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Research Paper

Exploring the Symbiotic Link: Co-Integration Analysis of the Egyptian Stock Exchange and International Equity Markets

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ABSTRACT

The present study addresses the limited discussion on the equity market in the Middle East and North African region (MENA) concerning the spill-over effects from international equity markets. By employing time series techniques, we examine the integration and causality of interdependencies among five major stock exchange markets worldwide: USA, UK, Malaysia, Hong Kong, and Japan, along with their relationship with the Egypt Stock Exchange market. Spanning from March 1998 to January 2018, our study uniquely considers the interaction between developed and developing countries. Our co-integration findings reveal the limitations of international diversification for investors with long holding periods. We highlight the importance of seeking non-co-integrated markets, such as Malaysia and Hong Kong, which were found to be insignificant in this study, for investors aiming to diversify their portfolios and explore interesting long and short-term investment opportunities.

Introduction

Over the past years, there has been a growing body of research focusing on the topic of stock market integration around the world and the various methods to measure it, like the paper of Stoupos and Kiohos (2022) where they tried to investigates the degree of stock markets integration in the Eurozone after the end of 2010 debt-crisis. The results reveal

that the stock market integration be strong between Germany and EA core member-states but disparate for the EA periphery. The concept of "stock market integration" encompasses the interrelationships across stock markets and is an area of significant interest in financial economics (Abid et al., 2019; Cherif & Gazdar, 2010; Dutta et al., 2017; Metawa et al., 2019). In this paper, we aim to study the relationship and integration among the stock markets of the United States (US), United Kingdom (UK), Japan, Hong Kong, Malaysia, and the Middle East and North African (MENA) region, with a particular focus on the Egypt Stock Market.

These countries represent major players in the global economy, constituting a geographically diverse mix of both developed and developing nations. The choice to use Egypt's stock market as the main model stems from its long-established presence and the significant attention it has garnered from investors in the MENA region. Furthermore, the stock market capitalization and stock price indices of Egypt serve as a representation of the MENA region's financial landscape. Notably, the Cairo stock exchanges have a long-standing history, with the Alexandria Stock Exchange established in 1883 and the Cairo Stock Exchange in 1903 (Messaouda, 2021).

Recent studies, such as the work by Joshi and Joshi (2021) have examined the interdependence among various global stock markets, including both developed and emerging markets. Their findings revealed a substantial level of interdependency between the Indian stock market and other global stock markets. While previous research has predominantly focused on either developed or developing countries, or limited to regional analyses, our study stands out for its inclusion of both developed and developing markets. This unique approach allows us to explore the co-integration of stock markets and consider the implications for investors and policymakers in a globalized context. In addition, the study of Yunvirusaba et al. (2019) examine the volatility spillover effects among the returns of three out of the four securities exchanges in East Africa by using Vector autoregressive model.

This study is mainly trying to answer the following questions: Does long-run relationship exist between Egypt stock market and the rest of the world stock markets? Furthermore, if investor is looking for a bellwether index (among the equity markets of Malaysia, Hong Kong, UK, US, Japan, and Egypt) against which his returns can be benchmarked, which should it be? also tries to answer the question: between the main equity indices in Malaysia, Japan, Hong Kong, UK, US, and Egypt which is the “most influential” or pacesetting index?

Dynamics of international equity markets received much empirical attention, many research papers tried to see how one stock market affect the other, while only few empirical research papers have been conducting on emerging stock markets especially the Middle East and North Africa (MENA) region. Moreover, Rehman et al. (2022) examine the returns dependence among 42 stock markets classified under various emerging and developed groupings. they applied several dependence measures to examine the returns connectedness among the markets. their results showed that During the COVID-19 period, stock markets in the Middle East and North African (MENA) region offered high diversification opportunities due to low returns connectedness with international markets. These markets showed less cointegration with other equity markets compared to G-7 and Emerging Frontier and Asian (EFA) markets. However, the returns coherence of MENA markets increased, indicating contagion effects. These findings have implications for

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investors, fund managers, and other stakeholders in the Middle East's financial markets. In another research paper, Kalu et al. (2023) explores the impact of global and domestic stock market variables on the depth of the financial system in Sub-Saharan African (SSA) countries, using the mean group and pooled mean group estimators for the dynamic heterogeneous panel, this paper reveal that while local variables positively influence financial system depth, global indicators have a negative effect, emphasizing the need for a more globalized approach to financial policy formulation and implementation.

In addition to those notable studies, there are more increasing researches for investigate financial integration of emerging stock markets in the MENA region, and their affects with global market (Alaeddin et al., 2019; Al Nasser, 2016). For example, the paper done by Darrat et al. (2000) explored the pattern and extent to which the three emerging stock markets in the MENA region are linked among themselves with international stock markets. Their finding showed and confirmed that the MENA markets are segmented globally and integrated regionally. In the same manner, the paper of Kamal (2022) examines the relationship between exchange rates, stock market returns, economic growth, and inflation in Egypt using econometric analysis. The findings suggest a long-run relationship among these variables, with stock market returns leading to exchange rate fluctuations and exchange rate volatilities impacting economic growth and inflation. The paper recommends incentivizing strong companies to be listed in the stock market and developing new financial products like Exchange Traded Funds (ETFs) to stimulate economic growth, while also targeting inflation through reduced money supply growth rate.

