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Long-term and short-term dynamic relationships on the country Stock Market Index due to the impact of explosion of Ammonium Nitrate (NH_4NO_3) in Beirut, Lebanon: An event study analysis on the Stock Market Index of countries in The Middle East and the country Stock Market Index in Indonesia

Fikri Irfan Adristi, Abdul Moin

Department of Management, Universitas Islam Indonesia, Yogyakarta, Indonesia

*Correspondents e-mail: 23917020@students.uii.ac.id

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Author's email:
abdul.moin@uii.ac.id

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Abstract

Objectives — This research aims to examine the long-term and short-term dynamic relationships of the major stock market indices in Lebanon (BLSI), Israel (TA35), Jordan (AMGNRLX), Saudi Arabia (TASI), and Indonesia (IHSG) due to the impact of the ammonium nitrate explosion. (NH_4NO_3) in Beirut, Lebanon.

Method — This research used samples after the explosion of ammonium nitrate (NH_4NO_3) in Beirut, Lebanon, from 10 August 2020 to 17 December 2020. Long-term and short-term dynamic relationships due to the impact of the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon were tested using the Johansen Cointegration Test and Granger Causality Test methods.

Findings — The results show that: (1) There is a cointegration relationship in the return of the country stock market index in Lebanon (BLSI), Israel (TA35), Jordan (AMGNRLX), Saudi Arabia (TASI), and Indonesia (IHSG) after the explosion; (2) there is no bi-directional causality relationship or unidirectional relationship between benchmark variables, that is Return BLOM Stock Index (BLSI) with the Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and Return Indeks Harga Saham Gabungan (IHSG) variable after the explosion event.

Originality — This paper presents a novelty with a study of events that link human events and capital market indices.

Keywords: Cointegration, dynamic relationship, ammonium nitrate (NH_4NO_3) explosion, country stock market index, stock market return.

Introduction

Lebanon faces a humanitarian emergency following the explosion on Aug 4, 2020, of more than 2000 tonnes of ammonium nitrate stored at Beirut's port that has added severe strain to a health system already buckling under an economic crisis, civil unrest, the COVID-19 pandemic, and the hosting of some 1-5 million refugees in a country of about 6 million people (Devi, 2020). The blast – equivalent to an earthquake of 3,5 magnitude – has been included among the largest artificial non-nuclear explosions, alongside other accidents resulting from the detonation of ammonium nitrate, such as the 2015 explosion in Tianjin, China. More than half of the approximately 200.000 damaged buildings in Beirut had their windows destroyed, injuring people in the streets and increasing the risk of burglary and looting, as assessed by the Lebanese Red Cross (Renino, 2020).

Furthermore, with the growing number of natural disasters, artificial disasters and terrorist incidents around the world, has led the public to focus attention on the impact of such events on the economy and the capital market. These disasters and terrorist incidents, which are usually sudden and unpredictable, have increasingly affected a large portion of the world population over the last decades. Human activity enhances the effect of such events in that, as the population grows and building expands, previously unpopulated areas become more vulnerable (Tavor & Teitler-Regev, 2019). Of course, with the occurrence of explosive events caused by artificial disasters and terrorist incidents around the world, this can affect the stock market, and this is also confirmed by several research findings.

In the research Giudici et al. (2019) the empirical results stated that the Tianjin explosions, analyzed over 4 days show an average CAR10 of roughly −3% in the three models. The incident took place near Tianjin, which is a logistics hub. The research Memdani & Shenoy (2019) found that all the global indices had long and short-run associations with the benchmark index of countries affected by the Mumbai terror attacks, i.e. BSE. Global indices like DJI, NIKKEI, SSEC, DAX and FTSE had a short-term association with the affected country's index. Gold moved as expected, with having a short-run impact on the country that was hit by the Mumbai terror attacks.

Furthermore, in the research Arif & Suleman (2017) also tested the impact of terrorist attacks on different industries listed in the KSE-100 index. The findings of his research claimed that various industries responded differently to terrorism. Some industries experienced decrease in price, while others recorded an increase. The financial, tobacco and health and care sectors experienced a rise in prices. In contrast, oil and gas, auto and parts, industrial and telecom sectors experienced a fall in prices. Then, in the research Sahu et al. (2014) the dynamic relationship between oil price shocks and the Indian stock market has been investigated. The cointegration result indicates the existence of long-term relationship. Further, the error correction term of VECM shows a long run causality moves from Indian stock market to oil price but not the vice versa. The results of the Granger causality test under the VECM framework confirm that no short-run causality between the variables exists.

Researching the impact of the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon on returns on the stock market indices of affected and unaffected countries as a result of the event is a challenge for the author to study because, the explosion event did not only affect human life, health, well-being, and politics but also penetrates into the economic sector with the potential for significant direct or indirect influence. The effects of these events can last for the short term or for longer.

In this research the analysis was carried out on four country stock market indices in the Middle East and country stock market indices in Indonesia, that is: (1) BLOM Stock Index (BLSI) from Lebanon, (2) TA-35 (TA35) from Israel, (3) Amman SE General (AMGNRLX) from Jordan, (4) Tadawul All Share Index (TASI) from Saudi Arabia, dan (5) Indeks Harga Saham Gabungan (IHSG) from Indonesia. Furthermore, the reason why the capital market in the Middle East was chosen as the object of this research is because the Middle East region is an area of the Lebanese state that is directly affected by the ammonium nitrate (NH_4NO_3) explosion event in which neighboring countries have the potential to be affected by the economy either directly or indirectly.

When compared to capital markets from other regions, the Middle East capital market has these characteristics: (1) capital markets in the Middle and East and North African (MENA) region have emerged compared to capital markets from Eastern Europe and Latin America; (2) the capital market in the MENA region is the second most-developed after Asia, but before Latin America and Eastern Europe, (3) however, levels of market emergence are still heterogeneous within the MENA region (Lagoarde-Segot & Lucey, 2008). Meanwhile, the capital market in Indonesia was also chosen as the object of this research because, the capital market in Indonesia was used to test whether the impact of the explosion event could affect the stock market index of countries that are located far from the location of the directly affected countries.

