The Effect of Futures Trading on Cash Market Volatility: Evidence from the London Stock Exchange

by

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Abstract

The stock market crash of October 1987 and the growing importance of index arbitrage and portfolio insurance helped to focus the attention of academics, practitioners and regulators on the possibly destabilising role of equity index futures on the underlying cash market. Although theoretical evidence on this question is somewhat ambiguous, empirical evidence, relating particularly to US markets, has been less equivocal: typically, no significant effect of futures trading has been found. This paper presents an analysis of daily stock price volatility on the London Stock Exchange for the period 1980-93. The measure of volatility produced is appropriate, given the distribution of returns and the time-varying nature of stock price volatility, and changes in monetary policy regime. The impact of futures on stock price volatility is measured within an augmented ARCH framework and the principal result is striking: rather than increasing volatility, index futures contracts are found to have reduced volatility significantly by around 17%.

1. Introduction

The stock market crashes in October 1987 and October 1989 helped to focus academic attention, and that of the regulatory authorities, on the possibly damaging role of the equity futures market and portfolio insurers in creating 'excess' cash market volatility. Not surprisingly perhaps, some of the most bitter complaints came from equity market makers in the United States who, because of their obligation to quote 'continuous' prices, suffered at the hands of portfolio insurers and index arbitrageurs.[(1)] Both practitioners and academics have alerted regulators to the possibility that futures markets and other derivative security markets will attract both ill-informed traders and risk-loving speculators, whose activities would tend to destabilise the cash markets. This concern has resulted in restrictive action by some regulatory authorities: in Japan, for example, trading hours have been reduced, margins and commission charges increased, and daily price limits reduced in an effort to control volatility.

Theoretical arguments can be advanced in support of *either* increased *or* decreased volatility due to futures trading. However, the weight of empirical evidence suggests that, at least for US securities markets, while derivatives trading may have served to increase extremely short term volatility [due particularly to the effect of 'witching hours', see

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(1) See Miller (1990) for a discussion of the consequences of index arbitrage for market-makers.

Stoll and Whaley (1987)], longer-term volatility has either remained largely unaffected by futures trading, or may even have been reduced.

This paper assesses whether futures trading has induced excess volatility on the London Stock Exchange (LSE). Specifically, we examine the effect on average daily volatility in the cash market (measured - for reasons explained later - by the FTSE-All Share index) of the FT-SE 100 Future traded on the London International Financial Futures Exchange (LIFFE). This is an interesting exercise in itself, given the different market and institutional structures in the United Kingdom (for example, market-makers on the LSE are not required to limit price changes between transactions) and the lesser importance of portfolio insurers in the UK equity market than in the US market, and in view of the scant evidence relating to UK financial markets.

The methodology of previous research in this field has been improved upon in an important respect. Other researchers have typically studied *unconditional* measures of price volatility, such as the standard deviation of the log-price difference measured through a moving sample window [eg Edwards (1988a,b), Stoll and Whaley (1987)]. By contrast, in this paper it is recognised that the measure of volatility appropriate to a particular financial instrument depends upon the nature of the distribution of returns. In particular, the sample standard deviation of returns is appropriate if the distribution of returns is characterised as a *stationary normal variate*. However, security market returns are typically found to be *non-stationary* [see, for example, Baldauf and Santoni (1991)] and even *non-normal* [see Bollerslev (1987)]. The studies of Baldauf and Santoni (1991), Lee and Ohk (1992) and Antoniou and Holmes (1992) tested for futures-induced volatility in the context of GARCH models (which condition current volatility on past volatility) but did not condition for changes in monetary regime. In addition, the volatility of stock returns has been found to exhibit an asymmetric response to news, associated with the effect of leverage: bad/bearish news increases volatility more than does good news [see Black (1976) and Nelson (1991)].(2) Measures of volatility are therefore calculated which are appropriate to a characterisation of the stock market returns distribution which takes into account these features as appropriate.

The paper is arranged as follows. Section 2 briefly reviews the theoretical discussion of futures-induced cash market volatility, and the empirical evidence available, mainly relating to US securities markets. In an effort to identify the likely causes of changing cash market volatility *other than futures trading,* Section 3 documents the period under review (1980-93) with particular reference to changes in monetary policy regime in the United Kingdom. On the basis of this discussion, and in view of the date on which the LIFFE futures contracts were introduced, the period of analysis is accordingly sub-divided. A preliminary analysis and characterisation of stock price volatility for each sub-period is given. Section 4 presents an ARCH-M model which allows us to infer the (*ceteris paribus*) impact of futures trading upon stock price volatility on the LSE. Finally, Section 5 draws some conclusions and regulatory policy implications.

