Occasional Paper Series ◆ 23

Measuring market cleanliness

Ben Dubow
Nuno Monteiro

FSA®
Financial Services Authority

March 2006

FSA OCCASIONAL PAPERS IN FINANCIAL REGULATION

Foreword

We are committed to encouraging debate among academics, practitioners and policy-makers in all aspects of financial regulation. To facilitate this, we are publishing a series of occasional papers in financial regulation, extending across economics and other disciplines.

These papers cover topics such as the rationale for regulation, the costs and benefits of various aspects of regulation, and the structure and development of the financial services industry. Since their main purpose is to stimulate interest and debate, we welcome the opportunity to publish controversial and challenging material and to publish papers that may have been presented or published elsewhere.

The main factor in accepting papers, which will be independently refereed, is that they should make substantial contributions to knowledge and understanding in the area of financial regulation. We encourage contributions from external authors as well as from within the FSA. In either case, the papers will express the views of the author and not necessarily those of the FSA.

If you want to contribute to this series, please contact Peter Andrews or Maria-Jose Barbero at:

The Financial Services Authority,
25 The North Colonnade,
Canary Wharf, London E14 5HS.
Telephone: (0)20 7066 3104 or 5808.
Email: peter.andrews@fsa.gov.uk or maria-jose.barbero@fsa.gov.uk.

FSA Occasional Papers are available on our website: www.fsa.gov.uk. We welcome comments on these papers; please address them to the contacts listed above.

MEASURING MARKET CLEANLINESS

BEN DUBOW
NUNO MONTEIRO

FSA Occasional Paper

© March 2006

Biographical note

Ben Dubow and Nuno Monteiro are members of the Economics of Financial Regulation Department within our Finance, Strategy and Risk Division.

Acknowledgements

We are grateful to our referee Kevin R. James of the London School of Economics for his detailed advice and comments on the methodology. We are also grateful to Ian Tonks, Isabel Argimon, Mohamed Serokh, Isaac Alfon, Lionel Stehlin, Hector Sants, Gay Huey Evans, Dilwyn Griffiths, Ruth Dent, Carlos Conceicao, Peter Andrews and Kari Hale. Any errors or omissions are, however, the sole responsibility of the authors.

Contents

1. Summary

The FSA has a Statutory Objective to maintain confidence in the financial system. The FSA's business plan for 2006/07 notes that all that we do, whether in wholesale or retail markets, reflects our belief that efficient, orderly and fair markets are the most efficient way of delivering value to both users and providers of financial services. The FSA has primary responsibility for tackling market abuse in the UK and we consider the successful reduction of market abuse to be one of our highest priorities. This has been emphasised by FSA Senior Management in recent speeches.[1]

The FSA has committed to evaluate its overall performance and this piece of economic analysis looks to establish a robust methodology to measure the level of market cleanliness. In selecting this measure, we have sought an outcome-based approach. Our methodology aims to assess the overall level of market cleanliness and the deterrent effect of FSA regulation. This may be more informative than, for example, looking at the number of successful Enforcement cases, which provides no direct information about the impact the FSA is having on the level of market abuse.

This paper develops measures of market cleanliness based on the extent to which share prices move ahead of the regulatory announcements which issuers are required to make to the market. We examine two broad kinds of announcement: announcements relating to take-over bids using data for 2000 and 2004 and announcements about the trading performance of FTSE350 listed issuers using data from 1998 to 2003. Share price movements ahead of such announcements may reflect insider trading.[2] The paper does not examine other forms of market abuse.[3]

We estimate statistical relationships between the returns to individual stocks and the return to the market as a whole. These relationships can be used to identify whether the returns to an individual stock at key times are "abnormal" in a purely

1 See e.g. Speech by Margaret Cole, Director of Enforcement, FSA to SII Compliance Forum, 18 January 2006

2 Throughout this paper the term "insider trading" is used to mean acting or causing others to act on material non-public information which could affect the value of an investment. This term is not a legal one but is intended to include the UK legal offences of insider dealing and misuse of information.

3 We believe that examining share price movements ahead of announcements is much less informative about the overall prevalence of other forms of market abuse, e.g. market manipulation.

statistical sense. We interpret a large abnormal return around the time of a regulatory announcement as indicating that the announcement contained important news about the stock's value; news which could be of interest to an insider trader. We refer to these regulatory announcements as "significant announcements".

Our measure of market cleanliness is based on the proportion of significant announcements where the announcement is preceded by an "informed price movement" (IPM). We define an IPM as an instance where there is an abnormal stock return *before* an announcement and that return is positive in the case of a good news announcement or negative in the case of a bad news announcement. We assert that IPMs can indicate insider trading, while asserting neither that most insider trading gives rise to IPMs nor that IPMs arise only as a result of insider trading.

We examine the measure for periods before and after 2001, when prosecuting the relevant forms of market abuse was made easier and greater penalties were introduced. Our analysis indicates that there was no change after 2001 in the level of market cleanliness in relation to the announcements made by FTSE350 issuers. For another analysis performed using announcements of take-overs, the measures we calculate provide some evidence of a deterioration in market cleanliness.

A previous study by Bhattacharya and Daouk (2002) suggests that enforcement, rather than the existence of rules alone is required for regulation to improve market cleanliness. So a possible explanation for the measure failing to decline for the FTSE350 announcements could be that the first successful enforcement against insider trading under the new post-Financial Services and Markets Act (FSMA) regime did not take place until 2004. However, the analysis of take-overs did include data for 2004, after enforcement had taken place. This may suggest that the scale of the fines (£1,000 to £18,000) and nature of the cases in fact had a limited deterrent effect.

We believe that following detailed examination of alternative approaches, we have developed a useful measure of market cleanliness. Although changes in the measure from year to year may not show up as "statistically significant"[4], we believe it may be useful to repeat the analysis presented in this paper in future.

4 The confidence intervals presented in section 9 below imply that with a 95% confidence interval an increase of at least 7.9% would have been required for us to find that the change in the measure associated with the FTSE350 announcements was significant; for the take-over announcements the figure is 4.1%.

2. Introduction

The FSA has a Statutory Objective to promote market confidence. That objective requires the FSA to keep markets "clean" – i.e. free from market abuse and the FSA has primary responsibility for tackling market abuse in the UK.

But how clean are UK markets? And has the tightening of regulation in recent years had a visible effect – not just on the number of punishments meted out, but on the way markets perform? This paper reports work to develop such an "outcome-focused" measure of market cleanliness and to assess whether the Financial Services & Markets Act[5] (FSMA), which came into force in 2001, had an impact on that measure.

