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EXCHANGE RATE AND INTEREST RATE EXPOSURE OF UK INDUSTRIES USING FIRST-ORDER AUTOREGRESSIVE EXPONENTIAL GARCH-IN-MEAN (EGARCH-M) APPROACH*

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We examine the sensitivity of 31 UK non-financial industries to exchange and interest rate exposure from 1990 to 2006 using first-order autoregressive exponential GARCH-in-mean (EGARCH-M) model. We find that the stock returns of UK industries are more affected by long-term interest rate risk than exchange rate risk and short-term interest rate risk. Moreover, the euro introduction decreases exchange and interest rate exposure and competitive industries exhibit higher returns volatility than concentrated industries. Furthermore, for most UK industries: increased risk does not necessarily lead to an increase in returns and persistence of volatility is much higher in some industries than others.

1 Introduction

Exchange and interest rates are two important economic and financial factors that can affect the value of the firm (Vardar *et al*., 2008; Kasman *et al*., 2011). For instance, fluctuations in exchange rates can impact the cash flows of multinational firms, importers, exporters, and also purely domestic firms (Hyde, 2007; Lin, 2012). Similarly, movements in interest rates can also impact the firm's cash flow by altering the firm's cost of finance, impinging on the amount of principal and loan interest payable (Hyde, 2007) and also the value of its financial assets and liabilities (Bartram, 2002; Ballester *et al*., 2011; Park and Choi, 2011). Joseph (2002) further explains that changes in exchange rates and interest rates can affect the domestic and global competitiveness of firms, by making their inputs and outputs cheaper or more costly. Consequently, if exchange rates and interest rate risk are not managed effectively, they have the potential of causing corporate failure. Although firms have been known to mitigate the undesirable effects of exchange rates and interest rates through the use of

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derivatives and operational hedges (e.g. matching), these have been unable to provide complete immunity.

A number of studies have examined empirically the exchange rate exposure of UK non-financial firms and industries. These include Donnelly and Sheehy (1996), Doidge *et al.* (2006), Dominguez and Tesar (2006), El-Masry *et al.* (2007) and Zhou and Wang (2012). Then for interest rate exposure, this has been investigated by Madura and Zarruk (1995), Dinenis and Staikouras (1998) and Oertmann *et al.* (2000). Then in some instances, exchange rate and interest rate exposure of UK non-financial firms and industries has been simultaneously examined in Prasad and Rajan (1995), Rees and Unni (2005) and Hyde (2007). However, these UK studies on interest rate risk have only been on the exposure to the short-term interest rate (one-month and three-month Treasury bill) while exposure to the long-term interest rate which have a considerable influence on the cost of borrowing and consequently corporate investment decisions of industrial corporations (Bartram, 2002 and Ferrer *et al.*, 2010) has not been investigated. Moreover, all these studies have used the traditional ordinary least squares (OLS) model or other functional linear methodology. However, due to the volatility clustering, non-normal distribution and ARCH effects inherent with most financial time series data, OLS is incapable of capturing the time-varying properties thereby producing biased or inefficient estimates resulting to unreliable inferences. Moreover, Koutmos and Martin (2007) indicate that exposure exhibits non-linear properties and which is better modelled using GARCH type models.

Apparently, there are only two known UK studies that have employed GARCH-type models: Joseph (2002) which was found to be limited in scope as only four industries were considered and Agyei-Ampomah *et al.* (2012) which used a linear GARCH (1,1)[1] process rather than more appropriate

[1]Nelson and Cao (1992) point out that the non-negativity constraint imposed on the linear GARCH (1,1) model is too restrictive since it may unjustifiably restrict the dynamics of the conditional variance process. Furthermore Koulakiotis *et al.* (2006) explain that the non-negativity constitutes a serious limitation to the generality of the time paths of the e_t and h_t processes of the linear GARCH (1,1). Specifically, a shock in the past (ε_{t-k}), irrespective of its sign, will always have a positive influence on the current volatility. These impacts increase with the magnitude of the shock thereby making the model incapable of detecting any non-linearity that might be inherent in the volatility. Engle *et al.* (1987) introduced the GARCH-in-mean (GARCH-M) as an improvement on the GARCH (1,1) based on the financial theory, which suggests that increase in volatility, or variance should lead to higher expected returns. Daly (2008) points out the ARCH model has been applied to asset pricing models, such as Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Model (APT) to capture the time-varying systematic risk process of these models. In the CAPM model, there is a fundamental trade-off between risk and return. Therefore, the incorporation of h_t^2 in the mean equation is intuitively appealing since the expected return of an asset is proportional to its expected risk (Taing and Worthington, 2005; Léon, 2008).

non-linear specifications such as the exponential GARCH (EGARCH) or exponential GARCH-in-mean (EGARCH-M).[2]

Besides, the introduction of the euro has been considered as an important economic landmark achievement in euro-land. Even for the UK, which has not adopted the euro, it is expected to benefit from the monetary union through reduced volatility of exchange rates and reduction of long-term interest rates. Nevertheless Joseph (2002) found that the introduction of the euro had no impact on the returns of the four UK non-financial portfolios in his study. But this result might have been unfavourably influenced by the very short duration of the post-euro data in the sample. Bartram and Karolyi (2006) also explored the impact of the introduction of the euro on the exchange rate exposure of non-financial firms from 18 European countries, the USA and Japan whereas Korkeamäki (2007) examined the effects of the euro on interest rate sensitivity of 12 EU countries. Although both studies included the UK, but the use of country level stock returns leads to data compression and consequently loss of information. We circumvent this problem in our study by using industry level returns instead.

Furthermore, industry concentration has been identified to have an important influence on exchange rate exposure. Bartram and Karolyi (2006) and Dominguez and Tesar (2006) have both used the Herfindahl index to examine this conjecture for UK industries. Bartram and Karolyi (2006) focus on the exposure to the trade weighted index while Dominguez and Tesar (2006) examined the influence of industry concentration on UK industry level exposure to the US$/£. However, both studies have employed linear based OLS which might result to unreliable inferences and although the UK does have significant level of trade with the USA, but trade with Japan is equally very important so the JP¥/£ should have been considered too. Then Faulkender (2005) suggests that changes in interest rates can have indirect effects on the competitive position of the firm by impacting the size of its future cash flows and consequently firm value but no study has examined the influence of industry concentration on the interest rate exposure of UK industries.

Therefore, using a methodology that encapsulates conditional heteroscedasticity, that may be appropriate to the financial data, this study aims to provide a more comprehensive and detailed analysis of exchange rate exposure (trade-weighted nominal exchange rate index, bilateral US$/£ and JP¥/£ exchange rates) and interest rate exposure (short-term interest rate and long-term interest rate measures) of UK non-financial industries. The study

[2]The EGARCH-M seems to be a superior method of estimation since it embodies the relationship between volatility and expected returns and also accommodates the asymmetric relationship that persists between equity returns and volatility. Additionally, the asymmetric relationship is separated into leverage effects, indicating that negative surprises (news) increases the volatility of returns more than positive surprises (news) whereas for asymmetric effects, positive surprises increase return volatility more than negative surprises.

also examines the impact of the introduction of the euro on exchange rate and interest rate exposure and the degree to which industry concentration may affect the extent to which industries can diversify away the exposure to exchange rate and interest rate risk thereby providing additional evidence and further insights to the relationship between industry concentration, exchange rate exposure and interest rate exposure.

This paper is organized as follows: Section 2 reviews related literature, Section 3 presents methodology and data sources, Section 4 summarizes and discusses the main results and Section 5 concludes the study.

2 Review of Related Literature

Despite the evident concerns of the impact of fluctuating exchange and interest rates on a firm's value, empirical studies have continued to produce mixed results. Bartram (2002) investigated the interest rate exposure of German non-financial firms using the three-month Eurocurrency as a proxy for the short-term interest rate index and the 10-year government bond was used as a benchmark for the long term. The findings indicated that exposure to changes in the long-term interest rates was mostly positive and firms exhibited higher exposure towards the long-term interest rate than the short-term interest rate. Ferrer *et al*. (2010) and Park and Choi (2011) examined the interest rate exposure of Spanish industry portfolios and US property/liability insurer stock returns respectively. Although they found that more industries were significantly exposed to the long-term interest rate than the short-term interest rate, however the exposure coefficients were negative for both interest rate measures. This result is similar to that of Ballester *et al*. (2011) who for Spanish banks find significant negative interest rate exposure coefficients for both the short-term and the long-term interest rate.

Zhou and Wang (2012) examine the exchange rate exposure of 148 UK non-financial firms using the trade-weighted index for the year 1999. They found that only 9.46 per cent of the firms exhibited statistically significant exchange rate exposure coefficient and for a majority of these, stock returns increase (decrease) with the appreciation (depreciation) of the index. Nevertheless, the incidence of significant exchange rate exposure coefficients is very low in comparison with most studies and this may probably be due to the limited time frame of one year employed for the study. Chow *et al*. (1997) and Bodnar and Wong (2003) point out that exchange exposure for stock returns mirror the effects of both interest rates and cash flow effects, which counterbalance over short time horizons leading to weak conclusions and distorted results (Jong *et al*., 2006) but are complementary over long time horizons. This has been identified as one of the reasons why previous studies have failed to find significant exposure coefficients. Similarly, Aggarwal *et al*. (2011) selected the period from July 2005 to July 2006, just one year after China changed its exchange regime to managed floating exchange regime. The

results indicated that Chinese firms generally benefited from the depreciation of Chinese Yuan but evidence of significant exchange rate exposure was particularly weak for the major trading partners as only 6 per cent was found for US dollar and 5.5 per cent for the HK dollar and the Association of Southeast Asian Nations (ASEAN) index respectively.

Tai (2010) investigates the exchange rate exposure of 12 Japanese industries (six from non-traded goods and six from traded goods) utilizing the generalized methods of moments (GMM) and multivariate GARCH-in-mean (MGARCH-M)[3] approach. The exchange rate exposure results were similar for both models as significant negative coefficients were found for 83 per cent of the industries suggesting these industries are hurt by unexpected changes in the Japanese yen. However, MGARCH-M revealed strong evidence of time-varying foreign exchange risk premium, which was totally ignored using the GMM as this was assumed to be constant. Agyei-Ampomah *et al*. (2012) in their investigation of foreign exchange exposure of UK non-financial firms find comparable exchange rate exposure results for the OLS and GARCH (1,1) model used. But the GARCH model also provided evidence of time-varying exchange rate exposure, which the OLS had assumed to be constant.

Chue and Cook (2008) find that, using Jorion's two-factor model to estimate the exchange exposure of 15 emerging market companies from 1999 to 2006, although Chile, Colombia, India, Pakistan and Philippines showed a low or no significant exchange rate exposure, other 10 countries had a higher proportion of significant exchange exposure. Moreover, mostly, the exchange exposures were negatively correlated with stock returns, especially in the middle-income countries of East Asia and Latin America. On the other hand, Choi (2010) finds that 50 per cent of the Korean oil-refining and petrochemical firms are significantly exposed to exchange rate changes when the changes are sizeable especially in years 1997 and 2008, which are known as Asian Crisis and recent global financial crisis periods. Cho and Song (2011) revealed that 44 of Korean firms had significant exchange rate exposure. Besides, they found that the majority of firms were harmed if the Korean Won depreciated.

Al-Shboul and Alison (2009) find that 8 per cent of Australian multinational firms have significant exposure coefficients. Aggarwal and Harper (2010) finds that, using 1047 US domestic firms, domestic firms also experienced significant foreign exchange risks which were not different from firms

[3]Al-Zoubi and Al-Zu'bi (2007) indicate that the GARCH-M model is characteristically linear (symmetric) so if used in the presence of asymmetric effects, this may lead to a misleading estimation of the risk–return relationship since the influence of past variance on current volatility is modelled as a function of their magnitude of the error term only whereas volatility is typically higher after a decrease than an equal increase.

involving international operations. They argued that domestic firms faced international competition because of foreign suppliers, competitors as well as the macro-economic factors.

Murtagh and Bessler (2003) investigated the exchange rate and interest rate exposure of some UK industries using the Bank of England trade weighted exchange rate, one- to three-year bond for the short-term interest rate and 10-year government bond for the long-term interest rate. The results revealed that the industries were more susceptible to interest rate exposure than exchange rate exposure. Also, there were more statistically significant exposure coefficients for the long-term interest rate measure (same number of negative and positive coefficients) than for the short-term interest rate. Conversely, Ryan and Worthington (2004), using a first-order autoregressive (AR(1))-GARCH-M model, find that banks' returns were only affected by the short-term and medium-term interest rate but not influenced by the long-term interest rate and the trade-weighted exchange rate. Likewise, Guay and Kothari (2003) indicate that for their sample of large non-financial US corporations, exchange rate exposure was smaller than interest rate exposure. Solnik (1984) explains that interest rate changes have the foremost monetary influence on stock returns, while for the exchange rate changes; a weak relationship is generally observed. But Jorion (1990) points out that exchange rates are typically four times more volatile than interest rates, therefore the impact of exchange rates should be more significant than that of interest rates. This assertion is further supported in Sweeney and Warga (1986), Choi and Elyasiani (1997) and Joseph and Vezos (2006).

Hyde (2007) found for industry sectors in UK, Germany and Italy that exposure to exchange rate was more significant than interest rate exposure. However, for France, exposure to exchange rate was equally as important to exposure arising from interest rates. Conversely, Bredin and Hyde (2011) also examine the exchange rate and interest rate exposure of G7 countries, which included the UK. They found significant evidence of interest rate exposure, which was mostly negative for Canada, Japan and the UK but indication of this was very weak for France, Germany, Italy and the USA. Then for changes in exchange rate, all the countries showed very little or no exposure with the exception of Canada.

Rees and Unni (2005) examine the exchange rate and interest rate exposure of 90 large European firms from UK, France and Germany. The exchange rate measures included the domestic currencies against the ECU, yen and US dollar and the short-term interest rate represented by the one-month Treasury bill. They found that UK firms had the highest number of significant exposure to the ECU (87 per cent of the firms), while exposure to the yen was generally weak as less than 25 per cent of the firms in all countries had significant coefficients. But regarding exposure to interest rate, 63 per cent of UK firms and 90 per cent of French firms had significant negative interest rate coefficients, but evidence of interest rate exposure was very weak

for German firms. The result here is more diverse though; for UK, incidence of exchange rate exposure is higher than interest rate exposure, for France, interest rate exposure is more significant while for Germany, evidence of both interest rate and exchange rate exposure is weak. Prasad and Rajan (1995) investigate the impact of exchange rate and interest rate risk exposure on the equity valuations of industry portfolios in Germany, Japan, the UK and the USA. Interestingly, they found that the German market had one of the highest numbers of industries with significant exposure to exchange rates while exposure to interest rates was found to be very significant too.

The OLS method has been used by most of these studies to examine exchange rate and interest rate exposure. But exchange rates and interest rates are volatile over time and exhibit leverage and ARCH effects. Since the OLS is incapable of capturing these time-varying properties, the results produced may be biased and misleading. Joseph and Vezos (2006) examined the exchange rate and interest rate (short-term) exposure of 50 US Banks and their constituent portfolios, using the OLS and EGARCH estimation methods. The results showed that 30 per cent of the banks and two of the three portfolios exhibited significant exchange rate exposure coefficients for the OLS model; while for interest rate exposure, only 8 per cent of the banks had significant exposure coefficients. They remark that the weak result from the OLS may be due to its inability to capture the time-varying properties of the series. Subsequently, from the EGARCH model, 40 per cent of the firms had significant exchange rate exposure coefficients but the result for interest rate exposure was still similar to that of the OLS. Vardar *et al*. (2008), in their study of financial, industrial, service and technology sector indices of the Istanbul stock exchange, using a AR(1)-GARCH (1,1) framework, find that all sectors are significantly affected by the interest rate, while for the exposure to exchange rate risk, only the services sector had a significant coefficient. Joseph (2003) using the OLS also finds exchange rate exposure to be weak for US industries, whereas most of the interest rate (short-term) coefficients were significant. Although when GARCH and GARCH-M models were employed instead, a slight increase in the incidence of significant exchange rate exposure coefficients was noticeable but this was still lower than exposure to interest rate. These findings are contradictory to Kasman *et al*. (2011) who find from their OLS estimate higher exposure to exchange rate exposure than interest rate exposure for Turkish banks. But when the GARCH model was used instead; incidence of significant interest rate exposure was higher.

Joseph (2002) examined the interest rate and exchange rate exposure of four UK industrial sectors namely the chemical, electrical, engineering and pharmaceutical sectors using the UK one-month Treasury bill as a proxy for interest rates and the trade weighted sterling for exchange rates initially using the OLS. But following the detection of autocorrelation and ARCH effects in the residuals, GARCH type models in the form of EGARCH and EGARCH-M were used instead. The results indicated that interest rates had

a stronger influence on portfolio returns than exchange rates (only significant for the electrical sector) and there was no indication of asymmetric effects (positive and negative news seemed to have similar effects on the volatility of stock prices). This result contradicts Jayasinghe and Tsui (2008) who investigated the exchange rate exposure of 14 Japanese industrial sectors and found evidence of asymmetric effects, as the volatility of sectoral returns, induced by the depreciation of the yen was higher than that caused by the appreciation of the yen. Likewise, Lobo (2000) investigated the asymmetric effects of changes in interest rates on the returns of the S&P index and US banks stock respectively. He found that the three-month Treasury bill had a significant negative effect on the returns of the index, evidence of high persistence of volatility and leverage effects; implying that past negative innovations had a grater impact on current volatility in the stock market than past positive innovations. Likewise for US bank stock found evidence of Verma and Jackson (2008) find evidence of asymmetric effects, as banks were more susceptible to negative changes in the interest rate than positive changes. Then for exchange rate and interest rate risk, Joseph and Vezos (2006) and Vardar *et al*. (2008) found increased riskiness of returns, presence of leverage effects and high persistence of volatility. The literature reveals that susceptibility to exchange rate or interest rate risk depends on the measure utilized.

But industry structure also plays an important role in the magnitude of a firm's exposure to fluctuations in exchange rates and interest rates as Marston (2001) stipulated that the type of competition displayed in an industry affects the economic exposure of firms within that industry. This argument has received support in Ceglowski (1989), Krishnamoorthy (2001) and Bodnar *et al*. (2002) as they express that the type of competition exhibited by firms in an industry determines the extent to which exchange rates and even interest rates impinge on their cash flows. Bradley and Moles (2001) find that, through a survey, for a large number of respondents, the appreciation of the pound is absorbed by their companies through reductions in profit margins, so as to maintain their market share. Helliar *et al*. (2005) explain that suppliers may be forced to increase their prices so as to cover the higher cost of funding. However, this increase may prove to have a negative impact on the financial performance of the firm, especially if competition is fierce in the industry.

