Impact of Political Instability on Cointegration: Evidence from MENA Region Stock Markets during Pre and Post Egyptian Revolution Period

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Abstract

This paper explores inter-market linkages between the Egyptian equity market and the MENA region markets of Turkey, Saudi Arabia, Israel and Jordan during the pre and post Egyptian revolution period of the 25th of January 2011. Johansen's cointegration was used to study long-run linkages. Granger causality was applied using the Toda and Yamamoto procedure to study short-run linkages. Results provided evidence of increased levels of cointegration during the post revolution period between (i) Egypt and Turkey, (ii) Egypt and Israel, and (iii) Egypt and Jordan and decreased levels of cointegration between Egypt and Saudi Arabia. Granger causality indicated a decrease in short-run linkages during the post revolution period between (i) Egypt and Turkey, (ii) Egypt and Saudi Arabia, and (iii) Egypt and Israel while short-run linkages between Egypt and Jordan remained the same.The variations in inter-market linkages between the two periods suggest that during the crisis period short term portfolio diversification may be successful while long term diversification is unlikely to be successful.

Keywords: Johansen's cointegration, Ganger causality, MENA region, political instability, interdependence, diversification, Egyptian revolution, Egyptian stock market.

JEL Classification: C01, G15, F15, F21.

1 Introduction

Investment diversification is a cornerstone of modern portfolio theory. In order to optimize the risk-return relationship, capital should be allocated among assets with minimum dynamic linkages and interdependence. However, with the increased interdependence of global equity markets, diversification opportunities have become increasingly more difficult to identify. Therefore, exploring the co-movements between equity markets during periods of tranquility and turbulence is of overriding importance in order to uncover whether or not true diversification opportunities exist. If two markets are uncorrelated during periods of tranquility but exhibit higher correlations during turbulent periods, then apparent diversification opportunities during the tranquil period would cease to exist during the turbulent period. The lack of correlations during the tranquil period would give the investor a false sense of protection as the jump in correlations during the turbulent period would lead to a breakdown in the diversification structure of the portfolio. Therefore, understanding how specific shocks or periods of turbulence affect the linkages between equity markets is essential in order to achieve successful portfolio diversification.

The increase in interdependence between equity markets during periods of turbulence is well documented in empirical research. A widely applied methodology in studying interdependence of equity markets is cointegration analysis. Cointegration analysis explores the presence of a long-run equilibrium relationship between markets. Cointegrated time series may diverge in the short-run while maintaining a common stochastic trend in the long-run subject to an Error Correcting Mechanism (ECM). When two markets are cointegrated, they exhibit long-run interdependence and co-movements, diminishing the success of portfolio diversification. In this research, we investigated the influence of the Egyptian revolution of January 25th 2011 on the cointegration relationship between the Middle East and North Africa (MENA) region countries of Egypt, Turkey, Saudi

Arabia, Israel, and Jordan. Pairwise Johansen cointegration analysis was conducted between the Egyptian market and the markets of the other countries prior and subsequent to the Egyptian revolution. Granger causality analysis was also performed in order to explore the short-run causal relationships between the equity markets. Specific objectives included exploring the long-run interdependence between the Egyptian market and the selected MENA region markets. How the long-run interdependence was impacted by the political, social, and economic instability triggered by the Egyptian revolution. The short-run causal linkages between the markets and finally how portfolio diversification opportunities evolved over the two periods. The main questions we seek to answer are do the cointegration relationships and causal linkages become more robust as a result of the events of the Egyptian revolution and whether or not portfolio diversification opportunities persisted during the period of the revolution.

The markets were selected for the regional importance of each country as well as the existence of mutual sovereign, economic and social links between the countries. Egypt was included because it is the place of origin of the revolution and is also home to the largest equity market in North Africa. Turkey has the largest GDP in the region ranked 17 worldwide (IMF, 2013) with significant commercial links with Egypt. Saudi Arabia has the largest equity market in the Gulf region with a market capitalization of approximately $474 billion (Tadawul Exchange, 2013) and enjoys deep historic economic, political, and social ties with Egypt and is the largest employer of Egyptian expatriates. Jordan is the second largest employer of Egyptian expatriates after Saudi Arabia and has maintained significant trading links with Egypt for decades. Israel has peace and economic treaties with Egypt. The Qualified Industrial Zone (QIZ) agreement signed in 2004 by Egypt, Israel and the United States allows Egyptian products to be exported to the US without customs duties as long as they contain a minimum percentage of Israeli components. Understanding how the events of the Egyptian revolution affected the cointegration between the Egyptian market and the equity markets of the selected countries and the impact on portfolio diversification is a significant outcome of this research.

The remainder of the paper is organized as follows. Section 2 provides a literature review. Section 3 provides description of the data and summary statistics. Section 4 presents the empirical methodology. Section 5 discusses the empirical results and Section 6 presents the summary and conclusion.