The scope of the paper is limited in at least three ways. First, given the data available and existing techniques at our disposal, we have focused on one form of market abuse – insider trading – and have not looked at other forms of market abuse (i.e. market manipulation).[6] Primarily, this reflects the fact there is a substantial economic literature investigating the impact of insider trading on markets which provides techniques directly applicable to our research aim. Secondly, we only look at "cash" equities, rather than their derivatives, including instruments such as contracts for difference. We explain below why we do not believe this to be a genuine limitation. Thirdly we are not seeking to measure the benefits of insider trading regulation. We note only that financial markets are built on trust and that insider trading erodes that trust and can increase costs for all market participants.[7]

The remainder of this paper is set out as follows. Section 3 introduces the key statistical and regulatory concepts required to understand, at an intuitive level, the measure of market cleanliness we have developed. Section 4 explains the regulatory changes which occurred in 2001 and discusses whether those should have changed the behaviour of market participants at that time so as to affect our measure of market cleanliness. Section 5 explains the data and method we have used. Section 6 presents the results and Section 7 the conclusions. Section 8 provides some descriptive statistics on our sample while Section 9 provides a more precise explanation of method and results for readers with some background in statistics.

5 and in particular the offence contained in section 118(2)(a)

6 Market manipulation can involve spreading false information about the value of a security or trading aimed at manipulating prices. Examples of the latter include "price positioning" and "abusive squeezes" and are given in FSA HANDBOOK MAR 1.6.12 and 1.6.18 respectively.

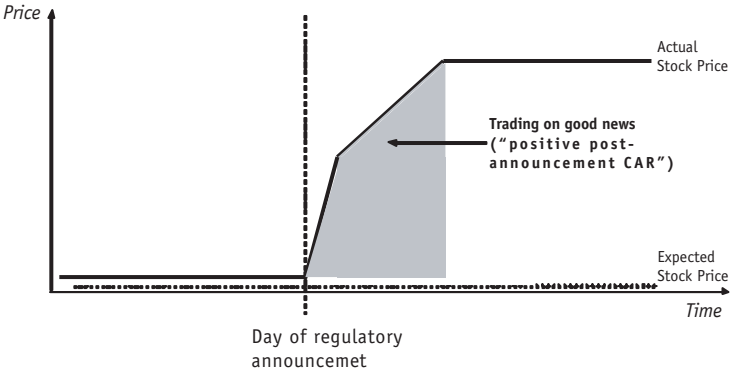
7 For a summary of the welfare effects of insider trading see Minenna (2003)

3. Key concepts

All the analysis in this paper revolves around the identification of "abnormal" movements in the return to an individual stock around the time of the announcements which issuers are required to make to the market under the FSA's Listing Regime.[8]

To identify whether stock returns are abnormal, we need a statistical model of normal or "expected" returns. The details of our model for expected returns are given in section 5 below but here we note only that the model can take into account movements in the market as a whole. The abnormal return on a given day is the difference between the expected return from our model and the actual return. By adding together abnormal returns over time we calculate cumulative abnormal returns (CARs)[9]. These concepts are illustrated in the diagram below.

Figure 1: Key concepts illustrated



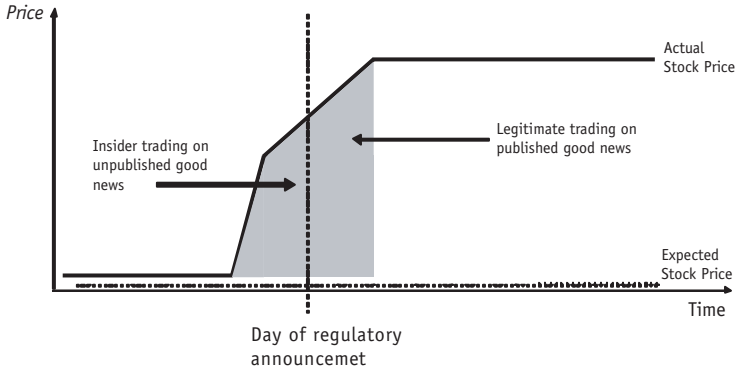
8 Most relevant here is Disclosure Rule 2.2.1 which imposes a general obligation on issuers to publish important information as soon as possible.

9 If the actual return is equal to the expected return the CAR is equal to zero.

The flat dotted line along the bottom of the chart represents the expected stock price. At a point in time represented by the vertical line, the firm makes a regulatory announcement to the market. Because this announcement contains new information (in this case good news) about the performance of the firm (and hence the firm's value) the stock price increases. This gives rise to a positive post-announcement CAR.

These concepts can be used to identify possible instances of insider trading as illustrated in Figure 2 below. Here, a positive abnormal price movement occurs before the announcement of good news (a "positive pre-announcement CAR"). This could indicate that the positive news in the announcement had been traded on before it had been made public, in breach of FSMA. The analysis we will present neither requires us to assert that all such price movements must be the result of insider trading nor that all insider trading must give rise to such price movements.

Figure 2: Key concepts and insider training



We have now introduced all the concepts required to explain intuitively the measure we have developed. The first step is to identify a set of regulatory announcements which we know to contain a lot of new information. We can identify such announcements where the associated CARs are so large that the probability that these CARs are simply the result of random variation in stock returns is very small. In fact, we require CARs to be so large that the probability of them arising purely by chance is just 1%. That is to say these CARs are "statistically significant at the

1% level". To identify these relatively informative announcements we examine the sum of the pre-announcement and post-announcement CAR (the "total CAR").[10] We refer to the announcement identified in this way as "significant announcements".

For these significant announcements we then examine whether there was a statistically significant pre-announcement CAR (at the 10% level[11]) and whether this CAR was in the "right" direction – i.e. whether there was a positive abnormal return ahead of good news announcements or a negative one ahead of bad news announcements.[12] Movements in the right direction are more likely to be the result of genuinely informed (and possibly insider) trading than those in the wrong direction. For ease of reference we refer to such price movements as "informed price movements" (IPMs) as these are price movements which are most likely to (but do not necessarily) reflect trading on unpublished information.

Our measure then is simply the proportion of significant announcements where the announcement is preceded by an IPM.[13] The effectiveness of FSMA is assessed by seeing if this measure changes after FSMA is introduced in 2001. The details of the data and method used are presented in section 5 below.

One point worth addressing here, however, is whether insider trading really will affect equity returns and give rise to statistically significant pre-announcement CARs. The reality is that only a proportion of insider trading will show up

10 Kim and Verrecchia (1991).As explained further below, we measure the CAR over a four-day peiod: two days before the announcement, the day of the announcement and the day following that.

11 i.e. so large that the probability of abnormal price movements of that scale arising purely by chance is 10%. The confidence level used to identify significant announcements is high because we are concerned to reduce the presence of "false positives" (announcements which are identified as containing significant information but which do not) in our sample, as these could undermine the analysis. We cannot directly perceive the information content of announcements (we can only infer it from the related price movement) and so we believe using a high threshold reduces the danger that the number of genuine significant announcements in our analysis is swamped by false positives. By contrast, when identifying IPMs we use a 10% confidence level and we are confident that the analysis of bias presented in section 6.3 and of confidence intervals presented in section 9 demonstrates that that our results are not driven by false positive IPMs.

12 In mathematical terms, a movement in the "right" direction means the pre-announcement CAR has the same as the total CAR.

