RAE REVIEW OF APPLIED ECONOMICS
Vol. 7, No. 1-2, (January-December 2011)

VOLATILITY SPILLOVER EFFECTS IN EMERGING MENA STOCK MARKETS

Ahmed S. Abou-Zaid*

Abstract: International stock markets worldwide experienced a downturn in stock prices and activities following the subprime mortgage crisis in the U.S. in mid-2008. This suggests that stock prices volatility do spillover from one market to another. Thus, the purpose of this paper is to investigate the international transmission of daily stock index volatility movements from U.S. and U.K. to selected MENA emerging markets: Egypt, Israel, and Turkey. Employing a multivariate GARCH in Mean technique due to Engle, the study finds that Egypt and Israel are significantly influenced by the U.S. stock market while Turkey is not.

JEL Classifications: G00, G15

Keywords: Volatility Spillover, Stock Prices, MENA

1. INTRODUCTION

Several recent studies have examined how news shocks from one international stock market influence the volatility process of other markets. Accordingly, stock market returns are vulnerable to both rising and falling swings. Empirical work has documented patterns in the vulnerability of countries to volatility and to identify possible channels through which a shock is transmitted. Trade links, regional patterns, and macroeconomic similarities make countries vulnerable to volatility (Dornbusch and Claessens, 2000). Furthermore, loosening capital controls between markets, advancing computer technology, and faster processing of worldwide news have enhanced the volatility process (Booth et al., 1997).

Volatility spillover, also known as contagion, usually results from the normal interdependence among market economies. This interdependence means that shocks, whether of global or local nature, can be transmitted across countries because of their financial linkages. That is, volatility spillover or contagion refers to the spread of market disturbances from one country to another, a process observed through comovements in stock prices, exchange rates, or capital flows (Dornbusch and Claessens, 2000).

Returns in emerging markets are very different from those in developed markets because emerging stock markets are characterized by high volatility. That is, emerging stock markets

* Assistant Professor, Department of Economics, 2375 Coleman Hall, Eastern Illinois University, 600 Lincoln Avenue, Charleston, IL 61920, US; E-mail: asabouzaid@eiu.edu

appear volatile to both downside and upside risks.Dornbusch and Claessens (2000) stated that in the mid-1990s, aggregate private capital flows into five crisis-affected East Asian countries (Indonesia, Korea, Malaysia, the Philippines, and Thailand) averaged more than $40 billion annually, reaching a peak of about $70 billion in 1996. In the second half of 1997, more than $100 billion in short term bank loans was recalled from these same five countries, as markets and stock markets there collapsed.

Episodes of volatility in international capital markets have occurred before the recent subprime mortgage crisis. Examples are the 1998 Asian financial crisis and the crisis known as the “Tequila Effect” that followed Mexico’s 1994 devaluation and mainly affected Latin American countries. But since the East Asian Crisis, economists have engaged in considerable research to identify and analyze the cause of financial contagion or volatility spillover.

The purpose of this paper is to augment the existing literature of volatility spillover in emerging markets by investigating the international transmission of daily stock index volatility movements from the United States and United Kingdom to the following selected MENA emerging markets: Egypt, Israel, and Turkey[1]. That is, do the U.S. and U.K. stock markets indeed influence MENA emerging stock markets? Are there any markets whose movements are causally prior to those of other markets? And how rapidly is the price movements in one market transmitted to other markets?

This cross-border relationship has become very important to study, notably with increasing global financial integration, with changes in one market leading to spillovers in others both in terms of returns and volatility. This integration was often strengthened through the formation of free trade areas or increasing trade volume among countries. The United States is the largest trading partner for Israel, and the second largest trading partner for Egypt and Turkey. It accounts for 36.7% of Israel’s exports ($11 billion) and 29.2% ($10.9 billion) of Israel’s imports. The U.S. constitutes 28.1% of Egypt’s trade with foreign countries[2]. In December 2004, Egypt, Israel, and the U.S. signed a protocol to set up seven Qualified Industrial Zones (QIZs), where goods would gain free access to U.S. markets provided that 35% of their inputs come from co-operation between Egyptian and Israeli companies. This constitutes an advanced step towards a free trade pact between the U.S. and Egypt. For Turkey as well, the United States is the second largest trading partner after the EU. In 2005, the U.S. accounted for 6.67% ($ 4.9 billion) of Turkey’s total exports and 4.6% ($ 5.3 billion) of total imports. Therefore, ties between the United States and the three MENA countries (Egypt, Israel, and Turkey) are strong.

MENA stock markets have not received significant attention in the literature. However, there is a growing interest among American and European investors in the MENA region. First, “newly launched markets” is usually characterized by high stock returns. Secondly, with increasing global integration, cross borders mergers and acquisitions in emerging markets, which accounted for 55% of Foreign Direct Investment (FDI) during the period 1991 to 2000, have become an important source of growth financing in emerging markets and a source of income for foreign investors. Results from Chari et al. (2002) suggest that the stock market anticipates significant value creation from cross-border transactions that involve emerging-market targets leading to substantial gains for shareholders of both acquirer and target firm. Consequently, Europa Events, an institution based in London interested in stock market returns worldwide, organized a conference in July 2006 to examine the future of the Middle East stock markets, and their ability to attract IPOs.

According to a recent IMF study, MENA stock markets have begun to help finance growth of local companies, which make the stock market an influential contributor to the growth process in MENA countries. As a result, studying volatilities in MENA markets has become very important for both foreign investors looking for high returns and portfolio diversification, and domestic businesses, which have become dependent on the stock market to finance their projects.

2. LITERATURE REVIEW

The relationship between volatility and risk has been one of the main factors underlying the interest in volatility modeling. Thus, a good understanding of the origins and drivers of cross-market correlation and volatility is important for investors, consumers, and policy makers (Baele, 2005).

Careful examination of international stock market movements in recent years suggests that there exists a substantial degree of interdependence among national stock markets. Furthermore, unexpected developments in international stock markets seem to have become important "news" events that influence domestic stock markets (Eun et al., 1998). Following that line, Engle and Ng (1993) examined the impact of news on the volatility of Japan's stock market returns at which they found a significant "news" effect on the volatility of the returns where negative shocks introduce more volatility than do the positive ones. This asymmetric effect is also confirmed by Dornbusch et al. (2000) and DeSantis and Imrohoroglu (1997). Pan and Hsueh (1998) examined the international information transmission among the U.S., Japan, and seven Asian countries. Their results suggest that international markets have become more interdependent.

Other literature in financial economics documents that linkages between returns on different assets appear as simultaneous interdependence or lead-lag relations. The former type of co-movement expresses itself in contemporaneous covariances or correlations and forms the basis for asset pricing and modeling market risk (Bollerslev et al., 1988, De Santis and Gerard, 1997, De Santis and Imrohoroglu, 1997). The lead-lag effect is measured by the cross-autocorrelation function (Boudoukh et al., 1997).

Certain empirical financial studies used volatility to proxy for the risk of an asset (Merton 1980). An example of this approach is the study by Kanas (1998), which reports the transmission of shocks between stocks in Paris, London, and Frankfurt.

Lin et al. (1994), Karolyi and Stulz (1996) and Booth et al. (1997), pointed out the importance of making distinctions in the identification of spillover effects. The innovations which have a potential impact on first or second moments can be categorized into local (idiosyncratic), regional (from a neighboring country) or global (from overseas) news. Furthermore, volatilities may react in an asymmetric manner to such shocks, so that positive and negative shocks can have a different impact. The persistence of the shocks is also an important characteristic of the transmission process, as shocks may be transitory or they may persist for a long time (Scheicher, 2001).

