CROSS-SECTIONAL VARIATION IN INVESTMENT TRUST DISCOUNT VOLATILITY

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ABSTRACT

Discount volatility is generally an important component of total risk for closed-end funds but there is considerable cross-sectional variation in the magnitude of this discount volatility. These are interesting aspects of the closed-end fund discount puzzle which have received little attention in the literature, particularly as regards UK investment trusts. This paper seeks to explain the cross-sectional variation in discount volatility for the UK investment trust sector. The sample consists of 59 UK conventional investment trusts in continuous operation over the five years from 1 January 1992 to 31 December 1996. Discount volatility is calculated using monthly intervals. Four explanatory variables are highly significant - trust share turnover, standard deviation of NAV return, ln(market value) and percentage of underlying assets which are unquoted. There is no evidence that either small investor sentiment or UK specific sentiment has any impact on discount volatility.

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1. INTRODUCTION

Investment trusts are UK companies whose assets consist of a portfolio of shares or other securities. They enable investors to purchase an interest in a professionally managed fund. Ultimate responsibility for running the affairs of an investment trust lies with the board of directors, but day-to-day management is normally delegated to professional investment managers. In common with any other company, an investment trust has a fixed capital structure which must contain share capital but which may also include loan capital. An advantage of this 'closed-end' structure is that the fund managers can act in the best long-term interests of their shareholders without having to worry about any future need to reduce the underlying portfolio of assets.

As the ordinary shares of an investment trust must be listed on the London Stock Exchange, the procedure for dealing in the shares is the same as for other listed shares. So investors wishing to purchase or sell investment trust shares do so at prices which reflect the supply and demand for the shares rather than the underlying net assets of the company. Nevertheless, investors generally regard conventional[1] investment trust shares as essentially claims on assets, and investment trust analysts watch the relationship between the investment trust share price and the underlying net asset value per share (NAV) very carefully.

Discount to NAV is defined as NAV less share price, expressed as a percentage of NAV. Investment trust discounts/premiums are of particular interest to academics as they provide an almost unique opportunity to compare the stock market valuation of a company with the value of that company's net assets. Investment trusts generally trade at a discount but providing a satisfactory explanation for this 'anomaly' has presented something of a puzzle to researchers.

[1] Conventional investment trusts are those without a split capital structure.

The equivalent of investment trusts in the US are known as US closed-end funds. As with UK investment trusts, they generally trade at a discount and therefore pose a similar discount puzzle. But there are important differences in their ownership structure compared with UK investment trusts, which are relevant to this paper. Typically, individuals hold a much higher percentage of the equity of US closed-end funds compared with UK investment trusts and there is much less variation in the importance of individual shareholders across the sector as compared with the UK investment trust sector.

There is a vast literature seeking to explain the closed-end fund discount puzzle. The literature mainly concerns US closed-end funds, but some work has been directed specifically at UK investment trusts. Explanations consistent with market efficiency that have been proposed include agency costs and miscalculation of NAV. The agency cost theory says that discounts are a consequence of capitalising future management fees or inferior future investment performance. However, for US closed-end funds, Malkiel (1977) finds no correlation between discounts and management fees, and Malkiel (1977), Lee *et al* (1991) and Pontiff (1995) find no significant relationship between discounts and future NAV performance. Miscalculation of NAV covers a number of theories, the most relevant from the perspective of UK investment trusts being the block discount hypothesis. This states that the current market valuation of underlying assets is calculated using the trading price of a marginal share whereas the proceeds from a liquidation, typically involving the sale of large blocks of shares, would be much lower. Unfortunately, miscalculation of NAV arguments are not consistent with the evidence that large positive abnormal returns are observed when funds are open-ended (Brauer (1984) and Brickley and Schallheim (1985) for the US, and Draper (1989) for the UK).

With the apparent inability to explain the closed-end discount puzzle within the framework of the efficient market hypothesis, recent attempts at explaining the phenomenon have adopted alternative theories that involve investor irrationality. The investor sentiment theory proposed by Lee *et al* (1991), which they developed from the De Long *et al* (1990) noise trader model, has been especially popular. Lee *et al* argue that US discount movements are driven by changes in the sentiment of small

investors who are the dominant owners of US closed-end funds. Institutional investors fail to offset fully the irrational whims of small investors because the risk of discounts widening is cross-sectionally correlated (i.e. systematic) and abitrageurs have finite time horizons. The discount on closed-end funds is therefore interpreted as an individual investor sentiment index. The theory *requires* that discounts vary stochastically because it is precisely this discount fluctuation that is responsible for the underpricing of closed-end funds relative to their underlying net assets.

If there is a cost to arbitrage, the difficulty to hedge determines the arbitrage profitability and the magnitude of discount anomalies. Discount volatility for funds with foreign assets, however, may partly reflect factors that preclude costless cross-border transactions: official and unofficial barriers to capital movements, transaction costs, time to complete transactions and time mismatch in trading hours.

Discount fluctuations are important in the context of investment trust risk analysis. As discounts vary over time, part of the return from a conventional investment trust share is due to changes in the discount. Thus, discount variation over time contributes to the variance of returns from investment trust shares.

Let P_t = share price of investment trust at time t

A_t = fully diluted[2] net asset value per share at time t

$r_t = \frac{P_t}{A_t}$ (= 1-discount) which we call 'the ratio'.