Then, the underlying assumption explains why it is necessary to connect the four country stock market indices in the Middle East and the country stock market index in Indonesia in a model, including: (1) The countries of Lebanon, Jordan, Saudi Arabia, and Indonesia have had economic and political cooperation relations since 1969 through multilateral organizations, that is

The Organisation of Islamic Cooperation (OIC) (Organisation of Islamic Cooperation, n.d.); (2) in the political aspect, the countries of Lebanon and Jordan have allied and been involved in the events of The *"Six Day War"* against The State of Israel (Oren, 2002); (3) then, The States of Jordan and Saudi Arabia have also allied and been involved in the events of The *"Yom Kippur War"* against The State of Israel (Siniver, 2013); (4) finally, in the trade aspect in 1979, the State of Indonesia purchased 32 units of the Skyhawk fighter aircraft A-4E and TA-4Hs models from The State of Israel (Winchester, 2005).

Then, the theoretical foundation that strengthens relations between countries as a result of this disaster is the contagion effect. The contagion effect refers to a country transmitting market changes to other countries after the impact of a major event and interdependency among countries. However, the contagion effect is not always related to financial crisis; when a major natural disaster occurs, such as an earthquake, the international financial market can become volatile (Lee et al., 2018).

Based on the underlying assumption and theoretical foundation, it can be seen that the ammonium nitrate (NH_4NO_3) explosion event in Beirut, Lebanon is relevant in the context of the modeling in this research because the economic, trade and political relations in the four countries in the Middle East and Indonesia in the model are closely intertwined since the past so that, the impact of the explosion event can extend to the respective country stock market indexes in the model.

The purpose of this research is to examine the cointegration and causality relationship between the return of the country stock market index in Lebanon (which was directly affected by the explosion) and the return of the country stock market index in Israel, Jordan, Saudi Arabia, and Indonesia.

Literature Review

Theoretical Foundation

Ammonium Nitrate (NH_4NO_3)

Ammonium nitrate (NH_4NO_3) is a chemical compound that is mostly found as a colorless and/or white to gray crystalline solid, odorless beads, and easily soluble in water. The molecular weight, specific gravity, melting, and boiling point of NH_4NO_3 are 80,06; 1,725; 169,51 °C; and 210 °C, respectively. Higher temperature (>210 °C) easily decomposes NH_4NO_3 and producing toxic gasses, especially nitrogen oxides, and may also cause an explosion. At room temperature, pure NH_4NO_3 neither flammable or combustible, but when heated, normally, it is decomposed into non-explosive gases such as oxygen. Nevertheless, it can also be decomposed into explosive material by detonation. Ammonium nitrate is strongly oxidant that easily detonates under certain circumstances, which include higher temperature (>210 °C), confinement, and impurities (Shakoor et al., 2020).

According to Cagnina et al. (2013) the use of ammonium nitrate has three major hazardous phenomena need to be considered: fire, decomposition and explosion. Whereas by itself ammonium nitrate is not combustible, it can thermally decompose and give off gaseous products of ammonia and nitric acid and other gases including vapours of toxic nitrogen dioxide (NO_2) when exposed to external heat. Additional factors like confinement or contamination may trigger an explosion hazard.

Human-made Disaster

Human-made disaster or anthropogenic hazard is known as a hazard that caused by human action or inaction. A human-made disaster has the potential to injure and harm people, animals, and plants. The definition of human-made disaster highlights that the effects of human-made disasters on every living thing on Earth must be stressed by all industry stakeholders, such as farming, manufacturing, and construction (Maskuriy et al., 2020). Harding (2007) defines human-made disasters as conditions that result from a range of policies and deliberate state actions. They produce adverse impacts on the economy and infrastructure of a country and facilitate the breakdown of social networks and community.

Event Study Approach

Event study methodology is one of the most frequently used analytical tools in financial research. The objective of an event study is to assess whether there are any abnormal or excess returns earned by security holders accompanying specific events (e.g., earnings announcements, merger announcements, stock splits) where an abnormal or excess return is the difference between observed return and that appropriate given a particular return generating model (Peterson, 1989).

According to Frunza (2016) the aim of an event study is to assess the extent to which security price returns around the time of an event became abnormal. According to El Ghoul et al. (2023) event studies are widely used in finance research to investigate the implications of announcements of corporate initiatives, regulatory changes, or macroeconomic shocks on stock prices.

The event studies approach examines the behavior of individual indicators in the period leading up to crises. For each variable, behavior during precrisis periods is compared with behavior during tranquil or noncrisis periods (Glick & Hutchison, 2012). Event studies examine the behavior of firms' stock prices around corporate events. Event studies also serve an important purpose in capital market research as a way of testing market efficiency. Systematically nonzero abnormal security returns that persist after a particular type of corporate event are inconsistent with market efficiency (Kothari & Warner, 2007).

According to Budiarto & Murtanto (2002) event studies involve 5 steps: (1) identify the event of interest, (2) identify the time of parameter, (3) estimate the abnormal return, (4) organize and group the abnormal return, and (5) analyze the result. Event studies will continue empirically contributing to the understanding of information and security price.

Event studies focus analysis on the impact of a particular event on asset prices, whereas contagion effects examine the spread of the event's effects to related markets. Both help understand how information or events influence financial market behavior. Many previous studies contained contagion effects in event studies such as research (Alqaralleh & Canepa, 2021; Tommaso et al., 2023; Yadav et al., 2023).

