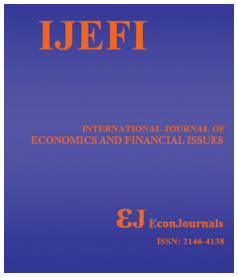

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Financial Cointegration and the Vector Error Correction Model: The Case of MENA Countries

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ABSTRACT

The aim of this paper is to study financial integration between emerging MENA countries and developed countries. We study short-term price series dynamics using Johansen's (1991) multivariate cointegration test to determine the number of cointegration vectors and Granger's (1987) causality test to determine causality direction across markets. The vector error correction model (VECM) model combines long-term cointegration modeling with short-term dynamics to determine equilibrium return rate. The results point to the presence of two long-term cointegration vectors between MENA and developed countries, while causality direction is bidirectional. The VECM results suggest the presence of a short-term cointegration between these countries. VECM's residuals and the Wald test confirm the robustness of our model.

Keywords: Financial Market, Financial Cointegration, Causality, Vector Error Correction Model, MENA Countries
JEL Classifications: G15, G11, G17, G1

1. INTRODUCTION

International financial integration came to be seen as a major concern for contemporary economic globalization movement. Understanding the notion is particularly useful for portfolio investors whose investment strategies fundamentally are balanced on integration degrees.

Over the past three decades, international portfolio diversification has been the core of global capital markets. Several advantages have encouraged investors to invest in international portfolios. Modern portfolio theory has admitted that diversification may reduce portfolio risk by not holding perfectly correlated assets. International assets are likely to offer investors greater diversification benefits since their prices are often less correlated and are determined by different economic fundamentals.

Grubel (1968) and De Santis and Imrohoroglu (1997), show that a higher percentage of capital invested in foreign equities benefits investors by increasing their expected returns, decreasing volatility in their returns, and decreasing correlation of foreign equities with domestic securities.

Bartarm and Dufey (2001) found that international investment attractions bear on diversification effects, participation in the growth of other foreign markets, and abnormal returns due to market segmentation.

The fact that cross-border market returns do not change exactly the same way over time translates into diversification gains. In this regard, whether country-specific factors or industry-specific factors lead to low correlation is still under review (Ang and Bekaert (2002), Gentzoglanis (2003) and Broner and Jaume (2016)).

Portfolio diversification is an investment strategy that helps reduce market unpredictability. It does not guarantee a profit or insure against losses when markets are down, but does provide protection for some

accumulated gains. According to modern portfolio theory these gains are inversely proportional to the degree of financial integration.

Market correlation coefficients refer not only to a correlation within developed stock markets, but also between some mature emerging markets that tend to increase slowly over time.

Nevertheless, there are several barriers to international investment. Solnik and Longin (2001) assume that lack of knowledge of foreign markets, political risk, market inefficiency, regulations, transaction costs, taxes, and exchange rate risks are serious problems that can hinder international investment, particularly in less developed countries.

Despite evidence of additional gains from international diversification, individual and institutional investors prefer to hold domestic securities. This home bias refers to the gap between the shares of assets invested in foreign markets and the optimal shares determined by financial theory. The potential benefits of international diversification can be undermined by the direct and indirect forms of investment barriers against foreign investors (French and Poterba, 1991).

International capital flows are also very high in volume and have increased considerably in recent years. The increasing internationalization of economic activity has led to a decrease in "domestic" factors.

The concern with developing emerging countries' financial markets triggered the liberalization process. This latter process called for major regulatory changes in order to facilitate foreign investors' access to domestic markets. Increase in capital flows helps to increase liquidity, reduce debt cost and improve profitability of some projects.

In this paper, we study empirically international financial integration of MENA countries in developed countries in order to detect the meaning of international portfolio diversification. The first section of this paper reviews the relevant literature on the main financial integration studies. The second section analyzes financial cointegration between the different countries of our sample using for the purpose the different cointegration and causality tests and the error correction vector model (VECM).

2. LITERATURE REVIEW

The last decade has seen a dramatic set back in stock markets in developed economies. During the 2008 US financial crisis, stock markets in Europe and the US fell. The accumulation of international debts and financial crises inflicted unprecedented damage. Record losses were recorded in emerging economies.

The recent military and political turmoil in the MENA region since 2010 has further aggravated the conditions already worsened by the US financial crisis. Financial liberalization policies have included plans to revive the different stock markets. The removal of obstacles to capital movement and implementation of policies conducive to strengthening the functioning of domestic financial markets aimed at improving direct investment and foreign investment in the region by encouraging international participation in listed companies.

