TESTING EFFICIENCY AND THE UNBIASEDNESS HYPOTHESIS OF THE EMERGING GREEK FUTURES MARKET[(a)]

Dimitris F. Kenourgios, Department of Accounting and Finance, Athens University of Economics and Business, 5 Stadiou Str., Office 115, 10562 Athens, Greece.

Abstract

This paper investigates the joint hypothesis of market efficiency and unbiasedness of futures prices for the FTSE-20 blue chip index futures contract. The FTSE/ATHENS STOCK EXCHANGE (ASE)-20 futures market is the first organized derivatives market established in Greece and its operation rests with the Athens Derivatives Exchange (ADEX) and the Athens Derivatives Exchange Clearing House (ADECH). The growing importance of this new market for both investors and the Greek capital market motivated this empirical examination of its efficiency, even though it is an emerging market with low liquidity, compared to other European developed futures markets, but strong growth rates. The Johansen cointegration procedure used to test the market efficiency shows that the joint hypothesis of market efficiency and unbiasedness in futures prices is rejected, indicating market inefficiency. This finding is consistent to earlier but limited studies in other European emerging futures markets, implying that, despite the significant role of an organized futures/derivatives market for a capital market and an economy more general, further necessary steps have to be taken in order to contribute to its efficiency.

Keywords: Market efficiency, Unbiasedness hypothesis, Athens Derivatives Exchange, FTSE/ASE-20 futures market.

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1. INTRODUCTION

As pointed out by Fama (1970), a financial market can be considered as efficient if prices fully reflect all available information and no profit opportunities are left

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unexploited. The agents form their expectations rationally and rapidly arbitrage away any deviations of the expected returns consistent with supernormal profits.

The investigation of the validity of the Efficient Market Hypothesis (EMH) has been and still is one of the favorite topics of the financial literature. Various markets have been tested throughout the years for the degree that they fulfill the hypothesis. However, a lot of controversy existed not only about the real meaning that is attributed to the concept of Market Efficiency but especially about the method that must be applied to test for its existence. The last two decades, the concept of cointegration opened new perspective for the methods to be used to test the hypothesis.

Fama (1970, 1991) contends that market efficiency per se is not testable and it must be tested jointly with some pricing assets model. According to the futures markets literature, the model that futures prices are unbiased estimators of future spot prices is the appropriate framework to test efficiency. Using this model, efficiency will necessarily imply that the market price fully reflects available information and so there exists no strategy that traders can speculate in the futures market on the future levels of the spot price exploiting profits consistently. However, if the joint hypothesis is rejected it is not possible to argue whether the market is inefficient or the asset pricing model used is inappropriate.

A significant number of studies have examined the efficiency of futures markets using different methodological techniques. The first studies used mainly the regression analysis (e.g., Frenkel, 1979; Huang, 1984; Goss, 1986). However, if price series are not stationary, a phenomenon typical in financial markets, then standard statistical tests of parameter restrictions are not reliable (Elam and Dixon, 1988). Thus, for overcoming the problems of nonstationary price series, the cointegration procedure has been used to examine the efficiency of various markets (MacDonald and Taylor, 1988; Baillie, 1989; Hakkio and Rush, 1989; Shen and Wang, 1990; Chowdhury, 1991; Lai and Lai, 1991; Barhart and Szakmary, 1991; Beck, 1994; Brenner and Kroner, 1995).

This paper presents a first empirical investigation of the Greek FTSE/ASE-20 futures market efficiency, even though this specific market goes through its first steps of growth and can be characterized as an emerging derivatives market. The establishment of an organized derivatives market was a significant and necessary step for the Greek capital market, towards its ultimate maturity, transparency and secure functioning. The Athens Derivatives Exchange (ADEX) and the Athens Derivatives Exchange Clearing House (ADECH) have the responsibility of organizing and operating this market in which a number of standardized contracts on futures and options are traded and cleared.

In ADEX's brief history, annual trading volume in derivatives contracts has increased 83% for the period 2000-2001 (4.358.866 contracts in 2001 relative to 2.381.260 in 2000). Additionally, daily average number of contracts has risen 127% for the same period (9.118 contracts in 2001 relative to 4.020 in 2000). After its establishment and from August 1999 until March 2000 (the beginning of our examined time period), average monthly trading volume in FTSE/ASE-20 futures contracts has risen 76.6% (30.978 contracts in March 2000), while daily average number of contracts in March 2000 have increased 131% relative to August 1999 (2.816 and 1.219 contracts in March 2000 and August 1999 respectively).