The study of volatility spillover among developed countries, notably the U.S. and other G7 stock markets, such as Canada, the U.K, and Japan, is also a focus of many empirical studies. Hamao et al. (1990) and Bekaret and Wu (2000) investigate volatility spillover of stock market returns in the U.S. and Japan, where they find evidence of direct volatility spillover running mainly from New York's stock market to Tokyo's stock market. That is, there is no evidence of the vice-versa effect. Contrary to the results of most studies, Lin et al. (1994), and McAleer and Veiga (2005) found that both the New York and Tokyo markets experience positive and significant spillovers from the other market. That is, cross-countries' interdependence in returns and volatilities exist. Lin's et al. (1994) results suggest that daytime returns in New York or Tokyo can significantly influence the overnight returns in the other market, while there is no evidence of lagged return spillovers from New York daytime to Tokyo daytime and vice versa.

Booth et al. (1997) examined the transmission of the intraday stock index future volatility movements among the U.S., U.K, and Japan. Using the EV-VAR technique, they found that intraday volatility in the New York stock market (or London market) spills over to the London stock market (or New York market), while volatility in the Tokyo stock market has only location specific autocorrelation so that a volatile day in Tokyo is likely to be followed by another volatile day there. New York and London stock market volatilities thus have no effect on the Tokyo stock market volatility. The same authors used the GARCH technique, by which the results were consistent with EV-VAR results but not for the United States. Karolyi (1995) also used GARCH to model the short run dynamics of returns and volatility for stocks traded in the New York and Toronto stock exchanges. They find that the magnitude and persistence of return innovations that originate in both markets and that transmit to other markets depend importantly on how cross-market dynamics in volatility are modeled. The same technique is also used by Baele (2005), in which he finds that both EU and U.S. shocks' spillover intensity has increased substantially over the 1980s and 1990s due to globalization as well as regional integration.

On the other hand, most of the literature interested in emerging markets studies the transmission of shocks to national stock markets in Asia and Eastern and central Europe. Bala and Premaratne (2003) examined the degree and nature of volatility co-movement between the Singapore stock market with those of Hong Kong, Japan, the UK, and the U.S., using GARCH and EGARCH techniques. They found that the Singapore stock market shows a higher leverage effect than exhibited by Hong Kong, Japan, the UK, and the U.S. Shields (1997) compared GARCH specifications for returns from the Warsaw and Budapest stock exchanges and Scheicher (1999) analyzed volatilities and jumps in Polish stock returns. Scheicher (2001) studied the regional and global integration of stock markets in Hungary, Poland, and the Czech Republic. He applied a VAR model with multivariate GARCH and he found that the stock markets of Eastern Europe's leading economies are influenced by Western financial markets as well as among each other, notably Hungary and Poland.

Bekaert and Harvey (1997), De Santis and Imrohorglu (1997), and Aggaraval et al. (1999) investigated return volatility in Asian, Mediterranean, and Latin American markets. The first study explores the forces that determine why volatility is different in various emerging markets. It finds that more open economies—in terms of world trade—have significantly lower volatilities. Moreover, their results suggest that volatility is strongly influenced by world factors in fully integrated markets, while it is more likely influenced by local factors in segmented capital markets. Aggaraval et al. (1999) found that periods of high volatility in these emerging markets are associated with important events in each country rather than global events. Bekaert and Harvey's (1997) and De Santis and Imrohorglu's (1997) studies support the significance of shocks transmitting from one market to another.

3. EVOLUTION OF THE STOCK MARKET IN TURKEY, ISRAEL, AND EGYPT[3]

Fuelled by an increase of capital in recent years, the stock markets of the Middle East have experienced rapid growth. With increased liquidity in the region, and relatively few listed companies and shares available, MENA stock markets have witnessed rapid growth in share prices.

The Istanbul Stock Exchange (ISE) opened in January 1986, but buying and selling securities were restricted for foreigners. In August 1989, ISE took the first step towards integrating into the world market by allowing foreigners to purchase and sell all types of securities. As a result, ISE gained full membership to the World Federation of Exchange in October 1992. Since then, ISE started to extend its working hours to four hours for two sessions in July 1994, to six hours in September 1999, and to six and a half hours in January 2002.

ISE also worked on launching new programs and initiatives in order to develop itself and become more involved in the world market. From January 1995 through mid-1997, ISE launched the regional market, the whole sale market, the real state certificate market, the watch list companies market, and the foreign mutual funds market. In May 1998, the ISE signed a protocol with the Organization of Economic Cooperation and Development (OECD) in order to initiate a three-year Securities Market Development Program, with the aim of providing assistance to the development of the securities markets in the Euro-Asian region and financing projects investing in that field. In June 1999, a Memorandum of Cooperation between the ISE and London Stock Exchange was signed. On April 16, 2007, the International Bonds Market started its operations within the ISE Foreign Securities Market, where listed Turkish Sovereign Eurobonds have been traded.

It is worth mentioning that the market value of the companies traded in the ISE in January 1996 was $938 million. By September 2007, the market value of these companies had reached $243,493 million. The traded value was $13 million during 1996, which averaged to $35,000 a day, while for the first nine months of 2007, the traded value was $199,879 million, which averaged to $1,110 million a day (Istanbul Stock Exchange official website).[2]

On the other hand, local trade in securities in Israel began in the 1930s. Trade was carried out through the Exchange Bureau for Securities, founded by the Anglo-Palestine Bank (which became Bank Leumi Le-Israel) in 1935. With rapid growth of the Israeli economy after the founding of the state, a formal stock exchange was incorporated and began operations in Tel Aviv in 1953.

The Tel Aviv Stock Exchange (TASE) offers four programs under which companies can list on the exchange: three programs for normal operating companies and an additional venture program for development-stage technology companies. In addition, TASE has a program for the listing of Limited Partnership Units. TASE lists some 660 companies, about 60 of which are also listed on stock exchanges in other countries. TASE also lists 60 government bonds, 180 exchange-traded funds, 500 corporate bonds, and more than 1,000 mutual funds. TASE links to the U.S. markets with a direct link to DTC, a subsidiary of the Depository Trust & Clearing Corporation, which facilitates the trading of dually-listed securities. Active involvement of foreign investors in the TASE began in 1994. In 2004, international holdings were 10.0 % of the total market capitalization of the shares and convertible securities tradable on the TASE. They increased to 11.4% in 2005, and 11.6% in 2006. In 2004, the total market value of all listed equity securities was $92.1 billion, compared with $122.6 billion in 2005, and $161.4 billion on December 31, 2006.

As for Egypt's Stock Exchange (CASE), it is comprised of two exchanges, Cairo and Alexandria, both of which are governed by the same board of directors and share the same trading, clearing, and settlement systems. The Alexandria Stock Exchange was officially established in 1888, with Cairo following in 1903. Both exchanges were very active in the 1940s, and the combined Egyptian Stock Exchange ranked fifth in the world. The central planning and socialist policies adopted in the mid-1950s led to the Stock Exchange's dormancy between 1961 and 1992. In the 1990s, the Egyptian government's restructuring and economic reform program resulted in the revival of the Egyptian stock market.

By the end of November 1998, there were 833 listed companies on the Egyptian Stock Exchange with a market capitalization of approximately (Egyptian pound) L.E. 71.3 billion ($21 billion) up from 627 companies listed in 1991 with a market capitalization of L.E. 8.8 billion ($2.5 billion).

4. DATA AND DESCRIPTIVE STATISTICS

The price data was obtained using DataStream. The sample period spans from January 2, 1997, through September 25, 2007. Daily returns data is able to capture most of the possible interactions. Using weekly or monthly data may block out interactions that last only a few days.

For the New York Stock Exchange (NYSE), we use the Standard and Poor 500 (S&P 500) Composite Index. This represents 76 percent of the equity capitalization of the NYSE as of midyear 1998, though it currently includes a small number of AMEX and OTC stocks. The S&P 500 is an equity value weighted arithmetic index.

For the London Stock Exchange, we use the Financial Times-Stock Exchange 100 Share (FTSE) Index, which represents 70 percent of the equity capitalization of all United Kingdom equities. This, also, is an equity value weighted arithmetic index.

