Interdepartmental Program of Postgraduate Studies in Economics

Thesis

VOLATILITY SPILLOVER EFFECTS

Of

Polyzoidou Konstantina

Supervisor: Pantelidis Theologos

August 2014

Thessaloniki

Contents

Abstract

This study examines the volatility dynamics in the stock and forex markets. We first use a BEKK-GARCH model to estimate the international information transmission between the stock market indices and the currency prices of two of the G-7 countries (Canada and the United Kingdom). Afterwards, we proceed to the calculation of the volatility impulse response functions based on historical shocks. This methodology allows us to explore the interdependencies between national stock markets and exchange rates.

1 Introduction

The modern economic world is multidimensional, representing, a more and more changing character in all its domains. One of the key elements under investigation nowadays, is the issue of volatility. In finance, volatility can be described as a measure of variation of price of a financial instrument over time. Much research has been devoted to modeling and forecasting the volatility of financial returns in order to understand its meaning and protect the investing decisions in general.

Over the past decades, many researchers and scientists, examined the volatility spillover effect. By definition, spillover effects are externalities of economic activity or processes that affect those who are not directly involved, exploring and exhibiting the linkages between two or more economic variables. The first studies have examined the characteristics and changes in volatility on individual markets trading foreign currency, bonds, stocks and commodities. A little attention was given in the relationship and the connection of the above variables that offers a better insight in the internal mechanics of the market and its power.

The globalization and the inextricably tight connection of the modern financial markets led to the outbreak of the spillover effect analysis and made it a contentious issue of research. Earlier empirical results show that the tendency of the volatility spillovers can be either unidirectional or bidirectional. There is a bulk of papers that have dealt with the above issue, like, Xu and Fung (2002), Choudhry (2004), Li (2007) and John Beirne, Gugliemo Maria Caporale, Marianne Schulze-Ghattas and Nicola Spagnolo. (2008). Other studies, like Baillie and Bollerslev (1990), Panopoulou and Pantelidis (2009), Choi et al. (2009) and Federova and Saleem (2010) explore the volatility spillover effects between stock and exchange markets. Their results are mixed, as it concerns the direction and the variables used, but all authors came to the same conclusion: the direct linkage between the equity markets (both in volatility and returns) and the currency markets.

Taking the above studies into consideration, we examine the international information transmission between the stock market indices and the currency prices of two of the G-7 countries (Canada and United Kingdom). The currency pairs of those countries are all against US dollar and the period of investigation covers 23 years, from 1990 until 2013. Employing a BEKK-GARCH model and the volatility impulse response functions (VIRF), we explore the volatility spillover effects. Moreover, we analyze the above variables in order to examine their linkages, show the financial dynamics and capture any possible asymmetries in general.

The research starts with the literature review in section 2. Section 3 describes the data and analyses the methodology. After that, section 4 presents the technical framework and all the empirical results of this study. Finally section 5 concludes.

2 Literature survey

The purpose of this section is to highlight the main aspects of several papers that are devoted to volatility spillovers. As it was mentioned above the spillover effects are externalities of economic activity or processes that affect indirectly the variables under investigation. The ever growing literature indicates the role and the dynamic of the volatility spillover effect in the modern financial markets and makes its examination crucial.

First of all the article by Panopoulou and Pantelidis (2009) investigates the international information transmission between the US and the rest of the G-7 countries (Canada, France, Germany, Italy, Japan, UK) using stock market return data for almost 20 years (1985-2004). Using a split-sample (pre and post 1995 sample) and a volatility impulse response analysis the authors find that the interdependence combined with the increased persistence in the volatility of all markets make volatility shocks perpetuate for a significantly longer period nowadays compared to the pre-1995 era.

Federova and Saleem (2010) analyze three group of countries. First, they look at the linkage between Eastern European equity markets and Russia, second they investigate the relationship among the currency markets of Poland, Hungary, Russia and Czech Republic and finally they examine the interdependence between Eastern European equity and currency markets. For this purpose, the authors employ a bivariate VAR-GARCH-BEKK model using weekly returns from 1995 to 2008. The evidence of this study show a direct linkage between the equity markets (both in volatility and returns), as well as in currency markets. Moreover, it is shown that there are unidirectional volatility spillovers from currency to stock markets.

Choi, Fang and Fu (2009) investigate the volatility spillover between stock market returns and exchange rates in New Zealand (NZ) before and after the 1997 Asian Financial crisis (AFC). For this purpose they employ a multivariate EGARCH model, which takes into account asymmetric or down-market effects, using daily observations from 1990 to 2004. The empirical evidence show that in the full sample the volatility of the NZ stock market spills over to all three exchange rates. Specifically, in the pre-AFC period, there are bidirectional volatility spillovers between the stock market returns and the NZD/USD and the TWI index. However, there are only unidirectional volatility spillovers from the NZD/USD and the TWI index to stock market returns in the post-AFC period.

Another interesting paper, is that by Baillie and Bollerslev (1990) which uses four foreign exchange spot rate series (British pound, West German deutschmark, Swiss franc and Japanese yen), recorded on an hourly basis for a six-month period in 1986. A seasonal GARCH model is developed to describe the time-dependent volatility apparent in the percentage nominal return of each currency. Hourly patterns in volatility are found to be remarkably similar across currencies and appear to be related to the opening and closing of the world's major markets. Moreover, robust LM tests fail to uncover any evidence of misspecification or the presence of volatility spillover effects between the currencies across the markets.

Engle, Ito and Lin (1988) first examined the behavior of the yen/dollar exchange rate using intraday observations from 1985 to 1986 and tested for informational effects from one market to another. Assuming that news has only country specific autocorrelation such as a heat wave, any intra-daily volatility spillovers (meteor showers) become evidence against market dexterity. ARCH models are employed to model heteroskedasticity across intra-daily market segments. Statistical tests lead to the rejection of the heat wave and therefore the market dexterity hypothesis. Using a volatility type of vector auto-regression the authors examined the impact of news in one market on the time path of volatility in other markets.