In order to test the efficiency of the FTSE/ASE-20 futures market we apply the cointegration analysis using the Johansen Maximum Likelihood Procedure (Johansen, 1988 and 1991). The futures contract that is used has three months expiration period since there are no other FTSE/ASE-20 futures contracts of different maturities launched on ADEX. This investigation is significant for two reasons. First, it is focused in an emerging futures market, such as is the case for Greece, given the existing paucity of research in such markets. Second, given that this market was the first organized derivatives market introduced in an environment with no prior relevant experience, and this contract has the greater liquidity among the other derivatives products traded in ADEX, the examination of market efficiency with more up-to-date econometric tests than were employed in the early literature on market efficiency is certainly of concern to existing and future participants.

The plan of this paper is as follows: Section 2 gives a brief discussion of the ADEX and the ADECH and displays the main characteristics of the FTSE/ASE-20 futures contract. Section 3 presents theoretical and testing issues regarding futures market efficiency. Section 4 describes the following methodology, while section 5 describes the sample data and presents the empirical results. Finally, Section 6 draws a summary and the conclusions.

2. ATHENS DERIVATIVES EXCHANGE (ADEX) AND THE FTSE/ASE-20 FUTURES CONTRACTS

Until the late years of the last decade, and prior to the creation of the institutional framework for the operation of the organized derivatives market in Greece, transactions on derivatives existed on a limited scale, over-the counter, mainly between financial institutions and companies. The development of the organized derivatives market in Greece, similarly with other developed European countries, was a result of the growth of the Greek capital market and economy in general[1]. The establishment of the ADEX and the ADECH in accordance with Law 2533/1997 offers a majority of standardized products to an enlarging number of participants (corporations, individual investors, banks, mutual funds, state enterprises, investment companies), contributes to the efficiency of the capital market and has positive influence on the national economy.

ADEX and ADECH were founded in April 1998 as autonomous companies. ADEX's purpose is to organize and support trading in the derivatives market. It is organized along two main axes. The first is the development of business and the second is related to the execution of transactions. The purpose of ADECH is to act as counterparty in all trades concluded on ADEX, the clearing of transactions that are effected, the settlement of the transactions, the ensuring of the fulfillment of obligations arising from these transactions, and co-operation with members and banks, to ensure the safe commitment and disengagement of margins, the financial settlement of transactions and every related activity. The electronic system provided by ADEX is part of the Integrated Automated Electronic Trading System (OASIS). All transactions on standardized derivatives are effected through this system, creating an electronic market in which access is via a computer installation at every member's location.

Direct access to ADEX and ADECH is restricted to those organizations, which have been accepted as members, having fulfilled the legal requirements and submitted the details required by the membership application. There are two types of membership in ADEX. The first category is the single members who act as broker-agents and are not allowed conducting transactions for their own account and the second category is the market makers.

The futures contracts traded on ADEX have underlying assets the FTSE/ASE-20 blue chip index, the FTSE/ASE-40 midcap index, the ten year Greek bond, the three-month ATHIBOR, and selected “blue-chip” stocks, while American style options contracts on major Greek “blue-chip” stocks and the above FTSE indexes and stock lending contracts have been launched recently.

The trading on ADEX began on 27/8/1999 and the first traded product was the FTSE/ASE-20 futures contract. The FTSE/ASE 20 index has been chosen as the most suitable due to the high liquidity, and turnover of its constituent shares. The futures on the FTSE/ASE-20 are cash settled and quoted in index points. At any point in time, there are six index futures contracts listed, corresponding to the associated expiration months: the three nearest consecutive months from the monthly cycle and the three nearest months from the March, June, September and December quarter cycle, not included in the consecutive months. The expiration day and the last trading day on the FTSE/ASE-20 futures is the third Friday of the expiration month. Open positions on futures are subject to daily settlement (marking to market). Table 1 displays the main specifications of the FTSE/ASE-20 futures contracts.

Table 1

3. FUTURES MARKET EFFICIENCY: THEORY AND TESTING

Efficient Market Theory is based on the assumption that the current prices reflect all the available amount of information including the expectations of the agents about the movements of the prices. All new information is immediately incorporated into the expectations about future prices. Based on these expectations, agents buy and sell, converting, this way, gradually the expected prices into current prices.

