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The Efficiency of the Finnish Equity Options and Futures Markets: A Review of Empirical Evidence

ABSTRACT

The purpose of this survey is to review the recent relevant research on the Finnish stock and stock index derivatives markets. Several empirical studies are examined, the topics of which cover a wide range of market efficiency tests. First, we briefly review development of the Finnish derivatives markets. Then, we review the studies that have looked for the presence of risk-free arbitrage opportunities. Thereafter, we present a survey of the studies that have dealt with the informational efficiency of the Finnish equity index options and futures markets.

1. INTRODUCTION

The continued worldwide expansion in the use of derivative instruments is attributable to the growing need of market participants to speculate and hedge against various financial risks. Derivatives may offer a cheaper way of managing the risks than the corresponding cash markets. Other factors contributing to the strong growth of derivative trading include globalization of investments and rapid advances in information and telecommunications technology.

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The development of Finnish derivatives markets has followed trends in international financial markets. However, trading in derivative products – with the exception of currency forwards – did not start until fairly late in Finland because of the underdeveloped state of the financial markets in general. Up to the mid-80's trading in derivative instruments was confined mainly to OTC forward contracts offered by banks. Trading in derivative products based on shares started in 1987 along with the rapid expansion of the equity market and the commencement of operations by two derivatives exchanges in Finland, the Finnish Options Exchange (FOEX) and the Finnish Options Market (SOM).[1] The year 1987 also saw the introduction of trading in forward rate agreements (FRA) in the OTC market. FRA's were intitially based solely on certificates of deposits (CDs) issued by the Finnish banks. Trading in interest rate derivatives based on benchmark government bonds did not start until 1994.

As mentioned above, there are two derivatives exchanges in Finland. Both exchanges are overseen by the Financial Supervision Authority. The exchanges differ from each other primarily in terms of ownership structure, size and the product palette. Both exchanges started with stock index derivatives[2]. The stock market collapse and the diminished volume of trading in the early 1990's led to a market split-up, with SOM focusing on stock-based derivatives and FOEX concentrating on foreign exchange derivatives. The focus of FOEX is mainly on currency derivatives and from 1996 on also on pulp derivatives. SOM now carries a wide range of products including stock-based options and futures and both short- and long-term interest rate futures. SOM's wholly-owned subsidiary, EL-EX Electricity Exchange Ltd., started its operations as a marketplace for ELEX electricity forwards in August 16, 1996. At the moment (June 1997) SOM's product range consists of:

– FOX Index Options and Futures
– STOX Stock Options and Futures
– FRX Currency Options and Futures
– LEX Stock Lending Contracts
– FIM Finnish Government Bond Futures
– HELIBOR FRA Interest Rate Futures
– STIBOR FRA Interest Rate Futures
– R Bond Futures on Swedish Government Bonds

1 In July 1997, SOM and Helsinki Stock Exchange Ltd announced they will merge to form a new company called HEX Ltd, Helsinki Stock and Derivatives Exchange, Clearing House. The new company formed by the combination merger is due to be registered in the Companies Register in December 1997.

2 SOM also had stock options based on the shares of Kymmene Oy but the trading was suspended in December 1989. The reasons for this were that the share price volatility was very low, the physical delivery of the stock in the settlement was considered too expensive and there was not enough interest by market makers in trading stock options.

The OTC market accounts for a dominant share of the total volume of derivatives traded in Finland. Currency and interest rate derivatives, in particular, are traded mainly in the OTC market. By contrast, options and futures based on shares are traded only on the Finnish Options Market (see e.g., Virolainen, 1995). Since the introduction of trading in 1988, the main products of the SOM have been options and futures based on the FOX (Finnish Options Index) index. The index is a value weighted index consisting of the 25 most liquid stocks traded on the Helsinki Stock Exchange. The base figure of the FOX index was set at 500 on March 7, 1988. On the first trading day the index was at the level of 551.

On SOM trades have been carried out either electronically via computer or via telephone by using a so-called block-order function. The role of block-order function was to match larger blocks (minimum 10 contracts) and most of the trading was carried out in this manner during the first few years of trading. Since then, the trading has been directed solely into the electronic system. FOX index futures and options expire six times a year, i.e. in February, April, June, August, October and December. The settlement of the contracts is in cash. FOX options are European options in contrast with the STOX options, which are American options based on individual stock series.

Most of the studies on the Finnish derivatives markets have employed a data base of daily closing values at 3:30 kindly delivered by SOM. A specific institutional detail of the Helsinki Stock Exchange used to be the so-called calling-out system. Trading in each stock started with calling-out, while the rest of the trades occurred in the 'aftermarket'. Since April 1990 trading on the stock market has been fully computerized under the HETI system (Helsinki Stock Exchange Automated Trading and Information System). The trading mechanism may naturally distort the index quotations in highly volatile periods. The FOX index is updated only when a stock transaction occurs. This may result in a stale index because of discontinuous trading with stocks. The effect of this should be rather small in the Finnish markets, however, as the value weighted index consists of only the 25 most liquid stocks.