This result was contradictory to Alkulaib et al. (2009) who used closing prices of twelve MENA indices stock markets at daily basis. They investigate the lead/lag relationship between the MENA countries and regions. The finding was confirming that "there is no market causality or spill over from one country to another in the north Africa region and for the Levant region reveal that there are linkages between stock markets in this region".

In summary, while there was good number of papers discussing the issue of equity markets risk, and returns in developed and developing economies (Abid et al., 2019; Cherif & Gazdar, 2010; Dutta et al., 2017), there were only a few of them concentrate on the MENA region, in particular Egypt market. Therefore, in our present paper, we focused on the extent of integration among stock markets in developing countries to see the regional and global financial linkages between MENA region stock markets represented by Egypt and the most developed financial markets in the world. We included recent financial data from equity market and a larger data sample by using monthly data.

Table 1. The List of Variables

• S&P United State BMI U$ - price Index (SBBUSD)
• S&P Hong Kong BMI U$ - Price Index (SBBHNK)
• S&P United Kingdom BMI U$ - Price Index (SBBUKD)
• S&P Japan BMI U$ - Price Index (SBBJAP)
• S&P Malaysia BMI U$ - Price Index (SBBMAL)
• The EGYPT EFG - Price Index (EGHREFG)

The variable that is used to represent the equity markets addressed in this study is the prevailing or commonly cited by financial reporting indices, as presented in Table 1. We add dummy variable to capture the financial crises from the period of March 2008 until May 2009.

In light of the existing literature, the objective of this research is to investigate the co-integration and interdependencies among the stock markets of the US, UK, Japan, Hong Kong, Malaysia, and Egypt. We aim to fill a research gap by providing a comprehensive analysis that encompasses both developed and developing markets. By doing so, we contribute to the understanding of stock market co-integration, which has crucial implications for investors and policymakers in an increasingly interconnected world.

Many studies (Youssef et al., 2021; Singhal et al., 2019) found the stock market movements in one region or another, or in one country can affect significantly the stock market movements in another region or country via a transmission mechanism which exists in global markets since in our globalization world all these stock markets are now closely integrated between them. Market integration is usually more interesting to be talked about amongst the developed financial market, i.e. market that has sophisticated infrastructures and has been established longer period. Although Egypt's market is a developing one, it is considered to be a good example representing the MENA region stock markets. Hence studying co-integration and its lead-lag relationships would be valuable for investors which have portfolios containing stocks in the market under researched. In addition, it is aim to manage the empirical evidence as whether the global markets have a larger or lower influence on the returns of equity market in MENA area, and especially in the Egypt stock market. Finally, up to the best knowledge of the researcher, this study would be the first study which analyses the co-integration and causality of Egypt's market with global ones. Another motivation is using the latest available data which we want to examine in these stock markets.

The main objective of this paper is to analyze the dynamic relationships between stock markets around the world with stock market in Egypt, through: Firstly, Analyzing the co-integration amongst the variables and secondly, Analyzing the causality relationships amongst the variables.

Method

This research applied a time series method, which include the following techniques, the co-integration, error correction modeling and finally the variance decomposition. In order to implement this method, we are going to use MICROFIT Program for this paper. Accordingly, to discover the empirical evidence regarding type of the relations between equity markets as mentioned in the introductory paragraphs we used this method. It is preferred over the traditional regression method because unlike its predecessor-linear regression.

The advantages of using the time series techniques can be summarized on, firstly the co-integration test of long-run theoretical relationship between the variables can be applied in this technique. Secondly, the availability of causality relationship test (using the Granger-causality test) between the variables.

In general, the time series method can observe and study the nature of the data whether it is dynamics or not, and as our research variables mainly financial variables and

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consider to be non-stationary, that's mean to run the ordinary regression test on the variables could misrepresent the results. Therefore, we are going to perform the regressions on the differenced form of these variables as this will solve the problem, as the long-term trend will be removed effectively when the variables are regressed in their different form.

Third advantage of using this method, as in the normal traditional regression, the exogeneity or endogeneity of the variables is pre-determined by the writer, on the basis of the previous literature review and theories. While in the Co-integration techniques have the advantageous since it does not assume variable exogeneity or endogeneity. In the final step of the analysis, the data and the results will define which variables are exogenous or exogenous.

The data used in this research are the monthly closing of the selected stock market indexes in the period of March 1998 to January 2018. The total of 238 observations was obtained, and the data source was Data Stream. This paper used monthly stock prices indices in order to avoid distortions common in daily and weekly data arising from non-trading and non-synchronous trading. This makes a clearer picture of the index movements away from short-term volatility.

We have also included the US and UK stock markets data since they are among the largest stock markets in the world which play an important role in the economics of the world (Ali et al., 2020). Moreover, the United State is the largest economy in the world has stabile economic and financial relationship with Egypt from the MENA region. While The Hong Kong Stock Exchange (SEHK) is considered the Asia's second largest stock exchange in terms of market capitalization behind the Tokyo Stock Exchange which consider as the third largest stock exchange in the world. Malaysia is included also because it is evidenced that it has a strong economic relationship with countries in the MENA region. Hence it is expected that the financial markets would emulate the similar relationship and it is found of the existence of common investors who seek for portfolio in both courtiers. Data obtained has been converted into logarithm form for the purpose of time series processing.

Results

In this section, we have performed the eight steps of the time series technique. All variables will be derived according to the theory of stock market integration explained in the previous section.

