report that financial transaction taxes can impose a negative impact on market quality. It is observed that financial transaction taxes are associated with lower trading volume, wider bid-ask spreads, and higher price volatility (e.g., Chou and Wang, 2006; Pomeranets and Weaver, 2013). In August 2012, after French financial transaction tax is implemented, a significant drop in trading volume is observed across all trading platforms in France (e.g., Gomber, Haferkorn, and Zimmermann 2016; Meyer, Wagener, and Weinhardt, 2015). Burman, Gale, Gault, Kim, Nunns, and Rosenthal (2016) comment that financial transaction taxes affect the decisions and behaviours of market participants. After the tax implementation, trades move to other exchanges in Europe and shift to smaller sized stocks, which are non-taxable under French financial transaction tax regime. In addition, Lepone and Sacco (2013) discover that after the introduction of the Integrated Fee Model (IFM) in Canada, there is a decline in quote submission, trades, and volume in the equity market. Frino, Mollica, and Webb (2014) also find that the trading volume of the main stock index futures contract in Australia decreases after the Cost Recovery Scheme (CRS). Further, modern financial transaction tax schemes incorporate a tax component that specifically targets high frequency trading activities. Given this, the market impact of financial transaction taxes is associated with the role of high frequency trading in capital markets.

Further, the literature provides abundant evidence on the index futures mispricing. Budish, Cramton, and Shim (2015) examine the price relationship between the E-mini S&P 500 stock index futures contract and the SPDR S&P 500 stock index Exchange-Traded Fund (ETF). They find that the correlation of those two instruments' percentage return is close to 1 at long time interval. However, over very short time interval, return correlation breaks down and leaves mechanical arbitrage opportunities, available to speed market participants. Arbitrageurs who employ fast trading speed can exploit those price misalignments. Similarly, Richie, Daigler, and Gleason (2008) investigate the limits to index arbitrage using the ETF as the underlying asset of S&P 500 futures contract. They confirm the existence of mispricing between those two instruments and estimate that arbitrage opportunities persist between 2 and 5.5 minutes, depending on the level of transaction costs assumption. Chaboud, Chiquoine, Hjalmarsson, and Vega (2014) point out that the frequency of arbitrage opportunity is adversely related to the growth of algorithmic trading, which is argued to increase informational efficiency of the market. However, Kozhan and Tham (2012) discover that the increase of high frequency trading activity imposes negative externalities on markets, due to aggressive competition against each other. Frino, Mollica, Webb, and Zhang (2016) find that the competition among high frequency trading firms drives up the amount of average daily profit, frequency, and duration of arbitrage opportunities between index futures and ETFs in Australia.

3. Institutional Details

3.1 Index Futures Contracts and Exchange-Traded Funds (ETFs)

The analysis in this research is based on four pairs of financial instruments (index futures contracts and ETFs). Introduced in 2000, the S&P/ASX 200 index is composed of the largest 200 stocks listed on the Australian Securities Exchange (ASX). This index is float-adjusted and commonly used to measure the performance of the Australian equity market. The SFE SPI 200™ Index Futures (SPI Futures) is the most actively traded equity index futures contract written on the S&P/ASX 200 Index. Trading of the SPI Futures is based on an electronic limit order book that follows a price-time priority rule. The minimum tick size is one index point, valued at 25 Australian dollars. The contracts follow a March-June-September-December quarterly maturity cycle. The day-time trading session is from 9:50 am to 4:30 pm on the ASX. The ASX also lists the SPDR S&P/ASX 200 Fund (STW), an ETF maintained by State Street Global Advisors. This ETF seeks to closely track the return of S&P/ASX 200 Index. The STW is traded on a centralised limit order book, following the price-time priority rule. Investors can trade the shares of the STW anytime during the trading session, from 10:00 am to 4:00 pm, on both the listed exchanges in Australia.

In Canada, the S&P/TSX 60 Index is an equity market index, which consists of the largest 60 stocks by market capitalisation listed on the Toronto Stock Exchange (TSX). The S&P/TSX 60 index standard futures contract (TSX Futures) is the main stock index futures traded in the Montreal Exchange. The contract is denominated in index points, expressed to two decimal places. Each index point of the TSX Futures is equivalent to 200 Canadian dollars. The TSX Futures follows a March-June-September-December quarterly maturity cycle, and it is traded between 9:30 am to 4:15 pm. In addition, the iShares S&P/TSX 60 Index ETF (XIU) is an ETF that seeks to replicate the performance of the S&P/TSX 60. The XIU commenced trading in 1999 and is maintained by BlackRock Asset Management Canada Limited. This fund is the most liquid stock index ETF in Canada, and it is publicly traded on the TSX. The trading hours of the XIU are identical to listed shares on the exchange (9:30 am to 4:00 pm).

In Italy, the FTSE MIB (Milano Italia Borsa) Index is the primary benchmark equity index. The index consists of the 40 most actively traded stocks listed on Borsa Italiana's MTA and MIV markets. FTSE MIB Index Futures (MIB Futures) are written over the FTSE MIB Index, trading on Borsa Italia. The MIB Futures are quoted in index points, valued at 5 Euros. The minimum tick size is 5 index points. The MIB Futures follows a March-June-September-December quarterly maturity cycle. Its continuous trading hours are from 9:00 am to 5:40 pm. In addition, LYXOR UCITS ETF FTSE MIB (ETFMIB) is an ETF that seeks to track the performance of the FTSE MIB index. It is denominated in Euros. The continuous trading hours are 9:00 am to 5:25 pm.

In France, the CAC 40 Index contains the 40 largest stocks by free-float market capitalisation. It is the most widely-used indicator of the Paris equities market. The CAC 40 index futures (CAC Futures) is the main derivatives contract written on the CAC 40 index. The CAC Futures is denominated in index points, which is equivalent to 10 Euros. The expiration month of the CAC Futures is up to 60 months. The CAC Futures has a central limit order book, which applies a price-time priority rule, trading from 8:00 am to 10:00 pm. In addition, the Lyxor UCITS ETF CAC 40 (CAC ETF) is the most actively traded fund, which tracks the performance of the CAC 40 index. The CAC ETF is continuously traded between 9:00 am and 5:30 pm.

