Market-Wide Shocks and Anomalous Price Behavior: Evidence from Closed-End Funds

ANA-MARIA FUERTES and DYLAN C. THOMAS*

Cass Business School, City University London

106 Bunhill Row, London EC1Y 8TZ

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This paper investigates the short-term behavior of closed-end fund prices following large market-wide shocks. Fund prices exhibit large jumps relative to net asset values in response to a shock. In the post-shock period, the discounts of small and difficult-to-arbitrage funds take longer to revert to pre-shock discount levels than large and easy-to-arbitrage funds. The speed of discount reversion is quicker for the small funds group when the difficult-to-arbitrage funds are filtered out, suggesting that, for small funds, ease of arbitrage is the key factor. For large funds, ease of arbitrage and fund size are intrinsically linked.

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Corresponding author: Dylan Thomas, tel. +44(0) 207 040 8633, fax. +44(0) 207 040 8881
e-mail: D.C.Thomas@city.ac.uk.

1 INTRODUCTION

The causes of price anomalies in financial markets remain a puzzle. Empirical studies typically fall into two broad categories. First, those studies that examine the price reaction to identifiable corporate announcements such as profit warnings or earnings. Second, other studies analyze prices following periods of extreme price performance. The abnormal returns documented by a number of studies in these two categories pose a challenge to the efficient markets theory which posits that prices respond to unanticipated economic events or news in such a way that expected arbitrage profits are zero.

One of the principal problems in testing for price anomalies is the need for a pricing model that provides an appropriate risk-adjusted benchmark. Thus, while a number of studies report price overreaction, the results critically rest on the assumption of a correct pricing model. Without the latter, there can be no unambiguous consensus as to whether overreaction occurs.

Closed-end funds provide an ideal laboratory to test for abnormal price behaviour. Data on individual fund prices and the value of the assets held by the individual funds (the Net Asset Value) are available daily for funds quoted on the London market. The NAV therefore provides a benchmark and so does away with the need to specify an asset-pricing model. We use the term 'anomalous fund-price behaviour' to signify excess fund-price changes relative to contemporaneous changes in the NAV. Thus, in instances where the fund price (*P*) falls, in relative terms, more than the corresponding fall in the NAV, the fund discount will widen (the premium will decline). [1]

This paper contributes to the literature in two respects: first, in investigating the short-term behaviour of the closed-end-fund discount at the time of market-wide shocks and second, in investigating the role of fund size (as a proxy for liquidity) and ease of arbitrage in explaining the pattern of post-shock prices. Although a number of studies (Thompson, 1978; Anderson, 1986; Pontiff, 1995) investigate the longer-term time series of the discount, no study, apart from

[1]The premium is defined as $(P_{it} - NAV_{it}) / NAV_{it}$. The discount is a negative premium.

Burch *et al*. (2003), examines the short-term behaviour of the discount during periods of market stress. Second, although Gemmill and Thomas (2002) provide evidence about the role of costly arbitrage in explaining the cross-sectional variation in average discounts and Pontiff (1996) provides evidence both on the cross-sectional variation and the impact of interest rates of the discount, no study has yet examined the relationship between the speed of short-term discount reversion and the ease of arbitrage.

Our findings indicate that fund prices overreact with respect to the NAV; the discount widens (narrows) on the day of the negative (positive) shock. In the subsequent post-shock period, the results are mixed. There is weak evidence that, in the case of negative shocks, the discount, following an initial widening on the day of the shock, tends to revert to pre-shock levels. A similar, but opposite, pattern is observed for positive shocks.

When funds are categorised by characteristic, we find that the discount for small funds widens following negative shocks but takes longer than large funds to return towards pre-shock levels. Following negative shocks, the discount of difficult-to-arbitrage funds widens but shows little inclination to revert. When difficult-to-arbitrage funds are filtered out from the small-fund group, the reversion in the discount occurs more rapidly. This finding suggests that, for small funds, the ease of arbitrage is a key factor in explaining the speed in the reversion of the discount. By contrast, the time profile of the post-shock reaction for the large-fund group is robust to the exclusion of easy-to-arbitrage funds.

Tests for differences in the average discount over longer pre-shock [-60,-11] and post-shock [+11,+60] windows suggest that, following negative (positive) shocks, the discount settles at a level that is wider (narrower) than its pre-shock average. Ease of arbitrage again appears to be the key factor driving the speed of reversion in the discount. There are also asymmetries in the effect of negative and positive shocks. For instance, for negative shocks the discount widens significantly for difficult-to-arbitrage funds whereas it remains unchanged (or marginally narrows) for easy-to-arbitrage funds. By contrast, for positive shocks the discount narrows significantly for easy-to-arbitrage funds while it remains unchanged for difficult-to-arbitrage funds. This may be driven by the type of investor holding these funds. Retail investors, who are the predominant holders of easy-to-arbitrage funds, appear to overreact to positive shocks while institutional investors, who hold difficult-to-arbitrage funds, overreact to negative shocks.

