“Mispricing in stock index futures markets - the case of Greece”

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Mispricing in stock index futures markets – the case of Greece

Abstract

This study investigates the pricing efficiency of FTSE/ATHEX-20 index futures contracts and examines whether arbitrage profits exist in the Greek market. By comparing ex-post mispricing with round-trip total transaction costs faced by different groups of market participants, the empirical investigation suggests that profitable arbitrage opportunities are likely to be common in the Athens Exchange.

The current paper also documents and tests the factors that determine the occurrence and the magnitude of the arbitrage opportunities in the Greek futures market. The findings suggest that variables, such as futures maturity, dividends, volatility, liquidity and short-selling restrictions, explain effectively the cash-futures mipricing.

Keywords: price discovery, futures, arbitrage, cost-of-carry model, Tobit regression, Greek Stock market, FTSE/ATHEX-20.
JEL Classification: G10, G13, G15.

Introduction

This paper tests and documents the pricing efficiency of the futures contracts that are written on the big capitalization stock index of the Greek market and considers whether index arbitrage is feasible. The empirical findings reveal the existence of significant differences between actual FTSE/ATHEX-20 futures prices and the respective theoretical fair prices derived from the cost-of-carry model. Additionally, by using daily data from January 2004 to December 2009, this study determines ex-post arbitrage opportunities by calculating the difference between the absolute value of the cash-futures mispricing and the total transaction costs.

Since the introduction of stock index futures contracts, academic research has focused on spot-futures prices relationship mainly in three ways. The first class of literature tests the practical validity of the cost-of-carry model and seeks to discover potential index futures pricing inefficiencies. The second group investigates the lead-lag relationships between spot and futures markets and their contribution in the price discovery procedure, while the third research class examines the volatility spillover effects between the two markets. This research paper contributes to the first line of research by testing the pricing efficiency of the FTSE/ATHEX-20 index futures contracts traded in the Athens Exchange (ATHEX). FTSE/ATHEX-20 index consists of the twenty larger in terms of market capitalization companies listed in the Athens Exchange. It was the first stock index that was used as an underlying asset in the Greek derivatives market in 1999.

Numerous studies have examined the efficiency of futures markets using different methodological techniques. Initially, researchers mostly employed the regression analysis (e.g., Stoll and Whaley, 1990). However, the cost-of-carry model implies that a pair of spot and futures prices should be cointegrated in the long run (Schlusche, 2009). Therefore, the use of some version of the vector error correction model (VECM) has become commonplace in the relevant literature (indicatively Ghosh, 1993; Tse, 1995). Cointegration theory implies that price differences between markets do not diverge significantly, as there is a long-run relationship between prices in parallel markets. The VECM specification defines that prices may deviate from their common long-run relation, but arbitrage forces make certain that prices converge to their theoretically fixed relationship. One limitation of the standard linear error correction model is that the cointegration relation of spot and futures prices, which is dictated by the cost-of-carry model, is not constant over time but rather changes daily (Schlusche, 2009). This is true because, as Yadav and Pope (1994) demonstrate, transaction commissions and costs, interest rate and dividend uncertainty and market impact risks essentially allow futures contracts to hover within a price range without triggering arbitrage intervention. Profitable arbitrage is feasible only when the absolute cash-futures basis sufficiently exceeds the total costs associated with arbitrage transactions. Therefore, the arbitrage-driven convergence towards the fair cash-futures relationship is discontinuous. Arbitrageurs will step in only when the absolute price discrepancy surpasses the total transaction costs.