R_t^p = share price total return in period t

R_t^A = net asset value total return in period t

Then the return on the investment trust shares due to changes in the discount, that is the return on 'the ratio',

$$= \log_e (P_t / P_{t-1}) - \log_e (A_t / A_{t-1})$$

$$= \left(\log_e r_t - \log_e r_{t-1}\right)$$

[2] Some trusts have warrants in issue. If so, it is normal practice in the investment trust industry to make adjustments to NAV on a per share basis by treating warrants as exercised if dilution of NAV

Share price total return is equal to net asset value total return plus the return on 'the ratio'. Hence:

$$\log_e\left(1+R_t^p\right)=\log_e\left(1+R_t^A\right)+\left(\log_e r_t-\log_e r_{t-1}\right)$$

The time intervals for the above returns could be of any length - one week, one month or even a year.

The standard statistical formula for the variance of the sum of two random variables then gives:

$$Var\left\{\log_e\left(1+R_t^p\right)\right\}=Var\left\{\log_e\left(1+R_t^A\right)\right\}+Var\left\{\log_e r_t-\log_e r_{t-1}\right\}$$
$$+2Cov\left\{\log_e\left(1+R_t^A\right),\left(\log_e r_t-\log_e r_{t-1}\right)\right\} \qquad (3)$$

Thus, the variance of share price total return has been split into the following three components.

a) Variance of net asset value total return.

b) Variance of the return on 'the ratio'.

c) Covariance between net asset value total returns and returns on 'the ratio'.

We define *discount volatility* to be the standard deviation of monthly return on 'the ratio', that is the square root of the second of the above components of total risk. The literature emphasises the importance of discount volatility as a component of total risk and just why discounts are so volatile forms another part of the discount puzzle.

This paper concentrates on discount volatility. More precisely, it aims to explain the cross-sectional variation in UK investment trust discount volatility. Any success in understanding discount volatility cross-sectionally may, of course, help in the quest to discover why closed-end fund discounts fluctuate so widely over time. We first review the literature relating to discount volatility and identify possible trust attributes that may influence discount volatility. We then carry out regressions to explain the cross-sectional variation in discount volatility and draw conclusions from the results.

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would occur, to give a 'fully diluted' figure. Discounts are then calculated by relating share price to fully diluted NAV.

2. LITERATURE REVIEW

Many recent studies have emphasised the importance of discount volatility as a component of total risk. Research relating to factors influencing discount volatility has concentrated on investor behaviour and can be divided into two categories: the investor sentiment hypothesis and the role of discount arbitrage traders. Most of the work relates to US closed-end funds.

The importance of discount volatility

Pontiff (1997), using monthly data from July 1965 to December 1985 on 52 US domestic-equity closed-end funds, calculates the figures in Table 1. The notation is as in the introduction above. R^R is the return on 'the ratio'.

Table 1

Monthly data 1965 - 1985

	(1) $Var(R^P)$	(2) $Var(R^A)$	(3) $Var(R^R)$	(4) $2Cov(R^A, R^R)$
Average	51.15	37.89	37.33	-25.42
Median	37.52	24.72	19.62	-7.74

He then 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 excess volatility is largely idiosyncratic and unrelated to aggregate market risk.

Bodurtha *et al* (1995) look at weekly data for 33 country funds trading on US exchanges during the 261-week period covering 1986 to 1990. They report that country fund premiums (and share prices) tend to be more volatile than domestic equity fund premiums (and share prices). There is a negative covariance between

changes in country fund premiums and their NAV returns but the weekly standard deviation of fund share price changes is still more than twice that of NAV changes.

Investor sentiment

Investor sentiment has long been seen as a possible source of discount variation over time. Zweig (1973), for example, examined the differential effect on US closed-end fund shares and their underlying net assets of trading by 'professionals' and 'non-professionals'. Lee *et al* (1991) present empirical evidence based on monthly data for 68 US domestic equity funds over the period July 1965 to December 1985, suggesting that discounts are a proxy for changes in individual investor sentiment and that the same sentiment affects the returns of small capitalization stocks and other stocks held and traded by individual investors. Their theory is compelling because other explanations seem incapable of explaining the closed-end discount puzzle, and there has been considerable argument in recent years about the validity of the theory (see, for example, Chen *et al* (1993) and Chopra *et al* (1993)).

Hardouvelis *et al* (1993), Suh (1993), Demirgures (1993) and Bodurtha *et al* (1995) use US country fund data to test for investor sentiment. The study of country funds is particularly useful for detecting movements in sentiment because fund prices are determined in the local equity market whereas underlying net asset values are determined in foreign equity markets. Country funds therefore capture the differences between local sentiment and foreign sentiment, unlike Lee *et al* (1991) who simply measure the differential sentiment between small US investors and those influencing the broader US market. All three papers report a persistent common component in the fluctuations of different country fund discounts, despite exchange rate volatility and the varying degree of investment restrictions imposed by countries. They suggest that this is because fund share prices reflect time-varying sentiments of US investors while their NAVs do not.

Ability to discount arbitrage

Hoskins (1994) concentrates on the analogy between US closed-end fund discount volatility and basis volatility in derivative securities, in that they are both a spread between two highly correlated prices. Basis volatility in derivatives markets is most

prevalent when cash-market hedges are difficult to transact, so Hoskins examines all the factors that affect the ability of discount arbitrage traders to perform their services of adding liquidity to the market for closed-end fund shares. He carries out a cross-sectional multiple regression analysis with discount volatility based on weekly intervals as the dependent variable. The two most significant explanatory variables are NAV volatility and turnover (number of shares traded as a proportion of shares outstanding) of the fund shares themselves. The former makes it more difficult to hedge the exposure to NAV. The latter is by far the most significant explanatory variable, suggesting that when turnover is high, liquidity is insufficient to keep discounts stable. Thus, low liquidity for fund shares is the primary contributor to discount volatility.