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(2) In this study, by contrast, no asymmetry is found for the FTSE All-Share index.

2. Futures Trading and Cash Market Volatility

(a) Theoretical Arguments

Key to the question of whether the existence of futures contracts should increase or decrease cash price volatility, is the related question of what kinds of investors and traders will be attracted to these markets by the availability of futures contracts. For example, it has been argued in support of reduced volatility that the existence of derivative securities which are riskier than their underlying securities, and which may be sold short, offer less risk-averse (or even risk-loving) investors opportunities which they would prefer to investment in the cash market. Consequently, these investors will desert the cash market in favour of the futures market, leaving predominantly risk-averse or long-term investors in the cash market, which then becomes less volatile. This in turn attracts further risk-averse investors who bring additional market liquidity, thereby making the cash market more able to absorb large trades and therefore less volatile [see Detemple and Selden (1987)]. However, this argument is surely flawed: because of arbitrage conditions which link derivatives prices and underlying cash prices, it is difficult to see how price volatility in these markets could change independently: there is unlikely to be any volatility transfer between the two markets. Consequently, we cannot evaluate the effect of futures trading on the cash market in isolation, but must consider the effect on both the cash market and the futures market as a system. Nevertheless, available equilibrium models have shown that the effect of futures trading on cash market volatility is ambiguous [see Kawai (1983), Subrahmanyam (1991), and Turnovsky (1983)].

In this section we examine a model which, because of arbitrage restrictions, could be considered to represent either the cash market or the futures market [the exposition is an extension of that in Cutler, Poterba and Summers (1990)]. Let there be two classes of trader. *Smart money* traders base their investment decisions on a rational forecast of future returns conditioned on their information set at time t, Ω_t, and their demand for stocks rises in response to expected excess returns over the risk-free rate, r. Their excess demand for stocks can be expressed as:

$$d_{st} = \theta(w_s, v_s, l)\,[E_t \; R_{t+1} \; - r] \tag{1}$$

where R_t is the return to the stock index, E_t is the conditional expectations operator and the parameter θ reflects the wealth of smart money traders, w_s, the leverage available through the futures market, l, and their speed of response, v_s to the perceived disequilibrium $(E_tR_{t+1} - r)$. The information set Ω_t will include, *inter alia*, information from the index option market, which will help investors distinguish between liquidity/portfolio insurance driven trades and trades which signify news on fundamentals [see Grossman (1988)].

Feedback traders base their forecasts of future returns on past returns. This class of investor includes technical analysts, contrarian strategists and portfolio insurers, since each of these types of investor buys and sells stock in response to past market changes. These traders may be called 'naive'. Their excess demand can be expressed as:

$$d_{ft} = \phi(w_f, v_f, l)\,\beta(L)\,[R_t \; - r] \tag{2}$$

where $\beta(L)$ is a polynomial lag function. The demand which any perceived disequilibrium generates depends upon the parameter ϕ, which in turn depends upon the wealth of feedback traders, w_f, their speed of response, v_f, and the leverage available through the futures market.

(Another class of trader may also be indentified: index arbitrageurs. However, it is assumed that they play an essentially superficial role in ensuring that equilibria in the two markets are mutually consistent.)

Equilibrium for this market obtains when the sum of excess demands of both types of investor is zero, and is given by the recursion:

$$R_{t+1} - r = \psi(w_s, w_f, v_s, v_f, l; L).(R_t - r) + \epsilon_{t+1} \quad (3)$$

where $\epsilon_{t+1} \sim iid$ is the innovation in returns, and $\psi(.) \equiv \phi(.)\beta(L)/\theta(.)$ reflects market structure, leverage and speed of response to news. Assuming the innovation in the stock fundamental has a constant variance σ^2, the variance of returns can be shown to be

$$\sigma_R^2 = [(1 - \psi(.))/(1 + \psi(.))].\sigma^2 \quad (4)$$

where $\partial\sigma_R^2/\partial\psi < 0$.

Market volatility is decreasing in the parameter $\psi(.)$ and therefore increasing (decreasing) in the importance of positive (negative) feedback trader demand relative to smart money demand. It follows that if the existence of futures contracts attracts a greater number of naive (in this context, positive feedback) traders, then this will increase volatility; otherwise it will decrease.

(b) **Empirical Evidence**

Whereas on theoretical grounds either an increase or a decrease in volatility is plausible, existing empirical evidence has been more clear cut: except in the very short term, and on contract expiry dates, cash market volatility appears to have been unaffected by futures trading. This is true of both interest rate contracts and stock market index contracts. Table 1 summarises recent empirical evidence relating (mainly) to US securities markets [many of these are summarised in Board, Goodhart and Sutcliffe (1992)]. The majority of the studies listed report that the introduction of equity index futures has had no significant effect on stock market volatility.