3.2 Regulations

In Australia, the Cost Recovery Scheme (CRS) was implemented on 1 January 2012 by the Australian Securities & Investments Commission (ASIC), which is the capital market regulatory authority in Australia. Through the CRS, ASIC allocates costs to regulated entities to fund their market supervision services. In addition to the fixed component of fees and costs, market participants are charged variable fees based on their proportion of total number of transactions and message traffic for securities executed on the ASX and Chi-X. The message traffic costing component of CRS only applies to equities market, which includes shares, ETFs, and managed funds.

In Canada, the Integrated Fee Model (IFM) took effect on 1 April 2012 by Investment Industry Regulatory Organisation of Canada (IIROC), the national self-regulatory organisation that oversees all investment dealers and trading activity on debt and equity marketplaces in Canada. Similar to the CRS in Australia, the IFM is a fee model allocating IIROC's market regulation costs (e.g., technology costs) to market participants. The cost allocation to each market participant is on a pro rata basis, based on the number of messages sent and trades executed.

In Europe, the EU Commission proposed to introduce the financial transaction tax. Although the proposal was postponed, some member states have already implemented their state-version of financial transaction tax, such as in France and Italy. In France, the financial transaction tax was imposed on 1 August 2012. It applies to the transfer of the ownership of equity instruments issued by a French firm, of which the market capitalisation is larger than one billion euros as at 1 January 2012. Equity instruments, in that bill, are defined as shares and other securities that could give access to capital or voting rights. Therefore, the taxable instruments in the French financial transaction tax regime specifically exclude ETFs and financial contracts. The effective tax rate is 0.2% of the acquisition value. In addition, high frequency trading activities are subject to a 0.01% tax if trading is carried out in France. In that bill, high frequency trading is defined as program trading with amendments or cancellation of orders exceeding two-thirds of transmitted orders.

In Italy, the financial transaction tax was implemented on 1 March 2013 in its equity market. Within the scope of the Italian financial transaction tax, transactions of equity instruments issued by Italian companies with a capitalisation higher than 500 million Euros are to be taxed at 0.22% if executed over-the-counter (OTC), and 0.12% if executed on a regulated market.[1] The definition of equity instruments above includes shares and equity-like instruments, such as ETFs. Six-months later, the Italian financial transaction tax was extended to the derivatives market (2 September 2013).[2] The tax on OTC derivatives applied at a fixed rate according to the type of derivatives involved and its notional value. Derivatives executed on regulated markets can have a reduced tax rate equal to 20% of the ordinary fixed rate. Similar to that in France, an additional high frequency trading tax was imposed for the trading of financial instruments (both equities and derivatives) executed by a computer algorithm that automatically makes decisions (e.g., send, modify and cancel orders) in a time frame shorter than 0.5 seconds. Italian financial transaction tax levies at a rate of 0.02% on any portion of the order (beyond a certain threshold) that are modified or cancelled on a daily basis. The tax is borne by the person on whose behalf the relevant orders are executed.

[1] In 2014, those rates reduced to 0.2% and 0.1%, respectively.

[2] The implementation date for the financial transaction tax in derivative markets was initially set at 1 July 2013, however, it was postponed to 2 September 2013.

4. Data

Intraday data for the index futures contracts and Exchange-Traded Funds (ETFs) for the four markets are sourced from Thomson Reuters Tick History (TRTH). The data contain (1) the price, time, and volume of each trade; (2) the price, time, and size of quotes that affect the best available bid and ask quotes in the central limit order book; and (3) the open, close, highest, and lowest prices during each trading day.

To mitigate the infrequent trading issue, the most actively traded futures contract, with the largest daily trading volume, is chosen for each trading day. The continuous trading hours of index futures and ETFs markets are not the same. Therefore, for analytical purposes, any observations of futures and ETFs before the other markets open, or after the other market closes, are excluded from the sample. Further, to minimise the effect of irregular trading behaviour of financial instruments shortly after the market opens and before the market closes, as well as increasing the pricing accuracy of ETFs, 30-minutes after the open of trading, and before the close of trading, is eliminated from the sample. Specific time periods for each of the four markets are described below -

- Australia: the continuous trading hours for equity market and futures market are from 10:00 am to 4:00 pm, and from 9:50 am to 4:30 pm, respectively. The daily time frame used for analysis is from 10:30 am to 3:30 pm.
- Canada: the continuous trading hours for equity market and futures market are from 9:30 am to 4:00 pm, and from 9:30 am to 4:15 pm, respectively. The daily time frame for analysis is from 10:00 am to 3:30 pm.

- Italy: the continuous trading hours for equity market and futures market are from 9:00 am to 5:30 pm, and from 9:00 am to 5:40 pm, respectively. The daily time frame for analysis is from 9:30 am to 5:00 pm.
- France: the continuous trading hours for equity market and futures market are from 9:00 am to 5:30 pm, and from 8:00 am to 10:00 pm, respectively. The daily time frame for analysis is from 9:30 am to 5:00 pm.

The event studies in this research are based on a sample of 180 trading days centred around the event date, with observations during 3 trading days before and after the implementation of message traffic restriction policies eliminated. Specific event dates for each of the four markets are described below -

- Australia: The Cost Recovery Scheme (CRS) was implemented on 1 January 2012. The sample period in the event study is from 22 August 2011 to 16 May 2012.
- Canada: The Integrated Fee Model (IFM) took effect on 1 April 2012. The sample period in the event study is from 17 November 2011 to 14 August 2012.
- Italy: The Financial Transaction Tax (FTT) was implemented on 1 March 2013 in the equity market. The sample periods are from 16 October 2012 to 12 July 2013. In addition, the FTT extends to derivatives market on 2 September 2013. A separate analysis is conducted to examine this, with a sample period from 22 April 2013 to 15 January 2014.
- France: The French FTT was implemented on 1 August 2012. The sample period in this study is from 19 March 2012 to 7 December 2012.

