A False Perception?
The relative riskiness of AIM and listed stocks
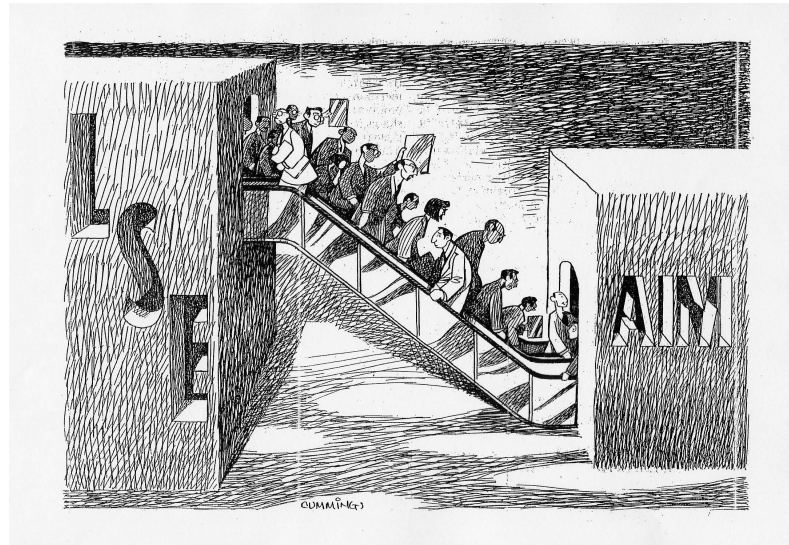
John Board
Alfonso Dufour
Charles Sutcliffe
Stephen Wells
ICMA Centre, University of Reading

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Executive Summary

The purpose of this research was to examine the truth behind the perception that the AIM market was systematically more risky than the Official List (OL) market in comparable stocks. The main finding of the research is that while at a superficial level AIM stocks may seem more risky than comparable OL stocks, as the analysis is refined to ensure that the comparisons focus purely on the effect of being on different markets the difference shrinks and finally disappears. This conclusion concurs with the current market practitioner view that there is no significant risk differential.

AIM has been a considerable success. Even by its survival over 10 years it has succeeded in relation to similar markets in other countries. During that period it has seen rapid growth and during the last 5 years has emerged as the market of choice for smaller, newer companies in the UK and increasingly beyond the UK.

The research comprised three elements – an interview program, a literature review and an extensive empirical analysis using 5 years of high frequency trading data. The interview program suggested four conclusions:

- While AIM has less demanding minimum requirements than the OL (for example in terms of free float) the Nominated Advisors almost always insist that new AIM companies exceed minimum standards, in practice, are similar to those of the OL.
- While AIM, in its earlier days may have been more risky, its growth in recent years and the diversity of companies attracted to the market mean that risk is now much lower and AIM companies are not significantly different in risk terms from comparable companies on the OL.
- Age (since admission) of company is an important factor in determining risk, but after a relatively short time, perhaps 2 to 3 years, its importance disappears.
- In the AIM (and OL) market there is segmentation between larger, investable companies and a non-investable group – typically very small companies. The non-investable portion is high-risk by its nature and because it is difficult to trade.

The literature review showed a surprising lack of research into small cap markets. Fifty-four published pieces were identified, most of which related to the now defunct Neuer Markt and/or to IPO pricing. The main relevant results from the review were that:
- Switches between markets have not been associated with changes in risk
- There are a number of risk-related characteristics of companies – in particular, size, age and industry – that tend to be related to market.

Whole market analyses of comparable stocks that did not switch markets.
- Simple ratio analysis comparing the annual volatility of AIM and OL stocks showed AIM to be substantially more volatile than the OL - ranging from 2 to 3 times that of comparable OL stocks.
- Normalising for the age difference to exclude the age effect. The results suggested that larger stocks are considerably more volatile than smaller stocks and also that AIM stocks were significantly more volatile than comparable OL stocks.
- Multi-variate regression analysis used the main risk-related variables (size, industry, age and market) to explain differences in volatility. Results suggested that AIM stocks were significantly more volatile, though the difference was far smaller than that given by the simple ratio analysis. However the strong correlation between age and market makes it difficult for a regression to distinguish the impact of the two variables.

A significant number of stocks (160) have moved between the two markets. These allowed study of a single event, a market switch, abstracting from other company-specific factors. Again a succession of progressively more complex analyses were applied

- Simple switchers analysis using ratios of pre and post-switch volatility to assess the impact of the switch with the following results:
  - o OL to AIM switchers, 55% of these have greater volatility on AIM.
  - o AIM to the OL, 45% of these have greater volatility on AIM.
  - o Overall switching stocks showed 10% higher volatility on AIM

These results are consistent with the notion that AIM is viewed as slightly more risky.

A more complex analysis of the switchers was conducted by using high-frequency data to construct GARCH models studying the dynamics of volatility. In this analysis, 11% of the switchers show a significant change in volatility with a majority showing lower volatility in the AIM period.

This analysis was extended in two ways

- Including risk-free principal trades (crosses done through market makers). These were a significant part of trading and proportionately more important for AIM. The effect is to smooth the price history of stocks consistent with the use of risk-free principal trades to reduce price impact. The results were:
  - o 19% of switchers had higher volatility in the AIM period
  - o 42% had lower volatility in the AIM period
- Applying more robust significance tests – i.e. being more demanding in deciding whether statistically small difference represented real differences. The results were:
  - o Only 1% of switchers showed increased volatility in the AIM period
  - o Almost 10% showed lower volatility in the AIM period

The main conclusion that comes out of this analysis is that the perception that AIM has higher volatility than the OL is perfectly understandable, but incorrect. Our simpler analyses generally found a large difference between volatility of AIM and OL stocks. However as we moved to more complex analyses differences in volatility between AIM and the OL are very small, usually not significant statistically and tend, if anything, to indicate a slightly lower volatility when on AIM.

1   Introduction

The AIM market has been a considerable success for the London Stock Exchange. Since its opening in 1995 it has grown steadily to reach over 1,000 listed companies with a market value exceeding £30bn by the end of 2004. This success has come even though recent years have not been kind to most second-tier markets and several have closed. AIM's success is said to be partly a reflection of the regulatory standards and also because it's marketing has targeted a wide range of companies rather than focussing on high-tech companies which have suffered since 2000.

The ICMA Centre at the University of Reading was commissioned to conduct a study into the continuing perception that AIM, although buoyant, remains riskier than corresponding stocks on the LSE's Official List, OL, although AIM stocks can obviously be expected to be more risky than blue-chip stocks.

2   Activities

The project team undertook three distinct activities:

1. A brief interview program among selected market participants. The purpose of this was not to gain an exhaustive understanding of the AIM market, but to gain an indication of factors that are relevant in looking at the risk of AIM stocks.

2. A review of the academic literature relating to smaller company markets. The objective of this review is to summarise existing, related research and to gain insights into the factors that might be relevant in assessing and explaining risk.

3. An empirical study of the volatility of returns in the two markets. The empirical study was the main element of the research which was guided by information gathered from the literature and interviews. Our empirical approach was conditioned by our wish to examine the question of "perceived" risk and we therefore undertook a number of analyses of increasing sophistication designed first to identify apparent risk and then to see whether any apparent risk persisted through more sophisticated examination. We therefore looked at the following:
    a. Basic analysis of relative volatility;
    b. Basic analysis with allowance for size, age and liquidity;
    c. Regression analyses with multiple variables;
    d. Analysis of stocks that switched from one market to the other ("switchers");
    e. A more sophisticated analysis of switchers using GARCH procedures;
    f. Variations on this to include statistical estimation of the effects.
    The results of these tests are presented in sections 7 onwards.

3   Interviews

The short interview program covered brokers, dealers and fund managers. The interviews suggested a number of key factors to consider in the subsequent research:

- AIM Stocks can informally be divided into two groups: the larger "investable" companies and a non-investable group. The latter is high-risk both by nature and because it is very difficult to trade. A similar division exists in the corresponding section of the OL.

- Age is an important factor, in that stocks which have been listed for less than two to three years are seen as riskier. However, there is no difference in risk between stocks of greater age than this.

- In practice, nominated advisors impose requirements on AIM companies that are as demanding as those imposed on OL stocks. Advisors believe that investors, and their own reputation, would suffer if AIM was perceived as subject to lower requirements. In particular, while the free float requirements are lower on AIM the nominated advisors require new AIM companies to have the same free float as new OL companies.

- The end of the lock-in period and the exit of Venture Capitalists may cause volatility. However, the volatility around these events is mainly a function of a small number of large transactions and is short-lived as it reflects market impact rather than fundamentals.

- Historically AIM has been more risky, but this has been compensated by higher returns. More recently as AIM has matured and become a broader market the riskiness has reduced. Now there is little, if any, perceived difference in risk between AIM and the OL.

- In general, no criticism of AIM as a market place was offered. It appears to be perceived as a success and was repeatedly cited as the market of choice for new issues.

4   Literature review

The full literature review is attached as Appendix A. The main findings are:

- There is almost no published research on risk in small cap markets.

- Our search found 54 empirical studies specifically of small cap markets which have been reviewed for this research. The studies have focussed on the mainland European markets, particularly the Neuer Markt (which has subsequently been closed). In addition there are studies of the NASDAQ market, but these tend to cover the range of stocks on NASDAQ (including many very large companies) and focus on differences in trading mechanisms between NASDAQ and other US equity markets. As such they are not relevant to this research.

- The main focus of much of the international research is IPOs and their pricing – reflecting the fact that issuance is the main purpose and function of many small cap markets and that many have not lasted long enough to support studies of volatility.

- Relatively little work has been conducted on the UK market. There have been five studies of IPO pricing on the USM and two on techMARK. There have been no studies on IPOs specifically on the AIM market, and only one study looks at the volatility of AIM stocks (using 1996 data).

- A number of studies have investigated the change in total risk or systematic risk (beta) associated with movements of stocks from the small cap market to the main market. With one exception these studies look at movements from the Nasdaq OTC market to AMEX or the NYSE. These studies have not detected any effects.

- A number of studies of volatility, all relating to the Neuer Markt, have shown very high volatilities. However, these studies are poorly specified and none offers any comparative data for the main market.

The literature did suggest a number of avenues for enquiry relating to differences between the AIM and OL markets:

- Firms listed on AIM tend to be smaller than firms on the OL. It is well known that small capitalization firms have higher total risk than similar large capitalization firms. Small companies are less diversified than large companies, and may in extreme cases effectively be a bet on whether there is oil or gas at the bottom of a hole in the ground. Eckert (2002) found that German firms, who choose to list on the Neuer Markt, rather than the 1st Market Segment, are riskier, smaller and younger.

- Firms listed on AIM tend to be younger than firms on the OL. Young firms tend to be riskier than well established firms because their business model may be unproven, and the staff less experienced.

- Firms listed on AIM tend to be in industrial sectors, like mining and oil and gas, which are inherently risky.

- AIM has less stringent regulatory requirements than the OL. For example, on AIM there is no requirement for a minimum proportion of the shares to be in public hands, no trading record requirement, no requirement for shareholder approval of transactions, and no minimum market capitalization.

- Firms traded on AIM tend to be less liquid than those on the OL with less frequent trading, and this may result in fewer, larger price movements.

- The steady flow of information to the market may be less well developed for small capitalization companies. Small companies may make fewer announcements, leading to fewer, but larger, information disclosures. They may also be followed by fewer analysts, who discover and publicize relevant information on the firm. If risk is quantified using a measure such as the standard deviation of returns, then this lumpiness of the information flow will also increase measured risk.

- Firms listed on AIM tend to have a smaller free float than firms on the OL. Since the ratio of tradable shares to total shares is lower for firms listed on AIM, the price impact of news tends to be larger for AIM companies, leading to higher measured risk.

- Firms listed on AIM are subject to the expiration of the lock-up period, which can lead to return volatility around the expiration date.

- Firms listed on AIM may be more highly geared than firms on the OL. In which case, even if the income streams of two companies are equally risky, the share price of the more highly geared company will be more volatile.

- Venture capitalists are more likely to be involved with firms listed on AIM, and they may create price volatility when they end their involvement.

- A trading mechanism involving market makers produces greater bid-ask bounce, leading to more volatile prices, than if prices are set by an order-driven process (e.g. SETS, SETS-MM). Since small firms on AIM use market makers, while some firms on the OL use an auction mechanism (where bid-ask bounce will be smaller), AIM price volatility will be higher.

- If the distribution of returns for shares listed on AIM is more negatively skewed than for shares in the OL (i.e. AIM stocks have a higher proportion of large downward price

movements), there will be more big negative returns on AIM, and this may give the impression that AIM is riskier.

Where the data allows, we have incorporated these avenues of enquiry into the empirical analysis.

5   Preliminary data analyses

The Stock Exchange supplied us with data on individual trades in AIM Stocks and in OL stocks for the five year period 1 January 2000 to 31 December 2004, and quote data for SEAQ stocks (all AIM stocks and most OL stocks at that time) for the same period. In the event we decided not to use the quote data as experience suggests that for many less-liquid stocks the quotes are wide and vary infrequently. Most trading takes place at prices negotiated within the quotes so the trade data gives a more accurate picture of prices.

We also obtained data from the LSE website showing entry date and industry group. The LSE also supplied data on stocks exiting from the AIM market including those that migrated to the OL.

5.1   Data and sample selection

The first step was to define a sample of AIM and OL stocks for analysis. Using data from the Exchange's website we identified 1035 AIM stocks and 1460 OL stocks. This dataset was cleaned by removing:

* non-UK AIM stocks and fixed income OL stocks

* stocks which were shown as having zero market value.

* large OL companies. At the end of January 2005 the largest market value of an AIM company was £777m. We took £800 million as the cut-off for OL stocks.

