European Research Studies,
Volume XIV, Issue (4), 2011

Abnormal Returns on CEFs in Pre- and Post-Credit-Crunch Periods

Emmanouil Mavrakis[1]
Bank of Greece and Technological Educational Institute of Crete

Abstract:

Compared to previous research, present work extends existing literature by considering if market performance, in Athens Stock Exchange, alternates the mean-reverting properties of Closed-end Funds' discount and as a result affects potential realization of abnormal returns. Employing cointegration analysis, reported results indicate that, examining an equally weighted portfolio of funds, when market performance characterized as moderate, there is evidence suggesting market inefficiency while; during the recent turmoil period due to the credit crisis evidences do not indicate potential realization of abnormal returns. However, individual data examination gives mixed results.

Key Words: *Close-end Funds' Discount-based Strategies, Cointegration*

JEL Classification: *C32, G11*

[1] *Economic Research Department, Bank of Greece, 21 El. Venizelou Ave., 10250, Athens, Greece. Tel: +30 210 320 2449, fax: +30 210 320 2696, e-mail: emavrakis@bankofgreece.gr*

1. Introduction

It is a well-documented fact that closed-end funds (CEFs) trade at significant discounts. According to a thorough literature review provided by Dimson and Minio-Kozerski (1999), previous research examined both economic and behavioural explanations regarding the existence of CEFs' discount. Examining data on CEFs, there are a number of studies employing cointegration analysis. Gemmill and Thomas (2002) provide evidence that cointegration analysis indicates a strong link between CEFs' discounts and retail flows. According to the findings by Cheng et al. (1994), Gemmill and Thomas (2002) and Copeland (2007), if there is cointegration between the price of shares and the Net Asset Value (NAV) of CEFs, it is not a relationship implying a zero long run discount. Gasbarro et al. (2003) found strong evidence of cointegration between the price of shares and the NAV of CEFs however; their results indicate that mean-reversion is caused by changes in both share prices and NAVs.

Previous research has also shown that, there is an opportunity for abnormal returns realization through exploitation of movements in the level of the discount. According to some researchers, efficiency in CEFs can be examined through Initial Public Offerings. Khorana et al. (2002) and Higgins et al. (2002) report, correspondingly, that rights offerings and new issues of shares are announced when funds trade at a premium. However, evidence is in favor of such strategies only when the price decline is substantial. There are also a number of papers, such as Brauer (1984 and 1988) and Brickley and Schallheim (1985), examining the opportunity for abnormal returns when open-ending pushes share price of CEFs to their NAV. Considering discount-based strategies, prior empirical evidences suggest the potential of abnormal returns realization (Thompson, 1978; Anderson, 1986; Cheng et al., 1994; Cakici et al. 2000 and 2002). Pontiff (1995) suggested that discounts' mean reversion is responsible for the correlation between fund discounts and future returns. In addition, Sias et al. (2001) have shown that, there is potential for abnormal returns by exploiting the mean reverting properties of CEFs' discounts.

Under the joint hypothesis of risk neutrality and market efficiency, time series of share prices characterized as random walk processes. It is a well documented fact that, examining stocks trading in liquid financial markets that operate on highly efficient trading platforms, most time series of log share prices have a unit root. Facing lack of mean-reversion property, we cannot apply statistical arbitrage strategies that rely upon unconditional variance in order to realize excess returns. However, examining CEFs, we have found that, under certain market conditions, the discount is often stationary. Still, just evidence of discount stationarity is not sufficient information in order to successfully apply statistical arbitrage strategies. That is, given that the discount is a spread between the share price and the NAV of CEFs, we should at first identify the long-run relation, if any, between these variables. Next, given that NAVs are not trading, we should verify that the error correction mechanism is such that, in the short run, the discount narrows/widens due to changes (increases/falls) in share prices. Simultaneously, we should examine if the cointegrating vector is (1, -1) implying stationarity of discount.

Present topic concerns the examination of weak form market efficiency, employing data from CEFs trading in Athens Stock Exchange (ASE). Our research extends the existing literature by considering if market performance, in ASE, alternates the mean-reverting properties of CEFs' discount and as a result affects realization of abnormal returns on CEFs. Reported results indicate that, examining an equally weighted portfolio of funds, there is no cointegrating relation between share prices and NAVs during the recent turmoil period due to the credit crisis while; moderate market performance characterizing pre-credit-crunch period ensures the mean-reversion of CEFs' discount and points to cointegration between the examined variables. Overall, considering the Greek Capital Market, moderate market performance points to the potential of abnormal returns realization, in the short-run, through exploitation of discount deviations from its mean value. This is because, regarding both hypotheses testing and estimates from the MA representation of the employed model, there is clear evidence about the identification of NAVs as the pushing force of our system while share prices were purely adjusting. Moreover, hypothesis testing on the implied stationary long-run relation indicates that, unlike the suggestions made by Cheng et al. (1994), Gemmill and Thomas (2002) and Copeland (2007), any shock coming from net asset values has the same effect to each of share prices and NAVs (long-run homogeneity assumption), implying that the share prices truly reflect the performance of NAVs over a long period. Given the above, and taking into account the statistical significance of a constant term (restricted to the cointegrating space), the presence of a nonzero but mean-reverting discount is verified throughout the examined mild bullish period. However, individual data examination gives mixed results.