The contract volumes of SOM have been growing remarkably in recent years. In 1994 the total volume exceeded one million contracts for the first time in SOM's history (1,034,653). The year 1995 showed a growth of 55% compared to the previous year, with a total contract volume of 1,607,490. In 1996, the growth compared to the previous year was 151%, with the total contract volume of 4,046,174. SOM's longest-standing product group, derivatives based on the FOX Index, was for many years also the most traded product group. In 1996, the STOX stock derivatives (1,418,959) surpassed the volume of FOX derivatives (607,299) for the second time (SOM, 1997)[3].

3 A good picture of the development of trading volumes in SOM is given at their website (http://www.som.fi.)

To fully understand the empirical work presented here it is necessary to look briefly into some issues that characterized the Finnish stock and derivatives markets in the late 1980's and early 1990's. First, there was no institutional framework for short selling of stocks in the Helsinki Stock Exchange. Therefore, most of the violations from the basic arbitrage conditions can be explained by the difficulties an arbitrageur faces when trying to benefit from arbitrage opportunities. Second, the liquidity in the Finnish stock market has changed dramatically during the last few years. Eklund, Harju and Lahti (1990) provide the first survey of the preliminary empirical evidence from the Finnish stock index options and futures markets. They conclude that (1990, p. 20) *'to guarantee the development of the derivative markets in Sweden and Finland, we should ensure that the stock markets are efficient enough. Things to be considered in the future are the short selling of stocks, system allowing the trading in stock market baskets and the regulation of these trades. Due to these changes the efficiency of the derivative markets would improve considerably since there would be a real arbitrage relation between the markets'.* It is now possible to investigate whether the markets have become more efficient or not.

2. ARBITRAGE EFFICIENCY

2.1. Cost of carry model

Puttonen (1993a) ran some empirical tests on the FOX futures market using daily closing prices from May 2, 1988 to December 21, 1990. First, he studied whether futures market prices differed from their theoretical cost-of-carry values. With zero transaction costs, the futures contract traded at a substantial discount most of the time. When transaction costs were taken into account, the amount of mispricings naturally decreased but did not disappear altogether. With the costs of a market maker, the contracts were underpriced in 31% of the cases. Even with the costs of a final customer, there remained a substantial number of discrepancies (21%). Unlike what has been discovered in many foreign markets, the mispricing had a tendency to persist, not disappear.

Puttonen also examined the profitability of early unwinding and rollover strategies. It was discovered that early unwinding generated potential arbitrage profits but considering transaction costs they were insignificant. However, many opportunities for significant rollover profits were found. When assuming a 1% market impact cost and market makers' transaction costs, approximately 22% of the 732 initial arbitrage positions were rolled over. Puttonen offers three possible explanations as to why such underutilized rollover opportunities exist. First, it is possible to benefit from rollover opportunities only if one has already initiated a traditional initiate-and-hold-to-expiration arbitrage position, which may be more costly than estimated in this

study. Secondly, rollover profits are ex post profits that are unobservable when forming the initial arbitrage position. Thus, the final discount on transaction costs is not clear when the arbitrageur makes the trading decision in the first place. A third (but unlikely) reason may be that participants with a long position in the index stocks have not been aware of the possibility of delayed unwindings.

Puttonen (1993b) carried out both ex ante and ex post tests when examining the profitability of index arbitrage in the FOX market for the period 2nd May, 1988 to December 21st, 1990. Frequent and statistically significant violations of the cost-of-carry lower boundary were reported. Particularly investors long in the index stocks had been able to exploit the arbitrage opportunities since there existed arbitrage opportunitites even after allowing an execution delay of two days.

Hietala, Jokivuolle and Koskinen (1995) examined the pricing of FOX futures and tested the equilibrium model presented by Chen, Cuny and Haugen (1993). The key feature of the model is that the futures and spot index are not perfect substitutes because the futures lack the so-called customization value characteristic of tailored portfolios. This factor can be expected to induce deviations between cash and the futures price. Hietala et al (1995) use daily data from the FOX market for the period May 2, 1988 to May 31, 1994. Unlike the tests of the CCH model with U.S. data, and data from the Netherlands (Berglund and Kabir, 1994), Hietala et al. (1995) reject the model and propose a model which is based on short selling restrictions and the speculative futures buying and selling demand of a monopolistic informed investor.

