Measuring the Effect of Exchange Rate Movements on Stock Market Returns Volatility: GARCH Model

قياس أثر تغيرات أسعار الصرف على تقلبات عوائد أسواق الأسهم باستخدام نموذج GARCH

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Abstract: This paper aims to investigate the dynamic links between exchange rate fluctuations and stock market return volatility. For this purpose, we have employed a Generalized Autoregressive Conditional Heteroscedasticity model (GARCH model). Stock market returns sensitivities are found to be stronger for exchange rates, implying that exchange rate change plays an important role in determining the dynamics of the stock market returns.

Keywords: Returns Volatility, Exchange Rate Fluctuations, GARCH Model.

Jel Classification Codes : C22, E44, G12, G15, F31.

ملخص : تهدف هذه الدراسة إلى قياس تأثير تغيرات أسعار الصرف على عوائد أسواق الأسهم، باستخدام نموذج GARCH. أشارت نتائج القياس إلى ارتفاع حساسية أسعار وعوائد أسواق الأسهم لتغيرات أسعار الصرف، ومعنوية هذا التأثير تجعل منها، أي أسعار الصرف، تلعب دورا كبيرا في تحديد ديناميكية عوائد اسواق الأسهم والأسواق المالية بشكل عام.

الكلمات المفتاح : تقلبات العوائد، تقلبات أسعار الصرف، نموذج GARCH.

تصنيف JEL: C22، E44، G12، G15، F31.

I- Introduction :

The dramatic increases in the world trade and capital movements have made the currency value as one of the main determinants of business profitability and equity prices[1]. Exchange rate movements rapidly affect prices (via import prices) and subsequently demand (by boosting imports and slowing down exports, or vice versa). Monetary policy affects exchange rates via the yield curve and from there via interest rate parity relations. To be more precise, it is the yield curve of both the home and the foreign country, and thus the monetary policies of both the home and the foreign country, which affect the exchange rate between two currencies[2].

Exchange rates can have a great impact on investor returns. They can convert mediocre returns or even losses into very attractive returns – and vice versa. Only one thing determines whether the currency effect is going to be positive or negative: the behavior of the United States Dollar (USD) relative to the currency in which the security is denominated. In essence, a stronger has a negative impact on total returns to local investors, and a weaker local currency has a positive impact[3].

When it comes to companies located overseas, particularly in emerging markets, the dividends can vary widely from year to year. Currency fluctuation can play a big part. In local currency, a company may pay a consistent dividend. But if that currency moves 10% per year against the USD, an investor in American Depositary Receipt (ADR) may get $2 per share in dividends one year and $1.8 the next year; all while the company actually shelled the same amount in its local currency[4].

Foreign investors in the local stock market facing, two types of risk, the first type of risk is the same risk as that faced by local investors, which relates to the fluctuations in the stock and bond prices. The second type is the Currency Risk facing foreign investors only, in order to convert financial funds in local currency to foreign currency. Of course, the

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greater the amount of fluctuation in the currency exchange rate, the greater the impact on total returns. The challenge facing global investors is to find not only the best performing foreign share(s) but also the best performing currencies[5].

According to macroeconomic theory, exchange rates and stock prices are positively related (if the exchange rate is expressed in units of the domestic currency per unit of foreign currency). The traditional approach concludes that exchange rates should lead stock prices. The transmission channel would be exchange rate fluctuations, which affect firm's values through changes in competitiveness and changes in the value of firm's assets and liabilities, denominated in foreign currency, ultimately affecting firm's profits and therefore the value of equity[6]. For instance, if the exchange rate appreciates, exporters will lose their competitiveness in international markets. Their profits will shrink, and the stock prices will drop. On the contrary, if the exchange rate depreciates, importers will lose their competitiveness in domestic markets (consumers may not afford to purchase ''higher-price'' imported products), their sales and profits will be reduced, and the stock prices will drop as a result[7]. That is, currency appreciation has both a negative and a positive effect on the domestic stock market for an export-dominant and an import-dominated country, respectively[8]. A fall in the exchange value of a nation's currency stimulates exports and increases the income of export and import-competing industries, thus boosting the average level of stock prices[9].