The structure of the rest of this paper includes a description of the examined data, in Section II, and the employed methodology, in section III, followed by model specification and results on cointegration rank tests and tested hypotheses, in Section IV. Finally, section V provides summary and conclusions.

2. Data Description

Data employed in this paper includes share prices and NAVs of CEFs trading in ASE for the period of *2003:10:20-2009:02:10*. In order to examine the relationship between share prices and NAVs under different market conditions, we have split the sample into two sub-samples. The sample under consideration contains a "non-extreme uptrend" period followed by an "extreme downtrend" period due to the recent credit crisis. "Non-extreme uptrend" period is characterized as a period of moderate market performance and "extreme downtrend" period is thought to be a period of extreme market performance. "Non-extreme uptrend" sample falls within the period of *2003:10:20-2007:10:31* and the data comprises of 146 ten-day period observations while; "extreme downtrend" sample falls within the period of *2007:11:09-2009:02:10* and the data consists 46 ten-day period observations.

Considering all funds operating in the Greek market, we have examined seven CEFs that offered us full data in each of the aforementioned sample periods. In turn, we have averaged (with equal weights) the share prices of CEFs as well as their NAVs, so as to produce an index for each of the two variables used in our econometric analysis.

In order to justify our choice to split the sample, we apply a breakpoint test, suggested by Chow (1960), on a linear regression of the relationship between returns' data of the two examined variables. According to the results reported in Table 1, examining average returns' data, we reject the null of no breaks at the starting point of second sub-sample. Considering individual returns' data, we reject the null for six out of all seven examined CEFs.

Table 1. Chow's breakpoint test

CEFs	*F-stats*	*p-values*
Averaged	174.397	(0.000)
1	8.371	(0.000)
2	0.523	(0.593)
3	254.518	(0.000)
4	22.763	(0.000)
5	64.425	(0.000)
6	153.767	(0.000)
7	343.607	(0.000)

In addition to the latter documentation of the two sub-samples, in order to reveal market performance, we define positive (negative) ASE General Index (ten-day) periodic returns as Up (Down) returns. Furthermore, following Fabozzi and Francis (1977), we redefine Up (Down) periodic returns as Substantially Up (Substantially Down) returns when the ten-day return of ASE General Index is larger (lower) than the sum (difference) between average market return and half of one standard deviation measured over the full sample.

Considering market performance, first sub-sample (*2003:10:20-2007:10:31*) is defined as a "mild uptrend" period and the data consists of 146 ten-day period observations while; considering performance of ASE General Index, there are 51 Down and 94 Up ten-day returns while 51.06% of the latter returns are also Substantially Up market returns. Second sub-sample (*2007:11:09-2009:02:10*) is defined as an "extreme downtrend" period and the data consists of 46 ten-day period observations while; there are 32 Down and 14 Up market returns while 62.50% of the former returns are also Substantially Down market returns.

3. Methodology and Research Organization

The empirical section has two parts. First, we have averaged (with equal weights) the share prices of CEFs as well as their NAVs, so as to produce an index for each of the two variables used in our econometric analysis. Working on averages, we employ data of the two sub-samples in order to test the hypothesis that moderate market performance, in ASE, is a sufficient condition for the realization of abnormal returns in the short run. In the second empirical part we shed more light in the first sub-sample, characterized as "mild uptrend" period, in order to test the aforementioned hypothesis employing data for each individual CEF.

We apply the Johansen (1988 and 1996) and Johansen and Juselius (1990) methodology of the Cointegrated VAR Model. As noted by Gonzalo (1994) and Kremers et al. (1992), the Johansen and Juselius approach performs better or at least as well as the Dickey-Fuller cointegration test of Engle and Granger (1987). In addition, the selected procedure is invariant to different normalizations (Hamilton, 1994) and thus the test outcome does not depend on the chosen normalization. Our results were obtained using CATS in RATS version 2 (Dennis et al., 2005).

The error correction form of the examined unrestricted VAR model is described below:

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \phi D_t + \varepsilon_t, \qquad \varepsilon_t \sim iid\ N_P(0,\Omega), \qquad t = 1,\ldots,T \quad (1)$$

where:

x_t is a vector of two variables: $[lsp_t, \quad lnav_t] \sim I(1)$ (2)

and D_t is a vector of deterministic variables such as a constant and intervention dummies.