Bekaert (1995), and Bekaert and Harvey (1997), examining integration of a set of MENA countries into developed countries, found that MENA stock market returns were high, predictable, and lacked correlation with the major markets. This means that in the event of a financial crisis these emerging stock markets may evade losses as large as those in mature markets during the last financial crisis. Diversification benefits tend to increase in the absence of financial integration with the global economic and financial system.

Using Markowitz's mean-variance analysis, Abraham, Seyyed and Alsakran (2002), studied the investment interests of MENA countries (Bahrain, Kuwait and Saudi Arabia). Their results indicate that an optimal allocation of 20–30% considerably reduces portfolio risk and improves expected profitability. The authors point to a low correlation between MENA countries' returns and US market returns and a positive correlation between MENA countries' stock returns and oil prices.

Hatemi and El-Khatib (2016) studied causality between MENA financial markets (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates). The author noted that an increasing integration between these financial markets led to a decline in risk coverage and increased vulnerability to shocks following assets diversification.

Neaime and Colton (2005) studied regional and international financial integration in MENA and developed countries (America, United Kingdom, France), using Johansen's cointegration model. The authors found that Jordan's, Morocco's, Egypt's and Turkey's financial markets are cointegrated with developed financial markets. MENA markets present low regional financial integration, except for Behrain, Kuwait and Saudi Arabia. These latter markets are segmented in the international financial market and offer profitable diversification potential.

Bekaert and Harvey (1995), Carrieri, Errunza and Hogan (2007) and Park and Rogelio (2014) found that diversification benefits of emerging countries tended to decline in recent years due to their increasing integration into the global economic and financial system encouraged by market opening policy. The substantial increase in inter-market relationships raises an intriguing question as to whether emerging markets' assets remain attractive for a foreign investor.

Like mature emerging markets, MENA financial markets are likely to become more sensitive to stock market volatility. Their increasing integration into global markets may reduce their ability to strengthen and diversify international portfolios, making stock markets more vulnerable to external financial shocks. According to Chari and Henry (2004), long-term stock market integration increases diversification opportunities for domestic and international investors and increases market vulnerability to price shocks.

Using cointegration models, Lagoarde-Segot and Lucey (2007) reject the hypothesis of cointegration between the financial markets of Morocco, Tunisia, Egypt, Lebanon, Jordan, Israel, Turkey, the European Monetary Union markets and the US financial market.

Neaime (2006), using Engle-Granger's co-integration approach, shows that the financial markets of Dubai, Egypt, Jordan and Kuwait are highly correlated with the US financial market, the financial markets of Tunisia and Morocco are highly correlated with the French financial market, while the market of Saudi Arabia is weakly correlated with developed financial markets.

The potential benefits of diversification in emerging markets can be compromised by irect and indirect forms of barriers against foreign investors. Direct barriers are institutional barriers that affect the ability of global investors to invest in the assets of a particular country. They include legal restrictions on cross-border securities trading, foreign exchange regulation, repatriation limits, taxes and transaction costs.

Financial liberalization generally refers to the removal of direct barriers to capital investment. In recent decades, institutional barriers have been significantly lowered, especially in the major developed countries. Market liberalization allows global investors to access the market. It leads to increased international investment and increased economic well-being.

Indirect barriers can also deter foreign investors from investing in stock markets. Indirect barriers include risk perception, information asymmetries between foreign and domestic investors that mainly relate to differences in accounting standards, industrial structures, regulations and company structures. Indirect barriers and global economic variables include specific risks such as economic instability, currency risk and liquidity risk.

According to Bekaert (1995) the presence of barriers does not necessarily mean market segmentation and their removal does not necessarily increase market integration. Behavioral factors determine market segmentation. In the international financial literature, the "home bias puzzle" is explained by behavioral variables. Investors do not always manage to use the gains of international diversification and prefer to focus their investment behavior on their domestic securities.

French and Poterba (1991) suggest that investors may simply be relatively more optimistic about their domestic markets. Solnik and Roulet (2000) explains the "home bias puzzle" using regret theory. Investors feel a painful regret if foreign assets underperform domestic assets.

Lewis (1999) shows that investors believe that domestic stocks provide better coverage of country-specific risks such as domestic inflation and wealth coverage that is not traded in capital markets. Global economic conditions could affect stock market integration degree. Low returns in domestic countries during recessions lead investors to venture abroad in search of higher returns that could lead to greater integration, while high domestic returns tend to keep them at home afterwards. Similarly, low interest rates and low economic growth in a domestic market could lead to higher market integration as the capital mobility across borders increases. Finally, exchange rate volatility could lead to high market segmentation.

