The Volatility of Market Returns: A Comparative Study of Emerging versus Mature Markets

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Abstract

This paper will examine the volatility of markets returns, dynamic conditional covariance and dynamic conditional correlation between the equity markets of developed countries (US and UK) and the equity markets of developing countries (Kuwait and United Arab Emirates). A multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) model will be used; Diagonal VEC (DVEC) - MGARCH <Diagonal VEC model originally by, Bollerslev, Engle, and Wooldridge (1988)> to identify the source and magnitude of volatility. The results will show the relation between the global mature market of USA and the UK on the emerging markets of Kuwait (K) and UAE.

Keywords: Stock market volatility, Gulf countries, MGARCH, Emerging markets, Oil

1. Introduction

Stock market volatility has grown rapidly with the general observation that stock markets around the world are becoming strongly interrelated and more interdependent. The interest in stock market volatility has extended beyond developed markets to emerging markets because the emerging markets are now considered an investment alternative to developed markets as reflected by the increasing share of the world's capital markets invested in emerging markets   (see Hartmann and Khambata (1993)).

In addition the emerging markets exhibit greater volatility than developed capital markets. Emerging capital markets also have differing characteristics such as higher average returns, lower correlations than developed markets, and more predictable returns, Bekaert, G. & Harvey, C. (1997).

Each of these characteristics has made the volatility of emerging markets an interesting topic.

Like their Asian counterparts, the six countries in Arabian Gulf Cooperation council (AGCC) have become the latest "emerging markets" in the Middle East. The decision by the AGCC leaders of states to reach a common currency in 2010 has widened the target of integration of AGCC countries. In a short span of five years, the market capitalization of AGCC countries have grown from US$112 billion at the end of 2000 to approximately US$1,061 billion at the end of October 2005. in accordance with the latest figures, the combined stock markets of the AGCC region is larger than the Hong Kong stock exchange and nearly 1/3 the size of the London stock exchange HSBC on 2005, Rao, A. (2008).

2. Literature Review

The stock markets of the GCC countries are relatively new compared to the advanced markets. The oldest regulated market in the Gulf area is the Kuwait stock market, commenced operations in 1983, followed by the Saudi market in 1984, while the UAE market was officially launched in 2000.

The GCC governments desire to integrate their markets into the emerging system of global governance for instance Hanelt, (2002) has observed these countries are also keen to adapt best international practice within the limits imposed by some special cultural behavior of the countries in question.

Ewing, Malik and Ozfidan, (2002), examined the volatility spillovers between the oil and natural gas markets using daily returns data. They found indications of volatility persistence in both markets. They showed that volatility in natural gas returns is more persistent than volatility in oil returns. They also found that current oil volatility depends on past volatility and not so much on specific events or economic news. In contrast, natural gas return volatility reacts more to unanticipated events (e.g. supply interruptions, changes in reserves and stocks, etc.) regardless of which market they originated in.

Assaf, (2003) examined the dynamic interactions among stock market returns of six (GCC) countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates). His empirical findings suggest that there is substantial evidence of interdependence effects among GCC stock markets. He found that the Saudi Arabia market was slow in responding to shocks initiated in other markets and that markets are not completely efficient in responding to regional news, providing an opportunity for portfolio diversification at the regional level.

*Oil price shocks ca*n affect corporate cash flow since oil is an input in production and because oil price changes can influence the demand for output at industry and national levels. Figure 1 shows how are the stock markets in the GCC countries and oil prices are interrelated. It is noticeable from figure 1 that there is a positive relation between stock markets in the GCC countries and international oil prices.

Malik and Hammodeh, S. (2005), examined the spill over effects of volatility in oil prices on equity markets for the US, Saudi Arabia, Kuwait and Bahrain by applying MGARCH models. The findings confirm that in all cases the three Gulf equity markets were affected by the volatility experienced in oil markets. This study also found significant volatility spill over's from the US equity markets to the three Gulf equity markets.

