

On the Evolution of Inter- and Intraregional Linkages to Middle East and North African Capital Markets

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This paper investigates the contribution of Middle East and North African (MENA) capital markets to global asset allocation strategies. Eleven MENA stock markets are examined from January 1st, 1990 to December 30th, 2001. Spillover studies are conducted on daily stock market index price to investigate short-term market linkages. Our results indicate that most MENA markets are segmented (to the exception of Turkey and Israel); we also find evidence of an increasing sensitivity to exogenous intraregional shocks throughout the period of study. Sensitivity to interregional exogenous shocks, however, remains modest. Finally, we uncover an uncanny situation in which most MENA capital markets exhibit a high degree of endogenous predictability. We suggest that MENA markets provide diversification potentials for the global investor and should not be treated as a block for global tactical asset allocation purposes.

Introduction

Middle East and North African region (MENA) countries are rarely referred to as influential countries in the global financial scene. Wars, political turmoil, economic instability, and institutional underdevelopment have traditionally been powerful obstacles to an increased access to MENA capital markets. But whereas MENA countries have yet to emerge as economic powers, their very small capital markets¹ have recently witnessed significant economic and financial development

¹ As of 2000, Saudi Arabia, Turkey, and Israel led the pack with total market capitalization of \$73 billion (75 stocks listed), \$69.5 billion (315 stocks listed), and \$66.8 billion (665 stocks listed), respectively. Egypt, Kuwait, Morocco, Bahrain, Jordan, Oman, Tunisia, and Lebanon had total market capitalization of \$28.5 billion (1076 stocks listed), \$19.8 billion (86 stocks listed), \$10.9 billion (53 stocks listed), \$6.6 billion (41 stocks listed), \$4.95 billion (163 stocks listed), \$3.46 billion (133 stocks listed), \$2.80 billion (44 stocks listed), and \$1.58 billion (13

geared toward an increase in openness to foreign investors. During the 1990s, the accessibility to MENA capital markets has increased. For instance, Egypt, Israel, Jordan, Lebanon, Morocco, Tunisia, and Turkey have been progressively lifting foreign investors' ownership and capital and dividends repatriation restrictions. Even the traditionally closed Gulf Country Council markets have become more accessible to foreign investors through international funds and trusts.

An important question examined in this paper is whether MENA capital markets should be treated as a block in a globally diversified portfolio. The proximity of the countries in the region may lead one to conclude that there is a close connection between their economies and, hence, susceptibility to shocks from neighboring countries. Studies such as Abraham, Seyyed, and Al-Elg (2001), Darrat, Elkhail, and Hakim (2000), and Omran and Gunduz (2001) show that no cross-linkages between MENA capital markets exist and, hence, there is no reason to treat such markets as a block in a mean-variance maximization objective function.

Most MENA markets also do not fit in the mold of emerging markets such as Asian, Latin American, and East European capital markets, which are characterized by high returns and volatility, low correlation with the world market, and volatility clustering (Harvey, 1995a, 1995b, 1995c). Erb, Harvey, and Viskanta (1996), for instance, find that Jordan has typically low return and volatility as compared to industrialized markets and other emerging markets. In addition, emerging markets from the Asian, Latin American, and East European blocks have experienced at least one international contagious financial crisis, such as the Tequila crisis, the Asian flu, or the Russian virus. There is no similar evidence in the literature for the MENA capital markets.

MENA countries have been subjected to multiple political and economic shocks. If those disturbances are local, though, the correlation between equity markets in the region may be low. An argument for international diversification exists in that each MENA capital market can be considered as a stand-alone asset class in a globally diversified portfolio. Abraham, Seyyed, and Al-Elg (2001), in an overview of the stock markets in Bahrain, Kuwait, and Saudi Arabia, conclude that the three markets are suitable for international diversification purposes and also can be used to hedge against oil price fluctuations. They use monthly index returns from 1993 to 1998 and observe low or negative correlations between markets. The authors argue that their findings underline the potential MENA capital markets offer for risk reduction. Omran and Gunduz (2001) use a multivariate cointegration methodology and find no long-term stochastic trends between Jordan, Turkey, Egypt, Israel, and Morocco from January 1996 to June 1999 and also conclude that MENA capital markets offer diversification incentive to the global investor. Darrat, Elkhail, and Hakim (2000)

stocks listed), respectively. As a reference, the total market capitalization in the U.S. was more than \$14.5 trillion in 2000.

find long-term bivariate cointegrative relationships for Morocco-Egypt and Morocco-Jordan, but no multivariate cointegrative relationships between the three capital markets from October 1996 to August 1999. They conclude that the three markets, as a block, offer diversification potentials for the global investor.

Previous studies have only used small samples of few MENA capital markets to conclude on the inexistence of intraregional long-term price linkages. These studies have not investigated intra and inter-intercontinental short-term linkages. Inherently, many issues have yet to be addressed: (1) Are there any intraregional spillovers between MENA markets? (2) Are there any interregional spillovers between MENA capital markets and other regional blocks? (3) Were MENA markets affected by any of the three major international financial crises that occurred during the 1990s? (4) Does the evolution of the change in dynamic of short-run price linkages in MENA capital markets reveal a globalization trend that has been observed in most emerging markets during the 1990s? Our paper intends to fill this void in the literature by investigating short-run linkage between eleven MENA capital markets and five regional indices.

The results of our study for the equity markets in Bahrain, Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Oman, Saudi Arabia, and Turkey indicate that most MENA markets are segmented (with the exception of Turkey and Israel); we also find evidence of an increasing sensitivity to exogenous intraregional shocks throughout the period of study. Sensitivity to interregional exogenous shocks remains modest. We conclude that the more integrated economies of Israel and Turkey seem to process information flows from global markets and act as conduits to other, smaller MENA markets. Finally, we uncover an uncanny situation in which most MENA capital markets exhibit a high degree of endogenous predictability. We conclude that MENA capital markets provide diversification potentials for the global investor. Should these markets become more stable and more accessible to foreign investors, their predictability and segmentation can be beneficial in global asset allocation strategies.