The implication of the random walk theory for the futures markets is that the prices of the underlying assets follow random movements and every change in them is unpredictable and both independently and identically distributed. So it can be said that the spot prices of the underlying assets, functioning by the way it has been described above, can be thought of as the best available predictor of the future spot rate:

$$S_t = E\ (S_{t+n}) \qquad (1)$$

But this way an agent could get some profit, buying an asset at a discount from spot and selling it at a premium in the future market. The premium or the discount can be considered as the markets expectations about the future rate of change of the underlying asset price and the current spot price as an equilibrium level of the price of the asset. In a financial market, risk- neutral agents will try to make a profit whenever the level of price of the futures contract differs from their expectations about the spot price an asset at a certain moment in the future. This way, through buying and selling the future contract, and if the number of participants in the market is big enough, its price will change until it equals the expected spot price:

$$F_t = E\ (S_{t+n}) \qquad (2)$$

Furthermore, it is known that the spot price of a financial asset is formed every time based on the already available information and will change only by some new development. It is also possibly that expectations about the future spot price will deviate from the price that finally is going to prevail by some random error observable only after the fact[2]:

$$S_{t+n} = E\ (S_{t+n}) + e_{t+n} \qquad (3)$$

Combining equations (2) and (3), it follows that

$$e_{t+n} = S_{t+n} - F_t \qquad (4)$$

or

$$S_{t+n} = F_t + e_{t+n} \qquad (5)$$

and the equation (5) is the algebraically representation of the Unbiasedness Hypothesis or Simple Efficiency (Hansen and Hodrick, 1980) or Speculative

Efficiency (Bilson, 1981). Under this hypothesis, deviations between F_t and S_{t+n} should have a mean zero and will be serially uncorrelated. This equation provides a pricing model specification and enables the efficiency of futures markets to be examined (under conditions of risk neutrality).

Fama (1991) supports that market efficiency tests involve testing a joint hypothesis of efficiency and the asset pricing model. Empirical analysis of (5) allows the examination of the joint hypothesis of market efficiency and unbiasedness in futures prices. Equation (5) can be written also by regressing the spot price at maturity on the futures price some time prior to maturity:

$$S_t = \alpha + bF_{t-n} + e_t \qquad (6)$$

Market efficiency requires that $\alpha=0$ and $b=1$. It is also normal to assume that futures prices closer to the expiration dates will provide better estimates of the future spot price than do those further away. Rejection of the restrictions imposed to the parameters α and b means that either the market is inefficient or a non-zero risk premium ($\alpha \neq 0$) is existed in futures markets.

4. METHODOLOGICAL ISSUES

4.1 Stationarity Tests

Standard statistical techniques of parameter restrictions as those presented in relation to equation (6) are not reliable in circumstances where data are non-stationary. However, cointegration provides a satisfactory means to investigate (6), in the presence of non-stationary series.

The existence of unit roots is tested following the analysis of Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1981) through the relationship:

$$\Delta S_t = \alpha + \beta T + \rho S_{t-1} + \sum_{i=1}^{k} \gamma_i \, \Delta S_{t-i} + \varepsilon_t \qquad \varepsilon_t \sim \text{i.i.d. } (0, \sigma^2) \qquad (7)$$

where $\Delta S_t = S_t - S_{t-1}$, S_t is the future spot price index, and k is chosen so that the deviations ε_t to be white noise. The same relationship is used to determine the order of the futures price index (F_t). The null and the alternative hypothesis for the existence of unit root in S_t and F_t is H_o: $\rho = 0$, H_1: $\rho < 0$.

Phillips and Perron (1988) have modified the ADF test (based on Equation 7 without lagged differences), as the ADF tests are only valid under the crucial assumption of i.i.d. processes. In practice, it may be more realistic to allow for some dependence among the u_t*'s*. In that case, the asymptotic distribution is changed. Phillips and Perron (1988) have weakened the i.i.d. assumption by using a non-parametric correction to allow for some serial correlation and heteroskedasticity:

$$y_t = \alpha_0 + a\, y_{t-1} + u_t \qquad (8)$$

The PP test tends to be more robust to a wide range of serial correlations and time-dependent heteroskedasticity. In the PP test, the null hypothesis is that a series is non-stationary (i.e. difference stationary) if $\alpha = 1$, hence, rejection of the unit root hypothesis is necessary to support stationarity. The asymptotic distribution of the PP *t*-statistic is the same as the ADF *t*-statistic.