This study examines volatility between foreign exchange markets (Forex or FX) and equity markets in selected developed countries by employing a GARCH model. More precisely, the main research question is: "**Is there any ARCH (Autoregressive conditional heteroskedasticity) or GARCH effects in volatility on developed stock markets?**".

This paper is structured as follows. Section 2 presents a brief review of previous empirical studies. Section 3 presents a preliminary analysis of the data. Section 4 details the econometric methodology used. The empirical results are reported in Section 5. Section 6 summarizes the main conclusions.

II- Literature review:

The existence of a relationship between stock prices and exchange rate has received considerable attention. The empirical literature provides conflicting findings regarding the dynamic linkage between FX and stock markets. Aggarwal (1981) examined the influence of exchange rate on U.S. stock prices for the period 1974 to1978. It was found that stock prices and exchange rates are positively correlated, i.e. a decrease in the value of the USD was correlated with a decline in stock prices and vice versa[10]. Solnik (1987) analyzed influence of several economic variables including exchange rates on stock prices in nine industrialized countries. Changes in exchange rates proved to be a non-significant factor in explaining the development of stock prices[11]. Soenen and Hennigan (1988) reported strong negative interaction using monthly data of the US dollar effective exchange rate and US stock market index during 1980–86[12].

Ma and Kao (1990) find that a currency appreciation negatively affects the domestic stock market for an export-dominant country and positively affects the domestic stock market for an import-dominant country[13]. Ajayi and Mougoue (1996) employ an error correction model (ECM) of the two variables to simultaneously estimate the short-run and long-run dynamics between stock indices and exchange rates for a sample of eight advanced economies. The ECM results reveal significant short-run and long-run feedback relations between the two financial markets. Specifically, the results show that an increase in aggregate domestic stock price has a negative short-run effect on domestic currency value. In the long run, however, increases in stock prices have a positive effect on domestic currency value. On the other hand, currency depreciation has a negative short-run and long-run effect on the stock market[14]. Abdalla and Murinde (1997) investigated the interaction between the real effective exchange rates and stock prices in the emerging financial markets using monthly observations on the International Financial Corporation IFC stock price index and the real effective exchange rate over 1985:01–1994:07. They found unidirectional causalities from exchange rates to stock prices in all sample countries except in the Philippines[15].

Wu (2000) found that when the Singapore currency appreciated against the US dollar and Malaysian ringgit, and depreciated against the Japanese yen and Indonesian rupiah, this led to a long-run increase in stock prices for most selected periods of the 1990s; however, the effect associated with the USD exchange rate has a sign reversal between the 1997–98 crisis period and the 1999–2000 recovery period. The influence of exchange rates on stock prices increases in a chronological order in the 1990s[16]. Nieh and Lee (2001) studied group of seven industrialized countries (G7) for relationship between exchange rate and stock market using data from 1993 to 1999. Their study indicated that there is no long run relationship that exists between the two variables, while the short run significant relationship exists between few G7 countries with united states of America (USA) having no relationship between their exchange rate and stock market[17]. Kim (2003) investigate the existence of long-run equilibrium relationships among the aggregate stock price, industrial production, real exchange rate, interest rate, and inflation in the USA. Applying Johansen's cointegration analysis to monthly data, it find that the standard and poor's 500 (S&P 500) stock price is positively related to the industrial production but negatively to the real exchange rate[18].