Pontiff (1996), using monthly data from July 1965 to December 1985 on 52 US domestic equity closed-end funds, as in Pontiff (1997), shows that fund share price is more likely to deviate from NAV for funds (a) with portfolios that are difficult to replicate, (b) that pay out smaller dividends, and (c) with lower market values. Although this work is concerned with the magnitude of discounts or premiums, it may also be relevant to discount volatility.

3. TRUST ATTRIBUTES THAT MAY INFLUENCE DISCOUNT VOLATILITY

In this section we discuss the choice of trust attributes to be used as explanatory variables in the cross-sectional analysis. Trust share turnover and standard deviation of NAV return are by far the most important attributes for explaining discount volatility in Hoskins' study of US closed-end funds and are therefore included in our study. Other attributes in the Hoskins study are not significant, even at the 5% level. Nevertheless, two of the remaining six variables chosen in our study, Ln(market value) and Ln(unadjusted share price), have close equivalents in the Hoskins study. Two of the variables in our study, percentage of shares held by individuals and percentage of underlying assets in the UK, are included to assess whether investor sentiment has any impact on discount volatility. Precise definitions of the eight trust attributes chosen as explanatory variables for the cross-sectional analysis are given in Table 2.

Trust share turnover

Trust share turnover (number of shares traded divided by number of shares outstanding), sometimes known as trading velocity, may be regarded as the driving force for share price movements but the extent to which this is translated into discount movements depends on the ability of discount anomaly traders to carry out their activities. Hoskins finds share turnover to be a very significant positive influence on US closed-end fund *weekly* discount volatility, contrary to what he expected, but his explanation for the result relies on the fact that closed-end funds with high share turnover tended to stand on large premiums.[3] This is not the case with the 59 UK investment trusts which form the sample to be analysed in this chapter. Of the ten trusts with the highest share turnover, only one reached a premium of more than 12% during the five year period of observation, with the other nine trusts each trading at a discount on average over the period.

Standard deviation of NAV return

Taking advantage of discount anomalies without exposure to movements in the underlying market(s) is difficult if the underlying net assets are volatile because this makes hedging the underlying net assets more difficult. But having a good hedge is all the more important in this situation because a poor hedge will translate into larger gains or losses. So volatile underlying net assets makes hedging difficult but also losses (or gains) from not hedging properly tend to be large.

Another possible reason for the influence of standard deviation of NAV return on discount volatility could be staleness of the trust share prices themselves. Such staleness would imply sluggish share price response to NAV movements, so the more volatile the NAV return the greater the discount volatility. But as discount volatility is calculated monthly in our study rather than, say, weekly, as is common in US studies, this is likely to be of minor importance.

[3] Hoskins argues that shares could no longer be borrowed for shorting once the funds stand on large premiums and the normal activity of traders adding liquidity to the market would be shut down. This would greatly reduce the liquidity for fund shares, and high trading volume could then create very large discount volatility.

Standard deviation of NAV return will depend partly on the trust's area of specialisation, as defined by the five FT-SE Actuaries investment trust sub-sectors - International, UK, Geographical, Europe and Venture Capital. International trusts should have relatively low standard deviation of NAV return. Correlations between the returns from shares held in the 'world' market are generally less than those between the returns from shares confined to a particular domestic equity market such as that of the UK, even when foreign-exchange risk is fully borne by the fund[4] (see, for example, Solnik (1996)). So international diversification reduces the standard deviation of NAV return. Geographical specialists will tend to have high standard deviation of NAV return because they are not diversified to the same extent, their underlying markets are often volatile (e.g. emerging markets) and currency movements increase NAV volatility. Venture capital trusts, which have a high proportion of unquoted assets, will tend to have low standard deviation of NAV return because valuations of the unquoted assets have varying degrees of staleness which tends to smooth NAV returns.

It is possible that trusts with volatile underlying net assets will attract trading activity[5] so standard deviation of NAV return may be positively correlated with our first explanatory variable, trust share turnover, leading to a possible multicollinearity problem.

Gearing

Gearing will influence discount volatility indirectly through its influence on the standard deviation of NAV return. But gearing also directly affects discount volatility because it reduces the denominator (NAV) in the discount to NAV calculation. This can be seen as follows:

$$\text{Discount to NAV} = (\text{NAV} - \text{Value of equity})/\text{NAV}$$
$$= (\text{Value of assets} - \text{Value of debt} - \text{Value of equity})/\text{NAV}$$

Therefore,

[4] However, currency exposure can be managed independently of the underlying portfolio and this may be carried out with the aim of boosting returns.

[5] This trading activity may be based on the fundamentals rather than discount anomaly trading.

Discount to NAV = (Value of assets - Total value of the firm)/NAV (1)

If we hold the value of the underlying assets constant and we assume that the level of gearing has no influence on the total market value of the individual firm, in line with the Modigliani and Miller (1958) and Miller (1977) proposition, it follows that the numerator of the right hand side of Equation (1) will not depend on the level of gearing. But the denominator (NAV) will be lower for higher levels of gearing. Thus, movements in the difference between the value of the underlying assets and the total market value of the firm (the discount) will be exaggerated with higher levels of gearing because discount to NAV is expressed as a proportion of NAV rather than as a proportion of total market value. It follows that gearing tends to increase discount volatility.

Ln (market value)

Low marketability of the trust shares makes discount anomaly trading less profitable. If a discount anomaly opportunity exists, there is only a small potential profit because a relatively small order will correct the pricing anomaly. Thus, the lower the marketability of the trust shares, the greater the discount trading range, and hence the higher the discount volatility.

Market value of a trust is often taken as a rough proxy for marketability (see, for example, the London Business School Risk Measurement Service). We take the logarithm of the market value so that the same percentage difference cross-sectionally in market value at different levels of market value has the same effect in the analysis.