According to Buhler and Kempf (1995) academic research has extensively documented the existence of mispricing in the futures markets of the USA, the UK and Japan. The Greek stock market has been also investigated in that context, but all the relevant attempts use a variation of an error correction model. Their findings are remarkably consistent. Kenourgios (2004) examines the relationship between the spot and futures prices of FTSE/ATHEX-20 index during the period from August 1999 to June 2002 using Engle-Granger and Johansen cointegration tests and develops an error correction model. His empirical results show that the two markets are cointegrated and also indicate the presence of a bi-directional causality between the two markets. Floros and Vougas (2007) employ a bivariate GARCH (1,1) model and confirm cointegration and lead-lag relationship between spot and futures for both FTSE/ATHEX-20 and FTSE/ATHEX Mid Cap indices during the period of 1999-2001. Kavussanos et al. (2008) also investigate the lead-lag relationships in daily returns and volatilities between cash and futures prices in the FTSE/ATHEX-20 and FTSE/ATHEX Mid Cap markets during the period from August 1999 to July 2001; their findings suggest that prices are cointegrated in both markets and restrictions on the cointegrating vector hold only in the Mid Cap index. Finally, Hourvouliades and Kousenidis (2008) find strong evidence of stationarity on first differences and Johansen cointegration between spot and futures for FTSE/ATHEX-20 index during the period of 2002-2006. However, none of the above-mentioned Greek-related efforts takes into consideration that the cointegrating relation, dictated by the cost-of-carry model, is not constant over time.

Given that the Greek market has developed considerably since the work of Floros and Vougas (2007) and Hourvouliades and Kousenidis (2008) it is appropriate to revisit the FTSE/ATHEX-20 futures market. Furthermore, the investigation of the cash and futures prices relation is conducted using a time variant approach depending on the presence or absence of arbitrage transactions, since it is well established that arbitrage activities affect market dynamics. The second contribution of the current paper is that it tests and documents the factors that determine the occurrence and the magnitude of the arbitrage opportunities in Greek futures markets. Finally, an important finding of this study relates to the linkage between cash-futures mipricing and the recent short-selling prohibition, which was instated by many international market regulatory commissions – including the Greek one – during the recent subprime crisis.

The remainder of the article is organized as follows. The next section describes the calculation of deviations from the no-arbitrage window and compares them to potential arbitrage profits. Section 2 examines the relation among cash-futures mispricing and a variety of factors, such as futures maturity, dividends, volatility, liquidity and short-selling restrictions. The last section includes the closing remarks.

1. Pricing index futures contracts and mispricing measures

According to the cost-of-carry model the theoretical fair price of an index futures contract should be equal to the underlying spot index price adjusted for the cost of carrying the spot index over the remaining life of the future. These costs consist of the interest cost on a loan contracted at t and redeemed at the futures maturity date, T, minus the present value of the dividends delivered by the index stocks in the contracts maturity period (t, T). In particular, the theoretical fair price of an index futures contract with maturity date T at time t, $F^*_{t,T}$, should be such that:

$$F^*_{t,T} = (S_t - D_{t,T})e^{r_{t,T}(T-t)} \qquad (1)$$

in which, S_t denotes the value of the spot index (FTSE/ATHEX-20) at time t, $D_{t,T}$ is the sum of the dividends paid by the index components in the period (t,T) expressed in index points and $r_{t,T}$ is the risk-free interest rate. Equation (1) defines the theoretical fair value of the futures contract on the assumption that there are no transaction costs and taxes and that all investors have identical risk-free interest rates.

Following Butterworth and Holmes (2000), I test for the presence of any mispricing by identifying differences from the theoretical futures price estimated in equation (1). The ex-post cash-future basis series (B_t) is calculated as the deviation between the actual futures price ($F_{t,T}$) observed at time t and its fair price at time t divided by the value of the FTSE/ATHEX-20 index:

$$B_{t,T} = \frac{F_{t,T} - F^*_{t,T}}{S_t}. \qquad (2)$$

The fair value deviations are normalized by dividing by S_t. In that way the basis series is directly comparable with the transaction costs of the potential arbitrageur, which are also expressed as percentage points of the spot index. Therefore, the basis series constitutes the potential rate of return to the arbitrageur.

The rationale behind this relationship is the ability to replicate the cash flows of the futures contract by borrowing money at the risk-free rate and buying the underlying index (either buying an exchange traded fund or buying the index components). Therefore, if the estimated basis is positive – that is the futures contracts trades above its fair value – an arbitrageur makes a risk-free profit by buying the spot index portfolio and opening a short position in the futures market (long arbitrage). Conversely, if the estimated basis is negative – that is the futures contracts trades below its fair value – the arbitrage profits are secured by buying the future and short selling the underlying index portfolio (short arbitrage). In each scenario, the arbitrageurs will continue to trade until their supply and demand in both the cash and the futures markets forces the prices to revert to values that are consistent with the no-arbitrage relationship.