13 As explained below, the final measure we examine is adjusted to take account of a bias which arises from the way in which we have selected our significant announcements.

statistically in this way.[14] [15]But so long as the proportion of insider trading showing up in this way remains stable over time (an issue we return to below) our test is not invalidated. Insider trading will show up in CARs even where insider traders trade in derivative instruments, rather than the shares themselves. This is because arbitrage transmits changes in the price of one instrument to the other.[16]

It is also worth noting that, while there are some novelties in the precise method we have used, the overall approach to identifying abnormal returns around the time of regulatory announcements has a long pedigree and wide application. For example, it is one of the methods the London Stock Exchange uses to generate alerts of possible insider trading, which are then referred to the FSA. The Securities and Exchange Commission (SEC) in the US may present statistical evidence on abnormal returns in the courts when it seeks to prove that a firm has committed securities fraud.[17]

Outside the law courts, studies of abnormal stock returns around the time of regulatory announcements (or other "events", such as changes in regulation) are used widely in policy analysis. They have been used to examine the effectiveness of financial regulation relating to insider trading and corporate disclosure in studies similar to our own.[18] For example, Bulkley and Herrerias (2002) and Bulkley

---

14 Even if insider trading is taking place, it may account only for a very small proportion of trading in a share, particularly for very liquid stocks, and fail to move the price. It may be possible for insiders to trade in a way which minimises the price impact. In addition, where stocks are volatile, the impact of insider trading will be hard to spot through prices alone. For this reason, market abuse detection systems consider more variables than just a stock's price. They may also look at volumes and the proportion of trading in the hands of each intermediary over time (see e.g. Minenna 2003).

15 Meulbroek (1992) identifies large price run-ups ahead of mergers and acquisition announcements where insider trading occurs.

16 E.g. Jayaraman, Frye, and Sabherwal (2001) look at options trading prior to M&A announcements. They conclude "Our analysis shows that there is a significant increase in the trading activity of call and put options for companies involved in a takeover prior to the rumour of an acquisition or merger…The increased trading suggests that there is a significant level of informed trading in the options market prior to the announcement of a corporate event.... This finding supports the hypothesis that the options market plays an important role in price discovery." More generally, Gadarowski and Sinha (2003) provide references to further evidence that trade by insiders will move stock prices including Kyle (1985).

17 See e.g. Mitchell and Netter (1994). The paper explains how financial economics can be used to provide evidence indicative of whether insider trading has taken place and provide guidance on the level of fine the guilty party ought to pay.

18 Bhagat and Romano (2001) describe a number of studies in which event studies were used to assess the effectiveness of changes to corporate law.

et al (2002) are two studies which focus specifically on regulatory announcements which relate to profit warnings. In their study on the US, abnormal returns of -4.6% were found for the five days before the warning. In the UK the average abnormal return was -0.6%. Both are found to be statistically significant.

4. The impact of FSMA

The first part of this section explains why it is reasonable to expect that FSMA may have had an impact on the statistic we have described. The second part discusses reasons it may not.

4.1 Reasons FSMA should affect our measure

There are two important features of the regime against insider trading. First, there are the FSA's Disclosure Rules which require issuers to disclose all material information as soon as possible or where issuers are not obliged to disclose information immediately – e.g. matters in the course of negotiation – to ensure it remains confidential. This should ensure that there is no material undisclosed information for insiders to trade on. Secondly, there are sanctions against individuals who are caught insider trading. Both features were enhanced by the introduction of FSMA – sanctions for failing to disclose information were toughened, while it was made easier to prosecute insider traders.

Before FSMA, the toughest penalty for breaching the Listing Regime was public censure. Following FSMA, the FSA can impose potentially unlimited fines on issuers and their directors.[19] Meanwhile, FSMA also made it easier to punish insider traders. Although insider trading has been specifically prohibited and treated as a criminal offence in the UK since 1985, criminal prosecution requires a case to be proved "beyond reasonable doubt". As Kern (2001) points out, "prosecutions for insider dealing were rare because of the high evidentiary requirements to prove beyond

19 See e.g. CP81 for detail on FSA policy on financial penalties in relation to breaches of the Listing Regime.

reasonable doubt that the behaviour in question was undertaken to make a profit or to avoid a loss." FSMA created a civil regime for prosecuting breaches of the listing regime and market abuse that would be policed by the FSA.[20] The civil regime requires a lower burden of proof for a successful prosecution and this was expected to lead to significant deterrent effects. [21]Whether this will be borne out by the case law remains to be seen.[22]

4.2 Reasons FSMA may not affect our measure

Both changes referred to should, in theory, deter insider trading. There should be less information to trade on, a shorter period in which to trade on it and a greater expected punishment for doing so. We would, therefore, expect to see a lower proportion of significant announcements being preceded by IPMs. However, there are at least three reasons why we may not actually detect a statistical impact.

The first reason is that the introduction of FSMA might not be the correct break-point for our study. For example Bhattacharya and Daouk (2002) found that it is *enforcement* of the regime which has an effect, not merely the *introduction* of rules. If the probability of detection remains small and the sanctions imposed by enforcement are limited relative to the gains to be had from it, there will be an insufficient deterrent to insider trading and the existence of the legal framework alone will not bring about a change in behaviour or our measure of market cleanliness. The FSA's first successful prosecution of insider trading came on 11 February 2004. This might suggest repeating the exercise in future with a later break-point, once more data after this date become available. A second reason is that, even where enforcement does occur, penalties imposed may be insufficient to act as a deterrent.

The third reason we may not detect a change in our statistic is technical. The changes we are seeking to detect may not be large enough to be detected statistically even if they are large enough to have real implications for market

20 This was announced in response to a parliamentary question on 6 May 1998, see HMT's press release at http://connect/fsma/data/press/prn_hmt_69_98.htm.

21 See sections 118-123 of FSMA (2000).

22 It has been argued that the burden of proof in prosecutions under the civil market abuse regime remains higher than for prosecutions under the Listing Regime.

participants.[23] Where expected changes in key variables are small it may be difficult for statistical tests to identify them – particularly where there is a large amount of volatility in the data – as can be the case in financial markets.

In addition to these issues, there are in theory a number of reasons why false inferences about the impact of FSMA could be drawn from changes in our measure. These are discussed further in section 6.4 below.

5. Data and method

Throughout the project we have needed to make a number of key decisions about our approach. To the greatest extent possible these decisions have been informed by the FSA's experience in pursuing insider trading cases. However, in many cases alternative approaches would have been possible. In this section we set out and explain the decisions we have made about which stocks to focus on, how to calculate abnormal returns, and how to identify which abnormal returns (CARs) are statistically significant. The remainder of this section addresses each of these issues in turn. We try to do this in plain English to make it as accessible as possible. For the sake of precision, we also set out the details of our method using mathematical notation in Section 9.

5.1 Data issues

5.1.1 Selection of issuers

Our main analysis is focused on announcements by issuers in the FTSE350. We acknowledge that a proportion of insider trading incidents will relate to issuers outside this list. For example, smaller AIM issuers have been the objects of market abuse. One reason to focus on the FTSE350 is methodological – there are difficulties with modelling abnormal returns for less liquid stocks. Another reason is that the vast bulk of equity market turnover relates to FTSE350 stocks and they are vastly

23 In this case the changes may be said to be "economically but not statistically significant".

more important from the typical investor's perspective than AIM stocks which would only account for a small fraction of a well-diversified investor's portfolio.