5. Research Design

The analysis in this study is based on the return correlation between two instruments – index futures contracts and Exchange-Traded Funds (ETFs). The correlation derives from the synchronised return for two instruments on a daily basis (Budish, Cramton, and Shim, 2015). We use the mid-price returns sampled at one second time intervals. The return refers to the percentage change in the mid-point price, which is the average of the best available bid and ask quotes. We simulate limit order books with best bid and ask for futures and ETFs based on the quote and trade data in the market.

$$Midpoint_t = \frac{Bidprice_t + Askprice_t}{2} \tag{1}$$

$$Return_t = \frac{Midpoint_t - Midpoint_{t-1}}{Midpoint_{t-1}} \tag{2}$$

where, for each one-second interval; $Midpoint_t$ is the midpoint of the best available bid and ask quotes in the limit order book at time t; $Bidprice_t$ is the price of the best quote in the bid side of the order book at time t; $Askprice_t$ is the price of the best quote in the ask side of the order book at time t.

To isolate the impact of the regulatory change on return correlation, the following regression is estimated:

$$Correl_t = \beta_0 + \beta_1 Event_t + \beta_2 Volatiltiy_t + \beta_3 Volume_t + \varepsilon_t \tag{3}$$

where the unit of observation is a trading day. *Correl*$_t$ represents the return correlation between those two instruments on trading day t. *Event*$_t$ takes the value of zero if trading day t belongs to the pre-event period, and one during the post-event period. *Volatility*$_t$ is defined as the natural logarithm of the highest futures price divided by the lowest futures price on trading day t. *Volume*$_t$ is the natural logarithm of the futures trading volume divided by 1,000 for trading day t. The *p*-values are computed based on Newey-West standard errors. To reduce the effect of extreme values, all continuous variables in the regressions are winsorised at 1% and 99% levels. Table 1, 2, 3, and 4 present the correlation coefficient matrix for the independent variables in the four markets.

<INSERT TABLE 1&2&3&4 HERE>

6. Empirical Results

6.1 Univariate Results

Table 5 reports descriptive statistics for index futures contracts and ETFs in four jurisdictions before and after the implementation of message traffic restrictions. The futures/ETF price is the daily closing price of the futures contract/ETF share. *Volatility* is defined as the natural logarithm of the highest price divided by the lowest price each trading day. *Trading Volume* is the total trading volume (number of contracts/shares traded) of the futures contract/ETF.

<INSERT TABLE 5 HERE>

In Australia, the average closing prices of the SPI Futures and the STW increase, which are statistically significant at 1%, after the implementation of the CRS. The SPI Futures is less volatile; the daily price volatility decreases from 0.0237 to 0.0131. The trading volume of the futures contract drops considerably after the transition. Similar changes are observed in the ETF market. The average daily price volatility decreases from 0.0127 to 0.0076. In addition, the average daily volume of the STW in the post-event period is 180,875, which is only 58% of the volume before the event. Both changes are statistically significant at the 1% level. Those results are consistent with previous research that a transaction/message tax reduces trading volume (e.g., Baltagi, Li and Li, 2006; Matheson, 2011) and price volatility (e.g., Stiglitz, 1989; Schwert and Seguin, 1993; Kupiec, 1996).

In Canada, the price of index futures and the ETF decreases after the introduction of the IFM. In contrast to the Australian market, the TSX Futures and the XIU price volatility do not experience substantial changes with the implementation of the message traffic restrictions.

These results are consistent with some previous research that shows the restrictive regulations do not necessarily reduce market volatility (e.g., Habermeier and Kirilenko, 2003; Chou and Wang, 2006). Further, it is observed that the trading volume of the XIU decreases approximately 21% after the policy event, which is statistically significant at the 1% level. In addition, the trading volume of the TSX Futures does not experience a substantial change after the transition.

In Italy, the price of those two instruments are less affected by the implementation of the financial transaction tax in the equity market. Results reveal that both the futures and ETF market volatility remain stable during the sample period. However, it is observed that the trading volume of the futures contract and the ETF increase by 34% and 22% respectively, both of which are statistically significant at the 1% level.

In France, the price of the CAC Futures and the CAC ETF increase after the financial transaction tax is implemented. Both of those two markets are less volatile after the transition. In addition, the trading volume of those two instruments decreases significantly. The average daily trading volume of the CAC Futures reduces 23%, from 147,646 to 112,317. The average daily trading volume of the CAC ETF drops 28%, from 658,480 to 476,111. The decrease in price volatility and trading volume is statistically significant at the 1% level.

Table 6 reports descriptive statistics for the daily return correlation between index futures and ETFs in the four countries. It is further supported by Figures 1 and 2, which plot the daily return correlations across the sample period. Preliminary results reveal that the average daily return correlation in Australia increases from 0.2441 to 0.3509 after the introduction of the CRS. This increase is statistically significant at the 1% level. Similarly, the average daily return correlation in Canada increases from 0.1782 to 0.2411 after the transition, statistically significant at 1% level. These results illustrate that the return correlation between index futures and ETFs improves after the implementation of the message restriction regulations in these two countries. In Italy, the average daily return correlation decreases from 0.2836 in the pre-sample to 0.2576 in the post-sample. This drop is statistically significant at 1% level. It shows that the financial transaction tax lowers the pricing consistency between index futures and ETF in Italy. In France, the average daily correlation does not experience a substantial change around the implementation of the financial transaction tax. Overall, there does not appear to be a consistent impact of the message traffic restrictions on relative pricing efficiency between index futures and index ETFs.

<INSERT TABLE 6 HERE>

6.2 Multivariate Analysis

Prior research suggests that price volatility and trading volume of the market may influence the pricing efficiency between two markets. Therefore, we incorporate two control variables, which are futures market volatility and futures contract trading volume, to isolate the impact of changes due to market conditions. Table 7 reports the regression results of the daily return correlation on message traffic restriction event, futures market volatility and futures trading volume. In Australia, the coefficient of $Event_t$ is positive and statistically significant at the 1% level, after controlling for market volatility and trading volume; the return correlation between the SPI Futures and the STW increases after the introduction of the CRS. Futures market volatility and futures contract trading volume do not exert a significant impact on return correlation during the sample period.

