Stock price distributions and news: Evidence from index options

by

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Abstract

We estimate the shape of the distribution of stock prices using data from options on the underlying asset, and test whether this distribution is distorted in a systematic manner each time a particular news event occurs. In particular we look at the response of the FTSE100 index to market wide announcements of key macroeconomic indicators and policy variables. We show that the whole distribution of stock prices can be distorted on an event day. The shift in distributional shape happens whether the event is characterized as an announcement occurrence or as a measured surprise. We find that larger surprises have proportionately greater impact, and that higher moments are more sensitive to events however characterised.

1 Introduction

In this paper, we ask whether the distribution of stock prices is influenced by new public information. We estimate the shape of the distribution of stock prices using data from options on the underlying asset, and test whether this distribution is distorted in a systematic manner each time a particular news event occurs. In particular, we focus on the impact of announcements of key macroeconomic figures on the distribution of a stock market index.

Uncovering the impact of news in the stock market has a long history. Early contributions include Sprinkel (1964), Palmer (1970), Homa and Jaffee (1971) and Hamburger and Kochin (1972) in the U.S.A., and Brealey (1970) and Saunders and Woodward (1976) for the U.K. With the exception of Brealey (1970), these early studies examined the impact of changes in the money supply on changes in the particular stock market price index. While the U.S. studies found that money supply changes were not immediately transmitted to stock market prices, the Saunders and Woodward study found the opposite result for the U.K. Brealey (1970) found that the U.K. stock market took more than one day to react to news about the trade balance.

More recently, studies have considered a wider range of macroeconomic surprises, reflecting the parallel literature on the pricing of macroeconomic risk factors that commenced with the work of Chen, Roll and Ross (1986).[1] Goodhart and Smith (1985) examined the relationship between U.K. stock market prices and surprises to the money supply, the retail prices index (inflation) and the government spending and trade deficits. They found that only the inflation surprise moved the stock market, while papers by Cutler, Poterba and Summers (1989) for the U.S. and Wasserfallen (1989) for a selection of European countries both concluded that macroeconomic news variables are able to explain only a tiny fraction of the variability of stock returns. McQueen and Roley (1993) found that by allowing for different stages in the business cycle, that a stronger relation between stock returns and news was evident. A comprehensive study of news and stock market behaviour was conducted by Mitchell and Mulherin (1994). They found that the number of

1. See also King (1966). Applications of the Chen, Roll and Ross two-step procedure to the U.K. stock market include Beenstock and Chan (1988), Poon and Taylor (1991), Clare and Thomas (1994) and Cheng (1995). In addition, Priestley (1996), applies the one-step method of Burmeister and McElroy (1988).

daily news announcements, observed on the Dow Jones wire service, had a significant impact on both the daily return and trading volume in the U.S. stock market. But, when this regression was supplemented by a dummy variable taking the value unity if the day was (also) a macroeconomic announcement day, this variable was not significant.[2]

What these previous studies share is a focus on the response of market prices to this news. This paper, by contrast, uses options market data to examine the response of the whole distribution of possible prices to the news. This builds on a body of work that has examined the relation between volatility implied by options markets and news releases. For example, Bailey (1988), Ederington and Lee (1993,1996 and 2001), Nofsinger and Prucyk (2003) and Sun and Sutcliffe (2003) have all explored the relation between macroeconomic announcements and the implied volatilities of options on a variety of underlying financial securities, while Patell and Wolfson (1979),(1981), Donders and Vorst (1996) and Acker (2002), among others, have examined the relation between stock option implied volatilities and microeconomic news. That research suggested that volatility reduced after news releases as uncertainty was resolved. Our results suggest that there is also higher moment sensitivity to macroeconomic surprises. Our research contributes in another way too. The earlier U.K. studies were undertaken at a time when monetary policy was conducted through controls on the money supply, whereas as the instrument of monetary policy is now the short term interest rate set by the Bank of England. Our results suggest that the stock market is extremely sensitive to these particular announcements. While knowledge of these distributional responses is helpful for market participants involved in risk management, it offers policy makers, perhaps more used to examining central tendency responses to macroeconomic shocks, a very rich additional source of market feedback.

The next section of our paper explains how probability distributions can be estimated from option prices, and then describes the application to stock index options. To determine whether news announcements have a systematic effect on the distributions, it is necessary to generate a time series of these distributions. The finite life of options contracts poses significant obstacles for the construction of a time

2. Some recent studies in this area include, Graham et al (2003), Kim et al (2004) and Nikkinen and Sahlstrom (2004a,b).

series of distributions, and in Section 3, we outline our method for constructing this series from the raw (i.e., maturity dependent) distributions. In Section 4, we describe in detail the macroeconomic announcements that will be used, and explain the method used to examine the relation between the distributions and the announcements. We present the results of this investigation in Section 5. Finally, Section 6 discusses the results in the context of event studies more broadly, and offers some concluding remarks.

2 Option prices and probability distribution functions

A European call option contract on an asset gives the holder the right, but not the obligation, to purchase the asset for a fixed "strike" price, X, at a fixed "maturity" date, T, in the future. The payoff to the call holder maturity is, therefore, $\text{Max}(0, S_T - X)$, where S_T is the price of the asset at date T. From the demonstration by Cox and Ross (1976) that option prices do not depend on preferences, option prices can be found as the expectation of the set of possible future payoffs discounted at the risk-free interest rate, namely

$$C(S,X,T) = \frac{E_Q[\text{Max}(0, S_T - X)]}{(1+R_T)^T} \tag{1}$$

where $C(S,X,T)$ is the price of the call option, R_T is the (discrete) risk-free interest rate, and E_Q denotes expectations under the risk-neutral probability measure. Alternatively, and working with the continuum of possible future asset prices, we can write

$$C(S,X,T) = e^{-rT} \int_X^{\infty} q(S_T)\text{Max}(0, S_T - X)]dS_T \tag{2}$$

where r_T is the (annualized) continuously compounded risk-free rate over the remaining life of the option, and $q(S_T)$ is the risk-neutral probability density over S_T.

The important characteristic of equation (2) is that it provides a link between option prices, the set of future payoffs to the option, and the density function. Given any two, it must be possible to find the third. Thus, it must be possible to infer the distribution of the underlying asset's price from option prices and the payoff structure of options. The possibility of obtaining probability distributions from option prices was first demonstrated by Ross (1976) and Breeden and Litzenberger (1978), who showed how combinations of option payoffs can represent the payoffs to Arrow-Debreu securities. Since the prices of these securities are proportional to the probability of the payoff, the link between option prices and probability densities is established.[3]

More usually, of course, equation (2) forms the basis of an option pricing relation. For example, under the assumption that asset prices evolve according to geometric Brownian motion, that is,

$$dS = \mu S\,dt + \sigma S\,dz \tag{3}$$

where μ and σ are constants, and dz are increments from a Wiener process, $\ln S_T$, has the probability distribution

$$\ln S_T \sim N[\ln S + (r - 0.5\sigma^2)T, \sigma\sqrt{T}] \tag{4}$$

where, $N(\alpha, \beta)$, indicates a normal density with mean α and standard deviation, β, and where (under risk-neutrality) μ has been replaced by r. Evaluating the right-hand side of (2), using (4), gives the Black-Scholes (1973) call option pricing formula.

There is now a considerable body of evidence to suggest that options are priced in markets that do not maintain the assumptions required for the Black-Scholes model. For example, all options on an asset should be priced with respect to the same constant volatility parameter, yet when the model is used in reverse, the volatility implied by market option prices is not constant across options with different

3. The distributions obtained from option prices will, of course, be risk-neutral. It is possible, by making assumptions about risk preferences, to derive the subjective distributions, see Jackwerth (2000). Where this has been done in previous studies, the general characteristics of the distributions tend to be quite similar. For example, Bliss and Panigirtzoglou (2004) show that the variability of risk neutral distributions is almost the same as for the subjective distribution.

characteristics. The frequently observed convex relation between implied volatility and strike prices is known as the volatility "smile". Early studies by Black and Scholes (1972) and Officer (1973) tested and rejected the constant variance assumption. Since then, a vast body of literature originating with Engle (1982) and Bollerslev (1986) documents the volatile behaviour of stock return variances. A property of these ARCH models is that, at least in part, they are able to explain the non-normality of returns. This feature of stock returns, in particular the excess kurtosis, was first noted by Fama (1965) and Mandelbrot (1963) and continues to persist.