Bodnar *et al*. (1998) and Williamson (2001) claim that monopolistic firms can pass the cost to consumers so their risk exposure may be small and undetectable. Dominguez and Tesar (2001) also point out that firms in less competitive industries such as oligopolistic industries, prices are elevated above marginal cost therefore they would be expected to have a different exposure to a firm in a globally competitive industry. Furthermore, Campa and Goldberg (1995), Allayannis and Ihrig (2001) and Krishnamoorthy (2001) highlight that the more competitive the industry, the higher the exposure.

Bartram (2002) also indicated that interest rate risk may have an indirect influence on the competitive position of the firm while Andrews (2005) posits that the market-place is becoming increasingly competitive, profit margins are consistently under the threat of being eroded. Consequently, significant higher cost of debt could be detrimental for the long-term profitability and survival of the business. Besides, Allayannis and Ihrig (2001) and Krishnamoorthy (2001) found that competitive industries in the USA, exhibited higher exchange rate exposure than industries monopolistic or oligopolistic industries. In contrast, Bartram and Karolyi (2006) and Dominguez and Tesar (2006) found that industries with higher Herfindahl indices (less competitive) had higher exchange rate exposure than industries with low Herfindahl indices (less competitive).

3 Methodology and Data

The AR(1)-EGARCH (1,1)-M is used to examine the responsiveness of UK non-financial industries stock returns to changes in exchange and interest rates over the period 1990–2006. The model is specified as follows:

$$R_{it} = \alpha_i + \beta_{ai} R_{it-1} + \beta_{m,i} RM_t + \beta_{r,i} XR_t + \beta_{s,i} SR_t + \beta_{l,i} LR_t + \lambda \log\left(h_{i,t}^2\right) + \varepsilon_{i,t} \quad (1)$$

$$\varepsilon_{i,t} | I_{t-1} \sim t\left(0, h_{i,t}^2, \upsilon_{i,t}\right) \quad (2)$$

$$\log h_{i,t}^2 = \alpha_o + \alpha_1 \frac{\varepsilon_{i,t-1}}{h_{i,t-1}} + \alpha_2 \left(\left| \frac{\varepsilon_{i,t-1}}{h_{i,t-1}} \right| \right) + \varphi_1 \log h_{i,t-1}^2 \quad (3)$$

where

- R_{it} is the return of industry i at time t,
- α_i is the intercept term for industry i,
- R_{it-1} (autoregressive lag parameter) is the returns for industry i at time $t - 1$ accounting for autocorrelation,
- RM_t is the rate of return of the market portfolio at time t,
- XR_t is the percentage change in the exchange rate index at time t,
- SR_t is the change in the short-term interest rate at time t,
- LR_t is the change in the long-term interest at time t,
- $h_{i,t}^2$ is the log of conditional volatility and reflects the fundamental trade-off relationship between expected returns and the measure of previous conditional volatility,
- λ captures the risk pattern over time, and
- $\varepsilon_{i,t}$ is the error term.

In equation (2), the error term, $\varepsilon_{i,t}$ has a mean 0, variance $h_{i,t}^2$ (time varying) and a t-density distribution with $\upsilon_{i,t}$ degrees of freedom, while I_{t-1} is information available at time $t - 1$. Equation (3) is the variance equation

where $h_{i,t}^2$, the log of the conditional variance is the current volatility forecast, conditional upon the previous period's conditional variance and error. α_o is the constant term. It is the time-independent component of volatility and also reflects the volatility measure when the ARCH, GARCH or other conditioning variables are not statistically significant. α_1 measures the asymmetric impact of past innovations on current volatility, therefore there are leverage effects when $\alpha_1 < 0$ and asymmetric effects when $\alpha_1 \neq 0$. α_2 is the ARCH term which links current volatility (conditional variance) to the asymmetric function of past innovations. A significant positive coefficient i.e. $\alpha_2 > 0$ validates the presence of volatility clustering (tendency of shocks to persist). Therefore volatility tends to rise (fall) when the absolute value of the standardized error is larger (smaller). The $h_{i,t-1}^2$ is the past period variance and φ_1 is the GARCH term which denotes the persistence parameter that associates current volatility with past volatility i.e. it measures the persistence of innovations on volatility (impact of old news on volatility). The system is only stable when $\varphi_1 < 1$. Generally, equation (3) stipulates that the log of the conditional variance (current volatility) is an asymmetric function of last period's error (past innovations) and the log of last period's conditional variance (past volatility).

Since daily data are noisy and usually suffer from the problem of non-synchronous trading (Nydahl, 1999; Jong *et al*., 2006), therefore, the preference for weekly data is justified. The weekly return index data sets are for the period January 1990 to December 2006. Although the sample period is relatively lengthy, this is more efficient at accurately capturing the exposure coefficients (Chow *et al*., 1997; Bodnar and Wong, 2003 and Jong *et al*., 2006).

The data for this study were obtained from DataStream Database. For firm level and industry level data, DataStream uses the Industry Classification Benchmark (ICB), which is an in-depth and comprehensive structure for sector and industry analysis. The benchmark also assigns firms to a subsector that depicts the nature of the firm's business, as determined by its major source of revenue. There categories are: INDM2 (12 industries), INDM3 (20 industries), INDM4 (41 industries) and INDM6 (102 industries). In all INDM categories, two industries, designated Unclassified and Unquoted, are considered unusable, and are therefore not considered for inclusion in the final sample. But INDM2 and INDM3 are too coarse, and thereby there is a possibility that significant exposures might be masked out in the industry level analysis. Conversely, INDM6 is too disaggregated and may not be within a manageable range (Jayasinghe and Tsui, 2008). Using the INDM4, 2837 firms, grouped under 41 industry classifications are found. But 35 firms are listed under unclassified industries while 109 firms are grouped under the unquoted equities. These are then removed from the initial sample set, leaving 2693 firms grouped into 39 industries. Moreover, only non-financial firms quoted on the LSE are relevant for this study, since financial firms are excluded because their rationale for use of complex risk management

Table 1
Number of Firms in Each Non-financial Industry

No.	*Industry*	*Number of firms*
1	Aerospace and Defence	8
2	Automobiles and Auto Parts	3
3	Beverages	4
4	Chemicals	12
5	Construction and Materials	22
6	Electricity	3
7	Electronic and Electrical Equipment	20
8	Fixed-line Telecommunications	2
9	Food and Drug Retailers	5
10	Food Producers	15
11	Forestry and Paper	2
12	Gas, Water and Multi-utilities	6
13	General Industrial	9
14	General Retailers	27
15	Healthcare Equipment and Services	10
16	Household Goods	19
17	Industrial Engineering	33
18	Industrial Transport	9
19	Leisure Goods	6
20	Media	29
21	Mining	7
22	Mobile Telecommunications	1
23	Oil and Gas Producers	9
24	Oil Equipment and Services	2
25	Personal Goods	14
26	Pharmaceuticals and Biotechnology	7
27	Software and Computer Services	21
28	Support Services	62
29	Technical Hardware and Equipment	11
30	Tobacco	1
31	Travel and Leisure	23
	Total	402

strategies is different from that of non-financial firms (Bradley and Moles, 2001; El-Masry, 2006 and Zhou and Wang, 2012). Financial firms are considered producers of financial services instead of end-users (Agyei-Ampomah *et al*., 2012). Subsequently, eight financial industries, comprising of 565 firms are identified and taken out of the data set. This leaves 31 non-financial industries consisting of 2128 firms. Firms with missing data were subsequently excluded leaving a final sample of 402 firms as shown in Table 1.

Griffin and Karolyi (1998) and Griffin and Stulz (2001) point out that using broad industrial classifications may result in putting together heterogeneous industries, therefore disaggregated industry benchmarks should be utilized for industry level studies. Furthermore, Muller and Verschoor (2006b) explained that use of a finer INDM classification will help reveal, in more detail and accuracy, industry-specific exchange rate and interest rate exposure; intuitively, the INDM4 was considered the most ideal for this

study. However, financial firms were excluded from the sample because they utilized complex risk management strategies for their foreign exchange exposure and interest rate exposure (Bradley and Moles, 2001 and El-Masry, 2006). The return index of the firm is determined by DataStream using equation (4) as follows:

$$RI_t = RI_{t-1} * \frac{PI_t}{PI_{t-1}} * \left(1 + \frac{DY_t}{100} * \frac{1}{N}\right) \tag{4}$$

where: RI_t = return index on day t, RI_{t-1} = return index on previous day, PI_t = price index on day t, PI_{t-1} = price index on previous day, DY_t = dividend yield per cent on day t and N = number of working days in the year which is taken to be 260 days.

Subsequently RI_t is estimated using equation (5) as follows:

$$RI_t = RI_{t-1} * \frac{P_t}{P_{t-1}} \tag{5}$$

The weekly firm returns are then computed using equation (6) as follows:

$$R_{it} = \ln(RI_t / RI_{t-1}) \tag{6}$$

The weekly return index of firms included in the final sample was used to construct equally weighted stock portfolio returns for each industrial sector.

The trade-weighted exchange rate is usually favoured by researchers because it eliminates multicollinearity (e.g. Joseph, 2002; Fraser and Pantzalis, 2004; El-Masry, 2006; Muller and Verschoor, 2006a). Therefore, in this study, the Bank of England trade-weighted effective nominal exchange rate hereafter TWN is used. However, for comparison purposes, we also use bilateral exchange rates such: US$, and Japanese yen exchange rates as they are the main trade partners with the UK. Then for the interest rate measure, the three-month Treasury bill is used as a proxy for short-term interest rate risk (e.g. Bae, 1990; Prasad and Rajan, 1995; Dinenis and Staikouras, 1998; Joseph, 2002; Staikouras, 2006; Korkeamäki 2007). Then following Bae (1990); Bartram (2002); Loudon (2004) and Staikouras (2006), the 10-year government bond is used as the benchmark for the long-term interest rate.

The underlying assumption that financial markets are efficient leads to the insinuation that expected changes would have been reflected in asset prices and, therefore only the unexpected changes should affect stock returns (Choi *et al*., 1992). The autoregressive integrated moving average (ARIMA) p,d,q model is particularly well favoured as a vital tool for extracting unexpected changes in exchange and interest rates, as evidenced by Fang and Loo (1994) and Atindéhou and Gueyie (2001) for exchange rates, and Dinenis and Staikouras (1998) and Korkeamäki (2007) for interest rates.

On the basis of the specified selection criteria,[4] ARIMA(3,1,2) is chosen for the TWN, ARIMA(3,1,3) for the US$/£ and ARIMA(2,1,2) for the JP¥/£. Then, for the interest rate measures, the ARIMA(7,4) was more appropriate for the three-month Treasury bill, while for the 10-year government bond, the ARIMA(1,1,1) was found to be suitable. Subsequently, the fitted values of the ARIMA model now correspond to the expected changes while the residuals are used as a proxy for the unexpected changes in exchange rates and interest rates.

The impact of exchange and interest rate fluctuations on the returns of UK competitive and concentrated industries is also investigated using the AR(1)-EGARCH-M model. A pooled regression analysis is used as follows:

$$R_t = \alpha + \beta_{ai} R_{t-1} + \beta_m RM_t + \beta_r XR_t + \beta_s SR_t + \beta_l LR_t + \lambda \log(h_t^2) + \varepsilon_t \tag{7}$$

Equation (7) is the mean equation where, R_t is the pooled return of the concentrated or competitive industries (the same parameters for equations (2) and (3) are also used here for the time-varying error term and the variance equation).

Additionally, we further test for any significant difference between concentrated and competitive industries as follows:

$$R_t = \alpha + \beta_{ai} R_{t-1} + \beta_{mi} RM_t + \beta_{ri} XR_t + \beta_{si} SR_t + \beta_{li} LR_t + \beta_{in}\text{INDUM} + \lambda \log(h_t^2) + \varepsilon_t \tag{8}$$

where

- INDUM is the industry dummy, which takes the value of 1 for concentrated industries and 0 for competitive industries (the same parameters for equations (2) and (3) in the variance equation are also used here)

The Herfindahl–Hirschman index (H.H.I), which measures concentration by summing the squared market shares of all the firms in the industry, is used to determine the level of competition in the UK industries. Nellis and Parker (2002) point out that the H.H.I is commonly used by government competition authorities, such as those in the USA and UK as a measure of competition. Generally, they perceive industries with H.H.I greater than 1800 as being highly concentrated. We measure industry concentration using the Herfindahl index (H) based on total sales by industry group as follows:

[4]The model is adequately specified when the Q statistics for all the auto-correlation and partial auto-correlation structures, up to 36 lags, are statistically insignificant, indicating no residual serial correlation. In addition, a Breusch–Godfrey serial correlation test is used to substantiate the results from the Q statistics. Again, the residuals obtained were white noise indicating that the model was adequate for the univariate series.

TABLE 2
HERFINDAHL INDEX FOR NON-FINANCIAL INDUSTRIES

No.	*Concentrated Ind.*	*H.I*	*No.*	*Competitive Ind.*	*H.I*
1	Aerospace and Defence	4567.71	1	Construction and Materials	1369.03
2	Automobiles and Auto Parts	7633.39	2	Electronic and Electrical Equipment	1326.23
3	Beverages	2984.81	3	General Retailers	936.42
4	Chemicals	2661.49	4	Household Goods	1081.49
5	Electricity	4331.41	5	Industrial Engineering	687.14
6	Fixed-line Telecom	7684.53	6	Industrial Transport	1233.62
7	Food and Drug Retailers	3920.58	7	Media	836.12
8	Food Producers	3302.91	8	Personal Goods	964.05
9	Forestry and Paper	5535.94	9	Software and Computer Services	1201.91
10	Gas, Water and Multi-utilities	4278.03	10	Support Services	436.09
11	General Industrial	2170.38	11	Tech Hardware and Equipment	1224.82
12	Healthcare Equipment Services	1934.29	12	Travel and Leisure	768.62
13	Leisure Goods	4465.69			
14	Mining	2312.85			
15	Mobile Telecommunications	9485.62			
16	Oil and Gas Producers	4571.75			
17	Oil Equipment and Services	3005.52			
18	Pharmaceuticals and Biotech	5535.57			
19	Tobacco	10000.00			

Notes: Concentrated Ind. and Competitive Ind. represent concentrated and competitive industries respectively. H.I is the Herfindahl index value indicating the degree of concentration in the industry. H.I values > 1800 represent concentrated industries.

$$H = \sum_{i=1}^{N} S_i^2 \tag{9}$$

where

- s_i is the market share of firm i in the market, and
- N is the number of firms.

The procedure entailed averaging the annual domestic sales of all firms within each industry during the period 1990–2006. The average sale for all the firms is then added together to determine the total sales for the industry. Subsequently, the market share, for each firm, is then calculated and squared to obtain the Herfindahl index. The addition of the Herfindahl indices for all firms in the industry corresponds to the Herfindahl index and therefore concentration of that industry. For firms in industries with low Herfindahl values, i.e. less than 1800, these were classified as competitive industries while those with high Herfindahl values that is over 1800, were referred to as being concentrated industries. The result indicates that there are 19 concentrated industries and 12 competitive industries as shown in Table 2. However, since the Herfindahl index only gives an insight into how the degree of competition in an industry is affected by the size and number of firms at the national level, it might not present a precise picture of competition (Mulhearn *et al.*, 2001). Consequently, the absolute value of the Herfindahl index is not included in the model, but only used as an indication to determine the type of concentration present in the industry.

With the introduction of the euro, Welsch (1999) and Barrett and Turongpun (1999) indicated that operational risks associated with fluctuating foreign exchange rates and interest rates will be eradicated. Bartram and Karolyi (2006) explain that the reduction of foreign exchange rate risk would be beneficial for European firms and also firms that undertake a significant level of trade or investments in Europe. Additionally, Korkeamäki (2011) noted that with the single currency, European corporate bonds markets, which were previously limited in size and scope have witnessed significant growth; thereby euro firms and even EU countries are able to manage interest rate risk more effectively. Ballester *et al*. (2011) also posit that the euro should bring about greater financial stability due to the common monetary policy and enlargement of the capital markets. Following on Morana and Beltratti (2002), Sfakianakis (2002), Bris *et al*. (2006), Simpson and Dania (2006), Korkeamäki (2007), Nguyen *et al*. (2007), Hutson and O'Driscoll (2010) and Korkeamäki (2011), the period after the euro is chosen to start from 1 January 1999.

Therefore we are motivated to investigate the change in market risk, exchange rate risk and interest rate risk following the introduction of the euro is determined for the TWN, US$/£ and JP¥/£ by extending the mean equation from 1a to include dummy variables. We also test the impact of introduction of the euro on industry return volatility ($\log h_t^2$) by including a dummy variable in the variance equation (11). The model is estimated as

$$R_{i,t} = \alpha_i + \beta_{a,i}R_{it-1} + \beta_{m,i}RM_t + \beta_{\text{Euro}m,i}RM_tD_{\text{Euro}t} + \beta_{r,i}XR_t + \beta_{\text{Euro}r,i}XR_tD_{\text{Euro}t} + \beta_{s,i}SR_t + \beta_{\text{Euro}s,i}SR_tD_{\text{Euro}t} + \beta_{l,i}LR_t + \beta_{\text{Euro}l,i}LR_tD_{\text{Euro}t} + \lambda\log\left(h_{i,t}^2\right) + \varepsilon_{i,t} \tag{10}$$

$$\varepsilon_{i,t}|I_{t-1} \sim t\left(0, h_{i,t}^2, \upsilon_{i,t}\right) \tag{11}$$

$$\log h_{i,t}^2 = \alpha_o + \alpha_1\frac{\varepsilon_{i,t-1}}{h_{i,t-1}} + \alpha_2\left(\left|\frac{\varepsilon_{i,t-1}}{h_{i,t-1}}\right|\right) + \varphi_1\log h_{i,t-1}^2 + \beta_{e,i}\text{EURDUM} \tag{12}$$

In equation (10), α_i is the intercept term for industry i, R_{it} is the return of industry i, RM_t is the rate of return of the market portfolio, XR_t is the percentage change in the exchange rate index in week t, SR_t is the change in the short-term interest rate in week t and LR_t is the change in the long-term interest in week t, $h_{i,t}^2$ is the log of conditional industry volatility, while the coefficient λ reflects the fundamental trade-off relationship between expected returns. $D_{\text{Euro}t}$ is a dummy variable that takes the value of 1 from 1 January 1999 and 0 before that date and $\varepsilon_{i,t}$ is the error term for industry i. In addition, other coefficients are:

- $\beta_{a,i}$ = autoregressive coefficient for industry i
- $\beta_{m,i}$ = market risk exposure coefficient for industry i before the euro

- $\beta_{r,i}$ = foreign exchange rate exposure coefficient of industry i before the euro
- $\beta_{s,i}$ = short-term interest rate exposure coefficient of industry i before the euro
- $\beta_{l,i}$ = long-term interest rate exposure coefficient of industry i before the euro
- $\beta_{\text{Euro}m,i}$ = change in the market risk for industry i after the euro
- $\beta_{\text{Euro}r,i}$ = change in exchange rate exposure for industry i after the euro
- $\beta_{\text{Euro}s,i}$ = change in the short-term interest rate exposure for industry i after the euro
- $\beta_{\text{Euro}l,i}$ = change in the long-term interest rate exposure for industry i after the euro.