Moreover, the paper by Beirne, Caporale, Schulze and Spagnolo (2008), models volatility spillovers from mature to emerging stock markets, tests for changes in the transmission mechanism during turbulences in mature markets, and examines the implications for conditional correlations between mature and emerging market returns. Tri-variate GARCH-BEKK models of returns in mature, regional emerging, and local emerging markets are estimated and weekly data is used for 41 emerging market economies (EMEs). Wald tests suggest that mature market volatility affects conditional variances in many emerging markets. Moreover, spillover parameters change during turbulent episodes. In the majority of the EMEs, conditional correlations between local and mature markets increase during these episodes. While conditional variances in local markets rise as well, volatility in mature markets rises more, and this shift is the main factor behind the increase in conditional correlations. With few exceptions, conditional beta coefficients between mature and emerging markets tend to be unchanged or lower during turbulences.

Another interesting paper is that by Hamao, Masulis and Ng (1990) which tests the short-run interdependence of prices and price volatility across three major international stock markets. Daily opening and closing prices of major stock indexes for the Tokyo, London and New York stock markets are examined from 1985 to 1988. The analysis utilizes the ARCH family of statistical models to explore these pricing relationships. Evidence of price volatility spillovers from New York to Tokyo, London to Tokyo and New York to London is observed but no price volatility spillover effects in other directions are found.

Yang and Doong (2004) explore the nature of the mean and volatility transmission mechanism between stock and foreign exchange markets for the G-7 countries. The data set consists of weekly closing exchange rates and stock market indices for the G-7 countries from 1979 to 1999. Empirical evidence supports the asymmetric volatility spillover effect and shows that movements of stock prices will affect future exchange rate movements, but changes in exchange rates have less direct impact on future changes of stock prices. The implication is particularly important to international portfolio managers when devising hedging and diversification strategies for their portfolios.

Morales and O'Donnell (2006) study the volatility linkages between stock returns and exchange rates in a number of East Asian markets (Hong Kong, South Korea, Singapore, Taiwan and Thailand), from 1997 to 2006. Overall, their main results indicate that since the Asian financial crises, there exists significant scope for investors and portfolio managers to diversify their assets between stocks and currencies in these markets. In particular, the lack of volatility spillovers between stock markets and exchange rates, and between exchange rates and stock markets in all countries, except Taiwan in the post crises period indicates that there is scope for investors to diversify their investments and to benefit from potential gains in the long run in this region.

Finally, Antonakakis (2012) examines co-movements and volatility spillovers in the returns of the euro, the British pound, the Swiss franc and the Japanese yen vis-à-vis the US dollar before and after the introduction of the euro. Based on dynamic correlations, variance decompositions, generalized VAR analysis, and a newly introduced spillover index, the results suggest significant co-movements and volatility spillovers across the four exchange returns.

3. Methodology

3.1 The BEKK model

Following the same methodology with Panopoulou and Pantelidis (2009), we estimate a bivariate VAR (1)-GARCH (1, 1) model. First of all, let $Y_t = (y_{1t}, y_{2t})'$ be the vector of returns, where y_{1t} stands for the exchange rate return and y_{2t} stands for the stock market return. We model the conditional mean with the equation below:

$$Yt = C + M * Y_{t-1} + Et$$

where: C = 2x1 vector of constants

M=2x2 coefficient matrix

E= $(e_{1t},e_{2t})'$ vector of zero mean error terms

After that, we consider the following BEKK presentation (where Var (Et│Ft-1) with Ft-1 a σ-field with all available information in time t-1) introduced by Engle and Kroner (1995):

$$Et = H_t^{\frac{1}{2}} * Zt$$

$$Ht = \Omega * \Omega' + A * E_{t-1} * E'_{t-1} * A' + B * H_{t-1} * B'$$

where $\Omega = [\omega_{ij}]$, i,j=1,2, is a 2x2 lower triangular matrix of constants, $A=[a_{ij}]$ and $B=[b_{ij}]$, i,j=1,2 are 2x2 coefficient matrices and $Zt = (z_{1t}, z_{2t})'$ ~iid

The off-diagonal elements of A and B provide evidence of increased interdependence (meteor showers) between the markets, while their diagonal elements capture any persistence (heat waves).

Moreover, it is essential to note that the BEKK model is more convenient to alternative GARCH representations, as it was proved by Engle and Kroner (1995). The unconditional variance of Et, Var(Et) is calculated by $vec[var(Et)]=[I_4-(A*A)'-(B*B)']^{-1}*vec(\Omega'\Omega)$. The conditional variance for each equation for the bivariate GARCH (1,1) can be described as follow:

$$h_{11,t} = \omega_{11}^2 + \alpha_{11}^2 * e_{1t-1}^2 + 2a_{11} * a_{12} * e_{1t-1}e_{2t-1} + a_{12}^2 * e_{2t-1}^2 + b_{11}^2 * h_{11,t-1} + 2b_{11} * b_{12} * h_{12,t-1} + b_{12}^2 h_{22,t-1}$$

$$h_{22,t} = \omega_{21}^2 + \omega_{22}^2 + \alpha_{21}^2 * e_{1,t-1}^2 + 2a_{21} * a_{22} * e_{1,t-1} * e_{2,t-1} + a_{22}^2 e_{2,t-1}^2 + b_{21}^2 * h_{11,t-1} + 2b_{21} * b_{22} * h_{12,t-1} + b_{22}^2 * h_{22,t-1}$$

$$h_{12t} = \omega_{11} * \omega_{21} + \alpha_{11} * \alpha_{21} e_{1,t-1}^2 + (a_{11} * a_{22} + a_{12} * a_{21}) * e_{1,t-1} * e_{2,t-1} + a_{12} * a_{22} * e_{2,t-1}^2 + b_{11} * b_{21} * h_{11,t-1} + (b_{11} * b_{22} + b_{21} * b_{12}) * h_{12,t-1} + b_{12} * b_{22} * h_{22,t-1}$$

Finally the bivariate BEKK is estimated by means of the maximum likelihood method.