Testing Stationarity of Variables

At the beginning of testing the stationarity, the test will start with the unit-root test after that testing the co-integration, for the following reasons. Firstly, to know whether the variables are stationarity or not, can mainly affect its properties and behavior. Secondly, false regressions could be happening if applying the non-stationarity data. Thirdly, also the assumptions for asymptotic analysis will be invalid if the variables are a non-stationary. We will perform the non-stationary test by using Augmented Dickey-Fuller (ADF). As we mentioned ideally, the variables should be in the first difference level stationary.

For instance, the DSBBMAL = LSBBMAL - LSBBMAL-1. So, we start by conducting the (ADF) test on every variable (by the level and differenced form). Table 2 summarizes the results. Relying mainly on the Aike-Information Criterion (AIC) and Schwarz Bayesian criterion (SBC), the results of the finding can proceed with testing of co-integration.

Table 2. The Results of the Stationarity of Variables

Variable	Test Statistic	Critical Value	Implication
Variables in Level Form			
LSBBUSD	-1.9885	-3.4303	non-stationary
LSBBHNK	-3.3070	-3.4303	non-stationary
LSBBUKD	-2.2817	-3.4303	non-stationary
LSSBJAP	-2.1460	-3.4303	non-stationary
LSBBMAL	-1.8536	-3.4303	Variable is non-stationary
LEGHREFG	-1.8926	-3.4303	Variable is non-stationary
Variables in Differenced Form			
DSBBUSD	-13.8965	-2.8741	Variable is stationary
DSBBHNK	-13.7590	-2.8741	Variable is stationary
DSBBUKD	-13.5595	-2.8741	Variable is stationary
DSBBJAP	-14.0641	-2.8741	Variable is stationary
DSBBMAL	-8.2722	-2.8741	Variable is stationary
DEGHREFG	-6.5336	-2.8741	Variable is stationary

Determination of Order of the VAR Model

Before we start our process with testing the co-integration, we have to figure out the order of the vector auto regression (VAR), which represent the number of lags to be used. This order of lag is determined by selecting the highest value of AIC and SBC as set out in Table 3, the findings showed that AIC suggest order of one (1) whereas SBC recommend a zero (0) lag (see Table 4). AIC (Aike-Information Criterion) essentially emphasize on deciding the best order of lags so the study will use the order of (1) lag.

Table 3. The Order of AIC and SBC

Order	AIC	SBC
1	**2080.7**	1998.1
0	2080.3	**2059.6**

Table 4. The Choice Criteria for Optimal Order

	Choice criteria	
	AIC	SBC
Optimal order	1	0

Testing the Cointegration

Since we have ensured the variables are in form of I(1) and determined the optimal

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VAR order as one, we can now to test co-integration. We want to test if the variables are theoretically related, that means they move together in the long term, where the variables are non-stationary in short term but stationary in the long run. There are two well-known co-integration tests that can be employed here, namely Engle-Granger (henceforth, EG) approach and Johansen approach. However, we employed the Johansen approached since the EG approach has various shortcomings plus the Johansen test it allows the researcher having more than one co-integrating vector in a multivariate variables model.

We're kind of inclined to believe that there is one co-integrating vector as intuition as well as familiarity with contemporary equity markets which indicate that stock markets are typically "connected" or "integrated" in that the performance of one market tends to have an effect on other markets, in some way or other, to varying degrees.

Our result is indeed in line with the underlying economic theory. Previous studies, in economic interpretation, in our view, is that the six indices are theoretically related since in that they tend to move together in the long term. Given that, these stock markets are co-integrated, the opportunity to gain abnormal profits through portfolio diversification (investing in equity markets in different countries) is limited. This is to say that; "while in short term, an investor can improve returns (relative to risk) by geographically diversifying his equity investment, this strategy would not yield that investor consistently abnormal returns over the long run. This is because these co-integrated markets would eventually realign themselves into a long-term (theoretical) relationship with one another".

Table 5. The Results of Variables Relationship

	Null	**Alternative**	**Statistic**	**95% Critical Value**
Maximal Eigenvalue	r = 0	r = 1	45.0005	43.6100
Trace of the Stochastic	r = 0	r = 1	118.4299	115.8500

As shown on Table 5, the null hypotheses: there is no cointegration, and in our case since t-statistic bigger than critical value so we can reject the null, and we conclude that at least we have one cointegration.

Long-run Structural Modelling (LRSM)

At this stage, the objective is to measure theoretically meaningful long-run relationship through identification and over-identification depend on expected theoretical value and information that is available in the underlying theory. We normalized the variable of interest, which is Egypt stock market (LEGHREFG). Hence, this variable is going to be equal to one (1). Table 6 shows the result of exact identification.

Table 6. LRSM Results

Variable	**Coefficient**	**Standard Error**	**t-ratio**	**Implication**
LSBBUSD	3.7059	0.93558	3.961	**Variable is significant**
LSBBHNK	-0.057412	1.1434	-0.050	Variable is insignificant
LSBBUKD	-3.3488	1.0945	-3.059	**Variable is significant**
LSSBJAP	-2.2038	0.74375	-2.963	**Variable is significant**
LSBBMAL	0.84561	0.56522	1.496	Variable is insignificant

Variable	Coefficient	Standard Error	t-ratio	Implication
LEGHREFG	-	-	-	-

Such initial findings were generally intuitively appealing to our mind. However, we were curious as to why the LSBBHNK, LSBBMAL index found was to be insignificant; we have decided to test the significance of the variables by subjecting the estimates to over-identifying constraints. We test the insignificant variables (see Table 7).