An approach often used to establish the effect of futures trading on cash market volatility has been to subdivide the period under study according to changes in monetary policy regime and introduction of futures contracts, and then to study variations in cash price volatility (typically measured by standard deviation or variance) both between and within the chosen sub-periods [examples include Edwards (1988a, b), Brorsen (1991), Maberly, Allen and Gilbert (1989)]. These studies have been criticised for failing to isolate the effect of futures trading from all the other influences which impinge upon cash market volatility.(3) Partly in response to this criticism, other researchers have

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(3) Apart from monetary policy regime, stock market volatility may, for example, vary with the business cycle due to the effect of gearing.

developed methods which aim to control more perfectly for factors which might influence volatility other than that of direct interest. In particular, Aggarwal (1988) calculated and analysed variations in the *ratio* of the S&P500 (moving average) volatility relative to the volatility of a closely correlated index. Provided the two indices are subject to similar influences *other than* the introduction of the S&P500 futures contract, the ratio of their volatilities will measure the effect of futures contract trading on S&P500 volatility.

Nevertheless, there are strong reasons for believing that this method may also fail to control for other influences, and may even systematically conceal the effect of futures trading on volatility if there are strong arbitrage links between the two indices, thereby prejudicing the results of empirical investigation *against* the discovery of any significant futures trading effect. Edwards (1988a) argues that the integration of modern capital markets (via the no-arbitrage conditions which must hold between closely related securities) implies that a change in the volatility of the S&P500 index due to the introduction of the S&P500 futures contract, would cause an increase in the volatility of other closely related securities (eg other liquid stocks) for which no derivative securities are traded. The device of taking the ratio of volatilities is therefore an imperfect control for non-futures influences on volatility, and may even lead to statistical results which are materially misleading.

This paper reports the effect of the FTSE-100 futures contract upon the volatility of a closely index, the FTSE All-Share index. The FTSE-100 futures contract presents a problem for measuring its effect upon the underlying index because the underlying index was created in

May 1984 in order to facilitate trading in the futures contract. Although the index was constructed for a period prior to the introduction of the contract, this period is extremely short (1 year). Consequently, 'before' and 'after' samples for the FTSE-100 index cannot be formed, and instead we examine the effect of the FTSE-100 future on the related but wider FTSE All-Share index. These indices are subject to similar influences and are highly correlated.

Two studies listed in Table 1 relate to the FTSE-100 index futures. Lee and Ohk (1992) compared returns volatility two years before and two years after the FTSE-100 future began trading. Using a GARCH(1,1) framework and a dummy to represent the introduction of futures, these authors found a significant rise in volatility due to futures trading. In a similar study, Antoniou and Holmes (1992) found similar results. However, both studies failed to account for other influences on volatility which may well have been important - in particular, changes in monetary policy regime.

3. A Preliminary Statistical Analysis of Stock Price Volatility in the United Kingdom, 1980-1993

As a preliminary to analysing the effect of the FTSE-100 futures contract on the FTSE-All Share volatility, we test for the possible effects of changes in monetary regime.

It is worth noting that, in spite of the changes in monetary policy over the last 15 or so years, the technical operation of monetary policy in the United Kingdom has remained, in essence, largely unchanged. Throughout this period, the Bank of England has sought to influence wider monetary conditions via short-term interest rates, through its operations in the money markets. However, some of the recent changes in monetary regime may well have had consequences for the volatility of short and long-term interest rates and therefore also for stock price volatility. Against a background of (more or less) free floating of the sterling exchange rate since 1972, two regimes were recently put into place which, in different ways, managed sterling's exchange rate against other currencies.

Between March 1987 and March 1988, the D-Mark Sterling exchange rate was a particularly important factor in determining domestic monetary policy. This period is often referred to as one of 'Deutschemark Shadowing'. Between October 1990 and September 1992 sterling was a member currency in the Exchange Rate Mechanism (ERM) of the European Monetary System. While this regime obliged the authorities to defend sterling against internal and external fundamental shocks, as well as speculation, the extent of any consequent increase in interest rate (and therefore stock price) volatility would be modified by the credibility of the authorities' commitment to defend sterling's ERM parity. There is strong evidence [Pesaran and Robinson (1993)] that sterling's membership of the ERM at its agreed parity was highly credible, suggesting that speculation on sterling was *less* than it was prior to joining the ERM. Interest rate volatility was also lower in the ERM period.