Murinde and Poshakwale (2004) investigate price interactions between foreign exchange market and the stock market for European emerging financial markets, before and after the adoption of the Euro. They found that for the pre-euro period, stock prices unidirectionally Granger-caused exchange rates to shift only in Hungary, while bidirectional causality relations existed in Poland and the Czech Republic. After the adoption of the euro, exchange rates unidirectionally Granger-caused stock prices to shift in all these countries [19]. Pan, Fok, and Liu (2007) examined dynamic linkages between exchange rates and stock prices for seven East Asian countries, for the period January 1988 to October 1998. The empirical results show a significant causal relation from exchange rates to stock prices for Hong Kong, Japan, Malaysia, and Thailand before the 1997 Asian financial crisis, and for all countries except Malaysia during the Asian crisis. their findings also indicate that the linkages vary across economies with respect to exchange rate regimes, the trade size, the degree of capital control, and the size of equity market[20]. Pilinkus and Boguslauskas (2009) used the impulse response function to test the existence of the short-run relationship between macroeconomic variables and stock market prices. Their study indicated that exchange rate negatively influence stock market prices[21].

Tian and Ma (2010) employs the Autoregressive Distributed Lag (ARDL) cointegration approach in order to examine the impact of financial liberalization on the relationships between the exchange rate and share market performance in China. They discovered that cointegration has existed between the Shanghai A Share Index and the exchange rate of the renminbi against the US dollar and Hong Kong dollar since 2005, when the Chinese exchange rate regime became a flexible, managed, floating system. They found that the exchange rate influenced stock price, with a positive correlation[22]. Walid et al (2011) employ a Markov-Switching exponential generalized autoregressive conditional heteroscedastic (EGARCH) model to investigate the dynamic linkage between stock price volatility and exchange rate changes for four emerging countries over the period 1994–2009. They provide strong evidence that the relationship between stock and foreign exchange markets is regime dependent and stock price volatility responds asymmetrically to events in the foreign exchange market. Their results demonstrate that foreign exchange rate changes have a significant impact on the probability of transition across regimes[23]. Katechos (2011) suggest that exchange rates and global stock market returns are strongly linked. The value of currencies with higher interest rates is positively related with global equity returns, whereas the value of currencies with lower interest rates is negatively related with global equity returns[24]. jamil and Ullah (2013) use the cointegration technique to analyze the impact of USD to Roupie pakistanaise (PKR) exchange rate on the stock market return. The results show that a relationship between the two variables exists in the short run in Pakistan[25]. Caporale, Hunter, and Ali (2013) examined the nature of the linkages between stock market prices and exchange rates in six advanced economies, using data on the banking crisis between 2007 and 2010. Bivariate GARCH-BEKK models ((the acronym BEKK stands for Baba, Engle, Kraft, and Kroner) are estimated producing evidence of unidirectional spillovers from stock returns to exchange rate changes in the USA and the UK, in the opposite direction in Canada, and of bidirectional spillovers in the euro area and Switzerland. Furthermore, causality-in-variance from stock returns to exchange rates changes is found in Japan and in the opposite direction in the euro area and Switzerland, whilst there is evidence of bidirectional feedback in the US and Canada[26]. R. Najaf and K. Najaf (2016) studied dynamic relationship between stock markets movement and volatility of stock market. They found a negative correlation. Granger causality test was used which has proved that there is unidirectional causality between stock returns and exchange rate[27]. Julio, Abdulnasser, and Edgardo (2016) investigate the informational efficiency of the Colombian stock market with regard to the information contained in the exchange rates as well as the yield to maturity. The results show that neither the exchange rates nor the yield to maturity is causing the stock price index. This is interpreted as empirical support for the efficient market hypothesis in that the Colombian stock market is with regard to these two main variables[28].

To summarize, even though the theoretical explanation may seem obvious at times, empirical results have always been mixed and existing literature is inconclusive on this issue. This paper attempts to investigate again this relationship between the two variables by employing a GARCH model.