Ln (unadjusted share price)

There may be a tendency for lower share prices to be associated with larger bid-offer spreads (as a percentage of share price), which directly increases dealing costs associated with discount anomaly trading. This implies that trusts with lower share prices will tend to have higher discount volatility. The share price to be used as an explanatory variable must be "unadjusted", that is not adjusted for subsequent capital changes. We also take logarithms so that the same percentage difference cross-

sectionally in share price at different levels of share price has the same effect in the analysis.

Unadjusted share price may be positively correlated with market value. The market value of a trust will reflect its share price history although this ignores capital changes such as scrip issues which may have occurred.

Percentage of underlying assets which are unquoted

Directors' valuations of unquoted investments[6] may be historic to some extent, only changing when 'something happens', such as a share stake changing hands. This is particularly relevant to venture capital trusts which invest mainly in smaller unquoted companies. If NAVs are stale, this has a direct effect on discount volatility as it reduces the correlation between share price returns and NAV returns. We therefore include percentage of underlying assets which are unquoted as an explanatory variable.

It has already been noted that the valuations of unquoted assets have varying degrees of staleness which tends to smooth NAV returns, so there may be negative correlation between the percentage of underlying assets which are unquoted and the standard deviation of NAV return, a trust attribute which has already been identified as a possible explanatory variable.

Percentage of shares held by individuals

According to the investor sentiment theory, small investors are assumed to deal on 'noise' rather than on the fundamentals. Rational arbitrageurs fail to offset fully the discount anomalies created by the irrational whims of small investors because such arbitrageurs have finite time horizons implying that their activities are risky and therefore limited. As there is considerable variation in the importance of individual shareholders across the UK investment trust sector, it is easy to test whether discount volatility is related to the proportion of shares held by individuals.

Percentage of underlying assets in the UK

[6] British Venture Capital Association guidelines are followed by most trusts.

There is a different type of investor sentiment that may be relevant to discount volatility, namely ‘UK market investor sentiment’. Investment trust shares are traded in the UK and may therefore be subject to investor sentiment that is specific to the UK. This UK specific sentiment may increase discount volatility if the underlying assets are held overseas but if the underlying assets are held in the UK, there will be a cancelling out effect and no consequent influence on discount volatility.

TABLE 2

Definitions of Trust Attributes Chosen as Explanatory Variables

Trust share turnover	Average over months 1/92 to 12/96 of (no of shares traded in month divided by average no of shares outstanding in that month)
Standard deviation of NAV return	Standard deviation of monthly undiluted NAV return over the months 1/92 to 12/96
Gearing	1/2*(actual gearing at 31/12/91 + actual gearing at 31/12/96) where actual gearing is the ratio of total assets (less fixed interest and cash assets) to shareholders' funds
Ln(market value)	Natural logarithm of the average over months 12/91 to 12/96 of the month-end market value of the trust
Ln(unadjusted price)	Natural logarithm of the average over the months 12/91 to 12/96 of the month-end share price (unadjusted for subsequent capital changes)
% of underlying assets which are unquoted	1/2*(% assets unquoted at 31/12/91 + % assets unquoted at 31/12/96)
% of shares held by individuals	Percentage of the share capital of the investment trust held by individual investors (1994, where possible)
% of underlying assets in the UK	1/2*(% of assets in UK on 31/12/91 + % of assets in UK on 31/12/96)

4. DATA

The sample consists of the 59 UK conventional investment trusts in continuous operation over the five years from 1 January 1992 to 31 December 1996 for which share trading volume data are available on Datastream.[7] These tend to be the largest trusts in the sector. Trusts in the sample are listed in the Appendix.

Table 3 gives data sources for all variables in the analysis.

Table 4 shows the actual values for the dependent variable, discount volatility, and for all the explanatory variables. A number of relevant points can be made from the study of Table 4:

a) The average value for discount volatility (Column 3) is 3.25% which compares with an average value for standard deviation of NAV return (Column 5) of 4.40%. So discount volatility is an important component of total risk.

b) Discount volatility varies widely across the sample, ranging from 7.22% for Dartmoor Investment Trust to 1.60% for Kleinwort Overseas Investment Trust. (Column 3).

c) International trusts tend to have relatively low standard deviation of NAV return, geographical specialists tend to have relatively high standard deviation of NAV return, and the two venture capital trusts have low standard deviation of NAV return. (Column 5). This is consistent with points made earlier.

d) There is little variation in the level of gearing across the sector. Only one trust in the sample, Dartmoor Investment Trust, has a high level of gearing. (Column 6). (This trust also has the highest standard deviation of NAV return and the highest discount volatility.)

[7] Bloomberg was used to obtain missing values in the data.

TABLE 3

Data Sources for Variables in the Cross-sectional Regression Analysis

Discount volatility	Datastream
Trust share turnover	Datastream Bloomberg
Standard deviation of NAV return	Datastream
Gearing	NatWest Securities, Daily NAV Service, Year-end 1996 County NatWest WoodMac, Daily NAV Service, Year- end 1991
Ln(market value)	Datastream
Ln(unadjusted price)	Datastream
% of underlying assets which are unquoted	NatWest Securities, Daily NAV Service, Year-end 1996 County NatWest WoodMac, Daily NAV Service, Year-end 1991
% of shares held by individuals[8]	NatWest Securities, Investment Trust Annual, 1994-95 AITC Investment Trust Directory, Summer 1994 AITC Investment Trust Index, 1992 NatWest Securities, Shareholders Over 3%, April 1997
% of underlying assets in the UK	NatWest Securities, Daily NAV Service, Year-end 1996 County NatWest WoodMac, Daily NAV Service, Year-end 1991

[8] There was some difficulty in obtaining the percentage of shares held by individuals for some trusts. In three cases, Abtrust New Dawn, Templeton Emerging Markets and Foreign & Colonial German, an estimate had to be made on the basis of the little information that was available on shareholdings.