<INSERT TABLE 7 HERE>

In Canada, it is observed that the return correlation increases, statistically significant at the 1% level, after the introduction of the IFM. In addition, the coefficient of futures volatility is positive and statistically significant at the 5% level. This suggests that when the futures market is more volatile, the return correlation between the TSX Futures and the XIU is higher. The futures trading volume does not exert a large impact on the relative pricing consistency.

In Italy, the coefficient of the Event dummy variable is negative and statistically significant at the 1% level. It indicates that the return correlation between two securities reduces after the implementation of the financial transaction tax in equities market on 1 March 2013. Results also highlight that futures price volatility and futures contract trading volume do not impose a significant impact on the price relationship between the MIB Futures and the ETFMIB.

In France, the coefficient of the event dummy variable is not statistically significant. This indicates that the financial transaction tax does not exert a significant impact on the price correlation. Neither futures market volatility nor futures contract trading volume impose a significant effect on the return correlation between those two instruments

From the above analysis, the message traffic restriction policies in Australia and Canada impose a similar effect on the return correlation between the index futures and index ETFs. The regulatory authorities in these two countries allocate the market regulation costs to participants based on the proportion of trades and quotes they submit. In this situation, the relative pricing efficiency improves when the message traffic restriction policies come into effect. In Italy, the high frequency trading tax, which levies on the value of orders from high frequency trading firms, lowers the pricing correlations between index futures and index ETF. However, the high frequency trading tax in France does not have a similar effect. Although the French financial transaction tax is implemented in the equity market, the tax bill specifically excludes financial derivatives contracts and ETFs. Therefore, the message traffic restrictions on the underlying equity market does not exert a direct impact on the return correlation between index futures and ETFs. This serves as a controlling scenario, indicating that the restriction on the index ETF affects the relative pricing efficiency between index futures and ETFs.

7. Robustness Tests

7.1 Introduction of the Australian Liquidity Centre (ALC)

On 20 February 2012, the ASX introduced a co-location service, named the Australian Liquidity Centre (ALC), for trading of equities and derivatives instruments. The new facility allows market participants to co-locate their computer servers next to exchange servers (ASX Trade for equities and ASX Trade24 for futures trading). The introduction of the co-location service widens the playground of high-frequency traders by significantly reducing trading latency. Since the implementation date of co-location service is within our sample period, we add an additional dummy variable into the regression, as follows

$$Correl_t = \beta_0 + \beta_1 Event_t + \beta_2 Colo_t + \beta_3 Volatility_t + \beta_4 Volume_t + \varepsilon_t \quad (4)$$

where the unit of observation is a trading day. $Correl_t$ represents the return correlation between index futures and ETF on trading day t. $Event_t$ is a dummy variable, representing the implementation of the CRS. It takes the value of zero if trading day t is either before the implementation of the CRS or after the introduction of the ALC, and it takes the value of one otherwise. $Colo_t$ is a dummy variable, describing the introduction of the ALC. It takes the value of zero if trading day t belongs to the pre-ALC period and one during the post-ALC period. $Volatility_t$ is defined as the natural logarithm of the highest futures price divided by the lowest futures price on trading day t. $Volume_t$ is the natural logarithm of the futures trading volume divided by 1,000 for trading day t. The correlation coefficient matrix is presented in Table 8. Table 9 reports the regression results of the daily return correlation on message traffic restriction event, introduction of co-location services, futures market volatility and futures contract trading volume. We observe that after the co-location service is introduced, the price correlation between index futures and index ETF increases. After controlling for that factor, the impact of message traffic restriction on price correlation remains positive and statistically significant. This suggest that the regression results for Australian markets in Section 5 are robust.

<INSERT TABLE 8 HERE>

<INSERT TABLE 9 HERE>

7.2 Italian Financial Transaction Tax in Futures Markets

On 2 September 2013, the Italian financial transaction tax regime further extended to its derivatives market, after which high frequency trading firms in futures market faced additional high frequency trading tax. We further examine the impact of this event on the return correlation between those two instruments. According to Table 10, after the financial transaction tax extends to the futures market, the price of index futures and ETF increases, statistically significant at the 1% level. The daily futures trading volume reduces from 24,517 to 21,691, which is statistically significant at the 5% level. The ETF trading volume increases from 989,184 to 1,229,187, statistically significant at the 1% level. In addition, the futures market is less volatile after the financial transaction tax is implemented; the daily volatility reduces from 1.79% to 1.50%.

<INSERT TABLE 10 HERE>

Regression analysis is performed to examine the impact of this event on the relative pricing efficiency between two instruments. The correlation coefficient matrix is presented in Table 11. Table 12 reports the regression results of the daily return correlation against the introduction of the financial transaction tax, futures market volatility, and futures contract trading volume. The coefficient of the tax regulatory event is positive and statistically significant at the 1% level. It demonstrates that the return correlation between index futures and ETF improves after the Italian financial transaction tax extends to its derivatives market. Neither futures market volatility nor futures contract trading volume has a significant effect on the daily return correlation.

<INSERT TABLE 11 HERE>

<INSERT TABLE 12 HERE>

8. Conclusions

This research investigates the impact of message traffic regulatory restrictions on the relative pricing efficiency of futures market. It focuses on the effect of message traffic restrictions on the return correlation between index futures contracts and Exchange-Traded Funds (ETFs) that track the stock index. An event study is performed based on the implementation of four restrictive policies in Australia (the Cost Recovery Scheme), Canada (the Integrated Fee Model), France (the Financial Transaction Tax), and Italy (the Financial Transaction Tax). It is observed that after the message traffic restrictions are implemented, the trading volume and price volatility of both ETFs and index futures in Australia and France decrease. Less ETF shares are traded in Canada and more futures contracts are traded after the financial transaction tax is implemented in the Italian equities market.

The regression results indicate that the daily return correlation in Australia, Canada, and Italy experience a change after the transition. In addition, the direction of the changes vary across those three markets. Specifically, this study documents that price correlation improves in Australia and Canada after the introduction of new market regulations, which are market supervision cost allocation based on the number of trades and quotes. In Italy, the price correlation decreases after the implementation of the financial transaction tax, which charges on the value of trades and orders. Moreover, results from French markets show that the financial transaction tax in underlying stock market does not exert a direct effect on the pricing efficiency of index futures against the corresponding index ETFs.