As mentioned earlier, evidence of prior empirical research (Cheng *et al.,* 1994; Gemmill and Thomas, 2002; Copeland, 2007), indicate that, if there is cointegration between the price of shares and the NAV of CEFs, it is not a relationship implying a zero long run discount. In the main part of our analysis (employing averaged and individual data), we choose to restrict the constant term to lie in the cointegrating space and in addition, when proper, we include dummy variables, as unrestricted to the cointegrating space.

Performing model specification, we choose the optimal number of lags using Schwarz, Hannan-Quinn and Akaike Information Criteria along with a Likelihood Ratio (LR) test. Following Juselius and MacDonald (2003), in order to secure valid statistical inference we need to control for the largest of observations by dummy variables or leave out the most volatile periods from our sample. Since the volatile periods could potentially be very informative we choose the former alternative. The dummy variables used in our models are permanent impulse dummies DPyyyy.mm.ddt (are equal to one at yyyy:mm:dd, and equal to zero otherwise).

Objective of this paper is to examine if our results indicate that, investors could achieve abnormal returns, in the short-run, due to the mean-reverting properties of CEFs' discount. Examining both averaged and individual data, apart from model specification, the methodology employed has three steps.

First, performing cointegration tests and hypotheses testing, we examine if there is a long-run relation, with a non-zero intercept, of the following form:

$$lsp_t = \beta \cdot lnav_t - Discount + stat.error. \quad (3)$$

Applying Johansen (1988 and 1996) and Johansen and Juselius (1990) methodology of the cointegrated VAR model, we examine the existence of a long-run relation with a non-zero intercept based upon the estimated eigenvalues, $\hat{\lambda}_i$, and the trace test, τ_{p-r}, along with the moduli of the two largest eigenvalue roots. In addition we perform hypotheses testing regarding multivariate stationarity, univariate normality and variable exclusion. In the presence of I(1) series, Johansen and Juselius (1990) developed a multivariate stationarity test which has become the standard tool for determining the order of integration of the series within the multivariate context. Multivariate stationarity test is a LR test distributed as chi-square with (p-r) degrees of freedom [$\chi^2(1)95\%=3.841$]. Testing univariate normality we apply Doornik and Hansen (2008) test, distributed as $\chi^2(2)$, [$\chi^2(2)95\%=5.991$]. In order to test variable exclusion we apply a LR test distributed as chi-square with r degrees of freedom. In addition, as described below, we perform detailed long run identification through testing the validity of over-identifying restrictions on the implied cointegrated vector.

Second, testing the null hypothesis of long-run weak exogeneity, we examine if there is evidence supporting the identification of NAVs as the pushing force of our system. Hence, we examine if the discount narrows/widens due to changes (increases/falls) in share prices. According to Juselius (2006), the hypothesis that a variable has influenced the long-run stochastic path of the other variables of the system, while at the same time has not been influenced by them, is called the hypothesis of "no levels feedback" or long-run weak exogeneity. Weak exogeneity test is a LR test distributed as chi-square with r degrees of freedom.

Third, testing if cumulating shocks driving the system have exactly the same influence on both variables (lsp_t and $lnav_t$) we examine if the hypothesis of long-run homogeneity holds. That is, we examine if the cointegrating vector is (1, -1) implying stationarity of discount. In order to further justify our suggestions, we apply the Augmented Dickey-Fuller (ADF) technique (Dickey and Fuller, 1981) testing the null hypothesis that the discount has a unit root.

If our results indicate the existence of a long-run relation with a non-zero intercept along with the acceptance of the joint hypothesis of long-run weak exogeneity for NAVs and long-run homogeneity for (lsp_t and $lnav_t$) then, market inefficiency is detected. In other words investors could achieve abnormal returns, in the short-run, due to the mean-reverting properties of CEFs' discount.

Apart from the above described general organization of our research, when examining averaged data of the pre-credit-crunch period, in order to re-examine our results from hypotheses testing, we perform estimates of the MA representation of our model. Using MA representation, we can express potential relations between the variables of the system as functions of the cumulated shocks. Hence, we can understand better our results from testing hypotheses of potential cointegrating relations.

4. Model Specification and Results on Cointegration Rank and Hypotheses Tests

As already mentioned, performing model specification, we choose the optimal number of lags using Schwarz, Hannan-Quinn and Akaike Information Criteria along with a LR test while; in order to secure valid statistical inference we choose to control for the largest of observations by dummy variables.

Considering averaged data, we have employed a model with one lag and eight dummy variables in "mild uptrend" period and a model with one lag and two dummy variables in "extreme downtrend" period. Equation (4) describes the model employed in the two sub-periods.

$$\Delta x_t = \alpha\left(\beta', \rho'\right)\begin{pmatrix} x_{t-1} \\ 1 \end{pmatrix} + \phi D_t + \varepsilon_t \qquad (4)$$

Being confident enough about the specification of our models, we shall try to determine the rank. Reported results, in Table 2, suggest acceptance of a cointegration rank equal to zero regarding the second "extreme downtrend" period. However, considering the first "mild uptrend" period, with 95% significance, the null hypothesis of r=0 is rejected while a cointegration rank equal to one is accepted. In addition, regarding the first sub-period, from the modulus of the largest roots in the companion matrix, with r=1, we have a second root enough different than unity.