Contagion Effect

Many economists, especially those performing empirical tests, prefer a very strict definition where contagion is defined as an increase in cross-market linkages during a crisis. Therefore, when contagion is defined as an increase in cross-market linkages, evidence of contagion could justify multilateral intervention. If there were no evidence of contagion, multilateral intervention would be less effective and harder to justify. Contagion also defined as a shock in one market or country that is transmitted to another market or country, but is not related to fundamentals (Claessens & Forbes, 2001).

Forbes & Rigobon (2016) defines contagion as a significant increase in cross-market linkages after a shock to one country (or group of countries). According to this definition, if two markets show a high degree of comovement during periods of stability, even if the markets continue to be highly correlated after a shock to one market, this may not constitute contagion. Furthermore, contagion only occurs if cross-market comovement increases significantly after the shock. If the comovement does not increase significantly, then any continued high level of market correlation suggests strong linkages between the two economies that exist in all states of the world.

According to Dornbusch et al. (2000) contagion is best defined as a significant increase in cross-market linkages after a shock to an individual country (or group of countries), as measured by the degree to which asset prices or financial flows move together across markets relative to this comovement in tranquil times. Then, Kaminsky et al. (2003) in Goldstein (2013) provide a nice review of the theories behind financial contagion. Kaminsky et al. (2003) define contagion as an immediate reaction in one country to a crisis in another country.

Previous Research and Hypothesis Development

The potential long-term and short-term dynamic relationships on the stock market indices of countries in the Middle East and Indonesia due to the impact of the ammonium nitrate (NH_4NO_3)

explosion in Beirut, Lebanon will be examined differently. There is no complete consensus in the literature regarding context, techniques and methodology.

In the research Mukherjee & Bose (2008) the movement of the Indian stock market with other markets in Asia and the United States in the era of capital market reform has been examined; as well as examined the sustained interest of foreign investors in the market. researcher find that, though there is definite information leadership from the U. S. market to all Asian markets, but the U. S. indexes do not uniquely influence the integration of Asian markets, while Japan is found to play a unique role in the integration of Asian markets. Returns on the Indian market are also seen to exert considerable influence on stock returns in major Asian markets.

Then, in the research Rajwani & Mukherjee (2013) the linkages between Indian stock markets with other Asian stock markets that is, Hong Kong, Indonesia, Japan, South Korea, Malaysia, Taiwan and China has been investigated. The results suggest that the Indian stock markets are not integrated with any of the Asian markets either individually or collectively, and conclude that Indian markets are not sensitive to the dynamics in these markets in the long run. From the results of earlier research above, this research proposes the following hypothesis:

H_1: There is a long-term relationship between the return on the stock market index of countries affected by the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon and the stock market index returns of countries not affected by the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon.

In the research Puah et al. (2015) has been revisits the long-run relationships and short-run dynamic causal linkages among BRIC stock market, with the particular attention to the 2008 subprime mortgage crisis. The evidence also found that China stock market is the most influential among the BRICs, in which China stock market has the ability to Granger cause the other three BRICs member countries.

Then, in the research Angelovska (2017) an empirical investigation of the long-run relations and short-term dynamics between the two Balkan stock markets: Macedonia and Croatia, was carried out. Granger's causality tests found two bidirectional or full causality between Macedonian and Croatian stock markets. From the results of earlier research above, this research proposes the following hypothesis:

H_2: There is a two bidirectional causality relationship between the stock market index returns of countries affected by the ammonium nitrate explosion (NH_4NO_3) in Beirut, Lebanon and the stock market index returns of countries not affected by the ammonium nitrate explosion (NH_4NO_3) in Beirut, Lebanon.

Research Methods

Population

In this research, the population is defined as the four country stock market indexes in the Middle East and the country stock market index in Indonesia. This research is a population research. The following are the four country stock market indices in the Middle East and the state stock market indexes in Indonesia which are the main indexes in each country:
BLOM Stock Index (BLSI) from Lebanon (BRITE, n.d.)
TA-35 (TA35) from Israel (The Tel Aviv Stock Exchange, n.d.)
Amman SE General (AMGNRLX) from Jordan (Amman Stock Exchange, n.d.)
Tadawul All Share Index (TASI) from Saudi Arabia (Tadawul, n.d.)
Indeks Harga Saham Gabungan (IHSG) dari from Indonesia (Bursa Efek Indonesia, n.d.)

Data and Data Source

In this research, the type of data used is secondary data. The data collection technique used is to download the stock market index return data of each country in csv format. from the web portal 'investing.com' (Fusion Media Limited, n.d.). The time frame used in all country stock market index

return data is daily. The data period in this research was five months after the explosion of ammonium nitrate (NH_4NO_3) in Beirut, Lebanon, from 10 August 2020 to 17 December 2020.

Operational Definitions of Variable

Ammonium Nitrate (NH_4NO_3) explosion event in Beirut, Lebanon

The measurement time of sample data for measuring this event refers to:
$T_0 \rightarrow$ On August 9, 2020 (5 days after the explosion)
$T_1 \rightarrow$ On August 10, 2020
$T_{final} \rightarrow$ On December 17, 2020

Stock Market Index

In this research, four country stock market indices in the Middle East and country stock market indices in Indonesia have been described in population section above. Population is the variable that will be tested in this research. In this research the BLOM Stock Index (BLSI) (BRITE, n.d.) is a benchmark index because this index comes from countries that were directly affected by the ammonium nitrate explosion (NH_4NO_3), that is Lebanon.

Calculating Market Return

$$\mathrm{R_m} = \mathbf{ln}\frac{\mathrm{CSMI_t}}{\mathrm{CSMI_{t-1}}}$$

Explanation:
R_m = Market return at t
$CSMI_t$ = Country Stock Market Index at t
$CSMI_{t-1}$ = Country Stock Market Index at t-1

Data Analysis Method

The Augmented Dickey-Fuller (ADF) test

According to Gujarati (2004) in conducting the DF test, as in Y_t is a random walk, Y_t is a random walk with a drift, or Y_t is a random walk with a drift around the stochastic trend, it is assumed that the error term pada μ_t is uncorrelated. But if the μ_t are correlated, Dickey and Fuller have developed a test, known as the augmented Dickey–Fuller (ADF) test. The ADF test here consists of estimating the following regression:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-1} + \varepsilon_t$$

From an operational aspect, the use of the ADF test in this research is to test the data stationarity of the Return BLOM Stock Index (BLSI), Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and Return Indeks Harga Saham Gabungan (IHSG) after the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon.