Abu Zarour, B. (2006), applied the Vector Auto-regression model to investigate the relation between oil prices and five stock markets in Gulf Countries during the period between 2001 and 2005. This study found that the response of these markets to shocks in oil prices has increased and became faster during the rise in oil prices, while both the Saudi and Omani markets only have the power to predict oil prices.

Maghyereh, A. & AL-Kandari, A. (2007), found that oil price influences the stock price indices in GCC countries in a nonlinear fashion and they supported the statistical analysis of a nonlinear modeling relationship between oil and the economy, which is consistent with some authors, such as Mork et al. (1994), and Hamilton (2000).

Insert figure 1 about here

In case of the effect of *oil price shocks on* stock market returns for the *advanced countries*, Jones and Kaul (1996), Sadorsky (1999) and Ciner (2001) report a significant negative relationship, while Chen *et al.* (1986) and Huang *et al.* (1996) do not. A negative association between oil price shocks and stock market returns has been reported in several recent papers. Nandha and Faff (2008) find oil prices rises have a detrimental effect on stock returns in all sectors except mining and oil and gas industries. O'Neil *et al.* (2008) found that oil price increases lead to reduced stock returns in the United States, United Kingdom and France, and Park and Ratti (2008) report that oil price shocks have a statistically significant negative impact on real stock returns in the U.S. and 12 European oil importing countries.

Again, Miller, I. & Ratti, R. (2009), analyzed the long-run relationship between the world price of crude oil and international stock markets for six OECD countries over the period from January 1971 to March 2008. They found a negative relationship signifying that as stock market prices increase oil price decreases and *vice a versa,* over the long run.

Haque, Hassan, Maroney & Sackley, (2004), studied volatility, time varying risk premiums and persistence of shocks to volatility in ten Middle Eastern and African emerging stock markets. Their findings indicate that in eight out of the ten markets there was evidence of volatility clustering and the presence of a nonlinear relationship between oil and the economy. In contrast the work by Ewing, Malik and Ozfidan (2002) and Maghyereh and AL-Kandari (2007), found the relationship between oil and stock priced in GCC countries was represented by a linear relationship.

In a study by Bley, J. & Chen, K. (2006), a low correlation was found between GCC market returns and US markets which reveals diversification opportunities for international investors. Co-integration revealed an increase in the number of co-integrating vectors across. This is likely to be the indication of ongoing attempts to coordinate market economies in preparation for an economic union and eventually the introduction of a single currency.

AL-Deehani, T. & Moosa, I. (2006), explored volatility spill over's in three regional Gulf emerging markets (Kuwait, Bahrain & Saudi Arabia) by estimating a SUTSE (Seemingly Unrelated Time Series Equation) model. In their research, volatility in each market is described by volatility in the other two markets and by other variables represented by a time-varying trend, the following findings may be concluded:

- The Kuwait market exerts strong volatility spillover in the other two markets.

- The Saudi market exercises strong spillovers effect on the Kuwait market with no effect on the Bahrain market.

- The Bahrain market has a positive effect on the Kuwait market but not on the Saudi market.

- Volatility in each of these markets can be explained by global effect rather than regional effect only.

Rao, A. (2008), concluded that, emerging markets in AGCC gain more of their volatility persistence from the domestic market. So that, international investors could increased diversification in the AGCC markets and utilize opportunities for high returns due to higher risk-return trade off.

The GCC countries include Saudi Arabia, United Arab Emirates, Bahrain, Kuwait, Oman, and Qatar. Moreover, these countries have rapidly growing stock markets and some markets have experienced a doubling of investors' money from 2001 to 2003, Malik, F. & Hammoudeh, S. (2005), Fig. 1 shows the performance in 2002 at a time when the world's major markets experienced a steep fall.

Insert figure 2 about here

Recently Hammoudeh, S. & Yuan, Y. M., M. (2009), estimated own market volatility, shocks and persistence volatility and volatility spillovers in three equity sectors of four Gulf Cooperation Council (GCC). The conclusion suggested that past own volatility and not past shocks is the stronger force in determining future volatility for the GCC stock markets.