The model proposed by Hietala et al. (1995) predicts that *a.* the basis is an increasing function of the signal received by the informed trader, *b.* given a positive signal the basis is an increasing function of the volatility, and *c.* given a negative signal the basis is a decreasing function of volatility. The empirical results supported the first hypothesis but did not support the second and third hypothesis. Hietala et al. find a positive relation between the basis and the insider's private signal. As the authors notice, the tests conducted are essentially the same as testing for the lead-lag relation between the futures and the cash market.

2.2. Option boundary conditions

Puttonen (1993c) extended the existing literature on simple call boundary conditions by considering the existing futures price and put options. Two rational boundary conditions were examined for FOX call and put options for the period 2nd May, 1988 to 21st December, 1990. Violations of the call lower boundary were reported for deep-in-the-money options. All the violations were from the lower boundary determined by the underlying index. Put options were found to have traded clearly above their rational lower boundary.

Many of the reported arbitrage opportunitites were too large to be attributed solely to transaction costs. The results suggested that particularly an investor with FOX stocks would have gained additional risk-free profits. It was noted, however, that there are certain problems related also to arbitrage by the stock owners. They may find it inappropriate to sell the stocks due to e.g., voting power or fiscal reasons. The large stock owners may also find it impossible to sell a large number of stocks due to the illiquidity of the market.

2.3. Put-call parity and put-call-futures parity

Puttonen (1992) provided some evidence on the put-call parity and put-call-futures parity in the FOX markets. The sample period covered August 29 – December 23, 1988, August 28 – December 22, 1989 and August 27 – December 21, 1990. These time periods were chosen based on earlier findings of large future mispricings during those times. Also, no dividends were paid and no changes were made to the FOX index during those time periods.

The results of the ex post tests suggest that put-call parity was frequently violated. In particular, the put options were overpriced relative to the calls. In other words, a short hedge was more profitable than a long one[4]. The greatest mispricings occurred in 1990, when 57% of all hedges were profitable even after considering the transaction costs of a final customer. Put-call-futures parity was much less violated than put-call parity. Even though the test setting was different, the results were consistent with the findings of Kahra and Kanto (1991), who examined the difference between put and call implied Black&Scholes volatilities using FOX data from May 1988 to December 1989. Kahra and Kanto concluded that put and call implicit volatilitites are usually different and especially put option implicit volatilities are larger than historical ones.

Again, arbitrage opportunities were explained by the absence of an institutional framework for short selling of stocks. As a result of this, option pricing in Finland has been more based on the futures price than on the underlying index.

Laaninen (1992) also tested the price parities using FOX closing prices for the periods August – December in 1990 and 1991. The results suggest that in 1991, an astonishing 317 out of 663 observations broke the put-call parity condition. The discrepancies in 1991 were so large that they cannot be explained by transaction costs only. In line with the results of Puttonen (1992), Laaninen found that put-call-futures parity holds pretty well in the Finnish markets.

4 A short hedge here is based on the inequality $C_a-P_b+Kr^{-t}+TC_{(s,c,p)}+D_{t,T}-S\geq 0$, where C_a = ask price of a call, P_b = bid price of a put, K = striking price, $TC_{(s,c,p)}$ = roundtrip transaction costs in stock, call and put markets, S = the value of the underlying security (index) and $D_{t,T}$ = the present value of dividends.

3. INFORMATIONAL EFFICIENCY OF THE INDEX OPTIONS AND FUTURES MARKETS

a. Information relationships in the Finnish markets

For derivatives markets to perform a function being a price discovering market the essential question is whether the new information is first reflected in options and futures prices. This means that there should be investors who regard derivatives as an investment vehicle superior to the underlying security and, therefore, options and futures prices determined by such traders will reveal 'real' stock prices. Some reasons for options and futures to be a superior vehicle are as follows. First, transaction costs are usually lower in derivatives markets than in the stock market. Second, the options and futures market may be more liquid than the stock market and index transactions generally take a relatively long time, i.e. tracking a specific index is not a matter of seconds but it may take hours to buy or sell all stock series included in the FOX index. Third, for a trader with bearish view it has been definitely easier to trade options and futures since there are no restrictions governing short sales.

Flow of return information has been mostly examined in the spirit of Granger causality. Puttonen (1993) uses a vector error correction (VEC) model to examine possible linkages between the FOX cash, options and futures markets. The sample covered the period from 1988 to 1990. The results clearly suggest that the short-term stock index returns can be predicted much better with past information from the derivatives markets than with its own past information. With longer time horizons, futures and options prices move further toward the underlying cash index prices than the opposite, which seems understandable: options and futures are still only derivative instruments. Also, the results revealed that the lead-lag relations vary greatly depending on the subperiod analysed.