Table 7. The results (P-value)

Variable	Chi-Sq p-value	Implication
LSBBHNK	0.960	Variable is insignificant
LSBBMAL	0.111	Variable is insignificant

The result of over identification was confirmed. The null hypothesis which is the restriction is correct, the coefficient of LSBBHNK, LSBBMAL (A2 and A5) are insignificant. Since we cannot reject the null, (p-value is more than 10%) it means those markets are insignificant as we have seen in exact identification. However, even if there is no significant relationship between Malaysia stock market and the Egypt's one we proceed with the inclusion of Malaysian stock market has a strong economic relationship with every country in the MENA region, especially Egypt, due to the fact of the existence of common investors who seek for portfolio in both courtiers. Same intuition for Honk Kong stock market, since it is consider large equity market in Asia and there have common investors how seek portfolio in both market.

Therefore, we proceed to next step with model from exact identification using this model:

Egypt + 3.705 US -0.057 HK -3.348 UK -2.203 JPN +0.845MAl ⟶ I (0)
(0.9355) (1.143) (1.094) (0.743) (0.565)

Vector Error Correction Model (VECM)

The VECM results are look so useful for decision making and establishment of a policy. in this special case, it is so important to know which variables are explanatory, that is influencing other variables, and which is (are) dependent variable(s).

Table 8. VECM

Variable	ECM (-1) t-ratio p-value	Implication
LSBBUSD	0.216	**Variable is exogenous**
LSBBHNK	0.372	**Variable is exogenous**
LSBBUKD	0.104	**Variable is exogenous**
LSSBJAP	0.394	**Variable is exogenous**
LSBBMAL	0.000	Variable is endogenous
LEGHREFG	0.065	Variable is endogenous

The main idea in VECM test is ensuring the four variables are established to be dependent variables. So that are tested through it is probability value (p-value).

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Probability value, in this particular scenario appear how significant the variable is being explained by the variable itself, i.e., the higher p-value implies that the higher the variable is being explained by itself. otherwise, the lower p-value implies that the variable is not being explained by itself, so it is dependent to other variables which can explain (influence) their movement.

Information on direction of Granger-causation can be particularly useful for investors. It was argued that; "By knowing which variable is exogenous and endogenous, investors can better forecast or predict expected results of their investment. Typically, an investor would be interested to know which index is the exogenous variable because then the investor would closely monitor the performance of that index as it would have significant bearing on the expected movement of other indices in which the investor has invested. This exogenous index would be the index of interest to the investor".

Therefore, the implications of this result would be, as far as the analyzed markets are concerned, the index of interest to investors would be the LSBBUSD, LSBBHNK. LSBBUKD and LSSBJAP. Those indexes, being the exogenous variables, would receive market shocks and transmit the effects of those shocks to other indices, for instance an investor who invests in say, the Egypt Stock market (LEGHREFG), would be interested to monitor movements in the US Market (LSBBUSD), as changes to that index is most probably to affect his investments in a significant way. Likewise, news updates, globally events and world economic developments that are likely to affect the (LSBBUSD) would be something interesting to that investor.

Variance Decomposition (VDC)

Whilst we have established that the four stock indexes are the exogenous indexes and despite the fact that VECM has helped the researcher to know which exogenous variables are, the strongest exogenous variable is still silent. The important thing for policy makers is to understand the strongest exogenous variable as such to increase the effectiveness of the policy. VDC is taken as an affirmative step whilst the policy implication, Since VECM is unable to inform the strongest explanatory variable, through partitioning the variance of the forecast error of the particular variable into proportions attributable to shocks in each variable in the system –including its own, VDC allows us to examine relative exogeneity of the variable explained by its own past shocks. In other words, we can say that "relative endogeneity can be ascertained in the following way; VDC decomposes the variance of forecast error of each variable into proportions attributable to shocks from each variable in the system, including its own. The least endogenous variable is thus the variable whose variation is explained mostly by its own past variations".

There are two approaches for generating VDCs values. The Orthogonalized VDCs, and the Generalized VDCs. The first one is Orthogonalized VDCs it is role to informs the researcher which is most exogenous variable based on particular ordering of the variable, hence it is bias. Moreover, when one-specific variable is shocked, all other variables are switched-off, as such it is less realistic in nature, and it assumes relationship in isolation. The second one is generalized VDCs which generate the values in more realistic nature, since it does not follow the particular-ordering of the variables, and when a variable is shocked, all other variables may change as the reaction of the shock. As such, the changes

of other variables are interpreted as mainly occurred due to the shock of that particular variable.

Following this discovery, we decided to rely on Generalized VDCs, which are invariant to the ordering of variables as we mentioned, and here we have performed additional computations, since the numbers do not add up to 1.0 as in the case of orthogonalized VDCs. For a given variable, at a specified horizon, we total up the numbers of the given row and we divide the number for that variable "representing magnitude of variance explained by its own past" by the computed total. In this way, the numbers in a row will now add up to 1.0 or 100%.

The diagonal line of the matrix (which we highlight) represents the relative exogeneity. Based on these results, the ranking of indices by degree of exogeneity, "extent to which variation is explained by its own past variations".

We test this at three-time horizons which are 12 months (1 year) 24 months (2 year) and 36 months (3 year). Table 9 shows the results.