Cointegration in Multiple Equations and the Johansen Approach

According to Asteriou & Hall (2007) if we have over two variables in the model, then there is a possibility of having more than one cointegrating vector. Johansen approach for multiple equations can test more than one cointegration relationship (n > 2). In order to present this approach, it is useful to extend the single-equation error correction model to a multivariate one with the following equation:

$$\mathrm{Z}_t = \mathrm{A}_1\mathrm{Z}_{t-1} + \mathrm{A}_2\mathrm{Z}_{t-2} + \cdots + \mathrm{A}_k\mathrm{Z}_{t-k} + \mathrm{u}_t$$

This equation is comparable to the single-equation dynamic model for two variables Y_t and X_t given in:

$$Y_t = \mu + \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{i=0}^{m} Y_i X_{t-i} + u_t$$

Thus, it can be reformulated in a vector error-correction model (VECM) as follows:

$$\Delta Z_t = r_1 \Delta Z_{t-1} + r_2 \Delta Z_{t-2} + \cdots + r_{k-1} \Delta Z_{t-k-1} + \prod Z_{t-1} + u_t$$

Where:
$r_i = (I - A_1 - A_2 - \cdots - A_k)\ (i = 1, 2, \dots, k-1)$ and $\prod = -(I - A_1 - A_2 - \cdots - A_k)$.

From an operational aspect, the use of Johansen Cointegration Testing in this research is to test the similarity of movement and long-term equilibrium relationship on the Return BLOM Stock Index (BLSI), Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and the Return Indeks Harga Saham Gabungan (IHSG) after the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon.

The Vector Error Correction Models (VECM)

According to Mills (2019) the VECM equation can be written as follows:

$$\nabla y_t = \Phi(B) \nabla y_{t-1} + \beta_\perp (\gamma_1^* + \gamma_2^* t) + \beta(\gamma_1 + \gamma_2 (t-1) + e_{t-1}) + u_t$$

The trend will be restricted in error correction if $\beta_\perp \gamma_2^* = 0$, that is, if $d = \beta\gamma_2$. Likewise, the intercept will be restricted to error correction if $\beta_\perp \gamma_1^* = 0\ (c = \beta\gamma_1)$. So, error correction "including trend" can be defined as $e_t^* = e_t + \gamma_1 + \gamma_2 t$.

Residual autocorrelations and portmanteau tests

According to Lütkepohl (1991) alternative analytical tools for checking a model are autocorrelations and portmanteau tests. Modified portmanteau statistics is

$$\bar{P}_h := T^2 \sum_{i=1}^{h} (T-i)^{-1} tr\left(\hat{C}_i' \hat{C}_0^{-1} \hat{C}_i \hat{C}_0^{-1}\right),$$

Where:

$$\hat{C}_i := \frac{1}{T} \sum_{t=i+1}^{T} \tilde{u}_t(\bar{y}, \widetilde{\beta}) \tilde{u}_{t-i}(\bar{y}, \widetilde{\beta})'$$

$\tilde{u}_t(\bar{y}, \widetilde{\beta})$ is the residual of the VARMA model estimated as before. Under general conditions $\bar{P}_h$ has an approximate asymptotic X^2 distribution. Degrees of freedom are obtained by subtracting the number of VARMA coefficients that are estimated to be free from $K^2 h$.

The Ordinary Least Squares (OLS) Estimator

According to Vogelvang (2005) the least squares principle yields an estimator that minimises the squared differences between the observed Y_t and the predicted $\hat{Y}_t$ from the estimated model. These differences are called the *residuals*. If estimastes $\hat{\beta}_1, \hat{\beta}_2, \dots, \hat{\beta}_k$ have been computed then *predicted values* $\hat{Y}_t$ are computed as:

$$\hat{Y}_t = \hat{\beta}_1 + \hat{\beta}_2 X_{t2} + \cdots + \hat{\beta}_k X_{tk}, t = 1, \dots, n$$

and the residuals e_t are computed as:

$$e_t = Y_t - \hat{Y}_t, t = 1, \dots, n$$

That best fit is obtained by using an estimator for the unknown parameters that ensures that we get a model with residuals e_t that are as small as possible. From an operational aspect, the use of Ordinary Least Squares (OLS) in this research is to determine the optimal amount of lag in Granger Causality Testing. The amount of lag to enter is selected using the minimum values from Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Hannan-Quinn Criterion (HQC).

Akaike Information Criterion (AIC)

According to Ward & Ahlquist (2018) the maximized likelihood, $\hat{\mathcal{L}}$, serves as the basis for two more recently developed diagnostic quantities: AIC and BIC. The Akaike Information Criterion, AIC, is given as:

$$\mathrm{AIC} = -2\log\hat{\mathcal{L}} + 2k$$

Where k is the number of estimated parameters in the fitted model.

Bayesian Information Criterion (BIC)

According to Ward & Ahlquist (2018) The Bayesian Information Criterion, known as BIC or, occasionally, the Schwarz Bayesian Criterion, is another model diagnostic. At the theoretical level, the BIC is an approximation to the Bayes factor – the posterior odds of two models, each conditional on the observed data. The BIC is defined as:

$$\mathrm{BIC} = -2\log\hat{\mathcal{L}} + k\log n$$

Hannan–Quinn Criterion (HQC)

According to Claeskens & Hjort (2008) The application of the law of the iterated logarithm to ensure strong consistency of selection leads to Hannan and Quinn's criterion

$$\mathrm{HQ}\{f(\cdot;\theta)\} = 2\log\mathcal{L}\,(\widehat{\theta}) - 2c\log\log n\,\mathrm{length}(\theta), \text{with } c > 1.$$

The criterion was originally derived to determine the order in an autoregressive time series model. Hannan and Quinn do not give any advice on which value of c to choose.

