EXCESS VOLATILITY AND INVESTMENT TRUSTS

by

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ABSTRACT

The variance of returns to investment trust shareholders may be split into three components - variance of net asset value (NAV) returns, variance of discount returns and twice the covariance between NAV returns and discount returns. Using historical data, the relative importance of each of these components is estimated for different return intervals, different periods of observation and different sub-sectors. There is clear evidence of excess volatility of trust share returns compared with NAV returns. Since Big Bang in 1986, there has been a significant 'double whammy' effect, meaning that discounts tend to widen when NAVs fall and narrow when NAVs rise. Overall, the results are consistent with the noise trader model.

1. INTRODUCTION

Investment trusts are UK public companies whose assets consist of a portfolio of securities. They enable investors to purchase an interest in a professionally managed fund and generally invest almost entirely in equities, often with a heavy overseas involvement. Ultimate responsibility for running the affairs of an investment trust lies with the board of directors, but day-to-day administration and investment management is normally delegated to an investment management firm. In common with any other company, an investment trust has a fixed (or 'closed') capital structure which must

contain share capital but which may also include loan capital.[1] To liquidate their holdings, investors must normally sell their securities to other investors.[2]

The net asset value (NAV) of the ordinary shares (common stock) of a conventional investment trust is obtained by deducting prior capital[3] from the value of underlying assets, and is normally expressed on a per share basis.[4] NAVs are published monthly with many investment trusts nowadays publishing the figures weekly or daily. Published NAVs are generally considered to be reasonably accurate[5] but if a significant proportion of investments held are unquoted, there will be some uncertainty as to the true value of underlying assets.

Investment trusts are characterised by one of the most interesting puzzles in financial markets - the discount to NAV.[6] There are a number of parts to this puzzle. Trust shares are issued at an average premium to NAV of about 2% (Levis & Thomas, 1995). This premium largely reflects underwriting fees and start-up costs which must be subtracted from initial proceeds. Subsequently, often within a matter of months, shares generally trade at a discount. Discounts then fluctuate widely over time and some trusts can on occasions trade at a premium to NAV. At the end of the life of a

[1] 'Split capital' investment trusts, which have innovative capital structures, are excluded from the discussion in this paper.
[2] However, a number of trusts have a limited life. There may be a fixed redemption date but very often there are a number of optional winding up dates. Furthermore, 'buy backs' have become popular recently.
[3] Prior capital is normally deducted at nominal value. This is consistent with current accounting requirements (FRS13) and is employed by The Association of Investment Trust Companies and by Datastream.
[4] If there are convertibles or warrants outstanding, it is standard practice in the investment trust industry to make adjustments on a per share basis to give a 'fully diluted' figure i.e. convertibles are assumed to be converted and warrants are treated as exercised if dilution of NAV would occur.
[5] The month end NAVs are generally not known until up to ten days after the month end but Datastream and Reuters estimate NAVs for most investment trusts on a daily basis.
[6] Discount to NAV is defined as NAV less share price, expressed as a percentage of NAV.

trust, due to 'open-ending' or liquidation, the discount narrows as the share price rises to meet NAV less any liquidation costs.

Discounts are important in the context of investment trust risk analysis. As part of the return from a conventional investment trust share is due to changes in the discount, discount variation over time contributes to the variance of returns from investment trust shares. Furthermore, discount changes over a period may be related to returns from the underlying net assets of the trust over the same period. If there is positive correlation between discount returns and NAV returns, this will increase the variance of share returns. These are interesting aspects of the discount puzzle that have received little attention in the literature.

Investment trusts are the UK equivalent of US closed-end funds that have attracted considerable research interest. Much of this research has concentrated on explaining the discount puzzle (Dimson & Minio-Kozerski, 2000). Explanations consistent with market efficiency that have been proposed include miscalculation of NAV, agency costs, tax timing and investment opportunities but, even taken together, they seem incapable of explaining all parts of the puzzle. In particular, they do not explain why there are wide variations in discounts over time.[7]

If movements in investment trust discounts over time reflect investor sentiment and do not conform to the efficient market model, there may be opportunities for investors to

[7] The most likely candidate is the agency cost argument in that the capitalised value of management fees will vary as the discount rate varies. However, changes in this discount rate will tend to coincide with changes in the discount rate for the underlying assets, using a discounted dividend approach to valuing the underlying assets. In any case, there is little empirical evidence to support the notion that discounts are a consequence of capitalising future management fees.

generate excess returns by exploiting errors in the pricing of trusts. Various US studies have suggested that it is indeed possible to generate excess returns systematically through decision rules based on discounts (e.g. Thompson, 1978; Richards *et al*, 1980; Pontiff, 1995) but evidence for the UK is less convincing (Draper & Paudyal, 1991). Proper analysis of the components of the variance of share returns for UK investment trusts may allow more sophisticated decision rules to be devised.

In this paper, we adopt a statistical approach based on historical data to analyse the components of total risk of conventional investment trusts. Excess volatility of the trust share returns compared to NAV returns would indicate investor irrationality since a trust share is a claim on the trust's underlying NAV. The results are compared and contrasted with those of the Pontiff (1997) variance decomposition analysis for US closed-end funds.

2. COMPARISON WITH US CLOSED-END FUNDS

Although UK investment trusts are similar to US closed-end funds, there are important differences relating to taxation, ownership structure and gearing.

The taxation of UK investment trusts is based on the principle of avoiding double taxation of shareholders, as with US closed-end funds, but there are nevertheless significant differences as regards the tax treatment of capital gains. The underlying fund of a UK investment trust is exempt from tax on capital gains but investors incur tax on realised capital gains in the same way as for the securities of any other type of company. UK investment trusts are required to retain all realised capital gains unlike

US closed-end funds which must distribute net realised capital gains[8] in a given year to shareholders as a capital gains distribution[9]. US closed-end fund shareholders in turn are liable for their proportion of capital gains tax, regardless of the length of time the shares have been held, so new shareholders inherit a contingent capital gains tax liability.