* Investment Trusts and Other Financial industrial sectors. Investment trusts were strongly represented in the OL stock but almost absent on AIM, and the converse was true of Other Financials. These companies were different in that the Investment Trusts were generally conventional trusts investing in listed companies whereas the Other Financial in AIM appeared more like venture capital trusts, which might be expected to be more risky than conventional trusts.

These removals resulted in the "eligible" sample of stocks shown in the following table.

End Jan 2005	UK OL	AIM
Total companies	1460	1035
Less non-UK	-	120
Less Fixed Interest	156	-
Less Zero Market Value	52	18
Less Market Value > £800m	203	-
Less Eligible Inv Trusts (Ind'l sub-sector 850)	247	23
Less Ineligible Inv Tsts (Ind'l sub-sector 890)	156	3
Less Other Fin (Ind'l sub-sector 879)	17	110
Sample "Eligible" stocks	**629**	**761**

Taking these stocks we conducted some basic analyses. Our intention was to try and identify groups of stocks, which were similar in terms of variables that had been suggested as important

determinants of risk but were differentiated by market segment. The variables that have been suggested as important are: Size (market value), Industry, and Age.

5.2 Market value

Figure 1 shows the distribution of AIM and OL stocks by market value (for stocks with market value below £800m). We concluded from this that the main "heartland of AIM for comparisons purposes was in the £5m to £200m bands. We felt that stocks smaller than this would probably be too illiquid for any serious analysis and stocks above this were not typical of AIM. This heartland represents 533 of the eligible AIM stocks and 264 of the eligible OL stocks and most of the following analysis is based on this group.
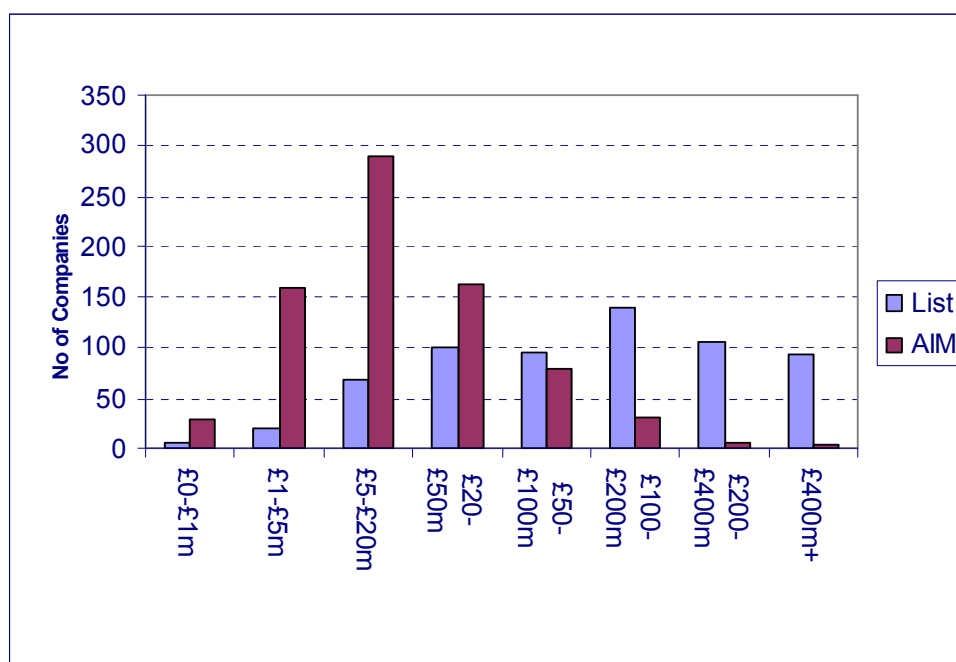

Figure 1:   Market Capitalisation Bands (January 2005)

5.3 Industry groupings

Figure 2 shows the eligible companies by major economic group as defined by FTSE International.
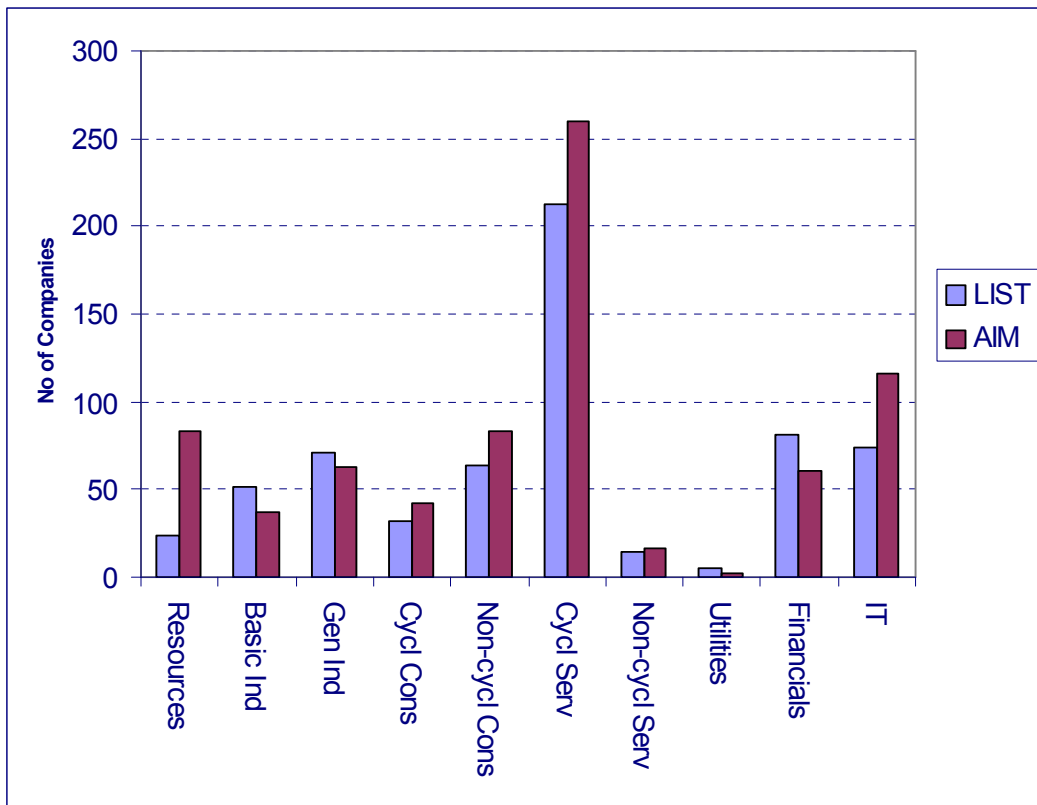
Figure 2: **Industry Groupings AIM V OL**

While there are few stocks of this size in the Utilities and Non-cyclical Services groups there is otherwise a substantial representation of AIM and OL stocks in each sector. We also examined a more detailed classification given by the 36 FTSE Industrial Sectors (shown in figure 3), however dividing the sample into so many groups leaves too few stocks in each group for useful analysis and, so, we use the broader groupings in the empirical analysis.
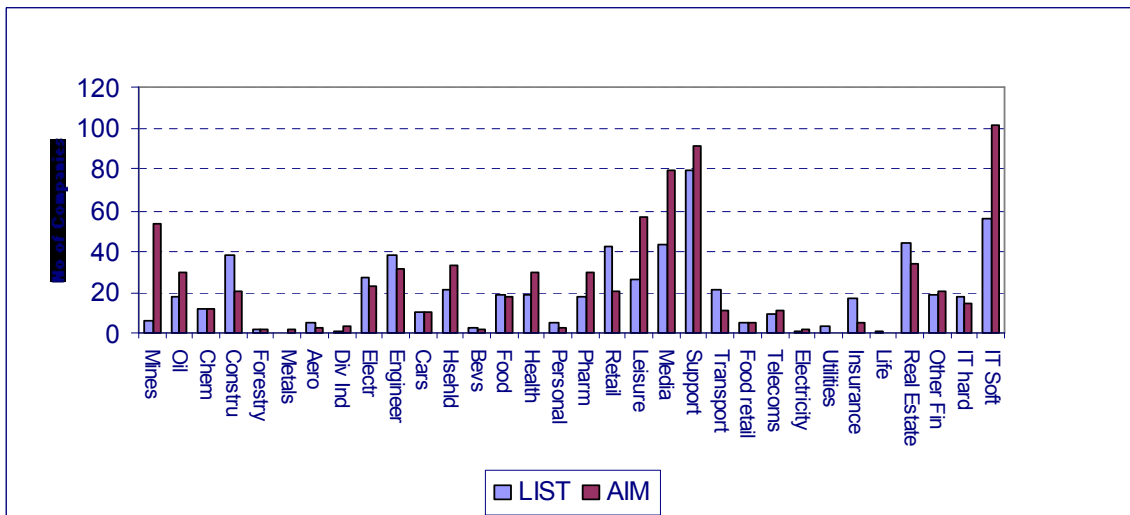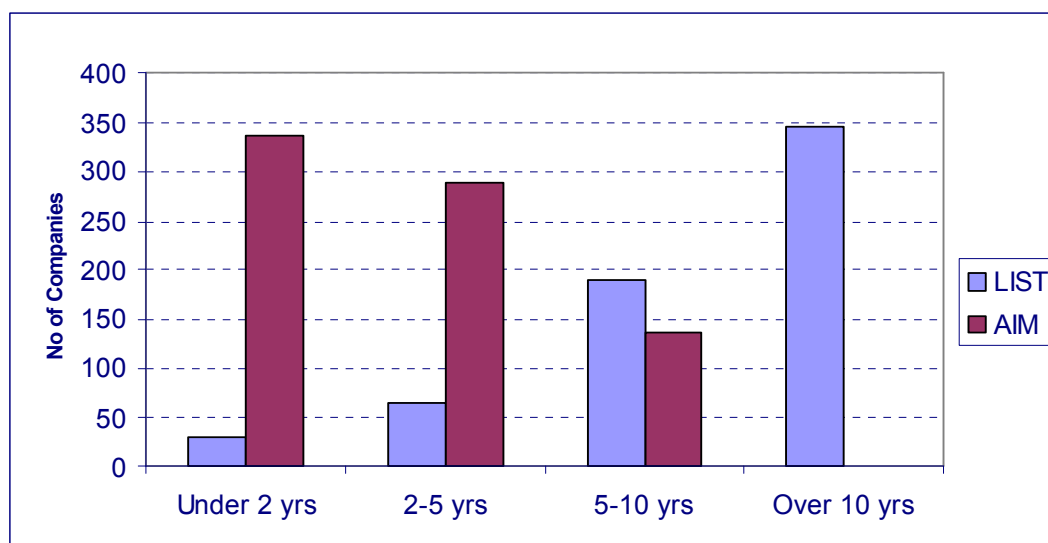

Figure 3: **Companies by Industrial Sector**

5.4 Age

Finally, figure 4 shows the age profile (measured as the number of years since admission to the market) of stocks in the two markets.

Figure 4:   Age Distribution AIM v OL

Figure 4 shows a sharp split - 44% of current, eligible AIM stocks have joined the market in the last two years and almost all, 82%, in the last 5 years. This is obviously a testament to the marketing success of AIM, but raises three issues for comparative analysis:

- Since age and AIM membership are so strongly linked, it will be difficult to disentangle the relative impact of the two factors.

- Survivor bias – it could be that the relative youth of current AIM Stocks reflects the fact that many of the older AIM stocks have failed. If this were the case, then our focus on stocks in existence at a particular date might understate the true risk of the market (since failed stocks would not be represented). To assess this possibility, the following table shows the history of stocks leaving AIM. This shows that the number of stocks leaving AIM was 376, split between 138 being taken over, 93 joining the OL (mainly in the early years as the table below illustrates) and 145 for miscellaneous reasons (including but not exclusively through failure).

| Number of companies leaving AIM | | | |
Moved to OL	Taken Over	Other	Total Leaving
1996 2	4	2	8
1997 20	10	6	36
1998 25	9	13	47
1999 14	13	13	40
2000 17	21	8	46
2001 6	14	12	32
2002 4	13	25	42
2003 3	30	47	80
2004 2	17	13	32
2005 0	7	6	13
Total 93	138	145	376

This suggests that AIM stocks were as likely to be taken over as they were to fail, though the relative number of departures for "Other reasons" has risen since 2000.

- A comparative analysis that was mainly focussed on older AIM companies would not be useful from a policy viewpoint since most AIM stocks are new and most investor interest is in newer stocks.

