Closed-End Country Fund Discounts and Systematic UK and US Market Movements: Co-integration and Error Corrected Granger Causality Tests

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Abstract

This paper examines the pattern of co-integration and causality between UK domiciled closed-end country funds and systematic country and domicile market movements. We analyse 13 UK domiciled funds that invest in UK securities and 5 UK domiciled funds that invest in US securities. When controlling for co-integration in the time series, we find no support for the market segmentation hypothesis for UK CECFs investing in US securities. The error-corrected Granger causality results also support this contention, as no short term causal relationship was indicated between the UK CECFs investing in US securities and the S&P 500 index. However, we do show evidence of a general systematic relationship between each fund's discount/premia and domestic market movements supporting the sentiment hypothesis. This result is interesting, as institutions own a strong majority of the CECF shares traded on the London Stock Exchange.

1. Introduction

The closed-end fund (CEF) discount/premium puzzle has perplexed market participants and researchers for some time. CEF shares typically trade at a discount to net asset value, but at times are observed to trade at a premium to net asset value. The puzzling attribute of CEF's is the persistent share price deviations from net asset values. To raise investment capital, a CEF sells a block of shares on one or more stock exchanges. Trading of CEF shares takes place on the relative exchanges, not between the investor and the fund as is typical of mutual funds. The generated capital is then invested according to stated objectives, typically in the debt and/or equity instruments of firms listed on the world's stock exchanges, and less frequently in unlisted companies or restricted shares. Closed-end country fund (CECF) shares trade in one country (domestic market) and invest in securities traded in that or one other country (local market). One question that remains is why the persistent deviations of CEF share prices from NAV's have not been arbitraged away?

Two primary and one emerging explanations of these phenomena appear in the literature. The Market Sentiment approach argues that "noise trader" sentiment drives the variation in CEF discounts. Noise trading involves trades based on information that is perceived true, but may not be. Noise traders are individuals considered to be either un- or miss-informed. The demand and/or supply impact of noise trading forces observed market prices away from intrinsic or fundamental value. The market Segmentation approach argues that market frictions preclude costless arbitrage in cross-border transactions. When the relevant systematic risks of the funds shares and its net assets are based in different markets, gaps between share price and NAV are plausible to the level of the market frictions; otherwise they will be arbitraged away. The Expected Managerial Performance approach is an emerging hypothesis that may be based on the long-term mean reverting nature of CEF discounts.

This paper examines both the market segmentation and sentiment hypotheses with closed-end country funds with and without the possible confounding influence of dual market segmentation. In addition, the significant difference in CEF ownership structure in the UK, where institutions own a strong majority of CEF shares, versus the US, where individuals own a strong majority of CEF shares provides an interesting setting for this analysis. Our sample consists of the 18 UK CEFs[1] that are traded on the London Stock Exchange, 13 of which invest only in UK securities,[2] and 5 invest only in US securities. Specifically, we examine the pattern of co-integration and error corrected Granger causality between CECF discounts, three FT-SE indices that proxy for UK small/noise/individual investor sentiment, UK large/institutional investor sentiment, and general UK investor sentiment and the S&P 500 Index that measures general US investor sentiment.

When the discounts reflect "noise" induced sentiment they are likely to be mean reverting (integrated) as opposed to random or stationary. Discounts should also be co-integrated with local sentiment measures, and causal relationships should exist between sentiment measures and fund discounts. When markets are segmented and discounts are driven by local and foreign price risk, discounts are not likely to be mean reverting (integrated), but are likely to be random or stationary. CEF discounts are also not likely to be co-integrated with domestic measures of sentiment, but are likely to be correlated with general local and foreign market movements. Causal relationships are likely to exist between fund discounts and general local and foreign market movements.

Our results indicate a strong notion of small/noise/individual investor induced sentiment in both the UK and US groups of CECFs trading on the London Stock Exchange. An institutional shareholding effect was not evident, a curious result given the high degree of institutional ownership of CECFs traded on the London Stock Exchange. A market segmentation influence was not evident in the multivariate results but indicated in the univariate results.

2. Background

Lee, Shleifer and Thaler (1991, LST hereafter) find a positive relationship between US CEF discounts and individual or small investor sentiment, which is also consistent with the Campbell and Kyle (1993) model that shows noise trading[3] can influence market prices. LST (1991) find that CEF discounts are related to the expected returns of small firms. Small-firm stocks are presumed held primarily by individual investors or noise traders. The logic of the argument is that when expected returns are high/low, stock prices will be low/high, and prices are low/high when individual or noise trader sentiment is bearish/bullish. Since small investor sentiment is likely to be systematic across CEF assets, it represents an additional source of non-diversifiable risk that must be priced. Other things equal, a higher risk premium forces a higher expected return and a lower share price relative to NAV.