The relationship between derivatives and cash markets was further improved by allowing the association between markets to differ for positive and negative returns. This was interpreted as a signal of short selling restrictions being a major factor leading to a delay in the pricing of Finnish stocks. It must be noted, however, that a later study by Martikainen and Puttonen (1994) suggested that this asymmetry in predictive power of derivatives over positive and negative index returns may partly be explained by heteroskedasticity. By employing White's matrix the t-values are far from significant. However, the information still flows from the futures market to the cash market at a 1% significance level.

Kinnala (1993) examined the predictability of FOX index changes using data from May 1988 to December 1992. Kinnala formed trading strategies based on the information from the futures price. Open positions were constructed in the cash market (index) when the futures contract was under/overpriced relative to its theoretical value. The profitability of trading strat-

egies varied depending on the critical levels chosen for the under/overpricing signal. However, the results suggested that significant trading profits could have been gained by employing futures market information.

No systematic information flow between options and futures (i.e. in derivatives) markets was found in Puttonen (1993) but Martikainen and Puttonen (1996) suggested that the options market may contain predictive power over the futures market. Using data from May, 1988 to May, 1992 they discovered that in the latter subperiod (May 1990 to May 1992) option returns predicted futures returns. This was explained by the relatively more liquid options market at that time. It is clear that the information relationship is highly dependent on the choice of the research time period.

b. Informational flows from the foreign markets to the Finnish market

In recent years several developments have increased the degree of global financial integration. These developments include deregulation, increase in the cross listings of multinational companies, harmonization of legislation and advances in communications and computer technology. The recent studies suggest a relatively high level of global integration between international stock exchanges, especially after the 1987 crash. However, the studies made on the Finnish market typically show only a low correlation between the Finnish and the world stock market returns (see e.g., Hietala, 1989).

The Finnish stock index derivatives markets have provided an interesting research arena for studying international flows of information. Martikainen & Puttonen (1994) suggested that world-wide stock return information is reflected in the Finnish FOX futures market but not in the Finnish stock market. They conclude that the Finnish financial markets indeed have followed the behavior of the world stock markets. By excluding the futures market previous studies may thus have underestimated the informational flow between international markets.

Puttonen (1995) also provided evidence on the intertemporal dependence between international financial markets by using data from the Swedish and Finnish markets. By investigating the transmission mechanisms of the conditional first and second moments in stock prices he found that volatility seems to flow from the Finnish market to the Swedish market rather than vice versa. This is in sharp contrast with the previous results that information only flows from Sweden to Finland. The results also imply that the volatility relations contain different information than suggested by the traditional lead-lag relations between market returns. The analysis of the conditional mean reveals no significant spillover effect from the Swedish market to the FOX futures market and, in addition, the reported volatility spillover from the FOX index and futures returns on the Swedish market does not exist in the case of mean spillovers.

Meanwhile, a slight spillover effect is found from the Swedish stock market on FOX index returns, which is consistent with prior studies.

c. Other studies on informational efficiency

Martikainen & Puttonen (1996) studied the predictability of stock index futures returns by the trading volume of index options. The call-put signal[5] turned out to give a good forecast of the market direction one day ahead during the research period May 1988 to December 1991. Thus, it was concluded that call and put option volumes offer valuable information. A trading rule based on the signal resulted in significant profits in the index futures market even after considering transaction costs.

Martikainen and Puttonen (1996) investigated the hypothesis of sequential information arrival in the FOX markets during the period May 1988 to May 1992. With no short selling restrictions in the derivatives market, no causality relationships between returns and trading volume were observed in the FOX futures and options markets. However, the call-put signal was found to offer significant information on futures returns.

4. FUTURE RESEARCH DIRECTIONS

This paper has presented evidence from several empirical studies on the efficiency of the Finnish stock index futures markets. Obviously, many interesting research directions exist.

First, most of the studies suggest that short sales restrictions in the Finnish stock market have been the major reason for the market inefficiencies reported. However, the SOM started a LEX stock lending system in 1995, which makes short selling possible also in the Finnish markets. It would be interesting to see how the adoption of the LEX system has affected the efficiency of the stock market. One might expect that strong violations of the basic conditions would not be found any longer. Therefore, it would be interesting to see some of the previous work being carried out with more recent data. Also, the stock market has obviously become more efficient as the restriction on foreign ownership of Finnish shares was abolished in 1992.

Another interesting research area is the pricing of STOX options and futures. The volume of trading in stock options and futures has grown recently. Therefore, it would be interesting to see how pricing in these new instruments has developed.

Research on market microstructure questions such as option trading volume, open interest and the effect of the market mechanisms would offer new insights into how the market

5 The call-put signal is calculated as $\frac{\text{Call volume} - \text{Put volume}}{\text{Total volume}}$

operates. Also, such research would make it possible to develop the market. It is obvious from the previous work that research results are not only helpful for developing the derivatives markets but in developing the stock market, too. ■

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