For our analysis of mergers and acquisitions (M&A), we focused on the share prices of the issuers for which offers were made. Almost three quarters of these issuers were outside the FTSE350. Our data indicated that most announcements lead to an increase in the price of the target firm.

5.1.2 Selection of time period and break point

For the FTSE350 analysis, we collected data for the years 1998, 1999, 2000, 2002 and 2003. This provides us data before and after the introduction of FSMA in 2001. Data for 2001 are excluded entirely because it is possible that market participants began changing their behaviour in the months leading up to FSMA taking effect on 1 December. Throughout the project we recognised that this may be the wrong break-point (and hence we might not detect a change in our measure) because it might require an enforcement action (and possibly a high-profile one) to change market participants' behaviour. Alternatively, as noted above, the changes in FSMA had been announced as long ago as 1998 and, hence, changes could have taken place in market participants' behaviour before 2001 in anticipation of the change in the law. However, the evidence from Bhattacharya and Daouk (2002) referred to above, which indicates that enforcement is required to make insider trading regulation effective, suggests this is unlikely.

The take-over related announcements we analysed were from the years 2000 and 2004 because the the FSA's Markets Division had obtained data from the Takeover Panel for these years.

5.1.3 Selection of announcements

For our FTSE350 analysis, we used the Factiva search engine and database to collect regulatory announcements headed "trading statement", "trading update", "contract award" or "drilling report". Price-sensitive information will often (but not always) appear under these headings. Announcements headed "annual results" or "interim results" would generally not contain price-sensitive information as issuers are under an obligation to publish price-sensitive information as soon as they are aware of it, and do not wait until a full set of accounting figures has been produced.

These first three steps yielded the sample of FTSE350 announcements for each year in the table below:

Table 2: Sample of FTSE350 announcements[24]

Number of announcements	1998	1999	2000	2002	2003	**Total**[25]
	99	135	251	369	367	**1221**

For the take-over announcements analysis there were 183 announcements in 2000 and 102 announcements in 2004 with sufficient data to analyse. These were formal announcements of take-over bids, registered by the Takeover Panel. These announcements mark the time when trading on knowledge of a takeover becomes acceptable.

5.2 Methodological issues

5.2.1 Modelling expected returns

As indicated in section 3 above, the key to identifying abnormal returns is to define what "expected" returns are. A simple "model" of expected returns would be to assume that a stock's return on any given day would be the average return over a previous time period. This is what we did for our take-over announcements – we took the average daily return for the 240 days ending 10 days before the announcement. The fact some of these stocks trade relatively infrequently reduces the value of more sophisticated models.[26]

24 Where there was incomplete stock price data for the issues, the announcement was dropped.

25 The annual number of regulatory announcements has substantially increased in recent years. This increase could reflect the impact of FMSA itself (including its impact on penalties for non-disclosure), economic coniditions, technological change and increased investor demand for communications from issuers among other factors.

26 We also applied the market model used for the FTSE350 announcements to the M&A announcements. This made no statistically significant or meaningful difference to any of our results or conclusions relating to M&A announcements.

For our FTSE350 analysis, we calculate the expected return by calculating a statistical relationship between the stock and the market[27]:

Equation 1: Daily expected return according to the market model

$$\text{Daily Expected Return} = \alpha + ß \cdot \text{Daily Market Return}$$

The model was estimated using daily data on the stock return and the FTSE350 return over the 240 trading days ending 10 days before the announcement.[28] The parameter ß in the model captures the extent to which the stock's return depends on the market return over that period while α represents the expected value of the daily return to that stock in addition to any market-driven movements over that period. E.g. a positive α could arise because an issuer's stock has outperformed the market during the period due to superior management. Using this model will help prevent us from identifying an abnormal return as being statistically significant in an instance where a stock price has moved significantly but only because the market as a whole has moved.[29] The daily abnormal return is the difference between the daily expected return (as defined above) and the actual return on the stock for that day. Cumulative abnormal returns (CARs) are the sum of abnormal returns over periods of two or more days.

An alternative approach to expected returns would be to include in the model not only the market return but also the return to a particular sector of the market (e.g. pharmaceuticals). One reason we have not done this is resource constraints. However, there is also a methodological justification. Individual stocks can comprise a relatively large part of a sector. If sector returns and stock returns are highly correlated for that reason, including the sector return could create a misleading impression that returns were not abnormal in some instances. This is because the stock return and sector return will move together in response to an announcement of significant news about that company.

In theory, failing to take account of movements in the sector could bias upward our measure of insider trading. This is because announcements by one firm in a sector,

27 For more information on the use of the market model and its properties see MacKinlay (1997)

28 This period is known as the "estimation window"

29 The use of this model for statistical purposes does not require us to assert that all the assumptions of the Capital Asset Pricing Model hold true.

which reveal new information about factors which affect all issuers in that sector, could affect the share price of other issuers in that sector. If other issuers then make announcements of their own within a few days, the pre-announcement movement in their share price could show up as an IPM. As explained below, we do not believe this phenomenon is driving our results, mainly because it is not applicable to our analysis of take-over announcements, for which the results are similar. In addition, Brown & Warner (1985) suggest that in studies similar to ours the specification of the model is relatively unimportant.

5.2.2 Choice of "event" window

The event window is the length of the period over which CARs are calculated. As explained in section 3 above there are two periods of interest to us for each announcement. One is the period before the announcement which is used to determine whether an IPM has taken place – the "pre-announcement window". The other is the period after the announcement (the "post-announcement window") which, together with the period before the announcement, is used to determine whether the announcement contains "significant" news.

The length of these periods (the "event window") is a critical decision which reflects a number of factors. One concern is that, the longer the window, the more difficult it is to detect statistically significant returns.[30] So there are reasons for keeping event windows relatively short – limited to just a few days. However, it is important that the pre-announcement window matches up with the time period over which insider trading is expected to take place. There is a trade-off between these two concerns. Based on the experience of the FSA's supervision and enforcement staff we decided to set the pre-announcement window as the two trading days before the day of the announcement.

We acknowledge that this window will both begin too late and end too soon to cover all instances of insider trading. It is possible for insider trading to take place weeks before an announcement.[31] It is also possible for insider trading to take place minutes before an announcement is made on the day of announcement. Our use of a two-day window is consistent with other studies such as Gadaroski and Sinha (2003), although as we noted above Bulkely et al (2002) use a five-day window.

30 In statistical language, a longer "event window" weakens the power of the test – see Ch.4 of Campbell et al (1997).

31 This was especially thought to be the case for M&A announcements which is one reason they have been treated separately in our analysis.

The choice of the post-event window is less problematic. It is only necessary that it is long enough for any new information in a regulatory announcement to be incorporated into the price of a stock. Again we use a two-day window comprising the day of the announcement itself and the day afterwards (i.e. the "two days after" the announcement). It is recognised that new information is incorporated into stock prices relatively quickly and that a two-day window should suffice.[32] So the length of the window over which total CARs are measured is four days.