A major part of the US closed-end fund industry consists of bond funds that do not exist in the UK. This is due to the special UK tax regime that applies to authorised unit trust bond funds, which is more favourable than the tax treatment of investment trust bond funds.

There is a marked difference in the ownership structure of UK investment trusts and US closed-end funds. Typically, individuals hold a much lower percentage of the equity of UK investment trusts compared with US closed-end funds. Private individuals held only 27% of UK investment trust shares in 1997 (HSBC James Capel, 1997). In contrast, Lee *et al* (1991) report that US institutions owned only 6.6% of US closed-end funds in 1988.

There are no legal restrictions on the level of debt or preference capital for UK investment trusts and a few trusts are highly leveraged. The level of debt in the capital structure of US closed-end funds, however, is severely restricted by the Investment

[8] Unrealised capital gains are not taxed and need not be distributed until and unless realised.
[9] Most closed-end funds elect to pay capital gains distributions to shareholders rather than retain them. The corporate capital gain tax rate normally exceeds the corresponding tax rate for individuals. Although the retention of realised gains is rare, any corporate capital gain tax paid is passed on to shareholders on a proportional basis as a tax credit.

Company Act of 1940. Funded debt and preferred stock must be covered at least three times and twice by total assets respectively (Anderson & Born, 1992).

3. NOISE TRADING

Recent attempts at explaining the discount puzzle for US closed-end funds have involved investor irrationality. The investor sentiment theory proposed by Lee *et al* (1991), and developed from the De Long *et al* (1990) noise trader approach to finance, has been especially prominent. Lee *et al* claim to have solved all parts of the closed-end discount puzzle, but their theory has been the source of much controversy in the last decade. We first describe the noise trader model before discussing the Lee *et al* investor sentiment theory of closed-end funds.

The noise trader model asserts that rational traders in financial markets interact with noise traders. These noise traders are uninformed market participants who are active traders and stock markets generate irrational valuations because of their activities. When noise traders are present, large positive returns are immediately followed by further large positive returns in the short term. Their irrational trading activity imparts so much risk to the markets that informed rational operators fear to trade against them. This is because arbitrage by rational investors, who have finite time horizons, is risky and therefore limited. The model suggests that share prices will be more volatile than that dictated by the fundamentals and that share prices will overreact to changes in the fundamentals.

Consistent with the De Long *et al* noise trader model is the notion that, in the absence of any capital gains tax complications, closed-end fund discounts will tend to narrow when the value of underlying assets rise. A rise in stock markets will encourage noise traders to look for ways into the market and closed-end funds, which provide a ready-made portfolio of shares, will meet this demand. On the other hand, a fall in the market for the underlying assets will tend to cause a widening of the discount leading to a 'double whammy' effect.

Lee *et al* (1991) argue that discount movements are driven by changes in the sentiment of small investors who are the dominant owners of US closed-end funds. Institutional investors (who are the rational traders) fail to offset fully the irrational fluctuating sentiment of small investors (who are the noise traders). As discount movements are cross-sectionally correlated (i.e. systematic), the noise trader risk is priced, so closed-end funds will generally stand at a discount to NAV. The theory *requires* that discounts vary stochastically because it is precisely this discount volatility that is responsible for the underpricing, in equilibrium, of closed-end funds relative to their underlying net assets.

Lee *et al* provide evidence in support of their theory. In particular, they report contemporaneous correlation between closed-end fund discounts and share prices of small firms (which tend to be held by small investors).[10] However, Chen *et al* (1993), using the same data as Lee *et al*, argue that the correctly measured comovement between fund discounts and small firm returns is neither strong enough nor robust

[10] According to Lee *et al* (1991), in 1988, the average institutional ownership in the smallest 10% of the firms on the NYSE was 26.5%, the average institutional ownership in the largest 10% of the firms

enough to support the investor sentiment theory. Other evidence on the Lee *et al* theory is mixed. Swaminathan (1996) shows that discounts forecast small firm returns, which is consistent with investor sentiment theory but also that discounts contain information about future economic activity (earnings growth rate and inflation) which is not consistent with investor sentiment theory. Elton *et al* (1998) find no evidence that small investor sentiment, as measured by the change in discount of US closed-end funds, is an important factor in the return generating process for US equities. Ammer (1992) makes the straightforward point that UK investment trusts are owned predominantly by institutional investors, yet the stylized facts about UK investment trust discounts are similar to those for US closed-end funds. Indeed, UK discounts are generally *larger* than US discounts. He argues that the discount puzzle cannot therefore be dismissed as an anomaly concerned with small investors.

Hoskins (1994) shows that US closed-end funds of the same type (stock, bond or international funds) have discounts that move together. It is not clear why this discount comovement occurs, as it is not explained by the general sentiment of small investors. If investor sentiment is the explanation, there would have to be three types of sentiment: one for stock funds, one for bond funds and one for international funds. A number of studies on US country funds (e.g. Bodurtha *et al*, 1995) detect a common component in the fluctuations of their discounts reflecting time-varying sentiments of US investors in general rather than specifically individual investors.

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on the NYSE was 52.1% and the average institutional ownership in the US domestic equity closed-end funds was 6.6%.

4. VOLATILITY

This section reviews work relating to the excess volatility of closed-end fund shares. Most of the studies concern US closed-end funds, but we might expect similar results for UK investment trusts apart from differences due to ownership structure, gearing or taxation.

Share price return is equal to NAV return plus discount return[11]. Using the standard statistical formula for the variance of the sum of two random variables, it follows that the variance of share return can be split into three components:

a) Variance of NAV return

b) Variance of discount return[12]

c) Twice the covariance between NAV returns and discount returns.

If the variance of closed-end fund share return is to equal the variance of the corresponding NAV return, the covariance between NAV returns and discount returns must be sufficiently negative to cancel out the variance of discount return.

Problems with variance decomposition studies include:

a) short-term volatilities in share prices are partly driven by technical factors related to market imbalances (e.g. liquidity, bid-ask spreads). Infrequent trading of shares (hence stale prices) will also bias variance estimates in the case of smaller less marketable closed-end funds.

b) NAV is derived from the underlying portfolio, which contains shares whose prices will have different degrees of staleness. So the NAV time series acts like a moving average of past 'true' prices and may be artificially smooth as a result.