TABLE 4

(1) trust	(2) sector	(3) discvol	(4) turnover	(5) stdevnavr	(6) gearing	(7) ln(MV)	(8) ln(UPrice)	(9) %U/Q	(10) %individs	(11) %UK
aot	internatnl	0.0164	0.0277	0.0357	105	6.1216	5.9887	3.5	9.2	41
bnkr	internatnl	0.0245	0.0372	0.0390	101.5	5.6207	5.1825	0.5	30.28	47.5
bti	internatnl	0.0205	0.0108	0.0363	101	5.0894	5.7579	3.5	16.1	54.5
bset	internatnl	0.0236	0.0318	0.0362	131	5.8280	4.5494	1	39.2	72.5
btem	internatnl	0.0205	0.0252	0.0366	99.5	4.8211	4.4183	7	4.68	57.5
edin	internatnl	0.0185	0.0231	0.0367	110	6.7498	5.6818	2	49.6	77
ensc	internatnl	0.0281	0.0201	0.0384	102	5.2075	4.7350	4.5	16.5	48.5
fcs	internatnl	0.0315	0.0357	0.0371	106	5.0260	5.0306	7.5	34.8	49
frcl	internatnl	0.0194	0.0391	0.0375	108	7.2081	5.1820	4	45.9	39.5
mnks	internatnl	0.0173	0.0208	0.0397	95.5	5.9503	6.2040	0.5	18.1	37.5
myi	internatnl	0.0255	0.0290	0.0379	101.5	5.9685	5.8039	24	53.1	48
rcp	internatnl	0.0438	0.0255	0.0261	105.5	5.7005	5.1114	29.5	16.56	24.5
scam	internatnl	0.0181	0.0266	0.0291	111.5	5.8277	5.0230	5.5	46.1	64
scea	internatnl	0.0211	0.0215	0.0377	113.5	6.2356	4.3894	7.5	18.2	52.5
scin	internatnl	0.0167	0.0273	0.0362	102	6.3774	5.3952	4.5	36.2	47.5
smt	internatnl	0.0203	0.0240	0.0397	106.5	6.6654	5.3825	0.5	23.3	51.5
sts	internatnl	0.0218	0.0221	0.0382	112.5	5.6021	4.4379	1	62.1	69
tru	internatnl	0.0324	0.0296	0.0401	107	5.7875	5.2098	5	12.44	64
wtan	internatnl	0.0154	0.0326	0.0372	102	6.6989	5.3928	2.5	12.5	60
dit	uk	0.0722	0.0627	0.0781	194.5	3.6389	4.7539	0.5	52.9	100.5
fmn	uk	0.0249	0.0330	0.0345	101	5.9980	5.6299	15	15.1	80.5
gvs	uk	0.0232	0.0439	0.0486	104.5	5.5398	5.5584	1	8.4	88
iei	uk	0.0705	0.0577	0.0609	129.5	3.8784	4.5639	15.5	19.1	91.5
mrch	uk	0.0232	0.0298	0.0427	105.5	5.5605	5.5376	1	39.5	91.5
mgs	uk	0.0416	0.0328	0.0413	87.5	4.5238	4.7844	1	12	96.5
mge	uk	0.0326	0.0380	0.0402	98	3.7150	4.8781	0	91.9	98
mut	uk	0.0212	0.0239	0.0359	95	5.6162	5.7913	10.5	61.2	84.5
smc	uk	0.0398	0.0775	0.0436	98.5	3.8471	4.7588	0	20	100
tmpl	uk	0.0247	0.0300	0.0382	97.5	5.2479	5.8043	4.5	42.2	95
thrg	uk	0.0489	0.0426	0.0464	126.5	5.3583	4.2610	19	23.5	98.5
trcd	uk	0.0218	0.0278	0.0398	109	5.6764	4.9835	0	60.5	100
try	uk	0.0608	0.0515	0.0364	116.5	4.7008	3.3660	22.5	12.4	84.5
vin	uk	0.0333	0.0211	0.0311	133.5	3.8101	4.6705	37.5	18.1	99
abd	geograph	0.0383	0.0581	0.0617	95.5	4.2508	5.2380	0	31.8	4
amts	geograph	0.0343	0.0500	0.0377	95.5	5.3580	5.5500	3.5	24.2	6.5
efm	geograph	0.0338	0.0311	0.0746	104.5	5.2881	4.2338	0.5	12	1.5
fam	geograph	0.0319	0.0530	0.0422	99	5.2807	5.6372	6.5	15.3	3
fem	geograph	0.0407	0.0254	0.0618	86.5	4.8158	4.9442	1	17.8	10.5
ffe	geograph	0.0284	0.0307	0.0654	118	6.1202	5.7068	2	12.8	0
flmj	geograph	0.0360	0.0677	0.0680	111	5.8286	5.3792	3	12.1	2
fov	geograph	0.0189	0.0293	0.0368	97.5	5.9143	5.6303	4.5	14.6	4.5
fct	geograph	0.0590	0.0607	0.0617	107.5	4.8698	4.5463	15.5	0.6	10
fcp	geograph	0.0307	0.0640	0.0497	99	5.7875	5.4642	1.5	34.5	1
gtja	geograph	0.0516	0.0535	0.0551	97.5	4.9062	5.3779	2	12	1
gtm	geograph	0.0439	0.0712	0.0720	108.5	4.2635	4.7038	0	12	0.5
gor	geograph	0.0281	0.0588	0.0561	120	6.3301	5.6746	4.5	14.3	1
kos	geograph	0.0160	0.0319	0.0379	103	5.2061	5.4264	7	18.7	14
msm	geograph	0.0259	0.0279	0.0517	109	5.3859	5.9708	7	51.9	14
oit	geograph	0.0246	0.0286	0.0378	97	4.8111	5.7826	0.5	15.7	0.5
tem	geograph	0.0456	0.0570	0.0595	89.5	5.8655	5.4133	0	34.7	9
trv	geograph	0.0441	0.0612	0.0705	102.5	4.8468	4.7808	4	31.2	1
fev	europe	0.0340	0.0440	0.0346	90.5	4.3336	5.0438	0.5	11	25
fut	europe	0.0312	0.0389	0.0404	101	5.3014	5.7279	9.5	18.4	5
fef	europe	0.0431	0.0503	0.0376	106.5	3.7712	4.5068	1.5	15.8	0
fcg	europe	0.0390	0.0597	0.0390	91.5	3.8254	4.7592	0	19.2	0.5
fcu	europe	0.0279	0.0400	0.0392	108	4.9186	5.4202	1	70.51	4
klc	europe	0.0256	0.0237	0.0364	109.5	5.1377	5.3483	17	11.6	55
elta	vencap	0.0579	0.0339	0.0263	103.5	6.2405	5.7011	64.5	8	62.5
fcet	vencap	0.0532	0.0153	0.0321	98	4.1718	4.2332	65.5	6.8	74