2 Literature Review

Cointegration between equity markets has become thoroughly researched due to its versatility as a tool for investigating many economic concepts such as interdependence between markets, portfolio diversification and market efficiency. Initial research covered cointegration between developed markets. Although cointegration research among developing markets has steadily increased as a result of greater investor interest due to the higher earnings potential and growth rates, research involving MENA region countries is still limited and research covering periods of crises in the region is rare. However, with political instability propagating in the Middle East encompassing Tunisia, Egypt, Libya, Yemen, Syria and Iraq, the ramifications of the regional instability on the rest of the world is very closely watched by politicians and people of economics and finance the world over. Their objective is to discern information to help them mitigate the effects of instability on their political and economic interests by understanding how regional markets affect each other and their impact on international markets. Studying how cointegration evolves during a crisis period will provide valuable insight on how market interdependencies change as a result of the crisis and its impact on portfolio diversification and risk management.

Omran and Gunduz (2001) investigated weekly stock indices from Turkey, Israel, Egypt, Morocco and Jordan over the period 1997:08 through 2000:07. They applied the Johansen cointegration procedure to test the multivariate relationship among the equity markets. They found no evidence of cointegration and concluded that MENA region stock markets are segmented and do not exhibit long-run co-movements. During the period of their research many MENA region equity markets were in their relative infancy and many of the structural reforms that exist today were not yet implemented.

Neaime (2002) investigated financial integration within the MENA region and between the MENA region and the rest of the world. Data consisted of weekly closing prices up to December 2000 and as early as 1990. Johansen cointegration tests indicated that the Gulf Co-operation Council Countries (GCC) markets presented international investors portfolio diversification opportunities while other emerging MENA region countries such Turkey, Egypt, Morocco and Jordan had matured and were more integrated with the world financial markets.Granger causality tests and impulse response functions provided evidence that shocks to the US and UK stock markets were transmitted to the MENA region but not to the GCC stock markets and shocks to the French market insignificantly affected the MENA stock markets.

Darrat et. al. (2000) applied the Johansen-Juselius cointegration test and the Gonzalo-Granger test on monthly time series of returns for the markets of Jordan, Morocco and Egypt over the period from 1996:10 through 1999:08. They concluded that the Middle East markets are highly integrated within the region but are segmented globally, providing international investors with profitable diversification opportunities. They also reported that the market of Egypt was a dominant force driving the other markets in the region. During the period under investigation, the privatization program in Egypt was underway in full force and many public sector companies were being offered on the market through IPOs attracting the interest of regional and international investors.

Darrat and Benkato (2003) examined stock returns and volatility linkages between the Istanbul Stock Exchange (ISE) and stock markets in the US, the UK, Japan and Germany. Multivariate cointegration tests suggested that the ISE became significantly integrated in the global market after the market liberalization in 1989. Girard and Ferreira (2004) conducted bilateral Johansen cointegration tests on daily, weekly and monthly market index data for 11 MENA region countries within the period from 1990:01 to 2001:12. They concluded that the markets of Israel and Turkey are more integrated while other MENA region markets do not exhibit long-run co-movements with a relatively high degree of segmentation.

Lagoarde-Segot and Lucey (2007) investigated capital market integration in MENA region countries with the European Monetary Union (EMU), the United States, and a regional benchmark using four cointegration methodologies. MENA region countries included Morocco, Tunisia, Egypt, Lebanon, Jordan, Turkey, and Israel over a period ranging from 1998:01 to 2004:11. They rejected the presence of a stable, long term bivariate relationship between MENA region countries and the EMU, the US, and the regional benchmark indicating the presence of successful diversification opportunities.

Finally, Paskelian, Nguyen, and Jones (2013) used weekly returns data of 9 MENA region countries over a period ranging from 2000:01 to 2012:02 to investigate the cointegrating relationship of the MENA region countries with the US markets. Granger causality tests indicated that returns of Egypt, Jordan, Kuwait, Malta, Oman, Qatar, Saudi Arabia and Tunisia exhibit cointegrating behavior. Results further indicated that MENA region stock markets tend to co-move but are not yet fully integrated with the US market.

Investigating interdependence between equity markets during crises periods has attracted increased attention due to the greater prevalence of economic and political instability around the world. Lau and McInish (1993) compared co-movements between international equity markets before and after the crash of 1987. They demonstrated that the average pair-wise co-relation between markets tripled during the period after the crash. Arshanapalli and Doukas (1993) and Arshanapalli et. al. (1995) investigated the cointegrating structure between international markets and the US during the pre and post 1987 crash periods. They reported that the degree of international co-movements among stock price indices increased substantially during the post crash period and a greater influence of the US stock market innovations. Meric and Meric (1997) used principal component analysis to investigate co-movement between the US and twelve European markets after the 1987 market crash. They provided evidence that co-movements became stronger and more harmonious after the crash.