Bodurtha, Kim and Lee (1995) investigate a market segmentation hypothesis in which the pricing of US CECFs that trade on non-US assets should reflect the systematic risk of the funds' local market and the US market. Their findings suggest a previously unidentified risk factor, attributed to general US investor sentiment, which is related to CEF share price but not NAV. Choi and Lee (1996) find that CECF discounts are sensitive to both local and US market factors, but only local market factors are priced in an equilibrium sense.

Chopra, Lee, Shleifer, and Thaler (1993) test an institutional holding effect for NYSE public utility firms and find that low institutional ownership utilities do co-vary with closed-end discounts more strongly than with high institutional ownership utilities. Chopra *et al.* rework Chen *et al.*'s analysis and find a strong correlation between the return on small stocks and the return on the portfolio of closed-end funds. Small firm excess returns explain more of the change in discounts than medium or large firm excess returns.

Bailey and Lim (1992) investigate the degree of diversification offered by US CECFs. First, the country fund daily and weekly return correlations with the New York market are invariably larger than the correlation with the corresponding country index, implying inefficient diversification. Bailey and Lim also find that CECF's are priced more like domestic US stocks than the foreign equities in which they are invested. They also document some divergence between the country funds and the foreign stocks' portfolio that is speculated to indicate the presence of some sentiment factor in the market.

Ben-Zion, Choi and Hauser (1996) examine the price linkages between three CECFs listed in the US and their respective local stock markets. Their work is the first to use the methodology of co-integration and Granger causality to investigate country fund price relationships. No co-integration is found between the country funds and their local market indices. Their Granger causality test reveals a significant two-way causal relationship between the local market returns and the country fund returns. This result is contrary to the findings of Bodurtha *et al.* (1995), and suggests that the traditional approaches to analysing co-integrated time series may not be appropriate.

3. Methodology and Results

Co-integration analysis will identify any long-term equilibrium relationship between changes in the level of CECF discounts and our proxies for different investor sentiments, while controlling for short term deviations from equilibrium related to individual or noise trading. The error-correction model will describe the process by which short-term deviations revert to this long-term equilibrium relationship. Error corrected Granger causality will identify the causal direction between changes in CECF discounts and changes in levels of the indices that proxy different investor expectations in both the UK and US markets. The analysis is undertaken at both the univariate and multivariate levels.

3.1 Data

The sample consists of the discounts/premiums for 18 UK CEFs that are traded on the London Stock Exchange, 13 CEFs that invest only in UK securities, and 5 that invest only in US securities. The FT-SE 100 is a proxy for large/institutional UK investor sentiment, the FT-SE Small Stock Index is a proxy for small UK investor sentiment, and the FT-SE.

All Stock Index is a proxy for general UK investor sentiment and the S&P 500 Index is a proxy for US investor sentiment.

Daily stock prices and NAVs are collected for each CEF, and daily values are collected for each index during the period July 30 1991 to January 31 1997. The FT-SE Small Stock Index was initiated on December 30 1992 generating 1055 observations; the other series are available for the sample period generating 1438 observations.

Daily premiums/discounts[4] (P_{it}) is calculated as:

$$P_{it} = [(NAV_{it} - SP_{it})/ NAV_{it}] = 1 - (SP_{it} / NAV_{it}), \quad (1)$$

where: Sp_{it} = stock price of fund i on day t, and NAV_{it} = net asset value of fund i on day. Changes in daily discounts are calculated as :

$$\Delta P = P_{it} - P_{it-1}. \quad (2)$$

And, the daily changes in the indices are:

$$\Delta I = I_t - I_{t-1}. \quad (3)$$

Table 1 contains parameters for the distribution of the average daily departure of CEF stock prices from their NAV's. The mean deviations of UK CEF share prices from their respective NAV's indicate discounts, the levels of which vary widely both within and across funds. The volatility of US closed-end fund discounts is well documented.[5] There is a marked difference between the time series average and the average of the cross-sectional means that is a hint for non-stationary in a time series. Seven of the CEF's trade at a discount for the entire sample period, and four others trade at a discount for a clear majority of the sample period. The remaining two CEFs trade at a premium on over half of the trading days during the sample period.

3.2 Univariate Analysis

Univariate analysis starts with the correlation matrix to establish the relationship between CECF discounts and the UK and US market indices. Each time series is then analysed for stationarity. Then the co-integration relationships between each CECF and each index are tested in two stages. Co-integrated time series implies a long run, equilibrium reverting relationship. Error corrected Granger causality is used to analyse the time varying behaviour between the CECF discounts and the UK and US indices. Significant results will imply that past changes in either CECF discounts or index levels can be used to predict future changes in discounts, index levels, or both.

3.2.1 Correlations

Correlation analysis is used to establish the linear dependence between the CEF discounts and the UK and US indices. Table 2 reports the correlation matrix of daily premium levels for the 18 closed-end funds and an equally weighted premium index. The UK and the US CEFs premium levels are reasonably correlated with each other. The pair-wise correlations are predominately positive and frequently exceed 0.5.

