ECONOMIC RESEARCH FORUM

منتدى البحوث الاقتصادية

2008

working paper series

SHIFT-CONTAGION IN MIDDLE EAST AND NORTH AFRICA STOCK MARKETS

Wajih Khallouli

Working Paper No. 420

Shift-Contagion in Middle East and North Africa Stock Markets

Wajih Khallouli

Working Paper 420

July 2008

Wajih Khallouli, High School of Economic and Commercial Sciences, University of Tunis.
E-mail: Wajih.khallouli@gmail.com

Abstract

This paper is an empirical study that seeks to determine whether any of the Middle East and North Africa (MENA) stock markets were vulnerable to financial contagion in the wake of the 2001 Turkish crisis. In line with Ayadi et al. (2006), we use a new procedure which consists of testing the non-linearity of the mechanisms spreading shocks, estimated with a model of long-term interdependence. Our results provide evidence of high level of interdependence between MENA stock markets. However, we find that, with the exemption of the contamination of Israel's stock market, there is no evidence of shift-contagion in the transmission of financial shocks across MENA stock markets.

ملخص

هذه الورقة هي دراسة تجريبية تهدف إلى تحديد قابلية أي من بورصات الشرق الأوسط وشمال أفريقيا للعدوى المالية بعد أزمة تركيا عام 2001. على نسق أيادي وآخرين (2006) نلجأ إلى إجراء جديد يقيس درجة افتقار آليات انتشار الصدمات إلى الخطية حسب نموذج طويل الأمد من المساندة المتبادلة من دول الشرق الأوسط وشمال أفريقيا. وقدمت النتائج الدليل على ارتفاع درجة الاعتماد المتبادل بين بورصات دول الشرق الأوسط وشمال أفريقيا. إلا أننا نجد أنه باستثناء بورصة إسرائيل، لا يوجد أي دليل على انتقال عدوى نتيجة انتقال الصدمات المالية عبر بورصات الشرق الأوسط وشمال أفريقيا.

1. Introduction

During the past decade, the financial liberalization policies adopted by the developed economies in the Middle East and North Africa (MENA) have increased integration between the international financial markets of the region. Several studies have suggested that increasing global integration is beneficial to growth and employment (Collins and Abrahamson, 2006). Other studies showed that the high integration among international financial markets generally increases the interdependence between them. Hence, present MENA stock markets display opportunities for international diversification (Lagoarde - Segot and Lucey 2007). On the other hand, the downside to high integration is an increased sensitivity to capital flows and an increased exposure to the transmission of negative shocks; the more integrated markets are more vulnerable to the effects of a shock in another country. The transmission of shocks results from financial panics and herding or switches of expectations of multiple equilibria (equilibrium with speculative attacks *vs.* equilibrium without speculative attacks) (Masson 1999). This phenomenon has often been described as contagion (Forbes et Rigobon, 2002). Forbes and Rigobon (2001) refer to crisis-contingent theories and give this phenomenon the name of "shift-contagion". The authors assume that investors behave differently after a crisis, implying a generation of the new temporary channels of propagation in addition to the permanent channels which characterize the interdependence between the economies. Empirically, the generation of new temporary channels corresponds to a non linearity characterizing both the asymmetric equilibria of stability and the crisis of the contaminated economy. By contrast, in non-crisis-contingent theories, there is no difference in the transmission mechanisms between crises and stable periods. Along the same lines, the shocks are propagated through strong linkages between countries, such as trade links (Gerlach and Smets, 1995 ; Corsetti et al. , 1999), financial links (Kaminsky and Reinhart, 2000 ; Van Rijckeghem and Weder 2003) or common shocks (Masson, 1999, Forbes and Rigobon, 2001). Forbes and Rigobon (2002) used the term interdependence to refer to this situation.

The objective of this paper is to investigate this issue in the context of emerging markets of the MENA region. Our aim is to estimate a model for financial interdependence and to detect non-linearity in the international propagation of shocks among the MENA countries in order to identify the shift-contagion during the Turkish crisis 2001. In fact, the MENA region is an under-investigated emerging market despite the significant equity market development in the region since the 1990s. Indeed, the financial liberalization policy of the 1990s included plans to revitalize stock markets in some countries and establish stock markets in others for encouraging private investment and capital markets. As a consequence, we can observe significant changes in the MENA equity markets if we compare some key financial market indicators in 2003. Table 1 compares the sizes, maturity and capitalization of the major MENA markets. Jordan leads the region in terms of market capitalization (110%) followed by Israel (67%) and the last on the list is Lebanon (with 7%). However, Turkey has the highest degree of liquidity; it has the highest turnover ratio (143%). The lowest turnover ratios are for Tunisia (7%) and Lebanon (8%). Finally, in terms of number of listed companies, Egypt is the biggest market with 967 compared to 285 for Turkey and 161 for Jordan. As shown, these markets are nevertheless heterogeneous. It suggests high integration into global financial economy due to diversification benefits (Lagoarde-Segot and Lucey, 2007). For Collins and Biekpe (2003), the spread of a crisis depends heavily on the degree of financial market integration since the international investors are actively investing in the afflicted markets. Therefore, the more globally integrated markets are the more susceptible they are to the contagious effects of a shock of another country.