Together with the date of introduction of the FTSE-100 futures contracts (May 1984), these regime changes suggest that our data might show changes in unconditional volatility through the following regimes/sample periods:

(S1):	March 1980 - April 1984 (1051 observations)
(S2):	May 1984 - February 1987 (1012 observations)
(S3):	March 1987 - March 1988 (276 observations)
(S4):	April 1988 - September 1990 (630 observations)
(S5):	October 1990 - August 1992 (485 observations)
(S6):	September 1992 - April 1993 (162 observations)

Our data are daily observations on the FTSE All-Share index, expressed in daily return (log-differenced) form. Table 2 displays the first four (unconditional) moments of the distributions of the stock price index log-differences for each of the chosen sub-samples. Also given is the ($\chi^2(2)$) normality test statistic, which summarises the skewness and kurtosis of the distributions, and therefore any departure from normality. Because other financial return distributions have been found to become more approximately normal as the differencing interval increases [see Boothe and Glassman (1987) and Hall, Brorsen and Irwin (1989)], the 3rd and 4th moments (skewness and kurtosis) and the normality test statistic for the 10 trading day log-difference are included for comparison.

Several features of these results are worth noting. First, all distributions appear to be significantly non-normal and unstable, although becoming substantially more normal as the differencing interval is increased [this result is consistent with Auto-Regressive Conditional Heteroscedasticity (ARCH) - see Diebold (1986)]. Second, kurtosis is typically a more noticeable feature of the distributions than skewness, a finding similar to that for many other speculative prices. Third, the D-Mark shadowing sample statistics are distorted by the stock market crash of October 1987; the subsequent 'mini-crash' of 1989, affects the Free-Float sample statistics to a lesser extent. Last, the pre-futures sample data are curious: they appear to be unstable in such a way that the distribution becomes *less* normal as the differencing interval is increased.

4. Modelling Stock Price Volatility

(a) Alternative Specifications

We have argued above that an adequate study of the effect of futures contracts on cash market volatility should focus on a measure of price volatility which is appropriate to the statistical distribution of security returns. Moreover, we know from the plethora of evidence on this subject, that security price volatility itself varies through time in a way which is consistent with Auto-Regressive Conditional Heteroskedasticity [ARCH, see Engle (1982)], and Generalised ARCH (GARCH) [see Bollerslev (1986)].

These considerations lead us to specify a model for stock price returns of the form:

$$\Delta lnp_t = a_t + b(L).\Delta lnp_t + \Sigma\, d_i\, Z_j + \rho.h_t + \epsilon_t \tag{5}$$

where $b(L)$ is a polynominal in the lag-operator, Z_j are exogenous factors (eg dummy variables), h_t, is the conditional variance of returns, and the error term is distributed as conditionally normal:

$$\epsilon_t \mid \Psi_{t-1} \sim N(0, \sigma_t^2 \mid \Psi_{t-1}) \tag{6}$$

and the conditional variance is described by the GARCH model, thus:

$$h_t = \alpha + \Sigma\beta_i.h_{t-i} + \Sigma\, \gamma_j.\epsilon^2_{t-j} + \Sigma\delta.Z_{jt} \tag{7}$$

However, because the principal objective of this study is to measure the impact of futures trading (and changes in monetary policy regime) upon stock market volatility, the estimation of GARCH-type models (ie those in which current conditional variance is partly determined by lagged conditional variance, h_{t-j}) is problematic. The presence of the lagged conditional variance in the variance equation has the consequence that the effect of the dummy variables for futures trading and policy regime cumulates through time in a way determined by the coefficient on lagged variance. This is undesirable if we believe that the effect of a regime is fairly constant during its operation. For this reason, only ARCH structures rather than GARCH structures were estimated, even though a GARCH model would have been more parsimonious. That is, conditional variance of the form:

$$h_t = (\alpha + D0_t\alpha') + \Sigma(\gamma_j + D0_t.\gamma_j')\, \epsilon_{tj}^2 + \Sigma\delta_j Z_{jt} \qquad (8)$$

was estimated. However, this is not unduly restrictive since a GARCH *(p, q)* model can be represented by an ARCH*(p')* model, provided *p'* is sufficiently high. As a further extension, we consider the ARCH in mean (ARCH-M) model due to Engle, Lilien and Robins (1987). In this model, conditional variance is included as a regressor in the mean process to reflect the idea that the expected rate of return will depend (positively) upon the risk of the instrument. However, it is questionable whether the conditional variance is the appropriate measure of risk, since only undiversifiable risk should be recorded. A more appropriate measure would be the covariation of the FTSE-All Share with a global market index.