Concerning the Asian financial contagion, Yang et. al. (2003) examined long-run relationships and short-run dynamic causal linkages among the US, Japanese, and ten Asian emerging stock markets, before and after the 1997-1998 Asian financial crisis. Results indicated that both long-run cointegration relationships and short-run causal linkages among these markets were strengthened during the crisis and that these markets have generally been more integrated after the crisis than before the crisis. Daly (2003) used correlation and cointegration analysis to investigate interdependence of the stock markets of Indonesia, Malaysia, the Philippines,Singapore, Thailand, and the developed stock markets of Australia, Germany, and the US over the period from 1990 to 2001. He reported an increase in the interdependency across the Southeast Asian stock markets during the period directly after the crisis. Cheng and Glascock (2006) investigated the stock market linkages between the US and China, Hong Kong, and Taiwan,before and after the 1997 Asian financial crisis using daily index data from 1995:01 to 2000:12. Results from the Granger causality test indicated increased feedback relationships between the markets in the post crisis period. Principal component analysis indicated fewer common factors affecting stock returns after the crisis, suggesting more harmonious co-movements between the markets.

The events of September 11 and their ensuing impact on the interdependence of equity markets received a moderate share of interest from researchers. Mericet. al (2008) applied principal component analysis to investigate co-movements between the US the UK, and Asian stock markets before and after September 11. They reported that the contemporaneous co-movement among the markets became closer after the 911 attack. Ahmed (2008) investigated the long-run relationships and short-run dynamic linkages between the Egyptian and G7 equity markets, prior to and following the events of September 2001, using Johansen's cointegration and variance decomposition analysis. Results indicated that the Egyptian Exchange shared no pairwise long-run cointegration relationships with its counterparts in the G7 countries across the pre- and post-attack periods. Yavas (2007) investigated correlations between the US and the markets of Japan and Germany following the events of September 11. Results indicated increased correlations between the U.S. and the Japanese markets and between Germany and the U.S.

The subprime financial crisis from 2007 to 2009 is considered the most devastating and pervasive financial turmoil in recent history with far reaching worldwide economic consequences. As such, it received the greatest share of interest from researchers in recent times. Parsva and Lean (2011) investigated the relationship between stock returns and exchange rates for six Middle East economies before and during the 2007 global financial crisis. They applied Johansen cointegration and Granger causality tests using data from 2004:01 to 2010:09. The results showed that the interactions were robust indicating no distinction between before and during the crisis period. Swamy and Sreejesh (2011) investigated the inter-linkages between commodity markets and capital markets during the global financial crisis by applying dynamic correlation and cointegration techniques. They reported a degree of co-movement between commodity and equity market indices especially after the global financial crisis. Hellstrand and Korobova (2010) investigated whether there are any long term relationships between equities in the Oil & Gas and Financials sectors in different countries. By applying the Augmented Engle-Granger test for cointegration during the period from 2000-2009, they found that for both sectors there was less cointegration during the financial crisis period. The VECM and VAR model were also used to investigate the causal relationships among indices in each of the sectors. They reported that for both sectors, causality increased during the crisis period. Pierdzioch and Kizys (2009) investigated whether the collapse of Central and Eastern European markets during the subprime crisis was due to international linkages of deteriorating fundamentals or international spillovers of speculative bubbles. They estimated a statespace model to decompose the market indices of the Czech Republic, Hungary, and Poland into fundamentals and speculative bubbles. Cointegration analysis was then applied to investigate equity markets linkages. Results indicated that cointegration linkages with the US strengthened in both fundamentals and speculative bubbles during the subprime crisis.

3Methodology

3.1CointegrationAmong Equity Markets

In its simplest form, two time series y_{1t} and y_{2t} that are both integrated of order one I(1) are cointegrated if a parameter α exists such that:

$$u_t = y_{1t} - \alpha y_{2t} \qquad (1)$$

is a stationary I(0) process.

Both y_{1t} and y_{2t} are non-stationary time series exhibiting drift. However, a stationary co-integrating relationship exists between them ensuring that a long-run equilibrium is always maintained between the two time series. Co-integrated relationships are frequent among economic models. Examples include cointegration between consumption and income, between money, income, prices and interest rates, between income, consumption and investment, between the nominal exchange rate and foreign and domestic prices among many others. In each case, as the individual time series diverge from one another, they are acted upon by economic forces that attract them back to the long-run equilibrium. From a statistical point of view, it is important to investigate cointegration since a co-integrated relationship implies the existence of long-run equilibrium and a common stochastic trend between the time series. Also, cointegration allows us to separate the short and long-run relationships among the variables and can be used to improve the accuracy of long-run forecasts (Lin, 2008). From an equity markets perspective, cointegration allows us to evaluate the diversification potential among assets. If the time series of asset prices are co-integrated then the underlying assets would be poor diversification candidates.