Overall, we have strong evidence that, regarding "extreme downtrend" period the examined system do not contain any cointegrating relations while considering "mild uptrend" period, our system contains one cointegrating relation and as a result one common trend.

Given the aforementioned results, regarding determination of cointegration rank, our further analysis is focused on first sub-sample (2003:10:20-2007:10:31) defined as a "mild uptrend" period. Considering results reported in Table 2, with rank=1, we cannot accept the exclusion of any of the variables of the system. Overall, we have a system where the employed variables are non-stationary and significant hence, they cannot be excluded.

Table 2. Trace test for cointegration rank, moduli of 2 largest roots and hypotheses testing (averaged data)

r	p-r	i	$\hat{\lambda}_i$	τ_{p-r}	$C_{95\%(p-r)}$	*Moduli of 2 Largest Eigenvalue Roots*		lsp_t	$lnav_t$
					Mild Uptrend (Pre Credit Crunch) Period				
0	2	1	0.111	21.791[a]	20.164	1.000	1.000	12.279[i,a]	12.449[i,a]
1	1	2	0.032	4.652[b]	9.142	1.000	0.809	2.280[ii,b]	2.600[ii,b]
								12.449[iii,a]	12.279[iii,a]
					Extreme Downtrend (Post Credit Crunch) Period				
0	2	1	0.255	18.355[b]	20.164	1.000	1.000	1.639[i,b]	1.423[i,b]
1	1	2	0.108	5.127[b]	9.142	1.000	0.971	5.839[ii,b]	4.348[ii,b]
								1.423[iii,b]	1.639[iii,b]

[a] Rejection of the null with 95% significance
[b] Acceptance of the null with 95% significance
[i] Multivariate Stationarity test is a LR test, distributed as $\chi^2(1)$
[ii] Doornik and Hansen (2008) univariate normality test, distributed as $\chi^2(2)$
[iii] Variable Exclusion is a LR test, distributed as $\chi^2(1)$

So far, we have considered the cointegrated VAR model (4) with rank=1 imposed. The MA representation of (4) is given by:

$$x_t = C\sum_{i=1}^{t}\varepsilon_i + C^*(L)\varepsilon_t + \text{deterministic components} \tag{5}$$

where:

$$C = \beta_\perp\left(\alpha'_\perp\Gamma\beta_\perp\right)^{-1}\alpha'_\perp = \tilde{\beta}_\perp\alpha'_\perp \tag{6}$$

is the long run impact matrix and

$$C^*(L) = \sum_{i=0}^{\infty} C_i^* L^i \tag{7}$$

is a convergent matrix polynomial in the lag operator L.

Normalizing to $lnav_t$ (without imposing any other restrictions) the C matrix should show us the long run effect of the cumulated shocks (=common stochastic trends) on the variables of the system. Using MA representation, we can express potential relations between the variables of the system as functions of the cumulated shocks. Hence, we can understand better our results from testing hypotheses of potential cointegrating relations. In the MA representation $a'_\perp$ determines the common stochastic trends and $\tilde{\beta}_\perp$ their loadings. As indicated by the results in Table 3, normalizing to $lnav_t$, we have evidence that share prices consist the adjusting process of the system because, the corresponding coefficient in $a'_\perp$ is insignificant. Regarding the dynamics of our system we can draw useful results from the significant coefficients in $\tilde{\beta}_\perp$. Hence, we observe that our common trend, identified by $lnav_t$, has a significant positive impact both on itself and share prices. Moreover, we should note that coefficients in $\beta_\perp$ are very close in magnitude. The indications of our results are repeated by the estimates of the C matrix where, the column vector corresponding to share prices is insignificant while NAVs have a significant column vector.

Given the results of our prior analysis, regarding the identification of variables, we shall try to test hypotheses, considering the long run identification of the examined system. In Table 4, we begin our analysis with the unrestricted model H_1, normalizing the β vector to share prices. Although, normalizing on lsp_t, leads to an identified cointegrating relation, we choose to impose two over-identifying restrictions.