Using longer return intervals can reduce the above problems, but this means that the period of observation needs to be longer for there to be sufficient data points. Unfortunately, this leads to time series estimation problems. That is, the variances are sample estimates of changing portfolios. As the variances are affected by all the observations in the time series, they will be imperfect estimates of the true variances. This holds for both the variance of the closed-end fund share returns and the variance of NAV returns. Nevertheless, there is an implicit assumption that the estimation problem will affect them identically.

US closed-end funds

There have been two variance decomposition studies for US closed-end funds, one by Sharpe & Sosin (1974) using both annual and quarterly return intervals and one by Pontiff (1997) using monthly return intervals. In addition, there have been a variety of studies, primarily concerned with other matters, which provide evidence concerning the covariance between discount returns and NAV returns.

Sharpe & Sosin (1974), using annual data from 1933 to 1972 on ten US closed-end funds invested largely in US equities, observe excess volatility of closed-end fund share prices compared with underlying NAV for eight of the ten funds. On average, the

[11] It is helpful to take logarithms as the returns are additive and their distributions are more symmetric. The time intervals for these returns could be any length - one week, one month or even a

standard deviation of return on the shares is approximately 17% greater than that of its underlying net assets. However, it is only a small sample of funds and an issue that is particularly important for such a long-term study is that variances are sample estimates of changing portfolios. Using quarterly returns for eight of the funds over the period 1966 to 1973, Sharpe & Sosin find that the standard deviation of return on a share is approximately 28% greater on average than that of its underlying net assets. The correlation coefficient between NAV returns and discount returns is negative for five of the eight funds but is not significantly different from zero (5% level, two tail test) for any of the funds.

Pontiff (1997), using monthly data from July 1965 to December 1985 on 52 US closed-end funds, including both equity funds and bond funds, computes, for each fund in the sample, the natural log of the ratio of the share return variance to the NAV return variance. The average ratio is 0.494, which implies that the variance of the average fund's monthly return is 64% greater than the variance of its underlying NAV return. This means that the standard deviation of the average fund's monthly return is 28% greater than that of its underlying NAV return. This excess volatility is largely idiosyncratic and unrelated to aggregate market risk. Although Pontiff's results are biased to the extent that infrequent trading or bid-ask spreads bias the variance estimates, when calculated for two monthly, three monthly and four monthly return intervals, the average log variance ratios are still significantly different from zero. And since the magnitude of these biases is the same regardless of the return interval whereas variance increases as the return interval increases, this suggests that the biases

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year.

[12] For monthly returns, the square root of b) is often known as 'discount volatility'.

are not severe. Log variance ratios for intervals greater than four months are not presented. Pontiff observes negative covariance between discount returns and NAV returns. This negative covariance persists when bimonthly returns are used.

Other studies have looked, directly or indirectly, at the covariance between discount returns and NAV returns, using return intervals ranging from weekly through to annual. They generally report negative covariance between discount returns and NAV returns (Anderson & Born, 1987; Chen *et al*, 1993). One exception is Brickley *et al* (1991) which finds positive covariance using annual data over the period 1954 to 1985. This suggests that the negative covariance relation observed by other authors using return intervals ranging from weekly to quarterly may dissipate when longer return intervals are considered. Negative covariance between discount returns and NAV returns is also observed for studies specifically looking at US country funds[13] and based on weekly data (Hardouvelis *et al*, 1993; Bodurtha *et al*, 1995; Klibanoff *et al*, 1998).

Malkiel (1977), using quarterly data over the period 1965 to 1972, shows that fund discounts narrow when the US domestic equity market falls and increase when the market rises. This suggests a negative covariance between discount returns and NAV returns, given that the funds in the sample are invested mainly in US domestic equities. Malkiel argues that the negative covariance is due to an increase (or decrease) in the contingent capital gains tax liability as the equity market rises (or falls). UK investment trusts do not suffer from this contingent capital gains tax effect that applies

[13] These are geographical specialists that invest solely in shares quoted on specific foreign stock exchange(s) located in one particular country.

to US closed-end funds and may therefore be regarded as more suitable vehicles for testing the noise trader model and market efficiency.

UK investment trusts

A few research papers have touched on the question of excess volatility for UK investment trusts, but the main emphasis of each of these papers has concerned other matters. They generally employ monthly return intervals. There is currently no published research that looks directly at the decomposition of the variance of investment trust share returns.

Corner & Matatko (1982) examine the monthly returns on 92 investment trusts over the period 1974 to 1979. The average standard deviation of share price total returns is 8.6% whereas the average standard deviation of net asset value total returns is 5.8%. However, this study covers a period in which discounts varied widely, both cross-sectionally and over time. The sector average discount climbed to around 40% in 1974 and again in 1976. This period is now viewed in investment trust circles as quite an unusual period.[14]

Both Draper & Paudyal (1991) and Cheng *et al* (1994) show that discounts tend to narrow as the UK equity market[15] rises and widen as it declines. As very few of the largest trusts are invested entirely in the UK, this suggests the possible influence of UK market sentiment on trust share prices and hence discounts. It could also be interpreted as overreaction in the pricing of trust shares.

5. VARIANCE DECOMPOSITION – MONTHLY RETURNS

In this section, we examine the components of total risk empirically for UK investment trusts, using monthly return intervals. We are implicitly assuming no structural changes over the period of observation. We use share prices unadjusted for ex-dividend discontinuities[16] together with fully diluted NAVs[17], as is normal practice for market participants, using data collected from Datastream.[18] Dividends are then ignored in calculating the three components of total risk.[19]

The sample consists of the 50 largest trusts as at 31 December 1981 (i.e. those with market capitalisation greater than £10m at that time) which survived until the end of 1996. Concentrating on larger trusts reduces the problem of infrequently traded shares (and hence stale share prices) distorting variance and covariance estimates. Trusts in the sample are listed in the Appendix 1.