Figure 4 shows that AIM stocks are typically much younger than those on the OL, with the average age on the OL some 13 years greater than for AIM (the average age of the OL stocks we examine was 14.5 years, while that of AIM stocks was 2.7 years). This means that any straightforward analysis will be unable to distinguish the effect of age from an 'AIM effect'. It is clear that there is a very strong relation between age and market membership. To control for this effect, we examine stocks' relative age (i.e. the difference between the stock's actual age and the average age of stocks in its market). The following figure shows this effect (the vertical axis shows the number of company/months of data, and negative numbers indicate stocks which are below their market's average age).
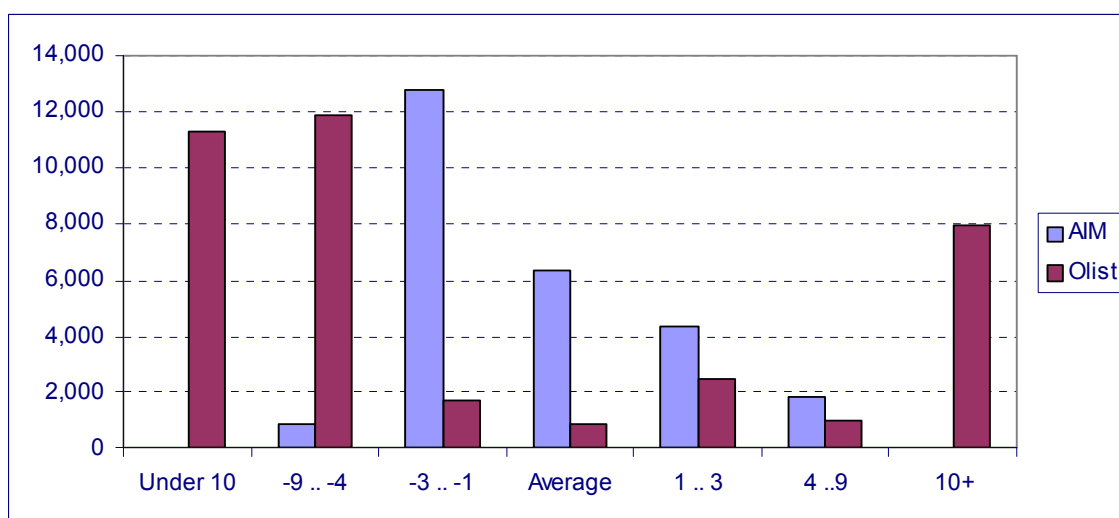

Figure 5: Relative ages of AIM and OL stocks

5.5 Liquidity

The following graph and table show the number of company months (i.e. months in which there was trading for a company) for stocks in the central market value bands (i.e. with capitalisations between £5m and £200m) in which given numbers of trades occurred. This shows that AIM stocks trade somewhat less frequently than do corresponding OL stocks overall, the two markets have both have similar numbers of illiquid company months (49 trades per month corresponds to fewer than three trades per day).
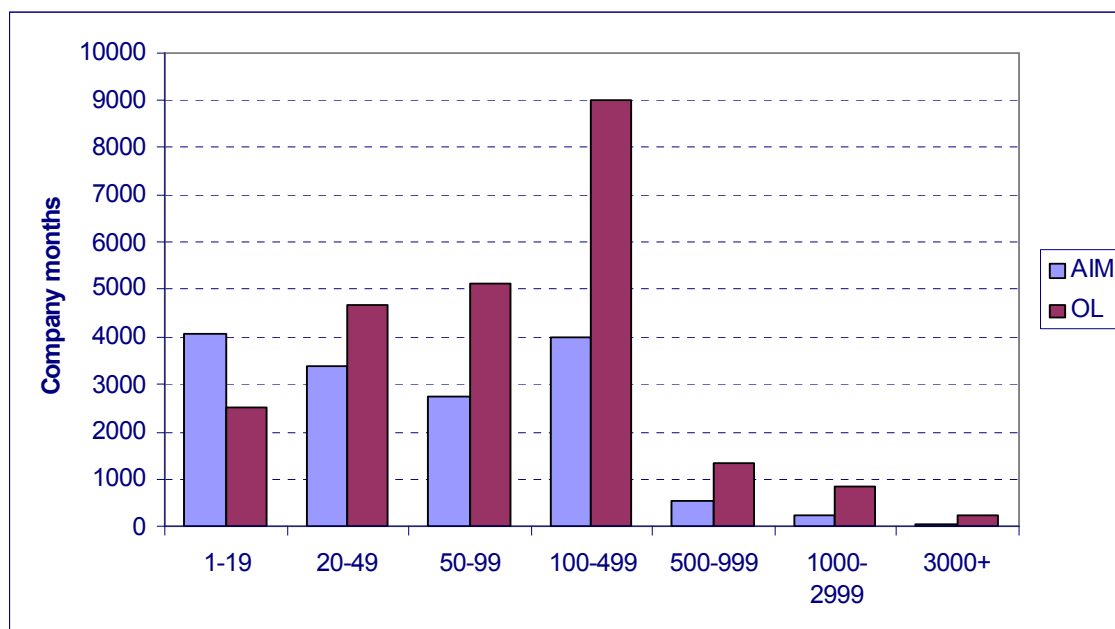
Figure 6:   Trading frequencies AIM v OL

This shows that, within the value bands examined, no stocks traded less than daily on average, and that the distribution of liquidity between the markets is broadly similar.

6   Volatility estimation

The request from the AIM Group was for straightforward measures of volatility. Our discussions with practitioners confirmed that they tended to use such straightforward measures – particularly the standard deviation of returns. As a result, we have generally avoided the use of complex measures, but concentrated on measures which are generally accepted as representing volatility.

To calculate the volatility values, we based the computations on returns, not raw prices, and calculated monthly volatility in a number of ways. Trade prices, rather than quote prices were used for reasons described above. To avoid biases caused by trade reporting at the close, we define a 'representative price' as being the price of the trade executed closest to 11:30 each day. Volatility is notoriously difficult to measure and is particularly troublesome in the case of illiquid stocks for which a regular series of trade prices may not be available. Because of this, we analysed a number of measures using the basic returns data.

6.1 Standard Deviation

 The most popular volatility measure is simply the standard deviation of daily returns over the month.   This is defined as

$$\text{StdDev}_{M} = \frac{1}{D} \sum_{d=1}^{D} \left(R_{id} - \bar{R}_{iM} \right)^{2}$$

where M indicates month, i indicates the firm, D indicates the total number of days within the month and d indicates the days within the month.

6.2 Garman-Klass

This measure was proposed to measure volatility when the data is not rich or frequent enough to allow use of the standard deviation. The measure requires only four values per month: the opening, closing, high and low prices for the period (all measured in logarithms). The measure is then

$$GK_{it} = (O_{it} - C_{it-1})^{2} + 0.5(H_{it} - L_{it})^{2} - 0.3862(C_{it} - O_{it})^{2}$$

6.3 Squared Returns

This measure is used only when almost no data exists, either because the data is incomplete or is highly aggregated, or the asset trades so infrequently that it is not possible even to compute the Garman Klass measure

$$Rsq_{iM} = \left(\frac{P_{iM} - P_{i(M-1)}}{P_{i(M-1)}} \right)^{2}$$

where P_{iM} is the price of share i in month M.

6.4 Trading frequency

The final measures of risk are those based not on price but on trading activity. These measures may capture a different aspect of risk – that relating to liquidity, market depth and the possibility of immediacy. We considered: the number of trades, the number of shares traded and the money value of such trading.

6.5 Period

The period for which volatility is calculated matters. For example it is important to calculate monthly volatilities if the objective is monthly rebalancing of a portfolio. We focus on monthly figures because this is the period most often used in the industry, and because illiquid stocks may not trade often enough to support more frequent estimates.

6.6 Portfolios

It is important to note that the basic rule of risk is that the risk of a portfolio is almost always less than the average of the risks of the constituent stocks. This insight forms the basis of modern portfolio theory and explains why "diversification pays". This research was specified to examine the volatility of individual stocks and therefore does not examine portfolio effects (although these are briefly shown below).

7   Basic analysis of relative volatility

In order to present a convenient summary of the results, we show the ratio of the volatility on AIM to that of the OL. To do this, we followed the approach below:

1.   Calculate the monthly volatility for each stock for each month

2.   Calculate the average volatility in each month for each market by averaging the volatilities for all stocks in the given market

3.   Calculate for each month the relative volatility as the AIM value divided by the corresponding OL value

4.   Finally, average the relative volatility figure over time.

Thus, relative risk measures above unity suggest that AIM is more volatile than the OL. It should be noted that this is not the only approach that could be used and that the statistical behaviour of the mean of the ratio of average standard deviations is not well defined – hence we do not attempt to assess the statistical significance of the results in this section.

Figure 7 shows the results for the volume measures described above.
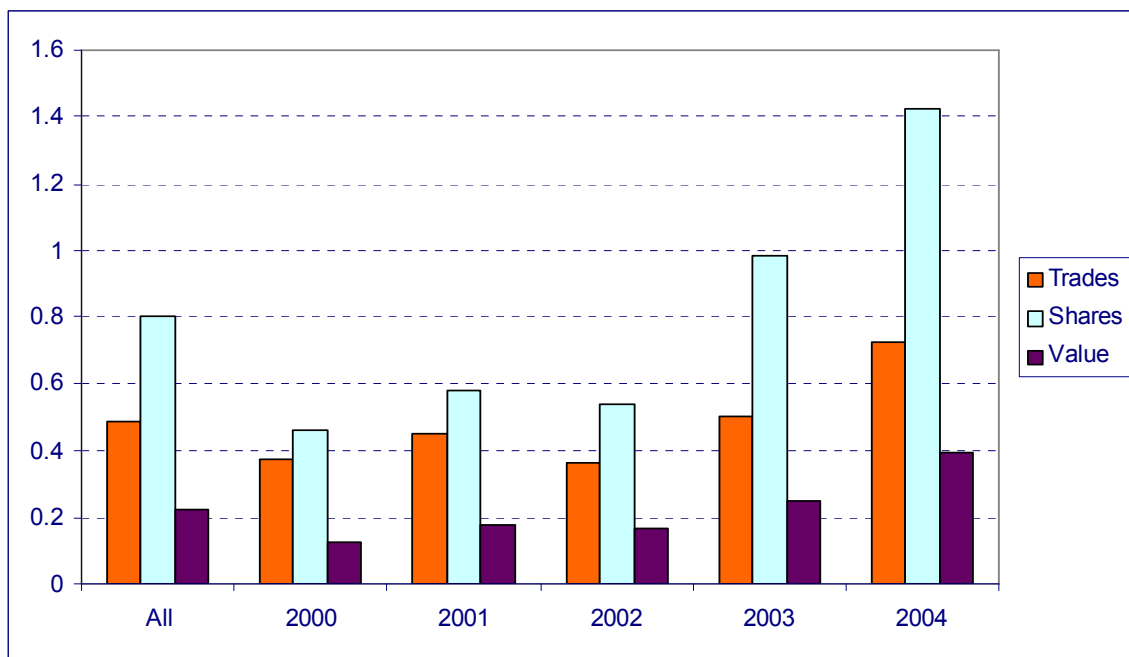
Figure 7:   Relative trading on AIM v OL

The results demonstrate that for two measures of volume – value of trading and bargains – the OL stocks in the sample traded significantly more frequently than the AIM stocks. For shares traded AIM volumes were below those of OL stocks but have increased in the last two years and in 2004 exceeded shares traded OL stocks.

Using the same ratio approach we compared the relative volatility of returns, and figure 8 shows the relative volatilities (using the three measures described above) of AIM and OL stocks in the sample.
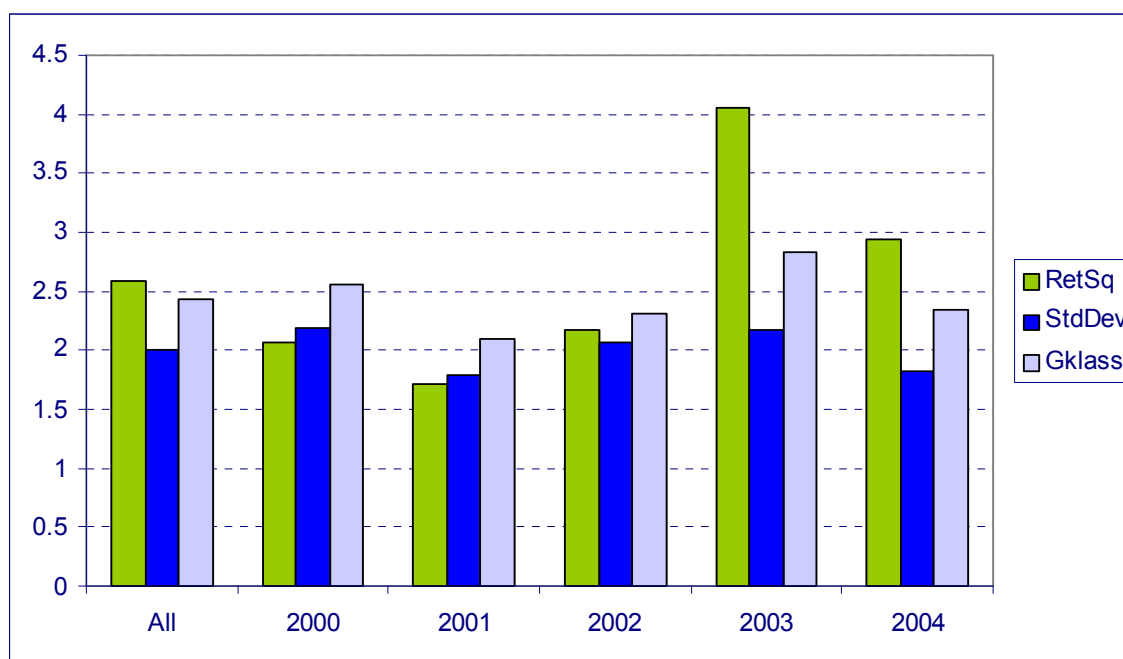
Figure 8:   Relative volatilities of AIM and OL stocks

In all years this shows AIM stocks to be substantially more volatile than comparable (in terms of size) OL stocks. The level of volatility of AIM stocks ranged from 2 to 3 times that of comparable OL stocks in every year and was particularly marked for one measure in 2003. Overall, volatility of AIM is much greater, by a factor of two or three.

We conclude that a simple comparison of volatilities is consistent with the perception that AIM stocks are riskier than corresponding OL stocks. In the next section, we consider whether this difference may be attributed to factors other than simply the market on which the stock has chosen to list.

8   Relative risk adjusting for size, age and liquidity

In this section, we consider the impact of other variables that are associated with AIM stocks. One of the striking features of the data is the unequal distribution of stocks reported in earlier sections in regard to:

* Size – OL stocks are generally much larger than those on AIM
* Industry – there were some differences between the industry profiles of the markets
* Age – OL stocks are much older than AIM stocks.
* Liquidity – AIM stocks are often relatively illiquid

The interviews with practitioners suggested that these factors might all contribute significantly to stocks' risk. However, the significant differences between the distribution of age and sizes for AIM and OL stocks means that the simple analysis presented below should be seen as indicative, rather than definitive.