The Granger Causality Test

According to Asteriou & Hall (2007) the Granger causality test for the case of two stationary variables y_t and x_t, involves as a first step the estimation of the following VAR model:

$$y_t = \alpha_1 + \sum_{i=1}^{n}\beta_i x_{t-i} + \sum_{j=1}^{m} y_j y_{t-j} + e_{1t} \quad (3.4.7.1)$$

$$x_t = \alpha_2 + \sum_{i=1}^{n}\theta_i x_{t-i} + \sum_{j=1}^{m}\delta_j y_{t-j} + e_{2t} \quad (3.4.7.2)$$

where it is assumed that both ε_{yt} and ε_{xt}, are uncorrelated white-noise error terms. The Granger causality test has the following null hypothesis and alternative hypotheses:

$$H_0: \sum_{i=1}^{n}\beta_i = 0 \text{ or } x_t \textit{ does not cause } y_t$$

$$H_1: \sum_{i=1}^{n}\beta_i \neq 0 \text{ or } x_t \textit{ does not cause } y_t$$

From an operational aspect, the use of Granger Causality Testing in this research is to test the causality relationship between benchmark variables, that is Return BLOM Stock Index (BLSI)

with the Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and the Return Indeks Harga Saham Gabungan (IHSG) variable after the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon.

Hypothesis Testing

According to Lind et al. (2019) hypothesis testing is a procedure based on sample evidence and probability theory to determine whether the hypothesis is a reasonable statement. According to Berenson et al. (2019) hypothesis testing analyzes differences between a sample statistic and the results you would expect if a null hypothesis was true. Hypothesis testing in this research applies the t-test with a significance level *(a)* of 0,05. The t-test examine the probability value with the following prerequisites:

$$Prob. > a = \text{accept } H_0, \text{ reject } H_a$$
$$Prob. \leq a = \text{reject } H_0, \text{ accept } H_a$$

Results and Discussion

Data Pattern Check

Examination of data patterns is carried out as a first step to test data stationarity. The following shows the results of the analysis of data patterns:

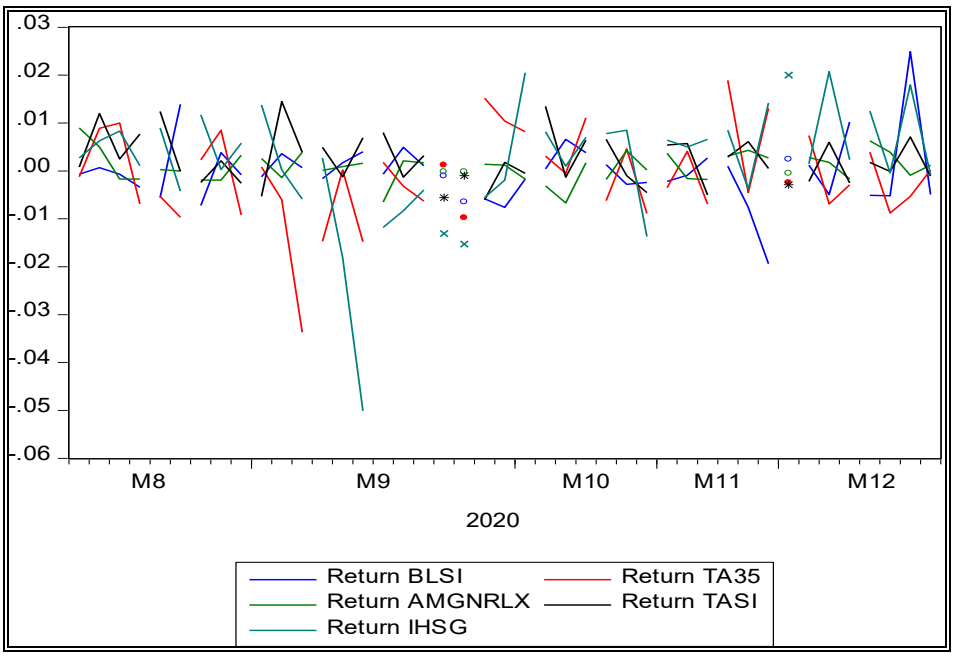

Figure 1. Actual Data Plot
Source: Secondary data (processed by researchers), 2020.

Based on the data pattern presented in Figure 1, the interpretation shows that the Return BLSI, Return TA35, Return AMGNRLX, Return TASI, and Return IHSG are stationary.

Stationarity Testing

In this research, the data stationarity test was performed using the Augmented Dickey-Fuller (ADF) method. According to Rosadi (2012) this test is one of the most frequently used tests in data stationarity testing, specifically by seeing whether there is a unit root in the model (called integrated data) or not. Testing is done by testing the hypothesis H_0: $\rho = 0$ (there is a unit root) in the regression equation. In this ADF test, the critical value used is 0,05 or 5%. The following shows the results of the ADF Test at the level of all the variables examined:

Table 1. Unit Root Test Results

Variable	Unit Root Test-Level	
	ADF	*Prob.*
Return BLSI	-3,550549	0,0117
Return TA35	-5,954821	0,0000
Return AMGNRLX	-6,497668	0,0000
Return TASI	-6,875337	0,0000
Return IHSG	-4,333076	0,0013

Source: Secondary data (processed by researchers), 2020.

Based on the results of the ADF test in Table 1, the interpretation is that the variable Return BLSI, Return TA35, Return AMGNRLX, Return TASI, and Return IHSG have a Prob value. at a level of less than 0,05. This shows that the data for Return BLSI, Return TA35, Return AMGNRLX, Return TASI, and Return IHSG are stationary.