The paper is organised as follows. Section 2 reviews the literature on overreaction. Section 3 describes the data and discusses the methodology. Section 4 presents the empirical results and Section 5 examines the robustness of the results. A final section concludes.

2 BACKGROUND LITERATURE

Studies examining daily price performance in the aftermath of a shock, typically document a price pattern that suggests overreaction. After negative shocks, prices fall initially and then rebound (Atkins and Dyl, 1990; Bremer and Sweeney, 1991). Park (1995), however, argues that these results might be fragile; overreaction disappears when mid-prices are used. In contrast, Melnik *et al.* (2003) report evidence of momentum using market indices. Markets continue to fall in the days immediately after large market-wide negative shocks and vice versa. Although allowance is taken of factors such as systematic risk and size, the problem of a valid benchmark against which to calibrate excess price-reaction remains.

Two features of the closed-end fund literature are relevant to this study. First, the response of fund prices to changes in the net asset value. Pontiff (1997) finds that while fund prices are more volatile that the price of the assets, fund prices tend to underreact to changes in the NAV. A similar finding is reported by Hardouvelis *et al.* (1994) who find prices of country funds to be sticky in response to changes in the NAV. This underreaction is, however, conditioned by the salience of the information in the NAV figure. The fund-price reaction to changes in NAV is less sticky in periods where salient news is reported (Klibanoff *et al.*, 1998). Second, the role of arbitrage in limiting the level of the discount. Pontiff (1996) identifies factors related to costly arbitrage that impact on the level of discount. His results suggest that both smaller funds (which have higher transactions costs, higher bid-ask spreads and subject to greater market impact costs) and funds that are more difficult to arbitrage should sell at wider levels of discount. The findings of Datar (2001) provide supporting evidence that those funds that are more liquid (proxied by, amongst other variables, fund size) trade at smaller discounts. Gemmill and Thomas (2002) confirm the role of arbitrage in defining boundaries for the discount and the discount at which the fund sells. Fund managers who manage funds that are difficult to arbitrage charge higher management expenses and this leads to wider levels of discount. They also find that smaller funds sell, on average, at wider discounts.

Burch *et al*. (2003) investigate the relation between the events of 'Nine-Eleven' and the average discount on a sample of US-traded equity and bond closed-end funds. They find that discounts widen from 3.3% on the Friday before 11 September (7th September) to 7.7% on the first trading Friday post-9/11 (21st September). In the 15 trading days immediately following 17th September, however, they note the close relation between the movement of the mean daily discounts and the relative movements of the S&P 500. This co-movement is attributed to investor sentiment and to investors looking to the broader market movements for guidance. This assertion is tested below.

3 DATA AND METHODOLOGY

3.1 The sample of funds and alternative groupings

The sample of funds that we use to track through the 8 shocks comprises 63 closed-end funds traded continuously on the London Stock Exchange during the period from January 1, 1988 to December 31, 2003.[2] Daily fund-price and NAV data on each of the funds over the 8 non-overlapping event windows [-60, +60] around each shock are gathered from *Datastream*.

[2] This dataset avoids the potential price effects associated both with newly floated funds and with funds being wound up. The former usually sell initially at a premium and subsequently record negative price-returns to trade at the usual discount. Funds in the process of winding up typically record positive price returns as the value of the fund moves up towards its NAV.

Let P_{it} denote the closing price of the *i*th fund on trading day *t*. The daily fund return in percentage points is calculated as:

$$RP_{it} = 100 \times \log(P_{it} / P_{i,t-1}), \quad i=1,2,...,63, \; t=-59,-58,...,60$$

and likewise for the NAV return (RN_{it}). The abnormal returns is defined as:

$$AR_{it} = RP_{it} - RN_{it}$$

for *i*=1,2,…,63 funds and *t*=-59,-58,…,60 days. We also construct two sub-samples of funds based on *size* and *ease of arbitrage* considerations. To classify by size, we rank the funds by their average NAV in 1992, 1998 and 2002 from the *Credit Lyonnais Year Books*. There is a high degree of correspondence in the ranking across these years. We use £200m and £500m as threshold market values for 'small' and 'large' funds. Funds with a market value below £200m are classified as small (*N*=21) and those above £500m as large (*N*=18). The average market value for 'small' and 'large' funds in 1998 is £77m and £1015m, respectively.

In order to categorize the funds by ease of arbitrage, we first label them as UK, US, or Far East on the basis of their investment mandates. Next, we regress the NAV returns (measured weekly over 1989:01-2002:12) of each fund against the FTSE 100, S&P 500, and Nikkei 300 returns, respectively. The regression R_i^2 statistic for the *i*th fund, *i*=1,2,...,63, provides a measure of the ease of replication. For instance, a large R_i^2=0.95 would suggest that arbitrage for the *i*th fund is feasible when it is selling at a large discount by buying the fund and selling the index which proxies the underlying assets. For such a fund it would be expected that any mispricing would be arbitraged away relatively quickly. We rank the funds in ascending order according to their R_i^2 and define the top and bottom quartiles with *N*=16 funds each as easy-to-arbitrage (EA hereafter) and difficult-to-arbitrage (DA) funds, respectively. The average R_i^2 for the EA and DA funds is 0.88 and 0.12, respectively.