Although a number of authors have proposed option pricing models when returns follow ARCH and other stochastic variance models,[4] we focus here on the distribution of returns rather than the process generating returns.[5] Specifically, we make an explicit assumption about the (non-normal) form of the density function, $q(S_T)$. Since this function could be compatible with more than one asset price process, it is arguably more general than the approach taken by the new pricing models of specifying a process.

Therefore, it is assumed that the density function of S_T can be adequately represented by the weighted sum of two lognormal density functions.[6] Option pricing using a weighted sum of more than one lognormal distribution has been explored by Ritchey (1990), and applied to estimating risk-neutral probability distributions by Melick and Thomas (1997) and Bahra (1997).[7] While any finite variance distribution model could be used to approximate the asset price density, Gaussian distributions have two desirable properties in this regard. First, they are stable under addition, such that the distributional form is preserved as the holding period increases. Second, empirical distributions from time series studies, such as the studies listed earlier, suggest that asset price distributions closely approximate lognormal distributions.

4. See, for example, Hull and White (1987), Heston (1993), Duan (1995), and Heston and Nandi (1997).

5. Corrado and Su (1996) and Backus, Foresi, Li and Wu (1997) have, independently, suggested using Gram-Charlier expansions to price options under skewness and excess kurtosis.

6. Evidence that mixture distributions more generally may be able to explain the non-normality of returns can be found in Clark (1973), Tauchen and Pitts (1983), Lamoureux and Lastrapes (1993) and Richardson and Smith (1994).

7. For a survey of additional applications of this and other methods of estimating implied distributions from options, see Jackwerth (1999).

The parameters of the two distributions and the weighting parameter are estimated using a non-linear least squares procedure, which minimizes the following function:

$$\underset{a_1, a_2, b_1, b_2, \phi}{\text{Min}} \quad \sum_{i=1}^{n} (c(X_i) - \hat{c}(X_i))^2 + \sum_{i=1}^{n} (p(X_i) - \hat{p}(X_i))^2$$
$$+ [\phi \exp(a_1 + (b_1^2/2)) + (1-\phi)\exp(a_2 + (b_2^2/2)) - \exp(r\tau)S]^2 \tag{5}$$

where the fitted call and put pricing functions, $\hat{c}(X_i)$ and $\hat{p}(X_i)$ are given by

$$\hat{c}(X_i, \tau) = \exp(-r\tau)\int_X^{\infty} [\phi\Lambda(a_1, b_1; S_T) + (1-\phi)\Lambda(a_2, b_2; S_T)]\,(S_T - X)dS_T \tag{6}$$

$$\hat{p}(X_i, \tau) = \exp(-r\tau)\int_0^{X} [\phi\Lambda(a_1, b_1; S_T) + (1-\phi)\Lambda(a_2, b_2; S_T)]\,(X - S_T)dS_T \tag{7}$$

where $\Lambda(a, b; S_T)$ indicates that S_T is lognormally distributed, with mean $\exp(a + b^2/2)$ and variance $(\exp(2a + b^2))(\exp(b^2 - 1)$.[8] The lognormal density is given by

$$\Lambda(a, b; S_T) = \frac{1}{\sqrt{2\pi}\, b S_T} \exp((-(\ln S_T - a)^2)/2b^2) \tag{8}$$

and the following parameter restrictions apply during estimation, $b_1, b_2 > 0$, and $0 \le \phi \le 1$. In the absence of arbitrage, the mean of the implied density function should equal the forward price of the underlying asset. By treating the underlying asset as a zero strike price option, we can use the incremental information that it provides by including its forward price as an additional observation in the minimization

8. Equivalently this implies $\ln(S_T) \sim N(a, b^2)$.

problem. Thus, the minimization problem also contains the weighted means of the two lognormal densities and the risk-neutral expectation of the underlying asset. Below we explain the estimation procedure as it applies directly to index options.

2.1 Estimating the Probability Density for the FTSE100 index

American style options on the FTSE100 index of the largest U.K. company stocks have been traded on the London International Financial Futures and Options Exchange (LIFFE) since May 3, 1984.[9] European style options were introduced on February 1, 1990, and these are the contracts used in this study. Although trading volumes in the European style options were low initially they had caught up by 1996 and overtaken the American style option volume by 1997.[10] In addition to being easier in principle to price, the European options also have the advantage of having a wider range of contracts available. Maturity dates are the 3rd Wednesday of the month in the next four in the quarterly cycle of March, June, September, December and the (union with the) next three calendar months. The options are cash settled. As with most index options, they are generally hedged using the index futures rather than the underlying. They are priced, therefore, as though they are options on the index futures. Of course, options on an index futures and options on the underlying index are equivalent when the assumptions of the Black-Scholes (1973) model hold. In fact, we explicitly recognize this property in the estimation routine by replacing risk-neutral expectation of the index value, which is forced to equal to weighted means of the lognormal densities, by the price of the corresponding index futures contract.

It is desirable to make a further modification to the estimation routine to by-pass the limit of infinity on the integral in equation (6). Attempting to evaluate this could lead to large numerical errors during the computations. An alternative procedure is to rewrite the call and put pricing functions in terms of cumulative normal

9. Prior to a merger with LIFFE in March 1992, options were traded separately from futures on the London Traded Options Market (L.T.O.M.).

10. While recovering implied distributions is more straightforward using European style options, methods appropriate to American style options have been developed by, for example, Jackwerth (1997), Barle and Cakici (1998), Flamouris and Giamouridis (2002) and Cincibuch (2004). In theory, the same information should underly both the prices of both American and European style options. In the case of FTSE100 options, European style contracts are more heavily traded and so their prices should be a more reliable input.

probabilities. Although this will require polynomial approximation, whereas an analytical expression was available for the lognormal density, it avoids the need to evaluate the integrals. It can be shown that equations (6) and (7) can be replaced by

$$C(X,\tau) = \exp(-r\tau)\{\phi[\exp(a_1 + b_1^2/2)N(d_1) - XN(d_2)] + (1-\phi)[\exp(a_2 + b_2^2/2)N(d_3) - XN(d_4)]\} \tag{9}$$

$$P(X,\tau) = \exp(-r\tau)\{\phi[-\exp(a_1 + b_1^2/2)N(-d_1) - XN(-d_2)] + (1-\phi)[-\exp(a_2 + b_2^2/2)N(-d_3) - XN(-d_4)]\} \tag{10}$$

where

$$d_1 = \frac{-\ln(X) + a_1 + b_1^2}{b_1} \quad , \qquad d_2 = d_1 - b_1 \tag{11}$$

$$d_3 = \frac{-\ln(X) + a_2 + b_2^2}{b_2} \quad , \qquad d_4 = d_3 - b_2 \tag{12}$$

Thus the minimization routine uses (5) and now (9) and (10) to estimate the parameters, a_1, a_2, b_1, b_2, ϕ, from which the fitted distribution can be obtained.[11]

3 Creating a time series of distributions

As the aim of this study is to determine how the distribution of stock prices responds to news announcements, it is necessary to create a time series of distributions with which to conduct the analysis. This presents particular difficulties as there are a selection of options available on any trading day and the contracts have finite lives. We now look at these particular features of the data and explain how we constructed a time series of distributions.