5.2.3 Identifying "significance"

We have explained how (four-day) total and (two-day) pre-announcement CARs are calculated. These are key to understanding the measure of market cleanliness:

Equation 2: The measure of market cleanliness

$$= \frac{\text{Number of IPMs}}{\text{Total number of significant announcements}}$$

"Significant announcements" are those for which the total four-day CAR (two days before and two days after the announcement) is statistically significant. IPMs are (two-day) pre-announcement CARs which are in the same direction (have the same sign) as the total CAR and are statistically significant. So we need a method to assess whether the observed pre-announcement CAR and total CAR for each announcement in our sample are statistically significant.

The approach we have used to make this assessment is called the "bootstrap" method. To implement the bootstrap method to assess whether the total (four-day) CAR associated with a particular announcement was significant or not, we take the following steps:

1. For each announcement we have data on daily stock returns for the 240 trading days ending 10 days before that announcement. By applying Equation 1 above and information on the daily market return we generate

32 This is the window used in Gadarowski and Sinha (2003).

an expected return for each of these days.[33] We then calculate the abnormal return for each of the 240 days as the difference between the expected and actual return for each day.

2. Because we are interested in the significance of a four-day CAR we draw four one-day abnormal returns from the set of 240 at random and sum them to calculate a "simulated" four-day CAR.

3. We repeat this exercise 10,000 times yielding 10,000 random simulated four-day CARs.

4. We compare the actual total CAR associated with the announcement with these 10,000 simulated total CARs. We deem the actual total CAR to be statistically significant at the 1% level if it is less than or equal to the 50th most negative simulated total CAR or greater than or equal to the 50th most positive simulated total CAR.[34]

These steps generate detailed information about the "distribution" of the total CAR for each announcement from the limited number of four-day CARs we have data for. The intuition behind this approach is that the 240 daily abnormal returns we have data on reflect a randomly drawn sample from a true population of abnormal returns (ARs). By drawing four ARs from this sample randomly 10,000 times in the manner described above and adding them together, it is as if we are sampling 10,000 from the true population of 4-day CARs, rather than just once. This provides enough information to understand the variation in four-day CARs and identify CARs which are statistically signficant.

A similar process can be used to identify whether the pre-announcement CAR associated with an announcement is significant. The only differences are in step 2 above, where we draw two one-day abnormal returns, rather than four; and in step 4, where we deem the two-day CAR to be statistically significant at the 10% level, i.e., if it is less than or equal to the 500th most negative or greater than or equal to the 500th most positive simulated two-day CAR.[35]

33 We are, therefore, applying Equation 1 to the same data which were used to estimate it.

34 The CAR will be statistically significant at the 1% level if it is less than or equal to the 50th most negative simulated total CAR or greater than or equal to the 50th most positive simulated total CAR.

35 Footnote 11 provides the explanation as to why different significance levels are used to identify significant events and to identify IPMs.

6. Results

We have explained the information required to calculate our measure. The first part of this section presents these calculations. The second part describes the method and results of further bootstrap analysis which is required to draw inferences from the calculation. The third part of this section returns to the question of what factors other than FSMA could affect the measure and considers the extent to which valid inferences about FSMA can actually be drawn from changes in the measure.

6.1 Calculating the measure

The results are presented in the table below.

Table 2: The measure of market cleanliness for the FTSE350 analysis

Time period	Significant announcements	IPMs	Measure
Before FSMA	55	19	34.5%
After FSMA	54	20	37%
Change			+2.5%

Table 3: The measure of market cleanliness for the take-overs analysis

Time period	Significant announcements	IPMs	Measure
Before FSMA	99	29	29.3%
After FSMA	57	22	38.6%
Change			+9.3%

From Table 2 and Table 3 above it might be tempting to draw two conclusions:

- the level of insider trading is very high with over 30% of significant announcements being preceded by informed price movements; and
- the level of insider trading has increased despite FSMA.

However, to draw these conclusions from this information alone would be incorrect. This is because the method we have used to select significant announcement tends to bias upward our estimate of the number of IPMs.

This in turn is because of a circularity in our approach. Large pre-announcement CARs can contribute to a finding that over the 4-day period before and after the announcement the CAR is significantly abnormal and that the announcement is therefore "significant". So "significant" announcements are more likely to have large pre-announcement CARs than other announcements, simply as a result of the way we have selected them and regardless of whether insider trading has occurred.

The implication is that our raw estimate of the proportion of IPMs is biased upward. Yet we cannot be certain that the effect of this bias will be the same before and after FSMA. Thus, the difference in the proportion of IPMs may be to some extent due to differences in the level of bias between the two periods. The next section explains how we have sought to deal with this bias.

6.2 Correcting for bias

We have taken two approaches to dealing with this bias.

The first approach ("method 1") proceeds on the assumption that the significant announcements we identify can be divided into two sorts. On the one hand there are announcements which contain genuine news and would have been identified by us as significant regardless of any "random" movements (unrelated to informed trading on that news) in the share price before the announcement. On the other hand there are announcements which contain no genuine information but have been identified as significant purely as the result of extreme random movements in the share price over a four-day period. Because we set the significance level for our announcements at 1% we would expect 1% of all announcements to be incorrectly identified as containing significant news when they actually do not. For example, because there were 485 pre-FSMA FTSE350 announcements in total, we would expect between four and five announcements to be incorrectly identified as significant.

The proportion of these "false significant" announcements which are preceded by significant price movements in the same direction is very high. The reason is that the post-announcement price movement for a false significant announcement is typically smaller than for a genuinely significant announcement. So a false significant announcement will only make it into our sample of significant events if it has a relatively big pre-announcement CAR, which is also in the same direction as the post-announcement CAR. In fact, for false significant announcements, the pre-announcement CAR will need to be statistically significant and in the same direction as the total CAR most of the time.[36] Including false significant announcements in our sample will therefore bias upward our measure.

Following this logic we recalculate the measure deducting the expected number of false significant announcements from the denominator and the expected number of "false IPMs" associated with those false significant announcements from the numerator. This gives the results in the table below.

Table 4: The measures of market cleanliness, adjusted for bias (method 1)

Time period	Adjusted FTSE350 measure	Adjusted M&A measure
Before FSMA	31.3%	28.5%
After FSMA	32.1%	35.9%
Change	+0.9%	+7.4%

We also investigated a second approach to handling bias ("method 2"). As noted above, Method 1 assumes that, aside from the "false significant" announcements which contain no real news at all, all the other announcements would have (rightly) been identified as significant, regardless of any "random" movements (unrelated to any informed trading on genuine news) in the share price before the announcement.

In fact, there may be other announcements among those we identify as significant, which contained some relevant information but not so much as to guarantee that they would have been identified as significant at the 1% level in the absence of chance movements in the pre-announcement stock price of sufficient size and in the right direction. The existence of such announcements will also bias upward our measure.

36 Bootstrap analysis for our samples indicates over two-thirds of random significant four-day CARs have a CAR for the first two days which is in the same direction and significant at 10%.

As an alternative approach to eliminating bias we sought to simulate what our measure would have been in the absence of informed trading. To do this we used a bootstrap to create 10,000 randomised versions of our dataset in which the actual two-day post-announcement CAR for each announcement was combined with a random two-day "pre-announcement" CAR generated in the manner described in section 5 above. Because these pre-announcement CARs are random, they cannot, by definition, reflect informed trading. As indicated in the table below, when we create a randomised data set in this way, we find that the number of significant announcements preceded by apparent IPMs is well above zero. To put it another way, we would not expect our measure to be zero if there were no insider trading.