All the components of the equation (10), the time-varying error term of equation (11) and the variance equation (12) are as explained previously in equations (1), (2) and (3), respectively, except EURDUM, which is used to assess the impact of the introduction of the euro on the volatility of industry returns. This binary variable has a value of 1 from 1 January 1999 and 0 before that date.

Then for concentrated and competitive industries, equation (12) is used as follows:

$$\begin{aligned} R_t = {} & \alpha + \beta_{ai} R_{t-1} + \beta_m RM_t + \beta_{\text{Euro}m} RM_t D_{\text{Euro}t} + \beta_r XR_t + \beta_{\text{Euro}r} XR_t D_{\text{Euro}t} \\ & + \beta_s SR_t + \beta_{\text{Euro}s} SR_t D_{\text{Euro}t} + \beta_l LR_t + \beta_{\text{Euro}l} LR_t D_{\text{Euro}t} + \beta_{in}\text{INDUM} \\ & + \lambda \log(h_t^2) + \varepsilon_t \end{aligned} \tag{13}$$

where INDUM is represented as 1 for concentred industries and 0 for competitive industries. Equations (11) and (12) are also used here as the time-varying error term and the variance equation.

All the models were checked for multicollinearity. In all the estimates, the condition index and variance inflation factor (VIF) had values in the range of 1.000–3.564 and 1.379–2.750 respectively. Evidently, multicollinearity is not a problem with these models.

4 Empirical Results

4.1 Descriptive Statistics

Almost all the industry returns (Table 3) and return on the market index, exchange rate indices and interest rate measures (Table 4) exhibit substantial skewness and kurtosis. The skewness measures are mainly negative indicating non-symmetric distributions. All the kurtosis measures exceed three, which is the normal value. This implies that all the series are highly leptokurtic (more peaked around the mean with relatively fat tails). The Jarque–Bera statistics is used to test the normality of all the series. The statistics are all significant at the 1 per cent level confirming that the series are not from a normal

TABLE 3
DESCRIPTIVE STATISTICS FOR NON-FINANCIAL INDUSTRY RETURNS

Industry	*Mean*	*Median*	*Maximum*	*Minimum*	*Std. Dev.*	*Skewness*	*Kurtosis*	*Jarque–Bera*
AERO	0.0030	0.0016	0.1555	−0.1628	0.0283	−0.2187	6.6988	512.1236***
AUTO	0.0009	0.0012	0.1569	−0.1490	0.0314	−0.1420	6.5314	463.3693***
BEVERAGE	0.0022	0.0017	0.0833	−0.0866	0.0174	0.2027	5.6974	274.6692***
CHEMICAL	0.0013	0.0014	0.1028	−0.1386	0.0227	−0.5687	7.4085	765.2281***
CONST	0.0024	0.0016	0.0737	−0.1053	0.0180	−0.2357	6.9375	580.5646***
ELECEQPT	0.0019	0.0028	0.0972	−0.1141	0.0231	−0.1631	5.2726	194.5994***
ELECT	0.0022	0.0022	0.6933	−0.2769	0.0397	5.4360	109.4133	422400.1000***
FIXLINE	0.0003	0.0019	0.2080	−0.3659	0.0453	−1.3525	13.6312	4442.5540***
FOODDRUG	0.0026	0.0014	0.1076	−0.1330	0.0269	−0.1004	4.6413	100.9312***
FOODPROD	0.0015	0.0014	0.0853	−0.0776	0.0196	−0.1971	4.9186	141.6300***
FORPAPER	0.0000	0.0000	0.3665	−0.6775	0.0480	−2.1936	56.3404	105745.7000***
GASWATER	0.0027	0.0020	0.2046	−0.1976	0.0278	−0.1605	11.0226	2379.8150***
GENIND	0.0015	0.0017	0.1198	−0.1430	0.0289	−0.5780	6.5790	522.2010***
GENRETAI	0.0022	0.0031	0.1184	−0.1120	0.0264	0.1865	5.3048	201.2485***
HEALCARE	0.0014	0.0011	0.4215	−0.2541	0.0392	1.5673	27.0189	21660.2600***
HHGOODS	0.0024	0.0038	0.1564	−0.1311	0.0279	−0.1527	6.0348	343.4437***
INDENGR	0.0019	0.0022	0.0794	−0.0962	0.0173	−0.1188	5.9884	331.7706***
INDTRANS	0.0025	0.0033	0.1428	−0.1506	0.0235	−0.4791	8.4434	1127.7520***
LEISGOOD	0.0006	0.0000	0.3534	−0.4207	0.0684	0.2783	10.1223	1884.0850***
MEDIA	0.0006	−0.0001	0.3487	−0.4146	0.0677	0.2776	10.0156	1828.3870***
MINNING	0.0021	0.0042	0.1825	−0.2863	0.0409	−0.7832	8.8406	1349.9130***
MOBTEL	0.0016	0.0016	0.1072	−0.1066	0.0223	0.2192	7.1423	640.5273***
OILEQPT	0.0023	0.0000	0.2173	−0.2786	0.0424	−0.3601	11.1210	2453.8050***
OILGASPR	0.0019	0.0013	0.1240	−0.1311	0.0297	−0.1322	4.5184	87.6914***
PERSGOOD	0.0018	0.0000	0.1410	−0.1132	0.0225	1.0435	9.4631	1702.8780***
PHARBIOT	−0.0005	−0.0008	0.2232	−0.3504	0.0428	−0.9647	15.6162	6013.3380***
SOFTWARE	0.0014	0.0021	0.2055	−0.2458	0.0426	−0.2366	7.6748	815.0338***
SUPPSERV	0.0019	0.0028	0.0990	−0.1003	0.0199	−0.1581	5.6593	264.7618***
TECHHARD	−0.0001	−0.0005	0.3943	−0.8742	0.0630	−2.7498	48.0173	75930.2000***
TOBACCO	0.0033	0.0015	0.3021	−0.1546	0.0387	0.8157	10.4604	2152.9340***
TRAVLEIS	0.0013	0.0017	0.1731	−0.1271	0.0272	0.1848	7.0279	603.9657***

Note: *** indicates significance the 1 per cent level.

Table 4
Descriptive Statistics for Independent Variables

Macro	*FTALLSH*	*TWN*	*JPY/£*	*US$/£*	*UKMBRYD*	*UKTBTND*
Mean	0.0018	0.0002	0.0000	0.0002	–0.0009	–0.0012
Median	0.0024	0.0004	0.0007	0.0009	–0.0012	0.0000
Maximum	0.0940	0.0252	0.0520	0.0379	0.0753	0.1185
Minimum	–0.0847	–0.0624	–0.1226	–0.0971	–0.0814	–0.1614
Std. Dev.	0.0196	0.0083	0.0160	0.0127	0.0193	0.0162
Skewness	–0.2555	–0.6892	–0.9629	–0.7543	0.1253	–2.3018
Kurtosis	5.4282	7.2153	8.6132	7.2463	4.1514	27.9944
Jarque–Bera	227.30***	726.10***	1300.09***	749.65***	51.26***	23844.97***

Note: *** indicates significance the 1 per cent level.

distribution, prone to rapid change from period to period in an apparently unpredictable way, thereby maybe volatile. Furthermore, the clustering of the observations is an indication that the series contains time-varying properties (Hill *et al*., 2008), which are intuitively best, captured through GARCH type methods of estimation (Joseph, 2003; Joseph and Vezos, 2006; Tai, 2010; Kasman *et al*., 2011).

The impact of changes in exchange rate and interest rate on UK non-financial industries' returns was initially determined using OLS. All estimates were then adjusted for autocorrelation and heteroskedasticity using the Newey–West HAC (Heteroscedastic and Autocorrelation Consistent) procedure. The residuals from all the models were then tested for autocorrelation, heteroskedasticity and normality. The diagnostic results for all the models are reported in Tables 5–7. Generally, the Ljung-Box Q statistics for the 7th and 21st lag and the Breusch–Godfrey Lagrange Multiplier test indicate the presence of autocorrelation in up to 85 per cent of all the regression estimates. In addition, the Q^2 statistics (7th and 21st lag) and the ARCH test revealed that heteroskedasticity was present in 90 per cent of the regression estimates. Baillie and Bollerslev (1989), Bollerslev *et al*. (1992) and Koutmos and Knif (2002) explain that heteroskedasticity can understate the precision of the estimation produce inefficient parameters inefficient estimates. The Jarque–Bera statistics rejected residual normality at the 1 per cent level for all estimates; thereby prompting the use of GARCH estimation instead.

The AR(1)-EGARCH (1,1)-M model was initially estimated under the assumption that the standardized residuals follow a conditional normal distribution and then a t-distribution.[5] The histograms associated with the

[5]Bollerslev *et al*. (1992) and Koutmos and Martin (2007) point out that in a lot of financial time series data, especially high-frequency financial data, models which are estimated with a normal distribution are incapable of fully accounting for the leptokurtosis in the residuals. Furthermore, Bollerslev (1987), Baillie and DeGennaro (1990), Elyasiani and Mansur (1998), Chang (2002), Joseph (2002), Joseph (2003), Brewer *et al*. (2007), Fang *et al*. (2007), Léon (2008) and Joseph and Vezos (2006) recommend that using a distribution that has fatter tails, such as a standardized Student t distribution, would be more suitable.

TABLE 5
DIAGNOSTICS OF OLS ANALYSIS USING TWN OF NON-FINANCIAL INDUSTRIES (TOTAL PERIOD)

Industry	*Q(7)*	*Q(21)*	$Q^2(7)$	$Q^2(21)$	*BG LM TEST*	*ARCH*	*SKEWNESS*	*KURTOSIS*	*Jarque–Bera*
Aerospace and Defence	7.7428	23.7370	43.0650***	118.0600***	2.79880*	10.4054***	–0.0085	6.5818	473.62***
Automobiles and Auto Parts	18.4770**	37.4560**	34.2480***	88.5420***	5.0143***	6.0462***	0.0252	6.8853	557.38***
Beverages	23.613***	39.1310***	94.9030***	117.5800***	4.6785***	56.6359***	0.2260	5.7387	284.44***
Chemicals	43.4400***	55.5220***	56.4670***	151.0500***	17.17871***	8.4837***	–0.3166	6.5644	483.83***
Construction and Materials	32.6080***	46.3710***	8.2660	31.3600*	6.8987***	1.6624**	–0.0726	6.5029	453.75***
Electricity	26.2390***	32.6780*	29.3190***	29.6330	3.8535***	4.9685***	5.6690	118.6534	498532.40***
Electronic and Electrical Equipment	11.4050	42.1870***	68.5940***	159.4600***	4.5441**	16.0641***	–0.0713	5.3647	207.18***
Fixed-line Telecommunications	23.5670***	48.9460***	80.5970***	94.0080***	5.4919***	7.0717***	–1.5202	18.4377	9139.42***
Food and Drug Retailers	2.4206	17.8530	43.8730***	121.5600***	0.6524	4.3356**	–0.1192	5.5892	249.59***
Food Producers	9.3332	38.5720**	316.5600***	598.0600***	2.4437*	58.9173***	–0.2013	6.2991	407.80***
Forestry and Paper	8.5805	23.3120	3.3390	5.2016	1.5263	0.0072	–2.2487	57.4090	110032.60***
Gas, Water and Multi-utilities	10.4850	36.8660**	18.2880**	65.3420***	1.9792**	11.3571***	–0.6268	11.5471	2754.88***
General Industrial	7.7668	35.5640**	79.8870***	155.3900***	1.7889**	13.2560***	–0.4466	7.8064	882.27***
General Retailers	9.2528	33.4570**	80.2900***	247.5300***	1.8689*	4.9889**	0.3666	7.9834	936.63***
Healthcare Equipment and Services	15.4190**	43.8720***	34.8630***	79.2870***	3.2736**	9.1257***	1.7327	29.0520	25498.83***
Household Goods	12.6200*	30.2940*	15.0700**	47.2140***	1.5713*	1.9416**	0.0149	4.7600	114.39***
Industrial Engineering	104.7300***	115.3400***	51.5780***	91.8560***	13.9487***	20.0810***	–0.0039	4.2949	61.904***
Industrial Transport	20.4110***	44.1450***	6.5732	11.0480	6.9845***	1.4490	–0.6025	9.4635	1595.90***
Leisure Goods	18.2370**	41.3760***	72.9000***	166.6100***	2.7520*	13.3927***	0.4232	11.2811	2558.09***
Media	17.5620**	41.2360***	70.7530***	163.5000***	2.6436*	13.0042***	0.4239	11.1717	2491.70***
Mining	5.5231	17.9100	48.0700***	101.5700***	2.8014*	3.69422*	–0.7206	9.5629	1666.75***
Mobile Telecommunications	10.6930	22.1550	67.5970***	185.5000***	4.0328**	9.0892***	0.2468	8.4315	1098.07***
Oil and Gas Producers	17.7820**	35.4800**	72.6380***	143.2300***	8.1865***	34.7730***	–0.2748	5.5515	251.49***
Oil Equipment and Services	19.5610***	38.7320**	13.2850*	48.3280***	3.9546**	5.0137**	–0.0823	10.6045	2135.85***
Personal Goods	18.0960**	38.3210**	25.5180***	67.9620***	4.4444**	9.3375***	0.9929	9.3661	1641.71***
Pharmaceuticals and Biotechnology	3.7900	24.7160	1.9552	12.0280	0.6565	0.2463	–1.0791	16.5299	6929.83***
Software and Computer Services	26.5330***	51.1200***	194.8800***	326.3900***	3.1349***	23.2481***	–0.0529	9.7619	1688.36***
Support Services	15.4950**	31.6130*	117.4100***	303.1900***	5.0623***	16.3747***	–15473.0000	4.7701	115.71***
Technical Hardware and Equipment	21.2120***	39.0740**	49.4480***	55.2550***	2.6422*	38.4894***	–3.3740	56.7933	108507.30***
Tobacco	36.2240***	53.9390***	75.3730***	201.3500***	16.3556***	6.8905***	0.8765	11.7437	2935.84***
Travel and Leisure	15.186**	30.5140*	75.5840***	99.1120***	2.7354*	34.2618***	0.2459	8.7659	1236.26***

Note: ***, ** and * represent statistical significance at the 1 per cent, 5 per cent and 10 per cent level respectively.

TABLE 6
DIAGNOSTICS OF OLS ANALYSIS USING US$/£ OF NON-FINANCIAL INDUSTRIES (TOTAL PERIOD)

Industry	*Q(7)*	*Q(21)*	$Q^2(7)$	$Q^2(21)$	*BG LM TEST*	*ARCH*	*SKEWNESS*	*KURTOSIS*	*Jarque–Bera*
Aerospace and Defence	7.7756	23.7210	43.1000***	118.7100***	2.7634*	10.1039***	0.0047	6.6291	486.2077***
Automobiles and Auto Parts	17.418**	36.9440**	35.1020***	89.5400***	4.8554***	3.9754***	0.0347	6.7325	514.4887***
Beverages	24.3960***	39.8610***	93.9990***	116.4800***	4.9526***	55.3608***	0.2404	5.7801	293.8634***
Chemicals	43.4790***	54.5760***	55.4050***	153.7200***	5.7680***	4.8937***	−0.3119	6.5089	468.8889***
Construction and Materials	34.6540***	47.9330***	8.7409	30.7870*	5.5270***	1.5452**	−0.0681	6.4827	48.4537***
Electricity	26.5950***	32.8510**	29.2630***	29.5650	5.4053***	5.9644***	5.6585	118.3934	496297.2000***
Electronic and Electrical Equipment	11.3870	41.9310***	68.4370***	162.1400***	4.5978**	16.1524***	−0.0488	5.5063	232.2508***
Fixed-line Telecommunications	23.7210***	49.4530***	82.6200***	95.6050***	5.6580***	18.5998***	−1.4920	18.3025	8973.3120***
Food and Drug Retailers	1.9068	17.6720	44.5610***	124.6800***	0.4002	4.7300**	−0.1231	5.6000	251.7968***
Food Producers	9.5737	38.7750**	325.9300***	605.7300***	2.5083*	60.2615***	−0.1649	6.3139	409.4354***
Forestry and Paper	8.9882	24.3220	3.2999	5.4979	1.6587	0.0072	−2.2838	58.4830	114413.0000***
Gas, Water and Multi-utilities	10.8540	39.4700***	18.2710**	70.2010***	2.8038*	10.5034***	−0.6245	11.4827	2713.9730***
General Industrial	8.0592	35.5040**	81.9480***	160.3100***	1.5086*	13.9960***	−0.4202	7.7104	845.1944***
General Retailers	9.0242	33.1600***	76.0430***	237.7600***	1.8633*	4.8506**	0.3771	8.0755	971.9867***
Healthcare Equipment and Services	15.4910**	42.3640***	34.6770***	78.3580***	2.9695*	9.0604***	1.7334	29.4980	26364.5200***
Household Goods	13.2950*	30.7580**	14.9240**	48.3940***	1.4287*	3.0466**	0.0134	4.7315	110.7072***
Industrial Engineering	104.3000***	114.8000***	51.7190***	91.5020***	41.7415***	20.1672***	−0.0032	4.2851	60.9681***
Industrial Transport	19.6710***	43.7600***	6.5975	10.9320	6.8278***	1.4719	−0.6109	9.4766	1603.6280***
Leisure Goods	17.8400**	39.5930***	71.1540***	164.3800***	2.9507*	13.8154***	0.4346	11.2734	2554.8050***
Media	17.1010**	39.2620***	69.0390***	161.4100***	2.8313*	13.4290***	0.4356	11.1651	2489.2470***
Mining	5.9412	18.3320	48.5710***	101.4000***	3.0064*	3.7787*	−0.6892	9.4268	1594.9880***
Mobile Telecommunications	10.9600	23.3150	70.3690***	190.5700***	4.1417**	9.1628***	0.2382	8.3859	1079.2700***
Oil and Gas Producers	18.5670**	35.9600**	72.9320***	139.2300***	8.5987***	35.6015***	−0.2811	5.5640	254.3492***
Oil Equipment and Services	19.6390***	38.9780**	12.7890*	47.6210***	3.9782**	4.6872**	−0.0907	10.7649	2227.0690***
Personal Goods	17.2410**	37.1860**	25.8730***	68.6370***	4.246**	9.7203***	0.9975	9.2571	1592.2950***
Pharmaceuticals and Biotechnology	3.7166*	26.4150	1.8347	12.3370	0.6735	0.1496	−1.0695	16.5462	6943.1070***
Software and Computer Services	28.0640***	53.1320***	187.8700***	315.7600***	4.7443***	22.383***	−0.0630	9.7830	1699.1020***
Support Services	16.2280**	32.0840*	118.3300***	307.0600***	5.2562***	16.8170***	−0.0107	4.7636	114.8335***
Technical Hardware and Equipment	21.3970***	39.5900***	49.5010***	55.4990***	4.6162**	38.9356***	−3.3701	56.5973	107726.6000***
Tobacco	34.3220***	51.5900***	71.6190***	192.0900***	15.6055***	6.2042**	0.9261	12.0616	3157.9550***
Travel and Leisure	15.5580**	31.0130*	76.2980***	100.3000***	2.8651*	34.4422***	0.2470	8.7612	1234.3170***

Note: ***, ** and * represent statistical significance at the 1 per cent, 5 per cent and 10 per cent level respectively.