Nevertheless, in reality, when we take into consideration the costs that are involved in the arbitrage transactions, the no-arbitrage cash-futures basis can deviate from zero. Assuming that there are no trading restrictions (e.g., short-selling is prohibited), the above-mentioned arbitrage strategies are only feasible when the absolute value of any cash-futures basis is sufficiently higher than the costs involved in the required transactions ($\left|B_{t,T}\right| > C$). In this case, the potential arbitrage profit $\Pi_{t,T}$ is equal to the cash-futures basis minus C, which denotes the transactions cost associated with the trading in both the spot and the futures markets:

$$\Pi_{t,T} = \left|B_{t,T}\right| - C \,. \tag{3}$$

Arbitrage profits calculated in equation (3) are considered to be ex-post, because they represent the profitability of an arbitrage transaction assuming that arbitrageurs can execute the required trades at the observed prices. Furthermore, the assumption is that the arbitrage positions are held until maturity.

Transaction costs comprise of several components: brokerage commissions, settlement fees, stamp duty, the bid-ask spread, taxes and any potential market impact costs that reflect the size of the trade and the market liquidity in both the equity and futures markets. Yadav and Pope (1990) estimate that the round-trip transaction costs for various arbitrageur groups in the UK cash and futures markets range from 0.5% to 2%. Using a similar rational in order to determine the transaction costs for the FTSE/ATHEX-20 contract and taking into consideration that the costs have been steadily decreasing over the years, I estimate the total round-trip costs for arbitrageurs in the 0.5% to 1.5% area. In Athens Exchange, the most favorably placed group of arbitrageurs is the derivative market makers of type B, who incur the lowest market commissions.

1.1. Data. Although recent academic attempts have used high-frequency data, the relative low liquidity of the derivatives market of Athens Exchange makes the use of intra-day data unattainable. Thus, the empirical analysis uses daily closing prices for the stock index and settlement prices for the index futures series (totally 1,491 daily observations). Until March 2007, FTSE/ATHEX-20 contracts expired every month (39 contracts), while afterwards contracts expired every quarter; therefore the total number of contracts under review for the six-year period is 50. The continuous time series of the futures price for the period from January 2004 to December 2009 consists of the daily settlement prices of the nearest-to-deliver FTSE/ATHEX-20 contract. From the last trading day onwards, the next-to-deliver contract is considered. The timing of the rollover in the dataset is based on the trading volume and open interest on the Greek derivatives market. In addition, according to Green and Joujon (2000) the cost-of-carry theory implies that the mispricing triggers arbitrage transactions at any time during the maturity of a contract, therefore the dataset used should not rollover to the next contract before expiration.

The dividend series is calculated using actual dividend disbursements of the component stocks of each period[1]. All data were obtained from the official website of Athens Exchange. The dividends are treated as discrete payments and expressed in terms of FTSE/ATHEX-20 index points. This is more appropriate for the Greek market, as Greek companies pay dividends mainly once per annum and usually during the second and the third quarter (primarily from April to August). Therefore it is not correct to use a dividend yield since most of the observations concern futures contracts with less than one month to maturity. Finally, one-month Euribor interest rates are used as the risk-free rate in the fair cash-futures basis calculation.

1.2. Results. The cash-futures mispricing is calculated using equation (2). The respective results are illustrated in Figure 1.

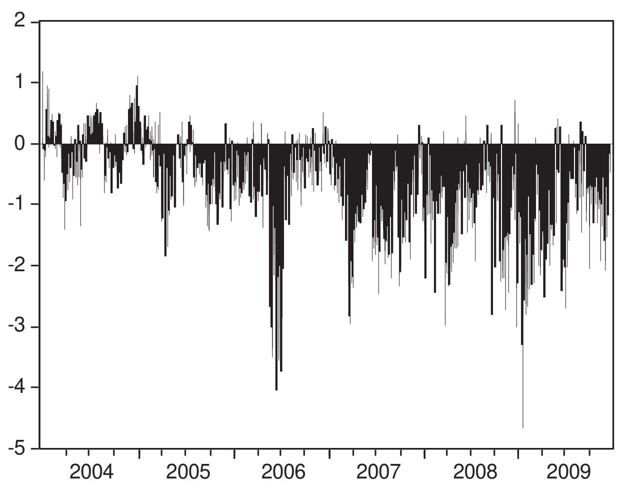

Fig. 1. The FTSE/ATHEX-20 cash-futures mispricing

As shown in Table 1, FTSE/ATHEX-20 futures contracts seem to be fairly priced on average with the mispricing deviations ranging in general be-