Data and Methodology

Sample Selection

Market indices are obtained from Datastream. There are several possible sources for MENA market returns: Morgan Stanley Capital International (MSCI), International Finance Corporation (IFC), and local indices. Each of these sources started to cover MENA markets at different dates. We choose the provider that started the coverage the earliest. For instance, Jordan and Turkey were covered by MSCI in the late 1980s. Egypt, Israel, and Morocco are also covered the earliest by MSCI during the

1990s. Saudi Arabia, Bahrain, and Oman² are only covered by IFC. Kuwait, Lebanon, and Tunisia³ price series are only available in local indices, coverage of which started in the 1990s. For the regional indices, we use MSCI AC Asia, MSCI AC Europe, MSCI AC East Europe, MSCI AC Latin America, and MSCI AC North America. We use regional indices rather than country indices for several reasons: First, it would be difficult to justify the choice of one country versus another within a region; furthermore, it is impossible to perform the analysis with all countries in each region. Second, we try to address the issue of spillover in the mindset of a global investor, who is likely to implement a global asset allocation strategy by allocating across regional blocks rather than specific markets. Third, we are also interested in investigating if the three major international catastrophic events that occurred during the 1990s (the Tequila crisis of 1994-1995, the Asian flu of 1997-1998, and the Russian virus of 1998-1999) have affected MENA markets.

We use daily market index data for observation periods within the January 1990 through December 2001 range. We chose a starting date of January 1st, 1990 because nine of the eleven MENA return series are only available after 1990. The observation periods for all countries are not the same, but the construction of the indices is based on value-weighted portfolios. MSCI and IFC country indices are usually highly correlated, providing consistency to our tests across markets; they capture the spirit of an all-share index by including replicable subsets of shares and targeting 60 percent of total market capitalization. These indices consider restrictions on foreign ownership when applicable. A summary of the source, starting date, observations, and capitalization for each markets and regional blocks is provided in Table 1.

We use daily data to capture potential short-lived interactions. It is well known in the literature that using monthly data may not be appropriate in describing the effect of capital movement (an intrinsically short-term occurrence). In view of the recent development in information network that is capable of disseminating news instantaneously around the world, a shock in a national stock market can be transmitted to another market within a short period of time. Thus, it is essential to use high-frequency data such as daily prices to examine spillover effects. In addition, many of our series have less than eight years in coverage; thus, there are serious methodological issues with using too few data points. Also, we should note that test results could be affected by infrequent trading.

All prices are in US dollars. This is more appropriate in segmented markets because inflation trends are taken into account through the Fisher equation (Liew,

² Oman MUSCAT (local index) is available since the mid-1990s. When plotting the return series from 1995 to 2001, we observed inconsistency in the series in 1998 and 1999. Subsequently, we use the price series from the IFC database.

³ IFC has started to cover Tunisia as a frontier market in a monthly frequency since the end of 1995. We found that the local series TUNINDEX (available in a daily frequency) has a correlation of 0.91 with IFCM-Tunisia from 1998:01 to 2001:06.

1995). Also, it provides uniformity in the comparison of one market to another. When we use local series (Kuwait, Lebanon, and Tunisia), prices are converted in dollars using the exchange rate series provided by Datastream.

Table 1—Data Source, Starting Date, and Number of Observations for Each Series

Country/ Region	Source ¹	Coverage (Start)	Number of Observations (Daily)	Total Market Capitalization as of 2000 (\$ Billion)	Number of Stocks Listed as of 2000
Bahrain	IFC (\$US)	4/19/00	476	6.6	41
Egypt	MSCI (\$US)	12/30/94	1857	28.5	1076
Israel	MSCI (\$US)	1/1/93	2378	66.8	665
Jordan	MSCI (\$US)	1/1/90	3161	4.95	163
Kuwait	KIC (local currency)	12/28/94	1859	19.8	86
Lebanon	BLOM (local currency)	1/22/96	1580	1.58	13
Morocco	MSCI (\$US)	1/2/95	1857	10.9	53
Oman	IFC (\$US)	4/20/00	476	3.46	133
Saudi Arabia	IFC (\$US)	1/2/98	1077	73	80
Tunisia	TUNINDEX (local currency)	1/1/98	1078	2.80	44
Turkey	MSCI (\$US)	1/1/90	3161	69.5	315
Asia free ²	MSCI (\$US) “All Countries”	1/1/90	3161	2607	na
Europe ³	MSCI (\$US) “All Countries”	1/1/90	3161	5,879	na
East Europe ⁴	MSCI (\$US) “All Countries”	1/1/95	1858	93†	na
Latin America free ⁵	MSCI (\$US) “All Countries”	1/1/90	3161	250	na
North America ⁶	MSCI (\$US) “All Countries”	1/1/90	3161	10,088	na

¹ Indicates the data providers of daily index prices in U.S. Dollar. Local market series are converted into U.S. dollars using the corresponding exchange rate series provided by Datastream

² All developed and emerging markets in the Asian MSCI universe

³ All developed markets in the European MSCI universe

⁴ Includes Russia and Poland

⁵ All markets in the Latin American MSCI universe

⁶ Includes USA and Canada.

†Estimated by adding the total market capitalization of Russia and Poland.

Methodology

Short-run linkages among equity markets are important components for country selection within a global tactical asset allocation. International equity linkages and benefits from diversification are known to be inversely related. Capital markets linkages that are unstable and short-lived affect investors who allocate tactically.

As indicated previously, MENA markets data coverage does not start at the same time. Thus, the overall sample is broken into twelve sub-samples as follows:

- Period 1 (1/1/1990-12/30/2001): Jordan, Turkey, Asia, Europe, Latin America, North America
- Period 2 (1/1/1991-12/30/2001): Jordan, Turkey, Asia, Europe, Latin America, North America
- Period 3 (1/1/1992-12/30/2001): Jordan, Turkey, Asia, Europe, Latin America, North America
- Period 4 (1/1/1993-12/30/2001): Israel, Jordan, Turkey, Asia, Europe, Latin America, North America
- Period 5 (1/1/1994-12/30/2001): Israel, Jordan, Turkey, Asia, Europe, Latin America, North America
- Period 6 (1/1/1995-12/30/2001): Egypt, Israel, Jordan, Kuwait, Morocco, Turkey, Asia, Europe, East Europe, Latin America, North America
- Period 7 (1/1/1996-12/30/2001): Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Turkey, Asia, Europe, East Europe, Latin America, North America
- Period 8 (1/1/1997-12/30/2001): Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Turkey, Asia, Europe, East Europe, Latin America, North America
- Period 9 (1/1/1998-12/30/2001): Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Saudi Arabia, Tunisia, Turkey, Asia, Europe, East Europe, Latin America, North America
- Period 10 (1/1/1999-12/30/2001): Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Saudi Arabia, Tunisia, Turkey, Asia, Europe, East Europe, Latin America, North America
- Period 11 (4/20/2000-12/30/2001): Bahrain, Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Oman, Saudi Arabia, Tunisia, Turkey, Asia, Europe, East Europe, Latin America, North America
- Period 12 (1/1/2001-12/30/2001): Bahrain, Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Oman, Saudi Arabia, Tunisia, Turkey, Asia, Europe, East Europe, Latin America, North America

We pool the coverage forward by increments of one year, and new indices are incorporated in the analysis as they become available (periods 1 to 12). Then, we investigate short-lived linkages (predictability) using integrated level series. We use a pooled vector autoregressive (VAR) methodology to infer the evolution of the two

components of spillover analysis: lag predictability of a shock and instantaneous shock transmission. We address these two components in terms of direction, amplitude, timing, and sign. The pooled VAR methodology refers to repeating the VAR analysis across the sample by moving closer to the date of the last observation and adding variables as they become available. We initially thought of the pooled methodology as a necessity because market index data are not available at the same starting date. Nevertheless, it adds to our analysis a novel dimension: the evolution of the dynamic of spillovers.