Cointegration Testing

Cointegration testing is carried out using the Johansen Cointegration Test method. The results of cointegration testing are presented in Table 2 below. Based on the results of the Johansen Cointegration Test in Table 2, the interpretation is as follows:

Table 2. Johansen Cointegration Test

Date: 12/20/20 Time: 22:17
Sample (adjusted): 8/19/2020 12/17/2020
Included observations: 38 after adjustments
Trend assumption: Linear deterministic trend
Series: RETURN_BLSI RETURN_TA35 RETURN_AMGNRLX RETURN_TASI RETURN_IHSG
Lags interval (in first differences): 2 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.871284	187.1742	69.81889	0.0000
At most 1 *	0.762802	109.2686	47.85613	0.0000
At most 2 *	0.511136	54.59195	29.79707	0.0000
At most 3 *	0.406511	27.39645	15.49471	0.0005
At most 4 *	0.180632	7.570426	3.841466	0.0059

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.871284	77.90564	33.87687	0.0000
At most 1 *	0.762802	54.67660	27.58434	0.0000
At most 2 *	0.511136	27.19550	21.13162	0.0062
At most 3 *	0.406511	19.82602	14.26460	0.0060
At most 4 *	0.180632	7.570426	3.841466	0.0059

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Secondary data (processed by researchers), 2020.

Based on the results of this cointegration test, it can be seen that the Trace Statistic value and the Max-Eigen Statistic value are greater than the Critical Value with a significance level of 0,05. This means that H_0 which states there is no cointegration relationship between variables is rejected and H_a which states there is a cointegration relationship between variables is accepted.

Based on the results of this cointegration test, it can be seen that the Return BLOM Stock Index (BLSI), Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and Return Indeks Harga Saham Gabungan (IHSG) have similar movements and long-term equilibrium relationships after the ammonium nitrate (NH_4NO_3) explosion event in Beirut, Lebanon**.**

Estimation of Vector Error Correction Models (VECM)

Vector Error Correction Models (VECM) are used to estimate data that is not stationary at the level, but the data has a cointegrated relationship. Besides that, Vector Error Correction Models (VECM) are used to correct disequilibrium between the long term and the short term, especially in index price data. Based on the estimated VECM model that has been processed, the following equation is obtained:

$$\begin{aligned}\Delta Y_{1,t} = {} & \varphi_1 + \lambda_1 e_{1,t-1} + \lambda_2 e_{2,t-1} + \lambda_3 e_{3,t-1} + \lambda_4 e_{4,t-1} + \gamma_{24}\Delta\text{BLSI Price}_{t-2} \\ & + \gamma_{24}\Delta\text{BLSI Price}_{t-3} + \gamma_{24}\Delta\text{BLSI Price}_{t-4} + \omega_1\Delta\text{TA35 Price}_{t-2} \\ & + \omega_1\Delta\text{TA35 Price}_{t-3} + \omega_1\Delta\text{TA35 Price}_{t-4} + \omega_2\Delta\text{AMGNRLX Price}_{t-2} \\ & + \omega_2\Delta\text{AMGNRLX Price}_{t-3} + \omega_2\Delta\text{AMGNRLX Price}_{t-4} + \omega_3\Delta\text{TASI Price}_{t-2} \\ & + \omega_3\Delta\text{TASI Price}_{t-3} + \omega_3\Delta\text{TASI Price}_{t-4} + \omega_4\Delta\text{IHSG Price}_{t-2} \\ & + \omega_4\Delta\text{IHSG Price}_{t-3} + \omega_4\Delta\text{IHSG Price}_{t-4}\end{aligned}$$

$$\begin{aligned}\Delta Y_{1,t} = {} & -0{,}309108 - 0{,}686569 e_{1,t-1} - 0{,}136292 e_{2,t-1} - 0{,}144436 e_{3,t-1} \\ & - 0{,}026175 e_{4,t-1} + 0{,}633475\Delta\text{BLSI Price}_{t-2} + 0{,}524374\Delta\text{BLSI Price}_{t-3} \\ & + 0{,}389852\Delta\text{BLSI Price}_{t-4} + 0{,}105934\Delta\text{TA35 Price}_{t-2} \\ & + 0{,}210489\Delta\text{TA35 Price}_{t-3} + 0{,}061030\Delta\text{TA35 Price}_{t-4} \\ & + 0{,}070649\Delta\text{AMGNRLX Price}_{t-2} - 0{,}188654\Delta\text{AMGNRLX Price}_{t-3} \\ & + 0{,}325863\Delta\text{AMGNRLX Price}_{t-4} - 0{,}006240\Delta\text{TASI Price}_{t-2} \\ & + 0{,}013665\Delta\text{TASI Price}_{t-3} + 0{,}027872\Delta\text{TASI Price}_{t-4} \\ & - 0{,}005562\Delta\text{IHSG Price}_{t-2} - 0{,}041173\Delta\text{IHSG Price}_{t-3} \\ & + 0{,}001412\Delta\text{IHSG Price}_{t-4}\end{aligned}$$

Next, residual testing is carried out from the VECM equation model to ensure that the VECM equation model is a good model.

Residual Testing

At this stage, residual testing of the VECM model is carried out. Residual testing was carried out using the Portmanteau Autocorrelation Test method. In this test, H_0 is accepted if no serial correlation is found from the residuals up to lag 12. In Table 3, the results of the Portmanteau Autocorrelation Test are presented.

Based on the results of the Portmanteau Autocorrelation Test in Table 3., the value of Prob. for Q-Stat it can be seen that in this model H_0 is accepted at a significance level of 0.05, that is, it can be interpreted that this VECM equation model is a good equation model.