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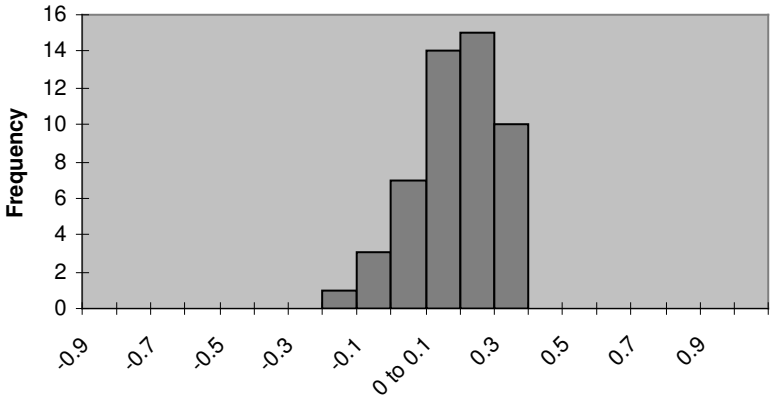
[14] Due to the capital gains tax rules applying to investment trust shareholders at the time, there was a tax incentive for investors to sell investment trust shares before other shares at times of sharp market falls (e.g. 1974) leading to very wide discounts.
[15] as measured by the FT-Actuaries All Share Index.
[16] There is a discontinuity in share prices when they go ex-dividend but revenue items are excluded in the NAV calculation for UK investment trusts. This is the case for NAVs published by both Datastream and the AITC. As a consequence there is a discount discontinuity at the ex-dividend date for UK investment trusts and hence *ceteris paribus* a corresponding apparent negative discount return. This effect was investigated and makes no qualitative difference to the results of this paper.
[17] The effect of using undiluted NAV together with the corresponding 'package' of shares and warrants, for those trusts with warrants outstanding at some point during the period of observation, was investigated. It made no qualitative difference to the results of this paper.
[18] Data was also obtained from the AITC to provide a check for the major results in this chapter.
[19] Dividends are included in the AITC return data.

Appendix 2a shows the results using monthly data over the entire 15-year period of observation.[20] The variance of share return (total risk) is shown in Column (2). Columns (3), (4) and (5) give the figures for the three components of total risk (all measured in $\%^2$) for each trust in the sample, together with an average figure for the whole sample. Column (6) gives the correlation coefficient between NAV return and discount return.

For the average trust, variance of NAV return represents only about 63% of the variance of share return so there is clear evidence of 'excess volatility'. Variance of discount return represents about 30% of the variance of share return, and the covariance term is positive and accounts for the remaining 7%.

Figure 1 shows the distribution of correlation coefficients between NAV returns and discount returns. The correlation coefficient is positive for 39 of the 50 trusts.

Figure 1 - Distribution of correlation coefficients with monthly returns from 1/82 to 12/96



[20] Very similar results were obtained using AITC data.

Trusts for which the correlation coefficient is significantly different from zero at the 5% (1%) level are indicated by an asterisk (two asterisks) in Appendix 2a. In all, 14 (11) of the 50 trusts have correlation coefficients which are positive and significantly different from zero at the 5% (1%) level and only 3 (1) trusts have correlation coefficients which are negative and significantly different from zero at the 5% (1%) level.

The average correlation coefficient of 0.086 is positive and significantly different from zero at the 1% level[21], suggesting a 'double whammy' effect for the investment trust sector. That is, discounts widen when NAVs fall and discounts narrow when NAVs rise. It could be argued, however, that the homogeneous population assumption in the significant test is invalid because the trusts in the sample are drawn from different sub-sectors, within which there may be different mechanisms working. We will therefore repeat the above test for more homogeneous sub-sectors in Section 9.

6. COMPARISON WITH PONTIFF'S RESULTS FOR US CLOSED-END FUNDS

[21] If we assume a homogeneous underlying population ($\rho_1 = \rho_2 = \rho_3 = \ldots\ldots = \rho_{50}$) then the average correlation coefficient is significantly different from zero at the 1% level (two tail test) if:

$$|\bar{z}| > \frac{2.576}{\sqrt{(n-3)}\sqrt{N}}$$

$$= 0.027$$

We also assume that the z_i are roughly normally distributed but the tests are robust to this assumption and the results are sufficiently strong to remain unchallenged.

Pontiff (1997) measures excess volatility by calculating the log variance ratio for each fund in his sample. This ratio is defined as the logarithm[22] of the ratio of the variance of share return to the variance of NAV return. It will have a value of zero if variance of share return is equal to the variance of NAV return. The average of the log variance ratios using figures in Appendix 1a is 0.444 which compares with an average of 0.494 using monthly returns for the sample of US closed-end funds in Pontiff's study. This suggests that there is similar excess volatility for UK investment trusts as for US closed-end funds.

Table 1 shows the figures for the variance of share returns and the components of total risk for the average trust together with corresponding figures from Pontiff's variance decomposition analysis.

Table 1: Comparison of results for average trust with those of Pontiff (1997)

	Var(shr)	**Var(navr)**	**Var(disr)**	**2xCovar**
UK investment trusts (82-96)	38.97	24.72	11.50	2.74
US closed-end funds (65-85)	51.15	37.89	37.33	-25.42

Note that variance of discount return is far greater on average for US closed-end funds than for UK investment trusts. This is consistent with the apparently greater success of decision rules based on discounts for US closed-end funds. But it should be stressed that the period of observation for the Pontiff (1997) study is earlier than the

[22] The logarithm of the ratio is taken to reduce skewness.

present study and includes the 1970s which were characterised by extreme movements in closed-end fund discounts both in the US and in the UK.

Note also the large negative covariance term for the average US closed-end fund compared with a small positive (but significant at the 1% level) covariance term for UK investment trusts. The negative covariance term for US closed-end funds may partly reflect the contingent capital gains tax liability effect.