4.2 Cointegration and Market Efficiency

When two price series, such as the future and the spot price series, are both integrated of the same order d, a linear combination of two I(d) series can be integrated of an order lower than d. More specifically, it is possible that two series that are non-stationary and contain a unit root, for example I(1), can generate a linear combination that is stationary, I(0). These two series are said to be cointegrated with a cointegrating relationship of the following form:

$$S_t - \alpha - bF_{t-n} = e_t \qquad (9)$$

Cointegration of two price series is a necessary condition for market efficiency, since the market efficiency hypothesis implies that the future price is an unbiased predictor of the future spot price. If the two series are cointegrated, S_t και F_{t-n} move together and will not tend to drift apart over time. If this is the case then the futures price is an unbiased predictor of the future spot price.

In order to test for cointegration between the two markets, the Johansen Maximum Likelihood Procedure (Johansen, 1988 and 1991) is implemented. This is a preferred method of testing for cointegration as it allows restrictions on the cointegrating vectors to be tested directly, with the test statistic being x^2 distributed[3].

The Johansen cointegration procedure firstly specifies the following unrestricted N-variable VAR:

$$x_t = \mu + \sum_{i=1}^{k} \Pi_i x_{t-i} + \varepsilon_t \qquad (10)$$

where $x_t^{'} = [\ f_t^{'}\ ,\ s_t^{'}\ ]$, μ is a vector of intercepts terms and ε_t is a vector of error terms. Johansen (1988) and Johansen and Juselius (1990) reparameterized the equation (10) in the form:

$$\Delta x_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} - \Pi x_{t-k} + \varepsilon_t \qquad (11)$$

Equation (11) is now a VAR reparameterized in error correction form, where $\Pi = -(\Pi - \Pi_1 - \ldots - \Pi_k)$ represents the long response matrix. Writing this matrix as $\Pi = \alpha\beta^{'}$, then the linear combinations $\beta^{'}\ x_{t-k}$ will be I(0) in the existing of cointegration, with α being the adjustment coefficients, and the matrix Π will be of reduced rank. The Johansen approach can be used to test for cointegration by assessing the rank (r) of the matrix Π. If r=0, then all the variables are I(1) and there are no cointegrating vectors. If 0<r<N, there will be r cointegrating vectors. Last, if r=N then all of the variables are I(0) and, given that any linear combinations of stationary variables will also be stationary, there are N cointegrating vectors.

However, Hakkio and Rush (1989) demonstrate that, while cointegration is a necessary condition for market efficiency, is not a sufficient one for two reasons. Firstly, it is necessary to consider the values of the parameters α and b in the equation (6). For the futures price to be an unbiased predictor of the future spot price it is required that α=0 (for zero expected profits) and b=1 (the only value that implies stationary excess return)[4]. In order to test these restrictions, Wald tests are conducted. Secondly, along with the restricted-cointegration test, a test for serial correlation of $S_t - F_{t-n}$ is needed to infer about market efficiency hypothesis (Liu and Maddala, 1992). The acceptance of the above restrictions imposed to α and b (both jointly and individually) and the serial independence of e_t is a second necessary condition for market efficiency. If the above two conditions are met, then markets are efficient and futures prices provide unbiased estimates of future spot prices.

If both necessary conditions are met, according to Hakkio and Rush (1989) and Antoniou and Holmes (1996), the short- run efficiency of the futures market (third condition) has to be tested, since in the short- run it is possible that there will be considerable departures from the long-run equilibrium relationship (implied by the first two conditions). This can be tested by using an error correction model (ECM) in the following form:

$$\Delta S_t = \alpha + \rho[S_t - \delta F_{t-n,t-1}] + \sum_{i=1}^{k} \beta_i \Delta S_{t-i} + \sum_{j=0}^{l} \gamma_j \Delta F_{t-n,t-j} + e_t \quad (12)$$

where $[S_t - \delta F_{t-n,t-1}]$ is the error-correction term. Short-term efficiency can be investigated by testing the following restrictions in the above equation; $\gamma_0 = \delta = -\rho = 1$, and α and all other lagged values are zero. If these restrictions hold, then the above equation collapses to $S_t = F_{t-n} + e_t$.