Table 3 shows the correlations of the CEF premiums with the market indices. An interesting pattern emerges, showing that over one-half the correlations of the premiums with the indices are negative. As well, the CEF premiums are reasonably correlated with the indices. The equally weighted UK and US indices are negatively correlated with the FT-SE 100 and FT-SE Small Companies and a positive correlation with the FT-SE All

Shares. The UK index is not significantly correlated with the US indices, and the US index is negatively correlated with the US indices.

3.2.2 Stationarity

The first step in testing for univatiate co-integration is to access the stationarity of each time series. For a time series to be stationary its mean variance over time should be constant. The basic idea of stationarity is that the probability laws governing a stochastic process do not change over time. Specially, a stochastic process $\{X_t\}$ is said to be strictly stationary if the joint distribution of $X(t_1)$, $X(t_2)$...$X(t_n)$ is the same as the joint distribution of $X(t_{1-k})$, $X(t_{2-k})$ ... $X(t_{n-k})$ for all $t \varepsilon t_n$ and for any number of time lags k.

Unit root tests are applied to determine if variables in a regression are stationary or non-stationary. Dickey and Fuller (1981) represented a time series X_t with an autoregressive representation and a time trend t as:

$$X_t = \alpha_0 + \alpha_1 t + \beta X_{t-1} + \sum_{j=2}^{n} \gamma_j X_{t-j} + \varepsilon_t \tag{4}$$

X_t is said to be non-stationary if $\beta = 1$, where ε_t is an error term, and α_o, α_1, γ_t and β are arbitrary coefficients. The null hypothesis is that the series is I(1) which implies that the series is stationary in its first differences..

Table 4 reports the results of the unit root tests from testing for the degree of integration. The null hypothesis is that of a unit root. This is accepted for 12 of the 18 CEFs, most fund discounts are I(1) with the exception of Finsbury-Growth, Fleming-Claverhouse, Malvern UK, Mercury Key, Murray and American OP that are stationary series or I(0). The discounts for Fleming-Claverhouse, Malvern UK, Mercury Key, Murray and American OP are dropped from the co-integration analysis as they remained I(0) after testing with 30 lags. Finsbury-Growth is kept in the co-integration analysis as the unit root hypotheses were only marginally rejected at the 5% confidence level, and the series became I(1) and after 20 lags.

The FT-SE and S&P indices are also tested for stationarity with the ADF procedure. These results, in Table 5, show that each of the indices are I(1) in their levels and I(0) or stationary in first differences. The unit root tests indicated that the levels of CEF discounts and raw market indices are non-stationary. However, their first differences were stationary. Existence of a unit root implies an integrated process where the impacts of innovations are permanent on the level of the series, but only temporary on the stochastic process by which the series changes.

3.2.3 Cointegration

Two time series are considered to be co-integrated if the series are I(1) and some linear combination of the two series is I(0) or stationary. The existence of co-integration implies a long-term relationship that may be distorted in the short term due to innovations in either one or both of the time series.

When satisfied that the CEF discount and index time series are I(1) in levels and I(0) in first differences, testing for co-integration is done in two steps. First, a co-integrating regression model is estimated.

$$X_t = \alpha + \beta Y_t + \varepsilon_t \quad (5)$$

where: X_t = discount/premium on day t,

Y_t = index level on day t, and

ε_t = residual on day t.

In the second step, the residual series is then tested for unit roots with the ADF procedure. If the null hypothesis of the unit root is rejected, the residual series is white noise I(0) and co-integration is present.

The results of the univariate co-integration tests of the UK CEFs are shown in Panel A of Table 6. The null hypothesis of no co-integration is rejected for five of the eight integrated discount series, that is their residual series were I(0). Albany, Edinburgh, Govett, Investment Guernsey and Welsh Ind are co-integrated with each index. No co-integration was evident between the indices and Finsbury Trust or Finsbury A Trust. Gartfield Scotland was co-integrated with the FT-SE Small and the S&P 500 indices, but not the FT-SE 100 ot the FT-SE All. In Panel B, all four of the US CEFs exhibited co-integration with each of the FT-SE indices. American TR and American TS exhibit Co-integration with each of the S&P 500 Indices, Fleming American with the $S&P 500, and North Atlantic with neither of the S&P indices. Evidence of co-integration implies a long-term, equilibrium reverting relationship and the possibility of long-term arbitrage opportunities.

The results of the co-integration tests are shown in Table 6. In Panel A, the null hypothesis of no co-integration was rejected for nine out of the twelve funds, that is, their residual series were I(0). The co-integrated funds with the FT-SE 100 are Albany, Edinburgh, Finsbury Growth, Govett Investment. Guernsey, Malvern. UK, Mercury. Key, Murray and Welsh.Ind. No co-integration was evident between Finsbury Trust, the Finsbury A Trust, the Gartfield Scotland and the FT-SE 100. In Panel B, 9 of the 12 funds exhibit co-integration with the FT-SE Small Stock Index. The differences between Panel A and Panel B are: Garfield Scotland was not co-integrated with the FT-SE 100 but is with the FT-SE Small Stock Index, and Mercury Key was co-integrated with the FT-SE 100 but not with the FT-SE Small Stock Index. In Panel C, the co-integrated relationships are consistent with those in Panel A.