III. Data and methodology:

The data consists of daily closing stock market indexes denominated in local currency and exchange rates for three developed countries, namely UK, Japan and Canada. To study the relationship between exchange rate movements and stock market volatility during bad and good times, we choose data from January 2001 to September 2016 (3443 observations). There have been frequent currency and financial crises during this period. The stock index series are from the **Google Finance database**. Exchange rates are extracted from the **IMF Exchange Rate Archives** and are expressed in USD per local currency (direct quotation system). The stock market asset returns ($r_{i,t}$) and the rate of changes in exchange rate ($e_{i,t}$) are computed as follows:

$$r_{i,t} = 100 \times \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) \quad (1)$$

and

$$e_{i,t} = 100 \times \ln\left(\frac{Fx_{i,t}}{Fx_{i,t-1}}\right) \quad (2)$$

where ($p_{i,t}$) is the stock price index for the stock market (i) at time (t). ($r_{i,t}$) is the stock market return. ($Fx_{i,t}$) is the exchange rates of currency (i) at time (t) and ($e_{i,t}$) is the rate of fluctuation in the exchange rate (nominal appreciation or depreciation).

Table 1 (Panels A and B) reports descriptive statistics for the stock index and FX rate changes time series. From these summary statistics, several traits can be identified. Firstly, Canada has the highest mean among the three developed stock markets, followed by Japan, and UK. Additionally, it can be seen that the selected developed stock markets are characterized by higher levels of volatility given that the standard deviations are significantly higher than the mean. Skewness normality tests indicate that return distributions are negatively and significantly skewed for all series except for UK. In addition, high excess kurtosis values suggest that all the stock return distributions are highly leptokurtic relative to the normal distribution. This result is confirmed by the Jarque–Berra test statistics, which reject the hypothesis of normality of the stock index returns at the 1% significance level. From the statistics reported in Panel B, we can see that, Canadian dollar and British Pound exhibit a negative mean return or a nominal appreciation against the USD; the others exhibit a positive mean return or a nominal depreciation against the USD. UK suffer from the highest currency depreciation while Japan appears to suffer the most volatile currency fluctuations during the sample period. Finally, Jarque–Berra tests indicate that we can reject the null hypothesis of normality of the FX rate changes for all countries.

Table 2 reports conventional unit root and stationarity test results for the stock index and FX market time series. Three alternative tests are employed namely the Augmented Dicky and Fuller (1979) (ADF), the Phillips and Perron (1988) (PP) and Kwiatkowski et al. (1992) (KPSS) tests. From the results of the ADF and PP tests, at the 1% significance level, both stock indexes and FX rates are non-stationary but their first order differences are stationary (i.e. stock index returns and FX rate changes). Thus both sets of series are I(1). Finally, the KPSS test for the null hypothesis of level or trend stationary against the alternative of nonstationary is also applied to provide robust results. Using this test we reject the null hypothesis of stationarity in the levels of all series. However, when the first differences of each stock price index and FX rates series is taken, the KPSS test again indicates that these series are I(1).

Most empirical studies employ Ordinary Least Squares (OLS) method to estimate the effect FX rate changes on the stock exchange returns. Thus, following model is estimated with OLS:

$$r_t = \beta_0 + \beta_1 e_t + \mu_t \qquad (3)$$

where r_t is the return of the stock exchange returns at time t; and, (e_t) is the rate of the exchange rate changes (nominal appreciation or depreciation). $\beta_0$is the intercept term, and μ_t is an error term. The suitability of the OLS estimation is tested with the ARCH test.

The GARCH process, first introduced by Bollerslev (1986)[29], is estimated next. The $GARCH\ (1,1)$ process is specified as follows:

$$r_t = y_0 + y_1 e_t + \varepsilon_t \qquad (4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad (5)$$

where other parameters are defined as before, the variance equation includes the long-term average volatility α_0, news about volatility from the previous period which is defined as an ARCH term and the previous period's forecast variance which is defined as the GARCH term. The GARCH specification requires that in the conditional variance equation, parameters α_0, α_1 and β should be positive for a non-negativity condition and the sum of α_1 and β should be less than one to secure the covariance stationarity of the conditional variance. Moreover, the sum of the coefficients α_1 and β must be less than or equal to unity for stability to hold.