We follow a methodology similar to Granger, Huang, and Yang (2000) by first investigating common stochastic trends for periods 1, 4, 6, 7, 9 and 11. We apply the Johansen (1988) procedure of cointegration to test multivariate relationships among the stock prices of the eleven MENA markets and the five regional indices. Then, we trace the dynamic response to each market to innovations in a particular market in two different ways.

First, if we find evidence of multivariate cointegration equation, we imply a diagonal GARCH(1,1)-vector error regression as follows:⁴

$$\begin{aligned}\Delta S_{j,t} &= \alpha + \delta \varepsilon_{j,t-1} + \sum_{j=1}^{j=n} \sum_{i=1}^{p-1} \beta_{i,j} \Delta S_{j,t-i} + e_{j,t} \\ \sigma_{j,t}^2 &= \omega + \gamma e_{j,t}^2 + \theta \sigma_{j,t-1}^2\end{aligned}\quad (1)$$

where:

- Δ = The first difference in levels;
- ε_t = The stationary error term of a multivariate cointegration regression;
- S_j = A vector of the indexes level series;
- γ = The ARCH term (volatility clustering); and
- θ = The GARCH term.

Second, if we do not find evidence of cointegration equations, we reduce the VEC to a simple diagonal GARCH(1,1)-vector autoregressive (VAR) as follows:

$$\begin{aligned}\Delta S_{j,t} &= \alpha + \sum_{j=1}^{j=n} \sum_{i=1}^{p-1} \beta_{i,j} \Delta S_{j,t-i} + e_{j,t} \\ \sigma_{j,t}^2 &= \omega + \gamma e_{j,t}^2 + \theta \sigma_{j,t-1}^2\end{aligned}\quad (2)$$

where each variable has the same definition as in system (1).

In both systems, variables are stationary, and the optimal lag is determined with multivariate versions of Akaike information criterion. Systems (1) and (2) consist of

⁴ This diagonal VAR-GARCH model is inspired by Engle and Sheppard (2001). By including a GARCH process for each equation of the VAR, we attempt to eliminate a potential problem of heteroskedasticity, i.e., the greatest drawback of the VAR methodology. Also, we do not seek to compute covariance equations as in an MGARCH model. It is unlikely that our likelihood estimator will converge to an answer or a global maximum for markets that are poorly correlated with each others. Furthermore, an MGARCH-VAR with 16 variables would require us to estimate 120 covariance equations.

at most (least) 30 (12) equations that need to be evaluated simultaneously, pooling forward from January 1990 to December 2001, by increments of one year. We use a Bollerslev-Wooldridge heteroskedasticity consistent covariance to compute the quasi maximum likelihood (QML) covariances and standard errors as described by Bollerslev and Wooldridge (1992). Ljung Box statistics on squared residuals are also computed to check for heteroskedasticity.

Of the GARCH-VAR (or VEC), we first conduct bilateral block exogeneity Granger causality tests between each pair of markets. Because the Granger causality tests are predictability rather than cause-and-effect tests, their results provide two types of information: (1) the existence of cross-market spillovers, and (2) the existence of predictability or determinism in the market prices generating process. For each mean equation in the GARCH-VAR (or VEC), we compute block exogeneity Wald statistics for the joint significance of each of the other lagged endogenous variables in that equation. It is worth noting that our study is interested in verifying if market predictability increased over time, as a result of globalization and a more efficient cross-country information flow. Also, we want to investigate the presence of feedback and possible role switching of markets from initiators to receivers of shocks.

Granger causality explains the relationship between the different markets, but doesn't provide a sign, timing, or amplitude for these market linkages. Thus, we study the short-run responses using impulse response (IR) and variance decomposition functions (VD) on the VAR (or VEC) between change in prices and lag change in prices in the different markets. IR and VD are used to provide further explanation on information shocks between the markets.

Impulse response maps the effect on current and future values of each current and future market indexes of a one standard deviation shock to one of the innovations. A shock to lagged variables is transmitted not only to all other lagged variables, but also to all endogenous variables through the VAR. Because innovations are usually correlated and not unique with a specific variable, impulses are orthogonalized with a Cholesky decomposition, requiring an ordering of the variables and attributing all of the effect of any common component to the variable that comes first in the VAR system. As a result, responses can change dramatically with a different ordering of the variables. To circumvent this problem, we follow Pesaran and Shin (1998) who build generalized impulses response function (GIRF) by constructing an orthogonal set of innovations that does not depend on the VAR ordering. As the variables in the VAR are stationary, the impulse responses are expected to die out to zero. The sign and timing provided by GIRF are interesting because they reveal market linkages in the form of how a shock in one country affects another country: If there is no linkage, there will be flight of capital from one economy to another, resulting in a positive impact on the latter markets. In contrast, if investors view other regional economies as prone to similar events, then there will be a nega-

tive reaction in those economies. Results inherent to endogenous shocks can be used to evaluate the persistence of price predictability using endogenous innovations. If a market is extremely segmented (small exogenous shocks), price change might be predictable using only past information endogenous to that market.

We then evaluate the variance decomposition functions to appraise the lagged impact of the variance from other countries' index price on the total variance of a particular country's index price. Variance decomposition provides further information on the VAR dynamics by decomposing variation in an endogenous variable into the component shocks to the endogenous variables in the VAR. In the same vein as GIRF, we use a generalized variance decomposition function (GVDF) by constructing an orthogonal set of innovations that does not depend on the VAR ordering. GVDF gives information about the relative importance of each random innovation to the variables in the VAR. Thus, GVDF provides information relative to the size of endogenous and exogenous shocks on a given market.