3. The Methodology and Model

3.1 Data

The daily data employed in this study is drawn from the weighted equity market indices of four major markets: namely the United States of America (USA), United Kingdom (UK), United Arab Emirates (UAE) and Kuwait (K). Daily data (*MSCI Barra)* employed for the period between 05/10/2005 to 05/10/2009; was used in the modeling.

All indices are in US dollars and do not include dividends; the indices include small, medium and large cap firms. The return for each market is expressed as a percentage change as in taking the first difference of the logarithm of stock market, $\Delta P_i = LOG(P_{it} / P_{it-1}) \times 100$ where ΔP_i denotes the rate of change of P_{it}.

Table 1 presents the descriptive statistics for each return series for the period between 05/10/2005 to 05/10/2009. Sample mean, medians, maximums, minimums, standard deviations, skewness, kurtosis, the Jarque-Bera statistics and P-value are reported for the daily returns. The mean return for all the markets was negative during the financial crises with higher negative returns for the UAE market (-0.120336) and a slightly lower negative value for the USA (-0.012191). Daily returns show lower negative returns for developed markets than for the emerging markets of Kuwait and UAE.

As illustrated in Table 1 the volatility (measured by standard deviation) for the UAE market is higher than the other three markets. The volatility across the other three markets varies between 1.599539 for Kuwait to 1.837527 for UK.

The distributional properties of the return series appear to be non-normal, since all the markets have negative skewness. The kurtosis in all markets, both developed and emerging, exceeds three, indicating a leptokurtic distribution.

The final statistics in Table 1 is the calculated Jarque-Bera statistics and corresponding $p-value$ used to test the null hypotheses that the daily distributions of returns are normally distributed. With all $p-value$ equal to zero at the six decimal places, we reject the null hypothesis that returns for developed and emerging markets are well approximated by normal distribution.

Insert Table 1 about here

3.2 DVEC- MGARCH Model:

Below we apply the DVEC- MGARCH mode, where the following conditional expected return equation accommodates each market's own returns and the returns of other markets are lagged one period:

$$R_t = \alpha + AR_{t-1} + \varepsilon_t \tag{1}$$

Where R_t is the $n \times 1$ vector of daily return at time t for each market.

ε_t is the innovation for each market at time t with its corresponding $n \times n$ conditional varience-coveriance

matrix, $\sum_t$. The market information available at time $t-1$ is represented by the information set I_{t-1} . The $n \times 1$ vector α represents long-term drift coefficients. The estimate of the elements of the matrix, A, can provide measures of the significance of the own and cross-mean spillovers.

We test for *unit roots* for each series (1st difference of raw data). We test the null hypothesis of an existence of unit-root (non-stationary) against the alternative hypothesis of stationary variables using the Augmented Dickey–Fuller (ADF) statistic, Dickey, D.A., Fuller, W.A., 1981.We employ the Automatic selection of lags based on Schwarz (SIC); appendix (Table A.1) reports the results which shows the all series are stationary.

Insert figure 3 about here

In order to reduce the number of parameters, Bollerslev, Engle, and Wooldridge (1988) have proposed the diagonal VEC model.

Definition (1) *the vec operator for a matrix* $A_{n \times d}$ *stacks the columns of* $A_{n \times d} = [a_1, a_2, \ldots, a_d]$ *sequentially, one upon another, to form a* $nd \times 1$ *vector* a

$$a = vec(A) = \begin{bmatrix} a_1 \\ a_2 \\ . \\ . \\ . \\ a_d \end{bmatrix} \text{, Timm, N. (2002).}$$

Where, $\sum_t = \Omega^* + \sum_{i=1}^{p} A_i^* \otimes (\varepsilon_t - i\varepsilon_{t-i}') + \sum_{j=1}^{q} B_j^* \otimes \sum_{t-j}$,   (2)

Ω^* is an (n,n) positive definite and symmetric matrix (Note 1), A_i^* and B_j^* are (n,n) symmetric matrix, each element of the covariance matrix $(\sigma_{ij,t})$ only depends on the corresponding past elements $\sigma_{ij,t-1}$ and $\varepsilon_{i,t-1}\varepsilon_{j,t-1}$ and $\otimes$ denotes the Hadamard product (Note 2) ,Jondeau, E., Poon, S.-H. & Rockinger, M. (2007).