For Cairo and Alexandria Stock Exchange (CASE), we use the CASE 30 price index which includes the top 30 companies in terms of liquidity and activities. The CASE 30 price index is weighted by market capitalization and adjusted by the free float. Adjusted market capitalization of a listed company is the number of its listed shares multiplied by the closing price of that company multiplied by the percent of freely floated shares.

In the Tel-Aviv Stock Exchange (TASE), we use the Tel-Aviv Stock Exchange 100 (TA-100). The TA-100 Index is one of the TASE's leading indices, published from 1992. The index consists of the 100 stocks with the highest market capitalization that are included in the TA-25 and TA-75 indices.

For the Istanbul Stock Exchange (ISE), we use the Istanbul Stock Exchange National 100 (ISE 100). ISE National-100, which has been calculated since the inception of the ISE, is composed of national market companies except investment trusts. The constituents of the ISE National-100 Index are selected on the basis of pre-determined criteria directed for the companies to be included in the indices. ISE National-100 Index contains the ISE National-50 and ISE National-30 Index companies.

The data used in this study consists of daily stock returns data, which is calculated from the market indexes at the close of the markets for Egypt, Israel, Turkey, the UK, and the U.S. The daily returns r_t data is computed using the following formula:

$$r_{it} = (\ln P_{it} - \ln P_{it-1}) *100^4 \tag{1}$$

where P_t and P_{t-1} are the closing prices in market i at time t and t-1. This paper adopts the following measure of volatility, at which the true volatility in closing returns is:

$$V_t = E_{t-1} [(r_{it} - E_{t-1}(r_{it}))^2] \tag{2}$$

Or more generally;

$$V_t = E_{t-1} [(r_{it} - E_{t-1}(r_{it})) (r_{jt} - E_{t-1}(r_{jt}))] \tag{3}$$

Table 1 provides some statistical properties of daily market returns for the five countries.

Table 1
Descriptive Statistics for Daily Market Returns: 97-07

	Egypt	Israel	Turkey	USA	UK
Mean	-0.1051	-0.0006	0.1637	-0.0002	-0.0001
Median	-0.0672	-0.0003	0.0000	-0.0005	-0.0004
Maximum	29.029	0.1038	17.456	0.0711	0.0558
Minimum	-27.110	-0.0769	-19.597	-0.0557	-0.0590
Std. Dev.	1.3239	0.0143	3.0538	0.0114	0.0115
Skewness	1.1083	0.3803	0.1191	0.0838	0.1500
Kurtosis	207.46	6.9191	7.3019	6.1229	5.2942
Jarque-Bera	3494743	1384	2064.4	1048.9	576.38
Probability	0.00	0.00	0.00	0.00	0.00

Turkey exhibits the highest standard deviation followed by Egypt, Israel, the UK, and the U.S. All five countries have distributions with positive excess kurtosis. If kurtosis exceeds 3, the distribution is said to be leptokurtic relative to normal. This implies that the distribution of the stock returns in these countries tends to contain extreme values. The Jarque-Bera test rejects the normality of returns for all five countries.

Turkey's stock market shows the most extreme values of daily market returns compared to the rest. Turkey exhibits the highest mean returns of 0.16. The other four markets show negative mean returns. On the other hand, the range between the maximum and minimum returns for the Egyptian market (29.02 to -27.11) is the highest followed by Turkey, while this difference in the U.S. and UK stock markets is minimal. This implies that Egypt's and Turkey's stock markets undergo large fluctuations compared to others markets. This is not surprising considering smallness and openness of the stock market and vulnerability to global shocks.

Figures 1 through 5 show a plot of stock price indices and figures 6 through 10 show a plot of returns for Egypt, Israel, Turkey, the U.S., and UK.

The movement of U.S. and UK stock price indices shows similar trends and patterns while that of Egypt and Israel are partially similar. Turkey's stock price index exhibits an upward trend. All indices consistently show a dip in mid-2001. The five markets also show a dip in late 2002 and early 2003.

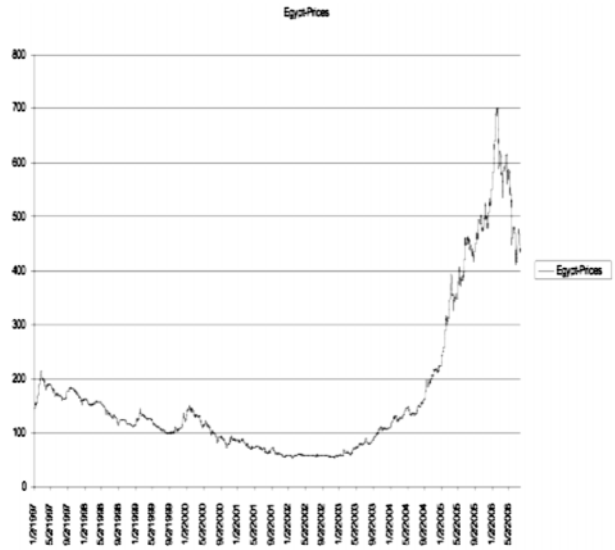

Figure 1: Plot of Stock Price Index for Egypt

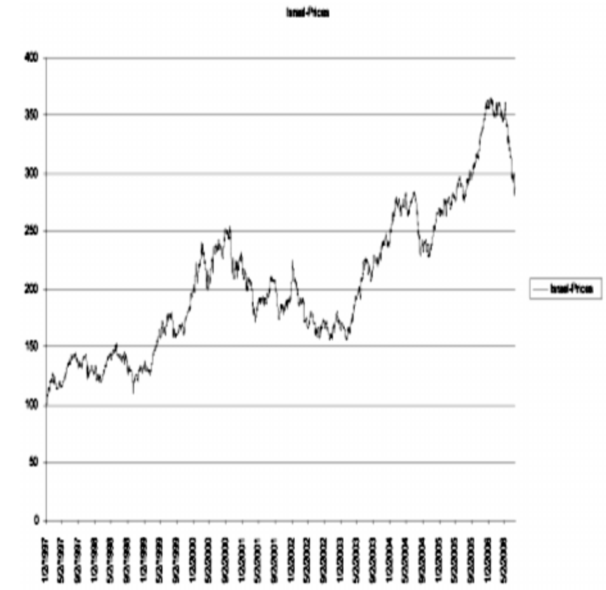

Figure 2: Plot of Stock Price Index for Israel

Figure 3: Plot of Stock Price Index for Turkey

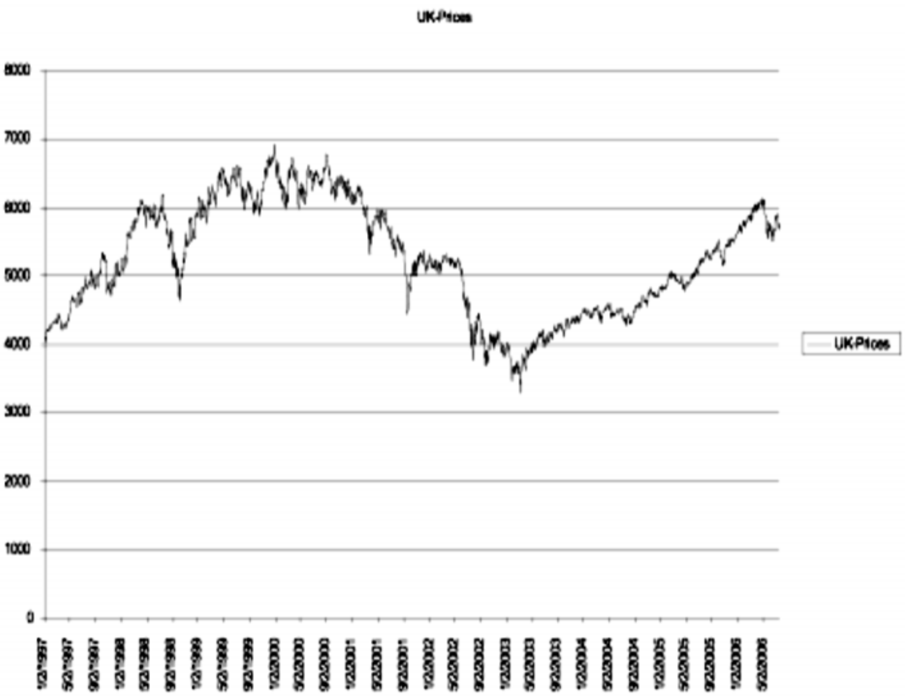

Figure 4: Plot of Stock Price Index for the U.K.