At this point, it is important to consider another type of linkage that is too often forgotten. Notice that our market linkage tests have focused so far on lead-lag relationships rather than on testing if price changes are simultaneous. After all, it is possible for markets not to reveal any lead-lag relationships and be linked contemporaneously. Thus, we look at contemporaneous linkages measured with the cross correlation between standardized residuals from the VAR (or VEC). Residuals are innovations relating to abnormal price change that are not predicted on the basis of the information reflected in past. Correlation of residuals reflects the degree to which new information producing an abnormal price change in one market is shared by the other market, i.e., price-change spillover. Correlation is a measure of amplitude that also needs to be addressed in terms of significance. For that reason, we compute Geweke's instantaneous measure of linear feedback, and 5 percent significance is reported close to residual correlation values. The pairwise Geweke (1982) test of causality starts by canonical representations of the relationship between two market price level (X and Y) as follows:

$$\Delta X_t = \alpha + \sum_{i=1}^{i=k} \beta_i \Delta X_{t-i} + \sum_{i=1}^{i=k} \gamma_i \Delta Y_{t-i} + \varepsilon_{1,t} \quad \text{Var}(\varepsilon_{1,t}) = \sigma^2 \quad (3)$$

$$\Delta X_t = \alpha + \sum_{i=1}^{i=k} \beta_i \Delta X_{t-i} + \sum_{i=0}^{i=k} \gamma_i \Delta Y_{t-i} + \varepsilon_{2,t} \quad \text{Var}(\varepsilon_{2,t}) = \sigma_2^2 \quad (4)$$

A maximum likelihood measure of contemporaneous linear causality between X and Y (at time t) is written $F_{X \otimes Y}$ and calculated as follows:

$$F_{X \otimes Y} = \ln \left(\frac{|\sigma_1^2|}{|\sigma_2^2|} \right) \times n \sim \chi^2 \quad (5)$$

Where n is the number of observations, χ^2 is the chi-square statistic and “|” is the determinant.

Results

We initially computed the augmented Dickey Fuller and Kwiatkowski, Phillips, Schmidt, and Shin⁵ tests for unit root in the level of each of the 16 index price series. The results indicate that the data are not stationary in the level series and are integrated of order one. Multivariate cointegration is performed and does not show any common stochastic trends among markets within any of the six groups.⁶ Thus, inherent VEC models that are reduced to simple GARCH-VAR models of price differences are used for each of the twelve periods; data are pooled as we they become available moving forward by increments of one year toward December 2001. From each VAR estimated,⁷ we imply GVDF, block exogeneity Granger causality, and GIRF. Tables 2 and 3 show a summary of inter- and intraregional shocks, respectively, through a generalized variance decomposition function. (We use a 20 day horizon.) Values are in percentage and represent the proportional effect of exogenous intraregional shocks to endogenous variance, reported in Table 2, and interregional shocks to endogenous variance, reported in Table 3. For example, as reported in Table 2, between 1990 and 2001, 0.068 percent of all shocks to Jordan came from Turkey, but 0.098 percent of all shocks to Turkey came from Jordan. Over the 2000-2001 period listed on the same column of Table 2, 3.992 percent of the variance decomposition of changes in the daily price series for Jordan came from all the other ten MENA markets, and so on. As reported in Table 3, for the same period, 2.798 percent of all shocks to Jordan came from the five listed regional blocks. As a result, we estimate that 93.205 $[=100 - (3.992 + 2.798)]$ percent of the changes in that country daily price index over the 2000-2001 period were induced by endogenous factors.⁸ The graphs below each table provide a visual summary of the results.

⁵ Because ADF tends to be biased not to reject the null hypothesis of non-stationarity, in particular for small samples, more restrictive KPSS tests for the null hypothesis of trend stationarity are used to complement our analysis.

⁶ ADF, KPSS, and multivariate cointegration tests are not reported and are available upon request.

⁷ ARCH-LM tests were conducted on the residuals of each mean equations of the GARCH-VAR model for each of the twelve periods. In all cases, the null hypothesis of no squared residual autocorrelation was never rejected, at least at the 1 percent level. Thus, it seems that our GARCH-VAR estimations are free of heteroskedasticity. All 126 tests are available upon request.

⁸ Although not reported in this paper tables and graphs, but as a mean of comparison with highly integrated markets for the same period, we find that (1) the shocks from MENA markets total 0.322 percent of the variance decomposition of the changes in daily price for the North American block index (heavily weighted in the US) and 0.792 percent for the European block index (heavily weighted in United Kingdom, Germany and France); (2) 15.343 percent of the shocks to the North American block come from other regional blocks (mostly the European block) and 19.551 percent of the shocks to the European block came from other regional block (mostly the North American Block); and (3) endogenous factors accounted for 84.335

Overall results of Table 2 indicate that MENA capital markets are extremely segmented. The fraction of error variance in forecasting a market due to endogenous shocks is usually greater than 90 percent. We can observe that all MENA markets have become more responsive to intraregional shocks over time. The increase in the changes in exogenous variance decomposition began to escalate in 1998.

Starting in 1999, openness with other regions (Table 3) increased for all MENA markets. In the case of Jordan, Morocco, and Oman, for instance, the change in variance decomposition indicates a decrease of interregional linkages in 2001. On the other hand, Egypt, Kuwait, Lebanon, Saudi Arabia, and Tunisia experienced the greatest increase in variance decomposition due to interregional shocks in 2001. Interregional shocks affecting Turkey and Israel in 2000 were also higher than in the previous year. Turkey demonstrates increasing sensitivity to intra- and inter-continental shock transmissions. By the end of the 1990s, Israel became dramatically more open to other MENA capital markets, as reported in Table 2; yet, as listed on Table 3, shocks to Israel from the rest of the world taper in 2000.

In light of our findings, the once segmented MENA capital markets seem to follow the global trend of market openness. Successive privatizations, liberalization of foreign ownership, and anti red tape laws implemented in all MENA markets during the second half of the 1990s have begun to crystallize.

We further investigate exogenous and endogenous shocks coming from each of the MENA markets and each of the regional indices. For sake of brevity, we only report in Table 4 what we believe to be relevant results (all results are available upon request), i.e., significant Granger causality relationships at least at the 5 percent level.

percent of the variance decomposition for the North American block, and 79.657 percent for the European block (the detailed periodic break-down is available upon request). These results for the North American and European blocks are in the same scale as to those reported in Eun and Shim (1989), Chowdhury (1994), and Nasseh and Strauss (2000). For instance, Eun and Shim (1989) examine daily return series of nine developed capital markets from 1980 to 1985 using an unrestricted VAR and generate a Cholesky variance decomposition that requires an ordering of the variables. The authors find that endogenous innovations account for approximately 88.98 percent, 47.98 percent, 77.94 percent, 71.98 percent and 77.81 percent of the variance in US, Canada, UK, Germany and France, respectively. Using a similar methodology, Chowdhury (1994) finds that endogenous innovations account for approximately 85.73 percent of the variance in US. Nasseh and Strauss (2000) find endogenous variance decomposition of 71.55 percent in UK, 69.77 percent in Germany and 77.59 percent in France using quarterly data from 1962 to 1995.