5. DATA AND EMPIRICAL RESULTS

We examine the unbiasedeness hypothesis and market efficiency for the three-month FTSE/ASE-20 index futures contract traded at the Athens Derivatives Exchange (ADEX) and the corresponding spot index traded at the Athens Stock Exchange (ASE). This paper models only three-month FTSE/ASE-20 contract expiration since there are no different contract expirations traded on ADEX. The data used in this study consist of minute-by-minute spot values of the FTSE/ASE-20 stock index and the FTSE/ASE-20 futures contract prices in the period from March 2000 to March 2002. By using a finer grid of per minute data, a more robust examination is offered. The logs of the spot and futures prices are used. The spot price relates to the values of the index for the days relating to the last ten days of futures trading for the examined contract, while the futures prices relate to the prices on the last ten trading days of one month prior to expiration (the number of observations is 61.650 for each price series). In order to eliminate the stale price effects, prices before and after the specified trading hours of ASE and ADEX are not used.

The selection of the period March 2000- March 2002 is due to the significant increase of a number of statistics concerning the FTSE/ASE-20 futures contract in 2001 compared to the previous year. Table 2 reports total volume, daily average volume and daily open interest on FTSE/ASE-20 index futures during the period 2000-2001. Average daily traded volume for 2001 was up to 173% compared to 2000, open interest averaged over 11.500 contracts, while daily average trading value for 2001 was 41,76 mil. euros. These statistics indicate the strong growth of so far the star product of ADEX[5].

Table 2

To determine the order of each price series, the Augmented Dickey-Fuller τ-test and the Phillips-Perron test are computed on the levels of each price series. Performing the tests on the levels of each series shows that the null hypothesis of a unit root is not rejected; thus, each series is I(0). On the contrary, the results of the tests on the first differences indicate that each series is I(1). Table 3 reports the results of the Unit roots tests.

Table 3

Since the two series are I(1), the Johansen procedure test for cointegration is used. Hall (1991) has demonstrated that in using this procedure to test for cointegration it is necessary to establish the appropriate order of the VAR. For the choice of the lag order k, the Akaike information criterion (AIC) and the Scwharz-Bayesian criterion (SBC) are applied. The results of the AIC established a lag length of 5, while the SBC a lag length of 2[6].

In order to assess the model adequacy, at each lag the VAR residuals are checked for satisfying the white noise assumption. Tests for serial correlation (Breusch-Godfrey LM test), normality (Jarque-Bera test), and Autoregressive Conditional Heteroskedasticity (Engle ARCH LM test) are performed, with the test statistics being x^2 distributed. The presence of serial correlation on the innovations of the VAR indicates also the existence of the effects of infrequent trading and the bid-ask price effect (Wahab and Lashgari, 1993)[7]. Moreover, we find heteroskedasticity and we use the White (1980) correction for heteroskedasticity to account for this problem. Table 4 reports the results of the four tests.

Table 4

The results indicate the serial independence of e_t, no ARCH effect, and statistically significant values of t-statistics after correction for heteroskedasticity for both lag orders, while there is a problem of non-normality. This appears to be mainly due to the events of 11th of September 2001 in the United Stated which had a major impact on the normality of each series. The problem of non-normality in the data is overcome by including a dummy variable relating to this one observation[8]. Hence, we proceed with the maintained hypothesis that k=5 on the grounds that choosing an excessive lag order is less hazardous than underestimating it.

Having established the appropriate lag length we can now proceed to test whether the spot and futures prices cointegrate. Table 5 reports the test statistics by Johansen and Juselius (1990) for the number of cointegrating vectors.

Table 5

The table shows that the null hypothesis of zero cointegrating vectors is rejected at the 5% level, whilst the null of one cointegrating vector cannot be rejected (according to both Maximal eigenvalue and Trace statistics). Thus, the spot price level and the futures price level are I(1), with linear combinations being I(0), confirming that the two price series are CI (1,1).

With respect to the parameters restrictions, α=0 and b=1 (both jointly and individually), the results of Table 5 show that for one month prior to expiration the restriction that α=0 holds at the 5% level. However, the restriction that b=1 and the joint restriction that α=0 and b=1 are rejected at the 5% level. Thus, the joint hypothesis of market efficiency and unbiasedness in futures prices is rejected, since both necessary conditions for market efficiency are not met, even though spot price and futures price series cointegrate.