Appendix A.1

Table A.1
Contract Specifications for Index Futures in Four Countries

	Australia	Canada	Italy	France
Underlying index	S&P/ASX 200	S&P/TSE 60	FTSE-MIB	CAC 40
Exchange	Australian Securities Exchange	Montreal Exchange	Borsa Italiana	Euronext
Contract multiplier	A$25	C$200	€5	€10
Unit	Index point	Index point	Index point	Index point
Tick size	1 point	0.1 point	5 Index points	0.5 index points
Contract months	March/June/September/December up to six quarter months ahead and the nearest two non-quarterly expiry months	March/June/September/ December	March/June/September/December	3 monthly, 3 quarterly (from March/June/September/December), 8 half-yearly maturities from June/December cycle
Trading hours	09:50 am – 04:30 pm (day session)	09:30 am to 04:15 pm (regular session)	09:00 am – 05:40 pm	08:00 am – 10:00 pm (central order book)
Last trading day	Third Thursday of the settlement month	Third Thursday of the contract month	Third Friday of the expiry month	Third Friday of the delivery month
Settlement method	Cash settlement	Cash settlement	Cash settlement	Cash settlement

For further information refer to
Australia: http://www.asx.com.au/products/index-derivatives/asx-index-futures-contract-specifications.htm;
Canada: https://www.m-x.ca/produits_indices_sxf_en.php;
Italy: https://www.lseg.com/sites/default/files/content/documents/%E2%80%A2LSEG_ITA_Products_Factsheet_v10.pdf;
France: https://derivatives.euronext.com/en/products/index-futures/FCE-DPAR/contract-specification

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Table 1
Correlation Matrix – Australia

	Event	*Volatility*	*Volume*
Event	1	-0.6786**	-0.4383**
	-	(<0.0001)	(<0.0001)
Volatility	-0.6786**	1	0.5336**
	(<0.0001)	-	(<0.0001)
Volume	-0.4383**	0.5336**	1
	(<0.0001)	(<0.0001)	-

This table presents the correlation matrix of the independent variables for the regressions in this study. The regulatory event is the Cost Recovery Scheme (CRS), which was implemented on 1 January 2012 in Australia. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 22 August 2011 and 23 December 2011. *Post period* is between 6 January 2012 and 16 May 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Event* takes the value of zero if the trading day belongs to the pre-event period, and one during the post-event period. *Volatility* is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. *Volume* is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. For each variable, the first row represents the correlation coefficients. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis.

Table 2
Correlation Matrix – Canada

	Event	*Volatility*	*Volume*
Event	1	0.0896	-0.0102
	-	(0.2316)	(0.8918)
Volatility	0.0896	1	0.4278**
	(0.2316)	-	(<0.0001)
Volume	-0.0102	0.4278**	1
	(0.8918)	(<0.0001)	-

This table presents the correlation matrix of the independent variables for the regressions in this study. The regulatory event is the Integrated Fee Model (IFM), which was implemented on 1 April 2012 in Canada. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 17 November 2011 and 27 March 2012. *Post period* is between 5 April 2012 and 14 August 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Event* takes the value of zero if the trading day belongs to the pre-event period, and one during the post-event period. *Volatility* is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. *Volume* is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. For each variable, the first row represents the correlation coefficients. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis.

Table 3
Correlation Matrix – Italy

	Event	*Volatility*	*Volume*
Event	1	0.0407	0.4423**
	-	(0.5875)	(<0.0001)
Volatility	0.0407	1	0.4722**
	(0.5875)	-	(<0.0001)
Volume	0.4423**	0.4722**	1
	(<0.0001)	(<0.0001)	-

This table presents the correlation matrix of the independent variables for the regressions in this study. The regulatory event is the Financial Transaction Tax (FTT), which was implemented on 1 March 2013 in Italy. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 16 October 2012 and 25 February 2013. *Post period* is between 6 March 2013 and 12 July 2013. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Event* takes the value of zero if the trading day belongs to the pre-event period, and one during the post-event period. *Volatility* is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. *Volume* is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. For each variable, the first row represents the correlation coefficients. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis.

Table 4
Correlation Matrix – France

	Event	*Volatility*	*Volume*
Event	1	-0.4683**	-0.3567**
	-	(<0.0001)	(<0.0001)
Volatility	-0.4683**	1	0.4734**
	(<0.0001)	-	(<0.0001)
Volume	-0.3567**	0.4734**	1
	(<0.0001)	(<0.0001)	-

This table presents the correlation matrix of the independent variables for the regressions in this study. The regulatory event is the Financial Transaction Tax (FTT), which was implemented on 1 August 2012 in France. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 19 March 2012 and 26 July 2012. *Post period* is between 6 August 2012 and 7 December 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Event* takes the value of zero if the trading day belongs to the pre-event period, and one during the post-event period. *Volatility* is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. *Volume* is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. For each variable, the first row represents the correlation coefficients. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis.

Table 5
Descriptive Statistics – Market Variables

		Futures Price	*Futures Volatility (%)*	*Futures Volume*	*ETF Price*	*ETF Volatility (%)*	*ETF Volume*
	Pre-CRS	4,164	2.37	45,844	39.58	1.27	309,249
Australia	Post-CRS	4,264	1.31	33,183	40.18	0.76	180,875
	Change	99**	-0.06**	-12,660**	0.60**	-0.51**	-128,374**
	Pre-IFM	694.9	1.30	13,185	17.51	1.09	7,083,838
Canada	Post-IFM	665.1	1.39	12,612	16.76	1.15	5,621,077
	Change	-29.8**	0.09	-573	-0.75**	0.06	-1,462,762**
	Pre-FTT	3,167	2.23	147,646	32.19	1.89	658,480
France	Post-FTT	3,462	1.52	112,317	34.61	1.29	476,111
	Change	295**	-0.71**	-35,330**	2.41**	-0.60**	-182,369**
	Pre-FTT	16,269	1.82	21,261	16.38	1.95	981,966
Italy	Post-FTT	16,083	1.87	28,573	16.40	1.95	1,202,339
	Change	-186	0.05	7,312**	0.02	0.00	220,373**