In this research, the Johansen multivariate cointegration test was used to investigate the co-integrating relationships between the Egyptian equity market and the MENA region markets of Turkey, Saudi Arabia, Israel and Jordan. The Johansen multivariate test is based on a VAR approach. It is first necessary to apply unit root tests to each time series to make sure they are individually non-stationary. Both the Augmented Dickey-Fuller (ADF) test and the Kwaitkowski, Phillips, Schmidt, & Shin (KPSS) test were used. If all system variables are I(1) then we may proceed to identify a co-integrating relationship between them. The final prediction error (FPE) and the Akaike Information Criteria (AIC) were used to determine the number of lags in the cointegration test which is the order of VAR model. The long-run relationships are evaluated using the β coefficient and the speed of equilibrium adjustment is evaluated using the α coefficient. The Johansen Maximum Likelihood (ML) procedure starts with a VAR of order *p* as follow:

$$y_t = A_1\ y_{t-1}\ + \cdots A_p y_{t-p} + Bx_t + \varepsilon_t \qquad (2)$$

y_t is a *k*-vector of non-stationary I(1) variables,

x_t is a*d*-vector of deterministic variables,

ε_t~i.i.d. (0, σ^2) is a vector of innovations representing random shocks.

The above VAR may be rewritten as follows:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i-1}^{p-1} \Gamma_i \Delta y_{t-i} + B x_t + \varepsilon_t \qquad (3)$$

$$\Pi = \sum_{i-1}^{p} A_i - I \qquad (4)$$

where$I$ is the identity matrix,

$$\Gamma_i = - \sum_{j=i+1}^{p} A_i \qquad (5)$$

The rank of the long-run impact matrix Π determines the number of co-integrating relations. According to Granger's representation theorem, if Π has reduced rank $r<k$, then there exists k x r matrices α and β each with rank r such that Π = α B' where $B' y_t$ is I(0) and r is the number of co-integrating relations. The columns of matrix β are the co-integrating vectors. The α coefficients are the adjustment parameters determining the speed by which the long-run equilibrium is restored.The β coefficient describes the long-run relationship between the time series. If the rank of Π is zero, equation (3) becomes a standard VAR in first differences and the variables in the equation are not co-integrated, while if Π has full rank k, then all variables are stationary. The number of co-integrating vectors in the system is determined using the trace and maximal eigenvalue tests. The trace statistic tests the null hypothesis of r co-integrating relations against the alternative hypothesis of k co-integrating relations, where k is the number of endogenous variables. The likelihood ratio of the trace statistic is computed as follows:

$$LR_{tr}(r|k) = -T \sum_{i=r+1}^{k} \log(1 - \lambda_i) \qquad (6)$$

Where λ_i is the i-th largest eigen value of the Π matrix, T is the number of observations.

The maximum eigenvalue statistic tests the null hypothesis of r co-integrating relations against the alternative of $r + 1$ co-integrating relations. The likelihood ratio of the maximum eigenvalue statistic is computed as follows:

$$LR_{max}(r|r+1) = -T \log(1 - \lambda_{r+1}) \qquad (7)$$

which can be rewritten as:

$$LR_{max}(r|r+1) = LR_{tr}(r|k) - LR_{tr}(r+1|k) \quad (8)$$

For $r = 0,1,\ldots, k$ -1.

In our analysis no a priori assumptions were made concerning the underlying trend of the each time series. For both time periods, we investigated the five deterministic cases considered by Johansen (1995) as described below:

1. No deterministic trends in the level data and no intercepts in the cointegrating equations:

$$H_2(r): \Pi y_{t-1} + Bx_t = \alpha\beta y_{t-1} \quad (9)$$

2. No deterministic trends in the level data with intercepts in the cointegrating equations:

$$H_1^*(r): \Pi y_{t-1} + Bx_t = \alpha(\acute{\beta} y_{t-1} + \rho_0) \quad (10)$$

3. Linear trends in the level data and only intercepts in the cointegrating equations:

$$H_1(r): \Pi y_{t-1} + Bx_t = \alpha(\acute{\beta} y_{t-1} + \rho_0) + \alpha_\perp \gamma_0 \quad (11)$$

4. Both the level data and the cointegrating equations have linear trends:

$$H^*(r): \Pi y_{t-1} + Bx_t = \alpha(\acute{\beta} y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0 \quad (12)$$

5. Quadratic trends in the level data and linear trends in the cointegrating equations:

$$H(r): \Pi y_{t-1} + Bx_t = \alpha(\acute{\beta} y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp(\gamma_0 + \gamma_1 t) \quad (13)$$

3.2 Granger Causality Analysis

Time series analysts are acutely aware of the fact that correlation does not imply causation. Yet to differentiate between the two remains a very difficult task.Using the concept of the arrow of time, which states that cause precedes effect, Granger (1969) proposed a definition which became known as Granger causality. Granger's simple definition states that *y* is Granger-caused by *x* if *y* is better predicted by both lagged values of y and x than it can by using lagged values of y only. Equivalently, the coefficients of the lagged x must be statistically significant and improve the explanation of y. In bivariate form, Granger causality is tested by estimating the following VAR model:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \cdots + \beta_l x_{t-l} + \epsilon_t \quad (14)$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \cdots + \beta_l y_{t-l} + u_t \quad (15)$$

where y_t and x_t are time series of equity indices, ϵ_t and u_t are serially independent stochastic error terms, and l is the lag length. The null hypothesis is that x does not Granger cause y in the first equation and y does not Granger cause x in the second equation.