8.1 Size

Figure 9 shows the relative volatility (measured as the ratio of the standard deviations of the two markets) for different market value bands.
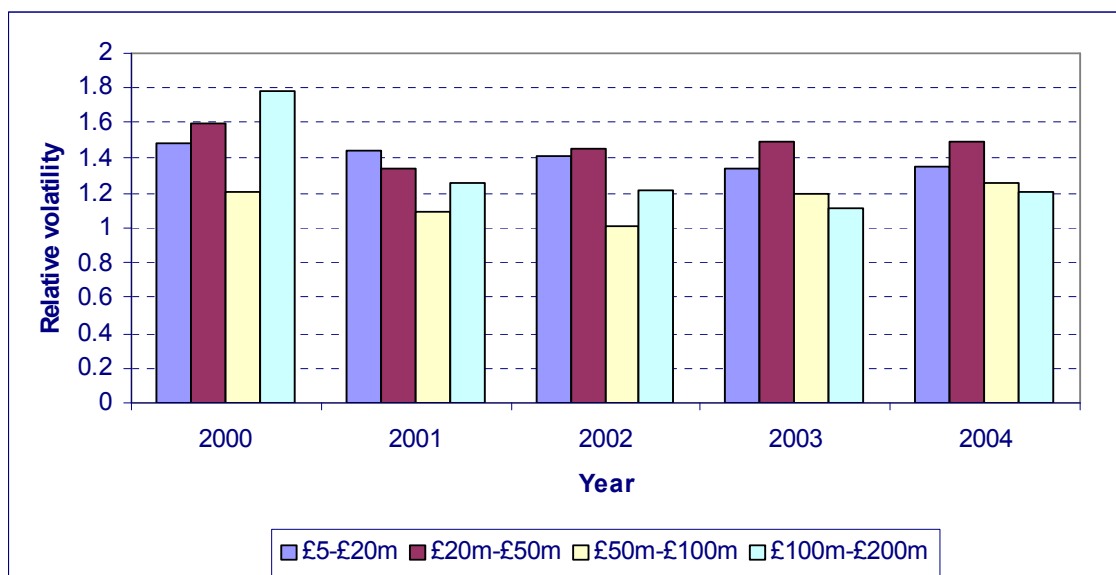
Figure 9:   Relative volatility by market capitalisation

The results show that there are differences between the volatility which are related to size. However, they also show that, in all size bands, AIM volatility is greater than OL volatility.

8.2 Industry

Figure 10 shows the analysis of the relative volatility (measured by the standard deviation) for the different industry groups.
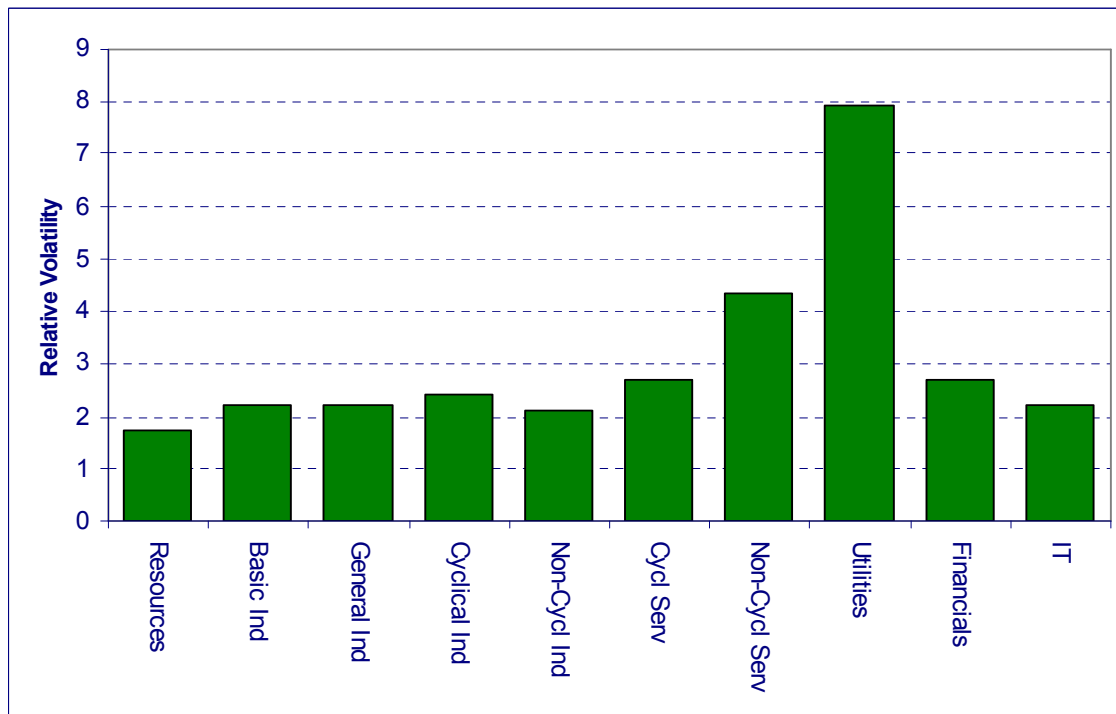
Figure 10:   Relative volatility by Industry

Overall, these results show AIM as having roughly double the volatility of the comparable OL stocks in most industrial sectors. It is clear that the utilities sector has much greater relative

volatility than do the other sectors. It may be that a greater investigation of this section would shed further light on the question of the differing risks between the markets. Figure 2 shows that there are very few AIM and OL stocks in this sector, and so this outlier is probably due to small sample bias.

8.3 Age

Figure 11 shows an analysis of relative volatility by age. The results suggest that relative volatility declines with age. This is consistent with the views expressed in the interview program – that age was a risk factor for about two to three years. However the different age distributions of AIM and OL stocks means there are relatively few AIM stocks in the older groups and relatively few OL stocks in the younger groups.
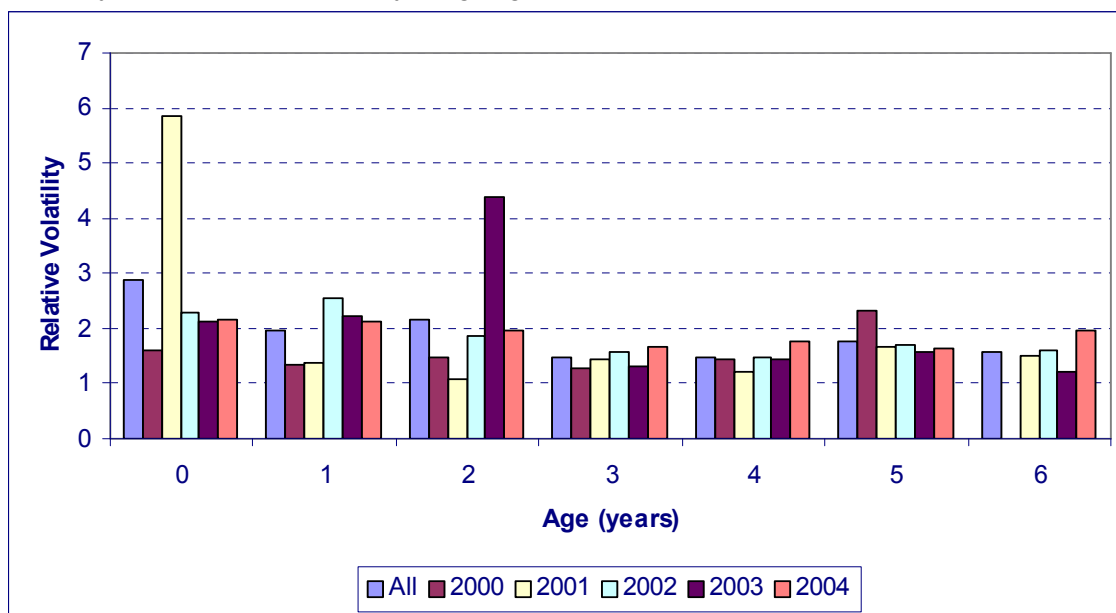

Figure 11:   Relative volatility by firm age

8.4 Liquidity and market volatility

One factor not considered so far is market volatility. Figure 12 shows the risk (measured by the monthly standard deviation of returns) of four groupings of number of trades-per-month for the two markets (AIM and the DOL), as well as the risk of the FTSE 100 index for the same period. The vertical axis shows percentage standard deviation per month.

This demonstrates that, whatever the differences in risk between AIM and DOL, they are minor compared to the differences between them and the FTSE 100. Comparing the related groups, the highest volatility AIM stocks are in the lowest liquidity category, where (as the table quantifies) AIM is almost twice as volatile as the corresponding OL group. However, the most important implication of the graph, and table, is to show how relatively small are the differences between AIM and its peer-group OL stocks when compared to the difference in volatility between either of the groups of small stocks and the market for the largest listed stocks (i.e. those in the FTSE 100). Of course this comparison greatly overstates the true differences in volatility as the FTSE is a diversified portfolio, while the AIM/OL samples are for individual stocks.
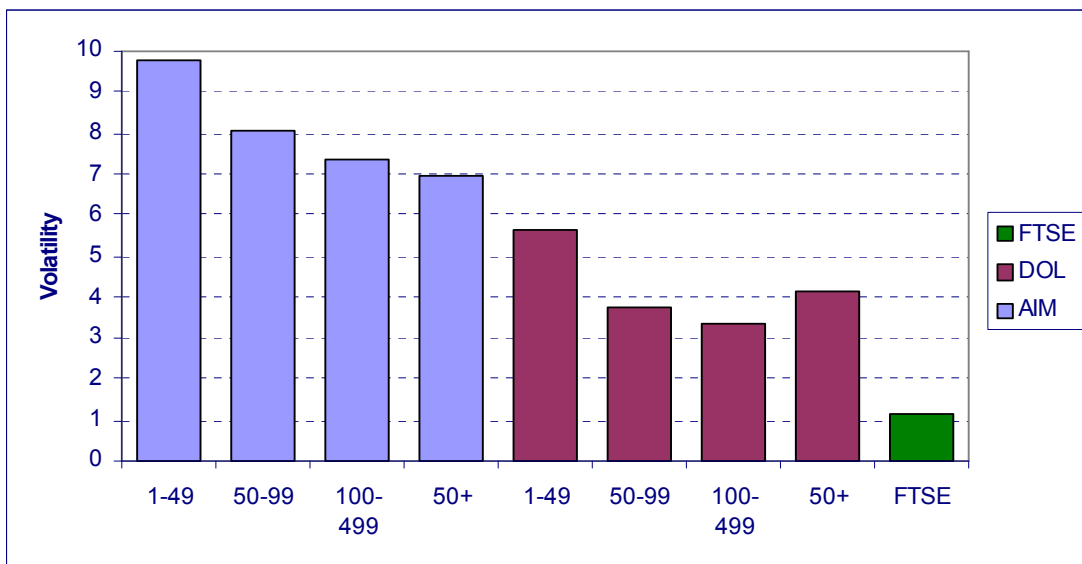
Figure 12:   Volatility by trading frequency

9   Portfolio effects

As noted above, this research is specified in terms of individual stock's volatilities. It therefore examines total risk, rather than the systematic (or beta, or market) risks of portfolios of such stocks. To highlight the size of the risk reductions in portfolios, the following graph shows the risks of all stocks on each market as the average of individual risks and also as the risk of an equally weighted portfolio of those stocks. The FTSE 100, itself a portfolio albeit value weighted, is shown for comparison.
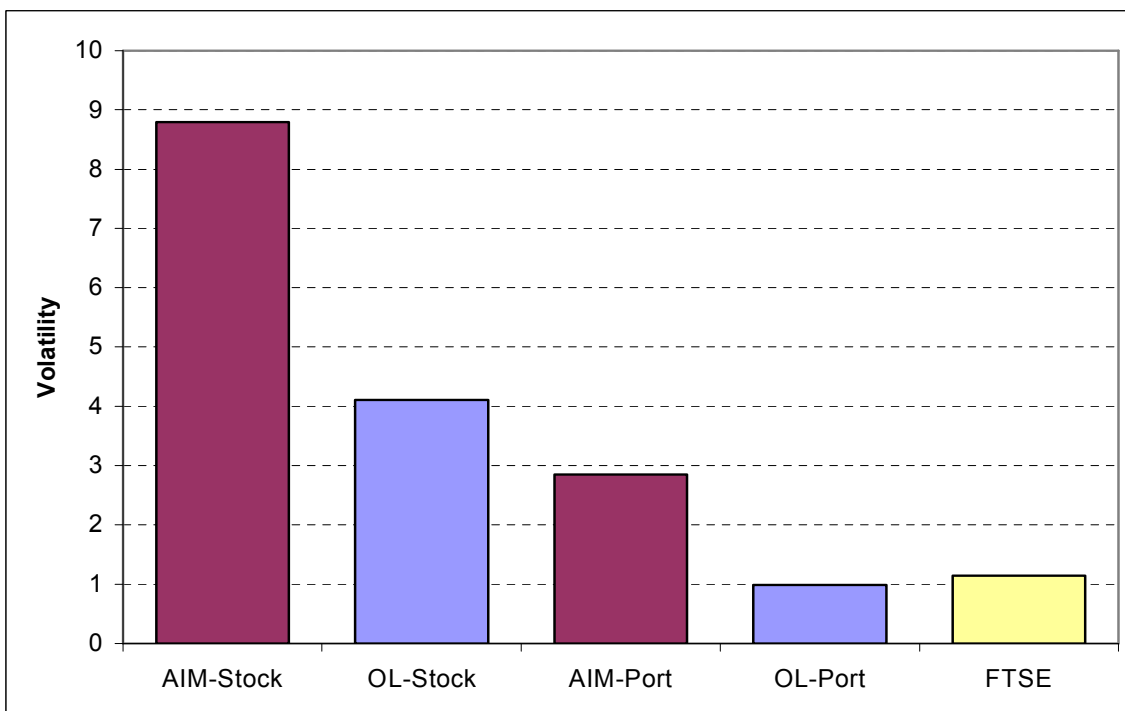
Figure 13:   Individual v portfolio risks for AIM and DOL stocks

As can be seen the systematic risk of each market is of the order of one-third the total risk.