[1] For the period under review there were 11 additions/deletions of the constituent companies and 10 changes regarding the constituent free-float weightings.

tween 0.4% and -1%. The mean deviation is -0.666%, while the median is -0.542%. The negative bias of the mispricing is also confirmed by the finding that the futures contract is found to be underpriced on 1,234 occasions (an overwhelming 83%), while it is found to be overpriced only on 257 days (17%). Considering mean price divergence on a contract-by-contract basis, only 7 contracts traded on average at a premium, while 43 traded at a discount. Mispricing is statistically significant at the 5% level for all but one contract.

Surprisingly, concerning the FTSE/ATHEX-20 futures contract there has been a noticeable deterioration in its pricing efficiency over the period under review. From March 2007 onwards the mispricing of the index future has increased in magnitude and has been steadily in negative territories. It seems reasonable to argue that this finding can be potentially related with the subprime crisis and the subsequent eurozone debt crisis which resulted in an impressive bear market for the Greek stock market in general and its big capitalization index in particular.

Table 1. Summary statistics relating to the FTSE/ATHEX-20 cash-futures mispricing

Contract	Mean	t-stat	Median	Std. dev.	Max	Min	Average absolute	# Obs.	# pos dev.	# neg dev.	B > C		
											C = 0.5%	C = 1%	C = 1.5%
January 2004	-0.078	-0.45	-0.102	0.522	1.173	-0.601	0.357	9	2	7	3	1	0
February 2004	0.302	5.31	0.217	0.285	0.943	-0.048	0.308	25	22	3	5	0	0
March 2004	0.121	2.03	0.125	0.259	0.498	-0.472	0.235	19	13	6	0	0	0
April 2004	-0.596	-6.85	-0.541	0.358	-0.028	-1.408	0.596	17	0	17	10	1	0
May 2004	-0.283	-4.46	-0.279	0.318	0.309	-0.926	0.351	25	5	20	8	0	0
June 2004	-0.161	-1.74	-0.065	0.404	0.326	-1.354	0.294	19	8	11	4	1	0
July 2004	0.187	3.92	0.231	0.213	0.461	-0.282	0.241	20	15	5	0	0	0
August 2004	0.330	7.69	0.365	0.210	0.679	-0.170	0.344	24	23	1	6	0	0
September 2004	-0.190	-2.93	-0.111	0.290	0.238	-0.804	0.253	20	5	15	4	0	0
October 2004	-0.277	-5.79	-0.323	0.214	0.144	-0.796	0.293	20	2	18	2	0	0
November 2004	-0.224	-3.54	-0.222	0.310	0.285	-0.729	0.310	24	7	17	6	0	0
December 2004	0.291	4.56	0.249	0.285	0.793	-0.158	0.334	20	16	4	7	0	0
January 2005	0.310	3.79	0.289	0.400	1.112	-0.342	0.397	24	18	6	6	1	0
February 2005	0.151	2.92	0.203	0.232	0.458	-0.290	0.236	20	16	4	0	0	0
March 2005	-0.258	-2.87	-0.185	0.392	0.343	-0.797	0.377	19	6	13	8	0	0
April 2005	-0.550	-4.33	-0.451	0.539	0.517	-1.270	0.607	18	1	17	10	6	0
May 2005	-0.911	-8.22	-0.852	0.532	-0.169	-1.839	0.911	23	0	23	17	8	5
June 2005	-0.228	-2.48	-0.019	0.409	0.140	-1.057	0.283	20	8	12	4	3	0
July 2005	-0.211	-2.52	-0.162	0.366	0.352	-1.017	0.306	19	5	14	4	1	0
August 2005	-0.154	-2.18	-0.174	0.347	0.465	-0.699	0.313	24	9	15	5	0	0
September 2005	-0.295	-6.85	-0.313	0.193	0.006	-0.673	0.295	20	1	19	3	0	0
October 2005	-0.796	-11.30	-0.734	0.352	-0.084	-1.422	0.796	25	0	25	21	7	0
November 2005	-0.763	-10.23	-0.817	0.325	-0.229	-1.320	0.763	19	0	19	14	4	0
December 2005	-0.320	-4.54	-0.291	0.315	0.325	-1.054	0.352	20	2	18	5	1	0
January 2006	-0.546	-7.30	-0.622	0.359	0.039	-1.264	0.551	23	2	21	13	2	0
February 2006	-0.590	-10.49	-0.635	0.252	-0.135	-1.007	0.590	20	0	20	13	1	0
March 2006	-0.329	-4.18	-0.342	0.343	0.349	-0.955	0.399	19	4	15	5	0	0
April 2006	-0.510	-5.36	-0.630	0.446	0.337	-1.200	0.571	22	3	19	13	2	0
May 2006	-0.405	-4.42	-0.375	0.388	0.179	-1.379	0.449	18	3	15	6	1	0
June 2006	-1.909	-9.62	-1.825	0.865	-0.282	-3.516	1.909	19	0	19	17	17	14
July 2006	-2.159	-9.27	-2.055	1.165	0.192	-4.042	2.174	25	1	24	22	21	18
August 2006	-0.634	-6.04	-0.518	0.458	0.142	-1.324	0.649	19	1	18	10	5	0
September 2006	-0.268	-4.81	-0.250	0.250	0.163	-0.751	0.297	20	3	17	4	0	0
October 2006	-0.311	-5.27	-0.243	0.295	0.141	-1.009	0.338	25	3	22	7	1	0
November 2006	-0.265	-4.64	-0.284	0.255	0.242	-0.790	0.308	20	3	17	2	0	0
December 2006	-0.203	-2.95	-0.218	0.308	0.499	-0.780	0.291	20	4	16	3	0	0
January 2007	-0.159	-2.55	-0.206	0.292	0.280	-0.689	0.268	22	8	14	2	0	0
February 2007	-0.461	-9.17	-0.412	0.225	0.034	-0.958	0.465	20	1	19	8	0	0
March 2007	-0.721	-9.74	-0.636	0.323	-0.236	-1.591	0.721	19	0	19	15	3	1
June 2007	-1.132	-12.67	-1.074	0.698	0.029	-2.963	1.134	61	2	59	50	35	16
September 2007	-1.255	-19.16	-1.398	0.544	0.154	-2.459	1.263	69	2	67	60	51	29
December 2007	-0.905	-11.30	-0.980	0.645	0.311	-2.336	0.924	65	4	61	46	32	13