The dummy variable $D0_t$, which is defined by :

$D0_t$ = 1, from May 1984 to present
= 0, otherwise.

records the existence of FTSE-100 derivatives. Existence of FTSE-100 derivatives is allowed to cause the dynamics of conditional volatility to change, since the mean of conditional volatility changes from α to $(\alpha+\alpha')$, and the ARCH parameters change from γ_j to $(\gamma_j + \gamma_j')$.

The Z_{jt} include any variables or factors which are hypothesised to influence the conditional variance, and therefore volatility. Thus, for example, Z will include dummy variables which should record changes in monetary policy regime. Specifically, the following dummy variables are included:

*D*1: (unity on 19.10.87 and 23.10.87 and -1 on 20.10.87) records the Stock Market crash of October 1987.

*D*2: (unity from March 1987 to March 1988) records the regime of Deutschemark-Shadowing;

*D*3: (unity from April 1988 to September 1990) records the regime of Free-Floating;

*D*4: (unity from October 1990 to August 1992) records sterling's membership of the ERM;

*D*5: (unity from September 1992 to present) records the post-ERM regime;

*D*6: (unity from November 1986 to present) records the deregulation of the London stock market.

The last dummy variable, *D*6, is included to account for any effect of deregulation of the London stock market in late October 1986 (the so-called 'Big Bang'), which abolished fixed commissions and the demarkation between stock broking and jobbing. These changes may have had the effect of reducing price volatility on account of the increased liquidity which these changes brought to the market; alternatively, volatility may have been increased if deregulation attracted predominantly speculative (ie feedback) traders.

In the case of stock prices, volatility may be asymmetric: higher in bear markets than in bull markets. This latter effect is probably due to the effect of company gearing(4) and, when present, renders the exponential GARCH (so-called E-GARCH) model more appropriate to

(4) If firms have fixed costs (eg payments to corporate bond holders) which must be met irrespective of company income, then a given item of news relating to future income will have a proportionally larger effect upon expected dividends when income is low relative to fixed costs than when income is high relative to fixed costs. [See Black (1976).]

stock price returns than the simple GARCH model [see Nelson (1991)]. As an alternative to the ARCH specification, we therefore considered the E-ARCH model which relaxes the symmetry restriction of ARCH by specifying conditional volatility as:

$$h_t = \exp\left(a + \sum_{i=1}^{i=n} \left[\beta_i (e_{t-i}/\sqrt{h_{t-i}}) + \gamma_i (|e_{t-i}|/\sqrt{h_{t-i}} - \sqrt{(2/\pi)}) \right] + \Sigma \delta_j z_{jt} \right) \quad (9)$$

which allows positive and negative values of e_t to have different impacts upon volatility. Moreover, exponentiation means that the variance remains positive even when the variance parameters are negative.

(b) Estimation

(i) *A General ARCH-M Model*

The specification search proceeded as follows. The autocorrelation function of $\Delta log(p_t)$ indicated the significance of the first (1 day) lag, and so $\Delta log(p_t)$ was regressed against $\Delta log(p_{t-1})$. Inspection of the residuals from this regression revealed a highly significant outlier associated with the stock market crash of October 1987. A dummy variable (*D*1) was therefore included in the mean return equation (5) in order that the final model was not distorted by this single observation. An ARCH test of the residuals from the mean equation (including the dummy variable *D*1) indicated that an ARCH structure which included lags of 1, 2, 6 and 9 trading days would provide an appropriate representation of time-varying volatility in the FTSE-All Share index. This model was therefore estimated, the results of which are given in Table 3. Also included in the conditional variance equation are dummy variables representing changes in monetary policy regime (*D*2→*D*5), a dummy variable to account for 'Big Bang' (*D*6) and, of particular interest in this study, a dummy variable (*D*0) which is activated by the existence of the

FT-100 futures contracts. Several aspects of the econometric results are worth noting.

The significant parameter on the lagged return suggests, *prima facie*, a rejection of weak efficiency. However, the equation does not suggest that *excess* stock returns are predictable, or - even if predictable - that trading could be effected which would be profitable after transaction costs.

The October 1987 stock market crash dummy is highly significant, indicating a fall in market value of around 9.5%. Perhaps surprisingly, the 'Big Bang' dummy is not significant, suggesting that deregulation of the London stock market had no discernible effect on price volatility. Of the monetary regime dummies the most significant effects on volatility would appear to have been produced by the D-Mark Shadowing regime, which is associated with a volatility increase of around 70% compared with the previous free-floating regime, and the recent post-ERM regime which is associated with a volatility increase of over 70% compared with the previous ERM regime. Both of these results may be interpreted in terms of the frequent changes in interest rates which characterised each of these regimes.