In order to identify the shift-contagion among the MENA countries during the Turkish crisis, this paper proposes a new procedure which consists of testing the non-linearity of the mechanisms for spreading shocks, estimated with a model of long-term interdependence (modelling the long-run dynamics of interdependence). Our test for presence of shift-contagion thus proceeds in two stages. In the first one, we test the possibility of presence of long-run interdependence by identifying co-integration relationship between the stock markets. Such a relationship shows the existence of permanent channels through which the shocks are normally transmitted. In the second stage, we test the assumption according to which these channels were modified during the period of crisis. In other words, we test non-linearity in the behavior of short-run adjustment which leads to long-run equilibrium in an Error Correction model using Escribano-Pfann approach (1998). By comparison with empirical work of the contagion literature, our approach uses the long-run interdependence to identify the shift-contagion. It may also solve the econometric problems such as the definition of the crisis periods. Using the daily indices for some MENA stock markets as the measurement of the risk aversion of investors to risk premium, our research shows some results related to the identification of the shift-contagion in the MENA stock market returns during the Turkish crisis, but it highlights that there is high level of market interdependence.

The remainder of the paper is organized as follows. Section 2 recalls different measurements of the shift-contagion and their limits. Section 3 outlines the methodology followed. Section 4 presents the data and the obtained empirical results. Section 5 concludes the paper.

2. Shift-Contagion Measurements

In order to identify a possible shift-contagion, several methodologies were used to test for the non-linearity of structural shocks (Favero and Giavazzi, 2002; Wälti, 2003 ; Bonfiglioli and Favero, 2005) or to investigate changes in the existence and directions of causality between the financial markets before and after the crisis (Masih et Masih, 1999 ; Sander et Kleimeier, 2003 ; Au Yong et al.ii, 2004). However, there are extensive empirical studies investigating the stability of international propagation of financial shocks by a correlation analysis. In the empirical literature, shift-contagion is measured by the significant increase in the degree of the cross-markets financial links (approximated by the correlation) between tranquil and crisis periods (Baig and Goldfajn, 1998 ; Forbes and Rigobon, 2002 ; Rigobon 2003). The pioneers who used this methodology to test for the presence of the contagion are King and Wadhwani (1990). They found that the correlation between United States, United Kingdom and Japan's stock markets had increased after the U.S. crash of 1987. Other studies applied this test of correlation to other types of financial markets (markets of sovereign debts, exchanges and interest rate) and other episodes of crises (Calvo and Reinhart, 1996; and Baig and Goldfajn, 1998). According to Forbes and Rigobon (2002), these tests based on cross-market correlations always reach the same conclusion that contagion had occurred. However, tests based on analysis of conditional correlation admit to several limits. The use of high frequency financial series affects the test through three types of bias: heteroskedasticity, simultaneous equations and omitted variables (Ronn, 1998; Forbes and Rigobon, 2002; Rigobon, 2003; and Yoon, 2005). Forbes and Rigobon (2002) tested the increase in the correlations coefficients but only adjusted for heteroskedasticity bias. They didn't detect a structural break. Thus, they concluded that propagation of the Asian crisis resulted from the interdependence between the financial markets and not from contagion. Moreover, Forbes and Rigobon (2002) showed, by simulations, that their tests were biased when data suffered from simultaneous equations and omitted variable problems. In order to correct these problems, an original methodology to test for structural breaks in the correlation across financial markets was proposed by Rigobon (2003). He applied a structural change test (determinant of the change in the covariance matrix test) using a limited information estimation based on an instrumental variable (IV) method which is constructed by splitting the sample into two windows (window of stability and window of crisis). Rigobon (2003) studied the stability of the international propagation mechanisms between 36 stock markets during the three recent international financial crises (Mexico 1994, Asia 1997 and Russia 1998). Their results showed that the increase in the correlation between these stock markets did not result from instability in the mechanisms of propagation, but was rather the consequence of a strong interdependence during the crisis period as well as during periods of stability. Although the conclusions of Rigobon (2003) were interesting, the results were not considered robust. Indeed, the size of the crisis window had an important influence on the sensitivity of the results (see, Billio and Pelizzon, 2003; and Dungey and Zhumabekova, 2001).