TABLE 7
DIAGNOSTICS OF OLS ANALYSIS USING JP¥/£ OF NON-FINANCIAL INDUSTRIES (TOTAL PERIOD)

Industry	*Q(7)*	*Q(21)*	*Q2(7)*	*Q2(21)*	*BG LM TEST*	*ARCH*	*SKEWNESS*	*KURTOSIS*	***Jarque–Bera***
Aerospace and Defence	7.4602	23.5940	43.1400***	115.8700***	2.6529*	10.7191***	−0.003281	6.58	473.1523***
Automobiles and Auto Parts	17.6910**	37.2100**	34.0910***	87.7810***	4.9362***	6.0655***	0.02716	6.8284	541.1842***
Beverages	23.8540***	39.2280***	93.1550***	115.2100***	4.7665***	54.3666***	0.2386	5.7541	288.4217***
Chemicals	43.4350***	54.5490***	55.0450***	152.9100***	17.3134***	6.3257***	−0.31153	6.5035	467.4700***
Construction and Materials	33.8390***	46.6890***	8.9634	31.03500*	7.1617***	1.6831**	−0.0647	6.4987	452.5252***
Electricity	26.5580***	32.8460**	28.7830***	29.0990	4.5534***	4.8752***	0.03818	5.6466	117.8877***
Electronic and Electrical Equipment	11.78	39.3040***	66.7890***	156.8300***	4.8186***	15.2975***	−0.078659	5.4062	214.6458***
Fixed-line Telecommunications	23.589***	49.2040***	80.6650***	94.0980***	5.5209***	18.0835***	−1.52476	18.4869	9197.5720***
Food and Drug Retailers	2.1097	18.4280	43.5010***	115.3200***	0.5153	4.5763**	−0.11575	5.594	250.3913***
Food Producers	9.6861	38.6720**	314.170***	591.5300***	2.3867*	58.2169***	−0.16685	6.40166	431.2855***
Forestry and Paper	9.1313	23.9010	9.1313	23.9010	1.7253	0.0058	−2.2492	58.0192	112497.9000***
Gas, Water and Multi-utilities	9.7911	34.9310**	17.5680**	71.8110***	3.2490*	10.1438***	−0.6362	11.4991	2726.4610***
General Industrial	8.1219	35.3580**	82.2390***	160.6500***	1.5094*	14.0611***	−0.41965	7.7005	841.6746***
General Retailers	9.1038	33.0150**	80.9790***	243.8300***	1.8025**	4.7759**	0.3763	7.9881	939.4276***
Healthcare Equipment and Services	15.3350**	41.8180***	34.0790***	79.1000***	3.1033**	8.6267***	1.6961	29.0266	25431.5500***
Household Goods	14.4980**	31.2560*	16.3790**	50.6150***	2.0558*	2.0617**	−0.003409	4.7165	108.7690***
Industrial Engineering	104.4800***	114.440***	53.0550***	92.1490***	42.0205***	20.8628***	0.0004	4.3064	63.0085***
Industrial Transport	19.7490***	43.438***	6.5509	10.8490	6.8724***	1.4325	−0.6125	9.4939	1612.2270***
Leisure Goods	18.8810***	40.97***	73.7510***	168.1900***	3.0588**	13.4812***	0.4486	11.2007	2512.4370***
Media	18.1960**	40.772***	71.77***	165.4400***	2.9473*	13.1211***	0.4505	11.0846	2442.8880***
Mining	5.7392	18.0640	47.579***	100.4100***	2.9139*	3.4056*	−0.6886	9.4504	1606.0360***
Mobile Telecommunications	10.761	22.7230	70.234***	190.3700***	4.0314**	9.1699***	0.23989	8.3549	1067.0770***
Oil and Gas Producers	17.4300**	34.1150**	68.389***	140.8400***	8.3961***	36.5461***	−0.2734	5.3203	209.7868***
Oil Equipment and Services	19.7080***	38.2990**	12.7400*	48.5590***	3.8179**	4.9014**	−0.07715	10.5466	2103.3050***
Personal Goods	18.0560**	38.49500**	25.4850***	66.7640***	4.5144**	9.2773***	0.9953	9.359	1639.0740***
Pharmaceuticals and Biotechnology	4.2849	25.8440	1.8649	12.0080	0.8745	0.2171	−1.0635	16.6066	7001.7090***
Software and Computer Services	27.1960***	51.5820***	191.5400***	320.1900***	4.6495***	22.9941***	−0.05281	9.7554	1685.1340***
Support Services	16.2800**	32.3560*	120.6200***	309.7700***	5.2288***	16.6968***	−0.0095	4.7584	114.1570***
Technical Hardware and Equipment	21.4260***	39.4440***	49.5740***	55.5750***	2.3766*	38.5814***	−3.37547	56.78459	108474.4000***
Tobacco	33.1800***	51.3850***	67.1030***	191.5200***	15.2768***	6.3309**	0.909	12.0084	3117.8200***
Travel and Leisure	15.4820**	30.8240*	78.0110***	102.1500***	2.8157*	34.7232***	0.2532	8.6915	1205.3380***

Note: ***, ** and * represent statistical significance at the 1 per cent, 5 per cent and 10 per cent level respectively.

normal distribution exhibited more skewness and peakedness than those estimated with the *t*-distribution, so the *t*-distribution was selected. Additionally, an autoregressive term AR(k) process is included in the mean equation as this captures serial dependence (Koutmos and Saidi, 1995; Fang and Thompson, 2004), improved the data generating process for the stock returns (Li *et al*., 2005) and also improved the fit of the model for a majority of the estimates. Estimates were made of different specifications of AR(k) up to 7 lags. The AR(1) was found to be more appropriate for our data so our preference for AR(1)-EGARCH-M.

4.2 Empirical Results

The exposure coefficients of the unexpected changes in the TWN, the short-term and long-term interest rates from the mean equation are reported in Table 8. Then, for the unexpected changes in the US$/£ and JP¥/£, these are presented in Tables 9 and 10.

From the mean equation, we find that for the TWN, 11 (35 per cent) industries have significant exposure coefficients (Table 8). The results also indicated that for the US$/£, 13 (42 per cent) industries exhibit significant exposure coefficients (Table 9). The results were slightly different for the JP¥/£ as five (16 per cent) industries had significant coefficients (Table 10). Generally, these results are somewhat stronger than the results estimated with the OLS model especially for the TWN and the US$/£ since only 10 and seven industries have significant exposure coefficients for the unexpected changes respectively while five industries exhibit significant exposure coefficients for the JP¥/£. Nonetheless, the incidence of significant coefficients was also predominantly positive indicating that most industries benefit from an appreciation of the pound.

Furthermore in Table 8, evidence of interest rate exposure is stronger for the long-term interest rate where we find 15 industries (48 per cent) with significant coefficients for the unexpected changes. Then for the short-term interest exposure, only five (16 per cent) industries were significantly exposed to unexpected changes. The result here is just marginally stronger than that found from the OLS estimates where significant exposure coefficients for the unexpected changes were 13 for the long-term interest rate and 3 for the short-term interest rate. Nevertheless, the significant coefficients to the long-term interest rate were mainly positive whereas the significant coefficients to the short-term interest rate were mostly negative. Usually, the finding of significant negative coefficients implies that industry returns increase (decrease) when interest rates fall (rise), whereas a significant positive coefficient suggests that industry returns increase (decrease) when interest rates rise (fall). The result from the OLS estimates also substantiates this finding.

Also included in the mean equation is the risk-return trade off parameter explained by the coefficient λ, which measures the relationship between

TABLE 8
UK NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES (TOTAL PERIOD): ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry	*Constant*	*FTSE*	λ	*INDt-1*	*TWN*	*UKTBTND*	*UKMBRYD*
Aerospace and Defence	0.0066	0.5074***	0.0007	0.1231***	0.0003	0.0127	0.0094*
Automobiles and Auto Parts	0.0004	0.5209***	0.0002	0.1433***	–0.0004	0.0030	0.0174***
Beverages	0.0083	0.3441***	0.0009	0.117***	0.0010*	–0.0083	–0.0011
Chemicals	0.0055	0.5263***	0.0007	0.2023***	0.0007	–0.0016	0.0045
Construction and Materials	0.0198**	0.3065***	0.0022**	0.1057***	0.0010*	–0.0448	0.0070**
Electricity	–0.0254	0.5864***	–0.0036	–0.0038	0.0023**	–0.0183	–0.0182***
Electronic and Electrical Equipment	0.0014	0.6808***	0.0001	0.1917***	0.0013**	–0.0387	0.0073**
Fixed-line Telecommunications	–0.0081	1.2157***	–0.0010	–0.1076***	–0.0011	0.1004*	0.0007
Food and Drug Retailers	–0.0012	0.5800***	–0.0004	–0.0240	0.0019**	0.0481	–0.0127**
Food Producers	–0.0036	0.5605***	–0.0005	0.0479**	–0.0007	0.0274	–0.0115***
Forestry and Paper	–0.005	0.1174***	–0.0013	0.0543**	0.0008	–0.0263	0.0002
Gas, Water and Multi-utilities	–0.0127	0.3892***	–0.0019	–0.0257	0.0013	–0.0583	–0.0387***
General Industrial	0.0104	0.8437***	0.0013	0.0535**	–0.0011	–0.0425	0.0005
General Retailers	0.0042	0.803***	0.0004	0.1465***	0.0017**	0.0455	0.0011
Healthcare Equipment and Services	0.0071	0.4238***	0.0009	0.0713***	0.0002	0.0312	0.0052
Household Goods	0.0209	0.7218***	0.0026	0.0766***	0.0001	–0.0900*	0.0037
Industrial Engineering	–0.0154	0.4295***	–0.0018*	0.3427***	0.0004	0.0087	0.0043
Industrial Transport	1.0865***	0.4862***	0.1395***	0.4945***	0.0001	–0.0096	0.0104**
Leisure Goods	–0.0088	0.4084***	–0.0012	0.0646***	0.0011	–0.0980*	0.0255***
Media	–0.0089	0.4134***	–0.0012	0.0655***	0.0011	–0.0970*	0.0255***
Mining	0.0171	0.8543***	0.0025	0.0147	–0.0029**	0.0209	0.0219***
Mobile Telecommunications	0.0135**	0.5656***	0.0015**	0.1168***	0.0015***	0.0039	0.0012
Oil and Gas Producers	–0.0072	0.9110***	–0.0010	–0.0716***	–0.0036***	–0.0334	0.0094*
Oil Equipment and Services	0.0024	0.2858***	0.0004	0.1181***	0.0017	0.0672	0.0068
Personal Goods	0.0103**	0.2111***	0.0012**	0.1691***	0.0005	–0.0133	0.0028
Pharmaceuticals and Biotechnology	1.0848	0.2933***	1.0335	0.376***	0.0017*	–0.1397***	0.0011
Software and Computer Services	0.0118	0.9753***	0.0015	0.099***	0.0007	–0.0790	0.0222***
Support Services	0.0085	0.6549***	0.0009	0.1892***	0.0005	0.0080	–0.0046
Technical Hardware and Equipment	–0.0086	0.8690***	–0.0010	0.1301***	0.0013	0.0390	0.0058
Tobacco	0.0161	0.6101***	0.0020	–0.1369***	–0.0031***	–0.0139	–0.0249***
Travel and Leisure	–0.0034	0.7287***	–0.0004	0.0666**	0.0011	–0.0476	–0.0016

Notes: FTSE is the coefficient for the market return, λ is the risk-return trade-off parameter coefficient, INDt-1 is the autoregressive lag parameter, TWN represents the trade weighted nominal exchange rate exposure coefficient while UKTBTND and UKMBRYD are the exposure coefficients for the three-month Treasury bill (TB) and 10-year government bond (GB) respectively. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 9
UK NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE US$/£ EXCHANGE RATE (TOTAL PERIOD): ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry	*Constant*	*FTSE*	λ	*INDt-1*	*US$/£*
Aerospace and Defence	0.0061	0.5119***	0.0007	0.1225***	0.0216
Automobiles and Auto Parts	–0.0004	0.5221***	0.0001	0.1438***	–0.0045
Beverages	0.0081	0.3496***	0.0009	0.1208***	0.0352*
Chemicals	0.0057	0.5325***	0.0007	0.2025***	0.0432*
Construction and Materials	0.0185**	0.2999***	0.0021**	0.1038***	0.0013
Electricity	–0.0265	0.5973***	–0.0038	–0.0023	0.0838**
Electronic and Electrical Equipment	0.0026	0.69***	0.0003	0.1938***	0.0655***
Fixed-line Telecommunications	–0.0077	1.2183***	–0.0009	–0.1059***	–0.0182
Food and Drug Retailers	0.001	0.598***	–0.0001	–0.0229	0.1080***
Food Producers	–0.0032	0.562***	–0.0004	0.0494*	–0.0081
Forestry and Paper	–0.0048	0.1118***	–0.0013	0.0536**	–0.0020
Gas, Water and Multi-utilities	–0.0114	0.3979***	–0.0018	–0.0239	0.0611*
General Industrial	0.0098	0.8491***	0.0013	0.0556**	–0.0065
General Retailers	0.006	0.7953***	0.0007	0.1497***	0.0259
Healthcare Equipment and Services	0.0077	0.4263***	0.0010	0.0708***	0.0090
Household Goods	0.0209	0.7202***	0.0026	0.0762***	–0.0050
Industrial Engineering	–0.0162*	0.4294***	–0.0018*	0.3428***	0.0120
Industrial Transport	1.8774	0.4925***	0.2408	0.5165***	0.0481*
Leisure Goods	–0.0089	0.4503***	–0.0012	0.0628***	0.1195***
Media	–0.0091	0.4548***	–0.0012	0.0646***	0.1192***
Mining	0.0182	0.8603***	0.0027	0.0143	–0.0480
Mobile Telecommunications	0.0138**	0.5636***	0.0016**	0.1147***	0.0249
Oil and Gas Producers	–0.0077	0.8963***	–0.0011	–0.0684***	–0.1493***
Oil Equipment and Services	0.0028	0.2845***	0.0005	0.1189***	0.0349
Personal Goods	0.0104**	0.2024***	0.0012**	0.1647***	–0.0128
Pharmaceuticals and Biotechnology	0.6792	0.3062***	0.4265	0.3312***	0.0699*
Software and Computer Services	0.0115	0.975***	0.0015	0.0988***	0.0084
Support Services	0.0086	0.6555***	0.0009	0.1886***	0.0211
Technical Hardware and Equipment	–0.0078	0.864***	–0.0009	0.1293***	0.0095
Tobacco	0.0167*	0.5949***	0.0021	–0.136***	–0.1242***
Travel and Leisure	–0.0024	0.7392***	–0.0003	0.0675**	0.0609*

Notes: FTSE is the coefficient for the market return, λ is the risk-return trade-off parameter coefficient, INDt-1 is the autoregressive lag parameter, US$/£ refers to the US$ exchange rate exposure coefficient. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

industry returns and volatility. If the parameter is positive and statistically significant, this implies that increase in volatility is compensated for by a higher average return (increased risk leads to an increase in the conditional variance which invariably leads to a rise in the mean return). Consequently industry returns will fluctuate in response to changes in the volatility of the returns. Retrospectively, all the models are estimated with the same interest rate factors but different exchange rate factors. Therefore, it will be more insightful if the explanations on the risk-return parameter, and even other estimated parameters in the variance equation, are also explained on the basis of the exchange rate factor used in the model. In the model using unexpected TWN (Table 8), five industries (Construction and Materials, Industrial Engineering, Industrial Transport, Mobile Telecommunications and Personal Goods) have significant trade-off parameters. Although the industries are the same, the magnitude and level of significance sometimes varied.

TABLE 10
UK NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE JP¥/£ EXCHANGE (TOTAL PERIOD): ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry	*Constant*	*FTSE*	λ	*INDt-1*	*JP¥/£*
Aerospace and Defence	0.0066	0.5082***	0.0007	0.1233***	0.0001
Automobiles and Auto Parts	–0.0002	0.5246***	0.0001	0.1444***	0.0002
Beverages	0.007	0.345***	0.0008	0.1180***	0.0000
Chemicals	0.0053	0.523***	0.0006	0.2002***	0.0001
Construction and Materials	0.0202**	0.3086***	0.0023**	0.1054***	0.0002*
Electricity	–0.0295*	0.5758***	–0.0041*	–0.01101	0.0003
Electronic and Electrical Equipment	0.0011	0.6787***	0.0001	0.1938***	0.0002
Fixed-line Telecommunications	–0.0078	1.2065***	–0.0009	–0.1062***	–0.0004*
Food and Drug Retailers	–0.001	0.5675***	–0.0003	–0.0260	0.0001
Food Producers	–0.0037	0.5615***	–0.0005	0.0483**	–0.0001
Forestry and Paper	–0.0049	0.1123***	–0.0013	0.0532***	0.0000
Gas, Water and Multi-utilities	–0.0113	0.3901***	–0.0018	–0.0301	0.0005**
General Industrial	0.0098	0.8471***	0.0013	0.0553**	–0.0001
General Retailers	0.006	0.7898***	0.0007	0.1469***	0.0001
Healthcare Equipment and Services	0.0078	0.4173***	0.0010	0.0724***	–0.0001
Household Goods	0.0205	0.7208***	0.0026	0.0765***	0.0000
Industrial Engineering	–0.0161*	0.4282***	–0.0018*	0.3419***	0.0002
Industrial Transport	1.9136	0.4862***	0.2457	0.4993***	0.0001
Leisure Goods	–0.0088	0.4229***	–0.0012	0.0641***	0.0005
Media	–0.0088	0.4268***	–0.0012	0.0651***	0.0005
Mining	0.0187	0.8729***	0.0027	0.0165	–0.0001
Mobile Telecommunications	0.0136**	0.5568***	0.0015**	0.1131***	0.0000
Oil and Gas Producers	–0.0088	0.9222***	–0.0012	–0.0709***	–0.0005**
Oil Equipment and Services	0.0037	0.2749***	0.0006	0.1181***	0.0002
Personal Goods	0.0104**	0.2156***	0.0012**	0.1699***	0.0002
Pharmaceuticals and Biotechnology	1.0592	0.288***	0.9659	0.3614***	0.0001
Software and Computer Services	0.0115	0.9746***	0.0015	0.0976***	0.0001
Support Services	0.0092	0.6514***	0.0010	0.1881***	0.0000
Technical Hardware and Equipment	–0.0077	0.8618***	–0.0009	0.1297***	0.0000
Tobacco	0.0136	0.6139***	0.0016	–0.1317***	–0.0007***
Travel and Leisure	–0.0029	0.7268***	–0.0004	0.0663**	0.0002

Notes: FTSE is the coefficient for the market return, λ is the risk-return trade-off parameter coefficient, INDt-1 is the autoregressive lag parameter, JP¥/£ refers to the JP¥ exchange rate exposure coefficient. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

Then for the unexpected US$/£ (Table 9), only four industries (Construction and Materials, Industrial Engineering, Mobile Telecommunications and Personal Goods) had significant trade-off parameters. Furthermore, the above industries except Industrial Engineering have an expected significant positive coefficient indicating that increased volatility is compensated for by a higher average return. The finding of a significant negative coefficient for the Industrial Engineering industry is similar to that reported in Joseph (2002). The results for the unexpected JP¥/£ (Table 10) also indicate that five industries have significant risk trade-off parameters. Besides, Koulakiotis *et al.* (2006) also find a significant negative volatility coefficient relationship between FTSE100 stock price returns and volatility.