Determining the extent to which a domestic capital market is segmented into international capital markets is therefore a research question of great interest to investors and researchers.

If financial markets are fully integrated, the expected return of a country portfolio should be determined uniquely by the country's exposure to global covariance risk. On the other hand, segmentation implies that the Risk-Return relationship in each domestic market is determined essentially by domestic or local factors. Thus, when markets are partially segmented, expected returns would be determined by the country's exposure to both specific and global risk factors.

A growing body of literature documents the time-varying nature of both expected returns and risk exposure in a domestic market. To account for this data feature, we estimate an international version of the asset-pricing model in which risk price and risk exposure change over time. To this end, we use information on global variables to condition global risk price and information on local variables to condition domestic risk price. Since some local variables correlate with integration and openness of domestic stock markets, our specification implicitly allows degree of integration to change over time.

The increasing internationalization of economic activities has led to a decrease in "domestic" factors. This latter had an effect only on the domestic level. This has in parallel induced the effect of greater integration between markets, although markets are known to be more independent in strictly updating "domestic" information because the quantity of information that can be classified as such is less and less available. This assumption is supported when we compare these results with those of Eun and Shim (1989) and Espitia and Santamaria (1994).

Generally, what is suggested is that international diversification does not have excessive economic rationality because of the strong correlation and integration between markets, except that diversification is implemented by choosing the stocks whose differential features allow them to behave in the domestic stock market on which they are listed. In other words, it makes more sense to take advantage of information, basically what is expected by a leading market to decide on equity before that information is incorporated into the stock price.

International portfolio diversification is the source of welfare benefits for international economic relationships.

Modern portfolio diversification theory affects the level of financial market integration through gains from trade liberalization, massive foreign capital inflows, and barriers restriction. These results have two important implications for companies and investors; first, capital cost can be significantly different across slightly segmented markets. Second, if domestic equity markets are segmented then international portfolios should provide higher risk-adjusted performance since a portion of domestic systematic risk can be diversified otherwise by investing internationally and without paying for low-return prices.

According to Stulz (1999), international stock market integration improves diversification opportunities for domestic and foreign investors, reduces risk premiums, and increases return rate for a given investment project.

Harvey (1995) and Gentzoglanis (2003) assume that financial market integration should reduce capital cost, increase investment and stimulate economic growth. However, the more integrated markets with global financial markets, the greater their vulnerability to international financial crises. In times of global financial crisis, contagion leads to a change in market expectations and an observable structural break between the different financial markets.

3. METHODOLOGY

We study the interdependent relationships between developed and MENA countries and their implications for the benefits of international diversification. We use Johansen's cointegration approach (1988), the Granger causality test and the error correction vector model.

Table 1: Benchmark equity indices

Equity market	Benchmark index
MENA countries	
Tunisia	TUNINDEX index
Egypt	EGEX 30 index
Morocco	MASI index
United Arab Emirates	DFMGI index
Kuwait	KWSE index
Turkey	BIST100 index
Lebanon	BLOM index
Developed countries	
United States	SP 500 index
Germany	DAX 30 index
France	CAC 40 index
United Kingdom	FTSE 100 index
Japan	NIKKEI average index

The data for the various indices are daily and cover seven main stock markets in the MENA zone (Tunisia, Egypt, Morocco, United Arab Emirates, Kuwait, Lebanon, Turkey) and five major stock markets in developed countries (United States, Germany, France, United Kingdom, Japan) over the 2010–2016 period, totaling 1964 market observations (Tables 1 and 2).

3.1. Stationarity Study

Before proceeding with the cointegration study, stationarity of the time series of the price indices should be checked first. The Augmented Dickey Fuller test and the Phillips-Perron (PP) test are used to estimate the null unit root hypothesis in order to see whether time series are order 1 integrated. These tests allow for error autocorrelation and heteroscedasticity.

The results of the Augmented Dickey Fuller tests for all series of the developed countries show that the t-statistics are well below the critical threshold. The results of the PP test are similar and indicate that the stock market index series of developed markets and MENA countries are non-stationary.

The study of the stationarity of the first differences of time series for the different stock market indices shows probability values >5%, rejecting thus the null hypothesis of non-stationarity (unit root) at the 1% level. It shows also that the series are order 1 stationary or order 1 integrated.

These results indicate that the series may follow a long-term equilibrium path, although in the short term they diverge substantially from equilibrium. The study of long-term relationships between time series is fundamental to study cointegration between the different markets.