3.2 Volatility Impulse Response Functions

The final and crucial step in our study is the estimation of the impulse response fuctions. Following Panopoulou and Pantelidis (2009), we examined each country separately, by constructing the VIRF's using a alternative GARCH representation (Engle and Kroner 1995):

Vech (Ht) = Q + R*vech (E_{t-1}*E'_{t-1}) + P*vech(H_{t-1})

where Q is a 3x1 matrix of constants, while R and P are 3X3 coefficient matrices, vech is the operator that stacks the lower triangular part of square matrix to a vector.

Matrices Q, R and P exhibit the following form:

$$Q = \begin{bmatrix} \omega_{11}^2 \\ \omega_{11} * \omega_{21} \\ \omega_{21}^2 + \omega_{22}^2 \end{bmatrix}$$

$$R = \begin{bmatrix} a_{11}^2 & 2a_{11} * a_{12} & a_{12}^2 \\ a_{11} * a_{21} & a_{11} * a_{22} + a_{12} * a_{21} & a_{22} * a_{12} \\ a_{21}^2 & 2a_{21} * a_{22} & a_{22}^2 \end{bmatrix}$$

$$P = \begin{bmatrix} b_{11}^2 & 2 * b_{11} * b_{12} & b_{12}^2 \\ b_{11} * b_{21} & b_{11} * b_{22} + b_{12} * b_{21} & b_{22} * b_{12} \\ b_{21}^2 & 2b_{21} * b_{22} & b_{22}^2 \end{bmatrix}$$

We assumed that at time t=0 the conditional variance is at an initial state H_0 and an initial shock $Z_0 = (z_{1,0}, z_{2,0})$ occurs. The VIRF, V (Z_0) is defined as follows:

Vt (Z_0) = E [vech(Ht) | Ft-1,Z_0] – E [vech(Ht) | Ft-1]

where, $v_{1,t}$ and $v_{3,t}$ denote the reaction of the conditional variance of the first and second variable to the shock Z_0, that occurred t periods ago.

It is essential to note that the VIRF's depend on the initial volatility H_0. The initial volatility can be either the volatility state the time the shock occurred, or any other date from the sample (Panopoulou and Pantelidis (2009)).

After the examination and the analysis of the VIRF’s we calculated an important element, called the half-life of the shock. Half-life, is the amount of time required for the effect of a shock to fall to half its initial value.

4. Empirical results

Section 4 presents the empirical results and the implication of this study.

4.1 Data

For the current analysis we employ two variables, the exchange rates and the stock market indices of two countries, Canada and Great Britain. The exchange rates are all expressed vis a vis the American dollar (GBP/USD and CAD/USD). For the stock market indices we use FTSE-ENG for England and ITSEC for Canada. The majority of studies use either daily or weekly data in order to examine the relationship of the above two variables and explore the volatility spillover effect. High frequency data in general, represent a significant explanatory power in contrast with monthly or quarterly data that cannot capture the information content of changes in stock prices (indices) and exchange rates. Therefore, weekly data provide us with the possibility to explore the short term dynamic relationships between the above variables, at the time of floating exchange rate regimes and the era of integration of financial markets. So, we use weekly data for all variables. The period of investigation is from January 1990 to December 2013 with a total of 1252 observations.

TABLE 1 DESCRIPTION OF THE VARIABLES	
EXCHANGE RATES	
GBP/USD	Great Britain pound against US dollar
CAD/USD	Canadian dollar against US dollar
STOCK MARKET INDICES	
FTSE ENG	Stock market of Great Britain
ITSEC	Stock market of Canada

Both the exchange rates and the stock market indices are all expressed, in a discrete logarithmical form (Dlog) by the following form:

Dlog (Variable) = 100*log (Variable $_t$ / Variable $_{t-1}$).

4.2 Descriptive statistics

The **first step** was to display the descriptive statistics of the variables used, in order to show and summarize the data. Descriptive statistics are very important because they examine the validity and the accuracy of the sample by using measures of central tendency, such as the mean, the median and the mode, and measures of spread, like standard deviation. Furthermore, the Descriptive statistics table presents the skewness and the kurtosis of the sample which are helpful tools to identify the location and the variability of the data. In particular, skewness is a measure of symmetry, or more precisely, the lack of symmetry, (a distribution, or data set, is symmetric if it looks the same to the left and right of the center point), and kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution. That is, data sets with high kurtosis tend to have a distinct peak near the mean, decline rather rapidly, and have heavy tails. Data sets with low kurtosis tend to have a flat top near the mean rather than a sharp peak.

The tables below summarize the Descriptive statistics of the stock market indices and the exchange rates. Along with the standard statistics, the tables report the Skewnees and Kurtosis coefficients, the Jarque-Berra statistic and the corresponding p-value for the normality hypothesis.

TABLE 2
DESCRIPTIVE STATISTICS (logs of the series)

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Observ.
EXCHANGE RATES										
CAD/USD	-0,2203	-0,2266	0,07112	-0,47551	0,14788	0,101987	1,78237	79,51421	0	1252
GBP/USD	0,49924	0,47844	0,73865	0,328728	0,09265	0,59531	2,52284	85,82771	0	1252
STOCK MARKET INDICES										
FTSE-ENG	8,40867	8,52487	8,84364	7,59599	0,32712	-0,74736	2,36512	137,5768	0	1252
ITSEC-CANADA	8,91132	8,95081	9,61475	8,022208	0,46941	-0,33959	1,81726	97,03876	0	1252

Table 2, shows the descriptive statistics of the 2 stock market indices (FTSE-ENG and ITSEC) and of the two exchange rate pairs (CAD-USD and GBP-USD) in a logarithmical form. The sample does not approach the normal distribution (the normal distribution has skewness zero and kurtosis three). All exchange rate pairs have positive skewness. The kurtosis of all variables is smaller than three, indicating a platykurtic distribution. So, the sample is not normally distributed as indicated by the Jarque – Bera statistics.