This table reports descriptive statistics for four variables within the sample period before and after the message traffic restriction policies are imposed in four countries (Australia, Canada, Italy, and France). The message traffic restriction policies are the Cost Recovery Scheme in Australia (1 January 2012), the Integrated Fee Model in Canada (1 April 2012) and the Financial Transaction Tax in Italy (1 March 2013) and France (1 August 2012). Three trading days before and after the regulatory change are removed from the sample. *Pre periods* are Australia: 22 August 2011 – 23 December 2011; Canada: 17 November 2011 – 27 March 2012; Italy: 16 October 2012 – 25 February 2013; France: 19 March 2012 – 26 July 2012. *Post periods* are Australia: 6 January 2012 – 16 May 2012; Canada: 5 April 2012 – 14 August 2012; Italy: 6 March 2013 – 12 July 2013; France: 6 August 2012 – 7 December 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Futures Price* is the daily closing price of index futures contracts. *Futures Volume* is the total trading volume (number of contracts traded) of the index futures contract chosen each trading day. *Futures Volatility* is defined as the natural logarithm of the highest price divided by the lowest price each trading day. Those three measures are repeated for Exchange-Traded Funds (ETFs). * (**) denote statistical significance at the 5% (1%) level.

Table 6
Descriptive Statistics - Return Correlations

Countries	*Pre-event*	*Post-event*	*Difference*
Australia	0.2441	0.3509	0.1069**
Canada	0.1782	0.2411	0.0629**
Italy	0.2836	0.2576	-0.0261**
France	0.5722	0.5905	0.0183

This table reports descriptive statistics for the daily return correlations between index futures and Exchange-Traded Funds (ETFs) within the sample period before and after the message traffic restriction policies are imposed in four countries (Australia, Canada, Italy, and France). The message traffic restriction policies are the Cost Recovery Scheme in Australia (1 January 2012), the Integrated Fee Model in Canada (1 April 2012) and the Financial Transaction Tax in Italy (1 March 2013) and France (1 August 2012). Three trading days before and after the regulatory changes are removed from the sample. *Pre- periods* are Australia: 22 August 2011 – 23 December 2011; Canada: 17 November 2011 – 27 March 2012; Italy: 16 October 2012 – 25 February 2013; France: 19 March 2012 – 26 July 2012. *Post- periods* are Australia: 6 January 2012 – 16 May 2012; Canada: 5 April 2012 – 14 August 2012; Italy: 6 March 2013 – 12 July 2013; France: 6 August 2012 – 7 December 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. * (**) denote statistical significance at the 5% (1%) level.

Table 5
Regressions of Return Correlation with Control Variables

	Constant	$Event_t$	$Volatility_t$	$Volume_t$	R^2	*N*
Australia	0.5640	0.0929**	-0.3636	-29.1155	0.1965	180
	(0.0909)	(0.0035)	(0.7735)	(0.3645)		
Canada	0.0964	0.0608**	1.6550*	6.5326	0.3375	180
	(0.1620)	(<0.0001)	(0.0407)	(0.3893)		
France	0.7110*	0.0145	-0.0689	-11.5963	0.0019	180
	(0.0163)	(0.4363)	(0.9558)	(0.6554)		
Italy	0.4300**	-0.0263**	-0.1701	-14.2981	0.1317	180
	(0.0003)	(0.0027)	(0.8074)	(0.2529)		

This table reports the regression results of the return correlation between index futures and ETFs. The message traffic restriction policies are the Cost Recovery Scheme in Australia (1 January 2012), the Integrated Fee Model in Canada (1 April 2012) and the Financial Transaction Tax in Italy (1 March 2013) and France (1 August 2012). Three trading days before and after the regulatory change are removed from the sample. *Pre periods* are Australia: 22 August 2011 – 23 December 2011; Canada: 17 November 2011 – 27 March 2012; Italy: 16 October 2012 – 25 February 2013; France: 19 March 2012 – 26 July 2012. *Post periods* are Australia: 6 January 2012 – 16 May 2012; Canada: 5 April 2012 – 14 August 2012; Italy: 6 March 2013 – 12 July 2013; France: 6 August 2012 – 7 December 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. $Event_t$ takes the value of zero if the trading day belongs to the pre-event period, and one otherwise. $Volatility_t$ is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. $Volume_t$ is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. The *p*-values are computed based on Newey-West standard errors. To reduce the effects of extreme values, all continuous variables in the regressions are winsorised at 1% and 99% levels. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis. R^2 is the adjusted R-squared. *N* is the number of observations.

Table 6
Correlation Matrix – Australia (Co-location)

	Event	*Co-lo*	*Volatility*	*Volume*
Event	1	-0.3162**	-0.2727**	-0.3047**
	-	(<0.0001)	(0.0002)	(<0.0001)
Co-lo	-0.3162**	1	-0.5041**	-0.2240**
	(<0.0001)	-	(<0.0001)	(0.0025)
Volatility	-0.2727**	-0.5041**	1	0.5336**
	(0.0002)	(<0.0001)	-	(<0.0001)
Volume	-0.3047**	-0.2240**	0.5336**	1
	(<0.0001)	(0.0025)	(<0.0001)	-

This table presents the correlation matrix of the independent variables for the regressions in this study. The regulatory change is the Cost Recovery Scheme (CRS), which was implemented on 1 January 2012 in Australia. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 22 August 2011 and 23 December 2011. *Post period* is between 6 January 2012 and 16 May 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Event* takes the value of zero if the trading day is either before the implementation of the CRS or after the introduction of ALC, and it takes the value of one otherwise. *Co-lo* denotes the introduction of co-location services by ASX on 20 February 2012. It takes the value of zero for the period between 22 August 2011 and 17 February 2012, and one for the period between 20 February 2012 and 16 May 2012. *Volatility* is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. *Volume* is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. For each variable, the first row represents the correlation coefficients. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis.