The following $GARCH\ (1,1)$ model is used next, to analyze whether FX rate return volatility have any impact on the stock exchange returns. e_t^2 is used to measure the FX rate return volatility.

$$r_t = y_0 + \varepsilon_t \qquad (6)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \theta e_t^2 \qquad (7)$$

IV. Empirical results:

IV-1. OLS estimation:

Table 3 reports the results of the OLS estimation. The variables of exchange rate change are positive for all series except for Canada, and they are statistically significant for all stock markets returns volatility. Moreover, the results show that the exchange rate change explains a greater proportion of stock markets returns volatility in Japan, compared to Canada and UK.

The suitability of the regression estimates is examined with the ARCH test. If the squared residuals in Eq. (3) contain autocorrelation or heteroscedasticity, it is likely that the null hypothesis will be rejected. The last column of Table 3 reports the results of the ARCH test. Unsurprisingly, a residual serial correlation is present for all the markets level analysis. The presence of residual autocorrelation is a very serious failure of the OLS classical assumption because its presence implies that the OLS coefficients are not efficiently estimated and statistical inferences based on standard t and F-tests would not be reliable. Therefore, GARCH type models would appear to be more appropriate for estimating such data.

IV-2. Estimation of return with GARCH (1, 1) model:

The estimated GARCH (1,1) parameters of the conditional return model are shown in Table 4. The coefficient γ_1, which measures the effect of exchange rate change on the stock markets returns, is positive and statistically significant in UK and Japan. But for the case of Canada the effect of exchange rate change on the stock markets returns, is negative and statistically significant, which means that the results indicate that the conditional return has a negative and significant relation with exchange rate risk exposure in one case.

The impact of exchange rate change on the conditional mean equation is found to be larger in magnitude and strongly significant in all cases. The exchange rate change is found to explain a greater proportion of conditional stock markets returns. The negative relationship with the exchange rate can be explained by the depreciation of the local currency may lead to damage in the equity market may result in a decline in the stock market return.

In a conditional variance equation, the intercept term (α_0) is positive and statistically significant in all cases, indicating that there is a significant time-invariant component in the return generating process. Both the ARCH parameter α_1 and the GARCH parameter β satisfy the non-negativity condition. The GARCH parameter is significantly greater than the ARCH parameter, which implies that the volatility of each stock market return is more sensitive to its own lagged values than it is to new surprises. To put it in another way, the effects of a previous period's forecast variance are more persistent. The sum of $\alpha 1$ and β parameters are close to unity for 3 out of 3 cases, stating that shocks to the stock index returns have highly persistent effects and the response of volatility decays at a slower rate. In particular, stock markets returns sensitivities are found to be stronger for exchange rates, implying that exchange rate change plays an important role in determining the dynamics of the conditional return of stock markets returns.

IV-3. Estimation of volatility with GARCH (1,1) model:

Table 5 presents the results of the stock market index return volatility model with the inclusion of variables reflecting exchange rate volatility. The small and statistically significant ARCH parameter α_1 provides a weak support for the presence of the last period's shock on the stock market index return volatility, whereas the larger and statistically significant GARCH parameter β indicates strong evidence of previous surprises. The sum of ARCH and GARCH parameters as a measure of volatility persistence are the same with the inclusion of exchange rate volatility.

The empirical findings show that the estimated coefficient θ, which measures the effect of the exchange rate volatility on the stock market return volatility, is found to be negatively significant in 1 out of the 3 cases. Finding significant exchange rate coefficients necessarily implies that the fluctuations in exchange rates lead to a decrease in the stock market return volatility.