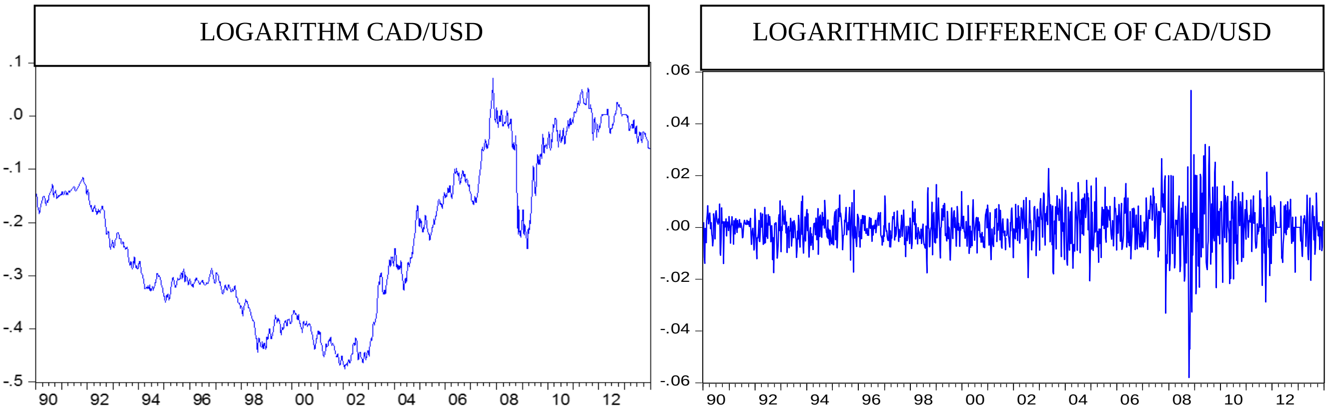
TABLE 3
DESCRIPTIVE STATISTICS (logarithmic difference of the series)

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	bservations
EXCHANGE RATES										
CAD/USD	6,91E-05	0	0,052918	-0,058014	0,008172	-0,334529	8,582099	1647,539	0	1252
GBP/USD	8,58E-06	0,000602	0,03104	-0,078386	0,010485	-0,915955	7,064425	1036,008	0	1252
STOCK MARKET INDICES										
FTSE-ENG	0,000812	0,001892	0,125832	-0,236316	0,023666	-0,828499	13,15387	5517,26	0	1252
ITSEC-CANADA	0,001003	0,002427	0,128168	-0,175418	0,022765	-0,900959	10,24038	2901,797	0	1252

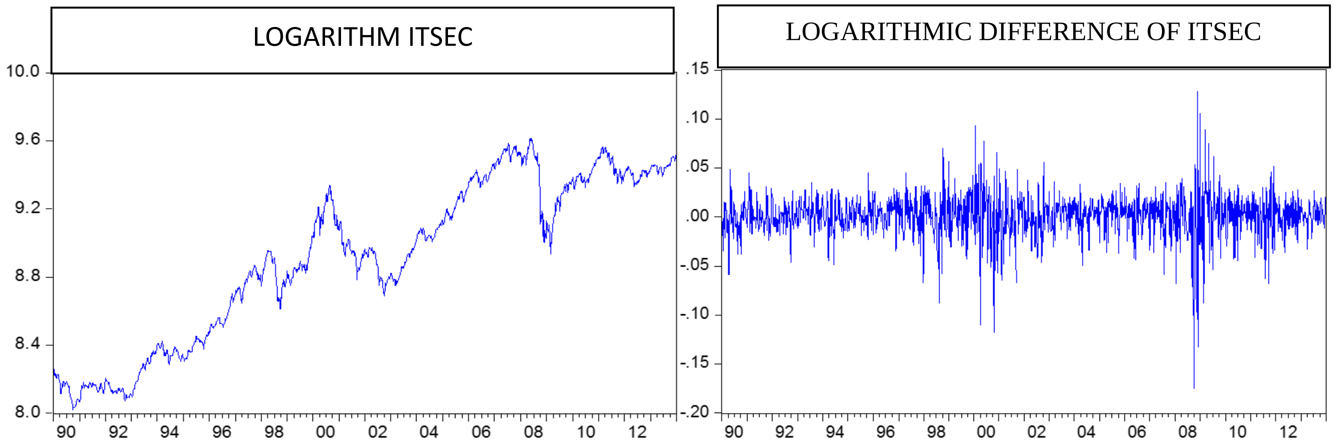
Table 3, shows the descriptive statistics of the 2 stock market indices (FTSE-ENG and ITSEC) and of the two exchange rate pairs (CAD-USD and GBP-USD) for the first logarithmic difference of the series. It is obvious that all four variables have negative skewness. The kurtosis of all variables exceeds by far three, indicating a leptokurtic distribution. So, the sample is not normally distributed as indicated by the Jarque – Bera statistics.

After that we present the graphical representation of our variables. Figure 1 plots the series under scrutiny.

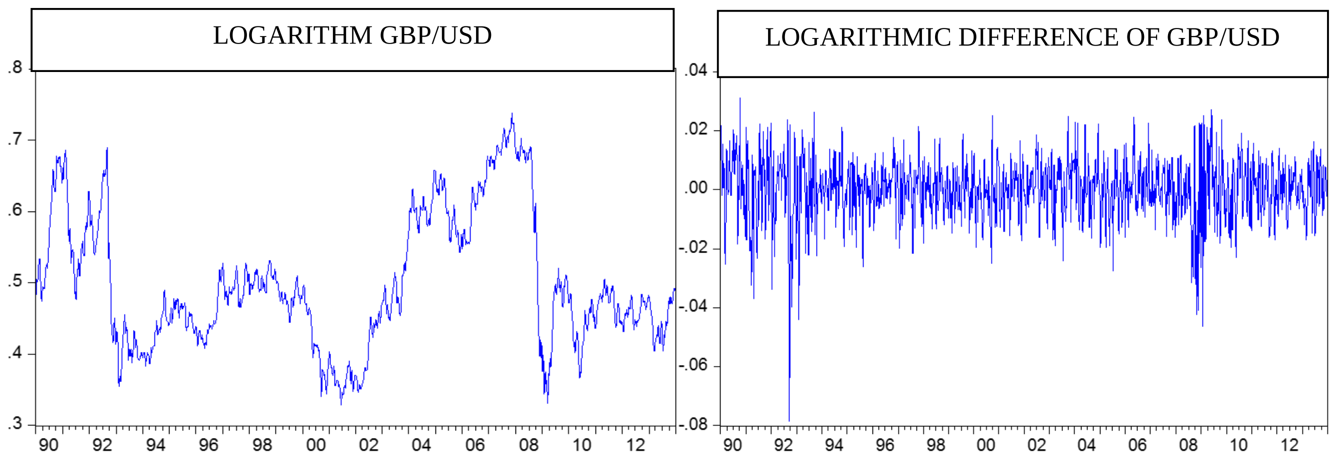
(a) Logarithm CAD/USD – Logarithmic difference of CAD/USD