Nine of the twelve CEF's appear to be co-integrated with the FT-SE 100 and the FT-SE All Stock Indices, and eight of these are also co-integrated with the FT-SE Small Stock Index. Evidence of co-integration implies an equilibrium reverting relationship, and the possibility of long-term arbitrage opportunities.

3.2.4 Error-Corrected Granger Causality

Granger (1969) introduced the concept of causality for stationary series in which information about X is expected to affect the conditional distribution of the future values of Y, given the 'dependent' variable (Y) and X the 'explanatory' variable. X will refer to a CEF discount series and Y will refer to an index series. The Granger test for causality relies on the estimation of the bivariate auto-regressive models. First, to test for causality from X to Y, the following model is used:

$$\Delta X_t = \sum_{i=1}^{p} \delta \Delta X_{t-1} + \sum_{j=1}^{q} \theta_j \Delta Y_{t-j} + \mu_t \quad (6)$$

where u_t is white noise, p is the order of the lag for X and q is the order of the lag for X. The null hypothesis that X does not Granger-cause Y is that $\theta_j = 0$ for j = 1,2, ...q (and $\beta_j = 0$ for j = 1,2, ...p below). Thus, a rejection of the null hypothesis indicates that X Granger-causes Y.

Then to test for causality from Y to X, the variables X and Y are interchanged as in the following equation.

$$\Delta Y_t = \sum_{t=1}^{p} \alpha_1 \Delta Y_{t-1} + \sum_{j=1}^{q} \beta_j \Delta X_{t-j} + \mu_t \quad (7)$$

Note that there is a lagged feedback effect if both tests reject the null hypothesis, in other words, the event when X causes Y and Y causes X. An underlying assumption in the test for causality is that the variables used in the estimation are stationary.

For co-integrated series, Engle and Granger (1987) indicate the following error-correction equations should be used:

$$\Delta X_t = \sum_{i=1}^{p} \delta \Delta X_{t-1} + \sum_{j=1}^{q} \theta \Delta Y_{t-j} + \gamma \mu_{t-1} + \varepsilon_t \quad (8)$$

and

$$\Delta Y_t = \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{q} \beta_j \Delta X_{t-j} + \gamma' \mu_{t-1} + \varepsilon_t \quad (9)$$

Where the μ_{t-1} terms are lagged residuals from (5) which serves to correct the estimation error. The test was carried out on levels that are I(0) with (6) and (7), and on first differences that were I(0) with (8) and (9).

The Granger causality results for the UK CEFs in Table 7 Panel A show significant one-way causal relationship between each of the CEF's discount series and each of the FT-SE indices. There is an error corrected Granger causality effect that runs from the London market to each of the CEFs. No evidence of reverse causality was found. A significant one-way causal relationship is indicated from the UK CEFs to the $S&P 500 in six cases and to the £S&P 500 in eight cases. Lagged feedback, or reverse causality was indicated between the $S&P 500 and Albany, Finsbury Growth and Finsbury Trust and the £S&P 500 and Finsbury Growth.

The Granger Causality results for the US CEFs in Panel B of Table 7 show a significant one-way causal relationship between each of the CEFs discount series and four of the five indices. The exception was American OP. Lagged feedback affects are indicated between the American CEFs: and the FT-SE 100 in two cases, and the FT-SE Small in three cases, and the FT-SE All in one case. No lagged feedback is indicated between the US CEFs and the US indices.

3.3 Multivariate Co-integration

To substantiate the univariate results a more powerful multivariate framework is employed to determine the number of co-integrating relationships in various specifications of discount series matrices. The objective is to identify the number of co-integrating vectors in a group of time series. The Vector Autoregressive (VAR) model provides a multivariate framework for determining the relationships between a number of jointly endogenous time series variables. For modelling variables that are likely to be co-integrated, a restricted VAR version with an error correction component is required. The process determines the rank of the matrix of stationary time series or the number of co-integrating vectors while controlling for the short-term causal relationships. The rank of the matrix is determined by the log-likelihood trace and the maximum eigenvalue statistic. Table 8 shows the matrix ranks of various groups of discount series, various groups of UK and the US discount series and the five indices.

Five co-integrating vectors are indicated for the group of the UK and US discount series, three attributed to the UK discount series and two attributed to the US discount series. Apparently different systematic influences drive discounts of the UK and US CECFs. Adding the FT-SE All and 100 and either of the S&P 500 indices to the matrix group does not generate an additional co-integrating vector, indicating the co-integrating vectors are not related to general domestic or local market activity. The additional co-integrating vector indicated when the FT-SE Small index is added to the matrix of UK and US discounts substantiates the small/noise/individual investor hypothesis.

3.4 Summary

The predominately positive correlation of CEF discounts over time suggests that the discounts are affected by at least one common factor or systematic component. The unit root tests indicated that discount levels if eight of 13 UK and four of five US CEFs and the levels of the market indices were non-stationary, but were stationary in their first differences.