The specification involves $[n(n+1)/2](p+q+1)$ unknown parameters, so for, $n=2$ time series & $p=q=1 \Rightarrow$ total number of unknown parameter is 9.

Example: In the case of $p=q=1$ and $n=2$, so this model will have 9 parameters.

$$\sum_t = \begin{pmatrix} \widetilde{w}_{11} & \widetilde{w}_{12} \\ \widetilde{w}_{12} & \widetilde{w}_{22} \end{pmatrix}$$
$$+ \begin{pmatrix} \widetilde{a}_{11} & \widetilde{a}_{12} \\ \widetilde{a}_{12} & \widetilde{a}_{22} \end{pmatrix} \otimes \begin{pmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} & \varepsilon_{2,t-1}^2 \end{pmatrix}$$
$$+ \begin{pmatrix} \widetilde{b}_{11} & \widetilde{b}_{12} \\ \widetilde{b}_{12} & \widetilde{b}_{22} \end{pmatrix} \otimes \begin{pmatrix} \sigma_{1,t-1}^2 & \sigma_{12,t-1} \\ \sigma_{12,t-1} & \sigma_{2,t-1}^2 \end{pmatrix}$$

   (3)

Where, $\begin{pmatrix} \widetilde{w}_{11} & \widetilde{w}_{12} \\ \widetilde{w}_{12} & \widetilde{w}_{22} \end{pmatrix}$ is a constant $(n \times n)$ positive definite symmetric matrix.

Where, $\sum_t = \begin{pmatrix} \sigma_{1,t}^2 & \sigma_{12,t} \\ \sigma_{12,t} & \sigma_{2,t}^2 \end{pmatrix}$.

Engle and Kroner (1995) and Kroner and Ng (1998) state that the DVEC systems can be estimated using full information maximum-likelihood method. The log-likelihood function of the joint distribution is the sum of all the log-likelihood functions of the conditional distribution, i.e. the sum of the logs of the multivariate-normal distribution.

Letting L_t be the log-likelihood of observation t, n be the number of stock exchange and L be the joint log likelihood gives. $L = \sum_{t=1} L_t$

$$L_t = \frac{n}{2}\ln(2\pi) - \frac{1}{2}\ln\left|\sum_t\right| - \frac{1}{2}\varepsilon_t' \sum_t^{-1} \varepsilon_t \tag{4}$$

A numerical procedure, e.g. BHHH algorithm, is often used to maximize the log-likelihood function. The maximum-likelihood estimate is then applied to obtain the estimate of unknown parameters. In this study, I choose the first derivative method of Marquardt as the optimization algorithm.

The Marquardt algorithm is the modification of BHHH. The starting values of the parameters in the mean equations and constants in the conditional varience-covarience equations are obtained from their corresponding univariate GARCH models by a two-step estimation approach.

4. Results

We observed that the daily market returns (Figure 3) gives an indication of volatility clustering and Leverage effects. Volatility clustering is a common appearance in financial markets. Large return ($\pm$ sign) are expected to follow large returns, and small returns ($\pm$ sign) to follow small returns. While leverage effects are the case in which asset returns are often observed to be negatively correlated with changes in volatility. Since bad news has a degree of expectations about future volatility that is not replicated for good news counterparts effect which was obvious on the return at the regional markets during the financial crises in the USA markets. Khedhiri, S., & Muhammad, N. (2008)

As in table 2 we found that the correlation coefficients (1st measure of correlation) between the market returns of the USA and UAE (0.269771) is higher than the correlation between the USA and Kuwait (0.115526), while the correlation between USA and UK is the highest (0.351755).