In order to solve this problem of crisis window definition, Caporale et al. (2005) tested for the stability of the propagation mechanisms using an approach based on an estimate of the full sample. They corrected the heteroskedasticity assuming that the structural shocks following a GARCH (1,1) process. Their results suggested the existence of contagion between Asian stocks markets. Using the same approach, McAleer and Wei Nam (2005) also verified the contagion between Asian foreign exchange markets. In contrast to Rigobon (2003), other studies tested for the stability of the propagation mechanisms using the full-information estimation (Favero and Giavazzi, 2000, 2002; Wälti, 2003; and Bonfiglioli and Favero, 2005). Indeed, Favero and Giavazzi (2002) showed that this approach provided a more powerful test. Wälti (2003) introduced a proxy variable for the international common shocks (Monsoonal Effect), and found that the null hypothesis of the stability of propagation mechanisms between Asian stocks markets is largely rejected. Bonfiglioli and Favero (2005) distinguished between long-run and short-run dynamics for interdependence. They verified the instability of the propagation mechanisms between the United States and Germany's stock markets using a Vector Error Correction Model (VECM).

In line with Ayadi et al. (2006), we propose a new procedure in this paper which consists of testing the stability of the mechanisms spreading shocks. We thus test the non-linearity of the structural shocks following Favero and Giavazzi (2002). We estimate these shocks through a cointegration system between the financial markets. Contrary to previous research, this new procedure uses the long-term interdependence and it also enables us to solve the problem of crisis window definition by using the totality of the period in our estimation.

3. Data and Methodology

3.1. Data

To identify the shift-contagion, many works use as indicators for international investors behaviors, the foreign exchange markets (AuYong et al., 2004; and McAleer and Wei Nam, 2005), the interest rate markets (Baig and Goldfajn, 1998; and Khalid and Kawai, 2003) and the sovereign debt markets (Sander and Kleimeier, 2003; and Marias and Bates, 2005). Following Tan (1998), Masih and Masih (1999), Baur (2003), and Rigobon (2003), stock indices of 5 MENA stock markets are examined in this study: Egypt (EGY), Israel (ISR), Jordan (JOR), Morocco (MOR) and Turkey (TUR)[1]. We choose a log-transformation of the data in order to interpret the links between variables in terms of elasticity. All of the daily indices are denominated in US dollar. The data covers the period from March 2, 1999 to March 1, 2004 (yielding 1305 observations), and is obtained from the MSCI database. The sample period is divided into a tranquil period (from March 1999 to January 2001) and a crisis period (from February 2001[2] to March 2004).

[1] For data availability constraints, we could not include other significant MENA stock markets in the analysis such as those of the Gulf countries.

[2] February 2001 is the date of the Turkish financial crisis and the flotation of the Turkish lira.

Table 2 provides the cross-market correlations and some descriptive statistics for all of the countries analyzed.

As Table 2 shows, most of the cross-market correlation coefficients of our sample seem higher, with the exception of Jordan. The higher correlation is between Egypt and Morocco (0.903). With the exception of Jordan, the Turkish stock market seems highly interdependent with the other MENA market: Egypt, Israel and Morocco (0.871, 0.805 and 0.69, respectively). This interdependence is generated by the risk aversion of investors to risk premium conveyed by the high degree of portfolios diversification (Kaminsky and Reinhart, 2000). We then make the assumption that international investors not discriminated between the affected countries by the degree of their financial fragility but they attacked seeking the high risk premiums during Turkish crisis.

On the other hand, Table 2 shows that Egyptian and Turkish stock markets have the highest volatility (Std. dev. is equal to 0.415 and 0.48 for Egypt and Turkey, respectively). The figures (see Appendix) graph the volatility of the different series of our sample that are characterized by switching their behaviors from a tranquil regime to a turmoil regime.

3.2. Estimating Financial Interdependence and Testing Shift-Contagion

Like Rigobon (2003), we define the shift-contagion as the rise in cross-market interdependency after a shock caused by one or more countries. The rise in interdependency must be associated with a non-linearity that shows the generation of the new transmission mechanisms of the shocks among countries (Favero and Giavazzi, 2002). Those new mechanisms did not exist during the tranquil period. Indeed, they reflect the switching in investors' expectations. In this paper, we distinguish between long-run and short-run interdependence for different markets. Shift-contagion is then identified via a model of long-run interdependence represented by co-integration system. Indeed, we test non-linearity in the behavior of short-run adjustment which leads to long-run equilibrium using Escribano-Pfann approach (1998) to estimate the Error Correction Model (ECM).