10 Regression analyses with multiple variables

This analysis attempts to explain the volatility of stocks by constructing a model in which volatility is a function of a number of other variables – such as size, industry and age. One of the variables represents whether a stock is on AIM or the OL. If this variable shows a significant causal effect on volatility then we would conclude that volatility was linked to the market on which a stock is traded.

10.1 Regression model

Our literature review identified twelve possible reasons why AIM stocks might be expected to be riskier than those on the OL. These reasons can be grouped into those that relate to the firms that list on AIM, and those that relate to the market structure on AIM. For some of these effects, we have sufficient data to analyse the variable directly. Others are less tangible, and have no satisfactory measure. Others are simply part of the 'AIM Effect'. The following table summarises these effects.

Effect Type	Detail	Measure
Firm Related	Size - Firms on AIM tend to be smaller than firms on the OL	Size bands
	Age – AIM firms tend to be younger than OL firms	Age relative to market norm
	Industrial Sector – AIM firms tend to be in riskier industrial sectors	1-digit FTSE classification
	Liquidity – AIM firms tend to be less liquid than OL firms, which may bias volatility upwards	Number of trades
Market Related	Regulation – AIM has less demanding entry requirements and regulations than the OL	The 'AIM Effect'
	Information – Fewer analysts follow AIM firms and less disclosure is required	
	Market Structure – AIM's trading mechanism may induce volatility (e.g. bid-ask bounce)	
Other	Free float – AIM firms may have a smaller free float than OL firms	No data available
	Lock-in – AIM firms may experience volatility around the expiration date	
	Venture Capital – AIM firms may be volatile when VCs close their investment	
	Skewness – Differences in the distribution of return may induce volatility	
	Gearing – AIM firms may be more highly geared than OL firms.	

In addition, we also constructed dummy variables (which take the value '1' if the event is true and zero otherwise. For example "Year1" is equal to 1 in 2001 and zero in 2000, and 2002-2004) to provide additional control:

- The stock – allowing for stock specific effects
- The Year – allowing for annual effects
- Market Volatility – the volatility of the FTSE 100 index in the given period
- Exit – if the stock is within six months of a takeover or other market exit

		Number of Dummy Variables
Stock	One per stock	856
Year	To control for different periods - one per year	5
Industry	1-digit groups	10
MV Band	4 groups	4
Age	Stock age relative to industry average	5
FTSE	Market volatility - standard deviation	n/a
Near Exit	Within 6 months of stock death?	1
Switch	Does stock switch markets	1
AIM	If on AIM	1

The regression is based on some 32,800 company months and the stocks in market value bands 3-6 (£5m-£200m as explained above).

10.2 Regression results

The following table shows the results. Only coefficients that were statistically significant are shown (those significant at 10% are shown in italic, all others are significant at 1% significance).

	Coefficient			
	Standard Deviation	Garman-Klass	Squared Return	Trade Value
Intercept	0.04557	*0.01614*		0.78106
Trades	0.00001	0.00003	0.00011	0.01008
Value 4	-0.01223	-0.00836		
Value 5	-0.01884	-0.01098	*-0.01915*	0.36457
Value 6	-0.02286	-0.01571	*-0.02630*	0.92458
Industry 6				*-0.77235*
Industry 8		*-0.00903*		
Industry 9		*0.00956*		
Age 1				*0.29778*
Age 2		*0.00679*		
FTSE Risk	0.72620	1.03738	0.63443	-1.69548
2001	*-0.00616*	-0.00643		-0.97394
2002				-1.39755
2003		*-0.00571*	0.02555	-1.57619
2004	-0.01652	-0.01793	*-0.01764*	-1.60013
Pure AIM	**0.01614**	**0.00879**	*0.02067*	
R-squared	0.07535	0.11735	0.03702	0.55204

The columns headed "coefficient" show the size of the effect. Here, a coefficient of, say 0.01 means that volatility is 1% higher in the presence of this effect than it would be without. Thus, for example, stocks in MV band 4 are, on average 1.223% LESS risky than the corresponding stocks in band 3 when measuring volatility by the standard deviation.

Key results include:
- The number of trades per month is significant for the standard deviation risk measure, indicating that volatility increases with trading volume.

- The market value indicators are negative and increasing in size for higher value bands. This means that volatility decreases, the larger is the company's capitalization.

- Industry groups have a very modest effect on volatility. Only groups 6, 8 and 9 (Cyclical Services, Utilities and Financials) have any effect on average volatility. Of note is that group 0, resources, has no effect on volatility.

- Company age is only modestly important with minor, but insignificant increases in volatility associated with very young companies.

- Contemporaneous market risk, measured by that of the FTSE 100, has a weakly positive effect. When the stock market is volatile, both AIM and the OL stocks tend to be more volatile.

- The year has an effect, with lesser volatilities associated with the later years.

- The individual company effects have been omitted from the table, but reveal nothing.

- There are no effects for companies which switch markets.

- Companies within 6 months of death do not exhibit unusual volatility.

- The explanatory power of the model is very low – but this is not unusual for panel datasets such as this.

- Finally, the variable 'AIM', which indicates whether a given stock is listed on AIM shows that volatility is somewhat greater for AIM stocks. However the effect is not numerically large. Being on AIM increases volatility by 1% to 2%.

11 Switching stocks

This section refines the analysis further by considering stocks which switched from one market to the other. The benefit of this is that many of the control variables are unnecessary, as we are comparing one company to itself.

Thus, we examine the volatility of companies switching from AIM to the OL, and from the OL to AIM during the sample period. This analysis allows us to control for company specific characteristics when comparing volatility on different markets.

We select all companies that switched markets during the sample period. We then exclude those that both switched exchange and changed their ISIN (because the ISIN change may be associated with structural changes). We also excluded the small number of companies that switched more than once. This results in a sample of 160 'switchers': 130 companies switched from the OL to AIM, and 30 companies switched from AIM to the OL.

	All Sample in Jan 05		Switchers	
	N.	Average Mkt Cap	N.	Average Mkt Cap Switch Time
AIM	760	£29.33m	30	£193.28m
OL	629	£183.52m	130	£17.25m
	1389		160	

Clearly companies that switch from AIM to the OL have greater market capitalisation than the average AIM stock, and companies that switch from the OL to AIM have lower market capitalisation than the average OL stock.
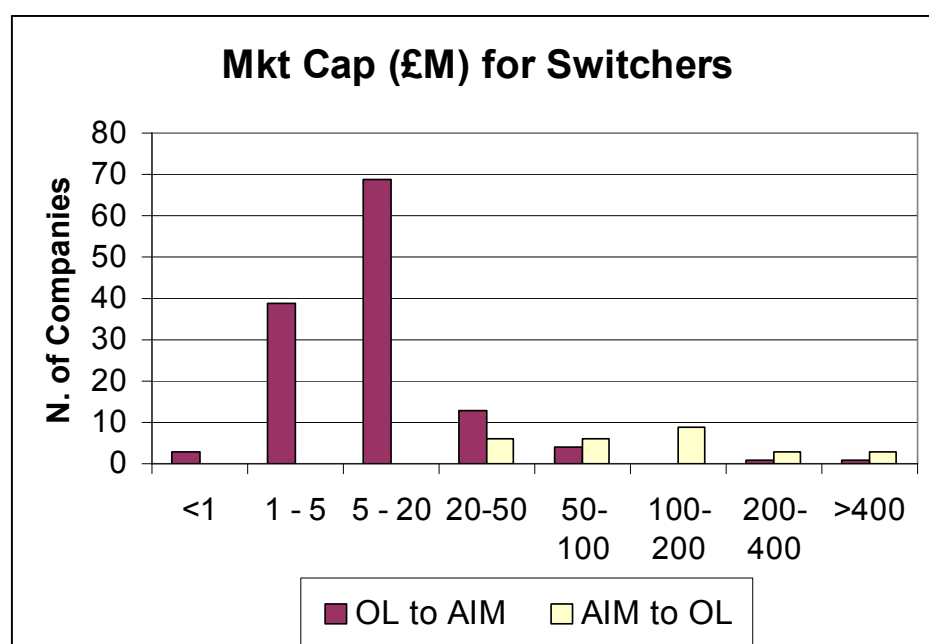

Figure 14:   Capitalisation of switching stocks

11.1 Relative volatility analysis
In this ratio analysis of the "switchers", we used the following procedure

1. for each stock which switched between markets once (either AIM-OL or OL-AIM), we defined the 'switch' period as the three month period centred on the switch date (e.g. one month before the switch, the switch month and the month following).

2. We then considered the two six month periods surrounding the switch period and defined these as the 'pre-switch' and post-switch' periods.

3. For each switching stock we calculated the average monthly volatility during the pre and post-switch periods.

4. We then calculated the relative volatility for each switching stock – defined as the average volatility in the post-switch period divided by the average volatility for that stock during its pre-switch period. Thus, a decline in volatility following a switch from one market to another would be revealed as a relative volatility of less than one. Note that this measure is independent of the absolute volatility of the stock – we are focussing only on changes in volatility.

5. We then averaged the relative volatilities across stocks both in total and based on the year of the switch (e.g. for all stocks which switched market in 2001).

The following diagram summarises the results
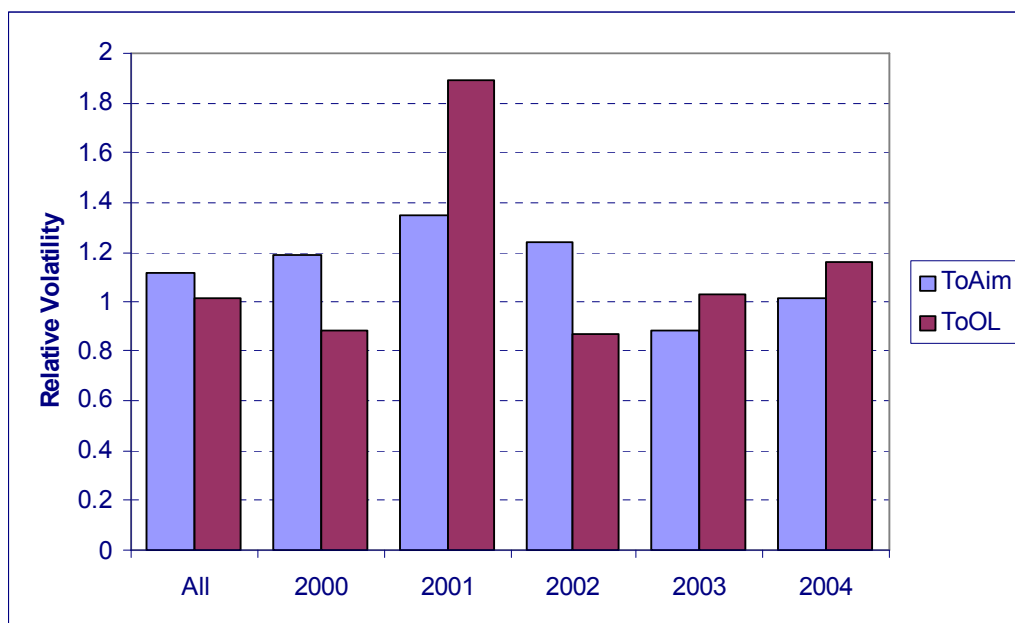
Figure 15:   Relative post to pre switch volatilities

This shows that on average stocks switching to AIM from the OL experienced a 10% increase in volatility, while those switching from AIM to the OL experienced a 1% increase. Equally, the later years show a much more varied set of results, with switchers to AIM in 2003 experiencing a decrease in volatility. In three of the five years analysed, switchers to the OL experienced larger rises in volatility than did switchers to AIM.

It should however be noted that, although there were 130 switchers to AIM, there were only 30 switchers to the OL. So on average, each "ToOL" column in the figure represents only 6 stocks, and the results will be heavily influenced by the behaviour of individual stocks.

11.2 Switchers' risk relative to the market

We defined the event day as the day of the market switch, and conducted an exploratory analysis by creating a grey period of 5 trading days (a week) around the event day. Data for these two weeks was discarded. Then we formed a sample window of 63 trading days (3 months) around the grey period. We used this period to compute pre- and post-event volatilities. We selected a 3-month trading window around the event because this maximises the number of market switches that we can study.

Because we compared the volatility for the same company during different time periods, we wanted to control for overall market volatility. In order to do this we used the ratio of stock specific volatility to market volatility, where the volatility of the FTSE100 index was used to approximate market volatility.

We define
- AIM to Market Risk = AIM Volatility/ FTSE 100 Volatility
- OL to Market Risk = OL Volatility/FTSE 100 Volatility

Having controlled for market risk in this way, we then computed the relative risk measure used in the previous part of the analysis (measuring volatility in 3 different ways), and counted the number of companies for which the relative risk (AIM to OL) was greater than 1 (see figure below). Thus, the diagram shows the proportion of stocks for which the relative risk measure was greater than one.
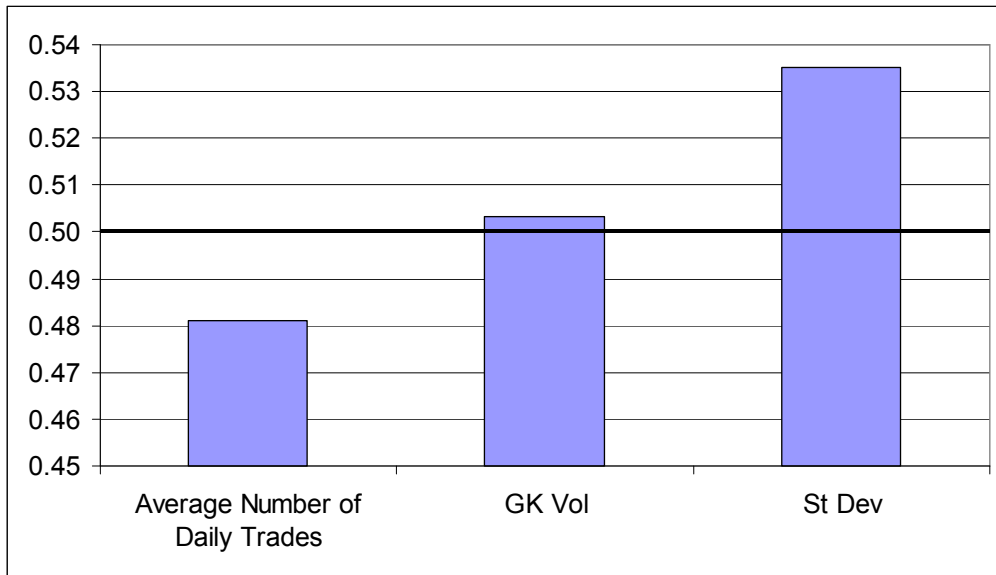
Figure 16:   Switchers risks between markets

This shows that when companies trade on AIM they tend to have
* a lower number of trades per day,
* marginally higher Garman-Klass volatility,
* a higher standard deviation of daily returns.