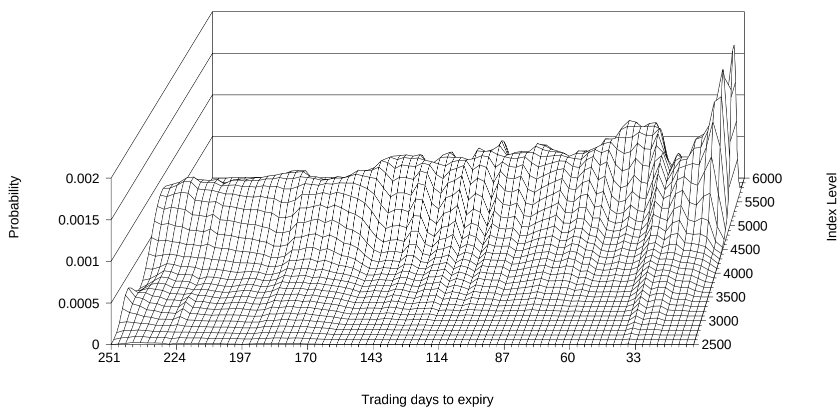
Our data consists of daily closing call and put prices on the FTSE 100 European style index option contracts spanning the period September 23, 1996 to May 22,

11. It has been noted by Bahra (1997) that on occasions this kind of estimation was assisted if the parameters of the lognormal densities were expressed in terms of the parameters of two geometric brownian motions, which have those lognormal densities. This substitution can be done using equation (4).

1998, a period of 421 trading days.[12] Using the method outlined above, distributions were estimated for the following option contract expiry months: January 1997 through to July 1998 and also September 1998 and December 1998.[13,14]

As an example, Figure 1 shows the path of estimated distributions for the December 1997 contract. At each date, the distribution represents the implied risk-neutral probabilities of the set of outcomes (index values) that could arise on the maturity date of the option, 15th December 1997. As the maturity date approaches so the distribution narrows, which indicates that the character of the distributions will change over time for reasons other than the impact of new information.

Figure 1: Implied Distributions from December 1997 FTSE100 Index Option Contract



12. The prices used are the daily settlement prices. While these will only be traded prices if a trade actually occurs during the last few minutes of the trading period, known as the closing range, they represent the best compromise between information content and synchronocity. Settlement prices are established at the end of the day and used for overnight "marking to market" and so should give a fair reflection of the market at the close of business.

13. Those contracts with a March expiry cycle have a one year maturity at issue, while those with maturities in between have maturities of three months.

14. The distributions were estimated for all contracts that existed over the period September 1996 to May 1998. This was done while the author directed the Instruments Research Group in the Monetary Instruments and Markets Division of the Bank of England. The assistance of former Group Analysts Bhupi Bahra and Paul Wesson in developing the estimation software is gratefully acknowledged.

For considering a local (in time) or once and for all news event, the examination of the distribution for a single date in the future may be sufficient. This could be augmented by considering longer and shorter maturity options to gain an assessment of longer and shorter term impacts of the particular news events. Rather than this static procedure, the framework here is dynamic and involves determining whether periodic news arrivals, in this case announcements of macroeconomic data, significantly change the shape of the distribution in a systematic manner. To capture the shape of the distributions, we calculate (standardized) moment-style statistics reflecting the mean, median, mode, variance, skewness and kurtosis of the estimated distributions. We now explain how these statistics, which for any given distribution are expiry dependent, were used to create a series of moments for capturing shape distortions in a dynamically consistent way.

Our solution to the problem of expiry date dependence is to combine the elements of the cross section of moment statistics on a particular day to create moment-style statistics that characterize a synthetic distribution, which is for a constant time in the future ahead of the observation date, as opposed to a fixed date which the observation date gradually approaches. Thus it will be as though there were "new" options available every day with the same length of time to expiry. The most natural and simple approach is to take a weighted average of the moments of the distributions whose maturities surround the chosen constant horizon.[15] So, the constant τ-period horizon distribution has moments defined by

$$M_{i,\tau} = \omega M_{i,a} + (1-\omega) M_{i,b} \qquad \omega = \frac{T_b - \tau}{T_b - T_a} \tag{13}$$

15. Except for the first moment, such weighted averages of moments will only be the moments of a weighted average distribution if the distributions are independent. An alternative approach would be to construct the entire synthetic distribution by interpolating between percentiles of the two estimated distributions, and then generating summary statistics from these distributions. In tests, this alternative approach produced similar results, so we chose to continue with the simpler weighted moments of the estimated distributions. For convenience, we refer to them as the moments of the synthetic weighted average distribution. Alternative methods to create a time series of distributions incorporating a non-parametric function for the implied distribution have been proposed by Clews et al (2000) and Panigirzoglou and Skiadopoulos (2004), while Hodges and Skiadopoulos (2001) develop a simulation approach using the lognormal mixture for the implied distribution.

where $M_{i,\tau}$ is the ith moment of the τ-period horizon distribution, $i = \{$Mean, Median, Mode, Standard Deviation, Skewness and Kurtosis$\}$, $M_{i,j}$ is the ith moment of the distribution of the jth contract within the appropriate expiration cycle, $j = a, b$, whose contracts maturities surround the τ-period horizon.

Two such constant horizons are chosen for investigation, six months (126 trading days), and six weeks (31 trading days). The former, longer horizon, series can be constructed using the sequence of options with quarterly expiry dates between March 1997 and December 1998. This six month horizon was always contained within the time to expiries of the second and third contract within this quarterly expiration cycle. Table 1 shows the pairs of contracts that were used to determine the six month fixed horizon moments, and the number of days to expiry as the contract pairs changed.

Table 1: Days to expiry of contract pairs defining "126-day" contract

		Days to expiry of contract expiring in							
Trading Date		Mar 97	June 97	Sept 97	Dec 98	Mar 98	June 98	Sept 98	Dec 98
Period beginning	23/09/96	126	187						
Period Ending	16/12/96	66	127						
Period beginning	17/12/96		126	190					
Period Ending	19/03/97		63	127					
Period beginning	20/03/97			126	191				
Period Ending	24/06/97			62	127				
Period beginning	25/06/97				126	188			
Period Ending	19/09/97				65	127			
Period beginning	22/09/97					126	187		
Period Ending	15/12/97					66	127		
Period beginning	16/12/97						126	190	
Period Ending	18/03/98						63	127	
Period beginning	19/03/98							126	191
Period Ending	22/05/98							83	148

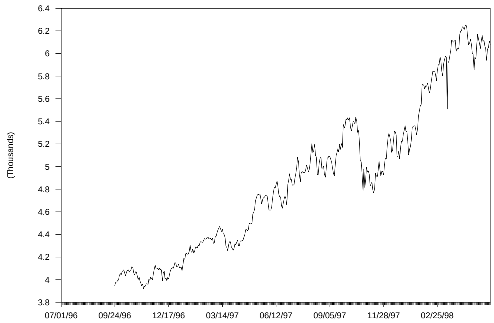
By contrast, the six week horizon contract, which is constructed from the near and next expiry month contracts, necessarily changes contract pairs every month. Indeed the window of potential fixed maturities that can be created from the near and next maturity contracts is small. During the sample period, the longest maturity of a next month contract on the expiry date of the near month contract is 26 days, while the shortest maturity of the near month contract on the issue of the next month contract is 36 days. The choice of 31 days, approximately 6 trading weeks, simply bisects this range.

The use of short maturity moment series alongside the long maturity, 6 month, moment series has these two advantages. Firstly, it provides an opportunity for validation of the individual findings. Second, the short maturity contracts are more heavily traded than their longer maturity counterparts and, therefore, should more obviously and more immediately reflect market news. Although as Figure 1 shows, the distribution data display a number of transitory characteristics towards the end of contract lives, these should be relatively week some six months out from maturity. Moreover for those options outside the March expiry cycle, six weeks is halfway through their contract life.