The most interesting result is that for the futures contract dummy, *D*0. The parameters $\gamma_1', \gamma_2', \gamma_6'$ *and* γ_9' are all statistically insignificant, suggesting that the dynamics of response of volatility to news was unchanged by the introduction of futures contracts. However, the change in the conditional mean variance, α', is both negative and highly significant, indicating that introduction of FTSE-100 futures was associated with a significant reduction in cash market volatility.(5)

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(5) A test of the joint insignificance of the parameters $(\alpha', \gamma_1', \gamma_2', \ldots)$ could have been included. However, this would almost certainly have been rejected owing to the significance of α'.

Diagnostic tests were performed in order to detect any asymmetric response of stock index volatility to news. In the first instance, the scaled residual $e_t/\sqrt{h_t}$ was tested for skewness in its distribution: this would reveal any failure of the ARCH model to account for asymmetry in the response of volatility to news. This test was very insignificant, indicating no requirement to estimate the alternative E-ARCH-M model or any other asymmetric volatility model. Also, following Engle and Ng (1991), the Sign-Bias-Test was used to determine whether positive and negative innovations in the error process have effects upon volatility which are unaccounted for in the null variance model. In view of this evidence, the exponential-ARCH (E-ARCH) model due to Nelson (1991) was not estimated.

Finally, the model was estimated to include 'in-mean' effects (ie ARCH-M), but conditional variance was found to have an insignificant effect on returns. This result is not surprising, since we should expect only non-diversifiable risk to be reflected in the rate of return.

(ii) *A Parsimonious ARCH Model*

The model was re-estimated with the insignificant variables - in-mean effect, free-float and ERM dummies, and the Big-Bang dummy - excluded. The results of this exercise are given in Table 4. The equilibrium unconditional variance of the FTSE-All Share index can be calculated as:

$$\hat{\sigma}^2_{PRE} = \frac{\hat{\alpha}}{1-\sum_i \hat{\gamma}_i} = 6.47\ (x10^{-3})\ \%$$

for the pre-futures sample, compared with

$$\hat{\sigma}^2_{POST} = \frac{\hat{\alpha} + \hat{\alpha}'}{1 - \sum_i \hat{\gamma}_i} = 5.38\ (\times 10^{-3})\ \%$$

The parameter estimates therefore suggest that the introduction of futures contracts was associated with a reduction in stock market volatility of around 17%.

(iii) *A Restricted ARCH Model*

For comparability with the study of Lee and Ohk (1992), the dummy variables associated with monetary policy regimes, the stock market crash and the Big Bang, are removed and the sample period is shortened to two years either side of the introduction of FTSE-100 futures.(6) The results are given in Table 5, and show that under this specification the effect of futures trading is statistically just insignificant at the 95% confidence level, but significantly *negative* at 94%. It would be difficult to conclude, as did Lee and Ohk (1992), that futures contracts have been associated with *increased* cash market volatility.

However, it should be noted that Lee and Ohk tested for the effect of futures contracts on the London stock market, only imperfectly and indirectly. In order to abstract from country-specific influences on volatility, these authors constructed a diversified international portfolio (consisting of stocks listed on US, UK, Australia, Hong Kong and Japan stock markets). A sample window of observations 500 trading days before and after the introduction of futures contracts in each market was taken, and these were weighted to form a diversified portfolio return. This portfolio return was then modelled within an ARCH

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(6) Although for the equation specified in Table 5 only the mean volatility is allowed to change following the introduction of FTSE-100 futures, changes in ARCH parameters were tested for but these were found to be insignificant.

framework. The effect of futures on any particular cash market was indirectly tested by excluding individual stock indices from the portfolio and observing whether the effect of futures on the resulting portfolio was significantly changed. This technique is far from perfect. First, even if the portfolio was well diversified contemporaneously (which is unlikely), taking samples from different points in calendar time may have the the effect of increasing correlation among the constituent indices. Second, it is not clear what should be the appropriate value weighting scheme. Third, the effect of US monetary policy in particular may have significantly distorted the results. Lastly, this method of testing pre-supposes that the effect of futures contracts on cash market volatility is the same across different markets. However, the discussion in Section II suggests that we should expect our results to be market structure specific.

5. Conclusions

While theoretical arguments are ambiguous regarding the effects of derivatives trading on cash markets volatility, empirical evidence (particularly for US, but also for other markets) has been much less equivocal: typically, researchers have failed to detect any significant effect of derivative trading on cash market volatility, although a few studies found that such trading caused a reduction. Unfortunately, the methodology employed in many existing studies is flawed in an important respect: the measure of volatility used has typically been unconditional, whereas the measure of volatility appropriate to any particular market depends upon the nature of the distribution of returns, and in particular should be conditional upon heteroskedasticity caused by a time-varying second moment, and upon the effect of changes in monetary policy regime.