Table 7
Regression Results of Return Correlation with Control Variables and Co-location

Constant	$Event_t$	$Co\text{-}lo_t$	$Volatility_t$	$Volume_t$	R^2	*N*
0.4344	0.1407**	0.0678*	-0.8280	-15.9347	0.2514	180
(0.1924)	(0.0001)	(0.0308)	(0.4970)	(0.6173)		

This table reports the regression results of the return correlation between index futures and ETFs. The message traffic restriction policy is the Cost Recovery Scheme (CRS), which was implemented on 1 January 2012 in Australia. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 22 August 2011 and 23 December 2011. *Post period* is between 6 January 2012 and 16 May 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. $Event_t$ takes the value of zero if the trading day is either before the implementation of the CRS or after the introduction of ALC, and it takes the value of one otherwise. $Co\text{-}lo_t$ denotes the introduction of co-location services by ASX on 20 February 2012. Co-location take value of zero for the period between 22 August 2011 and 17 February 2012 and one for period between 20 February 2012 and 16 May 2012. $Volatility_t$ is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. $Volume_t$ is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. The *p*-values are computed based on Newey-West standard errors. To reduce the effects of extreme values, all continuous variables in the regressions are winsorised at 1% and 99% levels. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis. R^2 is the adjusted R-squared. *N* is the number of observations.

Table 8
Descriptive Statistics – FTT in Italian Derivatives Market

	Futures Price	*Futures Volatility (%)*	*Futures Volume*	*ETF Price*	*ETF Volatility (%)*	*ETF Volume*
Pre-event	16,505	1.79	24,517	16.73	1.86	989,184
Post-event	18,588	1.50	21,691	18.68	1.66	1,229,187
Change	2,083**	0.29**	-2,826*	1.95**	-0.20	240,002**

This table reports descriptive statistics for three variables within the sample period before and after the implementation of message traffic restriction policies in Italian derivatives market on 2 September 2013. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 22 April 2013 and 27 August 2013. *Post period* is between 5 September 2013 and 15 January 2014. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Futures Price* is the daily closing price of index futures contracts. *Futures Volume* is the total trading volume (number of contracts traded) of the index futures contract chosen each trading day. *Futures Volatility* is defined as the natural logarithm of the highest price divided by the lowest price each trading day. Those three measures are repeated for Exchange-traded Funds (ETFs). * (**) denote statistical significance at the 5% (1%) level.

Table 9
Correlation Matrix – Italy

	Event	*Volatility*	*Volume*
Event	1	-0.2336**	-0.1741*
	-	(0.0016)	(0.0195)
Volatility	-0.2336**	1	0.4496**
	(0.0016)	-	(<0.0001)
Volume	-0.1741*	0.4496**	1
	(0.0195)	(<0.0001)	-

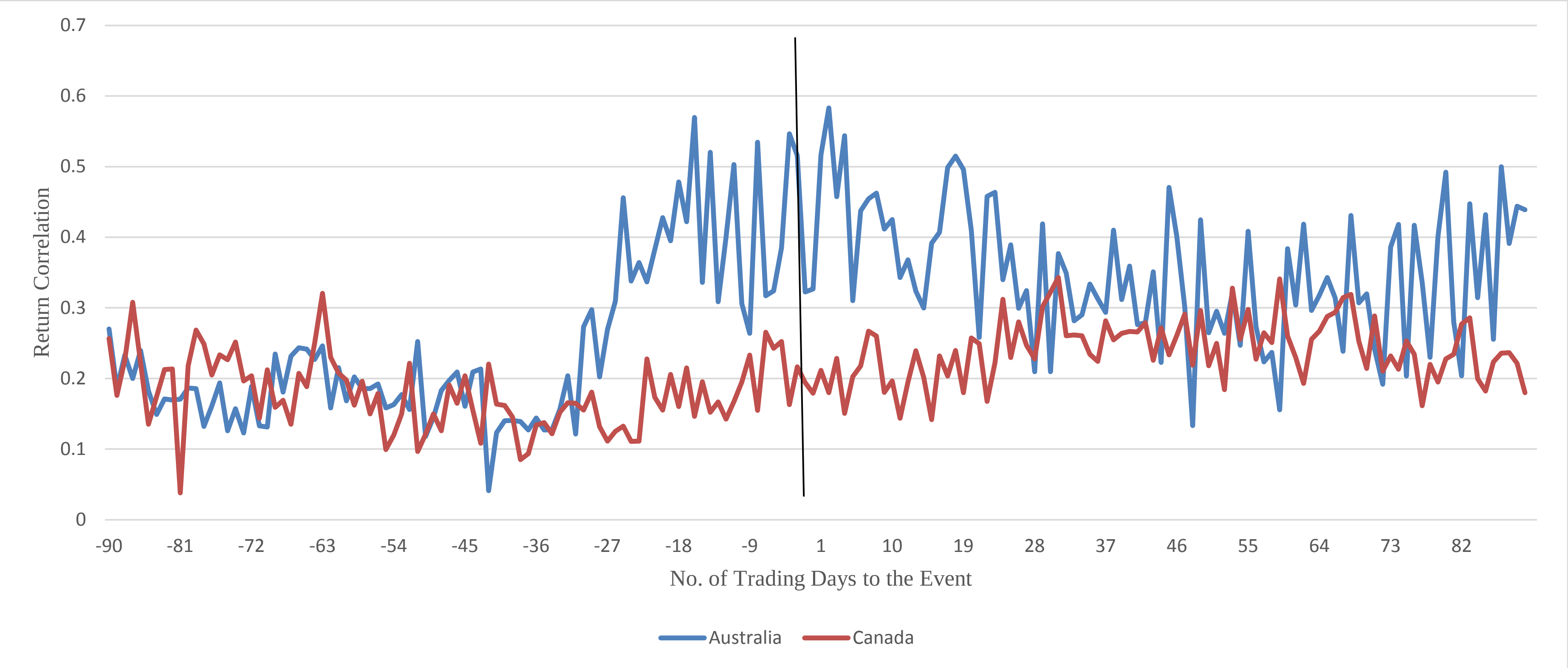
This table presents the correlation matrix of the independent variables for the regressions in this study. The regulatory event is the Financial Transaction Tax (FTT), which was implemented on 2 September 2013 in Italian derivatives market. Three trading days before and after the regulatory change are removed from the sample. *Pre-period* is between 22 April 2013 and 27 August 2013. *Post-period* is between 5 September 2013 and 15 January 2014. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. *Event* takes the value of zero if the trading day belongs to the pre-event period, and one during the post-event period. *Volatility* is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. *Volume* is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. For each variable, the first row represents the correlation coefficients. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis.