Table 3. MA representation and decomposition of the trends (averaged data)

	Coefficients of the Common Trend: $\hat{\alpha}_\perp$	*Loadings to the Common Trend:* $\hat{\beta}_\perp$	*Long Run Impact Matrix:* $\hat{C}$ $\sum \varepsilon_{sp}$	$\sum \varepsilon_{nav}$
lsp_t	0.296 (0.753)	0.747 (3.402)	0.221 (0.967)	0.747 (3.402)
$lnav_t$	1	0.779 (3.402)	0.231 (0.967)	0.779 (3.402)

Note: Numbers in brackets are t-ratios

First, given the importance of a zero error correction term for $\Delta lnav_t$, we test the validity of model H_2 where, as already indicated by the results in Table 3, we accept the hypothesis of long-run weak exogeneity regarding the net asset value of CEFs. Estimated coefficients of the error correction terms represent the short-run speed of adjustment; their magnitude and significance are of great importance regarding the results of our study. If the coefficient of either term is zero, then the error correction comes from only one variable. As mentioned earlier, short-run excess returns are generated only if the discounts are mean-reverting over time and the narrowing/widening of the discount is due to share price increases/falls. Considering our analysis so far, we argue that we have one cointegrating relation between the share prices of CEFs and their NAVs where, $lnav_t$ is the pushing force while lsp_t is purely adjusting. Our results so far could be of great importance regarding the potential realization of short-run abnormal returns for the CEFs trading in ASE.

Regarding the second over-identifying restriction, we have already take notice of the fact that, examining estimates of column vector $\beta_\perp$ (Table 3), coefficients of lsp_t and $lnav_t$ are very close in magnitude. That is, there is an indication that, cumulating shocks (from $lnav_t$) driving the system may have exactly the same influence on both variables. Unlike the suggestions made by Cheng et al. (1994) and Copeland (2007), reported results considering model H_3, in Table 4, verify prior indications and suggest acceptance of the null hypothesis of long-run homogeneity between CEFs' share prices and their NAVs. Moreover, examining model H_4, we accept the null joint hypothesis of long-run weak exogeneity and long-run homogeneity.

Summing up, long-run relation implied by model H_4 is:

$$\beta_1: \quad lsp_t = lnav_t - \underset{(-30.968)}{0.201} + stat.error. \tag{8}$$

Table 4. Long run identification (averaged data)

	H_1		H_2		H_3		H_4	
	$\hat{\alpha}_1$	$\hat{\beta}_1$	$\hat{\alpha}_1$	$\hat{\beta}_1$	$\hat{\alpha}_1$	$\hat{\beta}_1$	$\hat{\alpha}_1$	$\hat{\beta}_1$
lsp_t	0.149 (-2.698)	1	-0.181 (-3.334)	1	-0.156 (-2.811)	1	-0.178 (-3.257)	1
$lnav_t$	0.044 (0.937)	-0.960 (-24.718)	0	-0.966 (-24.420)	0.032 (0.669)	-1	0	-1
Constant		0.177 (6.503)		0.178 (6.440)		0.203 (31.827)		0.201 (30.968)
LogLikelihood	1236.415		1236.091		1235.903		1235.734	
LR statistic			0.648		1.023		1.361	
p-value			0.421 $\chi^2(1)$		0.312 $\chi^2(1)$		0.506 $\chi^2(2)$	

Note: Numbers in brackets are t-ratios

Cointegrating vector β_1 suggests a positive long-run relation between the share prices of CEFs and their NAVs which cancels the common trend identified by NAVs while; given statistical significance and sign of the constant term (restricted to the cointegrating space), the presence of a nonzero but mean-reverting discount is verified throughout the first sub-period. In addition, equation (8) suggests that, any shock coming from net asset value will have the same effect to each of share prices and NAVs (long-run homogeneity hypothesis), implying that the share prices truly reflect the performance of NAVs over a long period. Moreover, we should note here that, unlike the suggestion made by Copeland (2007), acceptance of long-run homogeneity hypothesis supports identification of CEFs' discount as an I(0) process. Performing ADF unit root tests on discount (calculated as the difference between lsp_t and $lnav_t$), choice of lag structure relies upon results from Akaike and Bayesian Information Criteria. Results, reported in Table 7, indicate rejection of the null hypothesis that the discount is I(1) and support our latter suggestion.

The above described cointegrating relation seems to be stable in the short run as well, as we can infer from the negative sign and significance of the coefficient corresponding to Δlsp_t in α matrix. In other words, the share prices of CEFs seem to adjust very well to the long-run relation. As mentioned previously, the latter result has important implications regarding the realization of abnormal returns in the short-run. From the significance of the coefficients in matrix Π (Table 5) we observe that there is a significant relation between short-run and long-run parameters. That is, we can infer that the share prices of CEFs are significantly affected from the cointegrating relation.

Considering estimates of model H_4 in MA form, reported results (Table 6) verify that the shocks coming from $lnav_t$ positively affect itself and lsp_t as well as, that effects' magnitude is the same on both variables. This is consistent with the results of the implied cointegrating relation, described in (8). Furthermore, estimates of the C matrix give the same picture.