Also it is noticeable that the correlation between the market returns of the UK and the UAE (0.230727) is higher than the correlation between the market returns of the UK and Kuwait (0.118499) respectively.

It is obvious that the Kuwait markets are highly correlated with the UAE markets with correlations of 0.375898 magnitudes. This indicates that GCC Countries have higher correlation in the regional aspect than the global one.

In spite of the previous debate we noticed the persistence of the leverage effect, according to the result achieved as in Figure A.1-appendix of conditional correlation, the relation between the regional markets of (Kuwait & UAE) and the Global markets of (USA & UK) is increased during the financial crises.

The estimated DVEC model for the variance and covariance equations has the form:

$$\sigma_{11,t} = M(1,1) + A1(1,1)*RESID1(-1)^2 + B1(1,1)*GARCH1(-1) \tag{5.1}$$

$$\sigma_{22,t} = M(2,2) + A1(2,2)*RESID2(-1)^2 + B1(2,2)*GARCH2(-1) \tag{5.2}$$

$$\sigma_{33,t} = M(3,3) + A1(3,3)*RESID3(-1)^2 + B1(3,3)*GARCH3(-1) \tag{5.3}$$

$$\sigma_{44,t} = M(4,4) + A1(4,4)*RESID4(-1)^2 + B1(4,4)*GARCH4(-1) \tag{5.4}$$

$$\sigma_{12,t} = M(1,2) + A1(1,2)*RESID1(-1)*RESID2(-1) + B1(1,2)*COV1\_2(-1) \tag{5.5}$$

$$\sigma_{13,t} = M(1,3) + A1(1,3)*RESID1(-1)*RESID3(-1) + B1(1,3)*COV1\_3(-1) \tag{5.6}$$

$$\sigma_{14,t} = M(1,4) + A1(1,4)*RESID1(-1)*RESID4(-1) + B1(1,4)*COV1\_4(-1) \tag{5.7}$$

$$\sigma_{23,t} = M(2,3) + A1(2,3)*RESID2(-1)*RESID3(-1) + B1(2,3)*COV2\_3(-1) \tag{5.8}$$

$$\sigma_{24,t} = M(2,4) + A1(2,4)*RESID2(-1)*RESID4(-1) + B1(2,4)*COV2\_4(-1) \tag{5.9}$$

$$\sigma_{34,t} = M(3,4) + A1(3,4)*RESID3(-1)*RESID4(-1) + B1(3,4)*COV3\_4(-1) \tag{5.10}$$

Where equation (5.1) to (5.4) represent the variance of the markets while the equation between (5.4) to (5.10) represent the co-variance relation between different markets. Those equations are practically presented through Figure 4.

Here M_i matrix is a constant $(n \times n)$ positive definite symmetric matrix, A_i and B_i are (n,n) symmetric matrix each element of the covariance matrix $(\sigma_{ij,t})$ only depends on the corresponding past elements $\sigma_{ij,t-1}$ and $\varepsilon_{i,t-1} \varepsilon_{j,t-1}$.

The value for M, A & B matrices are available on Table A.1 in the appendix while Figure 3 simulates the previous equations (5.1-10) as variance and covariance for the four markets.

It is obvious from the behaviour of conditional covariences (Figure 4) that the correlation between the log returns for UAE and between Kuwait, USA, UK are not constant over the study period. These mean that all the estimated figures of covariences (Figure 4) and variances (Figure A.2-appendix) have significant autocorrelation.

Further more, it has been observed in the multivariate DVEC model estimation that the volatility for the four markets is changing over time (see Figure A.2-appendix). It is noticeable also that the volatility for the emerging markets of Kuwait and UAE are more volatile than the advanced markets of USA and UK over the study period which matches with previous research findings, Bekaert, G. & Harvey, C. (1997) & Rao, A. (2008).