In this research we applied the procedure by Toda and Yamamoto (1995) for Granger causality which was applied in the following steps.

1. The order of integration of each times series was determined using results of the unit root tests.
2. The highest order of integration of the time series, m, is identified.
3. A VAR model was constructed using the levels of each time series.
4. The optimal lag length in the VAR model, l,was determined using the Final Prediction Error (FPE), the Akaike Information Criterion (AIC), and the Schwartz Information Criteria (SC).
5. To the VAR model, *m* additional lags of each variable were added to each equation.
6. The standard Wald test was used to test the hypothesis that the coefficients of only the first l lagged values of x are zero in the y equation. The same was repeated for the x equation.
7. Rejection of the null hypothesis indicated the presence of Granger causality.

For a detailed description of the Toda and Yamamoto (1995) procedure, see Giles (2011).

4 Data and Descriptive Statistics

Data included daily closing values for the EGX 30 for Egypt, the ISE 100 for Turkey, the TASI for Saudi Arabia, the TA-25 for Israel and the ASE for Jordan over the two periods. The first period was the pre Egyptian revolution period from January 1st 2007 till December 31st 2010. The second period was the post Egyptian revolution period from January 1st 2011 till July 31st 2013. In order for the contemporaneous data to have a one-to-one correspondence, each pair of indices was synchronized in order to avoid date mismatching due to different weekends and national holidays. This was achieved by matching indices in pairs by deleting non-overlapping trading days, resulting in 4 pairs: EGX 30-ISE 100, EGX 30-TASI, EGX 30-ASE, and EGX 30-TA-25.

Daily returns for market i at time t were defined as follows:

$$R_{i,t} = \log(P_{i,t} / P_{i,t-1}) \quad (16)$$

where $R_{i,t}$ is the daily index return for market i at time t. $P_{i,t}$ is the closing price of market i at time t.

From Table 1, we can see that during both periods returns of all indices were almost zero. During the pre revolution period, Turkey exhibited the highest maximum returns while Egypt exhibited the lowest minimum returns. The highest standard deviation indicating volatility is reported for Turkey followed by Egypt. All indices exhibited negative skewness indicating a longer left tail with Egypt exhibiting the most negative value. All indices exhibited excess kurtosis having heavier tails and narrower peaks than the normal distribution with Egypt displaying the highest kurtosis. Normality was rejected for all indices during both periods by the Jarque-Bera test.

For the post revolution period the highest maximum returns are reported for Egypt followed by Saudi Arabia. Lowest minimum returns are reported for Egypt. The highest standard deviation is reported for Egypt with little change in value from the pre revolution period. In order to limit excess volatility during the crisis period, the Egyptian Capital Market Authority (CMA) was forced to close the Egyptian exchange for almost two months during the February-March 2011 period. Once the market was re-opened, price limits of +/- 10% were applied to all stocks and more restrictive margin trading policies were implemented. These measures contributed to constraining the volatility during the crisis period keeping the standard deviation of returns unchanged during the two periods. All indices exhibited negative skewness with Saudi Arabia being the most negatively skewed. All indices indicated excess kurtosis with Saudi Arabia being the most leptokurtotic.

Table 1: Descriptive statistics for index returns

Panel A: Pre revolution					
	EGX 30	**ISE 100**	**TASI**	**TA 25**	**ASE**
Mean	5.28E-06	0.000534	-0.000186	0.000365	-0.000245
Median	0.001552	0.000736	0.000895	0.001215	0.000119
Maximum	0.063388	0.121272	0.090874	0.080626	0.046072
Minimum	-0.179860	-0.100949	-0.103285	-0.091783	-0.043772
Std. Dev.	0.018950	0.020290	0.017799	0.015764	0.010522
Skewness	-1.381150	-0.131160	-0.764836	-0.485119	-0.331057
Kurtosis	13.01661	6.415332	9.758279	7.114820	5.605223
Jarque-Bera	4421.979	490.3545	1994.591	730.5632	297.7543
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	983	1003	997	981	989