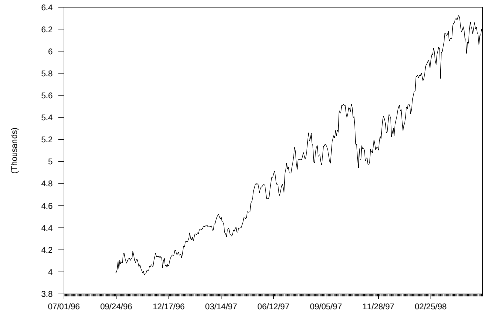
In addition to the two fixed maturity synthetic contracts the moment series for one of the individual contracts was examined, the December 1997 contract, as seen in Figure 1. As well as providing further evidence on the impact of news, this contract serves as a check that the concatenation of contracts does not cause any systematic distortions itself. Graphs of the moment series for both the six month and six week contracts indicate that the transitions across contract pairs appears smooth. Those for the six month series are included as an example, see Figures 2(a)-(f). Both sets of graphs do however suggest that some outlying observations may be present within the data. In particular, for the first and second moment series, the period October 27, 1997 until February 27, 1998 appears unstable, while for the third and fourth moment series, the period January 27, 1998 until February 23rd, 1998 may also cause problems. For example, the skewness of the distribution changes sign temporarily during this period. These two periods coincided with a period of global financial instability, precipitated by the devaluation of several south-east Asian currencies in the third and fourth quarters of 1997. In addition, there is a short period at the start of the data set, the period September 23, 1996 to October 21, 1996, where the skewness series shows some further instability. Procedures to control for the impact of these possibly outlying periods in the data are discussed in Section 4 below.

Figure 2: Time Series of Moments from synthetic "126-day" contract

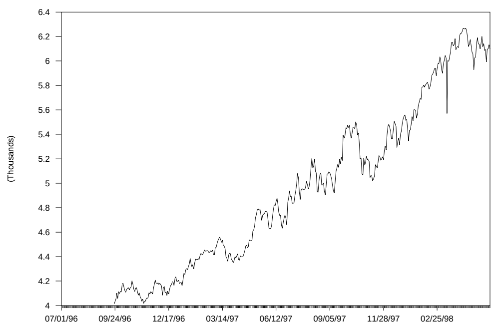
(a) Mean



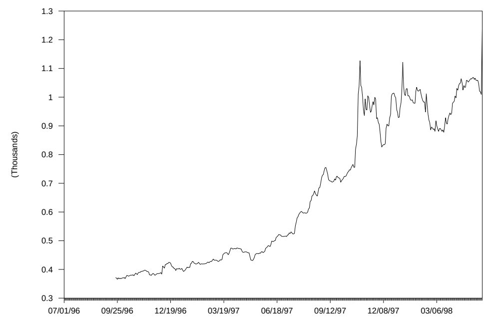
(b) Median



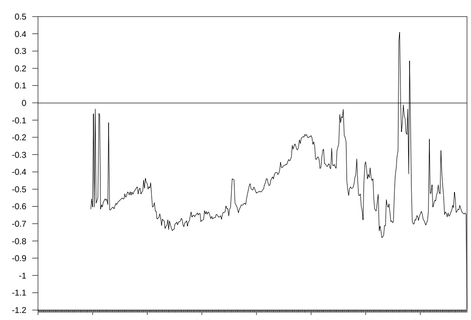
(c) Mode



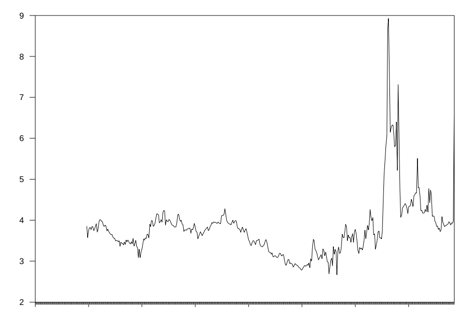
(d) Standard Deviation



(e) Skewness



(f) Kurtosis



In order to compare both within and across the moment series of the three contracts being studied, we consider as the dependent variable the daily proportional change in the moment series. Both summary statistics for the time series of distribution moment statistics and unit root tests indicated that this data transformation also provides for mean stationarity.

4 Representing the News in Macroeconomic Announcements

We consider announcements of the 4 macroeconomic variables that seem to attract the most public attention, the RPI (inflation), unemployment and other labour market statistics including wage growth, government borrowing (the Public Sector Borrowing Requirement, or PSBR), and the broad money supply, M4. In addition, we consider the announcements by the Treasury and latterly the Bank of England on the level of official short term interest rates. The impact of these, relatively recent, announcements has not been examined within the studies reviewed earlier.

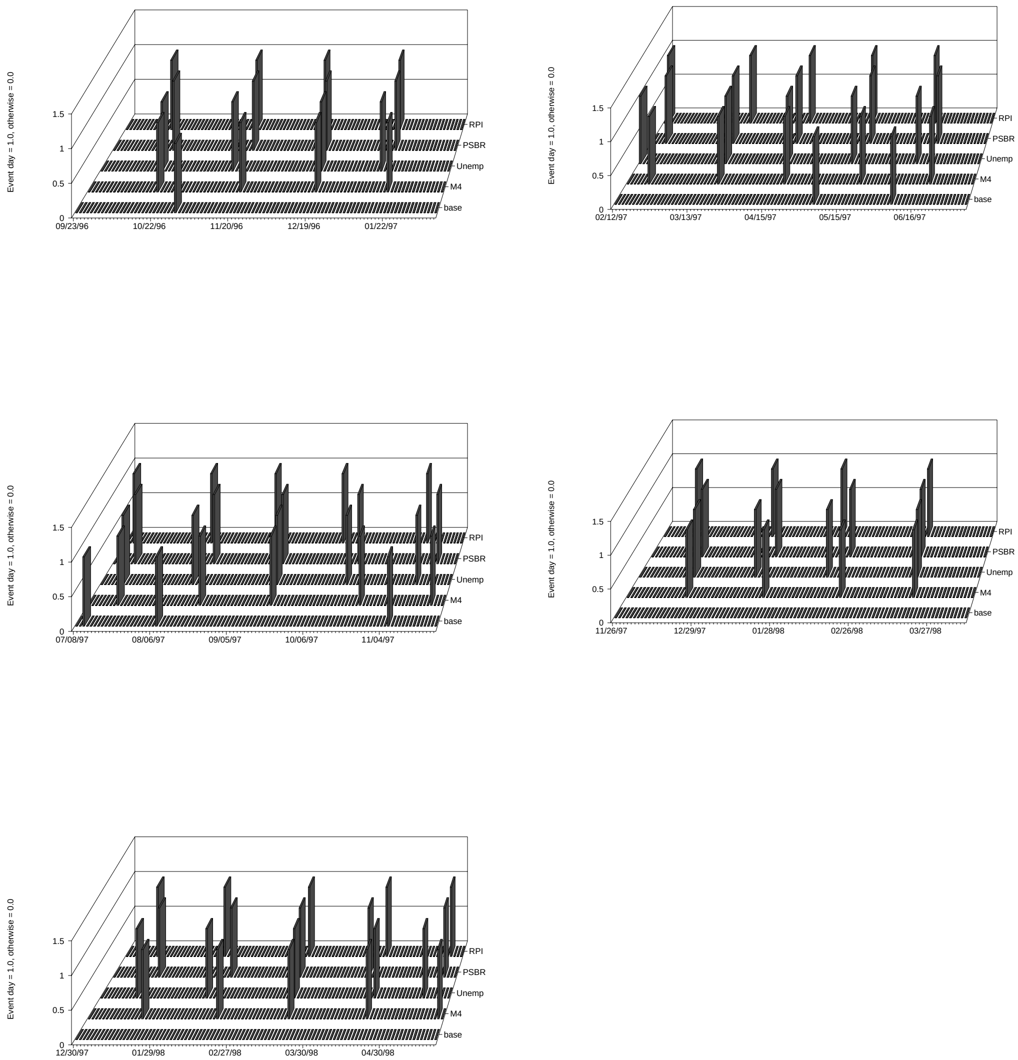
The impact of these announcements is examined in two ways. First, we focus on the announcement day as an "event" in its own right. That is, we ask whether on an announcement day the distribution of stock prices distorts from its usual (average) shape.