Furthermore, we find that the volatility of industry returns using the TWN (Table 8) is highest for Industrial Transport with unexpected volatility coefficients of 0.1395. In contrast, the volatility parameter was insignificant

for Industrial Transport for unexpected changes in the JP¥/£ (Table 10). But the Construction and Materials Industry, with risk premium coefficients of 0.0023 for unexpected changes, was the most volatile instead. On the whole, the number of industries with significant risk premium coefficients is considerably low. But, the industries with statistically insignificant positive coefficients are predominantly higher. We therefore posit that for most UK industries, increased risk will not necessarily lead to an increase in the returns.

Engle *et al*. (1987) explain that the sign and magnitude of the trade-off coefficient λ is dependent on investors' utility function for risk preference and the net supply condition of the asset. Taing and Worthington (2005) point out that λ is a measure of total risk (systematic and unsystematic risk); therefore, an increase in volatility is not always followed by an increase in the risk premium. Invariably if fluctuations in volatility are as a result of shocks to the unsystematic risk, then the trade-off parameter can be of any sign. Elyasiani and Mansur (1998) and Ryan and Worthington (2004) find negative risk parameters for banks in their study. They posit that if banks are not strongly affected by random shocks like other sectors then investors might switch over to bank stocks so as to steer clear of sectors that are highly affected. This changeover will result to lower bank stock premia. Furthermore, Glosten *et al*. (1993) provide further support for a negative relationship between the trade-off risk parameter and return. In the first instance, periods of higher risk may coincide with period when investors are able to bear the risk more, and then if investors decide to save more during period of higher volatility and assets are predominantly risky, competition may increase prices thereby leading to a reduction in the risk premium. Overall, findings for the trade-off between volatility and returns have been mixed, since Glosten *et al*. (1993), Campbell (1987) and Bree *et al*. (1989) find negative risk parameter coefficients, Campbell and Hentschel (1992) find significant positive coefficients, whereas Baillie and DeGennaro (1990), Chan *et al*. (1992), Joseph (2003) and Léon (2008) find no statistical significance for the risk parameter.

The parameters from the variance equations for the unexpected changes in the TWN, the short-term and long-term interest rates are reported in Table 11. Then, for the unexpected changes in the US$/£ and JP¥/£, these are presented in Tables 12 and 13.

The constant term (α_o) represents the time-independent component of volatility. In all the models using unexpected changes in the TWN (Table 11), US$/£ (Table 12) and JP¥/£ (Table 13) (in conjunction with the interest rate parameters), α_o is negative and significant for all the industries except the Forestry and Paper and Pharmaceuticals and Biotechnology industries. The result of significant α_o coefficients implies that the volatility of these industries returns is made up of time-independent components. Even then, for almost all of the industries with significant time-independent components (significant constant term), the ARCH (α_1) and GARCH (φ_1) parameters are significant, thereby indicating that the volatility of these industries' returns also

TABLE 11
UK NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES (TOTAL PERIOD): PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry	α_0	α_1	α_2	φ
Aerospace and Defence	–0.1544**	–0.0160	0.1043***	0.9889***
Automobiles and Auto Parts	–0.2264***	–0.0832**	0.1736***	0.9825***
Beverages	–0.7823***	–0.0143	0.2769***	0.9290***
Chemicals	–0.1974***	–0.0428**	0.1197***	0.9860***
Construction and Materials	–0.3247**	0.0187	0.1295***	0.9707***
Electricity	–0.5127***	–0.0380	0.1638***	0.9445***
Electronic and Electrical Equipment	–0.1226***	–0.0584***	0.081***	0.9924***
Fixed-line Telecommunications	–0.1532***	0.0102	0.1093***	0.9896***
Food and Drug Retailers	–0.284***	–0.0360	0.1210***	0.9743***
Food Producers	–0.1648***	–0.0099	0.1248***	0.9915***
Forestry and Paper	–2.1304	–0.2660	3.2343	0.2254
Gas, Water and Multi-utilities	–0.2332**	–0.0333	0.1044***	0.9790***
General Industrial	–0.2966***	–0.0446*	0.1516***	0.9751***
General Retailers	–0.1877***	–0.0078	0.1202***	0.9875***
Healthcare Equipment and Services	–0.1051***	–0.0170	0.1115***	0.9950***
Household Goods	–0.1447**	–0.0384***	0.0663***	0.9872***
Industrial Engineering	–0.4174**	–0.0404	0.1622***	0.9659***
Industrial Transport	–7.756***	–0.0686***	–0.001	0.0032
Leisure Goods	–0.0999***	–0.0090	0.2395***	1.0000***
Media	–0.1006***	–0.0101	0.2391***	0.9998***
Mining	–0.2808***	–0.0049	0.137***	0.9723***
Mobile Telecommunications	–0.2938***	0.0354	0.1753***	0.9792***
Oil and Gas Producers	–0.1672**	0.0013	0.1126***	0.9894***
Oil Equipment and Services	–0.1983***	–0.0730*	0.2363***	0.9846***
Personal Goods	–0.3917***	–0.0017	0.2964***	0.9739***
Pharmaceuticals and Biotechnology	–1.0449	–0.2138	–0.016	0.0049
Software and Computer Services	–0.0952***	0.0348**	0.1096***	0.9982***
Support Services	–0.1457***	–0.0543***	0.063***	0.9886***
Technical Hardware and Equipment	–0.1304***	–0.0281*	0.143***	0.9955***
Tobacco	–0.1197***	–0.0443***	0.0909***	0.9922***
Travel and Leisure	–0.159**	–0.0725***	0.0714***	0.9865***

Notes: α_0 is the constant term in the variance equation, α_1 represents the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

comprises of significant time dependent components. Then, more importantly, we discuss the results for α_1, which measures the asymmetric impact of past innovations on current volatility. This measure is further segregated (depending on the sign) into leverage effects when $\alpha_1 < 0$ and asymmetric effects when $\alpha_1 \neq 0$. But when $\alpha_1 = 0$, then the effects of negative or positive surprises on volatility of returns are of the same magnitude.

These results indicate that for the unexpected TWN model (Table 11), 12 industries (39 per cent) have significant coefficients. The industries were: Automobiles and Auto Parts, Chemicals, Electronic and Electrical Equipment, General Industrial, Household Goods, Industrial Transport, Oil Equipment and Services, Software and Computer Services, Support Services, Technical Hardware and Equipment, Tobacco and Travel and Leisure. Out of all these, only the Software and Computer Services industry have a

TABLE 12
UK NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN US$/£ EXCHANGE RATE (TOTAL PERIOD): PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry	α_0	α_1	α_2	α_2*	φ
Aerospace and Defence	–0.1519**	–0.0147	0.1037***		0.9891***
Automobiles and Auto Parts	–0.2185***	–0.0831**	0.1743***		0.9836***
Beverages	–0.8119***	–0.0176	0.2843***		0.9260***
Chemicals	–0.2192***	–0.0441**	0.1307***		0.9842***
Construction and Materials	–0.3340**	0.0197	0.1291***		0.9693***
Electricity	–0.4825***	–0.0356	0.1579***		0.9481***
Electronic and Electrical Equipment	–0.1221***	–0.0590***	0.0799***		0.9924***
Fixed-line Telecommunications	–0.1545***	0.0099	0.1097***		0.9894***
Food and Drug Retailers	–0.2768***	–0.0343	0.1217***		0.9754***
Food Producers	–0.1678***	–0.0108	0.1264***		0.9913***
Forestry and Paper	–2.1048	–0.2612	3.3008		0.2302
Gas, Water and Multi-utilities	–0.2241**	–0.0329	0.1015***		0.9799***
General Industrial	–0.2875***	–0.0437*	0.1507***		0.9762***
General Retailers	–0.1922***	–0.0038	0.1197***		0.9869***
Healthcare Equipment and Services	–0.1043***	–0.0171	0.1105***		0.9951***
Household Goods	–0.1441**	–0.0382***	0.0661***		0.9873***
Industrial Engineering	–0.4264**	–0.0403	0.1654***		0.9651***
Industrial Transport	–7.8597***	–0.0429	–0.0005		–0.0084
Leisure Goods	–0.0976***	–0.0068	0.2351***		1.0002***
Media	–0.0988***	–0.0081	0.2363***		1.0001***
Mining	–0.2687***	–0.0057	0.1341***		0.9738***
Mobile Telecommunications	–0.2916***	0.0396	0.1719***		0.9792***
Oil and Gas Producers	–0.172**	–0.0024	0.1128***		0.9888***
Oil Equipment and Services	–0.1850***	–0.0715**	0.2274***		0.9862***
Personal Goods	–0.4021***	0.0021	0.3026***		0.9728***
Pharmaceuticals and Biotechnology	–1.56804	–0.3387	–0.0072	–0.0387	0.0154
Software and Computer Services	–0.0939***	0.0348**	0.1087***		0.9983***
Support Services	–0.1512***	–0.0547***	0.0663***		0.9882***
Technical Hardware and Equipment	–0.1319***	–0.0284*	0.1441***		0.9954***
Tobacco	–0.1179***	–0.0463***	0.0879***		0.9921***
Travel and Leisure	–0.1628**	–0.0731***	0.0737***		0.9862***

Notes: α_0 represents the constant term in the variance equation, α_1 is the coefficient for the asymmetric impact of past innovations on current volatility, α_2 denotes the ARCH parameter coefficient and φ is the GARCH parameter coefficient. In the model for the unexpected changes in the US$/£, there is an instance where the AR(1)-EGARCH-M(1,1) could not be fitted as a result of lack of convergence, consequently, an AR(1)-EGARCH-M(2,1) was fitted instead. Therefore, α_2* stands for the coefficient of the second ARCH parameter. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

significant positive coefficient. The finding of significant negative coefficients follows the usual interpretation that lower stock prices reduce the value of equity relative to corporate debt and a sharp decrease in stock prices increases the level of corporate leverage and consequently the risk of holding stocks (Bollerslev *et al*., 1992; Joseph and Vezos, 2006). Another explanation inherent for leverage effects in Magnus and Fosu (2006) is that unexpected bad news increases predictable volatility of industry returns more than unexpected good news. Therefore, from the perspective of exchange rate and interest rate effects, a sharp contrary movement or negative increase in these measures makes industry returns more volatile or risky. Interestingly, only two industries (Electronic and Electrical Equipment and Tobacco) have significant exposure coefficients for the TWN (Table 11). The other 10 industries have significant coefficients for unexpected changes in either the short-term

TABLE 13
UK NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN JP¥/£ EXCHANGE RATE (TOTAL PERIOD): PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry	α_0	α_1	α_2	$\varphi\varphi$
Aerospace and Defence	–0.1531**	–0.0161	0.1035***	0.9889***
Automobiles and Auto Parts	–0.2126***	–0.0830**	0.1699***	0.9841***
Beverages	–0.7306***	–0.0156	0.2612***	0.9336***
Chemicals	–0.2017***	–0.0430**	0.1207***	0.9855***
Construction and Materials	–0.3354**	0.0213	0.1288***	0.9692***
Electricity	–0.4217***	–0.0323	0.1465***	0.9555***
Electronic and Electrical Equipment	–0.1353***	–0.0569***	0.0896***	0.9916***
Fixed-line Telecommunications	–0.1541***	0.0107	0.1097***	0.9894***
Food and Drug Retailers	–0.2905***	–0.0383*	0.1199***	0.9733***
Food Producers	–0.1671***	–0.0104	0.1266***	0.9914***
Forestry and Paper	–2.0975	–0.2677	3.3217	0.2284
Gas, Water and Multi-utilities	–0.2241**	–0.0345	0.1034***	0.9801***
General Industrial	–0.2904***	–0.0442*	0.1509***	0.9758***
General Retailers	–0.1985***	–0.0041	0.1222***	0.9863***
Healthcare Equipment and Services	–0.1051***	–0.0163	0.1125***	0.9951***
Household Goods	–0.1452**	–0.0381***	0.0666***	0.9872***
Industrial Engineering	–0.4311**	–0.0397	0.1655***	0.9646***
Industrial Transport	–7.8287***	–0.0401	–0.0007	–0.0054
Leisure Goods	–0.0994***	–0.0083	0.2397***	1.0001***
Media	–0.1001***	–0.0093	0.2397***	1.0000***
Mining	–0.2623***	–0.0066	0.1322***	0.9746***
Mobile Telecommunications	–0.2908***	0.0411	0.1716***	0.9792***
Oil and Gas Producers	–0.1748**	–0.0009	0.1140***	0.9886***
Oil Equipment and Services	–0.1802***	–0.0738**	0.2271***	0.9867***
Personal Goods	–0.3622***	–0.0047	0.2861***	0.9767***
Pharmaceuticals and Biotechnology	–1.0914	–0.2136	–0.0145	0.0051
Software and Computer Services	–0.0942***	0.0348**	0.1088***	0.9983***
Support Services	–0.1490***	–0.0551***	0.0617***	0.9881***
Technical Hardware and Equipment	–0.1317***	–0.0282*	0.1438***	0.9954***
Tobacco	–0.1216***	–0.0442***	0.0953***	0.9925***
Travel and Leisure	–0.1602**	–0.0730***	0.0708***	0.9863***

Notes: α_0 is the constant term in the variance equation, α_1 represents the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

or long-term interest rate but most especially the long-term interest rate measure. This suggests that volatility might be influenced more by changes in long-term interest rates (Table 11). For the Software and Computer Services industry, the significant positive α_1 indicates that good news has a higher impact on volatility of returns than that of bad news i.e. volatility is higher during a market boom than when the market declines. Apparently, this is the only industry with significant exposure coefficients with regards to both the short-term and long-term interest rate measures. The result of a significant positive asymmetric coefficient is similar to that of Koutmos *et al.* (1993) who also found for the Athens Stock Exchange that good news or positive innovations had a more pronounced effect on volatility than negative innovations.

Additionally, Koutmos and Knif (2002) also found evidence of asymmetric effects from their study on Finnish industry portfolios. Léon (2008)

explains that this might be attributable to the fact that investors believe that market booms are not supported by economic fundamentals and that market returns behave as speculative bubbles. Additionally, Glen (2005) points out that financial assets sometimes go through periods of boom where explosive upward movements engender unsustainable prices, which may persist for a while and then are followed by a market crash (bust). Theoretically, bubbles appear to be at odds with efficient markets since prices are not supposed to distinctly deviate from fundamental value. Nevertheless, for other industries where the α_1 coefficient was insignificant, the effects of positive or negative surprises on the industry volatility is of the same magnitude. Inherently, a contrary movement in exchange rates or interest rates does not appear to make the returns of these industries more risky.

The results for the leverage parameter in the unexpected US$/£ model (Table 12) were similar to that of the TWN in terms of industries with significant parameters but with regards to magnitude, the parameter is higher for 11 industries (Automobiles and Auto Parts, Chemicals, Electronic and Electrical Equipment, Household Goods, Industrial Transport, Oil Equipment and Services, Software and Computer Services, Support Services, Technical Hardware and Equipment, Tobacco and Travel and Leisure) in the unexpected US$/£ models. But for unexpected US$/£ changes, all significant leverage parameter coefficients are negative except that of the Software and Computer Services Industry which is positive.

The results for the unexpected JP¥/£ models (Table 13) are similar to that of the unexpected US$/£ since the same industries have significant coefficients. But a minor difference for the unexpected JP¥/£ model is that the Food and Drug Retailers industry has a significant negative coefficient. Furthermore, the magnitude of the leverage parameter is mostly higher than that of the TWN model but mainly lower than that of US$/£ model. On the whole, the magnitude of the leverage coefficient was higher for most industries in the unexpected US$/£ models. The ARCH term denoted by α_2 links current volatility (conditional variance) to the asymmetric function of past innovations. A significant positive coefficient i.e. $\alpha_2 > 0$ validates the presence of volatility clustering (tendency of shocks to persist) signifying that conditional volatility has a propensity to rise (fall) when the absolute value of the standardized error is larger (smaller).

Almost all the industries with the exception of Forestry and Paper, Industrial Transport and Pharmaceuticals and Biotechnology were found to have significant positive coefficients therefore indicating the presence of volatility clustering. Regarding the GARCH term (φ_1) which represents the persistence parameter and associates current volatility with past volatility, in all the unexpected models (TWN, US$ and JP¥), nearly all the industries have significant positive coefficients except three industries (Forestry and Paper, Industrial Transport and Pharmaceuticals and Biotechnology) which also had insignificant ARCH parameters.

Besides, for the unexpected TWN, US$/£ and JP¥/£, the estimate for the Leisure Goods industry does not satisfy the condition that $\varphi_1 < 1$ implying that the system might not be too stable since shocks to persistence over time are indefinite. Then for the Media industry, $\varphi_1 < 1$ is violated but only in the models for unexpected US$/£ and JP¥/£. Nonetheless, in all the models, the persistence of volatility is very high and close to one as it ranges from 0.9260 to 0.9999, suggesting that volatility has a long memory (once volatility increases, it may probably remain high over several periods). The finding of predominantly significant α_2 and φ_1 coefficients indicates that current volatility of industry returns (conditional variance) is time varying, is a function of past innovations and past volatility.