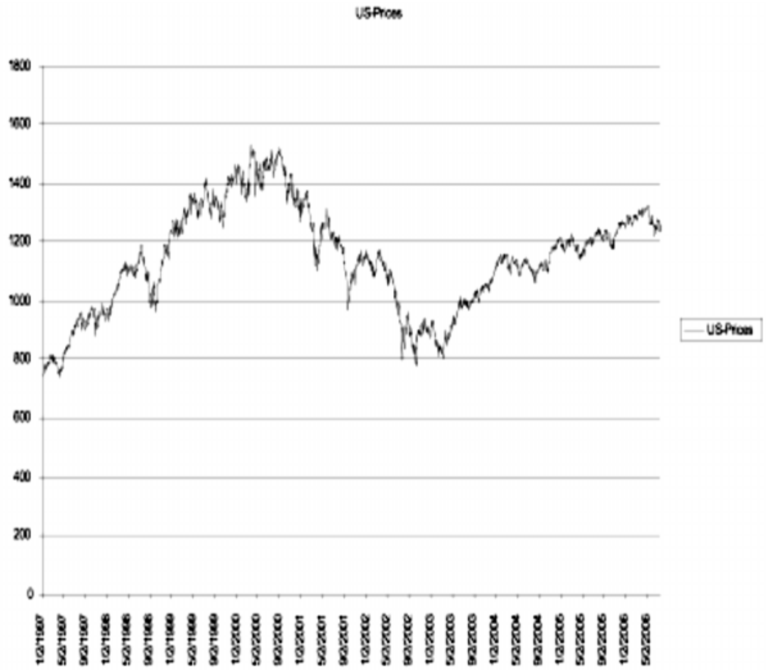

Figure 5: Plot of Stock Price Index for the U.S.