Table 2: Unit root test

Countries	Level series				First difference			
	ADF		PP		ADF		PP	
	Statistic	P value	Statistic	P value	Statistic	P value	Statistic	P value
MENA countries								
Tunisia	1.9086	0.3285	1.9282	0.3194	28.8949	0.000	28.9497	0.000
Egypt	1.4051	0.5811	1.2466	0.6560	31.0416	0.000	31.1095	0.000
Morocco	1.5816	0.4918	1.5831	0.4910	38.628	0.000	38.6281	0.000
UAE	0.8903	0.7971	0.8790	0.7952	35.8233	0.000	35.8392	0.000
Kuwait	1.5578	0.8294	0.9964	0.7565	32.2323	0.000	35.3526	0.000
Saudi Arabia	2.1848	0.2121	2.2017	0.2058	39.9365	0.000	39.9156	0.000
Turkey	1.6441	0.7751	1.4794	0.8374	34.2206	0.000	34.2609	0.000
Lebanon	2.3139	0.1677	2.3290	0.1629	37.1341	0.000	37.1082	0.000
Developed countries								
US	0.6968	0.8456	0.5276	0.8833	39.4243	0.000	40.1916	0.000
Germany	2.7867	0.2024	2.8259	0.1916	39.6748	0.000	39.7648	0.000
France	2.7781	0.2056	2.6856	0.2427	38.595	0.000	38.7031	0.000
UK	2.8632	0.2141	2.8632	0.2550	37.742	0.000	37.8615	0.000
Japan	2.8670	0.1737	2.6511	0.2575	31.0618	0.000	30.6689	0.000

Values in brackets indicate the optimal number of lags based on the Schwarts criterion (SIC) for the Augmented Dickey and Fuller test (ADF), and Bartlett Kernel for the PP test

Table 3: The number of lags (p)

Critère	VAR (0)	VAR (1)	VAR (2)	VAR (3)	VAR (4)
Akaike	187.3188	138.9418	138.7313*	138.8187	138.9122
Schwarz	187.3616	139.8015	139.4983*	140.4026	141.0098
HQ	187.3347	139.1492	139.1302*	139.4090	139.6940m

Table 4: Johansen multivariate cointegration test

A. All countries				
H0	**H1**	**Eigen value**	**Trace test**	**Critical value**
r=0	r>0	0.05806	399.805*	334.983
r≤1	r>1	0.05606	310.670*	285.142
r≤2	r>2	0.04211	244.698*	239.235
r≤3	r>3	0.02520	200.591*	197.370
r≤4	r>4	0.02120	172.550*	159.529
r≤5	r>5	0.01825	149.617*	125.615
r≤6	r>6	0.01361	93.176	95.753
r≤7	r>7	0.00947	52.744	69.818
r≤8	r>8	0.00973	38.558	47.856
B. Developed countries (USA, UK, Germany and Japan)				
H0	**H1**	**Eigen value**	**Trace test**	**Critical value**
r=0	r>0	0.05806	399.805*	334.983
r≤1	r>1	0.05606	310.670*	285.142
r≤2	r>2	0.04211	244.698*	239.235
r≤3	r>3	0.02520	200.591*	197.370
r≤4	r>4	0.02120	172.550*	159.529
r≤5	r>5	0.01825	149.617*	125.615
r≤6	r>6	0.01361	103.176	95.753
r≤7	r>7	0.00947	52.744	69.818
r≤8	r>8	0.00973	38.558	47.856
C. MENA countries				
H0	**H1**	**Eigen value**	**Trace test**	**Critical value**
r=0	r>0	0.05806	399.805*	334.983
r≤1	r>1	0.05606	310.670*	285.142
r≤2	r>2	0.04211	244.698*	239.235
r≤3	r>3	0.02520	200.591*	197.370
r≤4	r>4	0.02120	172.550*	159.529
r≤5	r>5	0.01825	149.617*	125.615
r≤6	r>6	0.01361	93.176	95.753
r≤7	r>7	0.00947	52.744	69.818
r≤8	r>8	0.00973	38.558	47.856

Denotes rejection of the hypothesis at the 5% level, the trace test indicates 5 cointegration relationships

3.2. Cointegration Tests

A Cointegration study determines whether the series are integrated or not and whether they have the same long-term cointegration rank. In fact, the cointegration relationship is interpreted as a long-term equilibrium relationship between the series.

To estimate cointegration between the indices over the long term, we proceed with Johansen (1991) multivariate cointegration test and the Granger (1987) causality test. On the short term, we proceed with the VECM model.

The VECM model combines the modelling of a long-term cointegration relationship with the specification of a short-term dynamic and defines the equilibrium adjustment and return rate.