The financial interdependence model is estimated by the ECM in the co-integrated system. Indeed, if two time series x_t and y_t are nonstationary, integrated of the same order and their linear combination z_t[3] is already stationary, the two series are said to be co-integrated (Engel and Granger, 1987). Thus, we estimate an ECM that represents the short-run dynamics which maintains the long-run equilibrium between the two series:

$$\Delta y_t = \sum_{i=1}^{p} \theta_i \, \Delta y_{t-i} + \sum_{i=1}^{q} \lambda_i \, \Delta x_{t-i} + \delta \, z_{t-1} + \varepsilon_t \qquad (1)$$

where ε_t is the error terms assumed to be independent and independently distributed with zero mean and unit variance. z_{t-1} is the error correction term. δ is the adjustment speed parameter, measuring the error-correction mechanism that drives the y_t back to their long-run equilibrium relationship.

For Forbes and Rigobon (2001), the linear co-integration relation shows the existence of the permanent channels of the shocks propagation between the financial markets. These channels are represented by the parameter β of the long-run equilibrium equation. However, the linear co-integration cannot identify the shift-contagion. For this reason, we use the ECM (Eqs. 1) as just the financial interdependence model between the two stock markets x_t and y_t. We extend our analysis by testing the non-linearity of the structural shocks of x_t to y_t (asymmetric adjustment) in order to identify the shift-contagion. For this, we use the Non-linear Error

[3] z_t is the residual of the log-run equilibrium equation ($y_t = \hat{\alpha} + \hat{\beta} x_t + z_t$).

Correction (NEC) model in which the linear error correction term z_{t-1} is replaced by the asymmetric term. To measure the asymmetric error correction we introduce the following concepts as Escribano-Pfann (1998):

- Positive error correction movements are characterized by positive differences between two subsequent measurement points of the long-run equilibrium error.

$$z_{t-1}^{+} = \begin{cases} z_{t-1} & \text{if } \Delta z_{t-1} > 0 \\ 0 & \text{otherwise} \end{cases}$$

- Negative error correction movements are characterized by negative differences between two subsequent measurement points of the long-run equilibrium error.

$$z_{t-1}^{-} = \begin{cases} z_{t-1} & \text{if } \Delta z_{t-1} < 0 \\ 0 & \text{otherwise} \end{cases}$$

This transformation allows the creation of two equilibria each characterized by a specific adjustment speed. The first equilibrium is reflective of the tranquility period and it is captured by the z_{t-1}^{-} term. On the other hand, the crisis equilibrium is captured by the z_{t-1}^{+} term. If Δz_{t-1} is equal to zero, the propagation mechanisms are approximated by the ratio of the variations of two series ($\Delta z_{t-1}=0 \Leftrightarrow \beta=\frac{\Delta y_{t-1}}{\Delta x_{t-1}}$). In fact, this ratio represents the short-run dynamics (co-movements) which ensure the permanent propagation of the shocks between the two financial markets x_t and y_t. During the stability period, these co-movements prove to be lower than a level β ($\Delta z_{t-1}<0 \Leftrightarrow \frac{\Delta y_{t-1}}{\Delta x_{t-1}}<\beta$). However, it becomes higher than this level β during the crisis period ($\Delta z_{t-1}>0 \Leftrightarrow \frac{\Delta y_{t-1}}{\Delta x_{t-1}}>\beta$). As a consequence, we note that if the ECM is non-linear, the behavior of the propagation mechanisms captured by the parameter β changes during the crisis period since we distinguish a significant increase in the degree of the co-movements between the financial markets. Thus, the non-linearity of the ECM shows the significant rise in cross-market interdependency after a shock. It then shows the existence of shift-contagion.

The new representation of the ECM with asymmetric adjustments is:

$$\Delta y_t = \sum_{i=1}^{p} \theta_i \, \Delta y_{t-i} + \sum_{i=1}^{q} \lambda_i \, \Delta x_{t-i} + \delta_1 \, z_{t-1}^{-} + \delta_2 \, z_{t-1}^{+} + \varepsilon_t \qquad (2)$$

In line with Escribano-Pfann (1998), the hypothesis of linearity of ECM is rejected if δ_1 is significantly different from δ_2. We confirm the existence of non-linear error correction mechanisms, and then we interpret this result by the existence of the shift-contagion that propagated from x_t toward y_t.

4. Empirical Results

We begin our cointegration analysis by applying the unit root tests for all series of our sample. In addition to the Augmented Dickey Fuller (ADF) test, we also use the Phillips Perron (PP) test which takes into account in a non parametric way both the autocorrelations and the heteroskedasticity bias. Table 3 provides the results of the two unit root tests on levels and first differences of logs all series. Our tests reveal that all series are integrated of order one (I(1)) at 5% level. As such, it is possible that some combinations of them are cointegrated. We use therefore the Johansen's approach to test this possibility.