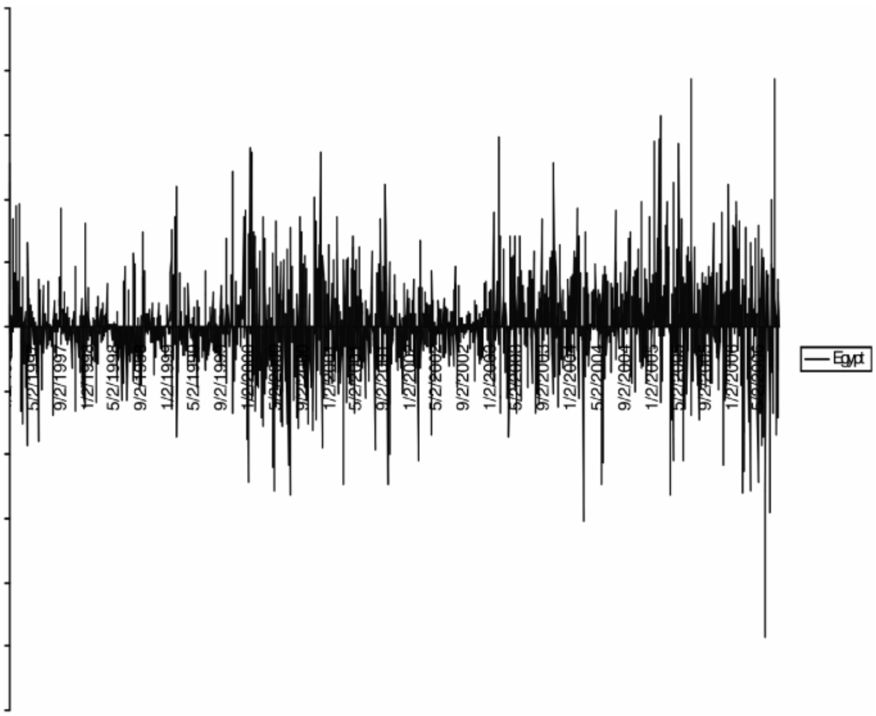

Figure 6: Plot of Returns for Egypt

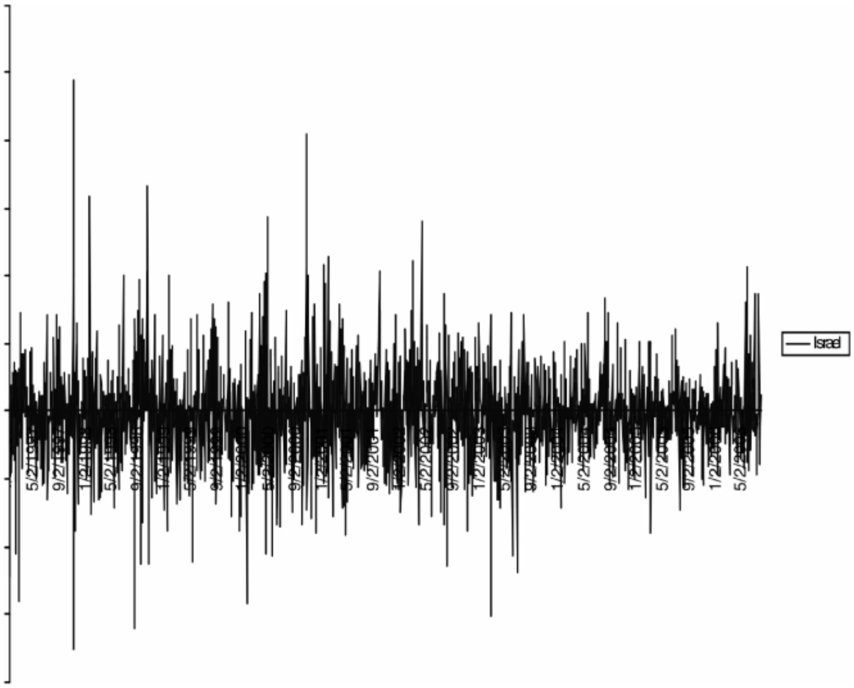

Figure 7: Plot of returns for Israel

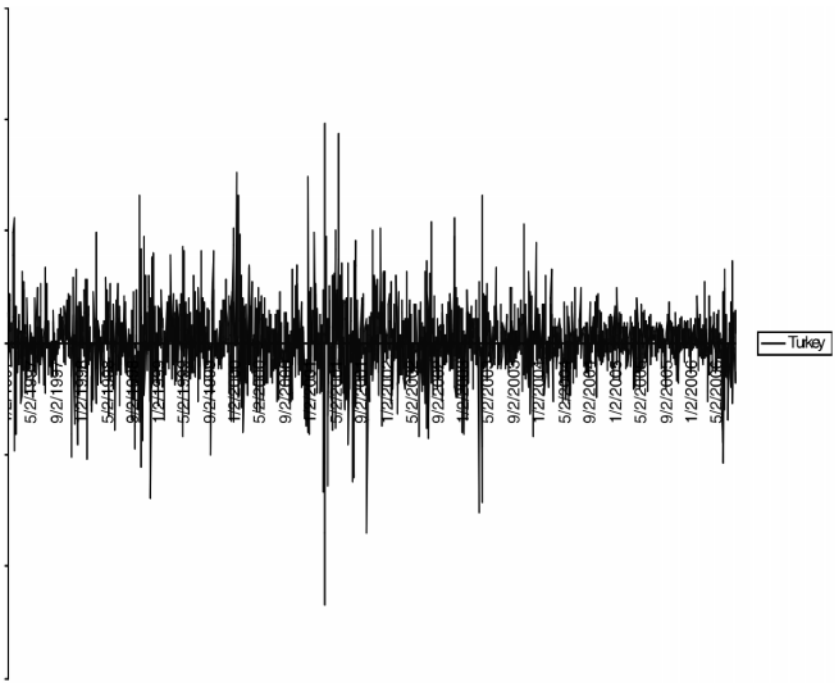

Figure 8: Plot of returns for Turkey

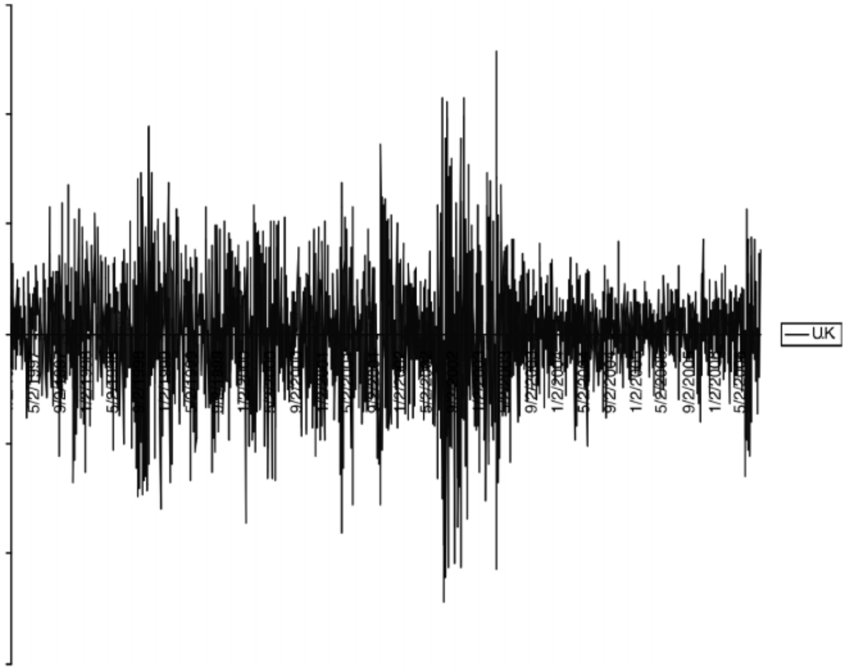

Figure 9: Plot of returns for the U.K.

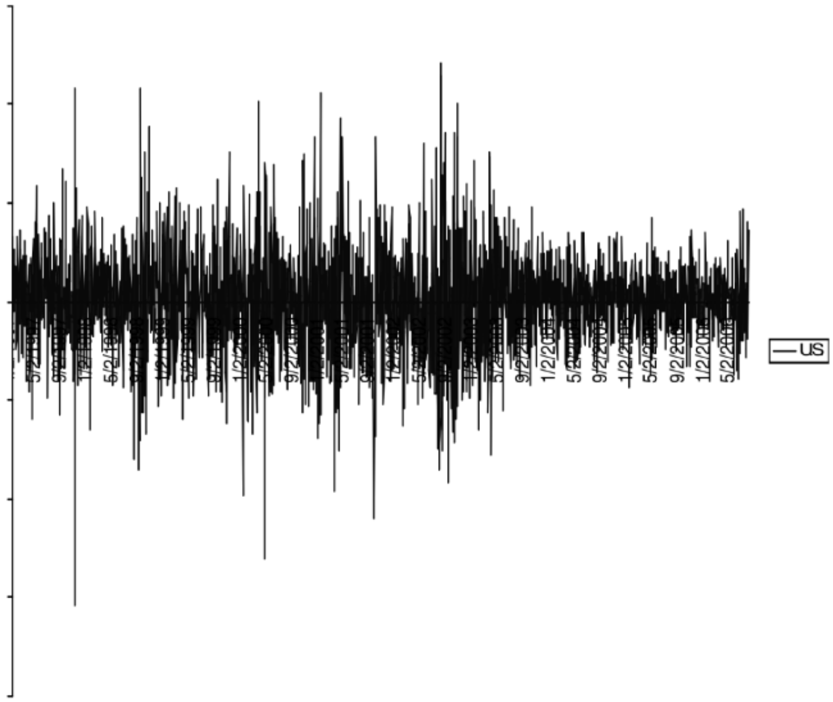

Figure 10: Plot of returns for the U.S.

The plot for returns shows regular trends for all markets, where upward and downward swings are significant, but not for Egypt. Egypt's stock market returns show a significant swing in late 1997 and a slow movement afterwards.

5. THE METHODOLOGY

The methodology in this paper is based on the ARCH family of models introduced by Engle (1982). Engle's insight was to set the conditional values of a series of errors, ξ_t's, as a function of lagged errors, time (t), parameters f, and predetermined variables x: (Bala and Premaratne, 2002)

$$h^2_t = h^2(\xi_{t-1}, \xi_{t-2}, \ldots, t, f, x_t) \tag{4}$$

$$\xi_t = h_t v_t \tag{5}$$

where v_t ~ i.i.d with zero mean and unit variance. By definition, ξ_t is serially uncorrelated and has zero mean. However, the conditional variance of ξ_t conditioned on all available information at time t-1 is:

$$h^2_t = \delta + \Sigma^n_{j=1} \delta_i \xi^2_{t-1} \tag{6}$$

where δ and δ_i's are nonnegative constants (in order for h^2_t to be nonnegative).

In this paper, the extended ARCH model by Bollerslev, Engle, and Wooldridge (1988) known as GARCH in Mean (GARCH-M) will be used. Unlike ARCH models, GARCH models allow past conditional variance to affect current conditional variance. The GARCH-M is a weighted average of the past squares residuals just like ARCH, but it has declining weights that never completely reach zero. According to Engle (2001), the most widely used GARCH specification asserts that the best predictor of the variance in the next period is a weighted average of the long-run average variance, the variance predicted for this period, and the new information in this period that is captured by the most recent squared residual.

GARCH models have some important limitations reported first by Nelson (1991). First, the choice of a quadratic form for the conditional variance has important consequences as far as the time paths of the solution processes are concerned. Typically, the time paths are characterized by periods of high volatility (corresponding to high past values of the error, of any sign) and other periods where it is low. The impact of past values of the innovation on the current volatility is only a function of their magnitude. However, this feature is generally not true in the financial context. Typically, volatility tends to be higher after a decrease than after an equal increase. Several authors have pointed out this asymmetry (Nelson, 1991 and Schwert, 1989), which seems to be another characteristic feature of financial time series. Obviously, the choice of a symmetric (quadratic) form for the conditional variance prevents the modeling of such phenomena.

Another drawback of GARCH models comes from the parameters of non-negativity. As noted by Nelson and Cao (1991), these assumptions are only sufficient and may be weakened in certain cases. However, the models remain highly constrained as the variance must be kept non-negative. This is important because these constraints may be the source of important difficulties in running the estimation procedures. In empirical work it seems difficult to consider a large number of lags p and q. Furthermore, these constraints constitute a serious limitation to the generality of the time paths of the (ξ_t) and (h_t) processes. More precisely, a shock in the past (such as ξ_{t-k}), regardless of its sign, always has a positive effect on the current volatility: the impact increases with the magnitude of the shock. This feature makes the model incapable of taking into account cyclical or any non-linear behavior in the volatility.

However, ARCH models of the same family i.e. GARCH, GARCH-M, etc… are still the best techniques that allow us to model volatility as well as to investigate the spillover effects across different countries.