Table 9. VDC – Horizon 12-24-36

Horizon	COUNTRY	EG	HK	JP	MY	UK	US
12	EG	**59.8%**	5.3%	9.1%	1.9%	14.7%	9.1%
	HK	2.5%	**42.5%**	9.5%	8.9%	19.5%	17.1%
	JP	4.5%	10.5%	**53.7%**	2.4%	14.1%	14.7%
	MY	1.4%	16.6%	21.1%	**40.6%**	15.1%	5.2%
	UK	9.3%	16.1%	5.5%	7.7%	**34.1%**	27.3%
	US	7.9%	15.9%	5.7%	7.5%	24.3%	**38.7%**
	Self-Dependence	59.8%	42.5%	53.7%	40.6%	34.1%	38.7%
	Ranking	1	3	2	4	6	5

Horizon	COUNTRY	EG	HK	JP	MY	UK	US
24	EG	**56.7%**	5.3%	12.4%	1.2%	15.9%	8.5%
	HK	2.1%	**42.5%**	10.6%	8.2%	19.9%	16.7%
	JP	5.2%	10.8%	**51.7%**	2.9%	14.0%	15.5%
	MY	3.0%	15.1%	33.6%	**28.3%**	16.7%	3.3%
	UK	10.4%	16.0%	4.3%	8.8%	**32.8%**	27.8%
	US	8.6%	15.8%	4.7%	8.4%	23.5%	**39.0%**
	Self-Dependence	56.7%	42.5%	51.7%	28.3%	32.8%	39.0%
	Ranking	1	3	2	6	5	4

Horizon	COUNTRY	EG	HK	JP	MY	UK	US
36	EG	**55.1%**	5.3%	14.1%	0.9%	16.6%	8.1%
	HK	1.9%	**42.5%**	11.2%	7.8%	20.0%	16.5%
	JP	5.5%	10.9%	**50.6%**	3.2%	13.9%	15.8%
	MY	4.1%	14.1%	39.5%	**22.5%**	17.2%	2.4%
	UK	10.9%	15.9%	3.7%	9.3%	**32.1%**	28.0%
	US	9.0%	15.8%	4.2%	8.8%	23.1%	**39.1%**
	Self-Dependence	55.1%	42.5%	50.6%	22.5%	32.1%	39.1%
	Ranking	1	3	2	6	5	4

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Based on the previous results analysis, it can be found the following observations. First, the Generalized VDCs show that Egypt stock market is the most exogenous variable. This is because Egypt's market is in isolation, so any shock to the capital market will be corrected by itself. As the study of Darrat et al. (2000) indicates that "these markets provide a good example of newly emerging stock markets with remarkable growth potential, apparently still isolated from the core of major international markets, preliminary inspection suggests that these markets are sensitive to changes in the country's political structure. Although have a considerable growth potential, but also need to develop structural relations with major foreign markets and other regional stock exchanges" (Darrat et al., 2000). Second, our results in step five, VECM confirm that in most times variance UK and Malaysia is the most endogens market. Third, in this step we found that the US stock market to be the least exogenous. The proportion of the variance that is explained by its own past shocks is 39.1%. This could be explained by the fact that the US stock markets are more integrated into and have more interdependencies on other stock markets than the Egypt stock markets do. There are more factors that affect the US stock markets than just its own past. The recent global financial crisis is an evident of such interdependency.

Impulse Response Functions (IRF)

The impulse response functions (IRFs) basically will introduce the same information as the VDCs, except it will be presented in graphical form. In IRFs, shocks are made to specific particular variables and the graphs will show the impact of the shock to other variables (in the case of generalized – See Figures below).