Table 5: Expected number of false IPMs in the absence of informed trading

Sample	FTSE350 dataset	M&A dataset
Before FSMA	7.6	8.6
After FSMA	9.9	6.4
Change	+2.3	-2.2

In percentage terms, the numbers in table 5 for our FTSE350 dataset represent 15.1% of significant announcements before FSMA and 19.7% of those after FSMA, indicating that the bias was higher after than before FSMA. By subtracting the expected number of false significant announcements from the denominator (defined in the same way as under method 1) and the expected number of false IPMs (from the table above) from the numerator we obtain measures adjusted for bias in the table below.

Table 6: The measures of market cleanliness, adjusted for bias (method 2)

Time period	Adjusted FTSE350 measure	Adjusted M&A measure
Before FSMA	22.8%	21%
After FSMA	21.7%	28.9%
Change	-1.1%	+7.9%

6.3 Are these results statistically significant?

We used further bootstrap analysis to understand the variation in the adjusted statistics calculated above. This allowed us to test whether there is evidence of informed trading (i.e. whether the level of the statistics is significantly different from zero) and whether there is evidence that FSMA had an effect (i.e. the change in the statistics from one period to the next is significant). The details of these bootstrap procedures and results (including confidence intervals) are provided in Section 9 below. The conclusions from this analysis can be summarised as follows:

- For both time periods, for both the FTSE350 and M&A analysis, both versions of the measure are above the level required for them to be considered significantly different from zero at the 1% level. This provides evidence that informed trading is taking place.
- In one case, the change in the measure is statistically significant. The measure for the M&A announcements in the post-FSMA period adjusted using method 1 is significantly different from the measure calculated for the pre-FSMA period at the 1% level. This provides evidence that informed trading may have increased for M&A announcements.
- In no other case is the change in the measure statistically significant although the change in the M&A measure adjusted using method 2 comes close to statistical significance. This provides evidence that FSMA had yet to have an impact in the period covered by the data.

The confidence intervals associated with the measures are quite wide. This implies a limited chance of finding a statistically significant increase or decrease from one period to another. Details are provided in Section 9.

6.4 Interpreting the results

There are several factors which, throughout the design of this study, we considered might prevent us from drawing meaningful conclusions from changes in our measure. Now the methodology has been set out in full we are able to consider these factors and comment on the extent to which they need to be accepted as a caveat to our analysis.

The potential difficulty with drawing inferences about market cleanliness from changes in our measure is that it is possible that differences in our sample and data

between two periods could lead to our measure changing but not as the result of changes in the level of insider trading. This means it may not be possible to "identify" changes in our measure with changes in the level of insider trading.

We have considered six factors which could change over time and, in theory, lead to such an identification problem: market direction; the overall number of announcements made by issuers; the ability of insiders to trade without moving prices; market volatility; the size of issuers in our sample (which might be associated with differences in the quality of inside information control by the issuer); the spending of issuers in our sample on R&D, the results of which may generate inside information.

Regarding the first three factors, we do not perceive any intuitive reason to believe these are driving our results. For the last three factors and several others we provide descriptive statistics below in section 8. Based on these statistics, we believe that there is unlikely to be a major identification problem. However, as we compile more data, it should be possible to employ a more sophisticated statistical approach which takes account of these factors and reduces or eliminates the potential identification problem.

7. Conclusion

We have developed what we hope is an intuitively simple measure of market cleanliness. We also believe it is a useful measure. The measure was developed following detailed consideration of alternative approaches, the full details of which are not presented in this paper. For example, we considered several ways of identifying those announcements which contain the most significant news. We believe our approach avoids subjectivity involved in reading and classifying announcements based on our own interpretation of the information in those announcements. Our approach also avoids problems associated with the overall increase in the number of announcements which appears to have taken place in recent years. We welcome any comments from interested parties on the methodology or results presented in this paper.

Analysis of this measure before and after the introduction of FSMA in 2001 does not suggest that the level of insider trading has fallen. Evidence from previous studies suggests that this could reflect the fact that the first prosecutions under the new rules did not occur until 2004. It may also be relevant that the fines imposed in those cases were relatively small.

The amount of work required to perform again the analysis in this paper is minimal, as data on announcements and stock prices is easily available in electronic form and we expect to continue to monitor this measure in future.

8. Descriptive statistics

The tables below show for both FTSE 350 and M&A samples the descriptive statistics of the variables mentioned in section 6. As noted above, changes in the average values of these variable over time could, in theory, lead to changes in our measure that would not be attributed to changes in the level of insider trading.

Tables 7, 8 and 9 present data on the FTSE350 announcements and tables 10, 11, and 12 present the same statistics for the M&A announcements. The first of each set of tables presents statistics calculated using all announcements in the relevant sample. The second presents statistics calculated only using data for significant announcements. The third table presents statistics using only data for significant announcements which are also preceded by IPMs.

Five statistics are presented:

- the market value of equity, which is used as a proxy for firm size;
- the ratio of research and development (R&D) expenditure as a proportion of sales. The amount of inside information generated by a firm may in theory increase as this ratio increases;
- the mean square error of the market model regressions. This captures the "fit" of the regressions and is presented as a proxy for market volatility;

- the standard deviation of the FTSE350 daily returns, as another proxy for market volatility;
- the 4-day mean absolute abnormal return, which measures the size of abnormal returns associated with significant events. This statistic is by definition much larger for the significant announcements than for the samples which include non-significant announcements; and
- the leakage ratio, which is the proportion of the 4-day abnormal return which occurs in the two-days before the announcement.

The last two statistics are presented for information only. We do not seek to draw inferences from changes in the leakage ratio because, as described in Schwert (1996) this statistic follows a Cauchy distribution with an infinite variance and undefined mean.

Table 7: Descriptive statistics for FTSE 350 sample by time period

Time period	Before FSMA	After FSMA	Full period
Market Value Equity (Mean (s.d.), £ Millions)	7713 (25966)	6474 (22605)	6966 (23986)
R&D/Sales (Median (s.d.))	0.89% (13%)	1.57% (20%)	1.45% (17%)
Volatility (Mean (s.d.) MSE of OLS regressions)	0.026 (0.011)	0.024 (0.012)	0.025 (0.012)
Standard Deviation of FTSE350 Daily Returns	1.09%	1.39%	1.22%
4-day Mean (s.d.) Absolute Abnormal Returns	6.4% (7.3%)	5.7% (9.2%)	6.0% (8.4%)

Table 8: Descriptive statistics for FTSE350 significant announcements' sample by time period

Time period	Before FSMA	After FSMA	Full period
Market Value Equity (Mean (s.d.), £ Millions)	2542 (4505)	3221 (10547)	2866 (7997)
R&D/Sales (Median (s.d.))	1.50% (4.3%)	3.82% (8.7%)	1.74% (6.55)
Volatility (Mean (s.d.) MSE of OLS regressions)	0.023 (0.009)	0.027 (0.016)	0.025 (0.013)
4-day Mean (s.d.) Absolute Abnormal Returns	20.7% (11%)	27.6% (20.1%)	24.1% (15.5%)
Leakage Ratio (Mean)	33.1%	27.8%	30.4%