Furthermore, the magnitude of significant persistence parameters (GARCH parameter) is higher than that of the significant ARCH parameter in all the models (TWN, US$/£ and JP¥/£) implying that the market has a memory longer than one period, volatility is more sensitive to old news (its own lagged value) than it is to news about volatility from the previous period (recent surprises in the market). Although it was observed that for most industries, the magnitude of the conditional variance tends to vary with the exchange rate index in the model.

A more intuitive measure of persistence is the half-life of an innovation calculated by $\ln(0.5)/\ln(\varphi_1)$ and represents the duration of time in weeks it takes for half the magnitude of a unit of shock to the returns to dissipate (Koutmos and Saidi, 1995). Therefore, using the coefficients, the effects of positive and negative innovations (news) on volatility can be determined by $\alpha_2 (1 - \alpha_1)$ and $\alpha_2 (1 + \alpha_1)$ respectively. Then utilizing $\alpha_2 (1 + \alpha_1)/\alpha_2 (1 - \alpha_1)$, will generate the ratio by which negative innovations increase volatility more than positive innovations. From Table 14, on average, negative innovations have about 1.1 times as large an effect on volatility as positive innovations. The ratio found in this section is relatively smaller than that of Koutmos and Saidi (1995), which found an average of 2.1 for the daily stock returns of 30 companies from the Dow Jones Industrial Index and Schwert (1990), which reported an average of 2.5 for the US stock market. We posit that this difference might have been influenced by their use of daily data. Using the measure of half-life, we find that the highest persistence is for the Software and Computer Services Industry with average half-life of 419 weeks whereas the lowest persistence was for the Beverages industry with average half-life of approximately 10 weeks. Incidentally, volatility persistence in the returns of UK industries is relatively high, but some industries are better able to absorb the volatility more than others. We attribute the finding of high persistence of volatility to the use of weekly data and which may have also been exacerbated by an increase in exchange and interest rate risk.

In Table 15, we present the results from the mean equation for the unexpected changes in the TWN model. We find that the concentrated, competitive and concentrated plus competitive industries have significant

TABLE 14
A SUMMARY OF THE RATIO OF NEGATIVE INNOVATION TO POSITIVE INNOVATIONS AND HALF-LIFE OF PERSISTENCE ON THE RETURNS OF UK NON-FINANCIAL INDUSTRIES USING UNEXPECTED CHANGES IN TWN, US$/£ AND JP¥/£ EXCHANGE RATES (TOTAL PERIOD)

	TWN		*US$/£*		*JP¥/£*	
Industry	*N.I/P.I*	*HL*	*N.I/P.I*	*HL*	*N.I/P.I*	*HL*
Aerospace and Defence	1.0325	62.1435	1.0298	63.7915	1.0327*	62.6261
Automobiles and Auto Parts	1.1815*	39.2789	1.1811*	41.9175	1.1810	43.1073
Beverages	1.0290	9.4209	1.0359	9.0169	1.0316	10.0942
Chemicals	1.0896*	49.2411	1.0922*	43.7458	1.0899*	47.6844
Construction and Materials	0.9632	23.3256	0.9614	22.2991	0.9584	22.2040
Electricity	1.0790	12.1496	1.0737	13.0298	1.0667	15.2331
Electronic and Electrical Equipment	1.1241*	91.3513	1.1254*	91.0972	1.1206*	82.8339
Fixed-line Telecommunications	0.9798	66.4236	0.9804	65.5288	0.9789	65.5727
Food and Drug Retailers	1.0746	26.6615	1.0710	27.8402	1.0796*	25.6290
Food Producers	1.0200	81.5852	1.0219	79.5546	1.0209	80.4017
Forestry and Paper	1.7247	N.A	1.7072	N.A	1.7309	N.A
Gas, Water and Multi-utilities	1.0689	32.7380	1.0681	34.2128	1.0715	34.5434
General Industrial	1.0933*	27.5284	1.0913*	28.8655	1.0925*	28.3835
General Retailers	1.0156	55.4078	1.0077	52.5768	1.0082	50.4141
Healthcare Equipment and Services	1.0345	140.3651	1.0347	140.9387	1.0332	142.5406
Household Goods	1.0798*	54.0470	1.0794*	54.2914	1.0793*	53.9320
Industrial Engineering	1.0842	20.0010	1.0840	19.5505	1.0827	19.2373
Industrial Transport	1.1473*	N.A	1.0896	N.A	1.0836	N.A
Leisure Goods	1.0181	N.A	1.0137	N.A	1.0167	N.A
Media	1.0204	N.A	1.0164	N.A	1.0188	N.A
Mining	1.0098	24.7322	1.0114	26.1443	1.0132	26.9929
Mobile Telecommunications	0.9316	33.0730	0.9238	32.9766	0.9211	33.1230
Oil and Gas Producers	0.9973	65.6166	1.0048	62.0030	1.0018	60.5460
Oil Equipment and Services	1.1576*	44.9385	1.1540*	50.0597	1.1595*	52.1400
Personal Goods	1.0034	26.3104	0.9958	25.1652	1.0095	29.4175
Pharmaceuticals and Biotechnology	1.5438	N.A	2.0246	N.A	1.5433	N.A
Software and Computer Services	0.9326*	405.7149	0.9325*	426.2054	0.9326*	418.2205
Support Services	1.1149*	60.4712	1.1157*	58.6540	1.1167*	57.8564
Technical Hardware and Equipment	1.0578*	154.6503	1.0586*	150.5013	1.0581*	150.5341
Tobacco	1.0928*	89.2416	1.0971*	87.9070	1.0925*	92.1713
Travel and Leisure	1.1564*	51.1763	1.1576*	50.1588	1.1576*	50.2917

Notes: N.I/P.I represents the ratio of negative innovation to positive innovation but this s only relevant in instances where the asymmetric parameter is significant as denoted by *. HL is the half-life of the innovation and in columns with N.A, the GARCH parameter had been unstable and cannot be used in the calculation. Unexpected represent the unexpected changes in the exchange rate measures respectively. TWN is the bank of England trade weighted index, US$/£ is the US$ exchange rate against the £ while JP¥/£ is the Japanese yen exchange rate against the £.

TABLE 15
A SUMMARY OF UK NON-FINANCIAL CONCENTRATED AND COMPETITIVE INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES (TOTAL PERIOD): ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry	*Competition dummy*	*Constant*	*FTSE*	λ	*INDt-1*	*TWN*	*UKTBTND*	*UKMBRYD*
CONCENTRATION		0.0007	0.5351***	0.0000	0.0449***	0.0004**	–0.0078	–0.0005
COMPETITIVE		0.0006	0.5583***	0.0000	0.1499***	0.0008***	–0.0208**	0.0051***
CONC AND COMP	NS (Negative)	0.0003	0.5450***	0.0000	0.0862***	0.0006***	–0.0147**	0.0022***

Notes: FTSE is the coefficient for the market return, λ is the risk-return trade-off parameter coefficient, INDt-1 is the autoregressive lag parameter, TWN represents the trade weighted nominal exchange rate exposure coefficient while UKTBTND and UKMBRYD are the exposure coefficients for the three-month TB and 10-year GB respectively. The industry dummy coefficient is negative but not significant (NS). CONC and COMP represents the pooled returns of concentrated and competitive industries ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 16
A SUMMARY OF NON-FINANCIAL CONCENTRATED AND COMPETITIVE INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE FOREIGN EXCHANGE RATE US$/£ AND JP¥/£ (TOTAL PERIOD): ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

	Industry competition	*Competition dummy*	*Constant*	*FTSE*	λ	*INDt-1*	*ERI*
Panel	CONCENTRATION		0.0006	0.5381***	0.0000	0.0452***	0.0179**
A—US$	COMPETITIVE		0.0007	0.5598***	0.0000	0.1500***	0.0211***
	CONC AND COMP	NS (Negative)	0.0003	0.5471***	0.0000	0.0860***	0.0197***
Panel	CONCENTRATION		0.0006	0.5339***	0.0000	0.0445***	0.0000
B—JP¥/£	COMPETITIVE		0.0008	0.5455***	0.0000	0.1507***	0.0001***
	CONC AND COMP	NS (Negative)	0.0003	0.0001***	0.0000	0.0859***	0.0001***

Notes: FTSE is the coefficient for the market return, λ is the risk-return trade-off parameter coefficient, INDt-1 is the autoregressive lag parameter, ERI is the Exchange Rate Index and in panel A, this represents the US$ exchange rate exposure coefficient while in panel B, this is the JP¥/£ exchange rate exposure coefficient. The industry dummy coefficient is negative but not significant (NS) in both panels. CONC and COMP represents the pooled returns of concentrated and competitive industries ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 17
A SUMMARY OF NON-FINANCIAL CONCENTRATED AND COMPETITIVE INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES (TOTAL PERIOD): PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry competition	α_1	α_2	φ
CONCENTRATED	–0.0128***	0.1173***	0.9928***
COMPETITIVE	–0.0185***	0.1322***	0.9940***
CONC AND COMP	–0.0152***	0.1231***	0.9934***

Notes: α_1 represents the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. *** indicates statistical significance at the 1 per cent level.

positive coefficients regarding the unexpected TWN. However, the magnitude of the exposure coefficient was highest for the competitive industries implying that concentrated industries are less exposed to change in the TWN.

Table 16 presents the results for the US$/£ and JP¥/£. Regarding the US$/£, the concentrated, competitive and concentrated plus competitive industries all have significant positive coefficients. The exposure coefficient for the competitive industries is the highest in terms of magnitude. However, the results for the JP¥/£ only the competitive and concentrated plus competitive industries have significant positive coefficients.

The results of the variance equation for all models are presented in Tables 17 (TWN) and 18 (US$ and JP¥/£). The asymmetric parameter coefficient (α_1) is negative and significant while for the ARCH (α_2) and GARCH (φ_1) term, the coefficients are significant and positive in all the models indicating the presence of volatility clustering and persistence of volatility. Furthermore, the magnitude of the ARCH term is lower than that of the GARCH parameter in all cases.

TABLE 18
A SUMMARY OF NON-FINANCIAL CONCENTRATED AND COMPETITIVE INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE US$/£ AND JP¥/£ EXCHANGE RATES (TOTAL PERIOD): PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

	US$/£			*JP¥/£*		
Industry competition	α_1	α_2	φ	α_1	α_2	φ
CONCENTRATED	–0.0127***	0.1175***	0.9928***	–0.0127***	0.1172***	0.9928***
COMPETITIVE	–0.0183***	0.1324***	0.9939***	–0.0187***	0.1316***	0.9940***
CONC AND COMP	–0.0151***	0.1233***	0.9934***	–0.0151***	0.1228***	0.9935***

Notes: α_1 is the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. *** indicates statistical significance at the 1 per cent level.

TABLE 19
A SUMMARY OF THE RATIO OF NEGATIVE INNOVATION TO POSITIVE INNOVATIONS AND HALF-LIFE OF PERSISTENCE ON THE RETURNS OF UK CONCENTRATED AND COMPETITIVE INDUSTRIES USING UNEXPECTED CHANGES IN THE EXCHANGE RATE MEASURES (TOTAL PERIOD)

Exchange rate	*Industry competition*	*CONCENTRATED*	*COMPETITIVE*	*CONC AND COMP*
TWN	N.I/P.I	1.0259	1.0377	1.0309
	HL	95.9235	115.1776	104.6753
US$/£	N.I/P.I	1.0257	1.0373	1.0307
	HL	95.9235	113.2838	104.6753
JP¥/£	N.I/P.I	1.0257	1.0381	1.0307
	HL	95.9235	115.1776	106.2911

Notes: N.I/P.I is the ratio of negative innovation to positive innovation. HL is the half-life of the innovation of unexpected changes in the exchange rate measures respectively. TWN is the trade weighted nominal exchange rate, US$/£ is the US$ exchange rate against the £ while JP¥/£ is the JP¥ exchange rate against the £.

It is observed that the ratio of negative innovations to positive innovations is similar for both concentrated and competitive industries. However, for the half-life of persistence, the average was 114 weeks for competitive industries and 96 weeks for concentrated industries implying that volatility persists more in competitive industries. The ratio of negative news to positive news and half-life of persistence measures are shown in Table 19.

4.3 Results of Structural Breaks

The findings from the mean equation for the unexpected changes in the TWN, US$/£ and JP¥/£ (Tables 20, 21 and 22 respectively) indicate that six industries have significant coefficients. Generally, most of the significant coefficients are positive and the number of industries with significant coefficients before the euro is more than those after the introduction of the euro. Moreover, most of the industries that had significant coefficients in the period after the euro, their pre-euro coefficients were sometimes of the opposite sign

TABLE 20
A SUMMARY OF NON-FINANCIAL INDUSTRIES' EXPOSURE TO MARKET RISK AND UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES BEFORE THE EURO AND AFTER THE INTRODUCTION OF THE EURO: ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry	*Constant*	λ	*INDt-1*	*FTSEALLSH*	*FTSEDUM*	*TWN*	*ERDUM*	*UKTBTND*	*TBTNDUM*	*UKMBRYD*	*BRYDUM*
Aerospace and Defence	0.0070	0.0008	0.1281***	0.4359***	0.1568*	–0.0004	0.0020	0.0484	–0.1577	0.0057	–0.0067
Automobiles and Auto Parts	–0.0033	–0.0004	0.1494***	0.4349***	0.2205***	–0.0008	0.0015	0.0085	0.0079	0.0122**	0.0118
Beverages	0.0114	0.0013	0.1144***	0.4310***	–0.1852***	0.0009	0.0000	–0.0428	0.1661**	0.0045	–0.0105
Chemicals	0.0061	0.0007	0.2069***	0.5457***	–0.1155*	0.0011	–0.0017	–0.0026	0.0208	0.0038	0.0196*
Construction and Materials	1.1195	0.1368	0.5614***	0.3664***	–0.1230***	0.0009	–0.0006	–0.0419	–0.1301**	0.0111***	–0.0035
Electricity	–0.0255	–0.0036	–0.0024	0.5595***	0.0756	0.0028**	–0.0008	–0.0057	–0.0532	–0.0155*	–0.0157
Electronic and Electrical Equipment	0.0012	0.0001	0.1912***	0.6779***	–0.0009	0.0010	0.0009	–0.0417	0.0228	0.0067*	0.0024
Fixed-line Telecommunications	–0.0083	–0.0010	–0.1043***	1.1592***	0.1582	–0.0021	0.0038	0.1091*	–0.0362	–0.0041	0.0039
Food and Drug Retailers	0.0020	0.0001	–0.0236	0.7504***	–0.3539***	0.0029**	–0.0024	–0.0222	0.2363**	–0.0053	0.0069
Food Producers	–0.0026	–0.0004	0.0532**	0.6329***	–0.1502***	–0.0004	–0.0004	0.0290	0.0115	–0.0061	–0.0099
Forestry and Paper	–0.0057	–0.0015*	0.0481**	0.0573	0.1516**	0.0000	0.0029	–0.0157	0.0118	–0.0027	0.0117
Gas, Water and Multi-utilities	–0.0124	–0.0019	–0.0292	0.4635***	–0.1253*	0.0039***	–0.0044**	–0.1273*	0.2123**	–0.0333***	0.0016
General Industrial	0.0101	0.0013	0.0546**	0.8396***	–0.0215	–0.0018*	0.0013	–0.0545	0.0683	–0.0033	0.0185
General Retailers	0.0037	0.0004	0.1489***	0.8108***	–0.0089	0.0014*	0.0010	0.0537	–0.0543	0.0018	–0.0031
Healthcare Equipment and Services	0.0038	0.0005	0.0793***	0.3724***	0.2214***	0.0003	–0.0005	0.0232	0.1921	0.0031	–0.0256
Household Goods	0.0168	0.0021	0.0778***	0.7900***	–0.1720**	–0.0003	0.0007	–0.1219**	0.1657	0.0063	0.0040
Industrial Engineering	–0.0085	–0.0010	0.3518***	0.5135***	–0.1519***	0.0012*	–0.0018*	0.0202	–0.0741	0.0096**	–0.0046
Industrial Transport	0.0068	0.0007	0.1454***	0.5462***	–0.1562**	–0.0001	0.0008	–0.0717**	0.0473	0.0094*	0.0131
Leisure Goods	–0.0118*	–0.0020*	0.0707***	0.2416***	0.8224***	0.0000	0.0065*	–0.0681	–0.1618	0.0134*	–0.0132
Media	–0.0120*	–0.0021*	0.0707***	0.2464***	0.8220***	–0.0001	0.0066**	–0.0671	–0.1644	0.0131	–0.0127
Mining	0.0331*	0.0048*	0.0134	0.7413***	0.1598	–0.0037**	0.0019	0.0485	–0.1629	0.0105	0.0403**
Mobile Telecommunications	0.0157**	0.0018**	0.1180***	0.6059***	–0.0732	0.0016**	–0.0002	–0.0028	0.0162	–0.0034	0.0169**
Oil and Gas Producers	–0.0098	–0.0014	–0.0796***	0.8735***	0.0774	–0.0031***	–0.0017	–0.0863	0.3450***	0.0080	–0.0025
Oil Equipment and Services	0.0010	0.0002	0.1120***	0.1830***	0.2106**	0.0012	0.0025	0.0467	–0.0292	0.0030	0.0130
Personal Goods	0.0105**	0.0012**	0.1833***	0.2396***	–0.0696	0.0008*	–0.0018	–0.0150	0.1128	0.0043	0.0019
Pharmaceuticals and Biotechnology	1.3300	0.5156	0.3442***	0.3568***	–0.1124	0.0017	–0.0002	–0.1665***	0.0927	–0.0019	0.0150
Software and Computer Services	0.0096	0.0013	0.1091***	0.7349***	0.6847***	–0.0002	0.0041*	–0.0751	–0.1003	0.0074	0.0154
Support Services	0.0137***	0.0015***	0.1896***	0.6103***	0.0760*	0.0008	–0.0002	0.0070	–0.0533	–0.0069**	0.0098
Technical Hardware and Equipment	–0.0135	–0.0017	0.1316***	0.7691***	0.5532***	0.0001	0.0083***	0.0414	0.0457	–0.0014	0.0150
Tobacco	0.0071	0.0008	–0.1300***	0.9850***	–0.7095***	–0.0032**	0.0013	–0.0300	0.1274	–0.0008	–0.0303*
Travel and Leisure	0.0074	0.0010	0.0733***	0.8534***	–0.2129***	0.0015	–0.0003	–0.0595	0.0765	0.0041	–0.0058