IV-4. Autocorrelation, Partial Autocorrelation, and Heteroskedasticity tests:

Autocorrelation and partial autocorrelation tests are useful in terms of examining time series behavior. To verify whether there is correlation or not we employ Ljung-Box-Pierce Q-test under the null hypothesis of no serial correlation (Box et al. 1994). The test results are presented in Table 6. The test is performed using lags from 1 to 10 with 5% level of significance. The results shows that all coefficients of AC and PAC are significant for all cases at 5 percent significance level. This could indicate the suitability of the GARCH model for all cases.

To test for homoscedasticity (i.e. a constant variance in the time series) we shall utilize the systematic framework for volatility modeling provided by the above mentioned ARCH model of Engle (1982) under the null hypothesis suggest that the time series is homoscedastic (as opposed to heteroscedastic). The results in the table 7 show clear evidence that residuals are homoscedastic. The critical values of Engle's ARCH and Ljung-Box-Pierce Q-test results are the same. Both test statistics are Chi-Square distributed. All the pre mentioned statistical analysis gives more support to the suitability of applying GARCH model.

V. Conclusion :

This paper has investigated the impact of FX movements on stock market volatility, using daily data for three developed countries (UK, Japan and Canada). Our methodology is based on a GARCH (1.1) model that allows to estimate the relationship between exchange rate movements and stock market volatility during bad and good times, by using data from January 2001 to September 2016 (3443 observations).

The results of this study provide evidence of strong linkage between the fluctuations of the stock markets and the changes in exchange rates. The results of the OLS estimation indicate that the variables of exchange rate change are positive for all series except for Canada, and they are statistically significant for all stock markets returns volatility. Moreover, the results show that the exchange rate change explains a greater proportion of stock markets returns volatility in Japan, compared to Canada and UK.

The ARCH test indicate the presence of serial correlation for all the markets level analysis. The presence of residual autocorrelation is a very serious failure of the OLS classical assumption because its presence implies that the OLS coefficients are not efficiently estimated and statistical inferences based on standard t and F-tests would not be reliable. Therefore, GARCH type models would appear to be more appropriate for estimating such data.

The results of GARCH (1,1) estimation indicate that the conditional return has a negative and significant relation with exchange rate risk exposure in Canada, and positive for UK and Japan. The impact of exchange rate change on the conditional mean equation is found to be larger in magnitude and strongly significant in all cases. The exchange rate change is found to explain a greater proportion of conditional stock markets returns. The negative relationship with the exchange rate can be explained by the depreciation of the local currency may lead to damage in the equity market may result in a decline in the stock market return.

In a conditional variance equation, the intercept term (α_0) is positive and statistically significant in all cases, indicating that there is a significant time-invariant component in the return generating process. Both the ARCH parameter α_1 and the GARCH parameter β

satisfy the non-negativity condition. The GARCH parameter is significantly greater than the ARCH parameter, which implies that the volatility of each stock market return is more sensitive to its own lagged values than it is to new surprises. To put it in another way, the effects of a previous period's forecast variance are more persistent. The sum of α1 and β parameters are close to unity for 3 out of 3 cases, stating that shocks to the stock index returns have highly persistent effects and the response of volatility decays at a slower rate. In particular, stock markets returns sensitivities are found to be stronger for exchange rates, implying that exchange rate change plays an important role in determining the dynamics of the conditional return of stock markets returns.

The results of the stock market index return volatility model with the inclusion of variables reflecting exchange rate volatility, indicate that the small and statistically significant ARCH parameter α_1 provides a weak support for the presence of the last period's shock on the stock market index return volatility, whereas the larger and statistically significant GARCH parameter β indicates strong evidence of previous surprises. The sum of ARCH and GARCH parameters as a measure of volatility persistence are the same with the inclusion of exchange rate volatility. The empirical findings show that the estimated coefficient θ, which measures the effect of the exchange rate volatility on the stock market return volatility, is found to be negatively significant in 1 out of the 3 cases. Finding significant exchange rate coefficients necessarily implies that the fluctuations in exchange rates lead to a decrease in the stock market return volatility.