Table 5. Estimates of the $\hat{\Pi}$ matrix (averaged data, model: H_4)

	lsp_t	$lnav_t$	*Constant*
Δlsp_t	-0.178 (-3.257)	0.178 (3.257)	-0.036 (-3.257)
$\Delta lnav_t$	0	0	0

Note: Numbers in brackets are t-ratios

Table 6. MA representation and decomposition of the trends (averaged data, model: H_4)

	Coefficients of the Common Trend: $\hat{\alpha}_\perp$	*Loadings to the Common Trend:* $\hat{\beta}_\perp$	*Long Run Impact Matrix:* $\hat{C}$ $\sum \varepsilon_{sp}$	$\sum \varepsilon_{nav}$
lsp_t	0	1 (3.768)	0	1 (3.768)
$lnav_t$	1	1 (3.768)	0	1 (3.768)

Note: Numbers in brackets are t-ratios

Table 7. Augmented Dickey-Fuller unit root test on discount (averaged data)

Lags	*Significance Level* 99%	95%	90%	*T-statistic*
0	-3.476	-2.881	-2.577	-4.958[a]

[a] Rejection of the null with 99% significance

Table 8. Augmented Dickey-Fuller unit root test on discount (individual data)

CEF #	*Lags*	*Significance Level*			*T-statistic*
		99%	*95%*	*90%*	
1	0	-3.476	-2.881	-2.577	-2.476[b]
2	1	-3.476	-2.881	-2.577	-1.919[b]
3	1	-3.476	-2.881	-2.577	-3.464[b]
4	3	-3.477	-2.882	-2.577	-6.075[a]
5	0	-3.476	-2.881	-2.577	-2.511[b]
6	0	-3.476	-2.881	-2.577	-3.971[a]
7	0	-3.476	-2.881	-2.577	-2.447[b]

[a] Rejection of the null with 99% significance
[b] Acceptance of the null with 99% significance

So far, considering an equally weighted portfolio of CEFs, we conclude with certainty that the discount narrows/widens due to changes (increases/falls) in share prices. Furthermore, taking into account that the cointegrating vector is (1, -1) implying discount's stationarity, market inefficiency is detected. That is, considering an equally weighted portfolio of CEFs trading in ASE, investors could achieve abnormal returns, in the short-run, through exploitation of discount deviations from its mean value.

In the second empirical part, employing data for each individual CEF, we shed more light in the first sub-sample, characterized as "mild uptrend" period, in order to test the hypothesis that moderate market performance, in ASE, is a sufficient condition for the realization of abnormal returns in the short run. The results reported in Table 9 support the existence of a long-run relation, with a non-zero intercept, between the share prices and NAVs of four CEFs (# 1, 4, 6 and 7). However, considering the first CEF (# 1), taking into account a second root close to unity as well as results indicating acceptance of stationarity for share prices and exclusion for NAVs, we choose to accept r=0. Results from hypotheses testing on the three CEFs (# 4, 6 and 7), indicate acceptance of long-run homogeneity for two CEFs (# 4 and 6) as well as acceptance of joint long-run weak exogeneity and long-run homogeneity hypothesis for all three examined CEFs. However, we note that for the last CEF (# 7) joint hypothesis is borderline accepted. That is, examining individual data of seven CEFs trading in ASE, market inefficiency is detected in two cases (# 4 and 6). In other words, in two out of seven cases, there is potential for abnormal returns realization, in the short-run, through exploitation of discount deviations from its mean value. Results from ADF unit root tests (Table 8) verify our evidence indicating rejection of the null hypothesis that the discount is I(1) for two CEFs (# 4 and 6).

Table 9. Trace test for cointegration rank, moduli of 2 largest roots and hypotheses testing (individual data)