3.2 Market-wide shocks

This study investigates the behavior of closed-end fund prices following exogenous, market-wide shocks. The criteria that we use to identify the latter are as follows. A 'large shock' is deemed to occur when (*i*) the FTSE All Share Index moves more than ±3% on any single day *t* over the period 24th July 1989 to 21st April 2003 and (*ii*) there is no other comparable daily return in a [*t*-60, *t*-1] window. We exclude the trading period over the Millennium where, although the Index recorded a drop of about -3.11% on 4th January 2000, UK markets had previously been closed for an extended trading period. Six negative shocks and two positive shocks are identified during the sample period. The former include the events of 9/11 (shock #5). [3]

Table 1 reports the (absolute) daily return on the Index at the identified event date, R_t, and its average over pre-event windows of 60-, 10- and 5-days length. We also calculate a standardized return measure, R_t/SD_t where SD_t denotes the moving standard deviation of daily returns over the [*t*-60, *t*-1] window.

[Table 1 around here]

The average change in the Index on day 0 across the six negative shocks is -3.75% with a maximum of -5.21% on 9/11. The average Index daily return on day 0 for the two positive shocks is 4.51%.

The R_t/SD_t ratio at day 0 confirms that, once we account for market conditions (volatility of returns) in the pre-shock period, the shocks identified still represent large price movements. The average R_0/SD_0 over the six negative shocks is -4.49%, with a minimum and maximum of -6.34% and -2.80%, respectively. The average R_0/SD_0 over the two positive shocks is 6.11%.

3.3 Methodology

We construct cumulative abnormal return (CAR) measures from day 0 to investigate anomalies in fund prices and test whether they are statistically

[3] Of the negative jumps, shocks #1 and #3 represent 'UK gloom' (increased perceived risk of a UK recession) whereas shock #2 responds to political event in Russia, shock #4 may be linked to mixed news about the UK and shock #6 represents an accounting irregularity. As for the positive jumps, shock #1 may be the response to an announcement regarding entry to the ERM and shock #2 represents the reaction to the UK government election. Thus negative shocks #1, #3 and #5 might be expected to have a relatively large impact on UK market sentiment. (See Appendix I).

significant. We consider 20 post-event days for the tests and construct the following statistics:

$$\overline{CAR}_t = \frac{1}{N}\sum_{i=1}^{63} CAR_{it}, \; CAR_{it} = \sum_{s=0}^{t} AR_{is}, \; t = 0,1,\ldots,20$$

The test statistic is a t-ratio for a hypothesis concerning the mean of a distribution:

$$Z_t = \frac{\overline{CAR}_t - \mu}{se(\overline{CAR}_t)} \quad t = 0,\ldots,20$$

where $se(\overline{CAR}_t)$ is the square root of the sample estimate of $Var(\overline{CAR}_t)$. We conduct tests of the null hypothesis $H_0: \mu = 0$ against $H_1: \mu \neq 0$. The null distribution of Z_t is asymptotically a standard normal or exactly a Student t with N-1 degrees of freedom if the sample population of CARs is normal.

Typically, inference in event studies utilizes the cross-section of abnormal returns in calculating the variance of the average CAR on day t as follows:

$$Var(\overline{CAR}_t) = \frac{1}{N^2}\sum_{i=1}^{N} Var(CAR_{it}) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_{t,b}^2 = \frac{\sigma_{t,b}^2}{N}, \; t = 0,1,\ldots,20 \qquad (1)$$

where $\sigma_{t,b}^2 \equiv Var(CAR_{it})$ is the dispersion of the cross-section distribution of fund CARs or 'between-fund' variation at t. Usually $Var(\overline{CAR}_{it})$ is estimated by substituting the sample variance

$$s_{t,b}^2 = \frac{1}{N-1}\sum_{i=1}^{N} (CAR_{it} - \overline{CAR}_t)^2, \; t = 0,1,\ldots,20$$

for $\sigma_{i,b}^2$. This estimator assumes that the event windows of the N securities do not overlap so that the covariance terms are set to zero. Thus it implicitly assumes that the CARs are independent in the cross-section. Our market-wide event definition implies clustering and so it is important to account for across-fund dependence in measuring $Var(\overline{CAR}_t)$. In the present context (average positive dependence), the resulting standard error from (1) will underestimate the true standard error and the t-tests will therefore suffer from a large probability of Type-I Error. This would lead us to reject H_0:μ=0 too often and thus to misleading evidence on overreaction. This paper adopts a time-series portfolio approach to circumvent this problem.[4]