- Appendices:

Table 1: Sample statistics for the daily market returns and FX rate changes.

	UK	Japan	Canada
Panel A: stock returns	**FT100**	**NIKKEI225**	**S&P/TSX**
Mean	0.001352	0.002315	0.006653
Std. Dev.	0.572357	0.716859	0.514774
Skewness	0.004921	-0.405470	-0.561953
Kurtosis	9.967983	8.782963	12.75671
Jarque-Bera	6965.316	4891.970	13837.51
Probability	0.000000	0.000000	0.000000
Observations	**3443**	**3443**	**3443**
Panel B: FX rates	**GBP**	**JPY**	**CAD**
Mean	-0.001853	-0.001791	-0.001694
Std. Dev.	0.293497	0.296782	0.287119
Skewness	-1.197591	-0.191381	-0.144088
Kurtosis	16.51771	6.485444	11.59697
Jarque-Bera	27036.93	1763.795	10614.62
Probability	0.000000	0.000000	0.000000
Observations	**3443**	**3443**	**3443**

Source : Calculated by the author using Eviews7

Table 2 Unit root and stationarity tests.

Country	ADF t-tests		PP t-tests		KPSS t-tests	
	tµ	tτ	tµ	tτ	ηµ	Hτ
UK						
$p_{i,t}$	-2.1624	-2.0164	-2.2042	-2.0777	3.4359	0.2706
$r_{i,t}$	-23.239**	-23.256**	-62.246**	-62.269**	0.1257**	0.0614**
$Fx_{i,t}$	-2.1988	-1.9325	-2.1961	-1.9184	1.5019	0.9781
$e_{i,t}$	-43.191**	-43.222**	-57.280**	-57.326**	0.2619**	0.0484**
Japan						
$p_{i,t}$	-1.9042	-1.7393	-1.9014	-1.7552	1.4097	0.6731
$r_{i,t}$	-61.109**	-61.111**	-61.222**	-61.226**	0.1271**	0.0691**
$Fx_{i,t}$	-1.3490	-1.6457	-1.3246	-1.6213	2.7319	1.0285
$e_{i,t}$	-59.932**	-59.925**	-59.951**	-59.944**	0.1260**	0.1035**
Canada						
$p_{i,t}$	-1.4445	-2.2354	-1.4962	-2.4132	5.2041	0.5287
$r_{i,t}$	-10.946**	-10.946**	-60.377**	-60.368**	0.0586**	0.0608**

$Fx_{i,t}$	-0.7123	-1.9534	-0.7144	-1.9977	3.6534	1.4977
$e_{i,t}$	-11.053**	-11.165**	-61.159**	-61.186**	0.3255**	0.0510**

Notes: (*) and (**) indicate significance at the 5% and 1% respectively, tμ and tτ are the standard augmented Dickey–Fuller (ADF) test statistics and Phillips–Perron (PP) test statistics when the relevant auxiliary regression contains a constant and a constant and trend, respectively. The critical values for ADF test and PP test at the 1% and 5% significance levels are: -3.4320, -2.8621 (with constant) and -3.9607, -3.4111 (with constant and trend). ημ and ητ are the KPSS test statistics when the relevant auxiliary regression contains a constant and a constant and trend, respectively (Kwiatkowski et al., 1992). The critical values for KPSS test at the 1% and 5% significance levels are: 0.739, 0.463 (with constant) and 0.216, 0.146 (with constant and trend).

Source : Calculated by the author using Eviews7

Table 3 Estimates of OLS regression

	β_0	β_1	AdjustedR	$D.W\ stat$	F-stat	$ARCH(1)$
UK	0.001835	0.260680*	0.017583	2.088146	62.60452*	341.8793*
	(0.8495)	(0.0000)			(0.0000)	(0.0000)
Japan	0.004054	0.970662*	0.161246	2.149409	662.7039*	177.5152*
	(0.7172)	(0.0000)			(0.0000)	(0.0000)
Canada	0.005719	-0.551483*	0.094351	2.187612	359.5876*	548.4044*
	(0.4934)	(0.0000)			(0.0000)	(0.0000)
No of Signif. cases	$^0/_3$	$^3/_3$			$^3/_3$	$^3/_3$

Note: Numbers in parentheses indicate the P-value.
* Indicates the significance level at 1%.