Determination of the Optimal Lag Length

The optimal lag testing phase is carried out to determine the amount of lag in Granger Causality Testing. Determination of the optimal lag length in Granger Causality Testing was selected using the minimum values of Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), and Hannan-Quinn Criterion (HQC) from the tested Least Squares equation. Determination of the optimal lag length is presented in Table 4.

Table 3. Portmanteau Autocorrelations Tests

VEC Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: No residual autocorrelations up to lag h
Date: 12/21/20 Time: 00:03
Sample: 8/10/2020 12/17/2020
Included observations: 38

Lags	Q-Stat	Prob.*	Adj Q-Stat	Prob.*	df
1	33.43480	---	34.33845	---	---
2	49.61164	---	51.41400	---	---
3	63.77661	---	66.79310	---	---
4	77.40024	---	82.01952	---	---
5	93.02303	0.0031	100.0094	0.0007	59
6	108.8183	0.0357	118.7663	0.0075	84
7	122.8887	0.1715	136.0139	0.0408	109
8	138.5760	0.3756	155.8845	0.0950	134
9	170.4537	0.2531	197.6552	0.0202	159
10	185.3452	0.4583	217.8651	0.0444	184
11	199.6693	0.6666	238.0250	0.0821	209
12	216.1307	0.7930	262.0840	0.1002	234

*Test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution after adjustment for VEC estimation (Bruggemann, et al. 2005)

Source: Secondary data (processed by researchers), 2020.

Table 4. Determination of Minimum AIC, SBC, and HQC Values

Num	Lag	The Least Squares Equation	AIC Value	SBC Value	HQC Value	Conclusion
1	1	return_blsi return_blsi(-1) return_ta35 return_ta35(-1) return_amgnrlx return_amgnrlx(-1) return_tasi return_tasi(-1) return_ihsg return_ihsg(-1) c	-7,03	-6,61	-6,87	Minimum
2	2	return_blsi return_blsi(-1) return_blsi(-2) return_ta35 return_ta35(-1) return_ta35(-2) return_amgnrlx return_amgnrlx(-1) return_amgnrlx(-2) return_tasi return_tasi(-1) return_tasi(-2) return_ihsg return_ihsg(-1) return_ihsg(-2) c	-6,86	-6,23	-6,63	
3	3	return_blsi return_blsi(-1) return_blsi(-2) return_blsi(-3) return_ta35 return_ta35(-1) return_ta35(-2) return_ta35(-3) return_amgnrlx return_amgnrlx(-1) return_amgnrlx(-2) return_amgnrlx(-3) return_tasi return_tasi(-1) return_tasi(-2) return_tasi(-3) return_ihsg return_ihsg(-1) return_ihsg(-2) return_ihsg(-3) c	-6,78	-5,94	-6,47	

Source: Secondary data (processed by researchers), 2020.

Based on the results of determining the optimal lag length presented in Table 4, the implication is Granger Causality Testing between benchmark variables, that is Return BLOM Stock Index (BLSI) with the Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and Return Indeks Harga Saham Gabungan (IHSG) variable after

the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon were tested using a lag amount of 1 (Minimum AIC, SBC, & HQC Value).

Granger Causality Test

Granger Causality Test is conducted to test the cause and effect relationship of a variable with other variables. In this study, testing was carried out using Pairwise Granger Causality Tests with a significance level of 0,05. Below are presented Pairwise Granger Causality Tests:

Table 5. Pairwise Granger Causality Tests

Pairwise Granger Causality Tests
Date: 12/21/20 Time: 03:30
Sample: 8/10/2020 12/17/2020
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
RETURN_TA35 does not Granger Cause RETURN_BLSI	42	0.92090	0.3432
RETURN_BLSI does not Granger Cause RETURN_TA35		0.09004	0.7657
RETURN_AMGNRLX does not Granger Cause RETURN_BLSI	42	1.02376	0.3179
RETURN_BLSI does not Granger Cause RETURN_AMGNRLX		0.95113	0.3354
RETURN_TASI does not Granger Cause RETURN_BLSI	42	1.08513	0.3040
RETURN_BLSI does not Granger Cause RETURN_TASI		0.10560	0.7469
RETURN_IHSG does not Granger Cause RETURN_BLSI	42	0.85080	0.3620
RETURN_BLSI does not Granger Cause RETURN_IHSG		0.50433	0.4818

Source: Secondary data (processed by researchers), 2020.

Based on the results of Pairwise Granger Causality Tests, in Table 5. it can be seen that:

Prob. value on each variable tested greater than 0,05. This means that H_0 which states there is no causal relationship between variables is accepted and H_α which states there is a causal relationship between variables is rejected.

There is no two bidirectional relationship or unidirectional relationship between benchmark variables, that is Return BLOM Stock Index (BLSI) with the Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and Return Indeks Harga Saham Gabungan (IHSG) variable after the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon.

Discussion

Long-term Relationship between Country Stock Market Indices in Lebanon, Israel, Jordan, Saudi Arabia, and Indonesia

Based on the results of cointegration testing, it can be identified that the first hypothesis (H_1) is supported. The results of the cointegration test show that the perceptions and assessments of investors on the capital markets of Lebanon, Israel, Jordan, Saudi Arabia and Indonesia after the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon are homogeneous. The crisis because of this event can affect directly or indirectly the fundamental value of the stock market index in the five countries so this results in a common perception and assessment of investors.

The implications of the results of this cointegration test include, among other things, that the sentiment and mood of investors in the capital markets of countries affected by the explosion event affect the sentiment and mood of investors in the capital markets of other countries in the long term *(contagion effect)*. Shu (2010) has examined how investors mood affects the behavior of financial markets. The results of this study indicate that the mood of the investors is a vital factor in determining the equilibrium price of the asset and the projected return. According to Mehrani et al. (2016) suggests that investors should consider the role of market sentiment in stock pricing, and regulators should consider market sentiment to prevent economic shock. Another implication of the results of this cointegration test is that after the ammonium nitrate (NH_4NO_3) explosion

event in Beirut, Lebanon, international investors cannot benefit from long-term arbitrage activities and portfolio diversification in that capital market.