5. Summary and Conclusions

Volatility plays an essential role in controlling and forecasting risks in various financial operations. In the case of univariate return series, volatility is mainly represented in terms of conditional variances or conditional standard deviations. Many statistical models have been used for estimating univariate conditional variance processes. The univariate volatility models have a limitation – they estimate the conditional variance of each series independently of all other series. This is a limitation for two reasons. First, there may be "volatility spillovers" between markets so the univariate model might be misspecified. Second, the covariances between series are of interest, as well as the variances of the individual series themselves, as is often the case in finance, Minović, J. (2009).

An important finding is that conditional co-variances show significant changes over time for all markets. Thus, we conclude that these models overcome the usual concept of the time invariant correlation coefficient. It is also noticeable that the volatility for the emerging markets of Kuwait and UAE are more volatile than the advanced markets of USA and UK over the study period.

The overall result showed that the model perform well statistically.The main findings is that the market daily returns have the indication of volatility clustering and Leverage effects since the relation between the regional markets of (Kuwait & UAE) and the Global markets of (USA & UK) is increased during the financial crises. Also it is noticeable that UAE market is relatively highly correlated with the advanced markets return of UK and USA comparing to Kuwait market which is highly bidirectional correlated to the regional markets in the Gulf area. This indicates that GCC Countries have higher correlation in the regional area than the global one.

Finally we can say that, the emerging markets in the GCC countries are subject to conditions within the Arabian Gulf region, which increases potential benefits for international diversification. Thus, international investors could search for increased diversification amongst the AGCC markets and utilize opportunities for higher returns due to higher risk-return trade off. The caveat when investing in segmented and illiquid markets such as the GCC countries is that one has to bear in mind that both of these limitations can provide significant obstacles to investing in any market not just emerging markets.

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Notes

Note 1. A is symmetric matrix if and only if $A^T = A$ (A Matrix transpose = A)

Note 2. The hadamard product defines the element-wise product of two matrices so we have $\{A \otimes B\} = A_{ij} B_{ij}$

Table 1. Summary statistics of daily returns for four markets

	USA	UK	UAE	K
Mean	-0.012191	-0.015126	-0.120336	-0.028712
Median	0.049850	0.076050	0.000000	0.000000
Maximum	10.79710	11.91230	10.47200	7.110800
Minimum	-9.702300	-10.29920	-16.23480	-10.63530
Std. Dev.	1.643828	1.837527	2.179109	1.599539
Skewness	-0.277612	-0.083752	-1.061726	-1.377084
Kurtosis	11.33196	10.94469	10.37790	12.57599
Jarque-Bera	3027.439	2741.594	2559.084	4310.622
Probability	0.000000	0.000000	0.000000	0.000000
Sum	-12.70262	-15.76178	-125.3899	-29.91795
Sum Sq. Dev.	2812.960	3514.942	4943.205	2663.425
Observations	1042	1042	1042	1042

Table 2. Correlation between markets returns

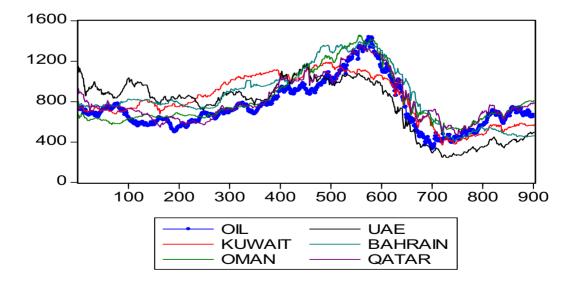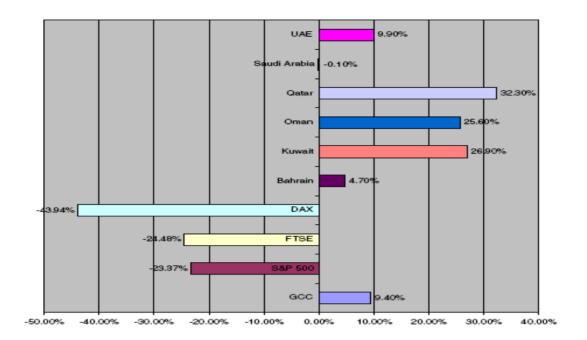|	USA	UK	UAE	K
USA(1)	1.000000	0.351755	0.269771	0.115526
UK(2)	0.351755	1.000000	0.230727	0.118499
UAE(3)	0.269771	0.230727	1.000000	0.375898
K(4)	0.115526	0.118499	0.375898	1.000000

Figure 1. Five GCC Stock Markets & Brent oil prices 21/04/2006 to 5/10/2009

Source: Malik, F., & Hammoudeh, S. (2005).