Panel B: Post revolution					
	EGX 30	**ISE 100**	**TASI**	**TA 25**	**ASE**
Mean	-0.000480	0.000181	0.000267	-0.000153	-0.000314
Median	0.000216	0.001079	0.000691	0.000216	-0.000103
Maximum	0.073113	0.050310	0.070115	0.044199	0.016345
Minimum	-0.111011	-0.081307	-0.070220	-0.079878	-0.023020
Std. Dev.	0.018094	0.014706	0.009747	0.011862	0.004775
Skewness	-0.733169	-0.741801	-1.219628	-0.551920	-0.364595
Kurtosis	8.790756	5.992856	18.81320	8.422962	5.021576
Jarque-Bera	883.1543	304.0626	6922.865	801.4060	124.3144
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	594	654	649	628	646

Table 2 presents the unit root tests results using the ADF and the KPSS tests during both periods. Both tests indicate that level data for all indices were non-stationary during both periods. Tests also indicate that all first difference data for all indices were stationary during both periods. This leads us to conclude that all indices are integrated of order one, I(1). This result allows us to proceed with the cointegration test to determine whether a stationary I(0) linear combination of each pair of indices exists indicating the presence of cointegration.

Table 2: Unit Root Test Results for Returns of Market Indices

Panel A: Pre-Revolution								
	For Log of Levels				For Log of First Difference			
	ADF		KPSS		ADF		KPSS	
Country	**Intercept**	**Intercept and Trend**	**Intercept**	**Intercept and Trend**	**Intercept**	**Intercept and Trend**	**Intercept**	**Intercept and Trend**
EGX 30	-1.276622 (0.6423)	-1.347208 (0.8753)	1.045183	0.343053	-26.44014 (0.0000)	-26.42687 (0.0000)	0.157955	0.156578
ISE 100	-0.715402 (0.84087)	-0.991579 (0.9433)	0.996319	0.758916	-30.19039 (0.0000)	-30.19342 (0.0000)	0.228339	0.131206
TASI	-1.412857 (0.5772)	-1.559404 (0.8082)	1.629359	0.357039	-28.89649 (0.0000)	-28.88283 (0.0000)	0.105527	0.098024
TA 25	-0.751856 (0.8313)	-0.861531 (0.9583)	0.651061	0.620840	-36.19551 (0.0000)	-36.19615 (0.0000)	0.221426	0.154136
ASE	-0.776120 (0.8248)	-2.002887 (0.5985)	2.457045	0.479579	-23.41401 (0.0000)	-23.43011 (0.0000)	0.255994	0.137102
Panel B: Post-Revolution								
	For Log of Levels				For Log of First Difference			
	ADF		KPSS		ADF		KPSS	
Country	**Intercept**	**Intercept and Trend**	**Intercept**	**Intercept and Trend**	**Intercept**	**Intercept and Trend**	**Intercept**	**Intercept and Trend**
EGX 30	-3.033368 (0.0325)	-3.322229 (0.0636)	0.523203	0.347225	-19.71322 (0.0000)	-19.76598 (0.0000)	0.235812	0.091755
ISE 100	-1.153071 (0.6960)	-2.008000 (05954)	1.767012	0.581396	-25.46781 (0.0000)	-25.46565 (0.0000)	0.131818	0.083247
TASI	-1.135331 (0.7033)	-2.356862 (0.4020)	1.554430	0.123600	-23.47910 (0.0000)	-23.48984 (0.0000)	0.103554	0.045408
TA 25	-2.278115 (0.1795)	-2.166392 (0.5070)	0.595703	0.577779	-28.42806 (0.0000)	-28.44484 (0.0000)	0.134924	0.035042
ASE	-2.731821 (0.0692)	-1.998889 (0.6003)	1.477192	0.617970	-2347300 (0.0000)	-23.57538 (0.0000)	0.360150	0.067736

Critical values are as follows: For ADF with intercept -3.441148 for 1%, -2.866195 for 5%, -2.569308 for 10%. For ADF with intercept and trend -3.973606 for 1%, -3.417415 for 5%, -3.131114 for 10%.For KPSS with intercept 0.739000 for 1%, 0.463000 for 5%, 0.347000 for 10%.For KPSS with intercept and trend 0.216000 for 1%, 0.146000 for 5%, 0.119000 for 10%.

Table 3 presents the cointegration results for the pre revolution period in Panel A and post revolution period in Panel B. For the pre revolution period, no cointegrating relation is identified for the markets of (i) Egypt and Turkey and (ii) Egypt and Israel for any model assumption. Egypt and Saudi Arabia demonstrated a maximum of one cointegrating relation for three model assumptions. Egypt and Jordan demonstrated a maximum of one cointegrating relation for one model assumption and a maximum of two cointegrating relations for one model assumption

For the post revolution period, Egypt and Turkey demonstrated a maximum of one cointegrating relation in three model assumptions and a maximum of two cointegrating relations in one model assumption. This indicated an increase in the level of cointegration between Egypt and Turkey during the post revolution period. Egypt and Saudi Arabia demonstrated a maximum of one cointegrating relation in one model assumption indicating a decrease in the level of cointegration. Egypt and Israel demonstrated a maximum of one cointegrating relation in one model assumption and a maximum of 2 cointegrating relations in two model assumptions indicating an increase in the level of cointegration. Finally, Egypt and Jordan demonstrated a maximum of one cointegrating relation in one model assumption and a maximum of 2 cointegrating relations in two model assumptions indicating an increase in the level of cointegration during the post revolution period.