The co-integration results indicate a long-run equilibrium relationship with the local and foreign indices for at least one-half of the CEFs. About one-half of the CEFs indicated co-integration with each of the UK and US indices. Four of the five US CEFs indicated co-integration with each of the UK indices, and about one-half indicated co-integration with the US indices.

Granger causality tests indicated a significant one-way causal relationship from each UK index to each CEF and from the US indices to each of the US CEFs. A significant one-way causal relationship is indicated from at least one-half of the UK CEFs to the US indices. Unidirectional causality implies an information transmition. For the UK CEFs this information flow is from the local market to the CEFs and from the CEFs to the US market. For the US CEFs this information flow is from both the local and foreign markets to the CEFs, which is in contrast to Lee *et al.* (1991) who reported that US domestic CEF discount changes were not correlated with the US market returns.

4. Conclusions

Our results support the co-existence of general market sentiment and segmentation for the UK traded CEFs. The finding that two thirds of the premium series appear integrated, that just over one-half are co-integrated with the FT-SE Small index and the one-way information flow from the FT-SE Small support the presence of "noise" induced sentiment trading by the UK institutional CEF shareholders. However, the relationships between the discount series and the other indices would imply a general relationship, not specifically related to "noise" trading. This contention is supported by the one-way information flow from the FT-SE indices to the UK and US CEFs.

Our findings that one-third of the fund discount series appear integrated in levels and that one-half of the CEF return series exhibit no co-integration with the UK or US indices indicates an absence of one single systematic component in the discount series of these CEFs. The co-integration exhibited by the US CEFs with both the US and UK indices would imply at least two systematic sources of risk impact the discounts of these CEFs. These two sources of systematic risk also impact the discount levels of the UK CEFs. The local impact is also evident in the one-way information flow from the FT-SE indices to each of the funds. The one-way information flow from the US indices to the US CEF discount series and the reverse information flow from the UK discount series to the US indices would also support the presence of dual market segmentation.

Endnotes

1. Also known as closed end investment companies, and investment trusts in the UK

2. CEFs have a long history in England where the first, Foreign and Colonial, was established in 1868. In the late eighties closed-end country funds emerged. Currently, the LSE lists more than 300 CEFs, including 46 single-country funds of which 13 invest in UK securities and 5 in US securities.

3. Noise trading consists of trades based on information that is perceived true, but may not be. Noise traders are individuals considered to be either un-informed or miss-informed. The demand and/or supply impact of noise trading pushes observed market prices away from intrinsic or fundamental value.

4. Note that a positive P implies a discount

5. See, for example, Lee et al. (1991)

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Table 1
Mean CEF Discount and Standard Deviation, Mean Time Series Standard Deviation, and Mean Cross Sectional Standard Deviation

Fund Name	Mean Daily Discount (%)	Std.dev. of Daily Discount (%)	Days of Discount n = 1438
Albany Inv Trust	13.376	4.711	1438
Edinburgh Inv Trust	10.858	2.656	1438
Finsbury Growth Trust	8.618	4.437	1438
Finsbury Trust	13.286	8.126	1438
Finsbury Tst 'A'	17.728	6.737	1438
Fleming Claverhouse	-0.195	3.247	693
Gartmore Scotland Pkg	3.381	8.133	1106
Govett Strategic	11.679	3.103	1438
Investment.Trust. Guernsey	13.902	4.091	1438
Malvern	3.461	2.391	1313
Mercury	5.099	6.310	1040
Murray Special Pkg Units	-1.409	8.445	623
Welsh Industrial	21.761	9.349	1433
American OP	13.46	7.05	1426
American TR	12.42	4.71	1438
American TS	14.23	4.60	1438
Fleming American	11.35	7.52	1415
North American	17.92	10.44	1438
		British	American
	Sample mean discount	9.3497	13.88
	Time series average standard deviation	5.5549	6.87
	Cross-sectional average standard deviation	8.4936	13.88

Table 2.
Correlations between CEF discounts, and between CEF discounts and an equally weighted index of the CEF's.
^{1} denotes significance at the 99% level, ^{2} denotes significance at the 95% level.