Thus, we employ the following regression model to undertake this test,

$$y_t = \beta_0 + \beta_1 \mathrm{baserate}_t + \beta_2 \mathrm{rpi}_t + \beta_3 \mathrm{psbr}_t + \beta_4 \mathrm{unemp}_t + \beta_5 \mathrm{M4}_t + \sum_{j=1}^{4} \beta_{j+5} \delta_{j+1,t} + u_t \tag{14}$$

where y_t is the proportional change from business day $t-1$ to day t in the value of the implied moment statistic of the distribution of future stock index prices, $\mathrm{baserate}_t$ is a binary variable that takes the value 1 if a base (interest) rate change was announced by the UK Treasury (or Bank of England) on business day t and takes the value 0 otherwise, rpi_t is a binary variable that takes the value 1 if a Retail Price Index (RPI) announcement took place on business day t and takes the value 0 otherwise, and $\mathrm{psbr}_t, \mathrm{unemp}_t, \mathrm{M4}_t$ are similarly defined for announcements of the Public Sector Borrowing Requirement, the unemployment statistics, and the M4 money supply figure, respectively. Since all the explanatory regressors are dummy variables, they directly detect deviations from the average (usual) value of the moments.

Figure 3: Sequence of Announcements



Figures 3(a)-(d) show the date sequence of announcements during the sample by plotting the value of the macroeconomic announcement variables.[16]

16. The dates on the graphs overlap from panel to panel.

Table 3: Macroeconomic Announcements and Days of the Week

	Monday	Tuesday	Wednesday	Thursday	Friday	Total
RPI	0	10	0	10	0	20
PSBR	4	10	3	2	1	20
Labour	0	0	20	0	0	20
M4	0	1	5	11	3	20
Base rate	0	1	1	3	1	6
Total	4	22	29	26	5	86

There are 86 announcements of the five variables during the sample period, and as there is some tendency for them to cluster on particular weekdays, see Table 3, we include a set of day of the week dummy variables in the announcement impact regressions, equation (14). For the U.S stock market, Chang, Pinegar and Ravichandran (1998) suggest that seasonal patterns in news can explain much of the usually observed day of the week effects in equity returns. Thus, the variables $\delta_{2,t}, \delta_{3,t}, \delta_{4,t}, \delta_{5,t}$ are day of the week dummy variables (2=Tuesday, 3=Wednesday, and so on).[17] We further introduce dummy variables, D_1, D_2, D_3, to control for the periods of outlying observations discussed earlier, which may in part reflect contagion effects from the south-east Asian financial crises during 1997 and 1998.

The second method considers the impact of the surprise in the announcement. The surprise to variable j on day t is defined as $S_{j,t} \equiv A_{j,t} - E_{j,t}$, where $A_{j,t}$ is the actual value of variable j on day t and $E_{j,t}$ is the expected, or forecast, value of variable j on day t. On days with no announcement on variable j, $S_{j,t} = 0$. Actual values of the announcement variables are available from the UK Office of National Statistics Publications: Economic Trends and Financial Statistics. For the macroeconomic aggregates, forecast values are medians from consensus forecasts published in the UK financial media.[18] Such forecasts of the base interest rate were not produced and so the entire change in the variable is considered to be the surprise.

17. Evidence regarding day-of-the-week effects in the U.K. stock market can be found in, for example, Choy and O'Hanlon (1989) and Steeley (2001).

18. I am grateful to Gary Xu for providing me with this data.

Both the infrequency and irregularity of these announcements, particularly in the early part of the sample where no official announcement timetable existed, suggests that this treatment of the announcements may not be unreasonable.

To enable comparisons of announcement effects, the surprises are scaled by the mean absolute surprise:

$$|\bar{S}_j| \equiv \frac{1}{N_j} \sum_t |S_{j,t}| \tag{15}$$

where N_j is the number of announcements of type j within the sample. Thus the regression equation for the surprise variables is now,

$$y_t = \beta_0 + \sum_j \beta_j \frac{S_{j,t}}{|\bar{S}_j|} + \sum_{i=1}^{4} \beta_{i+5} \delta_{i+1,t} + u_t \tag{16}$$

where y_t is the proportional change from business day $t-1$ to day t in the value of the implied moment statistic of the distribution of future stock index prices, $S_{j,t}$ is the surprise to the macroeconomic variable j, where j={baserate, RPI, PSBR, Unemp, M4}. Other variables are as previously defined.

5 Results

The results of estimating the coefficients in the regressions of the moment statistics on the announcement day dummies, using equation (14), are given in Table 4. The three panels contain results for, respectively, the six month, six week and December 1997 contracts.[19] Since the moment time series are constructed from distributions whose expiry periods overlap, we use the covariance matrix estimator of Newey and West (1987) to adjust the standard errors of the coefficients for autocorrelation.

19. The sample size for each contract is different. The six month contract uses the full span of data, from the date the first contract has 126 days to expiry. The six week contract starts at the point within the sample that the first available near contract has 31 days to expiry, some 50 days later. The December 1997 contract sample period stretches from issue until two months from maturity to prevent any impact from strong "pull to par" and delivery month effects.

The most striking result in Table 4 is in fact the least surprising. As the distribution estimation routine uses a constraint based on the forward price, and the fitted option prices also contain a discount factor, it is no surprise that changes in the central tendency measures show a strong relation to days on which base interest rates are changed. That this relation is at its strongest for the December 1997 (i.e., non-synthetic) contract, and at its weakest for the long maturity synthetic contract, supports this qualification further.

Maintaining attention at the measures of central tendency, we observe that for the six week and December 1997 contract there is some weak evidence that days on which unemployment and other labour market figures are announced are associated with unusual downward shifts in the centres of the (implied future) distributions of the underlying asset. Although, a proportionally greater effect is found in the December 1997 contract than in the 6 week contract, the impacts across the three measures of central tendency for a given contract are numerically very similar. Indeed, overall, the measures of central tendency produce very similar regression results.

Both the six month and six week contracts see a large significant reduction in the standard deviations of the distributions on days of base rate announcements. In addition, further large reductions in the standard deviations are experienced on days of inflation rate announcements, with the impact on the 6 week contract being numerically double that on the 6 month contract. This strongly indicates that the impact of news is more strongly felt in the nearer terms contracts. There is also some evidence that PSBR (government debt) announcement days are associated with an unusual increase in the standard deviation of the distributions. The standard deviation of the December 1997 contract seems only to respond, and then only weakly, to announcements concerning unemployment and labour market statistics. These announcements also influenced the central tendency measures of this distribution and it is possible, as this contract spans a semi-set of the overall sample, that labour market announcements could be relatively more important in the case of this contract.

Table 4: Regression Results: Announcement days

This table contains the estimated coefficients from the regressions

$$y_t = \beta_0 + \beta_1 \text{baserate}_t + \beta_2 \text{rpi}_t + \beta_3 \text{psbr}_t + \beta_4 \text{unemp}_t + \beta_5 \text{M4}_t + \sum_{j=1}^{4} \beta_{j+5}\delta_{j+1,t} + u_t$$

estimated using data from the period September 23, 1996 to May 22, 1998, where y_t is the proportional change from business day $t-1$ to day t in the value of the implied "moment" of the distribution of future stock index prices, baserate_t is a binary variable that takes the value 1 if a base (interest) rate change was announced by the UK Treasury on business day t and takes the value 0 otherwise, rpi_t is a binary variable that takes the value 1 if a Retail Price Index (RPI) announcement took place on business day t and takes the value 0 otherwise, and $\text{psbr}_t, \text{unemp}_t, \text{M4}_t$ are similarly defined for announcements of the PSBR, the unemployment and labour market statistics, and the M4 money supply figure, respectively. The variables $\delta_{2,t}, \delta_{3,t}, \delta_{4,t}, \delta_{5,t}$ are day of the week dummy variables (2=Tuesday, 3=Wednesday, and so on). The variable D_1 takes the value 1 between September 23, 1996 to October 21, 1996 and 0 otherwise. D_2 takes the value 1 between October 27, 1997 and February 27, 1998 and 0 otherwise. D_3 takes the value 1 between January 27, 1998 until February 23rd, 1998 and 0 otherwise.