7. LONGER RETURN INTERVALS

Appendices 2b and 2c show the results for the same analysis as in Section 5 but with three-monthly return intervals and six-monthly return intervals respectively. The results for longer return intervals emphasise the importance of the investor's time horizon in the risk assessment of investment trusts. There is still evidence of 'excess volatility' but the effect reduces with longer return intervals. For the average trust, variance of NAV return represents 69% of variance of share return for three-monthly intervals and 81% for six-monthly intervals.

Table 2 is a summary table for the average trust with monthly, three-monthly and six-monthly return intervals. The components are expressed as a percentage of the variance of share returns.

Table 2: Importance of the three components for the average trust

	Var(navr)	**Var(disr)**	**2xCovar**

Monthly	63%	30%	7%
Three-monthly	69%	17%	13%
Six-monthly	81%	12%	7%

If noise traders are affecting share prices in the market, the discount time series will pick up the noise and discount movements will show the same negative autocorrelation as the noise. This will be reflected in mean reversion of the discount, and the relative importance of the variance of discount returns as a component of total risk will be lower with greater return intervals. This effect is observed in Table 2. For three-monthly returns, variance of discount return contributes 17% of total risk for the average trust compared with 30% for monthly intervals. For six-monthly returns, the contribution of the variance of discount return reduces even further to only 12% of total risk for the average trust.

The contribution of the covariance term to total risk for the average trust is still relatively small at 13% for three-monthly returns and 7% for six-monthly returns. But 46 of the 50 trusts have positive covariance terms with three-monthly returns and 36 of the 50 trusts have positive covariance terms with six-monthly returns. Figures 2 and 3 show the distribution of correlation coefficients with three-monthly and six-monthly return intervals respectively.

Figure 2 - Distribution of correlation coefficients with three-monthly returns from 1/82 to 12/96

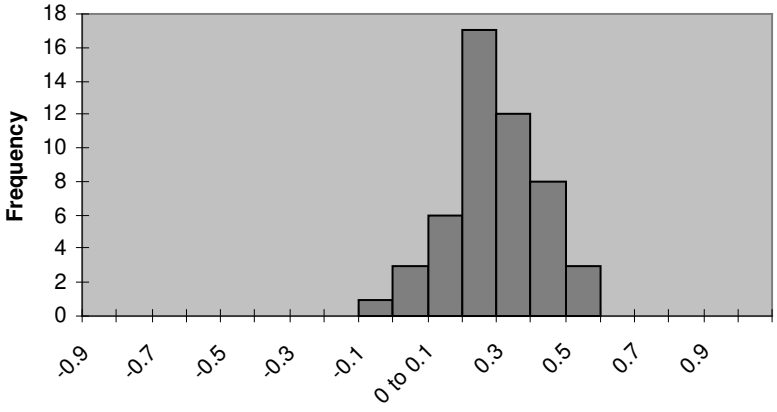
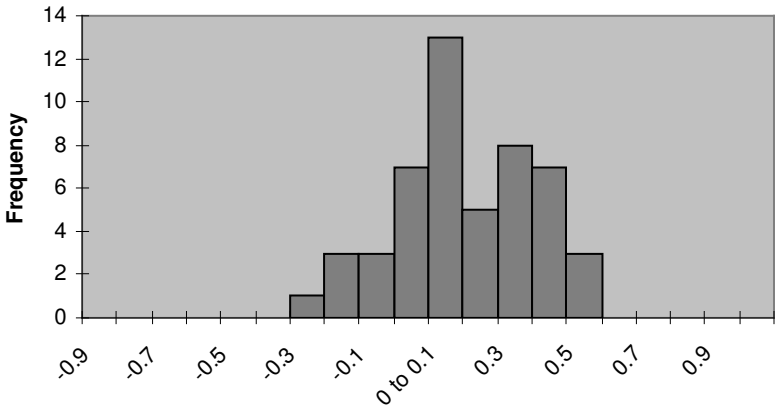


Figure 3 - Distribution of correlation coefficients with six-monthly returns from 1/82 to 12/96



Assuming a homogeneous population, the average correlation coefficient is again positive and significantly different from zero at the 1% level (two tail test) for both three-monthly and six-monthly returns.[23] The 'double whammy' effect therefore persists for longer return intervals.

[23] i.e. $\bar{z} > 0.048$ for three-monthly returns and $\bar{z} > 0.070$ for six-monthly returns.

8. PERIOD OF OBSERVATION SPLIT INTO THREE FIVE-YEAR SUB-PERIODS

We now split the period of observation into three five-year sub-periods - January 1982 to December 1986, January 1987 to December 1991, and January 1992 to December 1996, using monthly returns.[24] Note that the end of the first five-year period is just after 'Big Bang' of the London Stock Exchange (October 1986) and just before the international stock market crash of October 1987.

Table 3 is a summary table for the average trust in each of the three sub-periods.

Table 3: Results for the three sub-periods for the average trust

	Var(shr)	Var(navr)	Var(disr)	2xCovar	Corr
1/82-12/86	29.45	16.65	14.46	-1.63	-0.045*
1/87-12/91	60.87	40.65	12.84	7.25	0.179**
1/92-12/96	26.51	16.51	7.49	2.47	0.125**

Table 3 shows that the variance of share returns (total risk) and the variance of NAV returns are much higher in the second five-year period reflecting the turbulent equity markets worldwide during and after the October 1987 crash. Table 3 also suggests a downward trend in discount volatility over time. This may reflect some market participants' growing belief in the success of trading strategies based on selling low

[24] Very similar results were obtained using AITC data.

discount trusts and buying high discount trusts. Another possible reason for the reduction in discount volatility could be the reduction in transaction costs.[25]

The contribution to total risk of the covariance term tends to be relatively small for each of the three periods. For the average trust in the first period the correlation coefficient is negative (significant at 5% level, two tail test). But note the change of sign in the correlation coefficient for the average trust. For the second and third periods it is positive (in both cases significant at 1% level, two tail test). One possible reason for the apparent negative covariance term in the first 5-year period is that share prices were slow to react to changes in underlying NAVs prior to Big Bang, not least because information was not available. There is strong evidence of a positive correlation coefficient between discount returns and NAV returns since 1987, suggesting that market participants in the investment trust sector overreact to the fundamentals. A positive covariance term is consistent with noise traders 'jumping on the bandwagon' as regards NAV performance.