Table 4 shows results of the trace tests which provide the maximum number of cointegration relationships. As shown, the null hypothesis of absence of cointegration is rejected. On the other hand, we accept the null hypothesis of existence of at most only one cointegration relationship between the selected stock indices. Thus, Johansen's test shows that a single cointegrating vector exists without indicating the cointegrated variables. Indeed, the value of the trace test and Eigenvalue test are significant at the 5% level. Nevertheless, the evidence of cointegration between the MENA stock markets reveals the presence of high long-run interdependence between them. In fact, there are permanent channels which assure the international transmission of financial shocks among our sample countries.

As shown before, in the presence of cointegration, there always exists a corresponding ECM which represents the co-movements between stock indices and the possibility that they will trend together in establishing a long-run equilibrium or a long-run interdependence. Indeed, ECM estimates the propagation mechanisms of shocks (captured by error-correction term) from independent or explanatory stock indices[4] (x_t in equation 1) to the dependent stock indices (y_t in equation 1). The results for five ECM equations are thus presented in Table 5. In fact, since these equations require normalization (choice of a dependant variable) we reported estimations where we use an endogenous variable for each equation. As shown, the coefficients associated with error-correction terms for all equations always prove positive. Although these coefficients, except for the equation in which ΔISR is treated as the dependent variable, are significant at the 5% or 10%, their signs do not conform to the economic intuition. In fact, the coefficient must be negative to indicate the adjustment back towards equilibrium. This outcome shows that linear ECM wouldn't be an acceptable representation for the short-run interdependence between the MENA stock markets. We must then examine the interdependence using other representations that appear more realistic as the asymmetric ECM. Indeed, it is the linearity test for adjustment back towards equilibrium which allows identifying contagion from interdependence.

Table 6 reports results of Fisher test for the non-linearity of ECM equations and their estimations. Indeed, the estimated error correction parameters (δ_1 and δ_2 in equation 2) provide us with useful additional information for two asymmetry adjustments between MENA stock markets towards stability equilibrium and the Turkish crisis equilibrium by confirming the existence of the long-run cointegration relationship that represents the high long-run interdependence between these markets. As can be seen for all equations, the coefficients associated with z_{t-1}^{-} and z_{t-1}^{+} have negative signs except for equation in which ΔJOR is treated as the dependent variable. It is in line with the expected error correction mechanisms. Thus, the condition of the adjustment back towards two equilibria for the stability period and the turmoil period is verified. These results prove the existence of a permanent interdependence (permanent channels of shocks transmission) between MENA stock markets even with a non-linear representation. However, we rejected the hypothesis of linearity of ECM only for equation in which ΔISR is treated as the dependent variable: the *p-value* of the *F*-statistic testing the statistical significance of the asymmetry (Eq. 1) vs. the linear ECM model (Eq.2) yields *p-value* = 0.16[5]. We then verify the significant asymmetry of adjustment mechanisms towards stability equilibrium and crisis equilibrium for Israel's stock market. Indeed, this non-linearity implies the changes in the transmission mechanisms of shocks from MENA countries and in particular Turkey to Israel. These changes are generated by the realization of the new transmission mechanisms which reveals that investors in Israel's

[4] x_t is supposed to be at the origin of the shocks. It can represent several countries. In fact, we do not limit ourselves to only one country as the source of contagion since we suppose that shocks can to be caused by one or more countries.

[5] We can consider this value as significant at 10% level.

stock market don't have a uniform perception of regional country risk, particularly after the Turkish crisis. We then distinguish a significant increase in the degree of the co-movements or interdependence between the stock markets of our sample captured by the non-linearity of Israel's stock indices reaction following shocks in other independent stock indices. This finding can be interpreted as evidence of shift-contagion for the Israeli stock market contamination.

Overall, our results suggest that there is a high level of interdependence between MENA stock markets. However, we find that the the non-linearity of the transmission mechanisms of shocks affects Israel's stock market. Such non-linearity is interpreted as the existence of shift-contagion in that it amounts to a modification of interdependence in periods of turmoil implying a generation of new temporary channels of shocks transmission in addition to the permanent channels. Although our methodology does not aim to specify the country origin of shocks, there is hardly any doubt that Turkey played the role of ' *ground zero.'*

5. Conclusion and Policy Implications

Given the high heterogeneity of the MENA financial markets (Table 1), they are likely to be the most integrated with global capital flows. It would commonly be expected that those markets would be the most susceptible to contagion. This paper is thus an attempt to investigate the vulnerability to financial contagion in the context of the emerging MENA markets during the Turkish crisis of 2001. Following Ayadi et al. (2006), we propose a new test of shift-contagion by testing a non-linearity in the international propagation of shocks among a set of MENA stock market indices. Contrary to previous works, we estimate a long-run interdependence model using cointegration analysis. We test thereafter the non-linearity of shocks propagation mechanisms in an ECM model that represents the short-term dynamics. Our methodology enables us to solve the problem of crisis window definition by using the totality of the period under investigation.