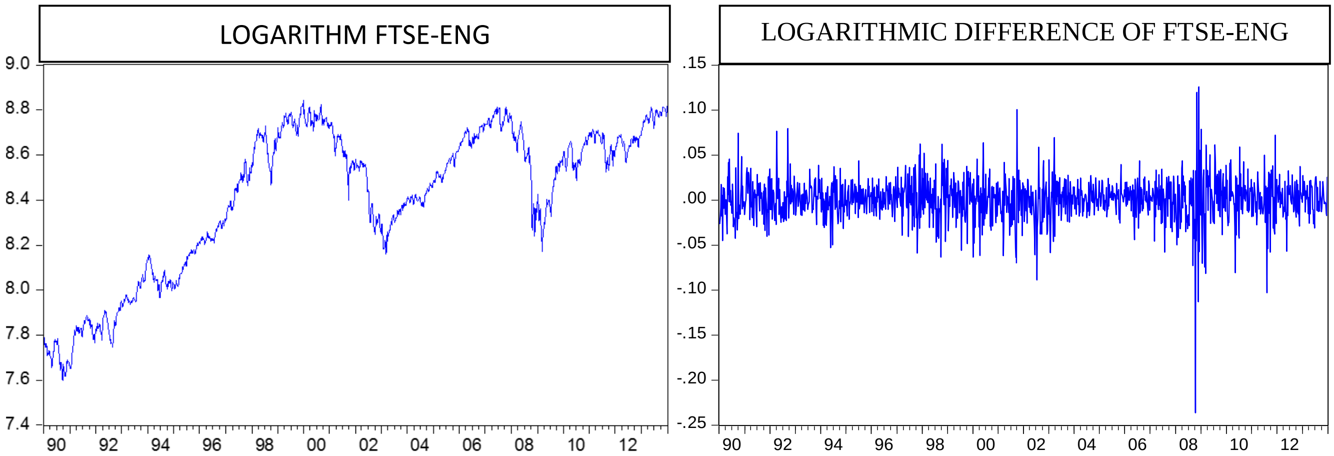
(b) Logarithm ITSEC-CANADA – Logarithmic difference of ITSEC-CANADA



(c) Logarithm CBP/USD – Logarithmic difference of GBP/USD



(d) Logarithm FTSE-ENGLAND – Logarithmic difference of FTSE-ENGLAND



4.3 Unit root tests

The **second step** was the estimation of two unit root tests, the Augmented Dickey Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test in order to decide about the stationarity of the series. All tests are performed with a constant and a trend. ADF tests (Dickey and Fuller 1979) for the null hypothesis that the series has a unit root against the alternative that is stationary, meaning that the rejection of the null indicates that the series are stationary. On the other hand, KPSS tests the null hypothesis of stationarity.

So, as we mentioned above, this subsection presents the results of ADF and both in levels and first difference of the log of the series. The unit root examination is essential in order to proceed to the estimation of our models. An asterisk, a double asterisk and a triple asterisk denote that the null hypothesis is rejected at the 10%, 5% and 1% level, respectively.

TABLE 4
UNIT ROOT TESTS IN LEVELS

	ADF t-statistic	KPSS LM-statistic
EXCHANGE RATES		
CAD/USD	-1,7785	0,87850*
GBP/USD	-2,7157	0,26610**
STOCK MARKET INDICES		
FTSE-ENGLAND	-2,079	0,60400*
ITSEC-CANADA	-2,4392	0,38720**

Note: Both a constant and a trend are included in the specification.

Both ADF and KPSS, reveal that all series are non-stationary. (Table 4)

TABLE 5
UNIT ROOT TESTS IN LOGARTHMIC DIFFERENCE

	ADF t-statistic	KPSS LM-statistic
EXCHANGE RATES		
CAD/USD	-24,923***	0,0922
GBP/USD	-23,053***	0,0359
STOCK MARKET INDICES		
FTSE-ENGLAND	-37,947***	0,0679
ITSEC-CANADA	-23,892***	0.0464

Note: Both a constant and a trend are included in the specification.

Table 5, presents the results of the Augmented Dickey-Fuller and Kwiatkowski-Phillips-Schmidt-Shin tests, for the returns. The results reject the null hypothesis. In the case of ADF test all series are stationary at 1%.

Testing for cointegration is a necessary step before proceeding to the estimation of our model. We employ Johansen's test. This is a test which has all desirable statistical properties. The weakness of the test is that it relies on asymptotic properties, and is therefore sensitive to specification errors in limited samples. In the end some judgement in combination with economic and statistical model building is unavoidable.

TABLE 6

Johansen's Cointegration tests (Canada)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0,002805	4,481848	15,49471	0,8611
At most 1	0,000784	0,978555	3,841466	0,3226

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0,002805	3,503293	14,2646	0,9077
At most 1	0,000784	0,978555	3,841466	0,3226

As mentioned above, it is essential to test for cointegration. The pairs under examination are each country's exchange rate with its corresponding stock market index.