October 1987 was an exceptional month and arguably could be distorting the results. In this month, for trusts in the sample, the unweighted average NAV return and discount return were -31% and -4% respectively. The analysis is therefore repeated with the month of October 1987 excluded. Figures for the average trust for the five-year period from January 1987 to December 1991 are shown in Table 7.

[25]The bid-ask spread has reduced considerably, particularly since Big Bang in October 1986. Also, transfer stamp duty for share purchases was 2% at the beginning of 1982 but was reduced to 1% in March 1984 and reduced further to 0.5% in October 1986.

Table 4: Results for average trust with month of October 1987 removed

	Var(shr)	Var(navr)	Var(disr)	2xCovar	Corr
1/87-12/91	38.90	23.87	11.89	3.09	0.125**

The differences caused by removing the month of October 1987 from the data set can be observed by comparing the figures in Table 4 with the corresponding figures in Table 3. All the variance and covariance figures are lower, as expected. The average correlation coefficient between NAV returns and discount returns has been reduced substantially although it is still significantly positive (at the 1% level, two tail test).

9. SAMPLE SPLIT INTO SUB-SECTORS

Most investment trusts in the sample fall into one of three broad categories - international, UK and geographical. We therefore calculate the average correlation coefficient for each of these sub-sectors. There are 23 international trusts, 12 UK trusts and 12 geographical trusts. Of the remaining three trusts out of the sample of 50, one is a venture capital trust and two are European trusts.

Table 5: Average correlation coefficients for sub-sectors

Period	International	UK	Geographical
	(23 trusts)	(12 trusts)	(12 trusts)
1/82 - 12/86	-0.028	0.002	-0.068
1/87 - 12/91	0.236**	0.069	0.203**

1/92 - 12/96	0.118**	0.130**	0.103**
1/82 - 12/96	0.111**	0.053*	0.090**

Table 5 gives the figures for the three five-year periods and for the whole 15 year period. Positive and significant correlation coefficients are observed for each of the sub-sectors for both the later 5-year periods, with the exception of UK-invested trusts in the period 1/87 - 12/91 for which the correlation coefficient is positive but not significant. For the early period 1/82 - 12/86, negative correlation coefficients are observed for the international and geographical sub-sectors but they are not statistically significant. For the whole 15-year period, the average correlation coefficient is positive for all sub-sectors. It is significant at the 1% level for geographical and international trusts but only at the 5% level for UK-invested trusts. It is not clear why the 'double whammy' effect is stronger for trusts investing overseas.

10. CONCLUSION

The results for the entire 15-year period of observation provide strong evidence of excess volatility of share returns compared with NAV returns. This is true for monthly, three-monthly and six-monthly returns although the effect reduces as the return interval increases. This excess volatility contradicts the efficient market model but is consistent with noise trader theory.

The results for monthly returns over the entire period of observation show the variance of discount return to be less important than in the Pontiff (1997) study of US closed-

end funds but still represents 30% of the variance of share returns for the average UK trust. There is, however, considerable cross-sectional variation in the magnitude of this discount volatility and there seems to be persistence in the relative importance of discount volatility for a given trust.

As the return interval is increased, discount volatility becomes less important because discounts are mean reverting. This implies that, in assessing risk, short-term investors should be concerned with discount volatility as well as variance of NAV return whereas most investors should be primarily concerned with variance of NAV return rather than the often quoted volatility (of share return) based on monthly data. The reduction in the importance of discount volatility with longer return intervals is consistent with the De Long *et al* noise trader model because some of the transient noise will be removed with longer return intervals.

There is clear evidence of a reduction in discount volatility over the 15-year period of observation. This may be due both to an increase in the number of discount anomaly traders (following the success of decision rules in the past) and a reduction in transaction costs. It suggests that decision rules based purely on discount movements may not generate excess returns in future.

The covariance term is small but has been significantly ***greater*** than zero for the average trust since 1987, which means that discounts have tended to widen (or narrow) when the underlying NAV falls (or rises). This contrasts with the negative covariance term reported by Pontiff (1997). This 'double whammy' effect could be due to noise traders overreacting to changes in the fundamentals (NAVs). The

contingent capital gains tax problem for US closed-end funds, which works in the opposite direction, is not relevant to this UK study.

Evidence of the 'double whammy' effect is stronger for international and geographical specialist trusts than for UK trusts. Positive and significant correlation coefficients are observed for each of the three major sub-sectors for both the later 5-year periods, with the exception of UK-invested trusts in the period 1/87 - 12/91, for which the correlation coefficient is positive but not significant. If the existence of noise traders is the underlying reason for the 'double whammy' effect, then why are they more in evidence for trusts investing overseas? This is an interesting area for further research.

A further question which is raised by the analysis is whether a decision rule based not only on the level of the discount but also based on exploiting the positive covariance between discount returns and NAV returns might be successful. For example, trusts on wide discounts would only be purchased when the NAV has risen x% and trusts on narrow discounts would only be sold if the NAV has fallen x%. This would mean less dealing activity in carrying out a particular decision rule but should also result in higher excess returns. Such a decision rule could be tested over the years since the end of the period of observation for this paper (31 December 1996).

To sum up, the results of the variance decomposition analysis are consistent with the noise trader model. There is strong evidence of excess volatility (trust share returns are more volatile than NAV returns) and a 'double whammy' effect (discount returns and NAV returns are positively correlated). Discount volatility is an important

component of total risk with monthly returns but becomes less important as the return interval is increased.