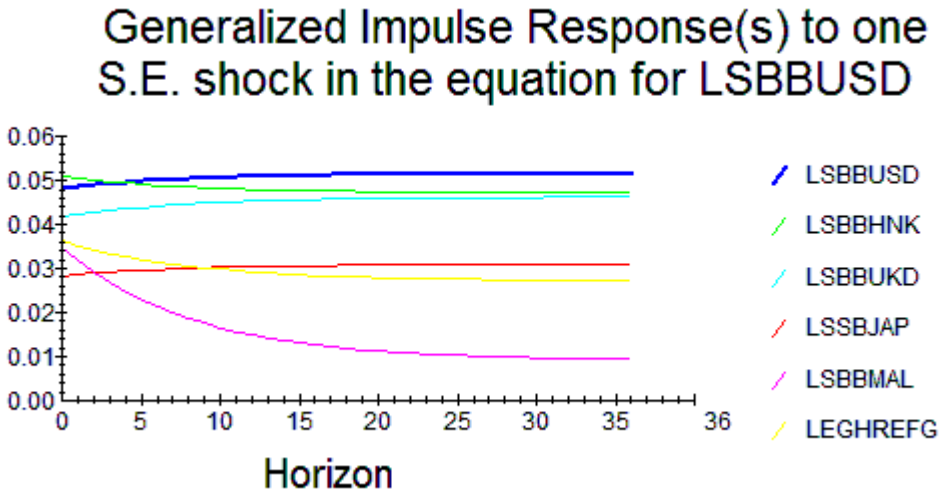

Figure 1. GIR - LSBBUSD

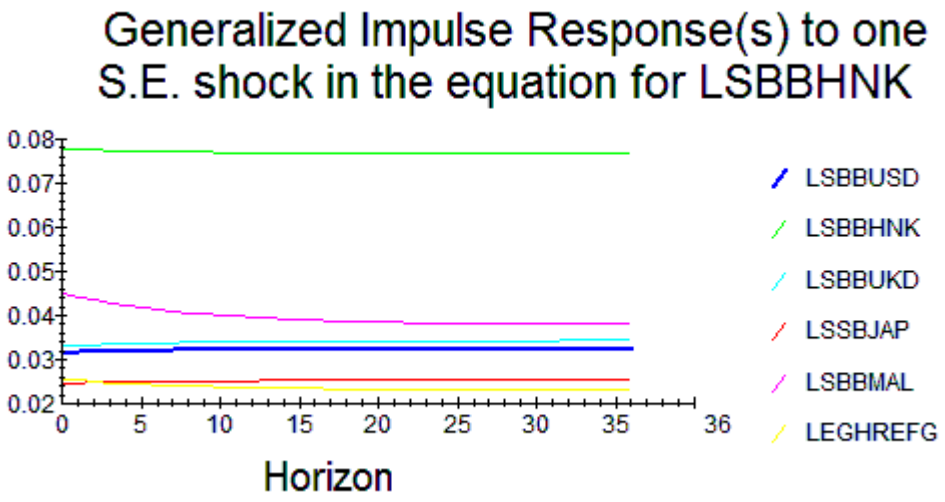

Figure 2. GIR - LSBBHNK

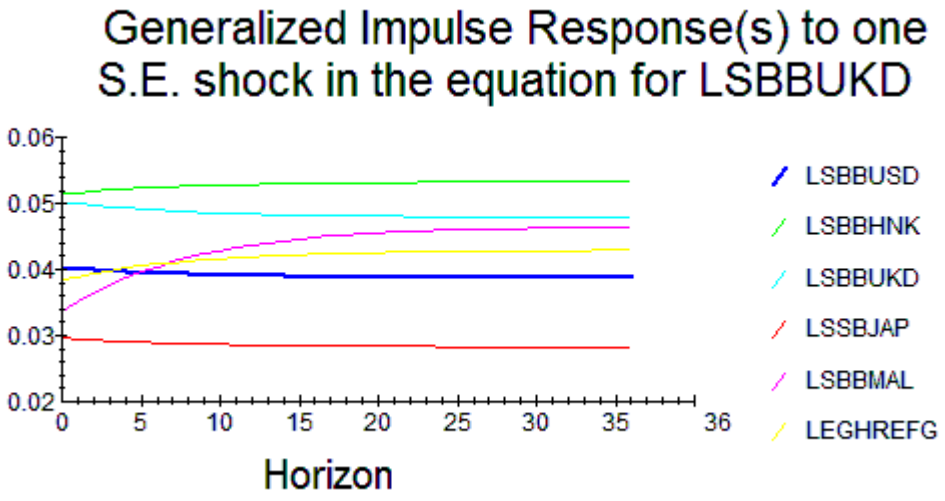

Figure 3. GIR - LSBBUKD

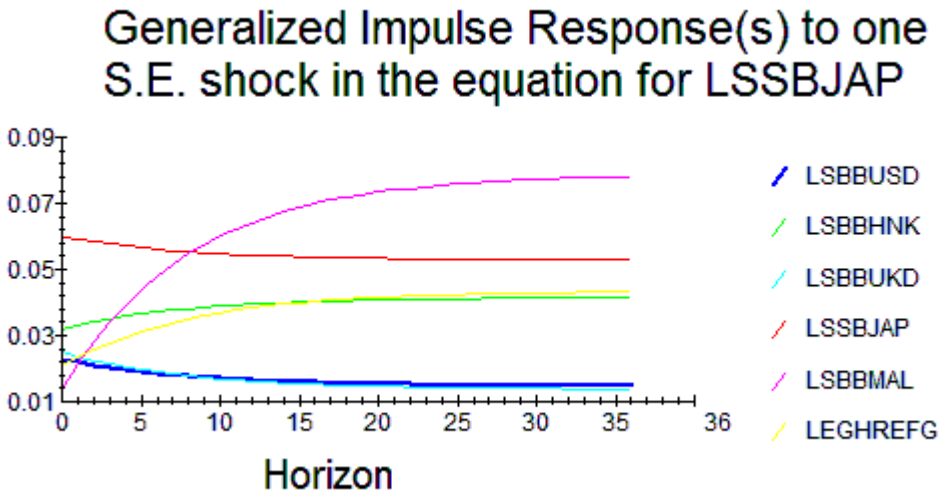

Figure 4. GIR - LSSBJAP

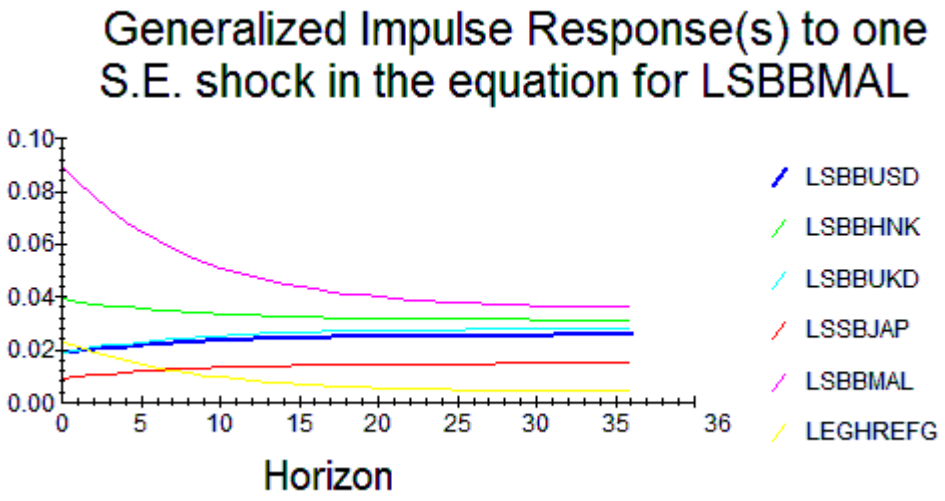

Figure 5. GIR - LSBBMAL

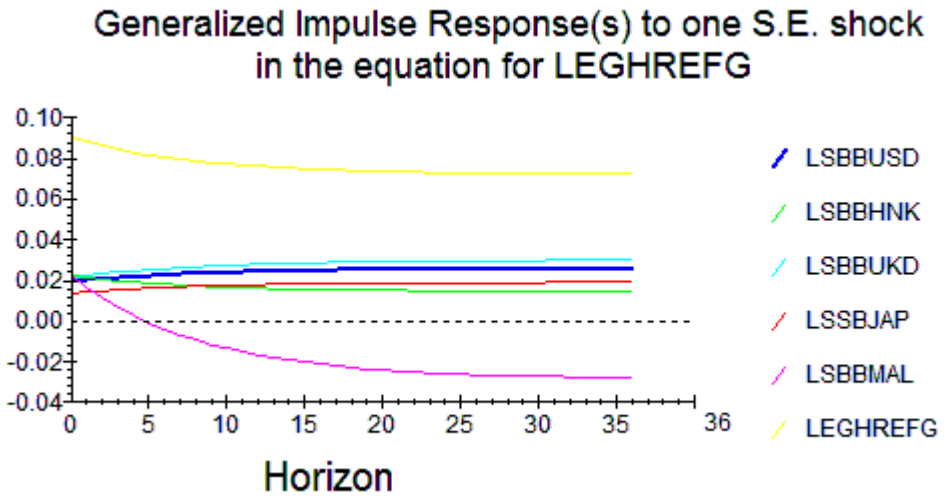

Figure 6. GIR - LEGHREFG

Persistence Profile

This persistence profile was created to suggest the required time horizon for all the mentioned variables to return to the equilibrium when a system-wide shock happens. The basic distinguish between the IRFs and persistence profiles is that the persistence profiles trace out the effects of a system-wide shock on the long-run relationship. It can be seen in Figure 7 that it would require almost 17 months for the cointegrating vectors to come back to its equilibrium, following a system-wide shock.

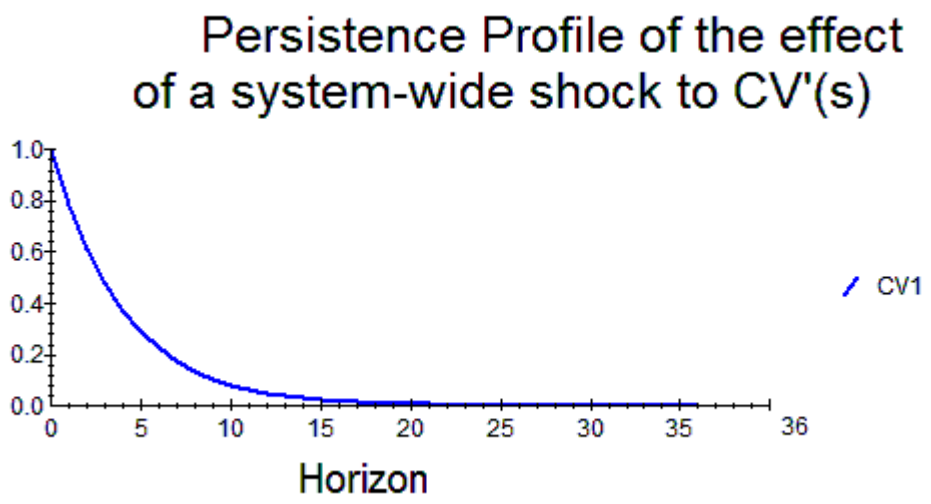

Figure 7. Persistence Profile

Discussion

In this paper, we performed various steps of the time series technique to analyze the stock market integration. We started by testing the stationarity of variables using the Augmented Dickey-Fuller (ADF) test. The variables were tested in both level and differenced forms. The results showed that all variables were non-stationary in their level form but became stationary after differencing. This was confirming the results of findings of Abid et al. (2019) and Dutta et al. (2017) which implies that these variables exhibit a trend or systematic pattern in their raw form. Non-stationarity refers to the presence of a trend or structural change in the data, making it difficult to analyze and model accurately. Differencing, which involves taking the difference between consecutive observations, is a common technique used to transform non-stationary data into stationary data.

Next, we determined the order of the Vector Auto Regression (VAR) model by selecting the highest values of the Aike-Information Criterion (AIC) and Schwarz Bayesian criterion (SBC). According to the papers of Kim et al. (2018) and Lütkepohl (2005) which have employed the AIC and SBC criteria to determine the lag order in VAR models, the AIC suggested an order of one lag, while the SBC recommended zero lag. Based on the AIC, we chose an order of one lag for our VAR model.

After determining the order of the VAR model, we tested for cointegration using the Johansen approach. The results indicated the presence of at least one cointegrating vector among the variables, supporting the theoretical assumption of long-term relationships between the stock markets which refer to consistent patterns of correlation and interdependence over extended periods, reflecting the interconnectedness and influence of global economic factors on market performance. This was supporting the results of Umar et al. (2022) where they found that there are relationships between the financial assets, and the Russian-Ukrainian conflict changed the relationship among the financial markets.