5. REGRESSION ANALYSIS

We now carry out regressions to explain the cross-sectional variation in discount volatility. Table 5 shows cross correlations for the explanatory variables. It confirms a number of points made earlier. There is high positive correlation between turnover and standard deviation of NAV return, and also between ln(market value) and ln(unadjusted price). Standard deviation of NAV return is positively correlated with gearing and negatively correlated with percentage of underlying assets which are unquoted.

TABLE 5

Cross correlations of Explanatory Variables

	turnover	stdevnavr	gearing	ln(mv)	ln(uprice)	%u/q	%individs	%UK
turnover								
stdevnavr	0.58							
gearing	0.14	0.30						
ln(mv)	-0.36	-0.23	-0.13					
ln(uprice)	-0.18	-0.13	-0.27	0.47				
% u/q	-0.23	-0.34	0.07	-0.05	-0.17			
% individs	-0.10	-0.07	0.16	0.04	0.11	-0.24		
% UK	-0.30	-0.34	0.33	-0.07	-0.24	0.23	0.27	

Table 6 shows the expected signs for correlations between discount volatility and each of the explanatory variables, together with the reasoning for these expected signs.

TABLE 6

Expected Signs for Correlations between Explanatory Variables and Discount Volatility

Explanatory variable	Expected sign	Reasoning
Trust share turnover driving	Positive	Trust share turnover is the central force for share price movements
St dev of NAV return	Positive	Standard deviation of NAV return proxies for both the ability and the need to hedge underlying net assets from the discount anomaly trader's viewpoint
Gearing	Positive	Gearing exaggerates discount movements because the discount is expressed as a percentage of NAV
Ln (market value)	Negative	The higher the market value the more marketable the trust shares and the narrower the discount trading range
Ln(unadjusted price)	Negative	Lower priced shares tend to have larger bid-offer spreads which increases dealing costs associated with discount anomaly trading
Percentage unquoted	Positive	Valuations of unquoted assets tend to be historic which reduces the correlation between share price returns and NAV returns
Percentage individuals	Positive	According to the investor sentiment theory, discount movements are driven by changes in the sentiment of small investors
Percentage UK	Negative	The more underlying assets held in the UK, the less impact UK specific

sentiment will have on discount volatility as there is a cancelling out effect

Table 7 shows the correlation coefficients between discount volatility and each of the explanatory variables. The signs are as expected for the first six explanatory variables but are opposite to that expected for the last two explanatory variables, namely percentage of shares held by individuals and percentage of underlying assets in the UK. The magnitude of the correlation coefficients between discount volatility and these last two explanatory variables are, however, fairly low.

TABLE 7

Correlations between Explanatory Variables and Discount Volatility

Explanatory variables	**Correlation with discount volatility**
Trust share turnover	0.55
St dev NAV return	0.44
Gearing	0.35
Ln (market value)	-0.58
Ln(unadjusted price)	-0.50
Percentage unquoted	0.38
Percentage individuals	-0.21
Percentage UK	0.03

Table 8 shows the results of the multiple regression of discount volatility on the eight explanatory variables. The signs for the regression coefficients are the same as the corresponding correlation coefficients in Table 7. The t-statistics, however, indicate that some of the explanatory variables are far more significant than others. Trust share turnover, standard deviation of NAV return, ln(market value) and percentage of underlying assets which are unquoted all have t-statistics which are significant at the 0.5% level (two-tail test). Ln(unadjusted price) has a t-statistic of -1.80 but Table 5 shows that this variable is highly correlated with ln(market value), with a correlation coefficient of 0.47, indicating possible multicollinearity in the multiple regression.