	Distribution Moment Series											
Coeff.	Mean		Median		Mode		Std. Deviation		Skewness		Kurtosis	
	6 Month Synthetic Contract											
Constant	2.022	(5.355)	2.243	(4.889)	1.719	(3.554)	1.195	(0.865)	-117.84	(-2.245)	13.746	(2.42)
RPI	1.149	(1.253)	0.516	(0.582)	0.834	(0.806)	-8.538	(-2.968)	-200.21	(-2.191)	0.391	(0.123)
PSBR	0.431	(0.246)	0.637	(0.409)	0.230	(0.143)	3.433	(1.712)	81.77	(0.337)	-13.860	(-1.813)
Unemp.	-1.713	(-1.431)	-1.628	(-1.439)	-1.603	(-1.447)	2.631	(1.002)	7.37	(0.231)	-0.769	(-1.075)
M4	-0.510	(-0.461)	-0.583	(-0.584)	-0.624	(-0.796)	1.861	(1.090)	-151.27	(-3.212)	-11.004	(-3.681)
Base	5.945	(2.744)	5.401	(2.595)	5.842	(2.833)	-5.988	(-2.292)	-24.35	(-0.685)	3.234	(0.942)
Tues	0.985	(1.275)	0.495	(0.513)	1.355	(1.483)	0.325	(0.313)	476.03	(1.924)	-10.317	(-2.220)
Wed	-1.407	(-1.545)	-1.646	(-1.658)	-0.898	(-0.838)	0.865	(0.417)	30.95	(1.653)	-6.217	(-1.500)
Thur	-3.151	(-3.324)	-2.570	(-3.553)	-1.837	(-3.474)	5.476	(7.025)	89.99	(3.075)	-22.074	(-2.449)
Fri	-2.246	(-3.728)	-2.824	(-4.889)	-2.621	(-4.483)	2.865	(4.617)	165.73	(2.346)	-14.345	(-3.189)
D1									1416.89	(11.497)		
D2	0.481	(2.003)	0.366	(1.824)	0.244	(1.274)	-1.221	(-1.378)				
D3									-0.49	(-0.064)	-1.534	(-1.249)
No. Obs.	420		420		420		420		420		420	
R^2	0.029		0.027		0.033		0.021		0.114		0.026	
Chow	0.560	[0.861]	0.706	[0.733]	0.775	[0.666]	0.620	[0.812]	0.976	[0.471]	0.360	[0.970]
Wald_J	9.097	[0.613]	10.160	[0.516]	11.611	[0.394]	10.614	[0.476]	23.978	[0.020]	5.527	[0.903]
	6 Week Synthetic Contract											
Constant	2.302	(4.335)	2.18297	(4.452)	2.405	(4.393)	-5.771	(-2.726)	-0.648	(-0.137)	7.031	(1.708)
RPI	1.118	(1.029)	0.771	(0.818)	1.106	(1.090)	-16.963	(-2.449)	54.625	(3.903)	29.465	(6.614)
PSBR	0.519	(0.325)	0.327	(0.260)	0.205	(0.153)	8.906	(2.541)	11.080	(1.468)	17.522	(2.180)
Unemp.	-2.190	(-2.052)	-2.274	(-2.378)	-2.017	(-2.102)	3.649	(0.844)	-15.279	(-2.813)	-7.490	(-0.768)
M4	-0.456	(-0.337)	-0.274	(-0.233)	-0.346	(-0.271)	4.009	(0.817)	34.434	(2.275)	2.706	(0.456)
Base	8.968	(4.866)	8.176	(4.226)	8.403	(4.530)	-30.570	(-10.527)	-159.688	(-6.396)	-14.012	(-1.256)
Tues	0.888	(0.904)	0.754	(0.798)	0.629	(0.622)	11.244	(4.514)	-6.594	(-0.780)	-12.784	(-2.957)
Wed	-1.227	(-1.221)	-0.799	(-0.930)	-1.362	(-1.382)	13.235	(3.554)	-6.725	(-0.966)	-12.411	(-1.646)
Thur	-3.434	(-3.162)	-2.822	(-2.947)	-3.329	(-3.100)	22.734	(6.800)	-3.708	(-0.365)	-20.657	(-6.334)
Fri	-3.470	(-4.054)	-3.293	(-4.546)	-0.349	(-4.318)	11.042	(2.790)	0.033	(3.722)	-1.507	(-0.189)
D2	0.432	(1.687)	0.279	(1.264)	0.368	(1.581)	-5.020	(-4.456)	0.025	(0.057)	3.931	(2.568)
No. Obs.	370		370		370		370		370		370	
R^2	0.038		0.038		0.037		0.024		0.061		0.038	
Chow	0.216	[0.997]	0.184	[0.998]	0.180	[0.999]	0.673	[0.764]	0.342	[0.976]	0.707	[0.732]
Wald_J	6.120	[0.865]	5.709	[0.892]	5.429	[0.909]	11.670	[0.389]	15.587	[0.211]	7.260	[0.778]
	December 1997 contract											
Constant	0.654	(1.007)	-0.734	(1.496)	0.640	(1.120)	-2.289	(-3.256)	0.322	(0.118)	7.117	(0.954)
RPI	-1.144	(-0.805)	-1.375	(-1.604)	-1.308	(-1.072)	-3.468	(-1.157)	-4.193	(-0.319)	-4.952	(-1.233)
PSBR	0.944	(0.353)	0.984	(0.437)	1.070	(0.432)	3.174	(1.171)	-23.476	(-3.478)	-1.443	(-0.605)
Unemp.	-2.819	(-3.160)	-2.051	(-2.370)	-2.724	(-3.128)	3.349	(2.223)	41.681	(1.748)	16.511	(-3.882)
M4	-2.363	(-1.379)	-1.458	(-1.114)	-1.913	(-1.220)	1.318	(1.690)	-7.639	(-0.364)	1.190	(0.400)
Base	12.235	(12.921)	10.766	(11.646)	11.562	(12.541)	-2.318	(-0.516)	-50.411	(-13.492)	5.013	(2.165)
Tues	3.776	(2.628)	3.683	(3.723)	3.755	(2.938)	-0.423	(-0.251)	22.366	(1.195)	-1.401	(-0.159)
Wed	1.198	(1.209)	0.907	(1.220)	1.131	(1.292)	-0.628	(-0.487)	5.499	(0.934)	-6.719	(-1.030)
Thur	-0.392	(-0.447)	-0.485	(1.220)	-0.420	(-0.516)	3.676	(3.214)	-13.401	(-4.043)	-5.979	(-0.917)
Fri	-2.545	(-2.528)	-3.083	(-3.468)	-2.704	(-2.821)	2.395	(1.826)	4.013	(0.668)	-8.728	(-0.927)
No. Obs.	209		209		209		209		209		209	
R^2	0.085		0.107		0.092		0.029		0.039		0.026	
Chow	0.447	[0.922]	0.377	[0.956]	0.424	[0.934]	0.788	[0.641]	0.841	[0.590]	0.708	[0.717]
Wald_J	9.817	[0.547]	9.052	[0.617]	9.521	[0.574]	12.021	[0.362]	9.213	[0.685]	5.743	[0.890]

Notes:

The regression coefficients were estimated using ordinary least squares and t-statistics (in parentheses) use standard errors that have been corrected for general forms of heteroskedasticity and also autocorrelation (up to N.oblags) using the Newey and West (1987) variance-covariance matrix with a Bartlett kernel. Coefficient values are all ×1000. Chow and Wald-J are tests for a structural break at May 1, 1997. Wald-J is the heteroskedasticity robust test of Jayatissa (1977). Probability values for both tests are given in brackets.

The skewness statistic series show a strong relation with many of the announcement day variables. There is, however, much less uniformity among the impacts of the different kinds of announcement on each of the three contracts than was the case with the first and second moment statistics. In the case of the six month contract there is weak evidence of response to the announcement of inflation and money supply statistics, but there is no evidence of any impact of the changes in the base interest rate. Although at first glance this appears surprising, it is easily explained. Intuitively at least, skewness can be represented by the difference between the mean and mode of a distribution. If the impact of base rate announcements on each of the measures of central tendency is roughly the same, as was the case with the six month contract, then it is quite possible that skewness shape could be preserved within a combination of the shape impacts of a particular news announcement.