Table 9: Descriptive statistics for FTSE350 IPMs sample by time period

Time period	Before FSMA	After FSMA	Full period
Market Value Equity (Mean (s.d.), £ Millions)	2264 (2840)	2701 (6324)	2477 (4838)
R&D/Sales (Median (s.d.))	1.06% (2.8%)	1.46% (1.6%)	1.46% (2.0%)
Volatility (Mean (s.d.) MSE of OLS regressions)	0.023 (0.010)	0.026 (0.014)	0.024 (0.012)
4-day Mean (s.d.) Absolute Abnormal Returns	19.6% (12.1%)	23.8% (16.9%)	21.8% (14.5%)
Leakage Ratio (Mean)	55.2%	47.5%	51.3%

Table 10: Descriptive statistics for M&A sample by time period

Time period	Before FSMA	After FSMA	Full period
Firms in FTSE 350 (% of total)	24%	28%	26%
4-day Mean (s.d.) Absolute Abnormal Returns	23.2% (19.3%)	22.0% (18.1%)	22.8% (18.9%)

Table 11: Descriptive statistics for M&A significant announcements' sample by time period

Time period	Before FSMA	After FSMA	Full period
Firms in FTSE 350 (% of total)	21.2%	28.1%	24.2%
4-day Mean (s.d.) Absolute Abnormal Returns	35.0% (17.7%)	31.8% (17.5%)	33.8% (17.6%)
Leakage Ratio (Mean)	21.3%	20.4%	21%

Table 12: Descriptive statistics for M&A IPMs sample by time period

Time period	Before FSMA	After FSMA	Full period
Firms in FTSE 350 (% of total)	27.5%	31.8 %	29,4%
4-day Mean (s.d.) Absolute Abnormal Returns	35.3% (17.4%)	29.0% (15.6%)	32.6% (16.6%)
Leakage Ratio (Mean)	40.4%	33.3%	36.4%

The main conclusions from the analysis of the variables' value in each period and of their difference between periods are the following:

- The Market Value of Equity, R&D /Sales and Volatility[37] variables for the FTSE350 sample and sub-samples show an increase after FSMA. This increase is insignificant (less than 1 s.d. in the sample). We also noted the decrease in the mean Market Value of Equity between the full sample and the sub-samples, which suggests that significant announcements and IPMs tend to be associated with smaller firms.
- The 4-day Mean Absolute Abnormal Returns increase for the two FTSE350 sub-samples and decrease for the two M&A sub-samples. These changes are insignificant (less than 1 s.d. in the sample) except for the sample of FTSE 350 significant announcements.

From changes in these descriptive statistics, we do not conclude an identification problem exists. However, as noted above, in future, as we compile more data, it should be possible to develop a more sophisticated statistical approach which would allow us to test for potential identification problems.

9. Mathematical specification of model and tests

The tables below show for both FTSE 350 and M&A samples the descriptive statistics of the variables mentioned in section 6. As noted above, changes in the average values of these variable over time could, in theory, lead to changes in our measure that would not be attributed to changes in the level of insider trading.

37 The only exception is Volatility that for the full FTSE350 sample shows a slight decrease

For each FTSE350 event (announcement) we computed the firm's abnormal return, which is defined mathematically as:

$$AR_{it} = R_{it} - E(R_{it}) \qquad (1)$$

where *i* refers to the firm, *t* to the day and where $E(R_{it})$ is the expected value of the return of firm *i* in day *t*. The expected returns $E(R_{it})$ are defined as:

$$E(R_{it}) = \alpha_i + \beta_i \cdot R_{mt} \qquad (2)$$

R_{mt} is the FTSE 350 return in day *t* and α, β are estimated for firm *i* by regressing the stock return on the index return in the regression window – the 240 tr ading days, *t* = -250 to *t* =-10, ending 10 days before the event day (where the event day *t* = 0) – according to the following linear relationship:

$$R_{it} = \alpha_i + \beta_i \cdot R_{mt} + \varepsilon_{it} \qquad (3)$$

For M&A events the expected return was simply the average over the estimation window.

$$E(R_{it}) = \frac{\sum_{t=-250}^{-10} R_{it}}{240} \qquad (4)$$

Aggregating abnormal returns over several days results in the cumulative abnormal return (CAR), which is defined mathematically as:

$$CAR_i(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{it} \qquad (5)$$

We examine two variables: a pre-announcement CAR τ_1 = -2 and τ_2 = -1 and a total CAR where τ_1 = -2 and τ_2 = +1 for each announcement *i*, where τ_1 and τ_2 are the first and the last day of the period under analysis.

2 and 4 drawn from $\hat{F}_i$, the sample of abnormal returns for stock *i* in the regression window.

$$\hat{F}_i = (AR_{I,-250},\ldots,AR_{i,-10}) \qquad (6)$$

where,

$$^2CAR^*_i(-2,-1) = S(AR^*_{i1}, AR^*_{i2}) \qquad (7)$$

$$^4CAR^*_i(-2,+1) = S(AR^*_{i1}, AR^*_{i2}, AR^*_{i3}, AR^*_{i4}) \qquad (8)$$

with

$$S = \sum_{s=1}^{n} AR_{is} \qquad (9)$$

Note that when we use * in the notation the indexes do not refer to the actual sample but rather to the randomized version of AR_{is}.

Our unadjusted measure is then a proportion p^k of m^k, with *k=before, after* implementation of FSMA:

$$p^k_{unadjusted} = \frac{r^k}{m^k} \qquad (10)$$

m^k is the number of announcements containing significant information:

$$m^k = \sum_{i=1}^{N} Y_i^k \qquad (11)$$

and Y_i^k equals: 1 – if the event is considered a "significant announcement", i.e., for which the four-day CAR is less than or equal to the *q*th most negative or *q*th most positive simulated CAR for that event where q is 50 given a 1% significance level is used; and
0 – otherwise.

r^k is the number of announcements containing significant information and with suspicious price movements before the event:

$$r^k = \sum_{i=1}^{N} X_i^k \qquad (12)$$

and X_i^k equals: 1 – if the event is considered a "significant announcement" as well as an "IPM", i.e., pre- announcement CARs is significant at the 10% level and the direction of the CAR is the same as that for the total CAR associated with that event; and
0 – otherwise.

To adjust the measure $p^k_{unadjusted}$ using method 1 we obtain yet another random observation of ${}^4CAR^*_i(-2,+1)$ for each firm in our sample and apply (11) and (12) above in order to obtain an individual observation of m^k , r^k , which we call m^k_{false} , r^k_{false} as these are only "false significant announcements" and "false IPMs" that result from a purely random process. The process is repeated 10,000 times to obtain the distribution of the adjusted measure under method 1:

$$p^k_{method1} = \frac{r^k - r^k_{false}}{m^k - m^k_{false}} \qquad (13)$$

with,

$$E(p^k_{method1}) = \frac{r^k - E(r^k_{false})}{m^k - E(m^k_{false})} \qquad (14)$$

since m^k , r^k are values obtained from the real data and so are given.