TABLE 7

Johansen's Cointegration tests (Great Britain)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0,005512	9,5617	15,49471	0,316
At most 1	0,002138	2,66873	3,841466	0,1023

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eige Statistic	0.05 Critical Value	Prob.**
None	0,005512	6,89297	14,2646	0,5019
At most 1	0,002138	2,66873	3,841466	0,1023

In general, cointegration is not supported (Tables 6 and 7).

4.4 BEKK estimation

The next step is the estimation of the BEKK model. We report (a) the estimated full model and (b) the final estimated model where all statistically insignificant parameters have been removed.

(a) CAD/USD-ITSEC The initial model

TABLE 8
BEKK estimation of Canada

Variables	Coefficient	Std. Error
c11	-7,48E-05	0,000154
μ11	0,296711	0,024997
μ12	0,059752	0,006887
c21	0,002357	0,000492
μ21	-0,167327	0,067317
μ22	-0,000343	0,029107
ω11	0,000918	0,000201
b11	0,943685	0,010614
b12	0,00495	0,003901
a11	0,311205	0,029796
a12	-0,017666	0,008256
ω21	0,003425	0,000544
ω22	0,000347	0,000978
b21	-0,046884	0,031662
b22	0,950087	0,009202
a21	0,104352	0,083994
a22	0,254048	0,024199
df	9,52802	1,487827

Table 8, shows the estimation of the full model for Canada. After removing sequentially, the coefficients that are statistically insignificant, we end up with the final model.

(b) CAD/USD-ITSEC The final model

TABLE 9
BEKK estimation of Canada

Variables	Coefficient	Std. Error
c11	-0,000123	0,000155
μ11	0,292741	0,024924
μ12	0,059762	0,007031
c21	0,002357	0,00049
μ21	-0,166193	0,066767
μ22	-0,002892	0,029343
ω11	0,000891	0,000197
b11	0,949026	0,009547
a11	0,298722	0,027585
a12	0,000394	0,007095
ω21	0,003435	0,000525
ω22	-3,70E-05	0,000379
b22	0,9495	0,009135
a22	0,261438	0,024118
df	9,619693	1,548841

Table 9, presents the final model of the BEKK estimation for the CAD/USD – ITSEC model.

Now we repeat the same steps for the UK.

(c) GBP/USD-FTSE eng The initial model

TABLE 10
BEKK estimation of Great Britain

Variables	Coefficient	Std. Error
c11	0,000313	0,000233
μ11	0,349264	0,025025
μ12	-0,012565	0,010303
c21	0,001965	0,000515
μ21	-0,097891	0,054297
μ22	-0,08936	0,02844
ω11	0,001617	0,000318
b11	0,95591	0,010387
b12	0,002951	0,004557
a11	0,242802	0,026772
a12	-0,004844	0,010857
ω21	0,003282	0,000621
ω22	-0,001523	0,001047
b21	0,004426	0,023982
b22	0,94937	0,010091
a21	0,042402	0,062637
a22	0,265896	0,02577
df	10,27314	1,241596

Table 10, shows the estimation of the full model. After removing sequentially, the coefficients that are statistically insignificant, we end up with the final model.

(d) GBP/USD-FTSE eng The final model

TABLE 11
BEKK estimation of Great Britain

Variables	Coefficient	Std. Error
c11	0,000283	0,000232
μ11	0,350023	0,025022
μ12	-0,011901	0,010303
c21	0,001994	0,000517
μ21	-0,104555	0,053912
μ22	-0,090129	0,028248
ω11	0,001491	0,000304
b11	0,957569	0,009597
a11	0,245887	0,025867
ω21	0,003516	0,000604
ω22	-0,000538	0,00033
b22	0,950682	0,009616
a22	0,260413	0,024938
df	10,19882	1,212524

Finally Table 11, presents the final model of the BEKK estimation for the GBP/USD – FTSE eng model.

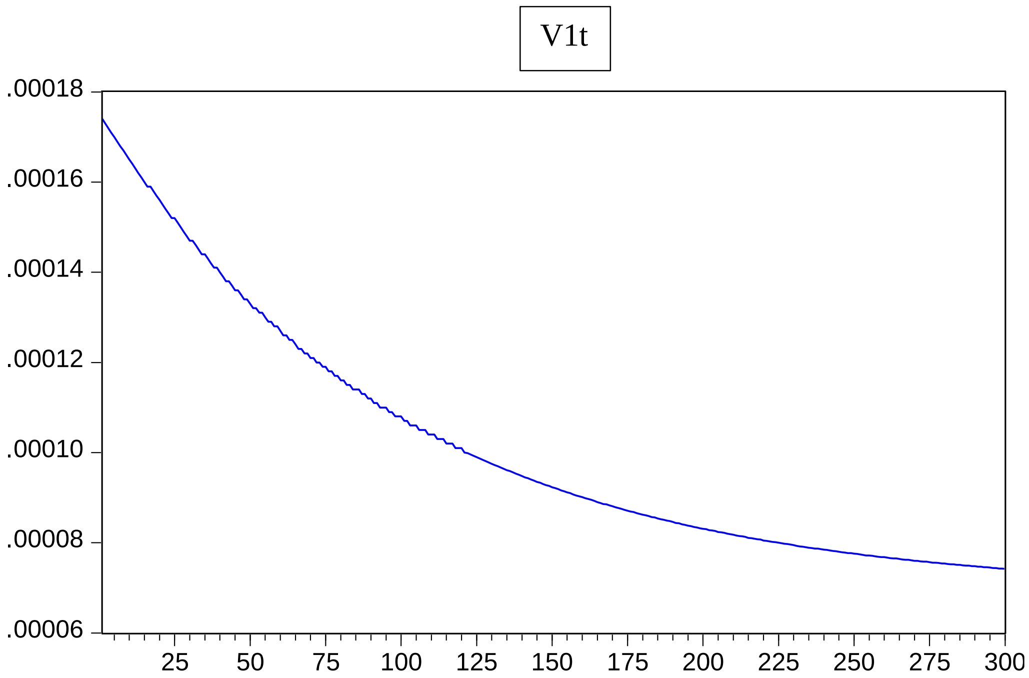
The results show that Great Britain has no volatility spillovers. The final model corresponds to an explosive process. This might be caused by a structural break in the series under examination. Given that this goes beyond the goal of our study, we choose not to calculate the VIRF for the UK and we focus only on Canada.