Interpreting $\overline{AR}_t$ as the abnormal return of an equally-weighted portfolio of closed-end funds, it follows that

$$Var(\overline{AR}_t) = \frac{1}{N^2}\sum_{i=1}^{N}\sigma_{i,w}^2 + \frac{2}{N^2}\sum_{i=1}^{N}\sum_{j>i}^{N}\sigma_{ij} = \frac{\overline{\sigma}_w^2}{N} + \frac{N-1}{N}\overline{\sigma} \quad (2)$$

where $\sigma_{i,w}^2 \equiv Var(AR_{it})$ is the dispersion of the time-series distribution of fund i abnormal returns (or 'within-fund' variation) and $\overline{\sigma}_w^2$ is its average over the funds; $\overline{\sigma}$ is analogously defined for the covariance parameter $\sigma_{ij} = Cov(AR_{it}, AR_{jt})$ and the average correlation of abnormal returns is thus defined as

$$\overline{\rho} = \frac{2}{N(N-1)}\sum_{i=1}^{N}\sum_{j>i}^{N}\frac{\sigma_{ij}}{\sigma_{i,w}\sigma_{j,w}}$$

The parameter $\sigma_{i,w}^2$ can be estimated as follows

$$s_{i,w}^2 = \frac{1}{T-1}\sum_{t=1}^{T}(AR_{it} - \overline{AR}_i)^2,\ \overline{AR}_i = \frac{1}{T}\sum_{t=1}^{T}AR_{it},\ i = 1,2,\ldots,N \quad (3)$$

over the (-60,-11] estimation window (i.e., T=49) and analogously for σ_{ij}. On the other hand $\overline{CAR}_t = \overline{AR}_0 + \overline{AR}_1 + \ldots + \overline{AR}_t$ and so it follows that $Var(\overline{CAR}_t) = (t+1)Var(\overline{CAR}_0)$ for t=0,1,…,20, where $Var(\overline{CAR}_0) = Var(\overline{AR}_0)$ can be estimated using (2) and (3).

This approach is equivalent to directly using the time series variation of average abnormal returns, $\overline{AR}_t \equiv N^{-1}\sum_i AR_{it}$, that is, to measuring

$$Var(\overline{AR}_t) = \frac{1}{T-1}\sum_{t=1}^{T}(\overline{AR}_t - \overline{AR}),\ \overline{AR} = \frac{1}{T}\sum_{t=1}^{T}\overline{AR}_t \quad (3)$$

where T signifies the estimation window (-60,-11]. This procedure is advocated by Brown and Warner (1985) for tackling clustering effects.[5] Using (2) instead of

[4] The variance estimator (1) is inconsistent under clustering (Campbell, Lo and MacKinlay, 1997; Ch.4).
[5] See also Kothari and Warner (1997) for a discussion of methodological issues.

(3) has the additional advantage that it facilitates estimates of the average within-fund variation ($\bar{\sigma}_w^2$) and co-variation ($\bar{\sigma}$) across all funds and over different fund groups to draw comparisons.

4 EMPIRICAL ANALYSIS

4.1 Summary statistics over pre-shock window

Table 2 provides summary statistics over the (-60, -11) estimation window. Panel A refers to all 63 funds while the other panels relate to the alternative groupings.

[Table 2 around here]

We report the average abnormal return $\overline{AR}$ and the average discount $\overline{D}$. Also reported are the within-fund abnormal return variation and standardized co-variation (or correlation), $\bar{s}_w^2$ and $\bar{\rho}$, respectively, averaged over funds.

The $\overline{AR}$ measure averaged over shocks is insignificant for all cases at conventional significance levels over the estimation window. The difference in $\overline{D}$ (averaged over shocks) for small and large funds is also insignificant. By contrast, the difference between $\overline{D}$ for difficult-to-arbitrage funds at 13.4% and easy-to-arbitrage funds at 10.3% (standard error 1.12) is significant at the 5% level.

The mean correlation in abnormal returns ($\bar{\rho}$) over all 63 funds averages around 17% for the eight pre-shock windows. As expected, while $\bar{\rho}$ increases with fund size, the opposite is true of $\bar{s}_w^2$, the within-fund volatility. In particular, the statistic $\bar{\rho}$ averaged over time is 9.8% for small funds whereas it rises significantly to 33.5% for large funds. By contrast, the AR volatility measure $\bar{s}_w^2$ averaged over shocks falls from 0.96 (small funds) to 0.59 (large funds) and the difference, with a standard error of 0.12, is significant at the 5% level.

The correlation of ARs across easy-to-arbitrage funds ($\bar{\rho}$ = 24.3%) is significantly higher than that across difficult-to-arbitrage funds ($\bar{\rho}$ = 8.2%)

whereas the average volatility of ARs is significantly smaller for the former (0.82) than for the latter (1.13).

4.2 Post-shock reaction of funds: overall pattern

Table 3 reports the average (C)ARs over all funds and their *t*-statistics (Z_t) in brackets.

[Table 3 around here]

For all negative shocks, fund prices drop significantly relative to the NAVs, either in day 0 or day 1. Thus for shock #1, the average discount increases by 3.01% on day 0. For negative shocks #1, #2, and #4, this drop is reflected in $\overline{AR}_0$, whereas in the case of shocks #5 and #6, it is reflected in $\overline{AR}_1$. For shock #3, both $\overline{AR}_0$ and $\overline{AR}_1$ are significant. There is also a significant increase in the premium associated with the two positive shocks with an average $\overline{AR}_0$ of 1.99%.