3.2.1. Johansen test (1991)

The Johansen test is a multivariate generalization of the Augmented Dickey Fuller test. This generalization allows us to examine linear combinations of unit root variables and to determine (multiple) cointegration relationships between developed and MENA stock indices in our case.

We use the methodology of Johansen (1991) as all the variables of our sample are order 1 integrated. Such an approach allows us to detect the number of long-term equilibrium relationships between stock market indices using the following two tests; the trace test for the hypothesis of the presence of more n cointegration vectors and the maximum eigenvalue test for the hypothesis of the presence of the exactly n cointegration vectors.

The optimal number of VAR lags (p) by the VAR vector autoregressive model is presented in Table 3. The results of the

Table 5: Granger causality test (short-term)

	BLOM	BIST	TUNINDEX	DFMGI	EGEX 30	MASI	KWSE	FTSE 100	CAC40	DAX 30	SP500	NIKKEI	Cause
BLOM	-	3.7292	7.9012	0.1102	3.7162	0.5649	0.5277	1.8956	2.2916	6.4686	0.4194	3.4294	0
		0.1550	0.0192	0.9464	0.1560	0.7539	0.7681	0.3876	0.3181	0.6661	0.8108	0.1800	
BIST	0.9053	-	1.1638	1.4709	0.0273	0.4288	3.5028	8.6769	3.4081	1.8467	15.516	0.2598	0
	0.6359		0.5581	0.4793	0.9864	0.8070	0.1735	0.1131	0.1819	0.3972	0.1454	0.8782	
TUNINDEX	2.2966	3.5547	-	3.0424	0.1787	2.9150	0.8022	0.0756	0.7095	0.4412	5.6971	2.1018	0
	0.3177	0.1691		0.2184	0.9145	0.2328	0.6696	0.9629	0.3413	0.8020	0.0551	0.3496	
DFMGI	1.0141	0.8540	0.7594	-	0.8584	0.1360	1.8837	8.4476	0.1290	0.5584	4.7816	3.1033	0
	0.6022	0.6524	0.6841		0.6510	0.2342	0.3899	0.6146	0.9375	0.7564	0.0916	0.2119	
EGEX 30	2.8888	8.8679	4.4481	1.9224	-	0.3588	0.7835	1.3285	0.1894	1.3681	0.2403	0.0275	0
	0.2359	0.2119	0.1082	0.3824		0.8357	0.6758	0.5147	0.9096	0.5046	0.8688	0.9863	
MASI	0.0687	0.1495	0.9879	0.0381	1.4230	-	0.5728	0.4741	0.3529	1.6047	0.0295	0.7558	0
	0.9662	0.9279	0.6102	0.9811	0.4909		0.7509	0.7889	0.8382	0.4483	0.9853	0.6853	
KWSE	4.9284	0.8178	0.2313	2.6213	2.0947	5.7346	-	1.1640	0.0222	0.5628	0.3486	5.7346	0
	0.0851	0.6644	0.8907	2.2696	0.3509	0.0569		0.5588	0.9889	0.7547	0.8400	0.0569	
FTSE100	2.8649	2.2870	1.2350	3.0752	0.2155	0.2377	0.9104	-	0.7880	0.4767	21.6115	3.4747	1
	0.2387	0.2488	0.5393	0.2149	0.8978	0.8879	0.6343		0.6744	0.7879	0.0000	0.1760	
CAC40	0.2614	5.2906	6.3488	0.3525	0.8583	3.0824	0.3819	6.0577	-	95.527	5.0978	4.7963	1
	0.8774	0.0710	0.1418	0.8384	0.6511	0.1214	0.8262	0.0784		0.0000	0.0782	0.0909	
DAX30	0.8125	1.7973	1.2728	0.8293	0.8612	1.0314	4.2933	1.6815	15.2205	-	1.0200	6.0725	2
	0.0394	0.4071	0.5292	0.6606	0.6501	0.5971	0.1169	0.4314	0.0005		0.6005	0.1480	
SP500	1.6342	0.5791	3.2342	2.9476	1.5729	0.9087	0.4298	9.1550	2.9706	3.9652	-	15.7086	1
	0.4417	0.7486	0.1985	0.2293	0.4554	0.6349	0.8066	0.1030	0.2264	0.1377		0.0004	
NIKKEI	0.3703	1.0919	0.1034	1.3393	0.4937	1.5097	2.2137	0.0117	1.0017	0.8059	3.1163	-	0
	0.8310	0.5793	0.9496	0.5119	0.7813	0.4701	0.3306	0.9942	0.6060	0.6683	0.2105		
Is caused	1	0	0	0	0	0	0	0	1	1	1	1	5

The second value for each market is *P* value, these tests indicate Granger causality direction

Akaike, Schwarz and HQ information criteria indicate minimum values at P = 2. The VAR model to be used is then of order 2 for both the developed and MENA countries.