12 GARCH analysis of switching stocks

In order to confirm the results of the preliminary analysis with a more formal econometric model for volatility, we estimated GARCH models using daily returns and assessed the AIM effect. Namely, we measured whether the volatility for stocks that switch market is statistically significantly larger when the stock trades on AIM than when the stock trades on the OL.

12.1 Introduction to GARCH

Total individual stock return volatility can be decomposed into a market-wide risk component and a company specific risk component. Following traditional asset pricing theory and the Capital Asset Pricing Model (CAPM), academics and market participants have mostly focused on the market risk component (beta risk) of a stock's volatility. However, recent studies (Campell, Lettau, Malkiel and Xu, 2001) argue that the company specific component has been the main driver of volatility variations in recent years. Furthermore, company specific volatility is important when studying the effects of particular events such as market switching. "Events affect individual stocks, and the statistical significance of abnormal event-related returns is determined by the volatility of individual stock returns relative to the market or industry" (Campbell, Lo, and MacKinlay, 1997).

The analysis involved constructing a series of daily log-returns, $Ret_{i,t}$ for each sample stock using the price of the last trade of the day. We checked for the robustness of our results by also using reference prices sampled at 11:30am. As a proxy for the market returns we used the FTSE 100 index, and constructed another series of daily log-returns, FTSE Ret.
We estimated the following model:

$$\operatorname{Ret}_{it} = \beta_0 + \beta_1 \operatorname{Ret}_{FTSE,t} + \varepsilon_{it}$$

where we assume that the disturbance is normally distributed with variance σ_{it}^2. In addition, we assume that the conditional variance of the disturbances σ_{it}^2 is modelled as a linear function of lagged squared disturbances $\varepsilon_{i,t-1}^2$ and lagged conditional variances $\sigma_{i,t-1}^2$:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 \sigma_{i,t-1}^2 + \alpha_3 I_{i,t}$$

where I_{it} is a dummy variable which is equal to one when company i trades on AIM, and zero otherwise. The specification above allows us to test whether there is a significant shift in the level of the volatility of company i when it trades on AIM.

12.2 GARCH results

The changing pattern of volatility for the whole market is shown in figure 17, which shows that the volatility of the market decreased significantly in the last part of the sample period.
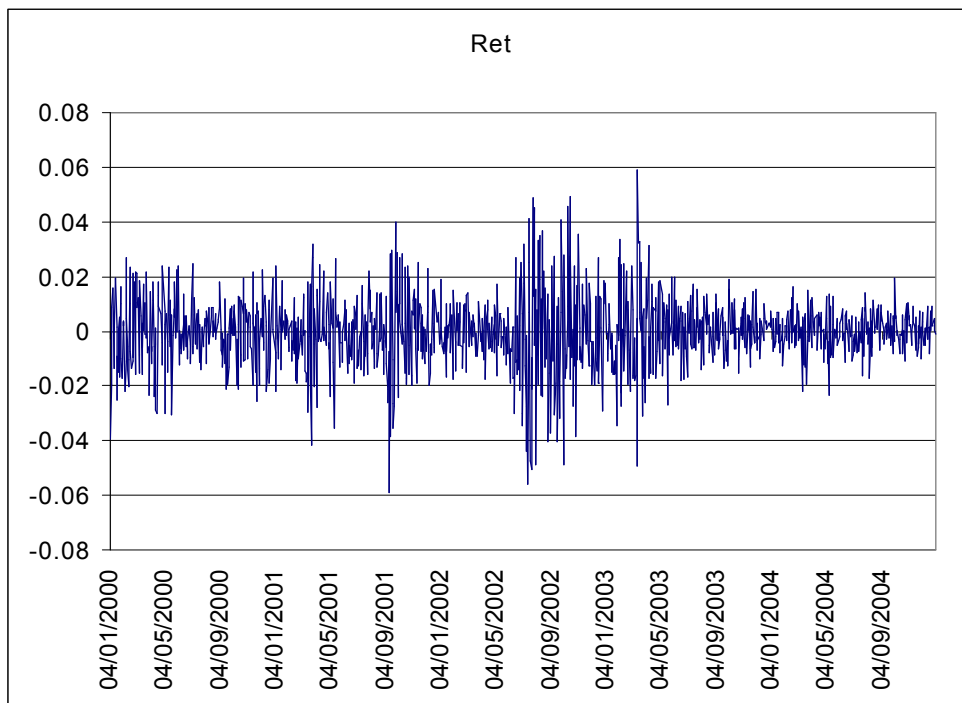
Figure 17:   GARCH results for returns on the FTSE index

The results from the GARCH model estimation show that only 37 of the switching companies had a significant increase in volatility when trading on AIM, while 65 companies had a significant decrease in volatility when trading on AIM.

Two examples are shown in figure 18 below. The first shows a company for which returns on the OL are more volatile than the returns on AIM, and the second is a company for which returns on AIM are significantly more volatile that the returns on the OL (always controlling for market volatility). The vertical line indicates the time when the company transfers from one to the other market and the plot immediately below shows the FTSE-100 index's volatility at the same time.

Airsprung Furniture Group (GB0000119940)	Aquarius Group (GB0000513548)

FTSE 100	FTSE100
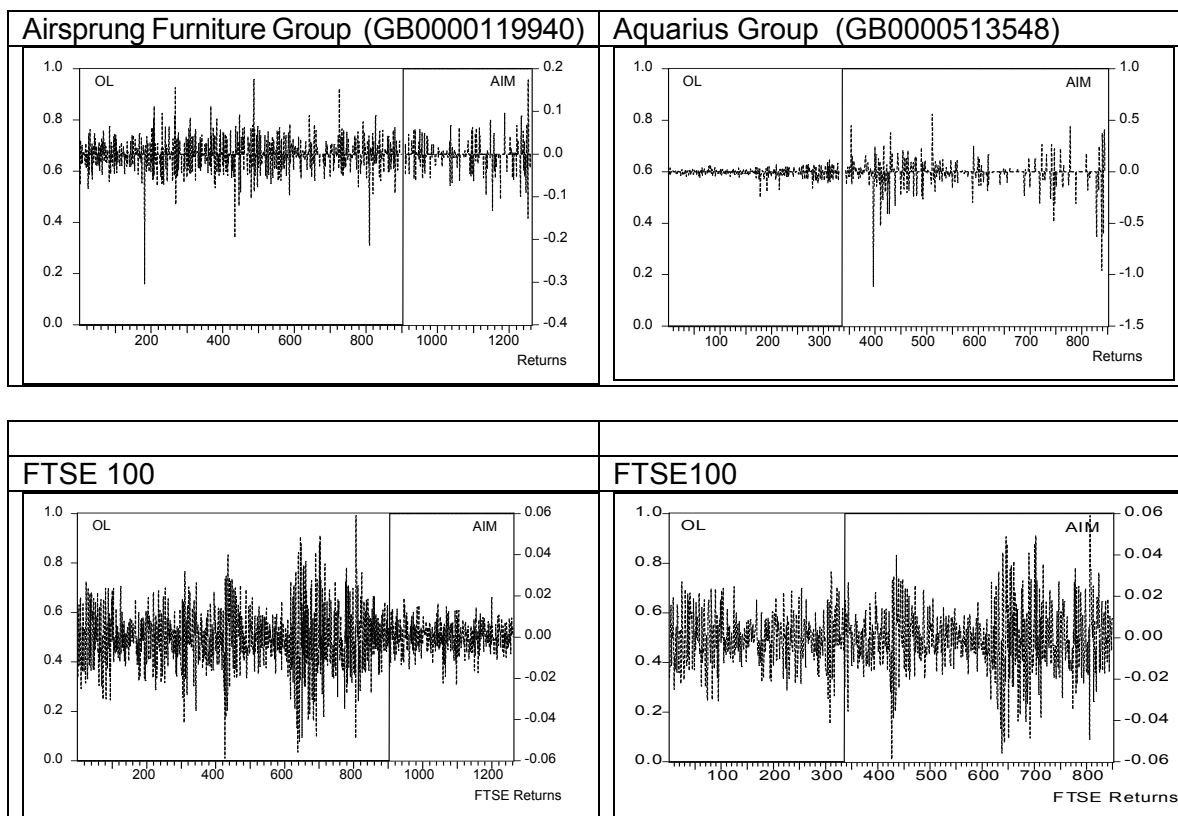
Figure 18:   Representative GARCH volatility changes over switch period

13 Including Riskless Trades

In order to check this result, we increased the sample by including all trades with trade indicator "RT" (riskless trades). Because some of the riskless trades are published several days after the trades are executed, we ranked trades using the publication time stamp rather than the trade time stamp. Therefore, we measure volatility of the market as perceived by a public trader that simply observes trades as they are published. Most of the RT trades are performed on AIM.
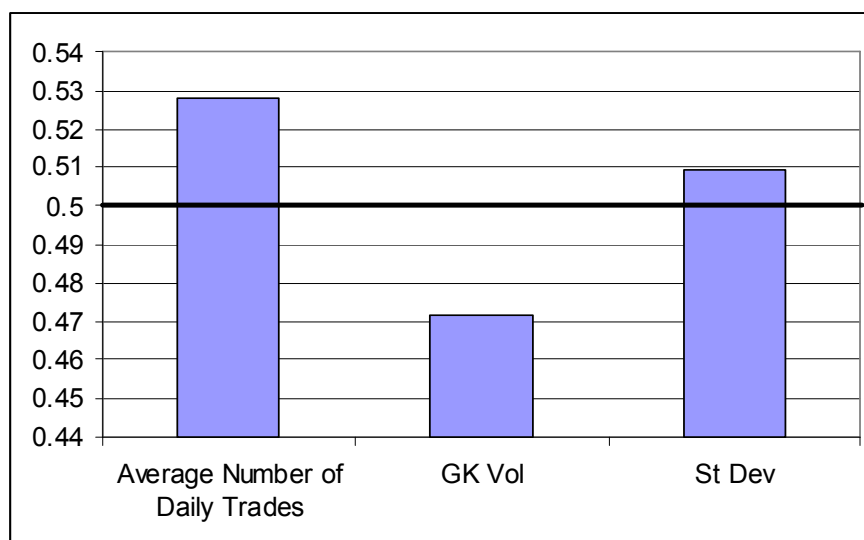
Figure 19:   Relative volatilities including riskless trades

Figure 19 shows that if we include riskless trades in the sample the new results indicate that there is a greater likelihood that companies trading on AIM have a greater number of trades per day, a lower Garman-Klass volatility (computed only over days with at least 1 trade), and a marginally higher standard deviation of daily returns.

With this new sample, the results change considerably in that the difference in volatilities between markets now vanishes. This result may reveal the importance of market makers in reducing volatility on AIM.

Finally, when we decompose the analysis by type of switch, we obtain the following results:

|	Firms	Average Daily Trades	Number of firms		Percentage of firms	
			GK Vol	St Dev	GK Vol	St Dev
OL to AIM	130	62	57	69	44%	53%
AIM to OL	30	23	18	13	60%	43%
Total	160	85	75	82	47%	49%

In the table, the final three columns show the proportion of companies in the sub-sample with a ratio greater than 1, namely with a higher ratio for AIM trading.

This more detailed analysis shows that, in each sub-sample, companies are more likely to have a greater number of trades and a higher Garman-Klass volatility when trading on the originating exchange, and a higher standard deviation of returns on the destination exchange. This can be interpreted as suggesting that the structure of the market may not, after all, consistently affect the volatility.

14 Extended GARCH analysis

We use the new sample, which includes RT trades, to re-estimate the GARCH model. The results from the GARCH model estimation show that only 30 (19%) of the sample companies have significantly greater volatility when trading on AIM, while 67 companies (42%) have significantly lower volatility when on AIM.

	Number	Number of firms		Percentage of firms	
		Higher Volatility on AIM	Lower Volatility on AIM	Higher Volatility on AIM	Lower Volatility on AIM
OL to AIM	130	23	58	18%	45%
AIM to OL	30	7	9	23%	30%
Total	160	30	67	19%	42%

Finally, we re-estimated the GARCH models using robust standard errors to correct for possible autocorrelation in the residuals. The estimation results show that only 2 (1.3%) companies have a significant increase in volatility when trading on AIM, while 15 (9.9%) companies have a significant decrease in volatility when trading on AIM.