With this in mind, the present paper has analysed volatility on the London International Stock Exchange in a way which takes into account variation in volatility through time, and also the effect of changes in monetary policy regime which may be important conditioning factors on stock price conditional volatility. The effect of futures trading was tested within this framework. The results are somewhat surprising. The FTSE-index volatility appears to show no strong evidence of gearing-related asymmetry, and far from suggesting that futures trading has increased stock market volatility, the results demonstrate that futures trading has been associated with a significant *reduction* in volatility of around 17%. This study has therefore further undermined the proposition that futures contracts pose a threat to cash market stability, and has suggested rather that futures contracts may well promote stability, at least in the context of the London market.

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Table 1: Studies of the Effect of Equity-Index Futures on Cash Market Volatility

Study	Index*	Period	Volatility Increase	Volatility No Change	Volatility Decrease
Santoni (1987)	S&P500	1975-1986	-	✓	-
Edwards (1988a, 1988b)	S&P500, VLCI	1973-1987	-	✓	-
Becketti & Roberts (1990)	S&P500	1962-1990	-	✓	-
Lockwood & Linn (1990)	DJIA	1964-1989	✓	✓	-
Freris (1990)	HS	1984-1987	-	✓	-
Chan and Karolyi (1991)	NK (Simex)	1985-1987	-	✓	-
Hodgson & Nicholls (1991)	AO	1981-1987	-	✓	-
Baldauf & Santoni (1991)	S&P500	1975-1989	-	✓	-
Brorsen (1991)	S&P500	1962-1986	✓	✓	-
Maberly, Allen and Gilbert (1989)	S&P500	1963-1988	✓	✓	✓
Aggarwal (1988)	S&P500, DJIA	1981-1987	-	✓	-
Harris (1989b)	S&P500	1975-1987	✓	-	-
Laatsch (1991)	MMI	1982-1986	-	✓	-
Garety & Mulherin (1991)	DJIA	1974-1989	-	✓	-
Lee and Ohk (1992)	Various	Various	Various		
Kamara, Miller and Siegel (1992)	S&P500	1976-1988	-	✓	-
Koch and Koch (1993)	S&P500, MMI	1987-1988	-	✓	-
Antoniou and Holmes (1992)	FTSE-100	1988-1991	✓	-	-
Bessembinder and Seguin (1992)	S&P500	1978-1989	-	-	✓

* S&P500 = Standard and Poors 500 index (US), VLCI = Value Line Composite Index (US), DJIA = Dow Jones Industrial Average (US), MMI = Major Market Index (US), AO = All Ordinaries (Australia), HS = Hang Seng (Hong Kong) and NK = Nikkei (Japan) with a future traded in Simex (Singapore).

Table 2: Summary Statistics of the FTSE-All-Share Index for Different Samples

variable	statistic	sub-period: (S1)	(S2)	(S3)	(S4)	(S5)	(S6)
		pre-future	*post-future*	*post-future*	*post-future*	*post-future*	*post-future*
	Monetary: Regime	*MTFS*	*MTFS*	*DM-Shadowing*	*Free-Float*	*ERM*	*post-ERM*
$\Delta \ln p_t$	mean	0.07	0.09	-0.04	0.01	0.01	0.18
	std dev	0.86	0.73	1.62	0.76	0.80	1.23
	skewness	-0.12	-0.27	-2.72	-0.60	0.80	-0.43
	kurtosis⁺	1.79	0.34	17.19	1.76	5.80	15.03
	normality*	133.50	11.65	3967.50	115.80	731.70	1529.30
$\Delta_{10} \ln p_t$	skewness	-0.66	-0.14	-2.81	-0.14	0.76	0.82
	kurtosis	2.68	-0.16	9.92	0.17	0.71	1.15
	normality*	386.20	3.24	1440.00	2.94	56.70	27.10

+ Normalised.
* The normality test statistic is distributed $\chi^2(2)$, for which the critical value at 95% confidence is 5.99.