Overall our results highlight that, with the exemption of the contamination of Israel, there is no evidence of significant change in the propagation mechanisms between MENA countries following the Turkish crisis. Actually, most financial shocks between the MENA stock markets are transmitted through non-crisis-contingent channels. In line with Forbes and Rigobon (2002), there is 'no contagion, only interdependence.' The results have two important implications. First, our empirical evidence of long-term interdependence between the MENA stock markets suggests that the potential long-run international diversification across these markets may be an effective investment strategy. Second, our empirical evidence of contagion in the MENA region is crucial to MENA monetary authorities' decisions. It conditions the definition of measurements that can be adopted in order to avoid contagion and reduce vulnerability to external shocks. Indeed, the authorities may find it beneficial to adopt strategies of insulation in the short term to regulate the negative externalities of financial liberalization.

References

AuYong, H. H., Gan, C., Treepongkaruna, S., 2004. "Cointegration and Causality in the Asian and Emerging Foreign Exchange Markets: Evidence from the 1990s Financial Crises," *International Review of Financial Analysis*, 13, 479-515.

Ayadi, M., Boudhina, R., Khallouli, W., Sandretto, R., 2006. "La Contagion de la Crise Asiatique : Dynamiques de Court Terme et de Long Terme," *Economie Internationale,* 105, 113-135.

Baig, T., Goldfajn, I., 1998. "Financial Market Contagion in the Asian Crisis," IMF Working Paper, WP/98/155.

Baur, D., 2003. "Testing for Contagion - Mean and Volatility Contagion," *Journal of Multinational Financial Management,* 13, 405-422.

Billio, M., Pelizzon, L., 2003. "Contagion and Interdependence in Stock Markets: Have They been Misdiagnosed?" *Journal of Economics and Business*, 55, 405-426.

Bonfiglioli, A., Favero C. A., 2005. "Explaining Co-movements between Stock Markets: The Case of US and Germany," *Journal of International Money and Finance*, 24(8), 1299-1316.

Caporale, G. M., Cipollini, A., Spagnolo, N., 2005. "Testing for Contagion: A Conditional Correlation Analysis," *Journal of Empirical Finance*, 12, 476-489.

Collins, D., Abrahamson, M., 2006. "Measuring the Cost of Equity in African Financial Markets," *Emerging Markets Review*, 7, 67-81.

Collins D., Biekpe N., 2003. "Contagion: A fear for African Equity Markets?" *Journal of Economics & Business,* 55(5), 405-426.

Corsetti, G., Pesenti, P., Roubini, N, Tille, C., 1999. "Competitive Devaluations: A Welfare-based Approach," NBER Working Paper Series, 6889.

Dungey, M., Zhumabekova, D., 2001. "Testing for Contagion Using Correlation: Some Words of Caution," Pacific Basin Working Paper Series, n° PB01-09.

Engle, R. F., Granger, C. W. J., 1987. "Co-integration and Error Correction Representation, Estimation and Testing," *Econometrica*, 55, 251-276.

Escribano, A., Pfann, A. G., 1998. "Non-linear Error Correction, Asymmetric Adjustment and Cointegration," *Economic Modelling*, 15, 197-216.

Favero, C. A., Giavazzi, F., 2000. "Looking for Contagion: Evidence from the ERM," NBER Working Paper Series, 7797.

Favero, C. A., Giavazzi, F., 2002. "Is the International Propagation of Financial Shocks Non-linear? Evidence from the ERM," *Journal of International Economics*, 57, 231-246.

Forbes, K., Rigobon, R., 2001. "Contagion in Latin America : Definition, Measurement and Policy Implications," Mit-Sloan School of Management and NBER, January 17.

Forbes, K., Rigobon, R., 2002. "No Contagion, Only Interdependence: Measuring Stock Market Co-movements," *Journal of Finance,* 57 (5), 2223-2261.

Gerlach, S., Smets, F., 1995. "Contagious Speculative Attacks," *European Journal of Political Economy, 11, 45-63.*

Kaminsky, G., Reinhart, C., 2000. "On Crises, Contagion and Confusion," *Journal of International Economics,* 51, 145-168.

Khalid, A. M., Kawai, M., 2003. "Was Financial Market Contagion the Source of Economic Crisis in Asia? Evidence Using a Multivariate VAR Model," *Journal of Asian Economics*, 14, 131-156.