Johansen cointegration test uses a VAR (2) model, presented in Table 4.

The results of Johansen multivariate cointegration test show that the estimated value of the trace test is higher than the corresponding critical value of Order 5 integration. This finding is significant at the 5% level, indicating that there are at most 5 cointegration relationships between the different stock market indices.

The study of long-term cointegration between the different developed countries shows that there is a cointegration relationship between these countries, whereas for the MENA countries the results of the trace test indicate the absence of a cointegration relationship.

Our aim is to detect the cointegration relationships between MENA countries and the stock markets of France, the United States, Germany, the United Kingdom and Japan. The idea is to see whether the so-called MENA-based emerging markets are more or less integrated into international stock markets. The results of the bivariate cointegration tests show that there is one unique cointegration relationship between developed and MENA markets.

These results indicate that MENA-based emerging markets may represent beneficial sources and opportunities for international portfolio diversification for the developed markets' investors.

Table 6: VECM

Dependent variable	Independent variable	Adjustment parameter
USA	Tunisia	0.937**
	Egypt	0.934**
	Morocco	0.936**
	UAE	0.934**
	Kuwait	0.933**
	Turkey	0.936**
	Lebanon	0.931**
UK	Tunisia	0.917**
	Egypt	0.913**
	Morocco	0.913**
	UAE	0.918**
	Kuwait	0.914**
	Turkey	0.913**
	Lebanon	0.918**
France	Tunisia	0.861**
	Egypt	0.863**
	Morocco	0.859**
	UAE	−0.863**
	Kuwait	0.857**
	Turkey	0.853**
	Lebanon	0.868**
Germany	Tunisia	0.812**
	Egypt	0.809**
	Morocco	0.814**
	UAE	0.806**
	Kuwait	0.815**
	Turkey	−0.803**
	Lebanon	0.808**
Japan	Tunisia	0.821**
	Egypt	0.826**
	Morocco	0.829**
	UAE	0.818**
	Kuwait	0.820**
	Turkey	0.814**
	Lebanon	0.815**

*, ** and *** shows statistics significant at the 1%, 5% and 10% levels, VECM: Vector error correction model

3.2.2. Granger causality (1969)

In order to study the short-term dynamics of cointegrated series, we make recourse to the Granger causality test. This test allows for specifying the direction of causality across the different markets.

Granger causality helps to determine non-restrictions on lagged variables by assessing interdependence between the different time series in a given system. This amounts to ensuring that information available on the past values of x_t does not have a statistical impact on the present or future value of y_t.

It is said that x_t does not Granger cause x_t if past-conditioned prediction of y_t is not improved by taking x_t into account; thus:

x_t does not cause y_t if $P(y_t \mid y_{t-1})=P(Y_T \mid x_{t-1},y_{t-1})$

Where y_{t-1} is the past of y_t and x_{t-1} the past of x_t.

We are ready to determine Granger causality between the prices of the financial markets of developed and MENA countries. The

Table 7: Error correction model (Turkey - Germany)

Cointegrating Eq:	CointEq1	CointEq2
BLOM(−1)	1.000000	
DAX_30(−1)	0.011473	
	(0.03108)	
	[0.36916]	
C	−1344.593	
Error correction:	D (BLOM)	D (DAX_30)
CointEq1	0.002836	0.007785
	(0.00124)	(0.00206)
	[−2.28635]	[−0.37691]
D (BLOM(−1))	0.038413	0.415305
	(0.02587)	(0.43086)
	[1.48479]	[0.96389]
	(0.00156)	(0.02595)
C	−0.296478	3.329604
	(0.15821)	(2.63482)
	[−1.87398]	[1.26369]
R-squared	0.008834	0.001971
Adjusted R-squared	0.005499	−0.001387
Sum sq. residuals	55138.65	15293369
S.E. equation	6.091422	101.4477
F-statistic	2.648951	0.586908
Log likelihood	−4809.917	−9006.409
Akaike AIC	6.455653	12.08098
Schwarz SC	6.476999	12.10232
Mean dependent	−0.282782	3.182507
S.D. dependent	6.108240	101.3774
Determinant residual covariance (dof adj.)		381572.7
Determinant residual covariance		378509.9
Log likelihood		−13815.73
Akaike information criterion		18.53852
Schwarz criterion		18.58832