Table 10
Regressions of Return Correlation with Control Variables – Italy

Constant	$Event_t$	$Volatility_t$	$Volume_t$	R^2	*N*
0.3032*	0.0444**	-0.0677	-4.8912	0.1372	180
(0.0265)	(0.0007)	(0.9409)	(0.7262)		

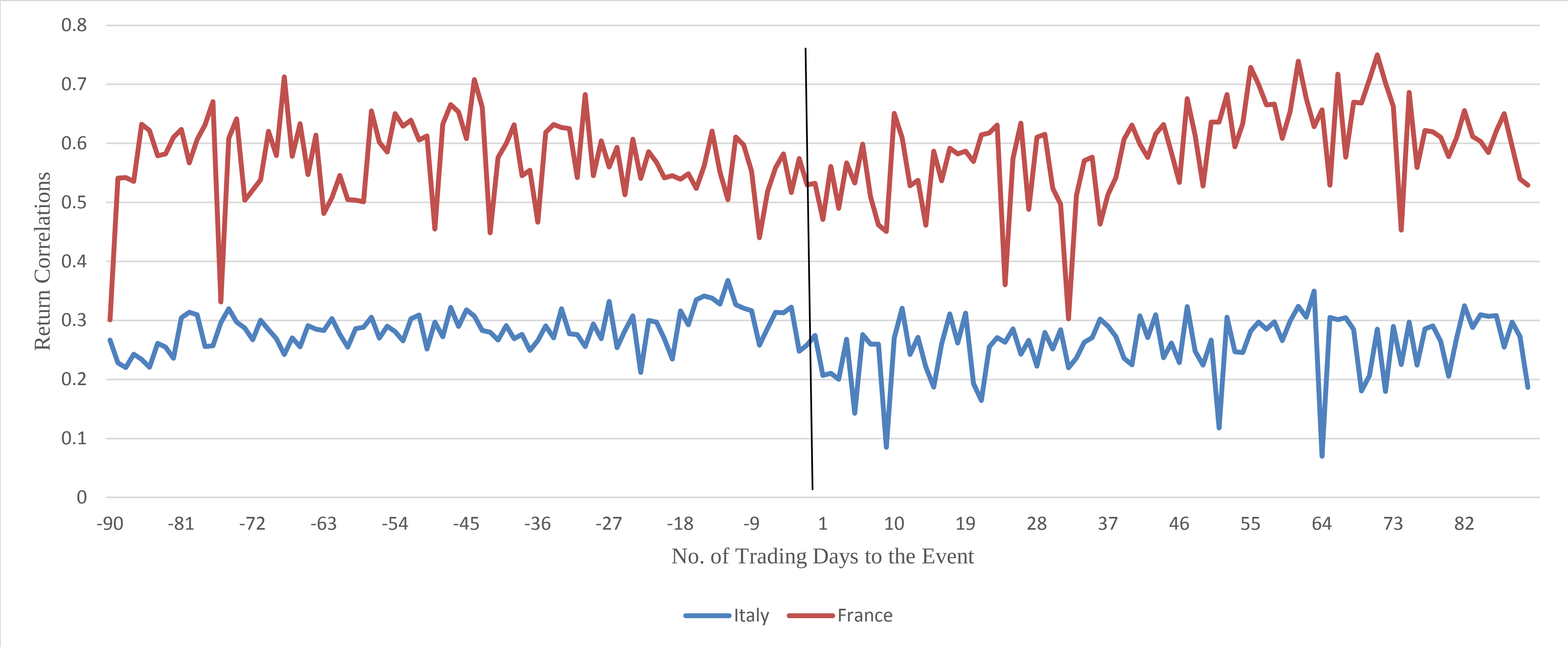
This table reports regression results of the return correlation between index futures and ETFs. The message traffic restriction policy took effect on 2 September 2013 in Italian derivatives market. Three trading days before and after the regulatory change are removed from the sample. *Pre period* is between 22 April 2013 and 27 August 2013. *Post period* is between 5 September 2013 and 15 January 2014. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition. $Event_t$ takes the value of zero if the trading day belongs to the pre-event period, and one otherwise. $Volatility_t$ is defined as the natural logarithm of the highest futures price divided by lowest futures price each trading day. $Volume_t$ is natural logarithm of the total futures trading volume (number of contracts traded) divided by 1,000 each trading day. The *p*-values are computed based on Newey-West standard errors. To reduce the effects of extreme values, all continuous variables in the regressions are winsorised at 1% and 99% levels. * (**) denotes statistical significance at the 5% (1%) level. The *p*-values are reported in parenthesis. R^2 is the adjusted R-squared. *N* is the number of observations.

Figure 1
Daily Return Correlation in Australia and Canada



This figure plots the daily return correlation between index futures contracts and index ETFs within the sample period before and after the message traffic restriction policies are imposed in Australia and Canada. The message traffic restriction policies are the Cost Recovery Scheme (CRS) in Australia (1 January 2012) and Integrated Fee Model (IFM) in Canada (1 April 2012). Three trading days before and after the regulatory change are removed from the sample. *Pre periods* are Australia: 22 August 2011 – 23 December 2011; Canada: 17 November 2011 – 27 March 2012. *Post periods* are Australia: 6 January 2012 – 16 May 2012; Canada: 5 April 2012 – 14 August 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition.

Figure 2
Daily Return Correlation in France and Italy



This figure plots the daily return correlation between index futures contracts and index ETFs within the sample period before and after the message traffic restriction policies are imposed in France and Italy. The message traffic restriction policies are the Financial Transaction Tax (FTT) in Italy (1 March 2013) and France (1 August 2012). Three trading days before and after the regulatory change are removed from the sample. *Pre periods* are Italy: 16 October 2012 – 25 February 2013; France: 19 March 2012 – 26 July 2012. *Post periods* are Italy: 6 March 2013 – 12 July 2013; France: 6 August 2012 – 7 December 2012. The futures contract examined for each trading day is the most actively traded contract. The sample includes 180 trading days, with 90 trading days each before and after the transition.