Notes: λ is the risk-return trade-off parameter coefficient; INDt-1 is the autoregressive lag parameter. FTSEALLSH refers to the market risk before the euro, FTSEDUM is the change in market risk following the introduction of the euro, TWN is the Trade-weighted nominal exchange rate exposure coefficient before the euro and ERDUM is the change in exposure after the euro. UKTBTND and UKMBRYD are the exposure coefficients for the three-month TB and 10-year GB before the euro while TBTNDUM and BRYDUM are changes in the exposure after the euro for the TB and GB respectively. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 21
A SUMMARY OF NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE US$/£ EXCHANGE RATE BEFORE THE EURO AND AFTER THE INTRODUCTION OF THE EURO: ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry	*Constant*	λ	*INDt-1*	*FTSEALLSH*	*FTSEDUM*	*ER INDEX*	*ERDUM*
Aerospace and Defence	0.0068	0.0008	0.1262***	0.4484***	0.1400*	0.0089	0.0302
Automobiles and Auto Parts	–0.0041	–0.0004	0.1480***	0.4325***	0.2510***	–0.0446	0.1835**
Beverages	0.0111	0.0013	0.1159***	0.4402***	–0.2050***	0.0493**	–0.0570
Chemicals	0.0058	0.0007	0.2069***	0.549***	–0.1010	0.0380	0.0184
Construction and Materials	1.0885	0.1330	0.5710***	0.3676***	–0.1277***	0.0202	–0.0227
Electricity	–0.0262	–0.0037	–0.0009	0.5832***	0.0501	0.10120**	–0.0457
Electronic and Electrical Equipment	0.0019	0.0002	0.1952***	0.6843***	0.0014	0.0452*	0.0928*
Fixed-line Telecommunications	–0.0092	–0.0011	–0.1012***	1.1567***	0.1636	–0.0518	0.1478
Food and Drug Retailers	0.0031	0.0002	–0.0218	0.7737***	–0.3649***	0.1269***	–0.0467
Food Producers	–0.0025	–0.0004	0.0528**	0.6309***	–0.1360***	–0.0148	0.0313
Forestry and Paper	–0.0044	–0.0015*	0.0469**	0.0544	0.1580**	–0.0246	0.1328*
Gas, Water and Multi-utilities	–0.0145	–0.0022	–0.0264	0.4769***	–0.1390*	0.1388***	–0.1586**
General Industrial	0.0089	0.0011	0.0542**	0.8496***	–0.0344	0.0077	–0.0438
General Retailers	0.0053	0.0006	0.1521***	0.7908***	0.0115	0.0007	0.0802
Healthcare Equipment and Services	0.0034	0.0005	0.0805***	0.3695***	0.2483***	–0.0061	0.1197
Household Goods	0.0167	0.0021	0.0787***	0.7933***	–0.1791**	–0.0001	0.0060
Industrial Engineering	–0.0106	–0.0012	0.3492***	0.512***	–0.1402***	0.0139	0.0024
Industrial Transport	0.0068	0.0007	0.1447***	0.5462***	–0.1518**	–0.0024	0.0796
Leisure Goods	–0.0122*	–0.0020*	0.0697***	0.2788***	0.7927***	0.0702	0.1759
Media	–0.0126*	–0.0021*	0.0719***	0.2783***	0.7996***	0.0676	0.1783
Mining	0.0335**	0.0049**	0.0162	0.7279***	0.2119*	–0.1349**	0.2376**
Mobile Telecommunications	0.0159**	0.0018**	0.1167***	0.6071***	–0.0782	0.0447	–0.0279
Oil and Gas Producers	–0.0097	–0.0013	–0.0758***	0.8579***	0.0971	–0.1667***	0.0478
Oil Equipment and Services	0.0013	0.0003	0.1125***	0.1869***	0.2148**	0.0260	0.1157
Personal Goods	0.0108**	0.0013**	0.1728***	0.2196***	–0.0518	–0.0074	–0.0300
Pharmaceuticals and Biotechnology	1.0711	0.5593	0.3549***	0.3703***	–0.1243	0.0833*	–0.0335
Software and Computer Services	0.0087	0.0011	0.1077***	0.7294***	0.6659***	–0.0212	0.0858
Support Services	0.0125**	0.0013**	0.1934***	0.6035***	0.0819*	0.0151	0.0197
Technical Hardware and Equipment	–0.013	–0.0016	0.1304***	0.761***	0.5402***	–0.0184	0.2378*
Tobacco	0.0079	0.0009	–0.1243***	0.9639***	–0.6879***	–0.1230***	0.0491
Travel and Leisure	0.0051	0.0007	0.0724***	0.8621***	–0.2066***	0.0356	0.0630

Notes: λ is the risk-return trade-off parameter coefficient; INDt-1 is the autoregressive lag parameter. FTSEALLSH refers to the market risk before the euro, FTSEDUM is the change in market risk following the introduction of the euro, ER INDEX is the unexpected changes in US$/£ before the euro. ERDUM refers to the change in the exposure to the US$/£ after the introduction of the euro. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 22
A SUMMARY OF NON-FINANCIAL INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE JP¥/£ BEFORE THE EURO AND AFTER THE INTRODUCTION OF THE EURO: ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry	*Constant*	λ	*INDt-1*	*FTSEALLSH*	*FTSEDUM*	*ER INDEX*	*ERDUM*
Aerospace and Defence	0.0076	0.0009	0.1278***	0.4431***	0.1388*	0.0000	0.0001
Automobiles and Auto Parts	–0.0037	–0.0004	0.1492***	0.4366***	0.2166***	0.0002	0.0000
Beverages	0.0107	0.0012	0.1161***	0.4309***	–0.1873***	0.0000	0.0004
Chemicals	0.0057	0.0007	0.2063***	0.5434***	–0.1097*	0.0002	–0.0007*
Construction and Materials	1.0447	0.1278	0.5604***	0.3713***	–0.1303***	0.0002*	–0.0003
Electricity	–0.0264	–0.0037*	–0.0053	0.5644***	0.0561	0.0005	–0.0005
Electronic and Electrical Equipment	0.0015	0.0001	0.1930***	0.6771***	–0.0088	0.0002	–0.0002
Fixed-line Telecommunications	–0.008	–0.0010	–0.1052***	1.1495***	0.1576	–0.0005*	0.0005
Food and Drug Retailers	0.0007	–0.0001	–0.0228	0.7331***	–0.3358***	0.0000	0.0004
Food Producers	–0.0035	–0.0005	0.0547**	0.6263***	–0.1303***	–0.0002	0.0005
Forestry and Paper	–0.0059	–0.0014*	0.0487**	0.0569	0.1299*	0.0000	0.0002
Gas, Water and Multi-utilities	–0.0125	–0.0019	–0.0280	0.4477***	–0.0984	0.0005*	0.0000
General Industrial	0.0084	0.0011	0.0510**	0.8447***	–0.0252	–0.0001	–0.0002
General Retailers	0.0055	0.0006	0.1500***	0.7903***	–0.0007	0.0000	0.0005
Healthcare Equipment and Services	0.0042	0.0006	0.0814***	0.3656***	0.2320***	–0.0001	0.0002
Household Goods	0.0162	0.0020	0.0780***	0.7872***	–0.1737**	–0.0001	0.0002
Industrial Engineering	–0.0087	–0.0010	0.3522***	0.5183***	–0.1509***	0.0002*	–0.0002
Industrial Transport	0.0095	0.0010	0.1458***	0.5581***	–0.1711***	0.0003	–0.0002
Leisure Goods	–0.0127**	–0.0022*	0.0703***	0.2494***	0.8064***	0.0002	0.0016
Media	–0.0131**	–0.0022*	0.0714***	0.2563***	0.8002***	0.0002	0.0016
Mining	0.0344**	0.0050**	0.0171	0.7548***	0.1563	–0.0002	0.0006
Mobile Telecommunications	0.0157**	0.0018**	0.1137***	0.5917***	–0.0671	0.0000	0.0001
Oil and Gas Producers	–0.0102	–0.0014	–0.0795***	0.8813***	0.0903	–0.0005*	–0.0002
Oil Equipment and Services	0.0008	0.0002	0.1097***	0.1823***	0.1817*	0.0001	–0.0002
Personal Goods	0.0107**	0.0012**	0.1802***	0.2408***	–0.0673	0.0002*	–0.0003
Pharmaceuticals and Biotechnology	1.0262	0.4888	0.3318***	0.3499***	–0.1110	0.0000	0.0001
Software and Computer Services	0.0094	0.0012	0.1084***	0.7333***	0.6514***	–0.0001	0.0003
Support Services	0.0125**	0.0013**	0.1818***	0.5944***	0.0754*	0.0000	–0.0003
Technical Hardware and Equipment	–0.0124	–0.0015	0.1307***	0.768***	0.5145***	0.0000	–0.0004
Tobacco	0.0053	0.0005	–0.1268***	0.9844***	–0.6993***	–0.0007**	0.0004
Travel and Leisure	0.0061	0.0008	0.0687***	0.8537***	–0.2127***	0.0001	0.0006

Notes: λ is the risk-return trade-off parameter coefficient; INDt-1 is the autoregressive lag parameter. FTSEALLSH refers to the market risk before the euro, FTSEDUM is the change in market risk following the introduction of the euro, ERINDEX is the JP¥/£ exchange rate exposure coefficient before the euro and ERDUM is the change in exposure after the euro. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

but insignificant. But only a few industries had significant pre-euro and post-euro coefficients and these were of opposite signs.

The overall finding here infers that the introduction of the euro has led to a reduction in foreign exchange rate exposure for some UK industries, most especially importers. Nonetheless, for most of the industries with significant negative coefficients (usually exporters), the change in coefficient in the period after the euro was mostly positive, but these were statistically insignificant. Table 20 also presents the findings for the unexpected changes in the short-term and long-term interest rates. We find that in the period before the euro, only five industries had significant coefficients, and one of these industries had a positive coefficient implying that an increase in short-term rates leads to an increase in industry returns while a decrease in rates leads to a decline in industry returns. In the period after the euro, we find five industries with significant coefficients with respect to the unexpected changes in the short-term interest rate. For instance, only the Construction and Material industry had a significant negative coefficient. However in the period before the euro, this had been negative but statistically insignificant. The results for the unexpected changes in the long-term interest rate reveal that four industries (Chemicals, Mining, Mobile Telecommunications and Tobacco) have significant positive coefficients, which had all being insignificant in the period before the euro. Then the Tobacco industry had a significant negative coefficient but this had been negative but insignificant before the euro. Another important finding was that a majority of the industries had significant coefficients with regards to either the short-term interest rate or the long-term interest rate.

Generally, most of the industries with significant exposure coefficients to the short-term and/or long-term interest rate in the period before the euro had insignificant coefficients after the euro. Then for the majority of industries with significant exposure after the euro, the coefficient before the euro was insignificant. Furthermore the sign of the coefficient in the period before the euro was usually of the opposite sign to that found in the period after the euro suggesting that the introduction of the euro led to a net reduction in interest rate exposure for some UK industries. Furthermore, our findings indicate that for industries with significant interest rate coefficients before the euro, these became insignificant or reduced in magnitude in the period after the euro. This result is similar to that of Korkeamäki (2007) in which interest rate exposure, which was significant prior to 1999 for the UK and other EU countries that have chosen not to adopt the euro, became insignificant in the post euro era. Rajan and Zingales (2003) and Korkeamäki (2007) also point out that this reduction in interest rate risk corresponds to the significant growth in fixed income related markets, which is attributable to the introduction of the euro.

From the variance equation results in Tables 23, 24 and 25 for TWN, US$ and JP¥/£ respectively, we find that almost all the significant coefficients

TABLE 23
A SUMMARY OF NON-FINANCIAL INDUSTRIES' EXPOSURE TO MARKET RISK AND UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES BEFORE THE EURO AND AFTER THE INTRODUCTION OF THE EURO: PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry	α_0	α_1	α_2	φ	*EURDUM*
Aerospace and Defence	–0.1533*	–0.0154	0.1029***	0.9889***	0.0014
Automobiles and Auto Parts	–0.3664**	–0.0851**	0.1947***	0.9661***	0.0293
Beverages	–1.7028***	0.0288	0.3050***	0.8296***	0.1338**
Chemicals	–0.4609***	–0.0669**	0.1516***	0.9579***	0.0321*
Construction and Materials	–9.1436***	–0.0687	–0.0007	–0.1163**	0.0228
Electricity	–0.5176***	–0.0375	0.1675***	0.9445***	0.0061
Electronic and Electrical Equipment	–0.1430**	–0.0616***	0.0834***	0.9903***	0.0029
Fixed-line Telecommunications	–0.1644*	0.0099	0.1094***	0.9882***	0.0023
Food and Drug Retailers	–0.2391**	–0.0398*	0.0996***	0.9776***	–0.0093
Food Producers	–0.1703**	–0.0111	0.1241***	0.9909***	0.0004
Forestry and Paper	–3.0896	0.0532	2.5364	0.1094	1.411***
Gas, Water and Multi-utilities	–0.2189**	–0.0367	0.0912***	0.9790***	–0.0125
General Industrial	–0.3029***	–0.0453*	0.1504***	0.9745***	0.0036
General Retailers	–0.1737**	–0.0067	0.1184***	0.9890***	–0.0029
Healthcare Equipment and Services	–0.2390**	–0.0311	0.1187***	0.9789***	0.0322
Household Goods	–0.2793**	–0.0567***	0.0564*	0.9696***	0.0175**
Industrial Engineering	–0.4406**	–0.0503	0.1467***	0.9626***	0.0115
Industrial Transport	–0.4392**	–0.0317	0.0708*	0.9519***	0.0247
Leisure Goods	–0.7578***	–0.1908	0.8105	0.8916***	0.2041***
Media	–0.7606***	–0.1881	0.7904	0.8917***	0.2035***
Mining	–0.4519***	–0.0331	0.1484***	0.9496***	0.0285*
Mobile Telecommunications	–0.3000***	0.0157	0.1690***	0.9771***	–0.0165
Oil and Gas Producers	–0.1639**	0.0015	0.1176***	0.9904***	–0.0021
Oil Equipment and Services	–2.0245***	–0.2227	0.7886	0.6921***	0.5033***
Personal Goods	–1.2627***	0.0276	0.3374***	0.8810***	0.2063***
Pharmaceuticals and Biotechnology	–2.5500	–0.1835	–0.0166	0.0126	0.0037
Software and Computer Services	–0.1323**	0.0373**	0.1168***	0.9944***	0.0075
Support Services	–0.0394*	–0.0471***	0.0139	0.9961***	–0.0094***
Technical Hardware and Equipment	–0.2081***	–0.0420**	0.1357***	0.9850***	0.0289
Tobacco	–0.1434***	–0.0335*	0.1134***	0.9911***	–0.0024
Travel and Leisure	–0.2055***	–0.1040***	0.0391	0.9784***	0.0170***

Notes: α_0 represents the constant term, α_1 is the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. EURDUM stands for the coefficient of the euro dummy, which examines the impact of the introduction of the euro on the volatility of industry returns. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 24
A SUMMARY OF NON-FINANCIAL INDUSTRIES' EXPOSURE TO MARKET RISK AND UNEXPECTED CHANGES IN THE US$/£ EXCHANGE RATE BEFORE THE EURO AND AFTER THE INTRODUCTION OF THE EURO: PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry	α_0	α_1	α_2	φ	*EURDUM*
Aerospace and Defence	–0.1499*	–0.0139	0.1021***	0.9893***	0.0013
Automobiles and Auto Parts	–0.3544**	–0.0870**	0.1875***	0.967***	0.0278
Beverages	–1.7412***	0.0261	0.3128***	0.8257***	0.1378**
Chemicals	–0.4702***	–0.0670**	0.1537***	0.957***	0.0332*
Construction and Materials	–9.1272***	–0.0720	–0.0006	–0.1146**	0.0232
Electricity	–0.4751***	–0.0356	0.1582***	0.9496***	0.0049
Electronic and Electrical Equipment	–0.1408**	–0.0617***	0.0834***	0.9906***	0.0023
Fixed-line Telecommunications	–0.1802**	0.0092	0.1132***	0.9864***	0.0039
Food and Drug Retailers	–0.2296**	–0.0384*	0.0994***	0.9789***	–0.0089
Food Producers	–0.1712**	–0.0117	0.1252***	0.9909***	0.0004
Forestry and Paper	–2.2981	0.1976	4.0481	0.084	1.4382***
Gas, Water and Multi-utilities	–0.2051**	–0.0380	0.0874**	0.9805***	–0.0116
General Industrial	–0.2882***	–0.0447*	0.148***	0.9762***	0.0028
General Retailers	–0.1869***	–0.0031	0.1211***	0.9876***	–0.0025
Healthcare Equipment and Services	–0.2251**	–0.0311	0.1154***	0.9804***	0.0297
Household Goods	–0.2765**	–0.0570***	0.0564*	0.97***	0.0173**
Industrial Engineering	–0.4584**	–0.0490	0.1516***	0.961***	0.0106
Industrial Transport	–0.4336**	–0.0330	0.0697*	0.9525***	0.0242
Leisure Goods	–0.7246***	–0.1730	0.7359*	0.8999***	0.1901***
Media	–0.7486***	–0.1893	0.7826	0.8938***	0.2006***
Mining	–0.4314***	–0.0322	0.1466***	0.9524***	0.0268*
Mobile Telecommunications	–0.298***	0.0180	0.1669***	0.9772***	–0.0158
Oil and Gas Producers	–0.1653**	–0.0017	0.1164***	0.9901***	–0.0018
Oil Equipment and Services	–2.0315***	–0.2182	0.7696	0.6944***	0.5019***
Personal Goods	–1.2322***	0.0338	0.3332***	0.8835***	0.2017***
Pharmaceuticals and Biotechnology	–1.8941	–0.2401	–0.02	0.0124	0.0036
Software and Computer Services	–0.1281**	0.0370**	0.1151***	0.9948***	0.0072
Support Services	–0.0194*	–0.0504***	–0.0072	0.9967***	–0.0096***
Technical Hardware and Equipment	–0.2171***	–0.0415**	0.143***	0.9844***	0.0295
Tobacco	–0.1474***	–0.0343*	0.1153***	0.9907***	–0.0022
Travel and Leisure	–0.2017***	–0.0978***	0.0506**	0.9799***	0.0145***