CEF #	*r*	*p-r*	*i*	$\hat{\lambda}_i$	τ_{p-r}	$C_{95\%(p-r)}$	*Moduli of 2 Largest Eigenvalue Roots*		lsp_t	$lnav_t$
1	0	2	1	0.172	33.809[a]	20.164	1.000	1.000	1.202[i,b]	4.379[i,a]
	1	1	2	0.047	6.812[b]	9.142	1.000	0.985	5.968[ii,b]	3.682[ii,b]
									4.379[iii,a]	1.202[iii,b]
2	0	2	1	0.076	18.522[b]	20.164	1.000	1.000	0.004[i,b]	0.005[i,b]
	1	1	2	0.048	7.079[b]	9.142	1.007	1.000	5.158[ii,b]	4.710[ii,b]
									0.005[iii,b]	0.004[iii,b]
3	0	2	1	0.058	13.658[b]	20.164	1.000	1.000	2.341[i,b]	3.302[i,b]
	1	1	2	0.034	5.053[b]	9.142	1.000	0.941	5.769[ii,b]	3.970[ii,b]
									3.302[iii,b]	2.341[iii,b]
4	0	2	1	0.186	31.297[a]	20.164	1.000	1.000	27.589[i,a]	27.323[i,a]
	1	1	2	0.013	1.854[b]	9.142	1.000	0.741	5.072[ii,b]	5.833[ii,b]
									27.323[iii,a]	27.589[iii,a]
									27.569[iv,a]	1.980[iv,b]
										3.795[v,b]
										4.593[vi,b]
5	0	2	1	0.084	16.189[b]	20.164	1.000	1.000	0.548[i,b]	2.531[i,b]
	1	1	2	0.024	3.466[b]	9.142	1.000	0.973	4.912[ii,b]	5.798[ii,b]
									2.531[iii,b]	0.548[iii,b]
6	0	2	1	0.139	29.847[a]	20.164	1.000	1.000	13.401[i,a]	13.208[i,a]
	1	1	2	0.055	8.221[b]	9.142	1.000	0.788	1.779[ii,b]	4.358[ii,b]
									13.208[iii,a]	13.401[iii,a]
									8.097[iv,a]	1.189[iv,b]
										2.703[v,b]
										4.673[vi,b]
7	0	2	1	0.120	23.944[a]	20.164	1.000	1.000	12.321[i,a]	12.723[i,a]
	1	1	2	0.037	5.450[b]	9.142	1.000	0.824	4.948[ii,b]	1.479[ii,b]
									12.723[iii,a]	12.321[iii,a]
									9.730[iv,a]	1.890[iv,b]
										5.041[v,a]
										5.420[vi,b]

[a] Rejection of the null with 95% significance

[b] Acceptance of the null with 95% significance

[i] Multivariate Stationarity test is a LR test, distributed as $\chi^2(1)$

[ii] Doornik and Hansen (2008) univariate normality test, distributed as $\chi^2(2)$

[iii] Variable Exclusion is a LR test, distributed as $\chi^2(1)$

[iv] Long-run Weak Exogeneity test is a LR test, distributed as $\chi^2(1)$

[v] Long-run Homogeneity test is a LR test, distributed as $\chi^2(1)$

[vi] Joint Long-run Weak Exogeneity and Long-run Homogeneity test is a LR test, distributed as $\chi^2(2)$

5. Summary and Conclusions

In this paper we employ Johansen (1988 and 1996) and Johansen and Juselius (1990) cointegration methodology in order to examine weak form market efficiency on data from CEFs trading in ASE. Employing ten-day periodic data, from October 20, 2003 to February 10, 2009, that represent the share prices and NAVs of seven CEFs, our objective is to investigate the potential of abnormal returns' realization, in the short-run, due to the mean-reverting properties of CEFs' discount. Examining a sample containing a mild bullish pre-credit-crunch period (*2003:10:20-2007:10:31*) followed by a bust post-credit-crunch period (*2007:11:09-2009:02:10*), our research extends the existing literature by considering if market performance, in ASE, alternates the mean-reverting properties of CEFs' discount and as a result affects realization of abnormal returns on CEFs.

In the first empirical part, examining an equally weighted portfolio of CEFs trading in ASE, we show that in a period of extreme market performance, as the recent turmoil due to credit crisis, there is no evidence for cointegration between the two examined variables. On the other hand, during the examined mild bullish period, our econometric analysis suggests that, the share prices of CEFs and their NAVs are cointegrated. Overall, considering an equally weighted portfolio of CEFs traded in the Greek Capital Market, moderate market performance points to the potential of abnormal returns realization, in the short-run, through exploitation of discount deviations from its mean value. This is because, regarding both hypotheses testing and estimates from the MA representation of the employed model, there is clear evidence about the identification of NAVs as the pushing force of our system while share prices were purely adjusting. Moreover, hypothesis testing on the implied stationary long-run relation indicates that, unlike the suggestions made by Cheng et al. (1994), Gemmill and Thomas (2002) and Copeland (2007), any shock coming from net asset values has the same effect to each of share prices and NAVs (long-run homogeneity assumption), implying that the share prices truly reflect the performance of NAVs over a long period. Given the above, and taking into account the statistical significance of a constant term (restricted to the cointegrating space), the presence of a nonzero but mean-reverting discount is verified throughout the examined mild bullish period.

In the second part of our empirical analysis, considering individual data of the pre-credit-crunch period, evidences are mixed. That is, moderate market performance ensures the mean-reversion of CEFs' discount and points to cointegration between the examined variables, for three out of all seven CEFs. In addition, further examining the implied cointegrating vectors, our results, regarding hypotheses testing, support the identification of NAVs as the pushing force of our system. However, only in two of these cases there is a cointegrating vector (1, -1) implying discounts' stationarity. Overall, examining individual data, our results, in two out of seven cases, support the suggestion that moderate market performance points to the potential of abnormal returns realization, in the short-run, through exploitation of discount deviations from its mean value.