First, we fit a univariate GARCH (1,1) as a baseline model where;

$$r_{it} = \alpha_1 + \beta_{i1} r_{i,t-1} + \xi_{it} \tag{7}$$

$$h^2_{it} = \delta_{io} + \delta_{i1} \xi^2_{i,t-1} + \delta_{i2} h^2_{i,t-1} \tag{8}$$

where i = Egypt, Israel, and Turkey.

h^2_{it} is a function of lagged values of ξ^2_i and lagged values of h^2_i.

This model will be estimated separately[5] for each of the emerging market countries in order to investigate the effect of domestic shocks on the current returns.

In order to capture the co-movement volatility between developed countries' markets (represented by the U.S. and UK) and emerging MENA markets (Egypt, Israel, and Turkey), we estimate using the multivariate GARCH model. Modeling the volatility of the three markets simultaneously (the U.S., UK, and one emerging market) has several advantages over the univariate approach. First, a multivariate approach eliminates the two-step procedure, thereby avoiding problems associated with estimated regressors. Second, it improves the efficiency and power of the tests for cross market comovement and spillovers. Third, it is methodologically consistent with the notion that volatility spillovers are manifestations of the impact of global shocks on any given market (Bala and Premaratne, 2002). Most importantly to this paper, multivariate models have the advantage that the changes in a stock index (returns) or changes in a price can be modeled to include interactions of this change with all possible variances and covariances. The changes in stock prices in MENA markets are likely to be influenced by large stock markets abroad such as the U.S.'s and UK's. Similarly, changes in stock prices (returns) influence market capitalization and provide future potential growth. Thus, it is important to take into account the interactions among stock prices and volatility stemming from own price movements as well as from the volatility in other markets. These interactions can be summarized in the following conditional mean equations (Hammoudeh et al., 2004):

$$r_{us,t} = a_{10} + a_{11} r_{us,t-1} + a_{12} h_{us,t} + a_{13} \operatorname{cov}(r_{us,t}, r_{uk,t}) + a_{14} \operatorname{cov}(r_{us,t}, r_{mena,t}) + \varepsilon_{us,t} \tag{9}$$

$$r_{uk,t} = b_{10} + b_{11} r_{uk,t-1} + b_{12} h_{uk,t} + b_{13} \operatorname{cov}(r_{uk,t}, r_{us,t}) + b_{14} \operatorname{cov}(r_{uk,t}, r_{mena,t}) + \varepsilon_{uk,t} \tag{10}$$

$$r_{mena,t} = c_{10} + c_{11} r_{mena,t-1} + c_{12} h_{mena,t} + c_{13} \operatorname{cov}(r_{us,t}, r_{mena,t}) + c_{14} \operatorname{cov}(r_{uk,t}, r_{mena,t}) + \varepsilon_{mena,t} \tag{11}$$

where $r_{us,t}$, $r_{uk,t}$, and $r_{mena,t}$ are the daily returns of stock prices In New York, London, and the corresponding MENA country i.e. Egypt, Israel, and Turkey. [H_t] is the 3x3 variance-covariance matrix, and $[\xi_t]$ is the vector of error terms from estimating $r_{us,t}$, $r_{uk,t,}$ and $r_{mena,t}$. The above formulation will allow for both domestic as well as global shocks to have an effect on returns.

To implement the model empirically, it is important to specify the dynamics of conditional variance and covariance. Extending the standard (univariate) GARCH-M model, Bollerslev et al. (1988) propose a multivariate GARCH-M specification that allows the covariance terms to influence the domestic return process. For the three-dimensional case (trivariate GARCH-M process), the conditional variance-covariance specification can be expressed as[6]

$$Vec[H_t]=\begin{pmatrix} h_{us,t} \\ h_{uk,t} \\ h_{mena,t} \\ \operatorname{cov}(r_{us,t},r_{uk,t}) \\ \operatorname{cov}(r_{us,t},r_{mena,t}) \\ \operatorname{cov}(r_{uk,t},r_{mena,t}) \end{pmatrix} = \begin{pmatrix} \phi_{us} \\ \phi_{uk} \\ \phi_{mena} \\ \phi_{us,uk} \\ \phi_{us,mena} \\ \phi_{uk,mena} \end{pmatrix} + \begin{pmatrix} \alpha_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & \alpha_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & \alpha_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & \alpha_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & \alpha_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & \alpha_{66} \end{pmatrix} \begin{pmatrix} (\varepsilon_{us,t-1})^2 \\ (\varepsilon_{uk,t-2})^2 \\ (\varepsilon_{mena,t-1})^2 \\ (\varepsilon_{us,t-1}\varepsilon_{uk,t-1}) \\ (\varepsilon_{us,t-1}\varepsilon_{mena,t-1}) \\ (\varepsilon_{uk,t-1}\varepsilon_{mena,t-1}) \end{pmatrix}$$

$$+\begin{pmatrix} \gamma_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & \gamma_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & \gamma_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & \gamma_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & \gamma_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & \gamma_{66} \end{pmatrix} \begin{pmatrix} h_{us,t-1} \\ h_{uk,t-1} \\ h_{mena,t-1} \\ \operatorname{cov}(r_{us,t-1},r_{uk,t-1}) \\ \operatorname{cov}(r_{us,t-1},r_{mena,t-1}) \\ \operatorname{cov}(r_{uk,t-1},r_{mena,t-1}) \end{pmatrix} + \begin{pmatrix} v_{us,t} \\ v_{uk,t} \\ v_{mena,t} \\ v_{us,uk,t} \\ v_{us,mena,t} \\ v_{uk,mena,t} \end{pmatrix} \qquad (12)$$

where Vec(·) is the vector operator that stacks the columns of the matrix $[H_t]$; and $[\varphi]$, $[\alpha]$, and $[\gamma]$ are diagonal coefficient matrices.

With reference to the previous two equations, the analysis will be modeled as GARCH (1, 1), which is very common in the financial economics literature. According to French's et al. (1987) results, modeling using GARCH of a higher order i.e. GARCH (2, 1) does not yield different significant results from GARCH (1,1).

According to Chancharoenchai and Dibooglu (2006), the tri-variate conditional variance-covariance specification of Equation 12 allows the conditional variances to depend only on past squared residuals, and covariances to depend on past products of error terms. The important cross-market effects, highlighted by Hamao et al. (1990) for the national stock markets of the United States, United Kingdom, and Japan, are not sufficiently included in the Bollerslev et al. (1988) tri-variate GARCH-M model. Even though a more general process could be specified to capture cross-market spillover effects, positive semi-definiteness of the conditional covariance matrix in that process is not assured. To reflect more general dynamics in Model 12, the $[\alpha]$ and $[\gamma]$ matrices would have to include nonzero, off-diagonal elements. The conditional variance–

covariance specification is, therefore, re-specified into Equation 13, as originally proposed by Baba et al. (1989), and denoted as BEKK below:

$$[H_t] = [P]^{'}[P] + [F]^{'}[H_{t-1}][F] + [G]^{'}[\varepsilon_{t-1}][\varepsilon_{t-1}]^{'}[G] \tag{13}$$

where $[H_t]$ denotes the 3.3 variance-covariance matrix conditional on information at time t, and $[\varepsilon_{t-1}]$ denotes the vector of disturbances from Equations 9, 10, and 12. The term [P] is an upper triangular matrix of three coefficients, whereas [F] and [G] are free (square) matrices of coefficients with nine parameters for each. Unlike full parameterization, this approach economizes the number of parameters in Equation 12, and guarantees that the covariance matrices are positive definite.

6. EMPIRICAL RESULTS

6.1. Univariate GARCH Results

Table 2 represents the estimation for the univariate GARCH (1,1) model.