Funds	Alban	Edinb	FinAs	Fin.Gr	FinTr	FlemC	Gart.S	Gov	InvSt	Malv	Merc	Murr	Welsh	UKE	AOP	ATR	ATS	FIA	NA	USE	EWI
Alban	1.00	0.63^{1}	0.21^{1}	0.43^{1}	0.10^{1}	0.41^{1}	-0.41^{1}	0.54^{1}	0.58^{1}	0.51^{1}	0.03	0.04	0.19^{1}	0.54^{1}	-0.08^{1}	0.56^{1}	0.63^{1}	0.55^{1}	0.39^{1}	0.56^{1}	0.60^{1}
Edinb		1.00	0.46^{1}	0.33^{1}	0.40^{1}	0.20^{1}	-0.17^{1}	0.54^{1}	0.48^{1}	0.23^{1}	0.11^{1}	0.06^{2}	0.05^{3}	0.62^{1}	-0.15^{1}	0.67^{1}	0.66^{1}	0.65^{1}	0.32^{1}	0.58^{1}	0.66^{1}
Fin.At			1.00	0.69^{1}	0.93^{1}	-0.31^{1}	-0.30^{1}	0.39^{1}	0.38^{1}	0.05^{2}	0.68^{1}	-0.43^{1}	0.36^{1}	0.78^{1}	0.37^{1}	0.32^{1}	0.45^{1}	0.10^{1}	0.75^{1}	0.63^{1}	0.79^{1}
Fin.Gr				1.00	0.59^{1}	-0.19^{1}	-0.66^{1}	0.41^{1}	0.33^{1}	0.32^{1}	0.72^{1}	-0.58^{1}	0.25^{1}	0.55^{1}	0.46^{1}	0.27^{1}	0.46^{1}	0.02	0.87^{1}	0.67^{1}	0.66^{1}
Fin.Tr					1.00	-0.44^{1}	-0.19^{1}	0.20^{1}	0.30^{1}	-0.04	0.66^{1}	-0.40^{1}	0.38^{1}	0.73^{1}	0.39^{1}	0.25^{1}	0.37^{1}	0.06^{2}	0.67^{1}	0.56^{1}	0.72^{1}
FlemC						1.00	0.08^{2}	0.38^{1}	0.34^{1}	0.05^{3}	-0.44^{1}	0.47^{1}	-0.02	0.12^{1}	-0.31^{1}	0.29^{1}	0.22^{1}	0.41^{1}	-0.23^{1}	0.04	0.09^{1}
Gart							1.00	-0.42^{1}	-0.16^{1}	-0.45^{1}	-0.67^{1}	0.73^{1}	-0.13^{1}	-0.09^{1}	-0.45^{1}	-0.23^{1}	-0.37^{1}	0.08^{1}	-0.76^{1}	0.56^{1}	-0.33^{1}
Gov								1.00	0.52^{1}	0.28^{1}	0.20^{1}	-0.08^{2}	0.14^{1}	0.52^{1}	0.10^{1}	0.57^{1}	0.56^{1}	0.43^{1}	0.48^{1}	0.61^{1}	0.62^{1}
Inv.S									1.00	0.13^{1}	0.00	0.17^{1}	0.40^{1}	0.72^{1}	0.11^{1}	0.59^{1}	0.64^{1}	0.57^{1}	0.34^{1}	0.61^{1}	0.74^{1}
Malv										1.00	0.18^{1}	-0.28^{1}	0.06^{2}	0.14^{1}	0.12^{1}	0.06^{1}	0.15^{1}	0.05^{1}	0.32^{1}	0.24^{1}	0.20^{1}
MercK											1.00	-0.84^{1}	0.19^{1}	0.29^{1}	0.52^{1}	-0.02	0.17^{1}	-0.38^{1}	0.82^{1}	0.42^{1}	0.39^{1}
Murra												1.00	-0.19^{1}	0.00	-0.51^{1}	0.14^{1}	-0.03	0.47^{1}	-0.72^{1}	-0.30^{1}	-0.14^{1}
Welsh													1.00	0.60^{1}	0.07^{1}	0.17^{1}	0.23^{1}	0.53^{1}	0.33^{1}	0.27^{1}	0.50^{1}
EWI														1.00	0.10^{1}	0.53^{1}	0.61^{1}	0.45^{1}	0.54^{1}	0.64^{1}	0.93^{1}
AOP															1.00	0.14	.20^{1}	-.15^{1}	.59^{1}	0.52^{1}	0.31^{1}
ATR																1.00	.91^{1}	.84^{1}	.30^{1}	0.78^{1}	0.71^{1}
ATS																	1.00	.72^{1}	.49^{1}	0.89^{1}	0.81^{1}
FIA																		1.00	-.02	0.55^{1}	0.54^{1}
NA																			1.00	0.77^{1}	0.70^{1}

Table 3
Correlations between CEF discounts and the domestic and local indices and between CEF discounts and an equally weighted index of the CEF's.
[1] denotes significance at the 99% level, [2] denotes significance at the 95% level.