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Appendix 1: Sample for Components of Total Risk

Trust	Mnemonic
Alliance Trust PLC	atst
American Trust PLC	amts
Anglo & Overseas Trust PLC	aot
Bankers Investment Trust PLC	bnkr
Baring Tribune Investment Trust PLC	bti
British Assets Trust PLC	bset
British Investment trust PLC	bits
Brunner Investment Trust PLC	but
Dunedin Income Growth Inv Tst PLC	dig
Dunedin Smaller Co's Inv Tst PLC	dndl
Dunedin Worldwide Inv Trust PLC	dww
Edinburgh Investment Trust PLC	edin
Electric&General Investment Co PLC	elgn
English & Scottish Investors PLC	ensc
Fleming American Inv Trust PLC	fam
Fleming Claverhouse Inv Trust PLC	fcv
Fleming Continental Euro Inv Tst	fut
Fleming Far Eastern Inv Trust PLC	ffe
Fleming Japanese Inv Trust PLC	flmj
Fleming Mercantile Inv Trust PLC	fmn
Fleming Overseas Inv Trust PLC	fov
Foreign & Col Invest Trust PLC	frcl
Foreign & Col. Pacific Inv Tst PLC	fcp
Foreign & Colonial Smaller Co's PLC	fcs
G.T.Japan Investment Trust PLC	gtja
Govett Oriental Inv Trust PLC	gor
Govett Strategic Inv Trust PLC	gvs
Kleinwort Charter Inv Trust PLC	klc
Kleinwort Overseas Inv Trust PLC	kos
Merchants Trust PLC	mrch
Mercury Keystone Investment Tst PLC	mki
Monks Investment Trust PLC	mnks
Murray Income Trust PLC	mut
Murray International Trust PLC	myi
Murray Smaller Markets Trust PLC	msm
Murray Ventures PLC	mvn
Overseas Investment Trust PLC	oit
Scottish American Investment Co PLC	scam
Scottish Eastern Inv Trust PLC	scea
Scottish Investment Trust PLC	scin
Scottish Mortgage & Trust PLC	smt
Second Alliance Trust PLC	sat
Securities Trust of Scotland PLC	sts
St Andrew Trust PLC	srw
Temple Bar Investment Trust PLC	tmpl
Throgmorton Trust PLC	thrg
TR City of London Trust PLC	trcd
TR Property Investment Trust PLC	try
TR Smaller Companies Inv Trust PLC	tru
Witan Investment Co PLC	wtan

Appendix 2a: Results with monthly returns from 1/82 to 12/96

Company	Var(shr)	Var(navr)	Var(disr)	2xCovar	Corr
ATST	27.61	17.99	6.51	3.09	0.143
AMTS	39.02	25.71	12.51	0.79	0.022
AOT	37.43	22.22	7.69	7.47	0.286**
BNKR	34.48	23.73	9.52	1.22	0.040
BTI	30.58	19.44	8.00	3.13	0.126
BSET	36.30	20.24	10.01	6.01	0.211**
BITS	22.49	20.38	8.15	-6.01	-0.233**
BUT	31.94	23.44	7.69	0.81	0.030
DIG	35.89	27.86	8.68	-0.65	-0.021
DNDL	29.48	21.70	7.81	-0.04	-0.001
DWW	30.35	23.26	7.90	-0.80	-0.030
EDIN	34.45	20.83	6.92	6.66	0.277**
ENSC	38.98	22.11	13.50	3.35	0.097
FAM	50.62	30.78	17.37	2.46	0.053
FCV	40.01	30.25	9.13	0.62	0.019
FUT	41.84	24.90	13.37	3.54	0.097
FFE	73.82	40.50	19.62	13.61	0.241**
FLMJ	66.15	39.07	23.63	3.44	0.057
FMN	27.63	16.88	8.12	2.61	0.112
FOV	42.82	22.51	11.17	9.09	0.286**
FCP	55.94	26.18	20.05	9.66	0.211**
FCS	37.72	24.71	12.47	0.53	0.015
FRCL	36.34	24.49	7.88	3.96	0.143
GOR	73.34	45.18	15.10	12.98	0.249**
GVS	49.97	38.43	11.73	-0.19	-0.004
GTJA	72.42	39.75	37.64	-4.95	-0.064
ELGN	41.04	27.03	9.52	4.46	0.139
KLC	31.70	18.62	9.61	3.45	0.129
KOS	35.46	21.67	9.45	4.32	0.151*
MRCH	36.89	23.60	8.38	4.88	0.173*
MKI	34.53	25.42	9.03	0.09	0.003
MNKS	31.34	23.98	6.49	0.87	0.035
MUT	30.07	21.10	10.24	-1.27	-0.043
MYI	31.30	19.94	10.25	1.11	0.039
MSM	48.22	33.31	13.12	1.78	0.043
MVN	26.73	15.21	17.41	-5.86	-0.180*
OIT	32.32	25.50	11.50	-4.65	-0.136
SCAM	28.45	13.69	9.13	5.60	0.251**
SCEA	37.37	24.05	7.53	5.75	0.214**
SCIN	30.17	19.88	7.10	3.18	0.134
SMT	35.87	25.93	6.39	3.52	0.137
SAT	25.45	18.44	5.39	1.60	0.080
STS	31.49	20.38	6.57	4.52	0.195**
SRW	23.38	19.76	7.80	-4.16	-0.167*
TMPL	33.36	20.94	8.27	4.12	0.156*
THRG	53.21	27.66	25.85	-0.30	-0.006
TRCD	36.49	24.16	8.59	3.72	0.129
TRY	54.94	24.00	25.25	5.67	0.115
TRU	46.32	23.81	13.50	8.96	0.250**
WTAN	34.76	25.37	6.34	3.03	0.120
Average	**38.97**	**24.72**	**11.50**	**2.74**	**0.086****