Table 8: VECM

Coefficient	Coefficient	Std. Error	t-Statistic	P
C (1)	0.002836	0.001240	2.286348	0.0224
C (2)	0.038413	0.025871	1.484791	0.1378
C (3)	−0.043997	0.025856	−1.701651	0.0890
C (4)	0.002143	0.001558	1.375049	0.1693
C (5)	0.001644	0.001559	1.054137	0.2920
C (6)	−0.296478	0.158208	−1.873979	0.0611
R-squared	0.738834	Mean dependent var.		0.282782
Adjusted R-squared	0.754929	S.D. dependent var.		6.108240
S.E. of regression	6.091422	Akaike info criterion		16.45565
Sum squared residual	55138.65	Schwarz criterion		16.47699
Log likelihood	-48.09917	Hannan-Quinn criter.		6.463607
F-statistic	2.648951	Durbin-Watson stat		16.99802
P (F-statistic)	0.021580			

Granger causality test bears on the notion of predictability, time-based succession and assumes the stationarity of price series on the long term. It tests the null hypothesis that the first market's price series does not cause the second market's price series against the alternative hypothesis.

The results obtained for a number of lags p equal to 1 are presented in Table 5. We notice that for 11 financial markets, 5 causality relationships have been defined at the 5% significance level. Causality is detected for developed countries with a bidirectional relationship for the market pair (Germany, France) and unidirectional relationships for the pairs (United States, United Kingdom/United States, Japan).

The Granger causality study of developed and emerging countries shows that the market pair (Germany, Turkey) presents a unidirectional relationship. This relationship implies that the impact of shocks on one market is more intense on the other market.

The results indicate that the most integrated market is Germany, which Granger causes the Turkish market and has a two-way relationship with France. The US market in turn causes the Japanese market and is caused by the UK market.

3.3. The VECM Model

Once the cointegration relationships between developed and MENA countries have been studied, it is possible to estimate the long-term relationship between the different stock market indices. The Granger representation theorem is used to establish equivalence between the cointegrated system and the vector error correction model (VECM) and to compensate for the inadequacy of the VAR representation to account for long-term relationships.

In the VECM model, the short-term dynamics of market indices are affected by deviations from long-term equilibrium. In the presence of cointegration, it is possible to estimate the dynamic coefficients of the model and the long-term relationship. To this end, it is necessary that regression residuals are stationary, as checked by ADF tests.

If y_t and z_t are order 1 integrated, the variables dispose of an error correction:

Table 9: Wald test

Test statistic	Value	P
F-statistic	1.5339	0.0216
Chi-square	3.0679	0.0215

Table 10: Residual analysis

Test	Value	P
Breusch-godfrey serial correlation LM	0.237822	0.7874
Breusch-Pagan-Godfrey Heteroskedasticity	14.8346	0.0897
Jarque-Bera normality	3953	0.0965

$$\Delta y_t = \alpha_0 + \alpha_1 \Delta z_t + \alpha_2 (y_{t-1} - \beta_0 - \beta_1 z_{t-1}) + \sum_{t=1}^{N} \gamma_t \Delta y_{t-1} + \varepsilon_t$$

Where β_1 is an adjustment parameter that represents the cointegration vector.

ε_t is white noise, α_0, α_1, α_2 and $\varepsilon\gamma_t$ are parameters.

α_2 is adjustment speed in order to reach long-term stable equilibrium. This parameter should be significantly negative to validate the VECM. Long-term equilibrium is reached when $y_{t-1}=\beta_0+\beta_1 z_{t-1}$ (Table 6).

The results indicate that there are two cointegration relationships between developed and emerging countries. Equilibrium adjustment coefficients are negative and statistically significant for both country pairs (Turkey, Germany) and (UAE, France). We notice that the prices returned to equilibrium over several periods. If we consider these adjustment coefficients, we notice that although international price changes affect domestic stock markets, the total impact on prices does not result from a single period.

3.4. VECM of MENA and Developed Countries

The presence of cointegration relationships between MENA and developed countries leads us to specify the equilibrium adjustment mechanisms between these markets through the VECM technique and to check the robustness of the results.