Fund	FT-SE 100 (n=1438)	FT-SE Small (n=1055)	FT-SE All (n=1438)	$S&P 500 (n=1438)	£S&P 500 (n=1438)
Albany	-0.040	0.740 [1]	-0.070 [1]	0.120[1]	-0.010
Edinburgh	0.081[1]	0.501 [1]	0.047 [3]	0.316[1]	0.205[1]
Finsbury A Trust	-0.497 [1]	-0.380 [1]	-0.529 [1]	-0.365[1]	-0.370[1]
Finsbury Growth	-0.648 [1]	-0.319 [1]	-0.680 [1]	-0.552[1]	-0.620[1]
Finsbury Trust	-0.452 [1]	-0.409 [1]	-0.478 [1]	-0.355[1]	-0.321[1]
Fleming Claverhouse	0.398 [1]	0.538 [1]	0.372 [1]	0.456[1]	0.366[1]
Gartfield Scotland	0.778 [1]	0.798 [1]	0.448 [1]	0.644[1]	0.791[1]
Govett St	0.382 [1]	-0.276 [1]	0.182 [1]	-0.018	-0.154[1]
Investment Guernsey	0.337 [1]	0.022	0.343 [1]	0.221[1]	0.130
Malvern UK	-0.353 [1]	-0.336 [1]	0.172 [1]	-0.328[1]	-0.371[1]
Mercury Key	-0.866 [1]	-0.878 [1]	-0.784 [1]	-0.797[1]	-0.830[1]
Murray	0.897 [1]	0.889 [1]	0.799 [1]	0.854[1]	0.833[1]
Welsh Ind	-0.219 [1]	-0.232 [1]	-0.303 [1]	-0.162[1]	-0.191[1]
American OP	-0.597[1]	-0.511[1]	-0.618[1]	0.575[1]	-0.578[1]
American TR	0.076[1]	-0.382[1]	-0.002	0.333[1]	0.188[1]
American TS	-0.115[1]	-0.547[1]	-0.168[1]	0.141[1]	-0.002
Fleming Amer	0.408[1]	0.590[1]	0.369[1]	0.609[1]	0.514[1]
North Atlantic	-0.799[1]	-0.887[1]	-0.833[1]	-0.656[1]	-0.739[1]
UK EWI	-0.117 [1]	-0.161 [1]	0.110 [1]	-0.007	0.038
US EWI	-0.411 [1]	0.134 [1]	-0.465 [1]	-0.302 [1]	-0.176 [1]
EWI	-0.272 [1]	0.128 [1]	-0.325 [1]	-0.151 [1]	-0.062 [2]

Table 4
Augmented Dickey Fuller (ADF) test for the presence of a unit root in the autoregressive series of UK and US CEF discounts and first differences
ADF test statistics are based on regression equations with a constant and with a constant and trend ([1]) where suitable. The critical test statistic values for the models including a constant are –2.86 (95%) and –3.44 (99%). The critical test statistic values for the models including a constant and trend parameters are –3.41 (95%) and –3.96 (99%).

Fund	Discount Levels	1st differences
	t-adf	t-adf
Albany	-1.0097	-36.313**
Edinburg	-0.74267	-37.168**
Finsbury-Growth[1]	-5.1264**	-35.837**
Finsbury-Trust	-0.67015	-35.218**
Finsbury-A Trust	-1.0560	-36.088**
Fleming-Claverhouse[1]	-3.8550**	-36.994**
Gartfield-Scotland	-1.6018	-39.034**
Govet-Str	-1.9248	-40.035**
Investment-Guernsey	-1.1987	-37.299**
Malvern UK	-5.6758**	-41.025**
Mercury Key[1]	-4.6069**	-38.201**
Murray[1]	-4.4675**	-38.829**
Welsh Ind	-1.1654	-36.016**
American OP	-3.5607**	-36.172**
American TR	-2.7072	-42.391**
American TS	-2.7227	-40.001**
Fleming American	-2.1883	-43.019**
North Atlantic[1]	-2.3813	-35.364**

Table 5.
Augmented Dickey Fuller (ADF) test for the presence of a unit root in the time series of the FT-SE and S&P 500 index levels and first differences.
The critical test statistic value for a 95% level of significance is -2.864, and for a 99% level of significance is -3.438 for the regressions of index levels and first differences with constant and trend parameters.

Index	Levels (t-adf)	First differences (t-adf)
FT-SE 100	-0.078237	-14.880**
FT-SE Small	-1.3452	-12.657**
FT-SE All shares	0.2592	-20.674**
$S&P 500	-0.2711	-34.930**
£S&P 500	-1.7492	-38.009**

Table 6
Panel A: Tests of Co-integration for the UK domestic funds and each index.
The 95% critical test statistic value is -1.94, and the 99% value is -2.567 for the residuals of the co-integration regressions.

Y(fund premium)	FT-SE 100 X⇒Y (residual t)	FT-SE SMALL X⇒Y (residual t)	FT-SE ALL X⇒Y (residual t)	$S&P 500 X⇒Y (residual t)	£S&P 500 XcY (residual t)
Albany	-2.9141*	-4.8445**	-2.9150*	-3.086**	-2.9259**
Edinburg	-3.3492*	-3.5125**	-3.3235*	-3.5866**	-3.4374**
Finsbury-Growth	na	na	na	na	na
Finsbury-Trust	-1.8026	-1.3594	-1.8489	-1.5470	-1.5899
Finsbury-A Trust	-1.8261	-1.5844	-1.8367	-1.6137	-1.6696
Fleming-Claverhouse	na	na	na	na	na
Gartfield-Scotland	-2.4629	-3.9024**	-2.6292	-2.3982*	-3.0721**
Govet-Str	-4.7332**	-4.4424**	-5.5610**	-5.4175**	-5.3693**
Investment-Guernsey	-3.8786**	-3.2650*	-4.3250**	-4.5009**	-4.4072**
Malvern UK	na	na	na	na	na
Mercury Key	na	na	na	na	na
Murray	na	na	na	na	na
Welsh Ind	-3.0634*	-2.9828*	-3.0772**	-2.9948**	-3.0257**

Table 7

Error-corrected Granger causality results: Tests of causality between the first differences of the UK CEFs and the indices.