King, M., Wadhwani, S., 1990. "Transmission of Volatility between Stock Markets," *Review of Financial Studies*, 3 (1), 5-33.

Lagoarde-segot T., Lucey B.M., 2007. "International Portfolio: Is There a Role for the Middle East and North Africa?" *Journal of Multinational Financial Management*,

MacKinnon, J., 1991. "Critical Values for Cointegration Tests, in Long-Run Economic Relationships, Engle R. & Granger C. (éd.), Oxford University Press.

Marais, E., Bates, S., 2005. "An Empirical Study to Identify Shift Contagion during the Asian Crisis," *Journal of International Financial Markets, Institutions & Money*, 16(5), 468-479.

Masih, A. M. M., Masih, R., 1999. "Are Asian Stock Market Fluctuations due Mainly to Intra-regional Contagion Effects? Evidence Based on Asian Emerging Stock Markets," *Pacific-Basin Finance Journal*, 7, 251-282.

Masson, Paul R., 1999. "Contagion: Macroeconomic Models with Multiple Equilibria," *Journal of International Money and Finance*, 18, 587-602.

McAleer, M., Wei Nam, J. C., 2005. "Testing for Contagion in ASEAN Exchange Rates," *Mathematics and Computers in Simulation*, 68, 519-527.

Rigobon, Roberto, 2003. "On the Measurement of International Propagation of Shocks: Is the Transmission Stable?" *Journal of International Economics*, 61, 261-283.

Ronn, E., Aking, S., Tompaidis, S., 1998. "The Impact of Large Changes in Asset Prices on Intra-Market Correlations in the Stock and Bond Markets," Working Paper, University of Texas at Austin.

Sander, H., Kleimeier, S., 2003. "Contagion and Causality: An Empirical Investigation of Four Asian Episodes," *Journal of International Financial Markets, Institutions & Money*, 13, 171-186.

Tan, J. A. R., 1998. "Contagion Effects during the Asian Financial Crisis: Some Evidence from Stock Price Data," Pacific Basin Working Paper Series N° 98-06.

Van Rijckeghem, C., Weder, B., 2003. "Spillovers Through Banking Centers: A Panel Data Analysis of Bank Flows," *Journal of International Money and Finance*, 22, 483-509.

Wälti, Sébastien, 2003. "Testing for Contagion in International Financial Markets: Which Way to Go?" HEI Working Paper 04/2003.

Yoon, G., 2005. "Correlation Coefficients, Heteroskedasticity and Contagion of Financial Crises," Manchester School, Vol. 73, No. 1, pp. 92-100.

Table 1: Comparative Indicators for MENA Financial Markets (2003)

Country	Market capitalization/GDP (%)[a]	Liquidity (%)[b]	Listed companies[c]
Egypt	33.79	15.61	967
Morocco	29.32	18.72	52
Tunisia	10.03	7.73	45
Jordan	110.73	23.78	161
Lebanon	7.91	8.72	14
Israel	67.23	27.74	577
Turkey	29.36	143.55	285

Source: Lagoarde-Segot and Lucey (2007)
a Market capitalization/GDP' is the market capitalization at the end of each year divided by GDP for the year.
b 'Liquidity' corresponds to total value traded for the year divided by market capitalization.
c 'Listed companies' are the number of listed companies at the end of the year.

Table 2: Correlations and Descriptive Statistics

	EGY	ISR	JOR	MOR	TUR
EGY	1.000000				
ISR	0.675454	1.000000			
JOR	-0.267475	-0.430140	1.000000		
MOR	0.903277	0.483156	-0.126180	1.000000	
TUR	0.871999	0.805902	-0.308419	0.690911	1.000000
Mean	*4.770125*	*4.884722*	*4.265798*	*5.086448*	*5.225393*
Median	*4.779611*	*4.851499*	*4.268970*	*5.062854*	*5.165300*
Maximum	*5.655065*	*5.464772*	*4.827241*	*5.540106*	*6.356762*
Minimum	*4.115910*	*4.426701*	*3.996162*	*4.679962*	*4.418817*
Std.dev.	*0.415832*	*0.262439*	*0.178601*	*0.224642*	*0.487709*

Table 3: Results of ADF and PP Tests for Unit Root on Levels and First Differences of Logs of MENA Stock Market Indices

Stock indice	Levels		First differences	
	ADF	PP	ADF	PP
EGY	-0.270444	-0.281007	-14.88241	-34.86724
ISR	0.346240	0.460853	-16.20865	-34.51575
JOR	-0.671955	-0.559857	-17.06448	-35.72431
MOR	-1.082337	-1.106046	-14.90310	-31.08128
TUR	0.033272	0.051163	-16.39052	-34.91509

The critical values for ADF and PP tests are equal to (-1.93) at the 5% level (source: Kwiatkowski et al., 1992).