Figure 2. Comparison of stock market returns GCC and major advanced markets 2002
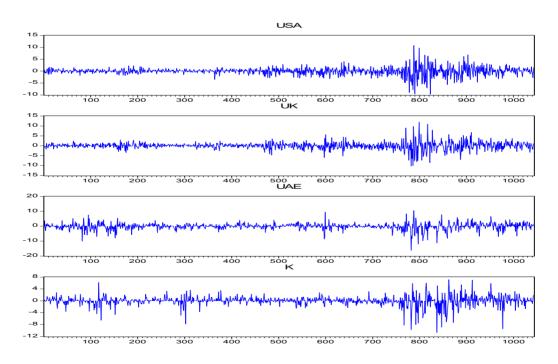

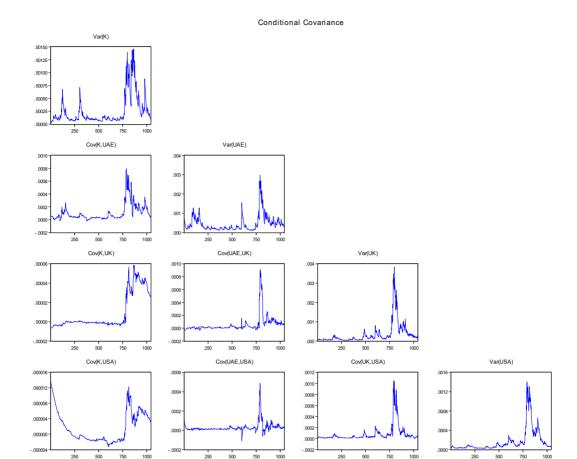Figure 3. Markets daily returns, 05/10/2005 to 5/10/2009

Figure 4. Conditional variance/covariance daily returns USA, UK, UAE & Kuwait. Multivariate DVEC

Table A.1.

Null Hypothesis: ***Unit root*** (individual unit root process)
Date: 03/02/10   Time: 18:45
Sample: 1 1044
Series: USA, UK, UAE, K
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic selection of lags based on SIC: 0 to 1
Total (balanced) observations: 4164
Cross-sections included: 4

Method	Statistic	Prob.**
ADF - Fisher Chi-square	629.332	0.0000
ADF - Choi Z-stat	-24.4159	0.0000

** Probabilities for Fisher tests are computed using an asympotic Chi
   -square distribution. All other tests assume asymptotic
   normality.
Intermediate ADF test results D(UNTITLED)

Series	Prob.	Lag	Max Lag	Obs
D(USA)	0.0000	1	21	1041
D(UK)	0.0000	0	21	1041
D(UAE)	0.0000	0	21	1041
D(K)	0.0000	0	21	1041