Source : Calculated by the author using Eviews7

Table 4 Estimation of return

	γ_0	γ_1	α_0	α_1	β
UK	0.020175*	0.065037*	0.006696*	0.121345*	0.856384*
	(0.0051)	(0.0056)	(0.0000)	(0.0000)	(0.0000)
Japan	0.023157*	0.867836*	0.015191*	0.117197*	0.848123*
	(0.0099)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Canada	0.023225*	-0.350813*	0.003021*	0.090802*	0.896069*
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
No of Significant cases	$^3/_3$	$^3/_3$	$^3/_3$	$^3/_3$	$^3/_3$

Note: Numbers in parentheses indicate the P-value.
* Indicates the significance level at 1%.

Source : Calculated by the author using Eviews7

Table 5 Volatility estimates.

	γ	α_0	α_1	β	θ
UK	0.020842*	0.006578*	0.122732*	0.855871*	-0.001905*
	(0.0035)	(0.0000)	(0.0000)	(0.0000)	(0.6794)
Japan	0.024833**	0.015264*	0.112200*	0.858563*	0.004914*
	(0.0117)	(0.0000)	(0.0000)	(0.0000)	(0.5711)
Canada	0.023998*	0.003025*	0.091887*	0.896004*	-0.007185*
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0632)
No of Significant cases	$^3/_3$	$^3/_3$	$^3/_3$	$^3/_3$	$^3/_3$

Note: Numbers in parentheses indicate the P-value.
* Indicates the significance level at 1%.
** Indicates the significance level at 5%.
*** Indicates the significance level at 10%.

Source : Calculated by the author using Eviews7

Table 6 GARCH Autocorrelation and partial autocorrelation tests

lags	UK				Japan				Canada			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	-0.008	-0.008	0.2028	0.652	-0.027	-0.027	2.5668	0.109	-0.022	-0.022	1.6468	0.199
2	0.005	0.005	0.2963	0.862	-0.001	-0.001	2.5677	0.277	0.035	0.034	5.7708	0.056
3	0.009	0.009	0.5918	0.898	0.017	0.017	3.5368	0.316	-0.006	-0.004	5.8880	0.117
4	-0.030	-0.030	3.6740	0.452	-0.019	-0.018	4.7276	0.316	0.001	-0.000	5.8936	0.207
5	0.005	0.004	3.7610	0.584	-0.009	-0.010	4.9904	0.417	0.000	0.001	5.8938	0.317
6	0.012	0.012	4.2283	0.646	-0.007	-0.008	5.1511	0.525	-0.019	-0.019	7.0760	0.314
7	0.000	0.001	4.2287	0.753	-0.005	-0.005	5.2445	0.630	0.012	0.011	7.5648	0.373
8	0.019	0.018	5.5244	0.700	0.020	0.020	6.6787	0.572	0.000	0.002	7.5649	0.477
9	-0.013	-0.012	6.0779	0.732	0.011	0.012	7.0771	0.629	0.011	0.011	8.0154	0.533
10	-0.014	-0.014	6.7974	0.744	-0.010	-0.009	7.3948	0.688	-0.009	-0.009	8.3138	0.598

Source : Calculated by the author using Eviews7

Table 7 Heteroskedasticity Test: ARCH

	UK	Japan	Canada
F-statistic	0.202574	2.564474	1.644824
Prob. F(1,3440)	0.6527	0.1094	0.1998
Obs*R-squared	0.202680	2.564054	1.644994
Prob. Chi-Square(1)	0.6526	0.1093	0.1996

Source : Calculated by the author using Eviews7

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