Table 3: Selected (0.05 level*) Number of Cointegrating Relations by Model

Panel A: Pre revolution					
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Egypt - Turkey					
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0
Egypt – Saudi Arabia					
Trace	0	0	1	0	1
Max-Eig	0	0	1	1	1
Egypt - Israel					
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0
Egypt-Jordan					
Trace	0	0	1	0	2
Max-Eig	0	0	0	0	0
Panel B: Post revolution					
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Egypt - Turkey					
Trace	1	0	1	0	2
Max-Eig	1	1	1	0	0
Egypt – Saudi Arabia					
Trace	1	0	0	0	0
Max-Eig	1	0	0	0	0
Egypt - Israel					
Trace	0	0	2	0	2
Max-Eig	1	0	0	0	0
Egypt-Jordan					
Trace	0	1	2	0	2
Max-Eig	0	1	2	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 4 displays the change in the number of cointegrating equations for each pair of indices over the two periods for the different model assumptions. Strong evidence is presented for (i) Egypt and Turkey, (ii) Egypt and Israel, and (iii) Egypt and Jordan supporting an increase in the level of cointegration during the post revolution period reflected by the marked increase in the number of cointegrating equations. On the other hand, evidence is presented for Egypt and Saudi Arabia supporting a decrease in the level of cointegration during the post revolution period reflected by the marked decrease in the number of cointegrating equations for 3 model assumptions.

Table 4: Changes in the Number of Cointegrating Equations during the Revolution Period

Data Trend:	**None**	**None**	**Linear**	**Linear**	**Quadratic**
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Egypt - Turkey					
Trace	+1	0	+1	0	+2
Max-Eig	+1	+1	+1	0	0
Egypt – Saudi Arabia					
Trace	+1	0	-1	0	-1
Max-Eig	+1	0	-1	-1	-1
Egypt - Israel					
Trace	0	0	+2	0	+2
Max-Eig	+1	0	0	0	0
Egypt-Jordan					
Trace	0	+1	+1	0	0
Max-Eig	0	+1	+2	0	0

Table 5 displays the results of the Granger causality test for each pair of indices over the two periods. For the pre revolution period strong evidence supports the presence of bidirectional Granger causality for the markets of (i) Egypt and Turkey, (ii) Egypt and Israel, and (ii) Egypt and Jordan indicating the existence of strong short-run linkages between those countries. Also, strong unidirectional Granger causality is indicated from Egypt to Saudi Arabia. For the post revolution period bidirectional weak exogeneity is reported for the markets of (i) Egypt and Turkey and (ii) Egypt and Saudi Arabia.Unidirectional Granger causality is reported from Egypt to Israel and bidirectional Granger causality between Egypt and Jordan.

Table 5: VAR Granger Causality/Block Exogeneity Wald Tests

Panel A: Pre revolution			
	Chi-Sq.	Prob.	Conclusion
Egypt - Turkey			
Egypt does not Granger cause Turkey	38.504753	0.0000	Reject
Turkey does not Granger cause Egypt	8.504753	0.0367	Reject
Egypt – Saudi Arabia			
Egypt does not Granger cause Saudi Arabia	26.53943	0.0000	Reject
Saudi Arabiadoes not Granger cause Egypt	5.527701	0.2373	Accept
Egypt - Israel			
Egypt does not Granger cause Israel	268.7359	0.0000	Reject
Israel does not Granger cause Egypt	32.92139	0.0001	Reject
Egypt-Jordan			
Egypt does not Granger cause Jordan	42.75542	0.0000	Reject
Jordan does not Granger cause Egypt	32.56161	0.0020	Reject

Table 5: VAR Granger Causality/Block Exogeneity Wald Tests continued

Panel B: Post revolution			
	Chi-Sq.	Prob.	Conclusion
Egypt - Turkey			
Egypt does not Granger cause Turkey	2.210034	0.3312	Accept
Turkey does not Granger cause Egypt	1.075513	0.5841	Accept
Egypt – Saudi Arabia			
Egypt does not Granger cause Saudi Arabia	1.083575	0.5817	Accept
Saudi Arabia does not Granger cause Egypt	3.176698	0.2043	Accept
Egypt - Israel			
Egypt does not Granger cause Israel	8.658889	0.0132	Reject
Israel does not Granger cause Egypt	3.024064	0.2205	Accept
Egypt-Jordan			
Egypt does not Granger cause Jordan	41.84993	0.0000	Reject
Jordan does not Granger cause Egypt	7.216351	0.0653	Reject