The post-shock CARs provide some evidence to suggest that fund-prices recover relative to the NAV. However, there are clear differences in the time taken for this recovery ranging from one day (negative shock #2) to more than four weeks (negative shocks #1 and #6). In other cases, it is difficult to classify the pattern of ARs. For instance, for negative shock #3 there is a significant positive AR on day 2 suggesting that fund-prices revert back relative to the NAV (with the discount narrowing) but a longer-term negative drift where the discount continues to widen. Tests for the CAR differential at subsequent days for shock #3 confirm the presence of a widening discount. One-sided tests for the hypotheses that $\overline{CAR}_5$ is more negative than $\overline{CAR}_0$ and, likewise, that $\overline{CAR}_0 > \overline{CAR}_{15}$ are statistically significant with *t*-statistics of 3.55 and 1.69, respectively. The same can be concluded for positive shock #2.

These findings clearly support the notion that fund-prices exhibit anomalpus behavior immediately following market-wide shocks. However, the evidence regarding fund-price behaviour in the 20 post-shock days is mixed. This issue is now further addressed.

4.3 Do large and small funds react differently?

Table 4, Panels A and B, report the (C)ARs for the funds classified by market size. Small funds are typically less liquid than large funds. Thus, we hypothesize that the fund prices of the small-funds group exhibit anomalous behaviour over relatively longer periods or equivalently, that the post-shock discount of the small funds group is more sticky than that of the large funds.

[Table 4 around here]

The results support the above conjecture. Following negative shocks, the CARs of the large funds become insignificant in a much shorter time frame than those of the small funds. For example, significant CARs are limited to a single day for large funds in the case of shocks #4 and #5 while in the case of shock #2, large funds do not record abnormal returns. By contrast, the mispricing lasts several days for small funds, particularly for shock #5 (9/11) when the discount continues to widen; one-sided tests for the difference between $\overline{CAR}_0$ and $\overline{CAR}_3$ (t-stat = 2.24) and between $\overline{CAR}_5$ and $\overline{CAR}_{20}$ (t-stat = 1.53) reveal significant continuation sequences from days 1 to 3 and then days 5 to 20. These two patterns align with the 9/11 terrorist attack and subsequent re-opening of the US markets on 17th September, respectively. This anomalous mispricing pattern is not apparent in the large funds. A broadly similar pattern is observed for negative shocks #1 and #3 where the abnormal returns are more pronounced and typically persist for longer than those for the large funds group.

Differences are also observed between large and small funds for the positive shocks. With shock #1, the anomalous fund-price behaviour is limited to 1 day large funds while it is reflected in the two subsequent days for small funds. In the case of shock #2, one-sided t-tests of the difference between CARs indicate that $\overline{CAR}_5 < \overline{CAR}_0$ (t-stat = 1.42) for small funds which is indicative of a reduction in the premium.[6] This is followed by an increase in the premium in the subsequent three weeks as borne out by the test that $\overline{CAR}_{20}$ is significantly larger than $\overline{CAR}_6$

[6] The 1-sided critical value at the 10% level is 1.29 (normal) and 1.33 (Student-t).

(*t*-stat = 1.44). By contrast, the comparable pattern for the large-funds group, although broadly similar, is insignificant.

4.4 Does the ease of arbitrage matter?

If the arbitrage argument holds, easy-to-arbitrage (EA) funds are less likely to be subject to mispricing than difficult-to-arbitrage funds (DA). The (C)ARs and *t*-statistics reported in Table 5 support this conjecture.

[Table 5 around here]

The anomalous price movement at day 0 is generally more marked for DA funds and they also exhibit a longer-term widening of the discount. For instance, the discount of the EA funds widens by 3.92% at t=0 for negative shock #1. It subsequently narrows and becomes insignificantly different from the pre-shock level by around day 6. In contrast, the DA funds suffer a continuing widening of the discount from day 0 to day 4 (*t*-stat $\overline{CAR}_0 - \overline{CAR}_4 = 2.5$) and a subsequent narrowing but it takes two further weeks for the CAR to become insignificant.

Likewise, for negative shock #3, the significant anomalous fund-price behaviour is limited to 3 days for EA funds, whereas the discount for DA funds gets progressively wider during the following 20 trading days. For the remaining negative shocks, the EA funds either record no anomalous price reaction or, if they do, the widening of the discount reverts immediately to its pre-shock level. It turns out that the re-opening of the US market following 9/11 (day 8) does not cause any anomalous price movement for the EA funds whereas significant negative returns are noted for the DA funds.

4.5 Size versus ease of arbitrage

Having determined that fund size and ease-of-arbitrage both impact on the pattern of post-shock fund-price behaviour, we now attempt to shed light on their relative importance. In order to use the maximum possible number of funds in the analysis, we rank the 63 funds by size and now define the 27 funds with the smallest market value as ‘small’ and the 27 funds with the highest market value as 'large'. The procedure discussed in Section 3 (the R_i^2 ranking from regressions of NAVs on stock market indexes) is applied to identify 27 funds that are easy-to-arbitrage (EA) and another 27 that are difficult-to-arbitrage (DA). There is a high degree of overlap between the small funds and the DA funds (19 funds in common). Similarly, there is a high degree of overlap between large funds and EA funds (20 funds). To separate these attributes, we filter out the EA funds from the large funds group to obtain a large-not-EA group (7 funds) and likewise, we construct a small-not-DA group (8 funds).