6. SUMMARY AND CONCLUSIONS

This paper has investigated the efficiency of the FTSE/ASE-20 stock index futures market, testing the joint hypothesis of market efficiency and unbiasedness of futures prices.

The unit root tests conclude that each series is nonstationary in the levels but stationary after first differencing. Both the spot and the futures indices are tested for cointegration using the Johansen cointegration procedure. The Johansen tests indicate that both indices are cointegrated, and then the first necessary condition for market efficiency is met.

However, the second necessary condition for market efficiency does not hold, since the restrictions on the parameters α and b in the cointegrating relationship (α=0 and b=1) are rejected, even though the serial independence of e_t is accepted.

The empirical results presented in this paper suggest that the FTSE/ASE-20 futures market is inefficient and futures prices appear not to be unbiased predictors of spot prices for one month prior to maturity of the futures contract. This finding has an important implication for market participants in the Greek capital market, indicating that there are opportunities for possible speculative profits to be made. Moreover, this evidence is consistent with the findings of earlier studies on other European emerging futures markets (e.g., Martikainen et. al, 1995; Bühler and Kempf, 1995), supporting the inefficiency in those markets[9].

Finally, the evidence presented in this paper implies that, despite the strong growth in Greek futures market's short history since inception and its development in accordance to other developed European markets, more actions have to be taken in order to contribute to its efficiency. These actions concern the price transparency, the further decrease in margins and trading costs, the development of more effective trading systems and market monitoring and the market liquidity by increasing the participation from local and foreign institutional investors.

FOOTNOTES

[1] The Greek capital market seemed ready to support an organised market on financial derivatives. The turnover ratio is over 30% since 1994 whilst, in 1998, it increased 62%. Accordingly, the total capitalisation has been over 20 billion dollars since 1996, reaching 81 billion dollars in 1998. Finally, the ratio of capitalisation to GDP has increased continuously from 1996. In 1998 it had doubled compared to it for 1997 and was well above 120% in 1999.

[2] At this point, a significant issue, beyond the purpose of this paper, is that of what the expectations of market participants reflect at the time of formation. In other words, one cannot for sure attribute to a particular reason the finding that F differs from S. What these deviations actually represent has triggered a long-standing debate. The standard view is that, apart from the forecast error, they are a combination of possibly time- varying risk premium, failure of rational expectations and "peso" problems (Fama, 1984; Bekaert, 1994; Engel, 1996).

[3] Although the cointegration method is applied to estimate long-run relationships, this paper uses minute- by- minute data for only two years period. However, other studies used this approach to examine the relationship between cash and futures markets for even shorter time span (e.g., Antoniou and Garrett, 1993; Pizzi, et. al, 1998).

[4] This can be seen if rewrite equation (6) in the following form: S_t-F_{t-n}=a+(b-1)F_{t-n} +e_t. The new equation is similar to (6) if b=1.

[5] According to Federation of European Securities Exchanges, ADEX ranked 7th in stock index futures by trading value during 2000-2001 among European derivatives markets, leaving behind the markets in Portugal, Denmark, Finland, Austria, Norway, Poland, and Hungary.

[6] In the interests of brevity, tests results are not presented here. Results are available from the author on request.

[7] Stoll and Whaley (1990) use an ARMA process every year to purge the effects of infrequent trading and the bid-ask price effect of the lagged differences for the spot and futures prices. However, by allowing the effects of nonsynchronous trading to change every year, the ARMA filtering may not completely purge the nonsynchronous trading components, if the effects change throughout the day.

[8] After the inclusion of dummies, the problem of normality is at least marginally solved. For the lag length of 5, the JB test is 8.502 (p-value= 0.10) and 7.933 (p-value= 0.107) for spot and futures prices as dependent variable respectively. The same holds for the lag length of 2. The results for the number of cointegrating vectors in Table 5 relate to tests including stationary dummy variables. However, exclusion of the dummy variables does not alter the pattern of the results.

[9] Those empirical studies tested the assumption of the random walk hypothesis, using different methodology, and provided evidence of the hypothesis violation and thus inefficiency in the examined emerging markets.