Panel A: X = UK CEF first differenced discounts, and Y = first differenced index values.

** indicates significance at the 5% level, and * indicates significance at the 1% level.

	Y = FT-SE 100		Y = FT-SE SMALL		Y = FT-SE ALL	Y=$S&P 500		Y=£S&P 500		
	X⇒Y Wald Stat	Y⇒X Wald Stat	X⇒Y Wald Stat	Y⇒X Wald Stat	X⇒Y Wald Stat	Y⇒X Wald Stat	X⇒Y Wald Stat	Y⇒X Wald Stat	X⇒Y Wald Stat	Y⇒X Wald Stat
Albany	1.0113	29.432**	0.71077	4.7784**	0.90301	27.765**	7.3758**	1.9617*	9.947**	1.1931
Edinburgh	0.53753	3.2017**	0.80232	4.0059**	0.62101	2.6118**	1.5807	0.5586	2.3018*	0.4572
Finsbury Growth	1.2571	68.75**	1.0658	15.787**	1.1924	65.92**	5.4536**	3.0256**	7.0027**	3.0256**
Finsbury Trust	0.44228	8.8592**	1.16	8.9723**	0.54477	9.9567**	1.5542	1.8823*	1.3593	1.1693
Fnsbury A Trust	0.71862	10.283**	0.78427	7.0669**	0.8775	11.309**	1.6586	0.9932	1.9442*	0.9825
Gartfield Scotland	0.82305	53.105**	1.2498	16.349**	0.59072	54.525**	4.5952**	1.3833	4.4385**	1.4700
Govett	1.141	2.9772**	1.6086	4.5375**	1.1505	3.5544**	0.6595	1.1983	1.3021	1.6835
Investment Guerns	2.339*	25.171**	1.2643	7.244**	1.7877	24.271**	2.9719**	0.9499	7.1376**	0.8391
Malvern	1.5381	3.2854**	0.47826	7.369**	1.6866	2.7033**	1.3565	1.2630	1.1502	0.5678
Mercury.Key	0.77733	26.138**	1.4223	2.534**	0.61211	22.305**	4.7407**	1.4671	5.401**	0.3421
Murray	0.77868	35.973**	1.4477	15.907**	0.63648	37.805**	3.7786**	0.6088	4.4791**	0.5952
Welsh.Ind	0.52356	3.1147**	0.25565	3.693**	0.54906	3.4724**	1.3276	0.8869	0.6961	1.1435

Table 7

Error-corrected Granger causality results: Tests of causality between the first differences of the US CEFs and the indices.
Panel B: X = US CEF first differenced discounts, and Y = first differenced index values.
** indicates significance at the 1% level, and * indicates significance at the 5% level.

	Y = FT-SE 100		Y = FT-SE SMALL = FT-SE ALL		Y=$S&P 500		Y=£S&P 500			
	X⇒Y Wald Stat	Y⇒X Wald Stat	X⇒Y Wald Stat	Y⇒X WaldStat	X⇒Y Wald Stat	Y⇒X Wald Stat	X⇒Y Wald Stat	Y⇒X Wald Stat	X⇒Y Wald Stat	Y⇒X Wald Stat
American OP	1.900*	5.719**	1.885*	2.156*	1.877*	5.433**	0.593	1.475	1.015	0.823
American TR	1.804	15.925**	2.491**	15.925**	1.583	17.661**	0.781	16.079*	0.673	17.370**
American TS	1.932*	6.002**	2.356**	9.245**	1.663	6.102**	1.778	10.666*	1.242	13.193**
Fleming American	1.472	9.438**	1.606	12.956**	1.103	10.891**	1.146	11.333*	0.709	12.773**
North Atlantic	1.482	2.678**	1.705	3.468**	1.290	2.7984**	0.707	2.312*	0.915	2.428*

Table 8
Matrix ranks for three groups of the discount series, the UK discount series and the UK and US market indices and the US discount series and the UK and US market indices. Rank significance based on log-likelihood trace and maximum eigenvalue statistics at a 95% critical value.

Matrix of Group Definition	**Definition Significant Cointegrating Vectors in the Time Series Group**
All discount series	5
UK discount series	3
US discount series	2
UK discounts	
+ FT-SE All	3
+ FT-SE 100	3
+ FT-SE Small	4
+ S&P 500	3
+ £S&P 500	3
US discounts	
+ FT-SE All	2
+ FT-SE 100	2
+ FT-SE Small	3
+ S&P 500	2
+ £S&P 500	3