	Number	Number of firms		Percentage of firms	
		Higher Volatility on AIM	Lower Volatility on AIM	Higher Volatility on AIM	Lower Volatility on AIM
OL to AIM	130	2	13	2%	10%
AIM to OL	30	0	2	0%	7%
Total	160	2	15	1%	9%

Therefore, we conclude that the differences in volatility which appeared to be present in the simple analyses markedly decrease when we use more sophisticated estimation procedures.I

15 Conclusions

The purpose of this research was to examine the truth behind the perception that the AIM market was systematically and consistently more risky than the OL market in comparable stocks. The research was conducted by the ICMA Centre at the University of Reading to a commission from the AIM Group of the London Stock Exchange. The main finding of the research is that while at a superficial level AIM stocks may seem more risky than comparable OL stocks, as the analysis is refined to ensure that the comparisons focus purely on the effect of being on different markets the difference shrinks and finally disappears. The final conclusion of the research is that the empirical analysis concurs with the current market practitioner view that there is no significant risk differential.

AIM has been a considerable success. Even by its survival over 10 years it has succeeded in relation to similar markets in other countries. But during that period it has seen rapid growth and during the last 5 years has emerged as the market of choice for smaller, newer companies in the UK and increasingly beyond the UK. This dominance of AIM has meant that in recent years the vast majority of newer companies coming to the UK market have joined AIM.

The research comprised three elements – an interview program, a literature review and an extensive empirical analysis. The interview program suggested three conclusions:

- While AIM has less demanding requirements than the OL (for example in terms of free float) the Nominated Advisors almost always insist that companies coming to AIM adopt standards that are higher than the minimum required and, in practice, are similar to those of the OL.
- While AIM, in its earlier days may have been more risky, its growth in recent years and the diversity of companies attracted to the market mean that risk is now much lower and, in the view of the interviewees, AIM companies are not significantly different in risk terms from comparable companies on the OL.
- Age (time since admission) of company is an important factor in determining risk, but after a relatively short time, perhaps 2 to 3 years, its importance disappears.
- In the AIM market there is segmentation between the larger investable companies and a non-investable group – typically very small companies. The non-investable portion is high-risk by its nature and because it is very difficult to trade. The same is also true of the OL.

The literature review showed, among other things, the surprising lack of research into smaller cap markets in general, and AIM in particular. The researchers only found about 50 research papers relating to these markets and most of these related to the ill-fated Neuer Markt and/or to IPO pricing. The main relevant results from the review were that:

- Movements between markets have not been associated with significant changes in risk
- There are a number of risk-related characteristics of companies – in particular, size, age and industry – that tend to be related to market. AIM, for example, tends to have relatively younger stocks.
- The analysis was considerably complicated by the success of the AIM market in attracting new companies in recent years. As a consequence, AIM companies are almost all much younger than comparable OL companies. Since age was identified in the interviews as a major risk factor, the fact that AIM companies were generally younger meant that the analysis would have to try and distinguish the effect of market (AIM or OL) from that of age of company. Therefore we were obliged to adopt a series of progressively more complex techniques and various measures of volatility for the empirical analysis. The study used 5 years of high frequency trading data to conduct the analyses described below.

Whole market analyses applying progressively more complex techniques to the stocks identified as comparable and which had not changed markets during the five-year period of the study.

- A simple ratio analysis – comparing the volatility (as calculated from trade data) of AIM Stocks with OL stocks in each year. In all years this showed AIM Stocks to be substantially

more volatile than comparable (in terms of size) OL stocks. The level of volatility of AIM stocks ranged from 2 to 3 times that of comparable OL stocks in every year.

- Normalising for the age difference in an attempt to offset the age effect. The results suggested that larger stocks were considerably more volatile than smaller stocks and also that AIM stocks were significantly more volatile than similar sized OL stocks.
- Multi-variate regression analysis – using the main risk-related variables (size, industry, age and market) identified in the literature review to explain differences in volatility. These results suggest that AIM Stocks were significantly more volatile, though the difference was far smaller than that given by the simple ratio analysis. However the strong correlation between age and market makes it difficult for a regression to distinguish the impact of the two variables.

A significant number of stocks have moved between the two markets – more recently the direction has been almost exclusively from OL to AIM. Such companies offer an opportunity to study the single event, a market switch, and abstract from other company-specific factors. Again, a succession of progressively more complex analyses was applied   A simple analysis of switchers' volatility using ratios of pre and post-switch volatility to assess the impact of the switch with the following results:
- o OL to AIM switchers, 55% of these has greater volatility on AIM.
- o AIM to the OL, 45% of these has greater volatility on AIM.
- o Overall switching stocks showed 10% higher volatility on AIM

These results are consistent with the notion that AIM is viewed as slightly more risky. However they are at odds with some previous studies of the US market, identified in the literature review that showed that a switch from the NASDAQ market to either NYSE or AMEX had no effect on volatility.

We then used high-frequency data to construct GARCH models to study the dynamics of volatility over time. GARCH models were estimated separately for each stock that switched market. The results show that it is hard to come to concrete conclusions about the change in volatility of switchers since it varies considerably from company to company. This is entirely to be expected, reflecting the specific circumstances of individual companies, but it makes it hard to draw overall conclusions. Only 11% of the switchers show a significant change in volatility after the switch. However, the prevalent change seems to be a reduction in volatility when trading on AIM rather than the opposite. We therefore conclude from this that for the switchers the move to AIM was accompanied, most usually by a decline in volatility.

Finally, we extended the complex switchers analysis we made two changes:
- Including risk-free principal trades (crosses done through market makers). These had been excluded as likely to distort the results, but on further inspection we found that these were a significant element of total business and proportionately more important for AIM stocks (since AIM stocks tend to be smaller and less liquid). The effect of including risk-free principal trades is to smooth the price history of stocks. This is consistent with the use of risk-free principal trades to reduce price impact caused by illiquidity. The results were:
    - o 19% of switchers had higher volatility in the AIM period
    - o 42% had lower volatility in the AIM period
- Applying more robust significance tests – i.e. being more demanding in deciding whether statistically small difference represented real differences. The results were:
    - o Only 1% of switchers showed increased volatility in the AIM period
    - o Almost 10% showed lower volatility in the AIM period

Our overall conclusion is that the analysis of switchers shows that the differences in volatility when stocks switch between AIM and the OL are very small, usually not significant statistically and tend, if anything, to indicate a slightly lower volatility when on AIM.

It is worth speculating briefly as to why AIM might not be more risky than the OL. By and large those we have spoken to and the literature we have reviewed have suggested that the regulatory differences, while important in attracting companies to AIM, may not have a large effect on investors because:

- initial and on-going disclosure requirements are similar
- nominated advisors are strict in ensuring companies comply with higher standards than the basic requirements
- the lower free-float requirements for AIM are rarely an issue as, we understand, most advisors would insist on an AIM issue having similar free float to the OL requirement.
- the lower requirements for consulting shareholders on corporate actions are rarely a problem – though in special cases one can see this might not be true.
- the shorter track record requirement, which could be an important risk factor, is less important than one might expect – largely because the minimum requirements for AIM and the OL both lie within the "young company" time horizon of 2 to 3 years.

The main conclusion that comes out of this analysis is that the initial conception that AIM has higher volatility than the OL is perfectly understandable. Our simpler analyses generally found a large difference between volatility of AIM and OL stocks. However as we moved to more complex analyses the difference dwindled or vanished. The schematic diagram below represents the results of the various analyses we have conducted.
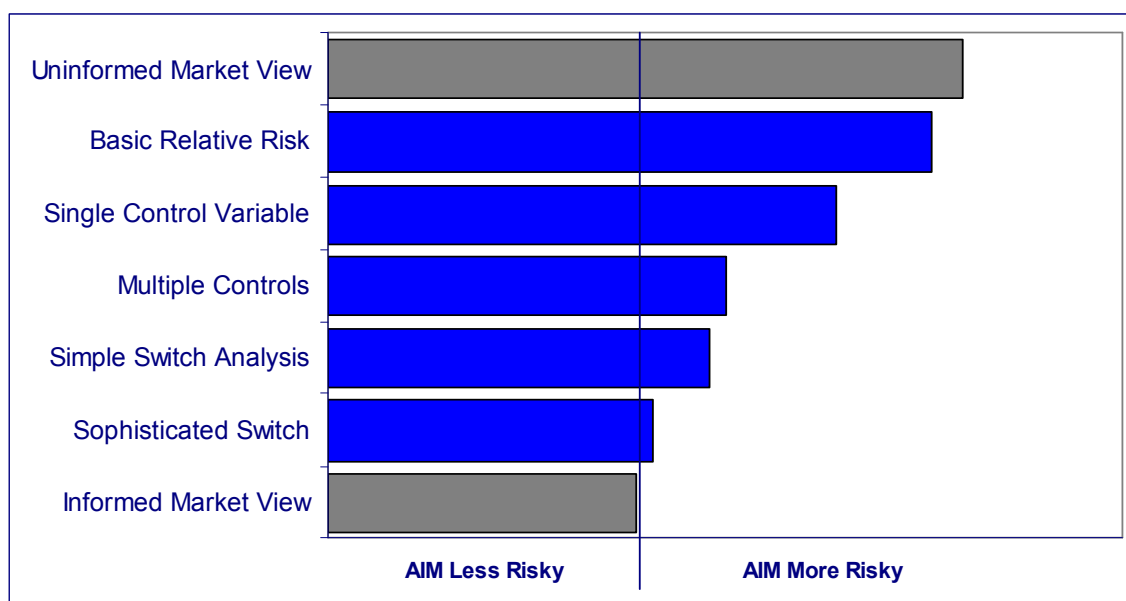
It is clear that more sophisticated - and therefore we believe more accurate – analyses have been associated with smaller or zero differences between the markets. It is revealing that the opinion of market practitioners and the conclusions of the most sophisticated analyses concur – when other factors are adjusted for, AIM and the OL do not display significantly different volatilities.

Appendix A – Literature review of empirical studies of small cap markets

A1 Introduction

A search was conducted for empirical studies of small capitalization exchanges, including those in the UK. The majority of small capitalization exchanges are located in Europe, and the exchanges (some of which have subsequently closed) for which empirical evidence is available are set out in table A1.

Market	Country	Start Date
Nouveau Marché	France	14 February 1996
Neuer Markt	Germany	10 March 1997
NMAX	Netherlands	25 March 1997
Euro.NM Brussels	Belgium	11 April 1997
Nuovo Mercato	Italy	17 June 1999
Unlisted Securities Market (USM)	UK	1980
Alternative Investment Market (AIM)	UK	19 June 1995
EASDAQ (subsequently NASDAQ Europe)	Europe	June 1996
TechMARK	UK	4 November 1999
AMEX Emerging Company Marketplace	USA	18 March 1992
JASDAQ	Japan	June 1976
KOSDAQ	South Korea	1 July 1996
SESDAQ	Singapore	February 1987
TAISDAQ	Taiwan	22 May 1998
Growth Enterprise Market (GEM)	Hong Kong	25 November 1999

Table A1: Small Capitalization Exchanges for which there is an Empirical Study

The date each exchange commenced is shown in the list above. The first five exchanges in the above list constitute Euro.NM. In addition to the exchanges listed in table 1, there are, or have been, small capitalization exchanges in Spain, Sweden, Norway, Switzerland and Austria; but no empirical studies were found relating to any of these exchanges. Outside Europe, small capitalization exchanges have been created in Malaysia, Australia, Hong Kong, Taiwan, South Korea and Canada. There are (or have been) small capitalization exchanges in other countries, but they tend to be created and closed with considerable frequency. For example, in February 2001 the Nairobi Stock Exchange established the Alternative Investment Market for small companies with high growth potential. The US does not currently have a dedicated small capitalization market (the AMEX Emerging Company Marketplace closed on 11th May 1995), and many small US companies are listed on NASDAQ, along with some very large companies. Many studies have compared the NASDAQ and NYSE markets, but because they do not focus on small NASDAQ stocks, they are not relevant to this research, and so are not included here.

Section 2 of this review summarizes the empirical studies of initial public offerings (IPOs) on small capitalization exchanges. Section 3 considers the available evidence on the volatility of small capitalization exchanges. Section 4 mentions the empirical studies of other aspects of small cap exchanges. Finally section 5 has the conclusions.

A2 Initial public offerings

A prime function for a small capitalization exchange is the floatation of small companies. This, coupled with the relatively short lives of the main small capitalization exchanges, means that the empirical literature on small capitalization exchanges is dominated by studies of initial public offerings (IPOs). These studies have addressed topics such as the size and determinants of the underpricing of IPOs, and the extent to which the initial underpricing is removed over time, the role of venture capitalists in the IPO, the change in the gearing of companies undergoing an IPO, etc. Table A2 lists (in chronological order) academic studies of various features of IPOs on small capitalization exchanges.

Study Authors	Small Cap Market Studied
Young & Zaima (1986)	US OTC
Buckland & Davis (1989)	Unlisted Securities Market
Levis (1993)	Unlisted Securities Market
Holland and Horton (1993)	Unlisted Securities Market
Rees (1997)	Unlisted Securities Market
Kutsuna, Cowling & Westhead (2000)	JASDAQ
Fischer (2000)	Neuer Markt
Arosio, Giudici & Paleari (2000)	EASDAQ, Nouveau Marché, Neuer Markt, NMAX, Euro.NM Brussels & Nuovo Mercato
Torstila (2001)	EASDAQ & Neuer Markt
Arosio, Bertoni & Giudici (2001)	Nuovo Mercato
Kiss & Stehle (2002)	Neuer Markt
Kraus (2002)	Neuer Markt
Aussenegg, Pichler & Stomper (2002)	Neuer Markt
Hunger,(2003)	Neuer Markt
Franzke & Schlag (2003)	Neuer Markt
Manigart & De Maeseneire (2003)	EASDAQ, Nouveau Marché, Neuer Markt, NMAX, Euro.NM Brussels & Nuovo Mercato
Goergen, Khurshed, McCahery & Renneboog (2004)	Nouveau Marché, Neuer Markt, NMAX, Euro.NM Brussels & Nuovo Mercato
Rindermann (2004)	Nouveau Marché, Neuer Markt & techMARK
Goergen, Khurshed & Renneboog (2004)	Nouveau Marché & Neuer Markt
Franzke (2004)	Neuer Markt
Giudici & Roosenboom (2004a)	NASDAQ Europe, Nouveau Marché, Neuer Markt, NMAX, Euro.NM Brussels & Nuovo Mercato
Giudici & Roosenboom (2004b)	NASDAQ Europe, Nouveau Marché, Neuer Markt, NMAX, Euro.NM Brussels & Nuovo Mercato

Table A2: Studies of IPOs on Small Capitalization Markets

Some studies of IPOs on small capitalization exchanges have focused on the lock-in agreement, and what happens to prices when it expires, and these are listed in table A3. Under a lock-in agreement, insiders agree not to sell their shares for a specified period of time after the IPO, or until the occurrence of some specified company event.