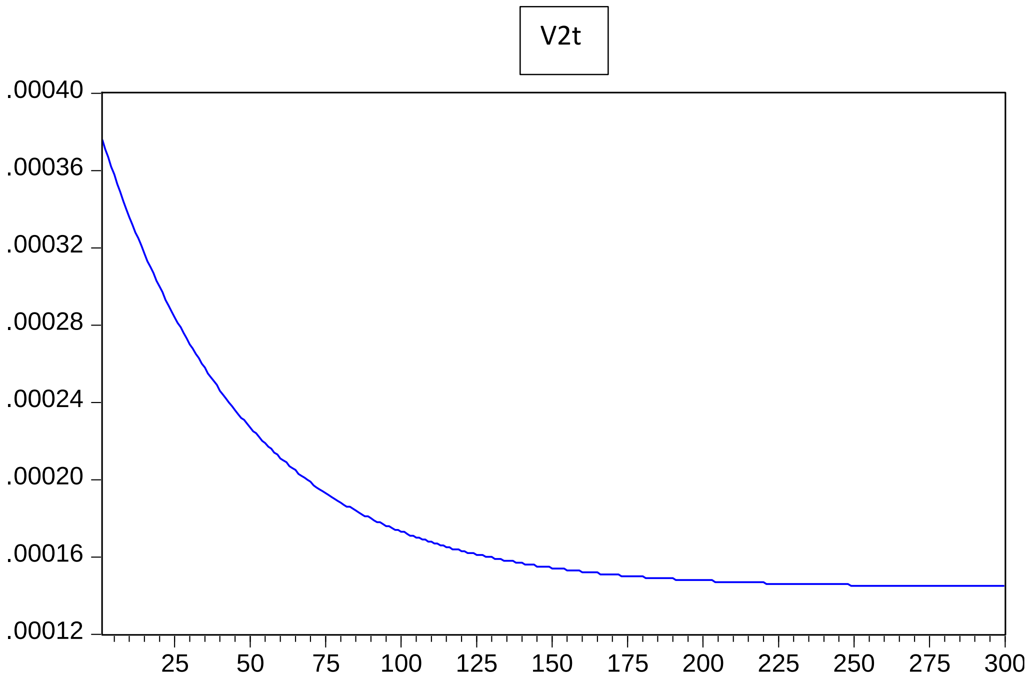
4.5 Estimates of the Volatility Impulse Response Functions (VIRF's)

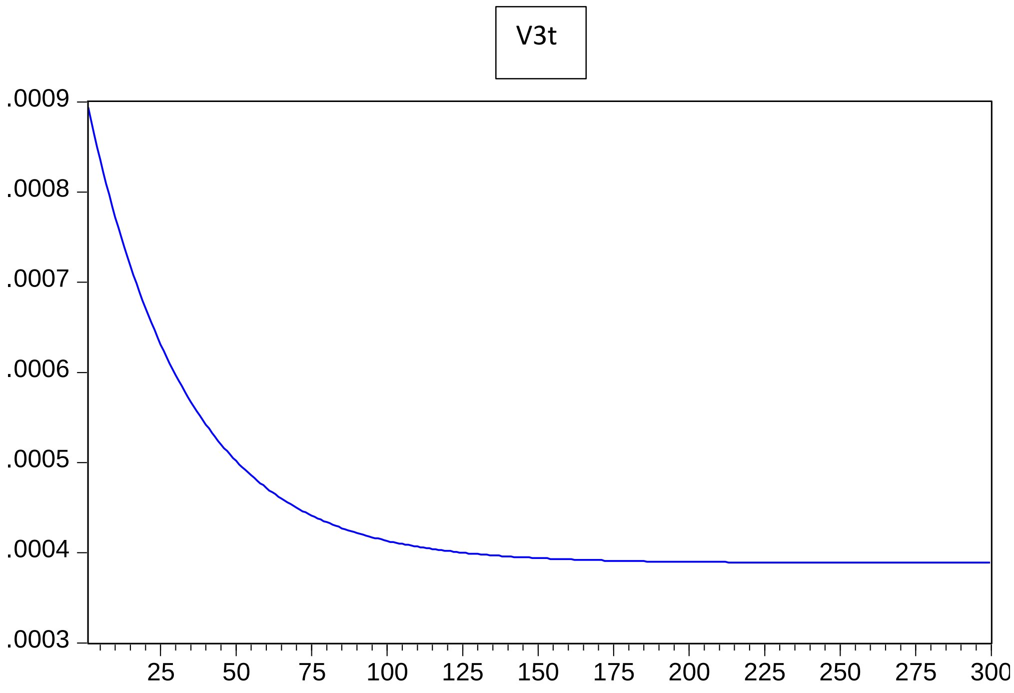
The final step in our study is the calculation of the volatility impulse response fuctions (VIRF's). We try to determine how a shock to one market influences the dynamic adjustment of volatility in other markets along with the persistence of this shock by mean of the VIRF (Panopoulou and Pantelidis (2009)). Rather than taking a set of random shocks we examine one historical shock, the beginning of the financial crisis in 2008. This provides us with the opportunity to examine the insights of a realistic event.

Following Panopoulou and Pantelidis (2009), we first calculate the historical shocks that are by construction the standardized residuals of our series that form an i.i.d sequence. The historical shock selected for the country under investigation (Canada), is 06 October 2008. So we estimated $\dot{E}_t$, and the estimated volatility state, vech($\hat{H}_t$). The initial shock is estimated to be $Z_0 = (\hat{H}_t^{1/2})^{-1} * \dot{E}_t$ = (-1, 9452, -4, 0818)´.