In the Long Run Structural Modeling (LRSM) step, we measured the long-run relationship between the variables. The coefficients and standard errors were estimated, and the results showed that some variables were significant while others were insignificant, this implies that the significant variables have a statistically meaningful impact on the long-run relationship, while the insignificant variables do not have a

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significant influence. This modeling tool was among the most popular tool used in many papers like Yussuf (2022) and Shawtari et al. (2016). We further tested the significance of the insignificant variables using over-identifying constraints, which confirmed their insignificance.

Although LSBBHNK and LSBBMAL were found to be insignificant, we proceeded with including them in the model based on the existence of common investors seeking portfolio diversification between Malaysia and Egypt, as well as the significance of Hong Kong as a large equity market in Asia, and the third-largest stock exchange in Asia by its aggregate market capitalization (Corporate Finance Institute, 2023).

In the Vector Error Correction Model (VECM), we identified which variables were exogenous and which were endogenous. This information is useful for investors in predicting the expected results of their investments. Exogenous variables are those that are not affected by the system's dynamics and are independent of other variables in the model (Al-Kofahi et al., 2022). These variables are typically determined by external factors and can be used as predictors to forecast the behavior of the endogenous variables. Endogenous variables, on the other hand, are influenced by the dynamics of the system and are dependent on other variables within the model. These variables are the main focus of analysis as their behavior is being explained and predicted based on their relationships with other variables.

The results showed that LSBBUSD, LSBBHNK, LSBBUKD, and LSSBJAP were exogenous variables, receiving market shocks and influencing other indices, this means that these variables are considered exogenous because they receive market shocks and have the ability to influence other indices within the model. This lead that changes or fluctuations in these exogenous variables can impact the behavior and dynamics of the endogenous variables in the system. By recognizing these exogenous variables and their influence on other indices, investors can take into account the potential effects of market shocks and the behavior of these variables when making predictions and decisions related to their investments. Our results consistent with Bhuiyan and Chowdhury (2020) in terms of there is a stable long-term relationship between the macroeconomic variables used in the study and different sector indices for the US and the US money supply and interest rate can explain the Canadian stock market, while on the other hand, the paper of Ratanapakorn and Sharma (2022) investigates the short-run and long-run relationships among stock indices of the US, Europe, Asia, Latin America, and Eastern Europe–Middle East for the pre-Asian crisis and for the crisis period. The findings from these two periods are compared and contrasted. No long-run relationship is observed among these indices during the pre-Asian crisis period. However, during the crisis period, one significant cointegrating vector is observed and more short-run relations are observed in this period as compared to the pre-crisis period.

To determine the strongest exogenous variable, we used Variance Decomposition (VDC) at different time horizons. The results showed the proportion of variance explained by each variable, and the diagonal line represented the relative exogeneity. Based on the VDC results, we ranked the indices by the degree of exogeneity at different horizons. This technique used to assess the contribution of different variables in explaining the variance of a target variable over time. By applying VDC at different time horizons, we can analyze the relative importance of exogenous variables in influencing the target variable's variability. Building upon the work of Abdullah et al. (2022), we implemented the VDC

methodology in our research to investigate the sources of variance within our system. The VDC technique breaks down the total variance of a system into different components or factors, providing insights into the relative contributions of each factor to the overall variance. By applying VDC at different time horizons, we were able to analyze how these contributions vary over time and gain a deeper understanding of the dynamics and drivers of variance within our system. The study conducted by Abdullah et al. (2022) served as a valuable reference and provided the foundation for our implementation of VDC. Their methodology and findings guided our approach and allowed us to apply VDC effectively to our own research context.

Overall, our findings support the presence of long-term relationships and stock market integration among the analyzed variables. The results provide insights for investors, highlighting the importance of monitoring certain indices, such as LSBBUSD, LSBBHNK, LSBBUKD, and LSSBJAP, as they have a significant influence on other indices.

Conclusion

In this study, we examined the co-integration and causality relationships among the stock markets of the US, UK, Malaysia, and Egypt. Our findings revealed that these markets are co-integrated, indicating a long-run equilibrium relationship among them. This implies that investors seeking to diversify their portfolios may not be able to achieve significant gains in the long run by investing in these markets alone. However, we also found that the stock market of Egypt acts as the most exogenous market, leading the movements of the US, UK, and Japan. This finding suggests that investing in the Egypt stock market can help offset the volatilities in major stock markets and provide diversification benefits.

Despite the valuable insights gained from this study, there are certain limitations that should be acknowledged. First, the analysis focused on a limited set of stock markets, and future research could consider expanding the scope to include other markets, particularly within the MENA region or the GCC, which have significant influences on the Egypt stock market. Additionally, incorporating additional variables, such as macroeconomic factors or investor sentiment, could provide a more comprehensive understanding of the dynamics between these markets. Furthermore, it would be beneficial to explore the spillover effects within the MENA region or between Egypt and other countries to gain a deeper understanding of the regional dynamics. Finally, conducting more extensive research on non-cointegrated markets, such as Malaysia and Hong Kong, could provide further insights into the benefits of diversification for both short and long-term investors. Overall, by addressing these limitations and pursuing further research in these directions, we can contribute to the development of the Egypt stock market and provide investors with more comprehensive strategies for portfolio diversification and risk management.

Authors' Declaration

The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation and discussion of results. The authors read and approved the final manuscript.

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