Appendix 2b: Results with three-monthly returns from 1/82 to 12/96

Company	Var(shr)	Var(navr)	Var(disr)	2xCovar	Corr
ATST	80.54	57.38	10.60	12.35	0.250
AMTS	134.23	93.61	26.39	14.00	0.141
AOT	125.71	80.15	14.97	30.08	0.434**
BNKR	118.96	77.11	23.24	18.30	0.216
BTI	93.88	67.58	12.18	13.89	0.242
BSET	99.36	64.70	16.54	17.82	0.272*
BITS	79.65	64.44	15.39	-0.18	-0.003
BUT	102.37	77.98	13.52	10.69	0.165
DIG	102.30	86.21	12.56	3.46	0.053
DNDL	122.48	91.60	17.21	13.44	0.169
DWW	116.91	88.96	13.96	13.76	0.195
EDIN	99.48	73.66	10.84	14.73	0.261*
ENSC	108.66	77.79	19.78	10.91	0.139
FAM	177.40	97.29	39.56	39.87	0.321*
FCV	114.65	96.75	10.82	6.96	0.108
FUT	139.93	79.46	27.18	32.74	0.352**
FFE	283.22	162.88	47.72	71.41	0.405**
FLMJ	225.02	154.88	46.14	23.60	0.140
FMN	87.27	63.77	18.03	5.39	0.079
FOV	137.54	82.77	19.45	34.73	0.433**
FCP	182.49	99.82	38.66	43.28	0.348**
FCS	135.24	92.91	20.43	21.53	0.247
FRCL	120.49	85.70	16.32	18.17	0.243
GOR	279.21	180.92	37.34	59.93	0.365**
GVS	201.94	169.23	17.75	14.72	0.134
GTJA	220.74	146.38	68.05	6.20	0.031
ELGN	142.11	104.06	15.33	22.35	0.280*
KLC	90.31	62.46	19.55	8.16	0.117
KOS	131.50	80.69	20.78	29.52	0.360**
MRCH	101.65	73.58	15.33	12.53	0.187
MKI	100.15	83.23	17.02	-0.10	-0.001
MNKS	121.12	86.85	14.90	19.05	0.265*
MUT	88.22	67.67	14.57	5.88	0.094
MYI	96.93	68.21	19.85	8.72	0.118
MSM	209.20	140.13	24.23	44.09	0.378**
MVN	90.39	50.75	30.07	9.40	0.120
OIT	145.08	92.30	19.44	32.78	0.387**
SCAM	73.01	49.44	16.18	7.27	0.128
SCEA	98.12	80.81	10.40	6.80	0.117
SCIN	88.27	67.95	13.86	6.35	0.103
SMT	126.88	90.59	11.75	24.13	0.370**
SAT	80.68	59.37	11.21	9.94	0.193
STS	86.60	64.08	16.35	6.07	0.094
SRW	96.31	71.57	26.47	-1.71	-0.020
TMPL	94.29	62.74	14.68	16.59	0.273*
THRG	131.33	98.11	58.89	-25.25	-0.166
TRCD	104.74	71.21	17.10	16.15	0.231
TRY	189.22	115.03	58.67	15.27	0.093
TRU	129.60	88.28	22.76	18.26	0.204
WTAN	115.95	92.19	15.09	8.52	0.114
Average	**128.43**	**88.70**	**22.38**	**17.05**	**0.196****

Appendix 2c: Results with six-monthly returns from 1/82 to 12/96

Company	Var(shr)	Var(navr)	Var(disr)	2xCovar	Corr
ATST	151.38	134.54	13.26	3.46	0.041
AMTS	243.06	220.66	30.34	-7.67	-0.047
AOT	205.69	163.01	16.39	25.40	0.246
BNKR	199.70	148.76	23.49	26.53	0.224
BTI	189.75	146.36	13.46	28.93	0.326
BSET	184.49	144.39	22.30	17.21	0.152
BITS	171.39	138.46	22.76	9.82	0.087
BUT	218.46	179.25	16.53	21.93	0.201
DIG	197.09	182.87	24.66	-10.09	-0.075
DNDL	221.25	192.19	26.27	2.70	0.019
DWW	245.67	196.33	15.05	33.14	0.305
EDIN	187.94	164.55	16.70	6.46	0.062
ENSC	220.33	173.88	22.97	22.70	0.180
FAM	335.24	234.10	60.50	39.28	0.165
FCV	183.09	168.79	18.00	-3.58	-0.032
FUT	274.03	175.75	38.21	58.07	0.354
FFE	472.09	356.00	40.18	73.37	0.307
FLMJ	477.68	384.64	66.31	25.85	0.081
FMN	144.40	141.75	17.13	-14.00	-0.142
FOV	278.37	191.08	25.26	59.96	0.432*
FCP	387.49	258.44	49.23	77.15	0.342
FCS	279.34	194.13	29.70	53.65	0.353
FRCL	254.13	198.41	25.96	28.77	0.200
GOR	502.83	408.89	35.08	56.90	0.238
GVS	307.53	321.95	17.49	-30.85	-0.206
GTJA	449.55	344.15	102.82	2.50	0.007
ELGN	308.54	227.06	20.75	58.71	0.428*
KLC	163.33	139.97	23.30	0.07	0.001
KOS	247.46	182.45	24.11	39.54	0.298
MRCH	185.14	150.55	24.96	9.31	0.076
MKI	193.34	157.50	23.76	11.68	0.095
MNKS	231.54	198.33	23.27	9.61	0.071
MUT	150.38	146.44	25.47	-20.82	-0.170
MYI	203.54	192.62	31.39	-19.79	-0.127
MSM	378.02	296.54	28.41	51.30	0.279
MVN	188.05	138.83	38.89	10.00	0.068
OIT	289.98	204.20	32.11	51.88	0.320
SCAM	124.31	113.80	19.78	-8.97	-0.095
SCEA	177.87	167.97	15.89	-5.79	-0.056
SCIN	179.52	149.78	11.74	17.40	0.207
SMT	238.80	189.96	10.51	37.04	0.414*
SAT	152.23	138.33	13.75	0.15	0.002
STS	166.73	153.22	14.43	-0.90	-0.010
SRW	149.98	153.37	27.03	-29.41	-0.228
TMPL	174.03	134.76	26.20	12.63	0.106
THRG	220.68	232.91	65.96	-75.59	-0.305
TRCD	130.93	134.63	17.34	-20.34	-0.210
TRY	428.87	281.52	71.47	73.35	0.259
TRU	184.11	169.08	28.24	-12.77	-0.092
WTAN	218.75	197.98	14.72	5.84	0.054
Average	**241.36**	**196.30**	**28.47**	**16.03**	**0.104****