Summary statistics for these two new groups are given in Table 2, Panels D1 and D2. The aforementioned overlapping helps to explain why the difference between the overall correlation in abnormal returns ($\overline{\rho}$) of 8.2% for DA funds and of 9.8% for small funds is insignificant. The same applies to the average within-fund variation in ARs ($\overline{s}_w^2$). Interestingly, despite the common funds, the difference in $\overline{\rho}$ for EA and large funds at 24.28% and 33.52%, respectively, is statistically significant. The difference in $\overline{\rho}$ for the small-not-DA funds and the DA funds is statistically significant and the same pattern emerges for the $\overline{s}_w^2$ statistic. For both the large-not-EA and EA funds, the overall correlation equals 24.3% and, likewise, the overall average AR is indistinguishable for both panels; the difference in average $\overline{s}_w^2$ is statistically insignificant (*t*-stat = 1.16) at the 5% level. These findings are taken to suggest that the difficulty-of-arbitrage and smallness of funds are, in effect, different attributes whereas the ease-of-arbitrage and largeness appear to be more closely related.

Table 6 reports the (C)ARs for the small-not-DA and large-not-EA samples.

[Table 6 around here]

Small-not-DA funds show no significant ARs at days 0 or 1 for negative shocks #2, #4 and #6. This contrasts with the significant anomalous fund-price behaviour for small funds (cf. Table 4, Panel A). For those negative shocks where the small-not-DA group does record abnormal negative returns at day 0 or day 1, the reversal of this widening of the discount is markedly quick relative to the speed of reversal for the small funds. For instance, for negative shocks #1 and #3, the CARs for small-not-DA funds become insignificant in 6 and 9 days respectively, whereas for the small-funds group the CAR is still significant at day 10 for shock #1 ($\overline{CAR}_{10} = $-2.30%) and at day 20 for shock #3 ($\overline{CAR}_{20} = $-4.46%). Interestingly also, for negative shock #5, the small-not-DA funds do not show negative abnormal returns when the American markets re-opened following 9/11. This suggests that the holders of these funds were able to hedge against such a price movement. There is, however, no significant difference in the pattern of ARs for the large and large-not-EA funds.

In sum, the difficulty-of-arbitrage appears to be a critical factor in explaining the sluggish post-shock reversal pattern in the discount of small-funds. The large-size and easy-to-arbitrage attributes are more difficult to disentangle in explaining the speed of reversal.

4.6 The type of fund ownership

We turn now our attention to the relation between the post-shock price pattern, the investment mandate and the shareholder profile. The shareholder profile for the individual funds is obtained from Computershare Analytics for the years 1998, 2000 and 2002.[7] We first focus on the earlier small- and large-sized fund classification. Of the 21 small funds, a total of 15 have a mandate to invest in small capitalisation companies. Of the 18 large funds, only 2 invest in small companies.

Details of the shareholder profile are illuminating. Small funds are held predominantly by institutional shareholders. The institutional investors' stake in the 15 small funds investing in small companies averages 71.5% while their stake in the other 6 small funds that invest in large companies is 48.3%. By contrast, the institutional investor stake in large funds, which invest almost exclusively in large companies, is only 34.5%.

The current empirical literature typically associates overreaction with the investing behaviour of retail investors who are thought to be more prone to 'irrational exuberance' and drive prices away from fundamentals (Lee, Shleifer and Thaler, 1991). More recent studies, however, suggest that institutional practices and frictions in the investment management industry (e.g. common investment strategies, herding, performance-related fund flows and career concerns) lead to correlated demand shocks unrelated to fundamentals which may be an important source of noise trading (Sias, 1996; Jackson, 2003). Our findings provide indirect support for this notion. In the post-shock period, it is the large funds group (owned principally by retail investors) that exhibits relatively quick discount reversal whereas the abnormal returns of the small funds (owned principally by institutional investors) are more persistent with less reversion in the discount. As noted earlier, this appears to be attributable to the ease of arbitrage rather than to issues related to fund-size.

Discussions with fund managers provide a rationale for this empirical finding. Institutional investors use closed-end funds as an efficient way of gaining exposure to small companies and most of the funds investing in small companies are themselves characterised by small capitalisation. Institutional investors who wish to invest in large market-cap stocks buy shares directly and do not use closed-end funds for that purpose On the other hand, retail investors choose large funds as an easy way of obtaining broad geographic and industry diversification. The evidence here suggests that it is not the type of investing behaviour associated with a particular group of investors that determines the speed of reversal. The 'cost' for the institutional investors of gaining exposure to the small-cap sector via closed-end funds is that they end up holding securities that are more difficult to arbitrage.

4.7 Shocks and long-term changes in the discount

Table 7 shows the average discount computed over pre- and post-shock windows of 50 days each alongside the *t*-statistics for the difference.