Table 6 presents the changes in long-run and short-run linkages between each pair of indices between the two periods. Evidence suggests that although the level of cointegration is clearly stronger during the revolution period, Granger causality is clearly weaker. As illustrated in the literature review, an increase in the level of cointegration during a crisis period is a common phenomenon. In the case of Egypt, this was not a result of an increase in volatility since the standard deviation remained unchanged during the two periods. Doukas and Lang (1995) suggested that increased co-movements during a post crisis period are due to the increase in arbitrage activity. However, this was also not the case in Egypt since no arbitrage opportunities existed between Egypt and the other markets. Law (2010) reported an increase in Granger causality after the Asian financial crisis while the level of cointegration remained the same. He suggested that strong co-movement after a crisis is caused by the unusual high sensitivity of investors to international financial news instead of market integration or the increase in arbitrage activities. He argues that this finding is consistent with the ambiguity aversion theory developed by Fox and Tversky (1995) which states that during periods of uncertainty, investors concentrate on less ambiguous information and ignore ambiguous information. During a crisis period, negative information is continuously being released to the market on which investors will concentrate rather than focusing on future fundamentals and economic prospects that are less certain. In the case of Egypt, investor reaction to the immediate negative news during the post revolution period led to the breakdown of short term linkages as indicated by weaker Granger causality during the crisis period. However, over the long term, as the crisis dissipated, the long-run linkages were maintained or even strengthened as investors re-focused on fundamentals and economic prospects leading to an increase in the level of cointegration.

Implications to portfolio diversification are difficult to interpret. Over the short term, weaker short-run linkages imply that portfolio diversification may be successful. However, over a longer time horizon stronger long-run linkages imply that diversification may not be successful as the level of conitegration increased. In order to determine whether or not portfolio diversification is successful, asset allocation and portfolio optimization models should be constructed and comparisons are then made between the two periods. Possibly the best strategy for the risk-averse investor is to exit the market experiencing a crisis in the short run and re-entering when the crisis has clearly ended, evidenced by strong economic fundamentals and growth prospects in the long run. Indication of this strategy is the decrease of non-Arab foreign participation as a percentage of total value traded on the Egyptian exchange from 23.55% in 2011 to 14.87% and 14.33% for 2012 and 2013 respectively. Non-Arab foreign investors exited the Egyptian market as a result of the negative news of instability and uncertainty and are currently awaiting more favourable economic indicators before re-entering the Egyptian market. On the other hand, Arab participation as a percentage of total value traded increased slightly from 5.27% in 2011, to 6.23% and 6.21% for 2012 and 2013 respectively.

Table 6: Changes in Inter-Market Linkages during the Revolution Period

	Cointegration (Long-run linkages)	Granger Causality (Short-run Linkages)
Egypt-Turkey	Stronger	Weaker
Egypt-Saudi Arabia	Weaker	Weaker
Egypt-Israel	Stronger	Weaker
Egypt-Jordan	Stronger	The Same

5 Summary and Conclusion

In this research we investigated the long-run and short-run dynamic linkages between the Egyptian equity market and the markets of Turkey, Saudi Arabia, Israel and Jordan over the pre and post Egyptian revolution period. Cointegration was explored using the Johansen's procedure while Granger causality was explored using the Toda and Yamamoto (1995) procedure. Synchronized daily index data were used. During the pre revolution period no cointegrating relations were discovered between (i) Egypt and Turkey and (ii) Egypt and Israel. Cointegrating relations were identified between (i)Egypt and Saudi Arabia and (i) Egypt and Jordan. Bidirectional Granger causality was identified between (i) Egypt and Turkey, (ii) Egypt and Israel, and (iii) Egypt and Jordan. A unidirectional causal relationship was identified from Egypt to Saudi Arabia. During the post revolution period at least one cointegrating relationship was identified between Egypt and all the other countries. A bidirectional causal relationship was identified only between Egypt and Jordan and a unidirectional causal relationship from Egypt to Israel. Changes in inter-market linkages during the post revolution period leads us to conclude that the political, economic, and social instability during the revolution period led to an overall increase in the level of cointegration and an overall decrease in the causality between the markets. These findings may be partially explained by the ambiguity aversion theory (Fox and Tversky, 1995) which argues that during periods of high uncertainty, investors will likely concentrate on less ambiguous information such as the negative news released to the market during the period of the revolution and ignore less certain information concerning future economic fundamentals and growth prospects of the country. From such investor reaction, we would expect a break-down in short-run linkages between the countries as evident by the weaker Granger causality, and a higher cointegrating relationship as the instability subsides allowing investors to focus on fundamental economic indicators. Portfolio diversification opportunities are more likely to be successful in the short term and less successful in the long term.

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