The results of this study are in line with the research Chen et al. (2018) who examine the effect of the Severe Acute Respiratory Syndrome (S.A.R.S.) epidemic on the long-run relationship between China and four Asian stock markets. The research findings support the existence of time-varying cointegration relation on the aggregate stock price index between China and four other Asian countries during the S.A.R.S. epidemic. Hence, the implication is to weaken the long-run relationship between China and these four markets and created some heterogeneity in investment opportunities and produced an inefficient international risk-sharing environment. In the research Chien et al. (2015) the dynamic process of convergence among cross-border stock markets in China and ASEAN-5 countries has been examined using recursive cointegration analysis. The results show that these six stock markets had at most one cointegrating vector from 1994 to 2002. Overall, the regional financial integration between China and ASEAN-5 has gradually increased. Additionally, the estimated coefficients of error correction terms are statistically significant and negative in China and Indonesia, but the coefficients of other countries are insignificant, meaning that all of the adjustment of this cointegration fell on these two countries' stock markets.

The results of this study contradict research Mukherjee & Bose (2008) which examines the movement of the Indian stock market with other markets in Asia and the United States in the era of capital market reform and the sustained interest of foreign investors in that market. By using techniques of cointegration, vector autoregression, vector error-correction models, and Granger causality, researcher find that, though there is definite information leadership from the United States market to all Asian markets, the United States indexes do not uniquely influence the integration of Asian markets, while Japan is found to play a unique role in the integration of Asian markets.

Causality Relationship between Country Stock Market Index in Lebanon and Country Stock Market Index in Israel, Jordan, Saudi Arabia, and Indonesia

Based on the results of the Pairwise Granger Causality Tests, it can be identified that the second hypothesis (H_2) is not supported. The results of the Pairwise Granger Causality Tests indicate that the capital markets in Lebanon, Israel, Jordan, Saudi Arabia, and Indonesia are efficient in a *semi-strong form*. According to Fama (1970) a market is classified in the *semi-strong form* if the price efficiently adjusts to other information that is obviously publicly available being considered (e.g., announcements of annual earnings, stock splits, etc.). Investors do not absorb private information so that, after the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon, there is no short-term dynamic relationship between capital markets in these five countries.

The implications of Pairwise Granger Causality Tests indicate potential benefits for international stock traders and international investors to arbitrage during daily stock trading activity and short-term diversification of country stock market indices in Lebanon, Israel, Jordan, Saudi Arabia and Indonesia after the ammonium nitrate explosion (NH_4NO_3) in Beirut, Lebanon. According to Madura (2015) arbitrage can be loosely defined as capitalizing on a discrepancy in quoted prices by making a riskless profit. In many cases, the strategy involves no risk and does not require that funds be tied up. According to Drake & Fabozzi (2010) diversification is the reduction in risk from investing in assets whose returns do not move in the same direction at the same time. Arbitration and diversification can be carried out if there are differences in the prices of two or more asset instruments.

The results of this study are in line with the research Sahu et al. (2014) which investigate the dynamic relationships between oil price shocks and Indian stock market. The results of the Granger causality test under the VECM framework confirm that no short-run causality between the variables exists. Then, the results of this study contradict the research Cevik et al. (2017) which analyse the presence of a causal link among financial markets of Central and Eastern Europe (CEE) countries by adopting an asymmetric causality test. The standard causality test results suggest a causal relation running from the Czech Republic to Poland. Also, the Poland stock market is found to be a Granger cause of Turkey stock markets. Asymmetric causality test results indicate only a

causal link going from the Czech Republic to Hungary and Poland. Then, in the research Burggraf et al. (2020) has been investigated the impact of political news on stock price movements. Analysing over 3,200 tweets from US President Donald Trump's Twitter account. The result find that tweets related to the US-China trade war negatively predict S&P 500 returns and positively predict VIX. Granger causality estimates indicate that the causal relationship is one-directional – from Trump tweets to returns and VIX.

Conclusion

This research has found empirical evidence of the impact of the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon on the return of the stock market indexes of countries in Lebanon, Israel, Jordan, Saudi Arabia, and Indonesia. The effects of these events can last in the long term but have no effect in the short term.

The empirical facts in this study are described from the analysis of the Johansen Cointegration Test and Pairwise Granger Causality Tests, where the results are: The Return BLOM Stock Index (BLSI), Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and the Return Indeks Harga Saham Gabungan (IHSG) have similar movements and equilibrium relationships in the long term aftermath of the ammonium nitrate (NH_4NO_3) explosion event in Beirut, Lebanon.

There is no two bidirectional relationship or unidirectional relationship between benchmark variables, that is Return BLOM Stock Index (BLSI) with the Return TA-35 (TA35), Return Amman SE General (AMGNRLX), Return Tadawul All Share Index (TASI), and Return Indeks Harga Saham Gabungan (IHSG) variable after the ammonium nitrate (NH_4NO_3) explosion incident in Beirut, Lebanon was due to the value of *Prob.* on each variable tested greater than 0,05.

The limitations of this research are: This research only uses 43 observation on return data from each country's stock market index; This research only uses data for a five month period, that is from 10 August 2020 to 17 December 2020; This research does not test the long-term relationship and causality of the sectoral stock market indices of each country, so the impact of the ammonium nitrate (NH_4NO_3) explosion in Beirut, Lebanon on certain sectoral stock market indices is unknown.

Suggestions for further research are: For future researchers who will conduct research on similar topics, it is recommended to use a larger amount of observational data and a longer time period; Future researchers who will carry out research on a similar topic are also advised to test sectoral stock market index variables so that, the impact of a particular event on a particular sectoral stock market index can be known.

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