References

1. Anderson, S., 1986, "Closed-end funds versus market efficiency", *Journal of Portfolio Management 13(1), 63–67.*
2. Brauer, G., 1984, "Open-ending' closed-end funds", *Journal of Financial Economics 13(4), 491–507.*
3. Brauer, G., 1988, "Closed-end fund shares' abnormal returns and the information content of discounts and premiums", *Journal of Finance 43(1), 113–127.*
4. Brickley, J. and J. Schallheim, 1985, "Lifting the lid on closed-end investment companies: a case of abnormal returns", *Journal of Financial and Quantitative Analysis 20(1), 107–117.*
5. Cakici, N., A. Tessitore, and N. Usmen, 2000, "Closed-end equity funds: betting on discounts and premiums", *Journal of Investing 3(4), 83–92.*
6. Cakici, N., A. Tessitore, and N. Usmen, 2002, "Closed-end funds and turnover restrictions", *Financial Analysts Journal 58(3), 74–81.*
7. Cheng, A., L. S. Copeland and J. O'Hanlon, 1994, "Investment trust discounts and abnormal returns: UK evidence", *Journal of Business Finance & Accounting 21(6), 813–831.*
8. Chow, G. C., 1960, "Tests of equality between sets of coefficients in two linear regressions", *Econometrica 28, 591–605.*
9. Copeland, L., 2007, "Arbitrage bounds and the time series properties of the discount on UK closed-end mutual funds", *Journal of Business Finance & Accounting 34(1-2), 313–330.*
10. Dennis, J. G., H. Hansen, S. Johansen and K. Juselius, 2005, "CATS in RATS version 2", Estima.
11. Dickey, D. A. and W. A. Fuller, 1981, "Likelihood ratio statistics for autoregressive time series with a unit root", *Econometrica 49, 1057-1072.*
12. Dimson, E. and C. Minio-Kozerski, 1999, "Closed-end funds: a survey", *Financial Markets, Institutions & Instruments 8(2), 1-41.*
13. Doornik, J. A. and H. Hansen, 2008, "An omnibus test for univariate and multivariate normality", *Oxford Bulletin of Economics and Statistics 70(s1), 927-939.*
14. Engle, R. F. and C. W. J. Granger, 1987, "Cointegration and error correction: representation, estimation and testing", *Econometrica 55, 251-277.*
15. Fabozzi, F. J. and J. C. Francis, 1977, "Stability tests for alphas and betas over up and down market conditions", *Journal of Finance 32(4), 1093-1099.*
16. Gasbarro, D., R. D. Johnson, and K. J. Zumwalt, 2003, "Evidence on the mean-reverting tendencies of closed-end fund discounts", *Financial Review 38, 273-291.*
17. Gemmill, G. and D. C. Thomas, 2002, "Noise-trading, costly arbitrage and asset prices: evidence from closed-end funds", *Journal of Finance 57(6), 2571-2594.*
18. Gonzalo, J., 1994, "Five alternative methods of estimating long-run equilibrium relationships", *Journal of Econometrics 60(1), 203–33.*
19. Hamilton, J. D., 1994, "Times series analysis" (Princeton University Press, Princeton).
20. Higgins, E. J., S. Howton and S. Howton, 2003, "An analysis of closed-end seasoned equity offerings", *Journal of Financial Research 26(2), 243-257.*
21. Johansen, S., 1988, "Statistical analysis of cointegrating vectors", *Journal of Economic Dynamics and Control 12, 231-254.*

22. Johansen, S. and K. Juselius, 1990, "Maximum likelihood estimation and inference on cointegration-with applications to the demand for money", *Oxford Bulletin of Economics and Statistics 52, 169-210.*
23. Johansen, S., 1996, "*Likelihood-based inference on cointegration in the vector autoregressive model*" (Oxford University Press, Oxford).
24. Juselius, K. and R. MacDonald, 2003, "International parity relationships between Germany and the United States: a joint modelling approach", *Working Paper (FRU 2004/08, University of Copenhagen, Department of Economics, Finance Research Unit).*
25. Juselius, K., 2006, "*The cointegrated VAR model: methodology and applications*" (Oxford University Press, Oxford).
26. Khorana, A., S. Wahal and M. Zenner, 2002, "Agency conflicts in closed-end funds: the case of rights offerings", *Journal of Financial and Quantitative Research 37(2), 177–200.*
27. Kremers, J. J., N. R. Ericsson and J. J. Dolado, 1992, "The power of cointegration tests", *Oxford Bulletin of Economics and Statistics 54, 325–348.*
28. Pontiff, J., 1995, "Closed-end fund premia and returns: implications for financial market equilibrium", *Journal of Financial Economics 37, 341-370.*
29. Sias, R., L. Starks and S. Tinic, 2001, "Is noise trader risk priced", *Journal of Financial Research 24(3), 311–329.*
30. Thompson, R., 1978, "The information content of discounts and premiums on closed-end fund shares", *Journal of Financial Economics 6(2/3), 151–186.*