A comparison of the impact of the base rate on skewness series on the 6 week and December 1997 contract suggests that it is the combination of impacts on first and second moments that preserves skewness rather than just the first moment. The numerical impacts on first and second moments in the case of the six month contract are approximately equal and opposite whereas for the six week and December 1997 there is a relatively large numerical difference between the impacts on first and second moments. For the 6 week contract, where this difference is larger, the impact on skewness is seen to be the greatest.

For the 6 week contract, which is the contract that most closely reflects the aims of this study, it is found that inflation and money supply announcement days are associated with unusual positive shifts in the skewness of the distribution, while unemployment announcement days see negative skewness changes. The December 1997 contract, by contrast, shows evidence of responding to PSBR announcements. Although the absence of uniformity among the results for each contract makes interpretation difficult, there are two general features to emerge. First, skewness certainly responds to announcement days, but this response appears strongly sample specific. Second, the impact of announcement days on skewness is much greater than the impact on the first two moments. This means that distribution shape may not be preserved through the passage of key market events. Third, announcements on skewness series appear to have more impact on the relatively shorter horizon distribution. This could mean that the fine characteristics of distribution shape implied by the options market are only detected within the shorter horizon and more heavily traded contracts.

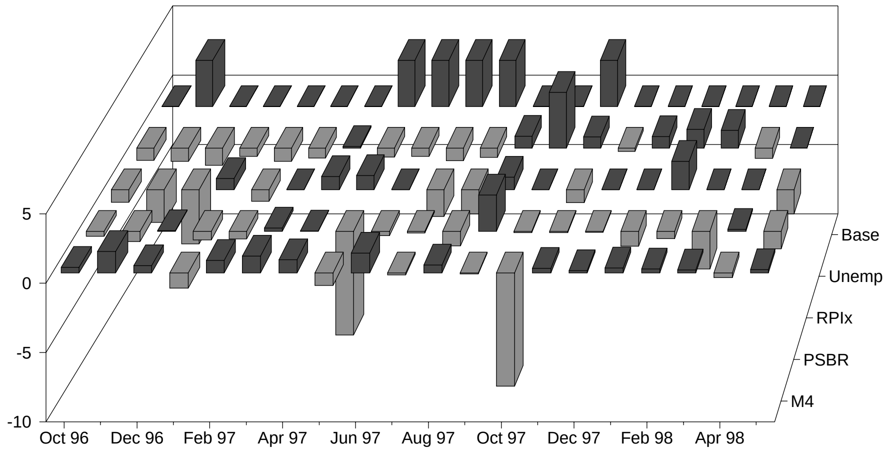
The impact of announcements on the kurtosis of the six month distribution similar characteristics to the impact on skewness; relatively weak and insensitive to base rate changes. In fact only the money supply announcement days appear to change the kurtosis shape in an unusual manner.

In the case of the six week horizon distribution, kurtosis appears to be influenced by the announcement of inflation and government debt figures. For the December 1997 distribution, kurtosis is affected by the announcement of unemployment figures. The kurtosis of this distribution is also affected by the base rate changes.

As was the case with the skewness of the distributions, there is little uniformity among the results concerning kurtosis, but again the impacts relative to the first and second moments are larger. One reason for this could be that identifying the event as the day of the announcement could be either masking or exaggerating the impact of certain announcements. In order to both assist in explaining the results found for the announcement day dummy variables and to provide further information in its own right, we now consider the results of the regression of the moment series on the scaled surprises in the macroeconomic variables.

Before discussing these results it is useful to consider the distribution of the scaled surprise variables. Figure 4 shows the sequence of the surprises scaled by their mean respective absolute surprise. There is considerable variation among them. Each of the M4, PSBR and RPI surprise variables contain one relatively large negative surprise, with the one for the money supply variable being particularly noticeable. The unemployment and base rate surprise variables each has relatively large positive surprises. The RPI variable has both noticeably large positive and negative surprises. If surprises in macroeconomic variables can distort distributional shape, then it would be expected that the greatest impact (certainly for the first moments) would be seen for the money supply variables, followed by the PSBR and RPI variables. The results of the regressions on scaled surprises, equation (16), which are given in Table 5, can be used to examine this hypothesis.

Figure 4: Scaled Surprises in Macroeconomic Variables



As with the announcement day variables, Table 5, shows that the impact of surprises is similar across the three measures of central tendency. This is particularly apparent for the 6 week distributions. The only exceptions are found for the December 1997 distribution where the impacts of the RPI, M4 and (to a lesser extent) unemployment surprises have quite distinct impacts across the measures of central tendency.

The impact of surprises on the standard deviation series are similar across the three distributions. All are strongly affected by changes in the base interest rate and by surprises in the level of government debt, the PSBR. In addition, the six month and six week contracts also respond strongly to surprises in M4. The December 1997 contract does not appear to respond to M4 surprises. As the sample for this contract excludes the large negative signed surprise in October 1997, this implies that the distributions are influenced by large surprises.

Table 5: Regression Results: Scaled Surprises

This table contains the estimated coefficients from the regressions

$$y_t = \beta_0 + \sum_j \beta_j \frac{S_{j,t}}{\overline{S}_j} + \sum_{i=1}^{4} \beta_{i+5}\delta_{i+1,t} + u_t$$

estimated using data from the period September 23, 1996 to May 22, 1998, where y_t is the proportional change from business day $t-1$ to day t in the value of the implied "moment" of the distribution of future stock index prices, $S_{j,t}$ is the surprise to the macroeconomic variable j, where j={baserate, RPI, PSBR, Unemp, M4}, $\overline{S}_j$ is the mean absolute surprise to variable j. The variables $\delta_{2,t}, \delta_{3,t}, \delta_{4,t}, \delta_{5,t}$ are day of the week dummy variables (2=Tuesday, 3=Wednesday, and so on). The variable D_1 takes the value 1 between September 23, 1996 to October 21, 1996 and 0 otherwise. D_2 takes the value 1 between October 27, 1997 and February 27, 1998 and 0 otherwise. D_3 takes the value 1 between January 27, 1998 until February 23rd, 1998 and 0 otherwise.