Table 1 (cont.). Summary statistics relating to the FTSE/ATHEX-20 cash-futures mispricing

Contract	Mean	t-stat	Median	Std. dev.	Max	Min	Average absolute	# Obs.	# pos dev.	# neg dev.	B > C		
											C = 0.5%	C = 1%	C = 1.5%
March 2008	-0.828	-12.60	-0.843	0.500	0.211	-2.431	0.838	58	2	56	45	21	4
June 2008	-1.161	-11.56	-1.153	0.771	0.447	-2.977	1.186	59	4	55	45	33	22
September 2008	-0.562	-10.63	-0.540	0.423	0.318	-1.921	0.587	64	6	58	36	7	1
December 2008	-1.070	-11.53	-0.942	0.742	0.729	-2.807	1.118	64	3	61	55	31	18
March 2009	-1.608	-13.39	-1.629	0.930	0.323	-4.679	1.622	60	2	58	52	43	34
June 2009	-1.013	-10.98	-1.192	0.703	0.416	-2.512	1.059	58	5	53	41	34	14
September 2009	-0.785	-9.04	-0.596	0.700	0.357	-2.704	0.812	65	6	59	39	21	11
December 2009	-0.921	-16.71	-0.843	0.441	0.002	-2.079	0.921	64	1	63	54	25	6
All	-0.666	-34.224	-0.542	0.752	1.173	-4.679	0.753	1491	257	1234	815	420	206