Next we show the graphical representation of the VIRF:


V1t
.00018
.00016
.00014
.00012
.00010
.00008
.00006
25
50
75
100
125
150
175
200
225
250
275
300


V2t
.00040
.00036
.00032
.00028
.00024
.00020
.00016
.00012
25
50
75
100
125
150
175
200
225
250
275
300



The shock's initial values are z (1) =-1.9452 and z (2) =-4.0818.

After the examination of the VIRF's and in order to show a measure of the intensity of volatility persistence we proceed to the estimation of the half-life for Canada. Half life is the time period (in weeks) required for the impact of the shock to reach half its initial value.

TABLE 12
HALF LIFE

	Half life
V1t	172
V2t	80
V3t	71

Table 12 reports the calculated half-lives. It turns out that the persistence of a volatility shock is higher for the forex market compared to the stock market.

5. Conclusions

This study examines the volatility in the stock market and forex. In particular we use a BEKK-GARCH presentation introduced by Engle and Kroner (1995) to estimate the international information transmission between the stock market indices and the currency prices of two of the G-7 countries (Canada and United Kingdom). After that, we proceed to the calculation of the volatility impulse response functions. The VIRF estimation conducted only for one country (Canada) because the final model of Great Britain corresponded to an explosive process, without leaving us the choice of further investigation.

Following the same methodology with the paper by Panopoulou and Pantelidis (2009) we examined the interdependencies between stock market indices and exchange rates, using although a different time period (1990-2013).

Our results do not support the existence of volatility spillovers between the stock and the forex markets. Moreover, the persistence of volatility shocks is much higher in forex markets compared to the stock markets.

References

Choi, V. Fang and T.Y. Fu (2010) “Volatility Spillovers between Stock Market Returns and Exchange Rate Changes: the New Zealand Case”

Daniel FS Choi, Victor Fang and Tian Yong Fu, (2009) "Volatility spillovers between New Zealand Stock Market Returns and Exchange rate Changes before and after the 1997 Asian Financial Crisis" Asian Journal of Finance and Accounting Vol.1, No 2: E5

David A. Dickey and Wayne A. Fuller, (1979) "Distribution of the estimators for Autoregressive Time Series With a unit root" Journal of the American Statistical Association Vol. 74, Issue 366, pp. 427-431

Ekaterini Panopoulou and Theologos Pantelidis, (2009) "Integration at a cost: evidence from volatility impulse response fuctions" Applied Financial Economics Vol 19, pp. 917-933

Elena Fedorova and Kashif Saleem, (2010) "Volatility spillovers between stock and currency markets: evidence from emerging Eastern Europe" Czech Journal of economics and finance Vol. 60, Issue 6

Fang Xu, and Luo Fung, (2002) "Information flows across markets: evidence from China-backed stocks dual-listed in Hong Kong and New York" The Financial Review, Vol. 37, 563-588.

Hong Li, (2007) "International linkages of the Chinese stock exchanges: a multivariate GARCH analysis" Applied Financial Economics, Vol. 17, pp. 285-297

John Beirne, Gugliemo Maria Caporale, Marianne Schulze-Ghattas and Nicola Spagnolo (2008) "Volatility Spillovers and contagion from mature to emerging stock markets" European Central Bank working paper series, No 1113

Lucia Morales and Mary O'Donnell (2006) "Volatility spillovers between stock prices and exchange rates: empiral evidence from six APEC economies" Conference papers School of Accounting and Finance

Nikolaos Antonakakis (2012) "Exchange return co-movements and volatility spillovers before and after the introduction of euro" FIW Working Paper No 80

Richard Baillie and Tim Bollerslev (1990) "Intra-day and inter-market volatility in foreign exchange rates" Review of economic studies Vol. 58, pp. 565- 585

Robert F Engle, Takatoshi Ito and Wen-ling Lin, (1988) "Meteor Showers or heat waves? Heteroskedastic intra-daily volatility in the foreign exchange market" Econometrica, journal of the Econometric society Vol.58, No 3

Robert F Engle and Kenneth F Kroner (1995) "Multivariate simultaneous Generalized ARCH" Econometric Theory Vol. 11, pp. 122-150

Sheng-Yung Yang and Shuh-Chyi Doong (2004) "Price and Volatility Spillovers between Stock Prices and Exchange Rates: Empirical Evidence from the G-7 Countries" International Journal of Business and Economics Vol. 3, No. 2, pp. 139-153

Taufig Choudhry, (2004) "International transmission of stock returns and volatility. Emerging Markets" Finance and Trade, Vol.40, No. 4, pp. 33-52.

Yasushi Hamao,Ronald W. Masulis and Victor Ng (1990) "Correlations in price changes and volatility across International stock markets" The review of Financial Studies, Vol.3, No 2, pp. 281-307

Further Reading

Francis X. Diebold and Kamil Yilmaz (2009) "Measuring financial asset return and volatility spillovers, with application to global equity markets" The Economic Journal Vol. 119, pp. 158–171

Francis X. Diebold and Kamil Yilmaz (2010) "Better to Give than to Receive: Predictive Directional Measurement of Volatility Spillovers" International Journal of Forecasting

Jung-Chang Chen and Ai-Chi Hsu (2002) "Spillover between Exchange rate and Stock Return: Multi-countries analysis National Yunlin University of Science and Technology, Institute of Finance

Kenneth A. Kim and S. Ghon Rhee (1997) "Price limit performance: Evidence from the Tokyo Stock Exchange" The Journal of Finance, Vol. LII, No 2

Lumengo Bonga-Bonga (2013) “Transmission of Volatility Shocks between the Equity and Foreign Exchange Markets in South Africa” The Journal of Applied Business Research Vol. 29, No 5

Mervyn A. King and Sushil Wadhwani (1990) “Transmission of Volatility between Stock Markets” The review of Financial Studies Vol. 3, No 1, pp. 5-33

Vit Bubak, Evzen Kocenda and Filip Zikes, (2010) “Volatility transmission in emerging European foreign exchange markets” CESifo working paper monetary Policy and International Finance, No 3063