	Distribution Moment Series											
Coeff.	Mean		Median		Mode		Std. Deviation		Skewness		Kurtosis	
	6 Month Synthetic Contract											
Constant	2.225	(5.695)	2.476	(5.497)	1.924	(4.191)	1.295	(1.058)	-117.209	(-1.926)	13.345	(2.419)
RPI	-0.932	(-1.286)	-0.750	(-1.169)	-1.152	(-1.635)	-0.880	(-0.698)	80.206	(2.202)	-0.631	(-0.167)
PSBR	1.405	(3.015)	1.570	(3.612)	1.511	(3.689)	0.045	(0.201)	-27.361	(-2.060)	2.281	(2.087)
Unemp.	-0.639	(-1.833)	-0.872	(-2.573)	-0.308	(-0.906)	-2.134	(-2.042)	-4.066	(-0.142)	-6.807	(-5.072)
M4	3.222	(6.702)	3.086	(5.990)	2.513	(5.116)	-0.828	(-7.952)	15.494	(3.079)	3.829	(7.506)
Base	1.748	(2.811)	1.582	(2.657)	1.697	(2.913)	-2.175	(-2.651)	-322.723	(-0.299)	1.446	(1.703)
Tues	1.026	(1.566)	0.461	(0.475)	1.324	(1.422)	-0.052	(-0.313)	460.064	(1.995)	-11.506	(-2.187)
Wed	-2.064	(-2.765)	-2.308	(-2.704)	-1.536	(-1.719)	1.687	(1.140)	25.611	(1.153)	-0.880	(-2.166)
Thur	-3.240	(-4.501)	-2.759	(-5.237)	-2.026	(-5.131)	4.305	(5.105)	54.528	(2.423)	-23.381	(-2.421)
Fri	-2.499	(-3.712)	-3.105	(-4.788)	-2.871	(-4.521)	2.938	(4.849)	160.148	(2.120)	-0.015	(-3.308)
D1									1418.080	(11.405)		
D2	0.477	(1.980)	0.367	(1.781)	0.246	(1.207)	-0.999	(-1.308)				
D3									-1.428	(-0.162)	-1.524	(-1.091)
No. Obs.	420		420		420		420		420			
R^2	0.049		0.050		0.051		0.044		0.112		0.023	
Chow	0.630	[0.803]	0.855	[0.585]	0.917	[0.523]	0.657	[0.779]	0.764	[0.688]	0.314	[0.983]
Wald_J	11.632	[0.392]	13.217	[0.279]	14.959	[0.184]	13.281	[0.275]	22.169	[0.036]	4.868	[0.937]
	6 Week Synthetic Contract											
Constant	2.552	(4.717)	2.421	(4.808)	2.640	(4.692)	-6.179	(-2.900)	-0.994	(-0.254)	9.024	(2.787)
RPI	-1.105	(-1.297)	-1.191	(-1.471)	-1.237	(-1.457)	-5.411	(-3.395)	-19.790	(-5.322)	-5.923	(-5.813)
PSBR	1.526	(3.277)	1.532	(3.818)	1.533	(3.515)	-3.745	(-2.567)	-21.056	(-9.575)	-8.828	(-4.731)
Unemp.	-0.791	(-1.854)	-0.752	(-2.157)	-0.784	(-1.983)	-3.567	(-1.827)	6.695	(1.678)	-7.318	(-5.614)
M4	3.278	(8.352)	2.874	(8.145)	3.133	(8.309)	-19.581	(-15.576)	23.605	(20.657)	12.392	(32.503)
Base	2.586	(3.849)	2.328	(3.367)	2.420	(3.584)	-10.380	(-13.528)	-50.177	(-6.807)	-4.757	(-1.449)
Tues	0.944	(1.165)	0.744	(0.963)	0.653	(0.774)	9.943	(4.283)	4.357	(0.628)	-6.437	(-1.284)
Wed	-1.958	(-2.315)	-1.540	(-2.109)	-2.042	(-2.394)	14.721	(5.282)	-5.750	(-1.115)	-12.786	(-2.343)
Thur	-3.518	(-4.442)	-2.932	(-4.105)	-3.405	(-4.218)	21.024	(7.210)	10.476	(1.519)	-15.860	(-6.070)
Fri	-3.728	(-4.015)	-3.535	(-4.470)	-3.737	(-4.251)	11.661	(2.776)	36.328	(4.275)	-0.979	(-0.127)
D1												
D2	0.384	(1.564)	0.243	(1.105)	0.326	(1.437)	-4.332	(-4.436)				
D3									-0.014	(-3.780)	-6.137	(-3.184)
No. Obs.	370		370		370		370		370		370	
R^2	0.059		0.060		0.059		0.093		0.068		0.038	
Chow	0.283	[0.989]	0.262	[0.992]	0.266	[0.991]	0.534	[0.880]	0.317	[0.986]	0.308	[0.984]
Wald_J	8.290	[0.687]	8.232	[0.692]	8.013	[0.712]	10.534	[0.483]	10.533	[0.569]	3.777	[0.976]
	December 1997 contract											
Constant	1.111	(1.883)	1.115	(2.472)	1.069	(2.048)	-2.173	(-2.776)	-1.935	(-0.643)	7.469	(0.998)
RPI	0.595	(0.488)	1.435	(1.709)	0.893	(0.825)	-5.077	(-2.790)	17.044	(1.316)	3.127	(0.664)
PSBR	1.871	(4.688)	1.512	(4.675)	1.716	(4.481)	-2.149	(-0.359)	-4.828	(-3.077)	1.951	(2.046)
Unemp.	-0.396	(-0.738)	-0.178	(-0.331)	-0.288	(-0.507)	-2.105	(-3.967)	-13.850	(-1.581)	1.015	(0.344)
M4	-2.045	(-1.281)	-0.750	(-0.663)	-1.441	(-1.002)	-1.759	(-1.328)	4.415	(0.497)	-2.671	(-0.632)
Base	3.719	(12.740)	3.388	(16.183)	3.550	(13.935)	-1.693	(-1.595)	-12.315	(-4.198)	1.698	(1.736)
Tues	3.143	(2.301)	3.190	(3.437)	3.186	(2.653)	-0.507	(-0.254)	22.459	(1.327)	-2.309	(-0.267)
Wed	-0.010	(-0.010)	0.012	(0.016)	0.005	(0.006)	0.256	(0.275)	16.234	(2.728)	-11.031	(-1.581)
Thur	-1.076	(-1.291)	-1.171	(-1.608)	-1.114	(-1.423)	3.498	(3.283)	-13.985	(-3.375)	-6.886	(-1.086)
Fri	-3.028	(-2.832)	-3.486	(-3.761)	-3.152	(-3.104)	2.529	(1.754)	4.968	(0.746)	-8.992	(-0.947)
No. Obs.	209		209		209		209		209		209	
R^2	0.092		0.114		0.099		0.030		0.034		0.017	
Chow	0.386	[0.952]	0.343	[0.968]	0.382	[0.953]	0.599	[0.814]	0.684	[0.739]	0.815	[0.615]
Wald_J	9.993	[0.531]	10.107	[0.521]	10.271	[0.506]	10.049	[0.526]	6.831	[0.869]	6.116	[0.865]

Notes: The regression coefficients were estimated using ordinary least squares and t-statistics (in parentheses) use standard errors that have been corrected for general forms of heteroskedasticity and also autocorrelation (up to N.oblags) using the Newey and West (1987) variance-covariance matrix with a Bartlett kernel. Coefficient values are all ×1000. Chow and Wald-J are tests for a structural break at May 1, 1997. Wald-J is the heteroskedasticity robust test of Jayatissa (1977). Probability values for both tests are given in brackets.

The higher moment series are also strongly influenced by the surprise variables. Again the variables showing the biggest relative surprises, M4 and the PSBR, appear the most statistically significantly. The impact of base rate changes is less noticeable in the higher moments, and there is some evidence that all the surprises affect at least one of the distribution series studies.

Overall for the surprise variables, larger coefficients are found for the higher moments indicating that surprises appear to have greater impact on skewness and kurtosis than on mean and standard deviation. This hints at possible distributional instability around key market events, which could influence tests that assume distributional stability.

The change of government in the UK in May 1997, which coincided with the granting of operational independence to the Bank of England, provides a further avenue of investigation to determine whether financial markets perceive macroeconomic announcements differently now than before the change. The first test employed was a simple Chow test of coefficient stability, using May 1, 1997 as the break point. As this test is not robust to heteroskedasticity, we supplement this test with that of Jayatissa (1977). Both tests, however, indicate that there is no reason to believe that the market reacts differently to announcements now to how it reacted before the change in government.[20] This is true whether announcement impacts are measured by indicator variables or surprises. One reason for this result could be that the actual operation of monetary policy announcements, as separated from responsibility for them, was the same both before and after the Bank of England's operational independence. The introduction of the gilt repo in January 1996 had brought about a change in the instrument of monetary policy and this was maintained through the change of government in 1997.

20. Although there is a case where a structural break is indicated, this can be explained within the tolerances permitted for multiple significance tests.

6 Summary and Conclusions

We have shown that the whole distribution of stock prices can be distorted on an event day. In particular, we found that announcements of official macroeconomic statistics, such as interest rates, inflation rates, unemployment and labour market variables, government debt and the money supply can significantly alter the moments of the distribution of a stock market index. We also considered whether surprises in these statistics mattered. We found that the size of the surprise in the variable appears to influence the distributions with larger surprises having a greater impact. Moreover, we found that the impact of announcements, and especially surprise ones, was felt more strongly within the higher moments: skewness and kurtosis.

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