Table 2—Summary of Intraregional Exogenous Standardized Shocks from MENA Markets to Country Indicated in Column—Values Represent Percentage Variance Decomposition¹

Year Period	Jordan	Turkey	Israel	Egypt	Kuwait	Morocco	Lebanon	Saudi Arabia	Tunisia	Bahrain	Oman		
1990-2001	0.068	0.098											
1991-2001	0.080	0.127											
1992-2001	0.124	0.110											
1993-2001	0.142	0.658	0.736										
1994-2001	0.031	0.510	0.055										
1995-2001	0.154	0.680	0.371									0.647	0.140
1996-2001	0.182	0.770	0.391	0.680	0.164	0.233	0.411						
1997-2001	0.176	0.842	0.421	0.677	0.192	0.233	0.530						
1998-2001	0.570	1.345	1.338	0.960	0.336	0.568	0.974					0.552	1.689
1999-2001	0.963	2.167	1.850	1.453	0.618	1.605	1.578	1.352	2.291				
2000-2001	3.992	4.073	6.031	3.007	3.092	3.848	3.131	2.989	4.463			1.847	2.599
2001	4.805	5.693	14.686	11.443	8.973	13.834	15.037	3.712	14.568			6.345	13.752

¹ Total Percentage of intraregional exogenous shocks to a market of country is reported for each period. For instance, after 20 days forecast horizon, 0.068 percent of the shocks to Jordan come from other MENA markets for the period 1990-2001. The shaded area corresponds to periods during which data series are not available as defined in the methodology section

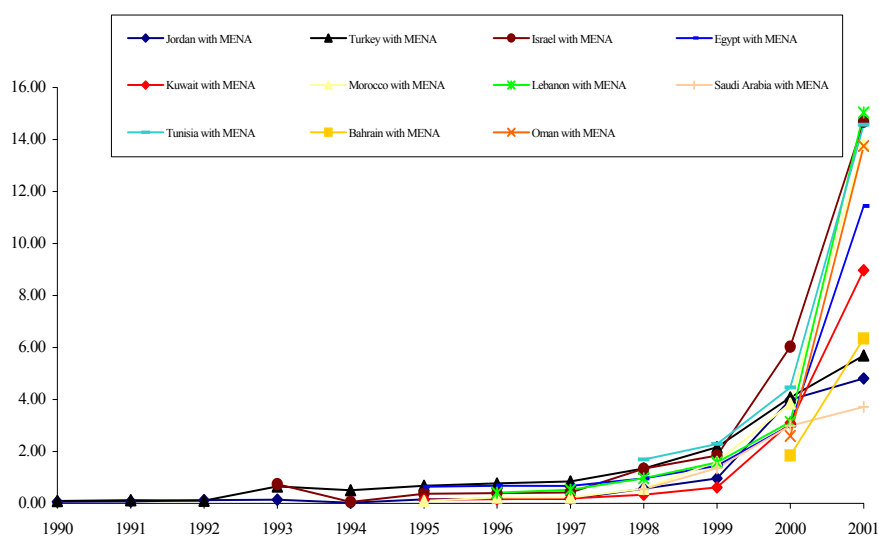


Table 3—Summary of Interregional Exogenous Standardized Shocks from Regional Blocks to Country Indicated in Column—Values Represent Percentage Variance Decomposition¹

Year Period	Jordan	Turkey	Israel	Egypt	Kuwait	Morocco	Lebanon	Saudi Arabia	Tunisia	Bahrain	Oman		
1990-2001	0.410	3.963											
1991-2001	0.365	4.191											
1992-2001	0.411	4.475											
1993-2001	0.447	4.499	5.970										
1994-2001	0.223	4.103	5.682										
1995-2001	0.393	4.727	6.397									1.197	0.726
1996-2001	0.290	5.165	6.924	1.341	0.911	1.371	0.682						
1997-2001	0.348	5.264	7.046	1.380	1.065	1.456	0.803						
1998-2001	0.379	5.272	5.941	1.391	1.291	1.525	0.234				1.112	1.045	
1999-2001	0.506	5.319	6.103	1.982	0.863	2.652	0.270				2.341	1.059	
2000-2001	2.798	10.173	2.973	3.456	1.845	4.335	0.334	3.383	1.695	1.186	2.553		
2001	2.322	11.820	4.079	4.648	6.472	2.958	4.328	5.747	2.663	2.491	1.583		

¹ Total percentage of interregional exogenous shocks to a market of country is reported for each period. For instance, after 20 days forecast horizon, 0.410 percent of the shocks to Jordan come from regional blocks for the period 1990-2001. The shaded area corresponds to periods during which data series are not available as defined in the methodology section

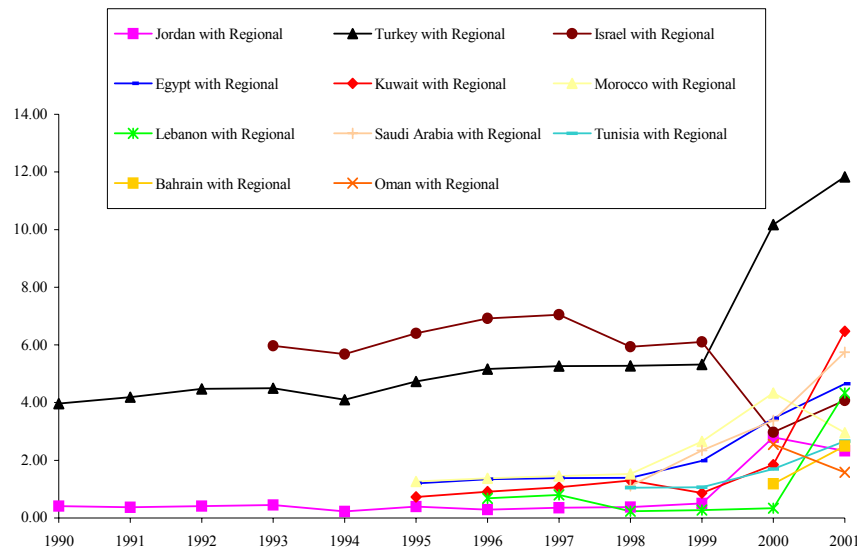


Table 4—Summary of Selected Endogenous and Exogenous Standardized Shocks Measured by Generalized Variance Decomposition¹

[illegible]