Finally, the last three columns in Table 1 report the transaction cost violations for the mispricing series. Three levels of total round-trip transaction costs are used as benchmarks: 0.5%, 1.0% and 1.5%. The empirical investigation shows that at the 0.5% level, the FTSE/ATHEX-20 contract is associated with violations on 815 days (55%); at the 1% level, it is associated with mispricing violations on 420 occasions (28%). Lastly, at the 1.5% level the big capitalization futures contract is associated with mispricing violations on 206 days (14%). By comparison, Butterworth and Holmes (2000) show that for the UK FTSE 100 futures contract the 0.5% transactions cost level is violated on only 5% of occasions. Conversely, the 1% level is surpassed in less than 1% of the days under review, while there is no violation of the 1.5% transaction costs level. Therefore, the results suggest that the arbitrage opportunities for the Greek benchmark index contract are much more frequent than for the respective UK index reflecting in part the illiquidity and the difficulties of trading in the Athens Exchange.

2. Which factors explain the spot-futures price efficiency/inefficiency?

A variety of factors, such as dividends, maturity, volatility, liquidity, or general market conditions and restrictions have been found to explain cash-futures mispricing and arbitrage opportunities in futures markets (Severac et al., 2009). This section tests whether differences in the values of these factors affect the futures mispricing in the Greek market. More specifically, six variables are included in the empirical investigation: the days until futures expiration, the FTSE/ATHEX-20 dividend yield, the volume of both the cash and the futures market. Additionally, I include a dummy variable that takes into consideration the ban of short selling, as the Greek Capital Commission followed the example of other international Capital Commissions and prohibited short selling from October 2008 until May 2009. The last variable aims at proxying market turbulence; in particular, it measures the deviation of implied volatility[1] of the underlying spot index from its fifty-day moving average. Therefore, I model the daily ex-post index-futures mispricing deviations, B_t, using the following specification:

$$\left|B_{t,T}\right| = \alpha_0 + \alpha_1 Fmat_t + \alpha_2 div_t + \alpha_3 Svol_t + \alpha_4 Fvol_t + \\ + \alpha_5 Dshort_t + \alpha_6 IV_t + \varepsilon_t + \phi_1 \Pi_{t-1,T} + \theta_1 \varepsilon_{t-1} \quad (4)$$

in which, $Fmat_t$ denotes the number of days until futures expiration in logarithmic form and div_t is the dividend yield measured as the discounted dividends paid by the FTSE/ATHEX-20 constituents from date t to the futures expiration date T in percentage of the value of the index. $Svol_t$ denotes the daily volume (in number of shares) of the spot index in logarithmic form, while $Fvol_t$ is the number of futures contracts traded on day t (in logarithmic form). $Dshort_t$ is a binary variable taking the value of 1 on the days that short selling was forbidden and 0 otherwise. Finally, IV_t is the difference of implied volatility from its fifty-day moving average (again in logarithmic form). An ARMA(1,1) model is applied in order to correct a significant degree of autocorrelation in the error terms.

The above multivariate analysis (equation (4)) is also conducted on daily pricing deviations after taking into consideration the round-trip transaction costs[2]. Hence, this specification tests whether arbitrageurs trading instantaneously can earn arbitrage profits. In this case the ex-post arbitrage profits, if positive, equal to the result of equation (3), or else they take the value of zero. Since the distribution of the average deviations net of transaction costs is characterized by a substantial number of zero values, equation (4) is estimated with a censored Tobit methodology using the same independent variables.

Table 2 lays out the results of the above two specifications. Both models estimates show that futures mispricing increases as the dividend yield of the index constituents increases. Concerning time to maturity, the empirical evidence generally shows that futures divergence from its fair value increases signifi-

[1] Implied volatility is calculated from a strip of options (both calls and puts) using the new VIX model-free methodology.

[2] The average round-trip transaction cost is assumed to be 1%.

cantly with time to expiration of the contract (e.g., Yadav and Pope, 1990; 1994; Bühler and Kempf, 1995). Confirming existing research for other markets, the current study confirms that in the Greek market cash-futures mispricing decreases when approaching the contract expiration date.