Two equations are proposed and estimate the pairs of Turkey-Germany and UAE-France:

Table 11: VECM (UAE-France)

Cointegrating Eq:	CointEq1	CointEq2
DFMGI(−1)	1.000000	
CAC_40(−1)	2.371516	
	(0.52340)	
	[4.53095]	
C	6805.680	
Error correction	D (DFMGI)	D (CAC_40)
CointEq1	0.001491	0.004456
	(0.00161)	(0.00164)
	[2.92364]	[2.72276]
D (DFMGI(−1))	0.074333	0.024130
	(0.02595)	(0.02631)
	[2.86475]	[2.91720]
D (CAC_40(−1))	0.012128	0.06354
	(0.02558)	(0.02594)
	[2.47408]	[2.24499]
C	0.842582	0.601042
	(1.31261)	(1.33085)
	[2.64191]	[2.45162]
R-squared	0.694176	0.006964
Adj. R-squared	0.003599	0.003622
Sum sq. residuals	3816685.	3923487.
S.E. equation	50.67967	51.38386
F-statistic	2.077165	2.084122
Log likelihood	−7970.933	−7991.522
Akaike AIC	10.69294	10.72054
Schwarz SC	10.71429	10.74188
Mean dependent	0.928673	0.602239
S.D. dependent	50.77112	51.47718
Determinant residual covariance (dof adj.)		6781212
Determinant residual covariance		6726781
Log likelihood		−15962.43
Akaike information criterion		21.41613
Schwarz criterion		21.46593

D(BLOM) = C(1)*(BLOM(−1) + 0.0114725065582*DAX(−1) - 1344.59340389) + C(2)*D(BLOM(−1)) + C(3)*D(BLOM(−2)) + C(4)*D(DAX(−1)) + C(5)*D(DAX(−2)) + C(6)

D(DFMG) = C(1)*(DFMG(−1) - 2.37151644496*CAC40(−1) + 6805.68040547) + C(2)*D(DFMG(−1)) + C(3)*D(DFMG(−2)) + C(4)*D(CAC40(−1)) + C(5)*D(DFMG(−2)) + C(6)

The results of the VECM model show us that adjustment rates or error correction terms are significantly negative. The results of the Wald test helped to check for the presence of a causal relationship between these country pairs. We notice that P < 5% for the Fisher and Chie square statistics, which implies the presence of a short-term relationship between these country pairs.

The results of the study of residuals from the VECM model equations show that they do not auto correlate, are homoscedastic and are normally distributed. R^2 confirms the adequacy and robustness of the model proposed to study cointegration between stock markets (Turkey, Germany).

The results for the country pair (Dubai, France) are less convincing and present a rather low R^2 (Tables 7-14).

Table 12: VECM

Coefficient	Coefficient	Std. Error	t-Statistic	Prob.
C (1)	0.001491	0.001614	2.923638	0.3558
C (2)	0.074333	0.025947	2.864748	0.0042
C (3)	0.025446	0.025952	2.980518	0.3270
C (4)	0.012128	0.025583	0.474077	0.6355
C (5)	0.003253	0.025573	0.127198	0.8988
C (6)	0.842582	1.312609	0.641914	0.5210
R-squared	0.694100	Mean dependent var.		0.928673
Adjusted R-squared	0.003599	S.D. dependent var.		50.77112
S.E. of regression	50.67967	Akaike info criterion		10.69294
Sum squared resid	3816685.	Schwarz criterion		10.71429
Log likelihood	−7970.933	Hannan-Quinn criter.		10.70089
F-statistic	2.077165	Durbin-Watson stat		1.998899
P (F-statistic)	0.065651			

Table 13: Wald test

Test statistic	Value	P
F-statistic	0.237822	0.7844
Chi-square	0.475055	0.7874

Table 14: Residual analysis

Test	Value	P
Breusch-Godfrey serial correlation LM	0.237853	0.2817
Breusch-Pagan-Godfrey Heteroskedasticity	14.43682	0.0654
Jarque-Bera normality	3.953956	0.0815

4. CONCLUSION

Markets are considered integrated when assets with identical risks generate identical returns in all markets. Liberalization is likely to lead to integration of emerging markets into the global financial market. Foreign investors then benefit from diversification, equity cost decreases and economic well-being increases.

We notice that despite the growing post-globalization relationships between different countries, the liberalization process led to a small increase in emerging countries' integration with the international market and most equity markets are segmented.

Although there are differences in financial sector development across the different MENA countries, two statistically significant long-term co-integration relationships with developed countries were identified by applying Johansen (1991) multivariate cointegration test and Granger (1987) causality test, and one unique short-term cointegration vector was identified by the VECM study.

Bekaert (1995) identifies three types of barriers to financial integration between countries. The first obstacles are legal in nature, reporting to restrictions on foreign ownership and taxes on foreign investments. The second obstacles are indirect and relate to differences in accounting standards and investor protection laws across countries. Third barriers report to market-specific risks and may include liquidity risk, political risk and currency risk that discourage foreign investment and promote market segmentation.

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