Table 2
Results of Univariate GARCH

	Egypt	Israel	Turkey
Mean Equation		$r_{it} = \alpha_1 + \beta_{i1}\, r_{i,t-1} + \xi_{it}$	
C	-0.034*	0.049*	0.019*
β(lag returns)	0.054*	0.057*	-0.013
Variance Equation		$h^2_{it} = \delta_{io} + \delta_{i1}\, \xi^2_{i,t-1} + \delta_{i2}\, h^2_{i,\,t-1}$	
C	0.018*	0.056*	0.001*
RESID(-1)^2	0.066*	0.1*	0.084*
GARCH(-1)	0.886*	0.879*	0.91*

*Significant at 1% significance level

In the mean equation, lag returns for Egypt and Israel are positive and significant, suggesting that the lag returns is an important element in forecasting future returns in both markets. Own lag returns in Turkey, however, is not significant, suggesting that the own long run persistence is dominated by spillover effect.

The variance equation suggests that both ARCH and GARCH effects are present. This implies that the available information, shocks at time t-1, as well as the past conditional variance in the three markets significantly affects the current volatility.

6.2. Trivariate GARCH-M Results

Table 3 represents the estimation results for the GARCH model using the BEKK parameterization for the three MENA countries.

In the mean equation presented for each of the three MENA countries, the intercept parameters are very close to zero.

The mean equation also shows that the autoregressive terms (a_{11}) and (b_{11}), in each model, are significant, indicating pronounced serial correlation in equity return in period t and period t-

Table 3
Estimates of the Trivariate GRACH-M

Estimates of the trivariate GARCH model

Country	EGYPT	ISRAEL	TURKEY
Estimates of the coefficients of the conditional daily return spillover			

$$r_{us,t} = a_{10} + a_{11} r_{us,t-1} + a_{12} h_{us,t} + a_{13}\ \mathrm{cov}(r_{us,t}, r_{uk,t}) + a_{14}\ \mathrm{cov}(r_{us,t}, r_{mena,t}) + \varepsilon_{us,t}$$
$$r_{uk,t} = b_{10} + b_{11} r_{uk,t-1} + b_{12} h_{uk,t} + b_{13}\ \mathrm{cov}(r_{uk,t}, r_{us,t}) + b_{14}\ \mathrm{cov}(r_{uk,t}, r_{mena,t}) + \varepsilon_{uk,t}$$
$$r_{mena,t} = c_{10} + c_{11} r_{mena,t-1} + c_{12} h_{mena,t} + c_{13}\ \mathrm{cov}(r_{us,t}, r_{mena,t}) + c_{14}\ \mathrm{cov}(r_{uk,t}, r_{mena,t}) + \varepsilon_{mena,t}$$

	EGYPT	ISRAEL	TURKEY
a_{10}	0.00031	0.0007522*	0.000175
a_{11}	-0.1537***	-0.17754***	-0.1801***
a_{12}	-0.442	0.07099	6.8859
a_{13}	5.325	0.7376	-3.6099
a_{14}	-14.535	12.5192	-5.236
b_{10}	0.000503	0.000672*	0.000606
b_{11}	-0.07659***	-0.5514***	-0.0278*
b_{12}	-1.5775	-1.571	-11.964**
b_{13}	3.453	0.63563	19.4123**
b_{14}	-11.816	-3.1805**	4.49
c_{10}	0.00183	0.001211**	0.001357***
c_{11}	0.0839***	-0.00011	0.0447
c_{12}	-3.576	-2.2881	-0.8955
c_{13}	66.096***	1.7793**	4.9136
c_{14}	-20.759	-0.2305	-0.0404

Estimates of the coefficients of the variance-covariance matrix equation

$$[H_t] = [P]'[P] + [F]'[H_{t-1}][F] + [G]'[\varepsilon_{t-1}][\varepsilon_{t-1}]'[G]$$

	EGYPT	ISRAEL	TURKEY
P_{11}	0.000268	-0.0001	0.001385
P_{12}	0.0001594	0.0001	-0.00009
P_{13}	-0.00107	-0.00002	0.0000195
P_{22}	-0.000045	0.000089	0.00048
P_{23}	0.002208	-0.001	0.00077
P_{33}	0.014054	0.0035	0.000011
G_{11}	-0.2678***	0.0948***	0.0656***
G_{12}	0.22176***	0.2806***	0.2331***
G_{13}	0.06059*	0.00875	0.3812***
G_{21}	0.4125***	-0.13377***	-0.169***
G_{22}	0.0748***	-0.1066***	-0.0596***
G_{23}	-0.05155	0.3164***	-0.6086***
G_{31}	0.00144	0.07312***	-0.0169***
G_{32}	0.0188	0.00099	-0.01611***
G_{33}	0.1089***	0.103349***	0.1987***
F_{11}	0.11376	-0.6853***	-0.04268
F_{12}	-0.7729***	-0.783***	-0.77751***
F_{13}	-0.2433***	0.7497***	1.7943***
F_{21}	-0.9114***	-0.4258***	-0.9303***
F_{22}	-0.3106***	0.1338	0.1515***
F_{23}	0.2247***	-1.164***	-0.07422
F_{31}	-0.2364	-0.2596***	-0.11704***
F_{32}	0.0929	0.4661***	-0.1869***
F_{33}	-0.2497	0.3295***	-0.7901***

*Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

1. That is, yesterday's return has a significant effect on determining today's return in both the U.S. and UK. This is also the case for Egypt (c_{11}), while that coefficient is not significant for Israel and Turkey, suggesting that the own long run persistence is dominated by spillover effects. The results of the trivariate GARCH coincide with that of the univariate GARCH except for Israel, suggesting that the model is sensitive to the inclusion of other variables such as covariance between the returns in British and American markets from one side and the returns in the Israeli market from the other side.

As for the conditional variance term for the three MENA markets (c_{12} parameter), all are insignificant. The lack of insignificance of the coefficient on the variance is somewhat surprising and implies that time variation in the conditional variance in some returns or price changes is not an important source of variation in those returns or price changes. According to Hammoudeh et al. (2004), this weak premium effect may be due to some diversifiable risk associated with the particular market, or else there is weak evidence of time variation in market risk.

The coefficients of the covariance terms (c_{13} parameters), which capture the presence or non-presence of volatility spillover from the U.S., indicate that the covariance effects are significant for cov($r_{us,t}$, $r_{egypt,t}$) and cov($r_{us,t}$, $r_{israel,t}$). This implies that returns in both Egypt's and Israel's stock markets depend positively on the covariance between the U.S. market returns and Egypt/Israel market returns. This strongly suggests the presence of spillover effects between the U.S.'s market from one side and Egypt/Israel stock markets from the other side. On the other hand, the coefficient for cov($r_{us,t}$, $r_{turkey,t}$) is not significant, indicating the absence of spillover effects from the American market to the Turkish stock market. Whereas the high trade volume and military aid between Egypt/Israel and the U.S. might provide a good explanation of the presence of spillover effects, which run from the U.S. to Egypt and Israel, the absence of this effect in Turkey's market is most likely due to the low trade volume with the United States.

On the other hand, the coefficient of the covariance term that relates the U.K. market to the MENA markets, cov ($r_{uk,t}$, $r_{mena,t}$), indicates the covariance effect is not significant for all of the three countries. This implies that though London's stock market is considered one of the largest in the world, it has no significant effect on MENA stock markets, since those markets have only a weak relationship with the UK, compared to their stronger bond to the United States. This also suggests that the major source of disturbance in both Egypt and Israel is the changes of these markets' specific fundamentals as well as the changes in the U.S. stock market.

Finally, it is hard to interpret the coefficient estimates of the variance-covariance matrix equations. The assumption of cross-market volatility effects can be confirmed by the high degree of significance of the off-diagonal elements Hammoudeh et al. (2004).

7. CONCLUSION

In this paper, close to close returns of CASE 30, TASE 100, and ISE 100 stock indexes were used to test for volatility spillovers from both the New York Stock Exchange and the London Stock Exchange. The GARCH modeling originally created by Robert Engle is used to model the multivariate conditional volatility and test for the presence of volatility spillover among different markets.