To adjust the measure using method 2 we combine the actual two-day post-announcement CAR for each announcement ($T1$= 0 and $T2$ = 1) with a random two-day pre-announcement CAR, obtaining:

$${}^{2+2}CAR^*_i(-2,+1) = S(AR^*_{i1}, AR^*_{i2}, AR_{i0}, AR_{i1}) \qquad (15)$$

where AR^*_{i1}, AR^*_{i2} are derived from $\hat{F}_i$ in a similar way to ${}^2CAR^*_i(-2,-1)$ and AR_{i0}, AR_{i1} are the real values of the abnormal return for firm i in the day and the day after the announcement.

We then apply (12) above, in order to obtain an individual observation of r^k , which we call r^k_{noIT} indicating that it is an estimate of r^k in the absence of informed trading since it results from a purely random process. The process is repeated 10,000 times to obtain the distribution of the adjusted measure under method 2:

$$p^k_{method2} = \frac{r^k - r^k_{noIT}}{m^k - m^k_{false}} \qquad (16)$$

with,

$$E(p^k_{method2}) = \frac{r^k - E(r^k_{noIT})}{m^k - E(m^k_{false})} \qquad (17)$$

To test whether a statistic is significantly different from zero, the point estimate and the 99% and 95% confidence intervals for statistics $p_{method1}$ and $p_{method2}$ are shown below. In all cases the point estimates and confidence intervals are well above zero.

Table 13: Tests of measures' difference from zero

	$E(P_{method1})$	99%	95%	$E(P_{method2})$	99%	95%
		confidence interval of $P_{method1}$	confidence interval of $P_{method1}$		confidence interval of $P_{method2}$	confidence interval of $P_{method2}$
Pre-FSMA, FTSE 350 sample	31.3%	[22.2%, 36.7%]	[25.0%, 35.8%]	22.8%	[7.7%, 35.4%]	[11.5%, 32.7%]
Post-FSMA, FTSE 350 sample	32.2%	[21.4%, 39.6%]	[24.4%, 38.0%]	21.7%	[2.1%, 37.8%]	[8.0%, 34.1%]
Pre-FSMA, M&A sample	28.5%	[25.5%, 30.2%]	[26.3%, 29.9%]	21.0%	[13.4%, 26.9%]	[15.5%, 25.8%]
Post-FSMA, M&A sample	35.9%	[31.4%, 38.9%]	[32.7%, 38.2%]	28.9%	[18.5%, 36.5%]	[21.4%, 35.2%]

From the distribution of $p^{k}_{method1}$ and $p^{k}_{method2}$ before and after FSMA, we generate for each firm a random sample of size 2 drawn from $\hat{G}_{j}^{\,beforeFSMA}, \hat{G}_{j}^{\,afterFSMA}$ where:

$$\hat{G}_{j}^{\,beforeFSMA} = (p^{beforeFSMA}_{method_j,1}, \ldots, p^{beforeFSMA}_{method_j,10000}) \quad (18)$$

$$\hat{G}_{j}^{\,afterFSMA} = (p^{afterFSMA}_{method_j,1}, \ldots, p^{afterFSMA}_{method_j,10000}) \quad \text{with } j = 1, 2 \quad (19)$$

We then form pairs of the random drawings of the measure and apply the difference between the 2 values, such that:

$$DIF_i^{*} = T(p^{afterFSMA\,*}_{method_j}, p^{beforeFSMA\,*}_{method_j}) \quad (20)$$

where,

$$T = p^{afterFSMA}_{method_j} - p^{beforeFSMA}_{method_j} \quad (21)$$

By repeating this process 10,000 times we obtain the distribution of the difference between pre-FSMA and post-FSMA measures, of which the point estimate and 99% and 95% confidence intervals are below. For the FTSE350 sample the point estimates are for both methods close to (and not significantly different from) zero. By contrast, the point estimates and confidence intervals for the M&A sample are well above zero.

Table 14: Tests of difference for pre-FSMA and post-FSMA measures

	$E(DIF_{method1})$	99% confidence interval of $DIF_{method1}$	95% confidence interval of $DIF_{method1}$	$E(DIF_{method2})$	99% confidence interval of $DIF_{method2}$	95% confidence interval of $DIF_{method2}$
FTSE 350 sample	0.9%	[-11.4%, 12.5%]	[-7.9%,9.5%]	-1%	[-25.3%, 21.5%]	[-18.7%, 16.0%]
M&A sample	7.4%	[3%,11.4%]	[4.1%,10.3%]	7.9%	[-3.8%, 18.6%]	[-1.0%, 16.2%]

10. References

Bhagat S and Romano R (2001) Event Studies and the Law Part II: Empirical Studies and Corporate Law, Yale Law School John M. Olin Center for Studies in

Law, Economics, and Public Policy Working Paper Series Year 2001 Paper 260

Bhattacharya U and Daouk H (2002) The World Price of Insider Trading, Journal of Finance, 57, 75-108, February 2002

Brown S and Warner J (1985) Using Daily Stock Returns – The Case of Event Studies, Journal of Financial Economics, 14, 3-31, 1985

Bulkley G and Herrerias R (2002) Stock Returns Following Profit Warnings, University of Exeter Xfi Centre for Finance & Investment, Paper Number: 04/02

Bulkley G, Harris R D F and Herrerias R (2002) Stock Returns Following Profit Warnings: A Test of Models of Behavioural Finance, University of Exeter Xfi Centre for Finance & Investment

Campbell J Y, Low, A W and MacKinley A C (1997) The Econometrics of Financial Markets; Princeton University Press

Gadarowski C and Sinha P (2002) On the Efficacy of Regulation Fair Disclosure: Theory and Evidence, Cornell University Working Paper.

Jayaraman, N, Frye, M B and Sabherwal S (2001) Informed Trading Around Merger Announcements: An Empirical Test Using Transaction Volume and Open Interest in Options Market , Financial Review (May 2001)

Kim, O, and Verrecchia R E (1991) Trading volume and price reactions to public announcements, Journal of Accounting Research 29, 302-321.

Kyle, A S (1985) Continuous auctions and insider trading, Econometrica 53, 1315-1136.

MacKinlay A C (1997) Event Studies in Economics and Finance, Journal of Economic Literature, Vol. XXXV, 13-39, March 1997

Meulbroek L (1992) An Empirical Analysis of Illegal Insider Trading, Journal of Finance 47 (5), 1992, 1661-1700.

Minenna, M (2003) The detection of market abuse on financial markets: a quantitative approach N. 54 Consob Studi e Ricerche

Mitchell M L and Netter J M (1994) The Role of Financial Economics in Securities Fraud Cases: Applications at the Securities and Exchange Commission, The Business Lawyer, February 1994.

Schwert, G. W. (1996), Markup Pricing in Mergers and Acquisitions, Journal of Financial Economics 41, 153-192

The Financial Services Authority
25 The North Colonnade Canary Wharf London E14 5HS
Telephone: +44 (0)20 7066 1000 Fax: +44 (0)20 7066 1099
Website: http://www.fsa.gov.uk

Registered as a Limited Company in England and Wales No. 1920623.
Registered Office as above.