Study Authors	Small Cap Market Studied
Espenlaub, Goergen & Khurshed (2001)	techMARK
Kraus & Burghof (2003)	Neuer Markt
Goergen, Renneboog & Khurshed (2004)	Nouveau Marché & Neuer Markt
Nowak (2004)	Neuer Markt
Bessler & Kurth (2004)	Neuer Markt
Espenlaub, Goergen, Khurshed & Renneboog (2004)	techMARK

Table A3: Studies on IPO Lock-ups on Small Capitalization Markets

Tables A2 and A3 reveal that the Neuer Markt has been extensively researched, while the other members of Euro.NM have also been widely studied. There have also been a few studies of the USM, techMARK, JASDAQ and EASDAQ. What is quite remarkable is the total absence of any empirical studies of IPOs on AIM.

A few studies have looked at how the companies were valued for the IPO, and these are listed in table A4. In this case there is one study (Botman, Roosenboom and Van Der Goot, 2004) which includes AIM.

Study Authors	Small Cap Market Studied
Botman, Roosenboom & Van Der Goot (2004)	EASDAQ, Nouveau Marché, Neuer Markt, NMAX, Euro.NM Brussels, Nuovo Mercato, AIM & NASDAQ
Cassia, Paleari & Vismara (2004)	Nuovo Mercato
Trautwein & Vorstius (2004)	Neuer Markt

Table A4: Studies on IPO Values on Small Capitalization Markets

A3 Risk

There are a number of reasons why companies listed on AIM may be riskier than firms on the OL:

- Firms listed on AIM tend to be smaller than firms on the OL. It is well known that small capitalization firms have higher total risk than similar large capitalization firms. Small companies are less diversified than large companies, and may in extreme cases effectively be a bet on whether there is oil or gas at the bottom of a hole in the ground. Eckert (2002) found that German firms which choose to list on the Neuer Markt, rather than the 1st Market Segment, are riskier, smaller and younger.
- Firms listed on AIM tend to be younger than firms on the OL. Young firms tend to be riskier than well established firms because their business model may be unproven, and the staff less experienced.
- Firms listed on AIM tend to be in industrial sectors, like mining and oil and gas, which are inherently risky.
- AIM has weaker regulations and surveillance than the OL. For example, there is no requirement for a minimum proportion of the shares to be in public hands, no trading record requirement, no requirement for shareholder approval of transactions, and no minimum market capitalization. This permits the listing of inherently riskier companies, run by people who may have criminal convictions and are more willing to take risks.
- Firms traded on AIM tend to be less liquid than those on the OL with less frequent trading, and this results in fewer, larger price movements. If risk is quantified using a measure like

the standard deviation that squares deviations, this will result in higher measured risk. The presence of liquidity providers can reduce price volatility by smoothing out demand and supply for uninformed traders.

- The steady flow of information to the market may be less well developed for small capitalization companies. Small companies may make fewer announcements, leading to fewer, but larger, information disclosures. They may also be followed by fewer analysts, who discover and publicize relevant information on the firm. If risk is quantified using a measure such as the standard deviation of returns, this lumpiness of the information flow will also increase risk.

- Firms listed on AIM tend to have a smaller free float than firms on the OL. Since the ratio of tradable shares to total shares is lower for firms listed on AIM, the price impact of news tends to be larger for AIM companies, leading to higher measured risk.

- Firms listed on AIM are subject to the expiration of the lock-up period, which can lead to return volatility around the expiration date.

- Firms listed on AIM may be more highly geared than firms on the OL. In which case, even if the income streams of two companies are equally risky, the share price of the more highly geared company will be more volatile. Hutchinson, Meric and Meric (1988) compared firms that floated on the USM with those of a similar size and industrial group that did not. Prior to joining the USM, the quoted firms were more highly geared, growing faster and had less liquid assets. Bottazzi & Rin (2002) present a large amount of information on companies which listed on the Nouveau Marché, Neuer Markt and Nuovo Mercato. The gearing (Debt/(Debt + Equity)) of firms that were about to list on the Nouveau Marché was 77%, while for the Neuer Markt it was 75%. After the IPO, gearing dropped to 43% and 28% respectively. For 135 companies that listed on the main markets in France, Germany and Italy during the same period, the pre and post gearing was 34%. This indicates that for France, firms on the small capitalization exchange had higher gearing than firms on the main market. Burghof and Hunger (2004) report that the gearing of firms before they listed on the Neuer Markt was 70%, while the corresponding figure for firms listing on other German markets was 73%, which is consistent with the results of Bottazzi & Rin (2002) for Germany.

- Venture capitalists are more likely to be involved with firms listed on AIM, and they may create price volatility when they end their involvement. However, the level of involvement of venture capitalists in Germany is lower than in the US. Vitols (2000) argues that the Neuer Markt was not creating companies similar to those of Silicon Valley because there was much less involvement of venture capitalists in Neuer Markt firms, and these firms were older and more profitable than those in Silicon Valley.

- A trading mechanism involving market makers produces bid-ask bounce, leading to a more volatile prices than if prices are set by an order-driven process (e.g. SETS, SETS-MM). Since small firms on AIM use market makers, while some firms on the OL use an auction mechanism (where bid-ask bounce between market maker quotes is absent), AIM price volatility will be higher.

- If the distribution of returns for shares listed on AIM is more negatively skewed than for shares in the OL, there will be more big negative returns on AIM, and this may give the impression that AIM is riskier.

Risk is usually measured in two alternative ways:- (a) total risk, and (b) systematic risk (or beta). Total risk is simply the variability of returns on the company's shares. Systematic risk measures the extent to which a firm's returns move with those of the market as a whole.

A number of empirical studies have investigated the change in the systematic risk (or beta) of a company's shares when it moves from a small capitalization exchange to the main market, or lists for the first time on the main market. These studies appear in table A5, and all but one are for the US. There is no evidence from any of these studies that a change in listing affects systematic risk. This indicates that the additional visibility and bonding (i.e. agreeing to comply

with the regulations) of the main exchange do not reduce systematic risk. The evidence is limited, and none is for AIM, but it suggests that the tougher listing requirements of the main exchange do not lead to a drop in systematic risk. If this result applies in the UK, it implies that whether a firm is included in the OL or listed on AIM has no effect on systematic risk.

Study Authors	Small Cap Market Studied
Reints & Vandenberg (1975)	OTC or AMEX to NYSE
Ying, Lewellen, Scharbaum & Lease (1977)	OTC to AMEX or NYSE
Fabozzi & Hershkoff (1979)	OTC to AMEX
Fabozzi (1981)	OTC to AMEX
Prakash, Parhizgari & Perritt (1989)	OTC to NYSE
Bacmann, Dubois & Ertur (2002)	Marché au Comptant or Second Marché to Marché à Règlement Mensuel

Table A5: Studies of the Change in Listing on Systematic Risk

If firms listed on AIM are riskier than those on the OL, this extra risk may be priced, i.e. expected returns on AIM stocks are higher than for firms on the OL, and this compensates for the higher AIM risk. In support of this view, Schulman (1999) describes small capitalization firms as having greater price volatility, default risk and price manipulation risk, but expected returns are higher to compensate for these increased risks.

In the course of studying other aspects of small capitalization exchanges, some researchers have reported volatility measures. These are comparisons of total, not systematic, risk.

- Board, Vila and Wells (1998) computed the average standard deviation of trade to trade price changes for 111 AIM stocks over a six month period in 1996. This was 5.19%. Using the standard deviation of daily closing prices, Board et al found that larger AIM companies were less volatile than smaller AIM companies. Sixty seven AIM firms were previously traded under rule 4.2, and these firms had a much higher volume of trading, and a slightly lower volatility when traded on AIM than under rule 4.2. [Rule 4.2 (previously rule 535.2) permitted unquoted stocks to be traded off-exchange.]
- Franzke and Schlag (2003) computed the volatility of daily returns for the 20 days after listing on the Neuer Markt, and obtained an annualized volatility of 78%. which is equivalent to an annualized volatility of 83%. Since a typical volatility of a stock on a main exchange is about 30%, this small cap volatility is very high.
- Kraus (2002) computed the standard deviation of daily returns for the 20 days after an IPO on the Neuer Markt, and this was about 0.062. On an annualized basis, this is equivalent to a volatility of 99%, and is again very high.
- Wagner (2004) examined the daily returns for ten firms after they were listed on the Neuer Markt. For each of the two years after listing, the average standard deviation of daily returns was 0.015. This is equivalent to an annualized standard deviation of 24%, which is on the low side. They also found that daily returns on these firms exhibited positive skewness, i.e. a long upper tail, indicating considerable upside risk, which is desirable to investors.
- Nowak (2004) computed the standard deviations of daily price changes for 142 firms traded on the Neuer Markt during the period 1997-9, and the mean value was 4.37%. This is equivalent to an annualized volatility of 70%.
- Leuz (2003) reported the standard deviation of share prices for 1999 and 2000 at between 0.036 and 0.042, but it is unclear how these numbers were computed.
- Uno, Shimatani, Shimizu and Mannen (2002) computed the standard deviation of daily price changes for JASDAQ stocks in 2001. The volatility for the order driven stocks was 8.0%, while that for those stocks traded using market makers was 6.3%. These are equivalent to annual volatilities of 127% and 100%, respectively.

Lee, Rui and Wang (2004) presented data comparing the total risk of the main market with that of the corresponding small capitalization exchange. Table A6 shows the annualized standard deviation of returns for five small capitalization Asian exchange indices, and the corresponding main market indices. The table shows that small cap indices have substantially lower volatility than individual stocks, which is only to be expected as they are portfolios.

Small Cap Exchange			Main Exchange			Small ÷ Large
Small Cap Index	Std. Dev. Daily Returns	Skewness of Daily Returns	Large Firm Index	Std. Dev. Daily Returns	Skewness of Daily Returns	
GEM	45.7%	Negative	Hang Seng	30.0%	None	53%
JASDAQ	26.1%	Negative	Nikkei 225	24.1%	None	9%
KOSDAQ	40.2%	Negative	KOSPI	43.4%	None	−7%
SESDAQ	31.9%	Positive	Strait Times	22.6%	Positive	41%
TAISDAQ	36.7%	None	Taiwan	28.5%	None	28%

Table A6: Annualized Standard Deviation of Daily Returns

For every market, apart from South Korea where main market volatility was high, the small cap index is more volatile than the large cap index. Across all five markets, the small cap exchanges were 25% more volatile than the corresponding main exchange. This accords with expectations, as no attempt has been made to control for the wide range of factors which make small cap firms riskier than large cap firms. For three markets (Hong Kong, Japan and South Korea) the distribution of returns on the small cap market is negatively skewed, i.e. a long lower tail, indicating considerable downside risk, which is undesirable to investors. For main market returns, the only skewness is positive skewness in Singapore.

A4 Other empirical studies

There have been some further studies of small cap exchanges which do not fall into any of the above categories.

- Lee, Rui and Wang (2004) investigated return and volatility spillovers from NASDAQ to five small capitalization exchanges in Asia: SESDAQ (Singapore), TAISDAQ (Taiwan), KOSDAQ (S. Korea), JASDAQ (Japan) and GEM (Hong Kong). They found that NASDAQ returns and return volatility leads those in these five Asian small cap exchanges; and that returns and return volatility in the main exchange lead those of the corresponding small cap exchange. Kim and Kim (2003) showed that the NASDAQ index led both the JASDAQ and KOSDAQ indices by one or two days. These results indicate that prices on small capitalization exchanges are related to both the corresponding main market and to the world financial system.
- Companies must seek to align the incentives of managers with those of the shareholders; and in a study of AIM Roosenboom (2004) investigated the determinants of the managerial incentives offered to managers of companies undertaking an IPO.
- Kutsuna, Okamura and Cowling (2002) used primarily accounting data to study the effects of the pre- and post-IPO ownership structure on the performance of firms listed on JASDAQ.
- Leuz (2003) found that the choice of international accounting standards (IAS) or US generally accepted accounting principles (GAAP) accounts by firms listed on the Neuer Markt had no effect on their bid-ask spread, traded volume or IPO underpricing.

- McCaffrey and Hamill (2000) studied the market reaction to the decision to start paying dividends after firms had listed on the USM or the OL. For the OL companies, the initiation of dividends signalled improved future prospects, but this was not the case for the USM stocks. In consequence, USM companies had a smaller price reaction to dividend initiation than did OL companies.
- Aggarwal and Angel (1999) investigated the causes of the failure of the AMEX Emerging Company Marketplace.

A5 Conclusions

This review has found over fifty empirical studies of small capitalization exchanges, and these have focused on the members of Euro.NM, particularly the Neuer Markt. For the UK, there have been five studies of the USM and two of techMARK, all of which used share price data. Two studies of AIM have relied primarily on prospectuses and accounting data, and there is only one previous study of AIM using share price data. Only one previous study has investigated the relative riskiness of large and small cap exchanges - Lee, Rui and Wang (2004). This examined market indices, and found that Asian small cap exchanges were about 25% more volatile than the corresponding main exchange. In addition, a number of studies have reported the volatility of selected stocks on small cap exchanges. These volatilities appear to be rather high, but no directly comparable volatilities for similar stocks on the main market are available for comparison.

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