A significant unidirectional return spillover from the U.S. to both Egypt and Israel is present, but not for Turkey. The British market has no influence whatsoever on any of the three MENA markets. The results also indicate that the own lag return effects dominate the spillover effects for both Egypt and Israel. That is, own lag market returns are crucial indicators in explaining the current trend and return volatilities in both markets. On the other hand, spillover effects dominate own lag returns in the Turkish market.

These findings have very important implications, notably for investor portfolio formation and trading decisions. Indeed, market participants should be aware of the relationship between international stock markets and the local stock market performance. For instance, the study findings generally suggest that international portfolio diversification and trading decisions in Egypt and Israel should be made in consideration of both the local and the U.S. markets' performance. Market participants should specifically pay closer attention to the local market conditions more than international ones in those two markets.

On the other hand, the international stock markets' performances should be the primary concerns the most closely watched markets for investors in the Istanbul Stock Market. This study, however, provides no evidence on these international markets. The paper just argues that both the American and British markets exert no influence on the Turkish market. A very useful future study would be to investigate the presence of the volatility spillover between the Istanbul Stock Market and other European markets.

Notes

1. Egypt, Israel, and Turkey are the largest economies in the MENA region other than oil producing countries
2. Note that the U.S. has committed itself, after signing the peace treaty between Egypt and Israel in 1979, to pay an annual financial aid to Egypt and Israel equaling $8 billion. This puts Egypt and Israel at the top of countries' list that receives aid from the U.S.
3. The information in this section is drawn from the Istanbul Stock Exchange, Tel-Aviv Stock Exchange, and Cairo Stock Exchange. For more information, visit their websites.
4. The standard multi-period continuously compounded return is multiplied by 100 to change it to percentage rates rather than decimal space. Note that this step does not influence the results of the model.
5. The problem of estimating all the markets at one time is exceeding the limit of the MGARCH. The model contains more than three variables and will suffer a non-convergence issue. This issue is unresolved in the literature.
6. Chancharoenchai and Dibooglu (2006).

References

Baba, Y., Engle, R., Kraft, D., and Kroner, K., (1989), "Multivariate Simultaneous Generalized ARCH." Working Paper, University of California San Diego.

Baele, L., (2005), "Volatility Spillover Effects in European Equity Markets." Journal of Financial and Quantitative Analysis, 40: 373-402.

Bekaert, G. and Harvey, C., (1997), "Emerging Equity Market Volatility." Journal of Financial Economics, 49: 29-77.

Bollerslev, T., Engle, R., and Wooldridge, J., (1988), "A Capital Asset Pricing model with Time Varying Covariance." Journal of Political Economy, 96: 116-131.

Booth, G., Chowdhury, M., Martikanian, T., and Tse, Y., (1997), "Intradaily Volatility in International Stock Index Futures Markets: Meteor Showers or Heat Waves?" Management Science, 43: 1564-1576.

Boudoukh, J., Ricahrdson, M., and Whitelaw, R., (1997), "Investigation of a Class of Volatility Estimators." Journal of Derivatives, 4: 63-71.

Campbell, J. and Ammer, J., (1993), "What Moves the Stock and Bond Markets? A Variance Composition for Long-Term Asset Returns." Journal of Finance, 48: 3-37.

Campbell, J., (1991), "A Variance Composition for Stock Returns." The Economic Journal, 101: 157-179.

Chancharoenchai, K. and Dibooglu, S., (2006), "Volatility Spillovers and Contagion during Asian Crisis: Evidence from Six Southeast Asian Stock Markets." Emerging Markets Finance and Trade, 42: 5-18.

Chari, V., Kehoe P., and McGrattan E., (2002), "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?" Review of Economic Studies, 69: 533-563.

De Santis, G. and Imrohoroglu, S., (1997), "Stock Returns and Volatility in Emerging Financial Markets." Journal of International Money and Finance, 16: 561-579.

De Santis, G. and Gerard, B., (1997), "International Asset Pricing and Portfolio Diversification with Time-Varying Risk." Journal of Finance, 52: 1881-1912.

Desroches, B., (2004), "The Transmission of World Shocks to Emerging Market Countries: An Empirical Analysis." Bank of Canada Working Paper No. 44.

Dornbusch, R. and Claessens, S., (2000), "Contagion: How it spreads and How it can be Stopped." World Bank Research Observer, 15: 177-197.

Eckner, A., (2006), "A Multivariate GARCH Model with Volatility Spillover and Time-Varying Correlations." Stanford University Working Paper.

Engle, R., Ito, T., and Lin, W., (1990), "Meteor Showers or Heat Waves? Heteroskedasticity Intra-daily Volatility in the Foreign Exchange Market." Journal of Econometrics, 58: 525-542.

Engle, R. and Ng, V., (1993), "Measuring and Testing the Impact of News on Volatility." The Journal of Finance, 48: 1749-1778.

Eun, C., Janakiramanan, S., and Senbet, L., (1998), "The Pricing of Emerging Market Country Funds." Georgia Institute of Technology Working Paper.

Flannery, M. and Protopapadkis, A., (2002), "Macroeconomic Factors Do Influence Aggregate Stock Returns." Review of Financial Studies, 15: 751-782.

French, K., Schwert, G., and Stambaugh, R., (1987), "Expected Stock Returns and Volatility." Journal of Financial Economics, 19: 131-147.

Goldberg, P., and Knetter, M., (1997), "Goods Prices and Exchange Rates: What Have We Learned?" Journal of Economic Literature, 35: 1243–72.

Hamao, Y., Masulis, R., and Ng, V., (1990), "Correlations in Price Changes across International Stock Markets." The Review of Financial Studies, 3: 281-307.

Hammoudeh, S., Dibooglu,S., and Aleisa, A., (2002), "Relationship among U.S. Oil Prices and Oil Industry Equity Indices." International Review of Economic and Finance, 13: 427-453.

Kanas, A., (1998), "Volatility Spillovers across Equity Markets: European Evidence." Applied Financial Economics, 8: 245-256.

Karolyi, A., (1995), "A Multivariate GARCH Model of International Transmission of Stock Returns and Volatility: The Case of United States and Canada." Journal of Business and Economic Statistics, 13: 11-25.

Karolyi, A. and Stulz, R., (1996), "Why Do Markets Move Together? An Investigation of US-Japan Stock Return Comovements." The Journal of Finance, 51: 951-986.

Lin, W., Engle, R., and Ito, T., (1994), "Do Bulls and Bears Move Across Borders? International Transmission Stock Returns and Volatility." The Review of Financial Studies, 7: 507-538.

McAleer, M. and Veiga, B., (2005), "Spillover Effects in Forecasting Volatilities and VAR." School of Economics and Commerce, University of Western Australia Working Paper.

Merton, R. C., (1980), "On Estimating the Expected Return on the Market: An Exploratory Investigation." Journal of Financial Economics, 8: 323-361.

Pan, M. S., and Hsueh, P., (1998), "Transmission of Stock Returns and Volatility Between the U.S. and Japan: Evidence from the Stock Index Future Markets." Asia Pacific Financial Markets, 5: 211-255.

Scheicher, M., (2001), "The Comovements of Stock Markets In Hungary, Poland And the Czech Republic." International Journal Of Finance And Economics, 6: 27-39.

Schornick, V., (2007), "International Stock Market Volatilities and Comovements: Effects of Differences in Opinion and Portfolio Constraints." LSE Working Paper.

Wei, K., Liu, Y., Yang, C., and Chaung, S., (1995), "Volatility and Price Change Spillover Effects Across the Developed and Emerging Markets." Pacific-Basin Finance Journal, 3: 113-136.

Yang, T. and Lim, J., (2004), "Crisis, Contagion, and East Asian Stock Markets." Review of Pacific Basin Financial Markets and Policies, 7: 119-151.