[Table 7 around here]

For all 63 funds, the average post-shock discount significantly widens by around 0.76% for negative shocks and significantly narrows for positive shocks by 0.67%.

[7] No shareholder data are available for 1990 and 1992.

This evidence confirms that fund prices overreact relative to NAVs following salient events.[8]

When the funds are categorised by size, the sluggish post-shock reversal phase noted above for the small funds continues during 3 months with the discount widening by around 1.5% following negative shocks. The discount does not change significantly following positive shocks. For large funds, in contrast, the discount does not change significantly after negative shocks, although it does narrow significantly following positive shocks. A further interesting finding is that the sluggish (or lack of) reversal in the case of small funds, predominantly held by institutional investors, is apparent for negative but not for positive shocks while the opposite holds for large funds. In the light of the fact that institutional and retail investors have a preference for small and large funds, respectively, this contrasting response to positive/negative shocks provides some evidence of an asymmetry in the behaviour of retail and institutional investors, notwithstanding the small number of positive shocks (two) in our sample.

Dividing the sample on the basis of arbitrage considerations provides strong support for the notion that it is the ease of arbitrage that brings the discount back to pre-shock levels. The long term discount for the easy-to-arbitrage group narrows marginally by 0.29% following negative shocks while the discount for difficult-to-arbitrage funds significantly widens after negative shocks by around 2%.

When the difficult-to-arbitrage funds are filtered out from the group of small funds, the widening of the discount post-negative-shock is now 0.45% only (c.f. a widening of 1.5% for the small funds group). The opposite is true for positive shocks; the narrowing of the discount is more marked in the small fund group than in the small-not-difficult-arbitrage group. This further corroborates the

[8] We assess the contention in Burch et al. (2003) that, following market-wide shocks, the discount and the broader market move closely. We replicate their methodology using the the FTSE All Share index level relative to its pre-shock level, $(FT_t-FT_{-1})/FT_{-1}$, $t=0,1,\ldots,20$. The coefficient from regressing the mean discount over the 8 shocks against the mean relative movement in the FTSE is insignificant (*t-stat*=1.11) and so does not support the claim.

notion that the key factor behind the anomalous fund-price behaviour following large shocks is the ease of arbitrage rather than fund size.

5 SENSITIVITY ANALYSIS

In this section we investigate the robustness of our results to four factors: the length of the estimation window, the bid-ask spread, the choice of index to measure ease-of-arbitrage and the impact of financial leverage.[9]

5.1 Estimation window

We assess the significance of the reported CARs using a estimation window closer to the event date. We choose (-50,-1) in recomputing (1) rather than (-60,-11). The standard errors are slightly larger but the results are not affected qualitatively since essentially the same CARs are significant.

5.2 Bid-ask effects

It is possible that the bid-ask spread for the fund widens after the shock and this may be what hinders arbitrage. To investigate this conjecture, we collect data on bid-ask prices for the individual funds. The spread (S) is computed as the ratio of (*ask-bid*)/*mid-price.* Table 8 reports, for each jump, pairwise tests of the difference in the average spread over two time periods straddling the shock.

[Table 8 around here]

We compute the average spread over the pre-shock windows [-20,-11] and [-10,-1] and over the post-shock windows [1,10] and [11,20] for each fund. We test the hypothesis that H_0: $\overline{S}_{[-20,-11]} = \overline{S}_{[11,20]}$ on the one hand, and H_0: $\overline{S}_{[-10,-1]} = \overline{S}_{[1,10]}$ on the other.[10] It turns out the statistics are uniformly significant at even the 10%

[9] We also compute the *t*-statistics on the basis of standard errors (s.e.) from the variance estimator (1). Unsurprisingly, a comparison of these s.e. with those used in Table 3 indicates that the former are downward biased by a factor of above 3 on average thus leading to a larger number of significant CARs.

[10]The ask (or bid) price is not available for some funds over specific periods. The tests are based on the maximum number of funds possible for each jump; this is 46 for negative jump #1 and positive jump #1, 60 for negative jump #2 and positive jump #2 and 61 for the remaining jumps.

level with two exceptions. This suggests that the changes in the bid-ask spread are not driving the anomalous pattern of fund prices

5.3 Stock index and easy- versus difficult-to-arbitrage classification

To investigate the sensitivity of the earlier easy-to-arbitrage (EA) versus difficult-to-arbitrage (DA) classification to the stock index used in the regressions, we repeat the analysis using the FTSE100 for all funds. We thus seek to account for the possibility that the funds co-move with their host index (the index of the country where they are traded) rather than with the index of the country where the underlying assets are located. The resulting R_i^2 ranking gives a new EA group (top quartile) which has eight funds in common with the earlier group. However, eight funds previously classified as easy-to-arbitrage are now classified as either difficult-to-arbitrage (2 Far East funds) or fall in the two mid quartiles (4 US funds and 2 UK funds). All of eight new funds now classified as easy-to-arbitrage have US mandates. Regarding the new DA group, it shares eleven funds with the earlier counterpart. However, five funds (all UK mandates) move out and fall in the mid quartiles and all five new funds entering the DA category have Far East mandates.