[†] Region notations: LA (Latin America), and NA (North America). Using the Granger causality tests the percentage of endogenous shocks that are only significant at least at the 5 percent level are reported; corresponding percentage of exogenous shocks, from regions or country, are reported in parentheses. For instance, 98.16 percent, 97.98 percent, and 97.94 percent of shocks observed for Egypt during the periods 1995–2001, 1996–2001, and 1997–2001, respectively, were endogenous. Also, during the same three periods, 20 days forecast-horizon-exogenous shocks of 0.38 percent, 0.37 percent, and 0.36 percent, respectively, from Morocco to Egypt are observed. The shaded area corresponds to periods during which either tests are not significant or data series are not available as defined in the methodology section

For instance, results reported in Table 4, second column and last row, show that over 1990-2001, 95.94 percent of all shocks affecting the Turkish market are internal and that the interregional shocks affecting that market were 1.36 percent from Latin America, 1.20 percent from North America, 0.31 percent from Asia (not reported because Asia does not significantly Granger cause Turkey), and 1.09 percent from Europe (not reported because Europe does not significantly Granger cause Turkey). These exogenous shock figures equal 3.96 percent. Also, over the same period, 0.10 percent of the shocks affecting Turkey came from Jordan⁹

Generally, patterns of causality and GVDF are difficult to summarize, but the following observations can be made. First, we observe that block exogeneity Granger causality tests and the size of exogenous shocks (percentage decomposition) are generally matching.¹⁰ Second, when granger causality is significant, the amplitude of the shock is extremely marginal (around 1 percent of total variance decomposition); furthermore, we generally find weak and rare significant cross-market linkages between MENA countries. Third, at the intercontinental level, the percentage of forecast error variance of the North American and European blocks explained by MENA markets is low (less than 1 percent) and not significant throughout the period of study, indicating that shocks in these markets do not significantly affect more integrated capital markets.¹¹ Fourth, we do not find evidence of feedback between markets, and intra- and interregional predictability is highly time-varying for all MENA markets. Finally, the most consistent cross-market spillovers in amplitude

⁹ As a reference for the same period, the shocks from MENA markets totaled 0.179 percent of the variance decomposition of the North American block index and 0.087 percent for the European block index. 13.988 percent of the shocks to the North American block came from other regional blocks (largely the European block, though other regions significantly Granger cause the American block), and 17.128 percent of the shocks to the European block came from other regional block (mostly the North American block, though other regions significantly Granger cause the European block). Finally, endogenous factors accounted for 85.833 percent of the variance decomposition for the North American block and 82.785 percent for the European block. (The detailed periodic breakdown is available upon request.) These figures for the North American and European blocks are also in the same scale as those reported in Eun and Shim (1989), Chowdhury (1994), and Nasseh and Strauss (2000).

¹⁰ This is reassuring, considering the debatable reliability of causality tests on GARCH-VAR models, i.e., size distortions inherent to the inability to discriminate between causality in mean and causality in variance could exist.

¹¹ The detailed breakdown for the European and North American block is available upon request. It is worth mentioning that (1) the sum of exogenous shocks to the European and North American markets ranges approximately from 10 to 25 percent for the overall period, (2) other emerging markets, such as Korea and Taiwan, have around 15 percent of exogenous shocks from 1985 to 1990 (Chowdhury, 1994), and (3) exogenous shocks to MENA markets range from 1 to 7 percent. Thus, one could imagine a scale of openness to exogenous stocks where developed markets would be the top group in the scale, and Asian and Latin American emerging markets would be the bottom group, with MENA markets (to the exception of Turkey and Israel) at the lower portion of the bottom group of emerging markets.

and direction are Israel to Turkey, Latin and North America to Israel and Turkey, and Eastern Europe to Kuwait; Israel and Turkey emerge as the most receptive markets to exogenous shocks from other regional blocks.

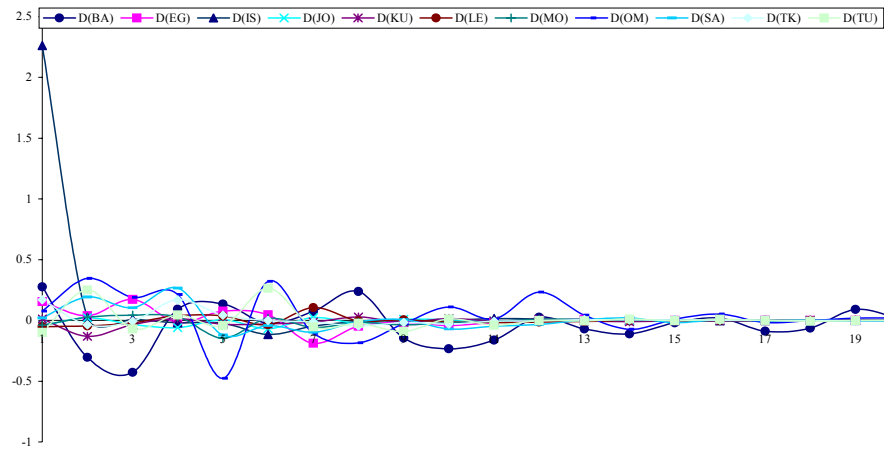
Investigating the issue of contagion to MENA capital markets during the three major international financial crises, we find an increase in exogenous shocks from the Latin American block to Israel and Turkey around 1994 and 1995, which correspond to the tequila crisis. The Asian flu might explain the existence of Granger causality of the Asian block to Israel around 1997 and 1998. Egypt, Morocco, and Kuwait exhibit an increase of exogenous shocks from the Eastern European block in 1998 and 1999, which corresponds to the Russian virus. In all cases, the change in variance decomposition is small, and it is not clear whether these findings provide evidence of “shift-contagion” as defined by Forbes and Rigobon (2001).

The Granger tests and GVDF indicate short-lived lead-lag patterns and amplitudes, but provide no indication about their signs and timing. For that reason, we also investigate the dynamic interactions among the variables, with GIRF. Using 20 forecast horizons (1 day to 20 days), we examine the signs and timing of endogenous and exogenous innovations in all MENA markets by tracing the impact of one standard deviation shock for each of the structural equations of the GARCH-VAR. Impulse responses from each market are computed starting when those market data are available. For instance, impulse responses to or from Jordan are estimated as of 1990, whereas impulse responses to or from Bahrain are estimated as of April 2000. Standard errors are generated for each shock and used to standardize the shocks. We report the ratio of amplitude to standard error in order to scale the shocks across time. Standardized shocks are comparable in terms of amplitude and provide a quick overview of the timing and sign of intra- and interregional shocks. To save space, we only report impulse responses to one shock standard deviation in Israel (Figures 1a and 1b) and Jordan (Figures 2a and 2b). Intra- and interregional shocks for Turkey are similar to those of Israel, and intra- and interregional shocks of Saudi Arabia look like the ones of Jordan. For Bahrain, Egypt, Kuwait, Lebanon, Morocco, Oman, and Tunisia, generalized impulse responses pattern from other MENA markets are in the same vein as Figure 1.a; generalized impulse responses pattern from other regional blocks are similar to Figure 2.b. (All graphs and data are available upon request.)