Now, regarding the effect of turnover in both the cash and the futures market, opposite arguments can be put forward (Severac et al., 2009). According to one point of view the occurrence and the magnitude of price divergence increase trading activity by triggering more arbitrage transactions. However, there is an opposing argument that higher volumes, if initiated by arbitragers, may result in a tighter cash-futures convergence. The findings of the particular study favor the first argument, as the coefficient for total volume in the cash market is significantly positive in both models. Surprisingly, the number of traded contracts in the futures market appears to be statistically insignificant in both specifications.

Another conclusion of the empirical investigation is that cash-futures price deviations in the Athens Exchange tend to increase in periods of turbulent/bear markets. A potential explanation of why the cash-futures mispricing may increase in a bear market can be related with the increased risk associated with the arbitrage transaction. This is true because when prices are falling, on the one hand the buy order for FTSE/ATHEX-20 futures can be filled relatively quickly, but on the other hand the sell order in the cash market is usually slower to execute. As a result, it is likely that the sell orders in the spot market are filled at a lower price turning the arbitrage trade of buying spot and selling futures unprofitable. The coefficient of the divergence of implied volatility from its fifty-day moving average has a high level of statistical significance in the Tobit regression, but it is barely insignificant in the ARMA(1,1) OLS model.

Finally, an important finding of this study concerns the relation between cash-futures mipricing and short-selling prohibition. The coefficient for the binary variable that relates to the short-selling ban is significantly positive in both specifications, proving that external intervention reduces the price efficiency of the markets.

Table 2. Modeling the daily ex-post index-futures mispricing deviations

Dependent variable	ARMA(1,1) OLS regression Daily ex-post mispricing before transaction costs	Censored Tobit regression Daily ex-post arbitrage profits after transaction costs
Intercept	-0.641021	-10.16902***
	(0.411675)	(1.566251)
$Fmat_t$	0.164530***	1.125703***
	(0.022121)	(0.088409)
div_t	0.440758***	0.548427***
	(0.114649)	(0.121504)
$Svol_t$	0.063295***	0.374116***
	(0.021937)	(0.082920)
$Fvol_t$	-0.027249	-0.062220
	(0.032893)	(0.151203)
$Dshort_t$	0.332379*	0.824727***
	(0.171917)	(0.161417)
IV_t	0.533760	1.524790***
	(0.333765)	(0.437314)
φ_1	0.912864***	
	(0.022546)	
θ_1	-0.535945***	
	(0.040089)	
Adjusted R^2	63.56%	
# of observations	1,441	419

Notes: Standard errors are in parentheses. *** Identifies coefficient significance at the 1% level. ** Identifies coefficient significance at the 5% level. * Identifies coefficient significance at the 10% level. An ARMA(1,1) ordinary least regression (OLS) is used to investigate ex-post cash-futures mispricing before transaction costs and a censored Tobit regression is employed to examine ex-post arbitrage profits net of transaction costs. $Fmat_t$ is the number of days until futures expiration in logarithmic form. Div_t is the dividend yield measured as the discounted dividends paid by the FTSE/ATHEX-20 constituents from date t to the futures expiration date T in percentage of the value of the index. $Svol_t$ is the daily volume (in number of shares) of the spot index in logarithmic form. $Fvol_t$ is the number of futures contracts traded on day t in logarithmic form. $Dshort_t$ is a binary variable taking the value of 1 on the days that short selling was forbidden and 0 otherwise. IV_t is the difference of implied volatility from its fifty-day moving average in logarithmic form. φ_1 is the AR(1) coefficient and θ_1 is the MA(1) coefficient.

Conclusions

This study investigates the mispricing of FTSE/ ATHEX-20 index futures contracts and the potential arbitrage profits in the Greek market by comparing ex-post mispricing with round-trip total transaction costs faced by different groups of market participants.

This study confirms the existence of significant divergence from the no-arbitrage window in FTSE/ ATHEX-20 index futures with potential profits for arbitrageurs, even when the round-trip transaction costs are taken into consideration. This finding shows that, when the FTSE/ATHEX-20 futures price deviates from its fair price the arbitrage transactions – which force prices back towards a theoretical equilibrium – are not as strong and effective in the Greek market as they are in the case of other mature markets (e.g., the S&P500 and the FTSE 100 markets). Nevertheless, it should be noted that it is still questionable whether the observed divergences are always feasible arbitrage profits or just the outcome of liquidity issues and especially regulatory constraints.

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