Although there are some changes in the group members for the new EA and DA categories relative to those discussed in Section 3.2, the inference does not change qualitatively. If anything, the contrasting post-shock abnormal return pattern in the two groups is now more distinct.

5.4 Leverage effects

Closed-end funds are able to lever up and thus the impact of an NAV change on the fund price could be magnified by the existence of large fund leverage. For the current sample of funds, the typical level of leverage is modest — the average level of gearing measured as D/E (where D is debt and E is equity) is 7% in 1991, 10% in 1998, and 9% in 2001 and 2002.

In order to control for gearing effects, we re-define the abnormal returns as

$$AR_{it} = RP_{it} - RN_{it}(1 + \frac{D_{it}}{E_{it}})$$

so that the AR for D/E>0 is smaller than that for D/E=0. It turns out that while the significance of the *t*-statistics declines, the decline in all instances is very marginal. For example, for negative shock #1, the ARs for the complete sample are now significantly negative until day 5 rather than day 6. The patterns of the (unreported) ARs incorporating leverage are very similar to the original results for all sub-samples.[11]

5 CONCLUDING REMARKS

This paper reports anomalous closed-end fund-price behaviour in response to market-wide shocks. The evidence is based on a sample of 63 closed-end funds traded continuously on the London Stock Exchange from January 1988 to December 2003.

Fund prices overreact to changes in the net asset value following market-wide shocks. This overreaction either on the day of the shock or on the following trading day for all eight large shocks identified in the sample. Overall, there is some weak evidence that in the [0,+20] post-negative-shock window, the discount shows some tendency to revert following an initial widening at the time of the shock.

For the 20-day windows following shocks, we find that ease of arbitrage (or replication using stock market indexes) to be an important factor in explaining the post-shock pattern of fund prices relative to the net asset values. The discounts of those funds that are easy to arbitrage, while widening at the time of a negative shock, revert quickly to pre-shock levels. The ease-of-arbitrage would appear to be a more important consideration in bringing fund-prices back in line with NAVs than factors related to fund size. This is particularly marked for funds that are small. Large fund-size appears to be intrinsically linked to the ease-to-arbitrage.

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[11] Detailed results are available upon request.

In comparing the average discounts over a 50-day pre- and post-shock window, we find a pattern confirming our conjecture that it is the ease-of-arbitrage that drives the speed of reversal. Following negative shocks, the discount of the easy-to-arbitrage group narrows by 29 basis points while that of the group of small funds widens by 148 basis points. However, the discount for the small-but-not-difficult-to-arbitrage group widens by only 45 basis points. These findings confirm the importance of arbitrage in determining the level of the discount (Pontiff, 1996)

Further investigation into the shareholder profile suggests that the small funds (that predominantly invest in small companies) are mostly held by institutional shareholders whereas large funds tend to be held by retail investors. It would appear to be the case that institutional investors use (small) funds as a means of gaining exposure to the small capitalisation sector. The cost of gaining this exposure to the small capitalisation sector is that institutional investors end up holding funds which are not easy to arbitrage.

APPENDIX I. Description of shocks

Negative shock #1 (16/10/89)

Monday sell-off in London (daily return –4.06% on FTSE All Share index) following Wall Street falls the previous Friday (-6.12% daily return S&P 500). The *Financial Times* (FT, 14 Oct) reported that "the BoE sees no reason for last's night dramatic fall on Wall Street to be repeated on the London equity market …" given "that London shares are not underpinned by leveraged situations to the same degree as US share prices" and that "…a large number of lessons were learned about policy and supervisory issues during the market crash of 1987".

Positive shock #1 (08/10/90)

Response to announcement regarding entry to ERM byt the FT cautions cautions that ERM entry is a predominantly domestic affair and that nothing has changed regarding the build-up in the Gulf and the international banking crisis.

Negative shock #2 (19/08/91)

Coup in Russia. FT reported that it was unclear what the direct external economic consequences would be but suggested that "… the further implosion of the Soviet economy should have little direct effect on corporate earnings" (20 Aug).

Positive shock #2 (10/04/92)

Conservatives win the election and a fourth term in office.

Negative shock #3 (27/08/98)

"Economic and financial crises gripping Russia (sovereign default) sparked the sell-off on world stock markets" made worse by "a picture of relentless gloom in (UK) manufacturing" (FT, 28 Aug).

Negative shock #4 (22/03/01)

"A rash of profits warnings and another weak start on Wall Street combined to depress sentiment" (FT, 22 Mar). The bad news is concentrated in the manufacturing and technology sectors but is mitigated by strong sales growth in the consumer sector.

Negative shock #5 (11/09/01)

Terrorist attacks in New York

Negative shock #6 (03/07/02)

Rumours about accounting irregularities at Vodafone (which dropped 6%) and WorldCom. The Treasury noted that "no country can insulate itself from the ups and downs in world financial markets but … the (UK) economy is better placed that it has been in the past to withstand shocks of this kind" (FT, 4 Jul).

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