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Table 1

SPECIFICATIONS OF THE FTSE/ASE 20 FUTURES CONTRACTS

PRODUCT	- FTSE/ASE-20 INDEX FUTURES
SETTLEMENT	- Cash settlement
MINIMUM LOT SIZE	- Single Market: 1, Block Market: 100
CONTRACT SIZE	- The contract multiplier is 5 EURO per index point
QUOTE UNIT	- Index points
MINIMUM TICK	- 0.25 index points
TICK VALUE	- 1,25 EURO
PRICE LIMIT	- No price limit
TRADING HOURS	- Monday to Friday: 10:45 am to 16:15 pm (local time)
MARGIN REQUIREMENTS	- 12% of the position
MARGINING SYSTEM	- RIVA (Risk Valuation) per end client
POSITION LIMITS	- No position limits
LAST TRADING DATE	- 3rd Friday of the expiration month
SETTLEMENT DATE	- First working day following the last trading day
LISTING RULES	- 3 closest consecutive months plus 3 closest from the Mar-Jun-Sep-Dec quarter cycle. On the working day following the last trading day, a new series is introduced
SETTLEMENT OF FEES	- Fees are settled on the working day that follows the trade day (T+1)
EXCHANGE FEE	- 0,15-0,55 EURO (Market Makers B) / 1,30-1,80 EURO (Others Members)
MARGIN	- Collateral using RIVA (Risk Valuation) at end client level by Clearing House

Source: ADEX

Table 2 MAIN INDICATORS: FTSE/ASE-20 INDEX FUTURES			
Year	2001	2000	% change from 2000
Trading days	252	250	
Total volume	1.320,625	484.243	
Daily average volume	5.259	1.927	173%
Daily average open interest	11.638	4.154	180%
Traded value (in mln euros)	41.76	26.20	60%
Source: ADEX			

Table 3

UNIT ROOT TESTS

Statistic tests	Spot index	Futures index
ADF levels	-2.5308	-2.4982
ADF first differences	-22.0832*	-25.2360*
PP levels	-2.5814	-2.6398
PP first differences	-31.4532*	-32.3639*

The null hypothesis is that series has a unit root.

*Denotes that the test statistics are significantly different from zero at the 5% level. The critical value for ADF and PP tests is -3.42 at the 5% level.

Table 4

PROPERTIES OF THE RESIDUALS OF THE VAR SYSTEM.

	k=2		k=5	
	Dependent variable		Dependent variable	
	Spot price series	Futures price series	Spot price series	Futures price series
LM Statistic Test	1.7583 [0.124]	0.91887 [0.338]	1.6986 [0.163]	1.7748 [0.183]
JB Statistic Test	2504.9 [0.000]	2737.6 [0.000]	2601.8 [0.000]	3072.9 [0.000]
ARCH LM Test	5.8976 [0.1125]	7.2346 [0.3785]	3.6798 [0.0583]	4.0146 [0.1976]
t- stats using White standard error	11.3563 [0.3373]	16.8234 [0.2045]	9.0456 [0.4129]	6.9875 [0.2875]

Notes: P – values are in parentheses.

LM Test is Godfrey's (1988) Lagrange Multiplier (LM) Statistic for second and fifth serial correlation in the residuals, being asymptotically distributed as x^2 under the null of serial independence.

The JB Statistic is Jarque-Bera's (1987) Test for normality, being distributed as x^2 with 2 degrees of freedom under the null of normal distribution.

The ARCH LM Test is Engle's (1982) Lagrange Multiplier (LM) Statistic for Autoregressive Conditional Heteroskedasticity under the null of no ARCH effect.

Table 5

JOHANSEN TESTS FOR COINTEGRATION OF SPOT AND FUTURE PRICES

$\mathbf{LS_t = a + b\ LF_{t-n} + e_t}$

Futures' maturity	Null	Alternative	Tests for cointegrating vectors based on				Wald Tests on Parameters Restrictions		
			Maximal eigenvalue statistic	Critical values (5%)	Trace statistic	Critical values (5%)	α=0	b=1	α=0 and b=1
F_{t-1}	r=0 r≤1	r≤1 r=2	15.9776* 1.2649	13.810 7.5300	19.9334* 1.2649	17.8800 7.5300	1.111 [.292]	1688.5 [.000]	1650.6 [0.000]

Notes: LS and LF denote the log of spot and futures prices respectively.

* Denotes that the null hypothesis of no cointegration is rejected, while the alternative hypothesis of one cointegrating vector is accepted at the 5% level.

The critical values are from Johansen and Juselius (1990), Table A3.

P – values are in parentheses.