Notes: α_0 represents the constant term, α_1 is the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. EURDUM stands for the coefficient of the euro dummy, which examines the impact of the introduction of the euro on the volatility of industry returns. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 25
A SUMMARY OF NON-FINANCIAL INDUSTRIES' EXPOSURE TO MARKET RISK AND UNEXPECTED CHANGES IN THE JP¥/£ EXCHANGE RATE BEFORE THE EURO AND AFTER THE INTRODUCTION OF THE EURO: PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry	α_0	α_1	α_2	β	*EURDUM*
Aerospace and Defence	–0.1539*	–0.0145	0.1032***	0.9888***	0.0014
Automobiles and Auto Parts	–0.3592**	–0.0858**	0.1964***	0.9670***	0.0289
Beverages	–1.8061***	0.0349	0.3045***	0.8174***	0.1431**
Chemicals	–0.4512**	–0.0653**	0.1473***	0.9586***	0.0318*
Construction and Materials	–9.0773***	–0.0735	–0.0008	–0.1093**	0.0244
Electricity	–0.4933***	–0.0361	0.1671***	0.9479***	0.0056
Electronic and Electrical Equipment	–0.1616**	–0.0598***	0.0910***	0.9888***	0.0042
Fixed-line Telecommunications	–0.1674**	0.0103	0.1110***	0.9879***	0.0023
Food and Drug Retailers	–0.2347**	–0.0390*	0.0965***	0.9778***	–0.0105
Food Producers	–0.1747**	–0.0091	0.1277***	0.9906***	0.0001
Forestry and Paper	–3.2391	0.0634	2.3719	0.1113	1.4197***
Gas, Water and Multi-utilities	–0.2112**	–0.0341	0.0897***	0.9798***	–0.0124
General Industrial	–0.2899***	–0.0453*	0.1475***	0.9759***	0.0030
General Retailers	–0.1863***	–0.0015	0.1210***	0.9876***	–0.0025
Healthcare Equipment and Services	–0.2373**	–0.0303	0.1191***	0.9791***	0.0319
Household Goods	–0.2863**	–0.0576***	0.0561*	0.9687***	0.0181**
Industrial Engineering	–0.4522**	–0.0487	0.1473***	0.9613***	0.0116
Industrial Transport	–0.4441**	–0.0313	0.0687*	0.9511***	0.0255
Leisure Goods	–0.7391***	–0.1980	0.8238	0.8940***	0.2009***
Media	–0.7163***	–0.1844	0.7691	0.8998***	0.1903***
Mining	–0.4221***	–0.0360	0.1419***	0.9533***	0.0267*
Mobile Telecommunications	–0.2894***	0.0199	0.1631***	0.9779***	–0.0157
Oil and Gas Producers	–0.1709**	0.0005	0.1171***	0.9894***	–0.0015
Oil Equipment and Services	–1.9767***	–0.2344	0.7830	0.6996***	0.4936***
Personal Goods	–1.2319***	0.0288	0.3286***	0.8836***	0.2028***
Pharmaceuticals and Biotechnology	–2.0726	–0.2363	–0.0199	0.0141	0.0038
Software and Computer Services	–0.1282**	0.0376**	0.1161***	0.9949***	0.0071
Support Services	–0.0251**	–0.0493***	–0.0114	0.9956***	–0.0087***
Technical Hardware and Equipment	–0.2228***	–0.0441**	0.1451***	0.9839***	0.0307
Tobacco	–0.1435***	–0.0334*	0.1163***	0.9914***	–0.0025
Travel and Leisure	–0.2043***	–0.1006***	0.0430*	0.9788***	0.0152***

Notes: α_0 represents the constant term, α_1 is the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. EURDUM stands for the coefficient of the euro dummy, which examines the impact of the introduction of the euro on the volatility of industry returns. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 26
A SUMMARY OF INDUSTRIES WITH CHANGE IN VOLATILITY OF THEIR RETURNS IN THE PERIOD AFTER THE EURO

Industry	*TWN*	*US$/£.*	*JP¥/£*
Beverages	0.1338	0.1378	0.1431
Chemicals	0.0321	0.0332	0.0318
Construction and Materials	N.A	N.A	N.A
Forestry and Paper	1.4110	1.4382	1.4197
Healthcare Equipment and Services	N.A	N.A	N.A
Household Goods	0.0175	0.0173	0.0181
Leisure Goods	0.2041	0.1901	0.2009
Media	0.2035	0.2006	0.1903
Mining	0.0285	0.0268	0.0267
Oil Equipment and Services	0.5033	0.5019	0.4936
Personal Goods	0.2063	0.2017	0.2028
Support Services	–0.0094	–0.0096	–0.0087
Travel and Leisure	0.0170	0.0145	0.0152

Notes: TWN is the trade weighted nominal exchange rate, US$/£ is the US$ exchange rate to the pound and JP¥/£ is the JP¥ exchange rate to the pound. A positive figure indicates increase in volatility of returns whereas a negative figure implies a decrease in the volatility of returns. N.A applies to instances when the EURDUM is statistically insignificant.

(10 out of 11) for all models indicating that the riskiness of these industries returns increased in the period after the euro. The industries were the same for the TWN and JP¥/£ models but there were very slight variations for the US$. This result differs to that of Morana and Beltratti (2002) who also use a GARCH (1,1) specification to examine the volatility in UK stock returns. Although the coefficient for the euro dummy (in the variance equation) was positive, it was statistically insignificant. On the other hand, the Support Services industry had a significant negative coefficient in all models suggesting that for this industry, the overall riskiness of its returns declined in the period after the introduction of the euro.

Table 26 also presents a summary of industries with significant difference in volatility in the period after the euro as denoted by the coefficient for the EURDUM in the variance equation, but only the magnitude of the coefficient is reported. The returns of Forestry and Paper industry and Oil Equipment and Services have the highest increase in riskiness irrespective of the exchange rate index used in the model while Travel and Leisure, Construction and Materials and Household Goods have the lowest increase.

The results on the impact of the introduction of the euro on competitive and concentrated industries are presented in Table 27 for the mean equation of the TWN. It was found that the risk return coefficients were not statistically significant at any level. We also observe that the market risk is significant and positive for the concentrated, competitive and concentrated plus competitive industries in the period before the euro. However in the period

TABLE 27

A SUMMARY OF NON-FINANCIAL CONCENTRATED AND COMPETITIVE INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES BEFORE AND AFTER THE EURO: ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

Industry competition	*Competition dummy*	*Constant*	λ	*INDt-1*	*FTSEALLSH*	*FTSEDUM*	*TWN*	*TWNDUM*	*UKTBTND*	*TBTNDUM*	*UKMBRYD*	*BRYDUM*
CONCENTRATION		0.0005	0.0000	0.0439	0.5607***	–0.0559***	0.0004	0.0001	–0.0203*	0.0738***	0.0006	0.0002
COMPETITIVE		0.0009	0.0001	0.1506	0.5616***	–0.0158	0.0007***	0.0002	–0.0193*	–0.0098	0.0047***	0.0035
CONC AND COMP	Not significant (negative)	0.0002	0.0000	0.0856	0.5609***	–0.0389***	0.0005***	0.0001	–0.0210***	0.0414**	0.00275***	0.0012

Notes: λ represents the risk-return trade-off parameter coefficient, TWN is the Trade-weighted nominal exchange rate exposure coefficient before the euro and TWNDUM is the change in exposure after the euro. UKTBTND and UKMBRYD are the exposure coefficients for the three-month TB and 10-year GB before the euro while TBTNDUM and BRYDUM are changes in the exposure after the euro for the TB and GB respectively. The industry dummy coefficient is negative but not significant. ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

after the euro, all the change in the market risk coefficients were negative but only statistically significant for concentrated and concentrated plus competitive industries. Regarding the TWN, only the coefficients for the competitive and concentrated plus competitive industries are significant and these are positive. However in the period after the euro, the changes in the exposure coefficients are all insignificant. Regarding the TWN, only the coefficients for the competitive and concentrated plus competitive industries are significant and these are positive. However in the period after the euro, the changes in the exposure coefficients are all insignificant.

Furthermore, for the unexpected movements in the short-term interest rates in Table 27, concentrated, competitive and concentrated plus competitive industries have significant negative coefficients in the period before the euro while the change in exposure after the euro is positive and significant for concentrated and concentrated plus competitive industries indicating that their exposure to the short-term interest rate reduced after the euro. The result for the long-term interest rate reveals that only the competitive and concentrated plus competitive industries have significant coefficients and these are positive. Then regarding the change in exposure after the euro, the coefficients for the concentrated, competitive and concentrated plus competitive industries are insignificant. This finding suggests that there is a significant reduction in exposure to short-term interest rates for concentrated industries after the euro but no exposure to the long-term interest rate in either period. Conversely, the competitive industries are exposed to the short-term and long-term interest rates before the euro and there is no indication of a reduction in the period after the euro.

In Table 28, the findings for the US$/£ and JP¥/£ are shown. For the US$/£ (panel A), only the concentrated plus competitive industries has a significant coefficient which is positive. But the change in the exposure coefficients were significant and positive for competitive and concentrated plus competitive industries implying an increase in exchange rate exposure. Then for the JP¥/£ (panel B), the exchange rate coefficients for the competitive and concentrated plus competitive industries are significant and positive whereas the change in the exchange rate exposure coefficient is insignificant for concentrated, competitive, and concentrated plus competitive industries. Overall, competitive industries seem to be slightly more exposed to exchange rates in the period before the euro. Then regarding the change in exposure after the euro, we observe that for competitive industries, the exchange rate exposure coefficients were statistically insignificant. Furthermore, all the coefficients for the risk return parameters in the US$/£ and JP¥/£ were insignificant.

Then from the variance equations (Tables 29 and 30), we find that the EURDUM coefficient is significant and positive for competitive industries with regards to the US$/£ and JP¥/£ respectively indicating that volatility increased for competitive industries in the period after the euro.

TABLE 28
A SUMMARY OF NON-FINANCIAL CONCENTRATED AND COMPETITIVE INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE US$/£ AND JP¥/£ EXCHANGE RATES BEFORE AND AFTER THE EURO: ESTIMATED COEFFICIENTS FROM THE MEAN EQUATION

	Industry competition	*Competition dummy*	*Constant*	λ	*INDt-1*	*FTSEALLSH*	*FTSEDUM*	*ER*	*ERDUM*
Panel A—US$	CONCENTRATION		0.0005	0.0000	0.0443***	0.5632***	–0.0551***	0.0133	0.0159
	COMPETITIVE		0.0008	0.0001	0.1500***	0.5611***	–0.0116	0.0095	0.0438**
	CONC AND COMP	NS (Negative)	0.0002	0.0000	0.0856***	0.5616***	–0.0366***	0.0111*	0.0291**
Panel B—JP¥/£	CONCENTRATION		0.0005	0.0000	0.0435***	0.5597***	–0.0566***	0.0000	0.0001
	COMPETITIVE		0.0012	0.0001	0.1496***	0.5638***	–0.0237	0.0001***	–0.0001
	CONC AND COMP	NS (Negative)	0.0002	0.0000	0.0851***	0.5609***	–0.0430***	0.0001**	0.0000

Notes: λ is the risk-return trade-off parameter coefficient, INDt-1 is the autoregressive lag parameter, FTSEALLSH refers to the market risk before the euro, FTSEDUM is the change in market risk following the introduction of the euro. ERI is the Exchange Rate Index and in panel A, this represents the US$ exchange rate exposure coefficient before the euro while in panel B, this is the JP¥/£ exchange rate exposure coefficient before the euro. Then ERDUM refers to the change in the exposure for the US$/£ after the introduction of the euro (panel A) and change in the exposure for the JP¥/£ after the introduction of the euro in panel B. The industry dummy coefficient is negative but not significant (NS) in both panels. CONC and COMP represents the pooled returns of concentrated and competitive industries ***, ** and * denote statistical significance at the 1 per cent, 5 per cent and 10 per cent level.

TABLE 29
A SUMMARY OF NON-FINANCIAL CONCENTRATED AND COMPETITIVE INDUSTRIES' EXPOSURE TO UNEXPECTED CHANGES IN THE TWN EXCHANGE RATE, SHORT-TERM AND LONG-TERM INTEREST RATES BEFORE AND AFTER THE EURO: PARAMETER ESTIMATES FROM THE VARIANCE EQUATION

Industry competition	α_1	α_2	φ	*EURDUM*
CONCENTRATION	–0.0129***	0.1175***	0.9926***	0.0003
COMPETITIVE	–0.0213***	0.1339***	0.9928***	0.0044
CONC AND COMP	–0.0159***	0.1239***	0.9930***	0.0017

Notes: α_1 is the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. EURDUM is the coefficient for the euro dummy, which examines the impact of the introduction of the euro on the volatility of industry returns. *** and * indicates statistical significance at the 1 per cent level and 10 per cent level respectively.

5 CONCLUSION

This study examines simultaneously the sensitivity of UK non-financial industries to movements in exchange rates and interest rates. The analysis is first estimated using OLS, but due to the presence of residual autocorrelation and heteroscedasticity, the AR(1)-EGARCH-M is used instead as this more efficient coefficients and also capture the time-varying properties inherent with the series used in this study.

Our findings suggest that the impact of changes in the long-term interest rate on industry returns is stronger than that of changes in the foreign exchange rate measures and even stronger than the changes in the short-term interest rate. Nevertheless, the detection of few significant exposure coefficients, in all instances, is a probable indication that the risk management strategies employed by non-financial industries has been effective in eradicating most of the impacts of the changes in the exchange rate and interest rate. Another plausible explanation is that industries maybe comprised of heterogeneous firms, whose exposure coefficients to exchange rates and interest rates might be of opposite signs thereby leading to cancelling effects. Furthermore, although the results from the GARCH model are stronger than that initially estimated with the OLS model, the inferences are generally the same.

The study also reveals that, for most UK industries, increased risk will not necessarily lead to an increase in the returns as the number of industries with significant positive risk-return trade-off coefficients is considerably low. However, the magnitude of the risk premium coefficient seemed to vary with different exchange rate factors. Conversely, we find more evidence of leverage effects as the asymmetric parameter, which measures asymmetric impact of past innovations on current volatility, was predominantly negative when significant, indicating that negative surprises increases the volatility of industry returns more than positive surprises. Therefore, severe contrary movements in the exchange rates and/or interest rates will potentially make the industry's returns more volatile. More so, contrary to Joseph (2002), we find

Table 30

A Summary of Non-financial Concentrated and Competitive Industries' Exposure to Unexpected Changes in the US$/£ and JP¥/£ Exchange Rates before and after the Euro: Parameter Estimates from the Variance Equation

	US$/£				JP¥/£			
Industry competition	α_1	α_2	φ	*EURDUM*	α_1	α_2	φ	*EURDUM*
CONCENTRATION	–0.0127***	0.1177***	0.9926***	0.0003	–0.0127***	0.1174***	0.9926***	0.0003
COMPETITIVE	–0.0210***	0.1340***	0.9928***	0.0043*	–0.0210***	0.1332***	0.9928***	0.0043*
CONC AND COMP	–0.0157***	0.1240***	0.9930***	0.0017	–0.0158***	0.1234***	0.9930***	0.0017

Notes: α_1 represents the coefficient for the asymmetric impact of past innovations on current volatility, α_2 is the ARCH parameter coefficient and φ is the GARCH parameter coefficient. EURDUM is the coefficient for the euro dummy, which examines the impact of the introduction of the euro on the volatility of industry returns. *** and * indicates statistical significance at the 1 per cent level and 10 per cent level respectively.

evidence of leverage effects on the returns of the Chemical and Electrical industries. Furthermore, the coefficients of the industry's returns' conditional volatility indicates that for a majority of UK industries, current volatility is time varying, is a function of past innovations and past volatility and persistence of volatility is very high, suggesting that volatility has a long memory, and once volatility increases, it may probably remain high over several periods. Additionally, the magnitude of significant persistence parameters (GARCH parameter) was generally higher than that of the significant ARCH parameter (presence of volatility clustering) in all the models, implying that the market has a memory longer than one period, volatility is more sensitive to old news than it is to news about volatility from the previous period. Even so, it was observed that for most industries, the magnitude of the conditional variance tends to vary with the exchange rate index in the model. Incidentally, volatility persistence in the returns of UK industries is relatively high, but some industries are better able to absorb the volatility more than others. We attribute the finding of high persistence of volatility to the use of weekly data and which may have also been exacerbated by an increase in exchange rate and interest rate risk. Nevertheless, the persistence of volatility on UK industries, measured by the half-life tends to dissipate much faster in some industries than others suggesting that, for these industries, inherent volatility is probably more effectively contained.

Finally, we also observed that competitive industries were generally more exposed to exchange rate and interest rate risk, and also exhibited higher persistence of volatility than concentrated industries. However, the AR(1)-EGARCH-M model used in this study does not seem to have captured all the non-normality in the residuals. This finding is consistent with some other studies which point out that GARCH-type models are incapable of capturing all the non-linearity that is particularly characteristic of time series data. However, this specification of GARCH model generally provided a better fit to the data and even produced more instructive results than the OLS model.

Following Vardar *et al.* (2008) and Kasman *et al.* (2011) procedure for the Istanbul stock exchange, we propose that future research can be extended to examine the direct effects of exchange rate and interest rate on the volatility of UK stock returns. This can be achieved by including the exchange and interest rate in the conditional variance equation. Consequently, the predictive power of exchange and interest rate risk on stock return volatility can be determined. Another feasible area for future research would be to investigate the half-life of persistence of individual firms, since only the half-life volatility pertaining to portfolios have been examined, and this may not reflect that of the individual firms within the industry. In addition, we also recommend using non-linear and non-parametric models, which can detect more significant exposure coefficients (Aysun and Guldi, 2011).

This study suggests that the body of empirical evidence may not be unreasonable considering the fact that stock returns only reflect the exposure of firms net of corporate hedging. Non-financial firms can implement risk management not only through financial hedging (e.g. with derivatives), which primarily reduces volatility in the near term, but also through operational hedging via the location and structure of operations and the ability to modify operations in response to currency movements, which reduces the long-term impact of exchange rate changes on firm value. Consequently, if firms react rationally to their exposure, most firms will either have no exposure to start with, or reduce their exposure to levels that may be too small to detect empirically. The empirical evidence in this study has several practical implications. Our findings suggest policymakers to consider very heterogeneous effects of foreign exchange rates on industries and firms. For example, if a currency depreciation policy targeting at boosting exports is implemented, benefits from it will sink into a small number of big companies at cost of many firms' benefits. And since smaller firms of negative foreign exchange exposure are more exposed to foreign exchange risks, they need to be encouraged effectively to manage the risks. In addition, for policy, monetary and exchange rates, management should emphasize achieving sustainable stability in exchange rates movements. This study also provides important implications for investors who wish to understand links between policies that affect exchange rates and relative wealth effects. The empirical results of this study should help investors to examine how stock returns of various sectors react to exchange rate fluctuations when making financial decisions, and prove useful for financial managers when measuring exposure to foreign exchange rate changes. From a methodological view, our results suggest that this approach effectively rules out the influence of the time variation of foreign exchange rate exposure. In addition, the observed increased stock return volatilities and the corresponding increase in market risk have important implications for the decision-making process of international investors, as well as for firms in financial operations.

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