In all cases, the endogenous impulse responses are positive, large, and with a slow decay (10 to 15 days). This result implies that in most of these markets, the direction of price change could be predictable days or even weeks before such change occurs, which is consistent with the findings of Omran and Gunduz (2001) and Girard, Omran, and Zaher (2003). Predictability is commonly attributed to time-varying risk premia or serial correlation in returns in internal markets, which can be random or period specific. It can also be due to market microstructure effects. If MENA markets are characterized by market thinness, i.e., infrequent trading, non-

Figure 1—Standardized Response of Israel to Generalized One Standard Deviation Innovations

Panel A: Response of Israel to Generalized Intraregional



Panel B: Response of Israel to Generalized Interregional

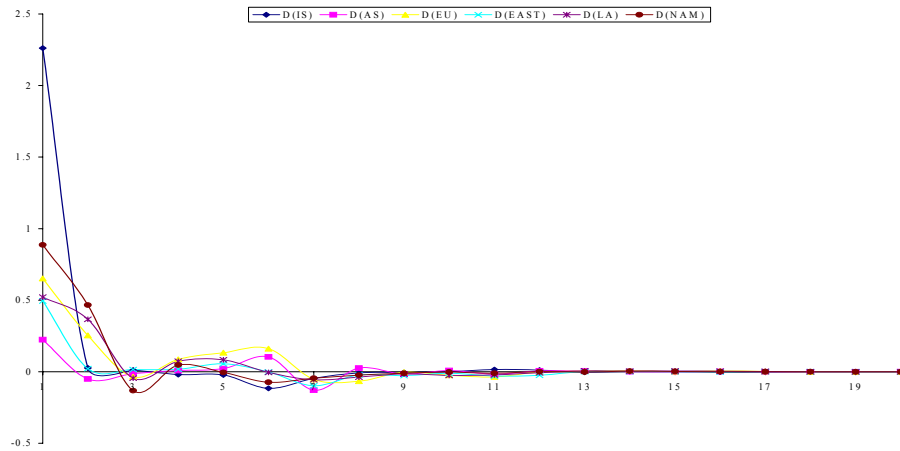
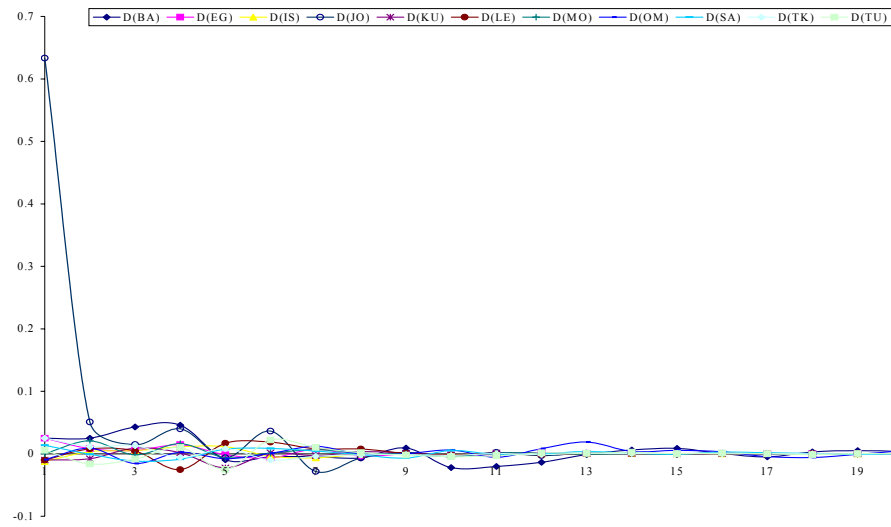
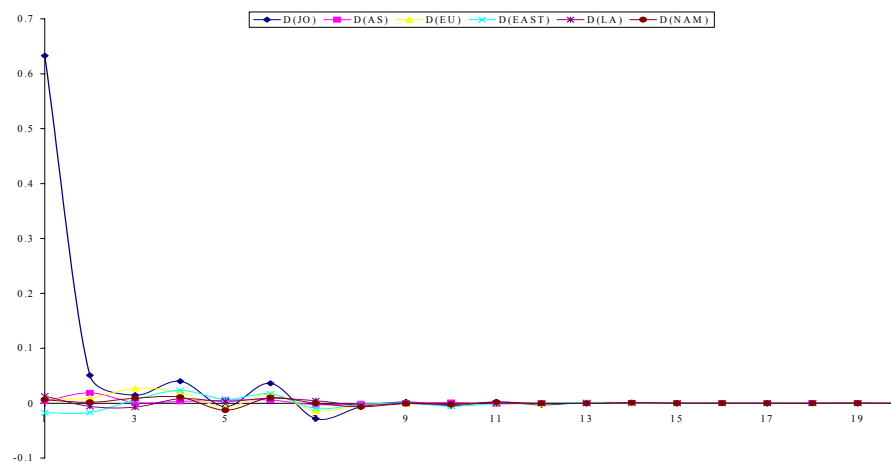


Figure 2—Standardized Response of Jordan to Generalized One Standard Deviation Innovations

Panel A: Response of Jordan to Generalized Intraregional



Panel B: Response of Jordan to Generalized Interregional



synchronous trading can lead to a measurement error in the observed data for returns on individual stocks, portfolio, and market indexes. Our findings also suggest that persistence (slow decay of endogenous responses) in shocks may indicate that prices tend to wander a longer period away from the mean. Interestingly, there is a mean-reversion cycle in which shocks then overshoot to oscillate around zero. This phenomenon leads to a dampening volatility in returns.

Intra- and interregional exogenous shocks to Jordan and Saudi Arabia are almost nonexistent. For the other nine markets, intraregional exogenous shocks taper late, but do not reveal any definite sign patterns of linkages. In some cases, these shocks are negative and interestingly suggest that some MENA markets view each other as prone to similar economic and financial shocks. This is the case of Israel and Turkey and of Morocco and Tunisia. Nevertheless, positive shocks are usually more frequent and indicate that a positive impact on exogenous markets is tied to flight of capital from one economy to another. In that sense, investors could view other regional economies as prone to different events. Interregional shocks to Israel and Turkey are strong and positive; they are marginal for the other markets. In all MENA markets, interregional shocks decay rapidly.