Table A.2. Transformed Variance/covariance Coefficients

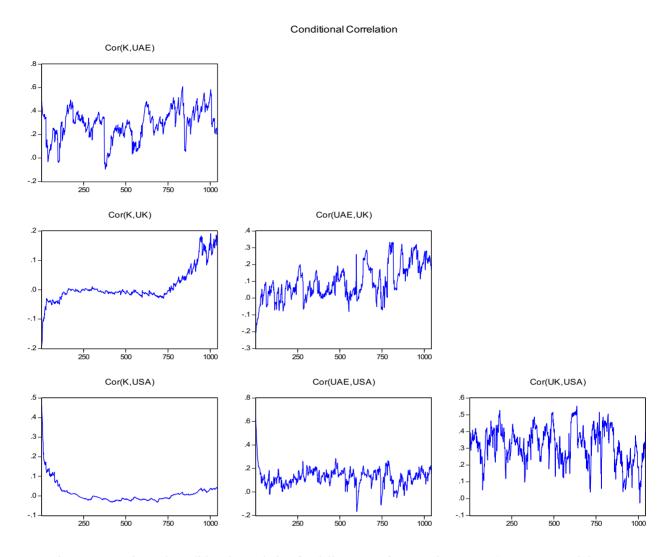|	Coefficient	Std. Error	z-Statistic	Prob.
M(1,1)	2.78E-06	4.05E-07	6.848304	0.0000
M(1,2)	4.21E-06	4.84E-07	8.695926	0.0000
M(1,3)	2.31E-06	3.76E-07	6.134447	0.0000
M(1,4)	1.44E-06	2.55E-07	5.638676	0.0000
M(2,2)	6.39E-06	1.07E-06	5.999575	0.0000
M(2,3)	3.50E-06	5.79E-07	6.042429	0.0000
M(2,4)	2.18E-06	3.95E-07	5.526753	0.0000
M(3,3)	1.92E-06	5.41E-07	3.542573	0.0004
M(3,4)	1.20E-06	2.77E-07	4.309569	0.0000
M(4,4)	7.46E-07	2.36E-07	3.163189	0.0016
A1(1,1)	0.059943	0.005156	11.62483	0.0000
A1(1,2)	0.050518	0.009494	5.320956	0.0000
A1(1,3)	0.000966	0.029538	0.032690	0.9739
A1(1,4)	0.001089	0.025305	0.043050	0.9657
A1(2,2)	0.064320	0.007857	8.186217	0.0000
A1(2,3)	0.042431	0.014725	2.881489	0.0040
A1(2,4)	0.035946	0.014594	2.463162	0.0138
A1(3,3)	0.092137	0.013029	7.071528	0.0000
A1(3,4)	0.058281	0.011651	5.002211	0.0000
A1(4,4)	0.062621	0.239834	0.261103	0.7940
B1(1,1)	0.929538	0.005374	172.9568	0.0000
B1(1,2)	0.885231	0.010869	81.44666	0.0000
B1(1,3)	0.703476	0.159646	4.406480	0.0000
B1(1,4)	0.782447	0.092473	8.461370	0.0000
B1(2,2)	0.921663	0.007414	124.3139	0.0000
B1(2,3)	0.786337	0.057498	13.67594	0.0000
B1(2,4)	0.850085	0.037069	22.93259	0.0000
B1(3,3)	0.903424	0.013105	68.93666	0.0000
B1(3,4)	0.903395	0.015553	58.08643	0.0000
B1(4,4)	0.930722	0.010005	93.02950	0.0000

Figure A.1. Estimated conditional correlation for daily returns for Kuwait, UAE, USA & UK. Applying
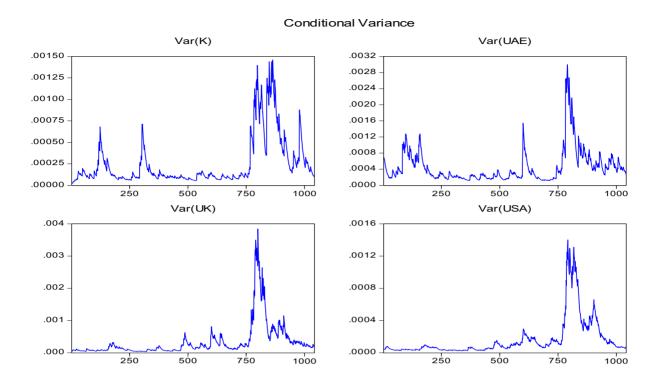
Multivariate DVEC model

Figure A.2. Estimated conditional variance for daily returns for Kuwait, UAE, USA & UK. Applying Multivariate

DVEC model