Table 3: A General ARCH-M Model of Stock Price (FTSE-All Share) Volatility

Model:

$$\Delta log(p_t) = a + b.\Delta log(p_{t-1}) + d_1.D + \rho.h_t + e_t$$
$$e_t \mid \Omega_{t-1} \sim N(0,h_t \mid \Omega_{t-1})$$
$$h_t = (\alpha + D0.\alpha') + (\gamma(L) + D0.\gamma'(L))e^2_{t-1} + \delta' D$$

Parameter	Estimate	t-statistic	Significance level
a	5.59 ($\times10^{-4}$)	1.83	0.07
b	0.115	10.95	0.00
d_1	-0.093	35.11	0.00
ρ	1.034	0.24	0.81
α	4.69 ($\times10^{-5}$)	11.6	0.00
γ_1	0.138	3.79	0.00
γ_2	0.065	1.70	0.09
γ_6	0.079	2.13	0.03
γ_9	0.054	1.38	0.17
α'	-1.32 ($\times10^{-5}$)	-2.71	0.01
γ_1	4.04 ($\times10^{-4}$)	0.01	0.99
γ_2	0.084	1.88	0.06
γ_6	-0.024	0.55	0.58
γ_9	0.016	0.37	0.71
δ_2	3.51 ($\times10^{-5}$)	3.33	0.00
δ_3	8.30 ($\times10^{-6}$)	0.94	0.34
δ_4	1.22 ($\times10^{-5}$)	1.36	0.17
δ_5	4.48 ($\times10^{-5}$)	4.88	0.00
δ_6	-5.30 ($\times10^{-5}$)	0.60	0.55

Log likelihood = 14285.1 Sign-Bias Test (t) = 1.29

Statistics for standardised residual ($e_t / \sqrt{h_t}$)

mean	=	-0.0075	Variance = 1.000683
t statistic	=	-0.43	(significance = 0.61)
skewness	=	-0.11	(significance = 0.01)
kurtosis	=	1.94	(significance = 0.00)

Table 4: A Parsimonious ARCH Model of Stock Price (FTSE-All Share) Volatility

Model:

$$\Delta log(p_t) = a + b.\Delta log(p_{t-1}) + d_1.D1 + \epsilon_t$$
$$\epsilon_t \mid \Omega_{t-1} \sim N(0, h_t \mid \Omega_{t-1})$$
$$h_t = \alpha + \gamma(L).\epsilon_t^2 + \delta'.D$$

Parameter	Estimate	t-statistic	Significance level
a	5.92 ($\times 10^{-4}$)	4.23	0.00
b	0.11	10.19	0.00
d	-0.095	-39.36	0.00
α	4.48 ($\times 10^{-5}$)	14.25	0.00
γ_1	0.14	10.75	0.00
γ_2	0.13	6.92	0.00
γ_6	0.013	3.29	0.00
γ_9	0.025	3.73	0.00
α'	-7.63 ($\times 10^{-6}$)	2.51	0.01
δ_2	2.82 ($\times 10^{-5}$)	4.57	0.00
δ_5	3.78 ($\times 10^{-5}$)	9.81	0.00

Log likelihood = 14282.0 Sign-Bias Test (t) = 1.40

Statistics for standardised residual ($\epsilon_t / \sqrt{h_t}$)

mean	=	-0.00537	Variance = 0.9999
t statistic	=	-0.31	(significance = 0.76)
skewness	=	-0.11	(significance = 0.01)
kurtosis	=	1.99	(significance = 0.00)

Table 5: A Restricted ARCH Model of Stock Price (FTSE-All Share) Volatility estimated over a Short Sample Period (May 1982 to May 1986)

Model:

$$\Delta log(p_t) = a + b.\Delta log(p_{t-1}) + e_t$$
$$e_t \mid \Omega_{t-1} \sim N(0,h_t \mid \Omega_{t-1})$$
$$h_t = \alpha + \gamma(L).e_t^2$$

Parameter	Estimate	t-statistic	Significance level
a	8.10 ($\times 10^{-4}$)	3.39	0.00
b	0.158	4.79	0.00 cc
α	4.30 ($\times 10^{-5}$)	8.33	0.00
γ_1	9.58 ($\times 10^{-2}$)	2.49	0.01
γ_2	7.83 ($\times 10^{-2}$)	2.19	0.03
γ_5	7.49 ($\times 10^{-2}$)	2.73	0.01
γ_6	8.90 ($\times 10^{-3}$)	0.25	0.81
γ_9	7.73 ($\times 10^{-3}$)	1.87	0.06
α'	-8.97 ($\times 10^{-6}$)	1.88	0.06

Log likelihood = 4323.0 Sign-Bias Test (t) = 1.14

Statistics for standardised residual ($e_t / \sqrt{h_t}$)

mean	=	0.016	Variance = 1.00076
t statistic	=	-0.49	(significance = 0.62)
skewness	=	-0.10	(significance = 0.19)
kurtosis	=	0.17	(significance = 0.28)

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