One of the pitfalls of lead-lag spillover analysis is that it fails to take account contemporaneous spillovers. We investigate the proportion of contemporaneous exogenous price change spillovers. Tables 5 and 6 results show the correlation between residuals from each of the VAR previously modeled on the same calendar day. For sake of clarity, we only report contemporaneous relationships for which Geweke tests are significant at least at the 5 percent level. Table 5 depicts intraregional contemporaneous linkages; contemporaneous interregional linkages are presented in Table 6.

Table 5 highlights the generally weak instantaneous links between MENA markets. The exception is Turkey and Israel, for which we find continuously significant contemporaneous linkages from 1990 to 2001. Generally, most of the residuals correlation coefficients are positive, revealing that investors view other regional economies as prone to different events. The residuals correlation coefficients can be negative, which indicates that capital tends to flow naturally from one market to another. This is the case of the four GCC markets studied (Bahrain, Kuwait, Oman, and Saudi Arabia). Similar findings have been reported by Hassan (2003) who examines links among Bahrain, Kuwait, and Oman stock markets from October 1994 and August 2001. The author uses a multivariate cointegration analysis to show that the three GCC capital markets have become more open to each other. Gulf Cooperation Countries have started working toward economic integration to form a single market. GCC country members have started extensive privatization, computer-based trading, and shares inter-listing programs.

An interesting aspect of Table 6 is the increasing amount of contemporaneous spillovers between Israel and the five regional indices. In Table 3 we observed that

Table 5—Intraregional Contemporaneous Linkages: Significant Geweke Causality Tests and Inherent Pairwise Correlation Coefficients between Residuals from the Vector Autoregression¹

Year Period	93→01	94→01	95→01	96→01	97→01	98→01	99→01	00→01	01
Bahrain									S. Arabia (-0.22) Egypt (0.28) Turkey (0.22) S. Arabia (-0.16) Tunisia (0.18) Bahrain (0.28) Turkey (0.17)
Egypt									
Israel	Turkey (0.11)	Turkey (0.12)	Turkey (0.11)	Turkey (0.13)	Turkey (0.15)	Turkey (0.14)	Turkey (0.13)	Turkey (0.16)	
Jordan									
Kuwait									Oman (-0.13) Turkey (-0.17) Tunisia (0.17)
Lebanon									
Morocco									Tunisia (0.19) Kuwait (-0.13) S. Arabia (-0.13) Bahrain (-0.22) Egypt (-0.16) Oman (-0.13) Morocco (0.17) Egypt (0.18) Israel (0.17) Lebanon (-0.18) Bahrain (0.22)
Oman									
S. Arabia									
Tunisia									
Turkey	Israel (0.11)	Israel (0.12)	Israel (0.11)	Israel (0.13)	Israel (0.15)	Israel (0.14)	Israel (0.13)	Israel (0.16)	

¹ Only significant Geweke causality relationships (at least at the 5 percent level) and inherent pairwise residuals correlation (in parentheses) are reported. For instance, Saudi Arabia, Egypt, and Turkey significantly Geweke cause Bahrain in the period 2000-2001; inherent correlation coefficients between the residuals from the VAR are 0.22, 0.28 and 0.22, respectively. The shaded area corresponds to periods during which either tests are not significant or data series are not available as defined in the methodology section

Table 6—Interregional Contemporaneous Linkages: Significant Geweke Causality Tests and Inherent Pairwise Correlation Coefficients between Residuals from the Vector Autoregression

	90>01	91>01	92>01	93>01	94>01	95>01	96>01	97>01	98>01	99>01	00>01	01
Bahrain												Asia (0.14) East Eur. (0.14)
Egypt												
Israel												
Jordan												
Kuwait												
Lebanon												
Morocco												
Oman												
S. Arabia												
Tunisia												
Turkey												

^aRegion notations: LA (Latin America), and NA (North America). Only significant Geweke causality relationships (at least at the 5 percent level) and inherent pairwise residuals correlation (in parentheses) are reported. For instance Asia and East Europe significantly Geweke cause Bahrain in the period 2000-2001; inherent correlation coefficients between the residuals from the VAR are 0.14 and 0.14, respectively. The shaded area corresponds to periods during which either tests are not significant or data series are not available as defined in the methodology section

those lead-lag spillover effects had decreased from 2000 to 2001. In that case, lead-lag spillover analysis fails to capture existing links that have become increasingly contemporaneous. The same conclusions can be drawn from Turkey and, to a lesser extent, for Morocco and Tunisia. As in Table 5, most of the residuals correlation coefficients are positive, revealing that investors view other geographical blocks as prone to different events. Saudi Arabia is the sole exception.¹²

Results from using the IR and VD functions illustrate a striking feature of MENA markets, namely the slow and small transmission of shocks during any period of this study. Results of our spillover tests (Granger, GIRF, GVDF, residuals correlation, and Geweke) provide evidence that MENA markets are gradually opening to other regional and trans-continental economies, but remain highly segmented (with the exception of Turkey and Israel) and perhaps predictable. In this case, tactical asset allocation strategies across MENA markets can be beneficial.

Conclusion

We investigate short-lived linkages between five regional blocks and eleven MENA capital markets. Although previous research has shown that MENA capital markets are segmented, these small markets have recently shown interest in opening their borders and relaxing foreign ownership and capital repatriation restrictions. Using the first difference in price levels, we find evidence of a relative high degree of segmentation between MENA markets. Short-lived spillover analysis is conducted using a diagonal VAR-GARCH methodology inspired by Engle and Sheppard (2001). Subsequently, Granger causality, GVDF, GIRF, and Geweke causality tests are performed. We find that Israel and Turkey are more integrated; they seem to process information flows from global markets and act as conduits to other, smaller MENA markets. Apart from Israel and Turkey, our lead-lag and contemporaneous price spillover analyses find little evidence of short-term inter- and intraregional links in MENA capital markets. Although our findings suggest that MENA markets are becoming increasingly responsive to each other and to other economies, such market responses are still marginal. When generalized impulses response tests are applied, persistent endogenous shocks are found, suggesting that most MENA markets have a relative long memory of price predictability. As a result, tactical asset allocation strategies across MENA markets can be considered by global investors if peace and stability can be restored in the region.

¹² A clear shift was not found in contemporaneous residual correlation between MENA markets and Latin American around 1994 and 1995 (Tequila crisis), nor with the Asian block around 1997 and 1998 (Asian flu) and the Eastern European block around 1998 and 1999 (Russian virus). In all cases, the change in residual correlation is small and does not suggest contagion.

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