Table 4: Johansen's Multivariate Cointegration Tests Using Trace Statistics

Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.022525	87.34498	87.31	96.58
At most 1	0.019432	58.22951	62.99	70.05
At most 2	0.010421	33.15149	42.44	48.45
At most 3	0.010001	19.76318	25.32	30.45
At most 4	0.005398	6.917883	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level.
Trace test indicates 1 cointegrating equation(s) at the 5% level.
Trace test indicates no cointegration at the 1% level.

The critical values are given by Osterwald-Lenum (1992).

Table 5: Estimation Results of Different Linear ECM Equations

	ΔEGY	ΔISR	ΔJOR	ΔMOR	ΔTUR
C	-0.000123	0.000269	0.000340	-0.000275	0.000146
	(-0.251973)	(0.515590)	(1.408555)	(-1.150338)	(0.136070)
ΔEGY (-1)	0.013583	0.013478	-0.018122	0.001213	-0.055596
	(0.484036)	(0.450209)	(-1.300026)	(0.088214)	(-0.904006)
ΔISR (-1)	0.060831	0.036686	-0.002706	0.020975	0.318982
	(2.285830**)	(1.288654)	(-0.204896)	(1.606736)	(5.458038**)
ΔJOR(-1)	0.059019	0.038123	0.004132	0.052387	0.012828
	(1.043366)	(0.627901)	(0.146716)	(1.887690*)	(0.103136)
ΔMOR(-1)	0.067390	0.060489	-0.001286	0.145609	0.236723
	(1.192459)	(1.003295)	(-0.045976)	(5.252435**)	(1.913002*)
ΔTUR(-1)	0.025537	-0.004593	0.000453	0.002151	-0.013334
	(1.992462**)	(-0.335659)	(0.071517)	(0.342613)	(-0.472097)
z_{t-1}	0.010541	0.004315	0.005762	0.005146	0.024529
	(2.254688**)	(1.198463)	(3.720888**)	(1.767381*)	(4.112977**)

The variables on top are the endogenous variables of equation 1. Note that the lag length is arbitrarily determined.
The numbers in parentheses are *t-statistics*.
** Significance at the 5% level.
* Significance at the 10% level.

Table 6: Estimation Results of Different Non- linear ECM Equations

	ΔEGY	ΔISR	ΔJOR	ΔMOR	ΔTUR
C	-9.01E-05 (-0.184125)	0.000204 (0.390386)	0.000357 (1.469919)	-0.000265 (-1.104226)	6.01E-05 (0.055639)
ΔEGY(-1)	0.024167 (0.863764)	0.011883 (0.397624)	-0.015944 (-1.138301)	-0.001199 (-0.087205)	-0.064384 (-1.042683)
ΔISR(-1)	0.064272 (2.418159**)	0.039089 (1.372438)	-0.003032 (-0.227105)	0.020201 (1.546824)	0.309485 (5.263322**)
ΔJOR(-1)	0.056951 (1.009374)	0.061021 (1.007542)	0.011783 (0.415498)	0.051735 (1.863840*)	-0.029020 (-0.232534)
ΔMOR(-1)	0.044961 (0.798487)	0.067020 (1.113642)	0.001491 (0.053078)	0.151555 (5.465303**)	0.247633 (1.994552**)
ΔTUR(-1)	0.018479 (1.442571))	-0.007607 (-0.557332)	0.000801 (0.125987)	0.003594 (0.572312)	0.012781 (0.449060)
z^{-}_{t-1}	-0.012939 (-1.912746**)	-0.014854 (-2.871858**)	0.004558 (1.955606**)	-0.003603 (-0.874470)	-0.022445 (-2.698564**)
z^{+}_{t-1}	-0.019362 (-3.003332**)	-0.004887 (-0.976735)	0.001098 (0.518174)	-0.007269 (-1.772970*)	-0.011942 (-1.374599)
H0: $\delta_1 = \delta_2$					
F-statistics (*p-value*)	0.471915 (*0.492233*)	1.917198 (*0.166409**)	1.208347 (*0.271867*)	0.398409 (*0.528025*)	0.757976 (*0.384127*)
Linearity Hypothesis	Accepted	Rejected	Accepted	Accepted	Accepted

The variables on top are the endogenous variables of equation 1. Note that the lag length is arbitrarily determined.
The numbers in parentheses are *t-statistics*.
** Significance at the 5% level.
*Significance at the 10% level.

Appendix

Stock Indices Evolution