TABLE 8

Regression(1) of Discount Volatility on Explanatory Variables

Trust attribute	Coefficient	t-statistic
Constant	0.03362	2.51
Trust share turnover	0.32392	4.32*
St dev NAV return	0.33962	3.31*
Gearing	0.00007	0.99
Ln (market value)	-0.00421	-3.32*
Ln(unadjusted price)	-0.00349	-1.80
Percentage unquoted	0.00052	6.61*
Percentage individuals	-0.00003	-0.47
Percentage UK	0.00002	0.64

* significant at the 0.5% level (two-tail test)

R-square = 0.79

Gearing, percentage of shares held by individuals and percentage of underlying assets in the UK have t-statistics of 0.99, -0.47 and 0.64 respectively. It is no surprise that the t-statistic for gearing is not significant; we have already noted that there is little variation in the level of gearing accross the sample. What is perhaps surprising is that the t-statistics for the other two variables, which both relate to investor sentiment, are not significant.

Table 9 shows the results of a regression of discount volatility on the four most significant explanatory variables only, with the other four original explanatory variables excluded. The R-square is 0.76 and the constant together with the four explanatory variables each have t-statistics which are significant at the 0.5% level. It should be remembered from Table 5, however, that there is a correlation coefficient of 0.58 between turnover and standard deviation of NAV return, so the coefficients for these variables may be unreliable due to multicollinearity.

TABLE 9

Regression(2) of Discount Volatility on Explanatory Variables

Trust attribute	**Coefficient**	**t-statistic**
Constant	0.02817	3.35*
Trust share turnover	0.31570	4.15*
St dev NAV return	0.37583	3.99*
ln (market value)	-0.00543	-4.61*
Percentage unquoted	0.00058	7.72*

* significant at the 0.5% level (two-tail test)

R-square = 0.76

The t-statistic for percentage of assets which are unquoted is very high at 7.72. It is interesting to note therefore that if the two venture capital trusts, Electra and Foreign & Colonial Enterprise, which have by far the highest proportion of unquoted assets among trusts within the sample, are removed from the data set, the t-statistic reduces to 4.74. But this is still significant at the 0.5% level and the regression coefficient for this variable is roughly unchanged at 0.00059 (compared with 0.00058). Given the relatively little variation in the proportion of underlying assets which are unquoted across the sector, however, further investigation is necessary.

To test the stability of the regression coefficients in Table 9, we now split the period of observation into two equal sub-periods, 1/92 to 6/94 inclusive and 7/94 to 12/96 inclusive, and carry out regressions for these two 30 month periods separately. The results are given in Table 10. Note that all four explanatory variables have t-statistics which are significant at the 0.5% level for the regressions in respect of both 30 month periods, as was the case for the full five year period. It is clear, however, that the coefficient for "percentage of underlying assets which are unquoted" is unstable, being 0.00080 in the first period and much lower at 0.00020 in the second period.

TABLE 10

	Period 1/92 to 6/94		Period 7/94 to 12/96	
Trust attribute	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**
Constant	0.03011	2.51	0.03483	5.38*
Trust share turnover	0.23121	2.82*	0.22526	3.45*
St dev NAV return	0.49108	4.04*	0.26383	3.38*
In(market value)	-0.00667	-4.17*	-0.00494	-5.21*
Percentage unquoted	0.00080	7.37*	0.00020	3.42*
	R-square = 0.72		R-square = 0.64	

When all eight explanatory variables are included in the regressions, each of the four explanatory variables in Table 10 are significant at the 0.5% level for both 30 month periods. The other four explanatory varibles are not significant at this level, although Ln(unadjusted price) is significant at the 1% level in the second period. In particular, "percentage of shares held by individuals" is not significant in either period (t-statistics -0.50 and -0.49) and "percentage of underlying assets in the UK" is also not significant in either period (t-statistics 0.30 and -0.02). This confirms the earlier observation that both small investor sentiment and UK specific investor sentiment have little impact on discount volatility when defined with monthly intervals.

6. PRINCIPAL COMPONENTS

To assess possible problems in the collinearity of our explanatory variables, we carry out a principal component analysis of the eight original explanatory variables for our sample of 59 trusts. Eigenvalues and factor loadings are shown in Table 11 and Table 12 respectively.

TABLE 11

Eigenvalues

	Eigenval	% total Variance	Cumul. Eigenval	Cumul. %
1	2.207	27.586	2.207	27.586
2	1.842	23.028	4.049	50.614
3	1.365	17.059	5.414	67.673
4	0.864	10.801	6.278	78.474
5	0.569	7.115	6.847	85.590
6	0.435	5.440	7.282	91.029
7	0.412	5.151	7.694	96.181
8	0.306	3.819	8.000	100.000

TABLE 12

Factor loadings

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
TURNOVER	-0.826	0.147	-0.026	-0.018	-0.244	-0.231	-0.413	-0.107
STDNAVR	-0.825	0.207	0.159	0.269	0.026	0.094	0.116	0.396
GEARING	-0.336	-0.551	0.389	0.583	-0.017	0.013	0.154	-0.260
LOG_MV_	0.578	0.431	0.204	0.497	0.228	0.093	-0.359	0.046
LOG_UP_	0.422	0.658	0.238	0.187	-0.399	-0.304	0.212	0.017
%UQ	0.321	-0.502	-0.557	0.274	-0.452	0.169	-0.097	0.129
%IND	0.131	-0.140	0.832	-0.304	-0.286	0.287	-0.111	0.035
%UK	0.314	-0.764	0.292	-0.035	0.107	-0.401	-0.095	0.223
Expl.Var	2.207	1.842	1.365	0.864	0.569	0.435	0.412	0.306
Prp.Totl	28%	23%	17%	11%	7%	5%	5%	4%
	28%	51%	68%	78%	86%	91%	96%	100%

The first four factors represent 78% of the total variation, but there is only a gradual reduction in the contribution to total variance from the factors, so multicollinearity would not appear to be a problem.

Factor 1 represents 28% of the total variation. It is heavily loaded towards turnover and standard deviation of NAV return. Factor 1 scores for all the trusts in our sample

are illustated in Figure 1. Note that the factor 1 scores for all the international trusts are positive and for nearly all the geographical trusts they are negative. This suggests that inclusion of binary variables for 'international' and 'geographical', indicating whether or not trusts are international or geographical specialists, as explanatory variables in the regression analysis may help to explain the cross-sectional variation in discount volatility. The results are given in Table 13.

TABLE 13

Regression(3) of Discount Volatility on Explanatory Variables

Trust attribute	**Coefficient**	**t-statistic**
Constant	0.02111	2.38
Trust share turnover	0.34753	4.51*
St dev NAV return	0.49859	4.69*
Ln (market value)	-0.00514	-3.87*
Percentage unquoted	0.00059	7.78*
Geographical	-0.00521	-1.90
International	0.00112	0.40

* significant at the 0.5% level (two-tail test)

R-square = 0.78

As 'international' is clearly not significant, we now exclude it from the regression, but we retain the explanatory variable 'geographical'. The results of the regression are given in Table 14

.

TABLE 14

Regression(4) of Discount Volatility on Explanatory Variables

Trust attribute	**Coefficient**	**t-statistic**
Constant	0.02066	2.36
Trust share turnover	0.33977	4.59*
St dev NAV return	0.49785	4.72*
Ln (market value)	-0.00488	-4.21*
Percentage unquoted	0.00058	8.06*
Geographical	-0.00566	-2.27

* significant at the 0.5% level (two-tail test)

R-square = 0.78

The sign of the 'geographical' coefficient is negative and is significant at the 2.5% level. This suggests that geographical specialists tend to have *lower* discount volatility than other trusts, other things equal. Note, however, that this variable is correlated with trust share turnover (corr coeff = 0.41) and with standard deviation of NAV return (corr coeff = 0.62).

7. CONCLUSION

Discount volatility is generally an important component of total risk for closed-end funds, but there is considerable cross-sectional variation in the magnitude of this discount volatility. These are interesting aspects of the closed-end fund discount puzzle which have received little attention in the literature, particularly as regards UK investment trusts.

In this paper, we try to explain the cross-sectional variation in discount volatility for the UK investment trust sector. The sample consists of 59 UK conventional investment trusts in continuous operation over the five years from 1 January 1992 to 31 December 1996. Discount volatility is calculated using monthly intervals. Four

explanatory variables are highly significant - trust share turnover, standard deviation of NAV return, ln(market value) and percentage of underlying assets which are unquoted. The likely reasons for the significance of these variables are as follows. **Trust share turnover** is the central driving force for share price movements. **Standard deviation of NAV return** proxies for both the ability and the need to hedge underlying net assets from the discount anomaly trader's perspective. **Market value** proxies for marketability, and the more marketable the trust shares, the narrower the discount trading range. **Percentage of underlying assets which are unquoted** is significant because valuations of unquoted assets tend to be historic which reduces the correlation between share price returns and NAV returns.

There is no evidence that either small investor sentiment or UK specific sentiment has any impact on discount volatility.

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APPENDIX - Sample for Cross-sectional Analysis of Discount Volatility

Trust	Mnemonic
Abtrust New Dawn Inv Trust PLC	abd
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 Empire Sec & General TstPLC	btem
Dartmoor Investment Trust PLC	dit
Edinburgh Dragon Trust PLC	efm
Edinburgh Investment Trust PLC	edin
Electra Investment Trust PLC	elta
English & Scottish Investors PLC	ensc
Fidelity European Values PLC	fev
Fleming American Inv Trust PLC	fam
Fleming Continental Euro Inv Tst	fut
Fleming Emerging Mkts Inv Tst PLC	fem
Fleming European Fledgling Inv Tst	fef
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 emergingMktsInvTstPLC	fct
Foreign & Col Enterprise Tst PLC	fcet
Foreign & Col Invest Trust PLC	frcl
Foreign & Col. German Inv Tst PLC	fcg
Foreign & Col. Pacific Inv Tst PLC	fcp
Foreign & Colonial Eurotrust PLC	fcu
Foreign & Colonial Smaller Cos PLC	fcs
G.T.Japan Investment Trust PLC	gtja
Gartmore Emerging Pacific Inv Tst	gtm
Govett Oriental Inv Trust PLC	gor
Govett Strategic Inv Trust PLC	gvs
INVESCO English & Intl.Trust PLC	iei
Kleinwort Charter Inv Trust PLC	klc
Kleinwort Overseas Inv Trust PLC	kos
Merchants Trust PLC	mrch
Monks Investment Trusts PLC	mnks
Moorgate Smaller Co's Inc Trust PLC	mgs
Morgan Grenfell Equity Inc Tst PLC	mge
Murray Income Trust PLC	mut
Murray International Trust PLC	myi
Murray Smaller Markets Trust PLC	msm
Overseas Investment Trust PLC	oit
RIT Capital Partners PLC	rcp
Scottish American Investment Co PLC	scam
Scottish Eastern Inv Trust PLC	scea
Scottish Investment Trust PLC	scin
Scottish Mortgage & Trust PLC	smt
Securities Trust of Scotland PLC	sts
Smaller Companies Inv Trust PLC	smc
Temple Bar Investment Trust PLC	tmpl
Templeton Emerging Markets IT PLC	tem
Throgmorton Trust PLC	thrg
TR City of London Trust PLC	trcd
TR Pacific Investment Trust PLC	trv
TR Property Investment Trust PLC	try
TR Smaller Companies Inv Trust PLC	tru
Value & Income Trust PLC	vin
Witan Investment Co PLC	wtan

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