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Causality and Cointegration among Stock Market Indices A Study of Amman Stock Exchange (ASE)

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Abstract: The aim of this paper to examine the non-stationary theory, causality and cointegration among stock indices of Amman Stock Exchange (ASE). The daily closing prices of indices were obtained from Amman stock exchange (ASE) website from 2011-2020. The general index of the stock exchange was calculated based on 100 stock. The normality, stationarity, causality and cointegration of the time series were evaluated using statistical techniques such as the Jarque-Bera statistic , Granger Causality test and Johansen's Cointegration test.
The results indicate that the variables are integrated of order zero. I (0), consequently reject the null hypothesis for the non-stationary. It was also observed that there is causal relationship in uni/bi directional between those indices. This study also found the existence of long-run relationship between variables, these results indicate that diversification is no useful and there is market risk in market portfolio.

Keywords: Cointegration, Causality, Non-Stationary, (ASE).

1. Introduction

Financial markets are one of the mainstays of financial systems in developed and developing countries, due to the fundamental role played by these institutions in attracting surplus funds available from savers and making them available to investors with fiscal deficits. Where financial markets play an important role in the national economy, they facilitate the confluence of the supply of securities with the demand for them, by bridging the gap between the excess supply of cash, represented by savers or lenders, and the demand for cash, represented by investors or borrowers. There must be pillars that facilitate this process and make the meeting of the audience of investors on both sides easy and feasible in order for this to be reflected in the development of the national economy, which is intended from those markets.

Efficiency is one of the fundamental pillars of financial markets, that is, all information should be available to the market and available to all investors and quickly reflected in the prices of securities. The most important instrument that provides this characteristic is the general indicator of the financial market, which is the instrument that reflects market conditions. Therefore, this study aims to test the ASE non-stationary

theory, to ascertain the unpredictability of time series, to examine the causal relationship and the co-integration between the series of market index returns and the indicators of the sectors operating in the market and the ability of each series to predict the other in the short and long term.

In order to achieve the objectives of this study, the ASE general index and market segment indicators were used to test the non-stationary theory through the application of the Augmented Dickey-Fuller test and the causality hypothesis between time series through the application of the Granger Causality test, as well as to test the long-term relationship between variables through the application of the Cointegration test.

This study seeks to answer a set of questions:

1. Do the time series represented by the ASE Index and sectoral indicators follow the non-static hypothesis?

2. Is the ASE Index an efficient instrument and therefore reliable as a sign of changes in the market through its short-and long-term relationship with sectoral indices?

3. Does the causal relationship between ASE indices achieve the ability of any of the indices to predict the other index and vice versa?

4. Is the relationship of co-integration between the stock exchange index and sectoral indicators realized?

The importance of this study comes from the importance of financial markets, which are one of the most important pillars of financial systems in countries and complement other financial institutions. The efficiency of the financial market is a reflection of the efficiency of the operators of that market, and therefore that efficiency must be demonstrated by the speed at which the information coming to the market is reflected in the prices of traded securities, and the inability of any investor to make abnormal returns. The importance of this study also comes from the importance of the market financial indicator, which should reflect the market performance and the ability of that indicator to simulate the daily reality of the market and the extent to which investors benefit from following it in making profits on their portfolios similar to the return of the market index. Finally, the importance of this study comes from the fact that it is the first study (according to the researcher's knowledge) that examines the test of the non-stationary theory applied to ASE indices, and the causal relationship between those indices and the possibility of the indices being influenced by each other, and thus the ability of the investor to predict any indicator through the use of the index causing it, and through the previous data of that indicator, and to test the relationship of their cointegration.

2. Conceptual Framework and Literature Review:

Concept of Efficiency:

The term "efficiency" refers to the fact that investors do not have the opportunity to receive abnormal returns from capital market transactions compared to other investors, and they cannot beat the market. Therefore, the only way an investor might get a bigger profit is to invest in high-risk assets (Alexandra, 2015). The efficiency of the stock exchange is related to the efficiency of the information flow in a way that ensures transparency, accuracy and speed to minimize uncertainties in the conditions of investments, so the

market efficiency theory assumes that everyone has complete knowledge of all the information available in the market. The rational behavior of investors assumes that past and present information has been reflected in the prices of securities and therefore cannot make any abnormal returns without others.

(Beaver,1981) considered market efficiency on the basis of how to balance prices, since the prices of investments in a given period depend on the information received to individuals during that period, and the market is inefficient if investors notice a difference between the real value of investments and their price.

(Fama,1970) identified three levels of market efficiency:

1. Weak-form efficiency: Prices of the securities instantly and fully reflect all information of the past prices. This means future price movements cannot be predicted by using past prices, i.e past data on stock prices is of no use in predicting future stock price changes. Thus, the investor cannot make abnormal returns by relying on historical information.

2. Semi-strong efficiency: Asset prices fully reflect all of the publicly available information. Therefore, only investors with additional inside information could have an advantage in the market. Any price anomalies are quickly found out and the stock market adjusts.

3. Strong-form efficiency: Asset prices fully reflect all of the public and inside information available. Therefore, no one can have an advantage in the market in predicting prices since there is no data that would provide any additional value to the investors.

The stock market index is an index that measures the stock market, or a subset of the stock market, and helps investors compare current price levels with past prices to calculate market performance, is calculated from the prices of selected stocks (usually the weighted average) (S&P Dow Jones Indices).

The ASE Index is one of the most advanced indicators in the region, where the management of the ASE has changed the method of calculating the general index of the ASE from the method based on the market value to the method based on the free stock available for trading in order to increase the efficiency of the exchange and increase transparency. It features the record to give better representation to the prices of stock traded in the market so that it does not move significantly for companies with high market capitalization and thus the diversity in the components of the sample number value of equality by giving greater opportunity for SMEs to influence his movements. The companies operating on the stock exchange have been reclassified into three sectors instead of the four sectors, where the financial sector, services sector and industry sector come in line with the international standards adopted by international institutions, and so that the investor can follow the changes in the prices of the shares of different sectors through indicators Which the exchange calculated for each major and subsidiary sector. (www.ase.com.jo)

Non-Stationary Theory:

Most studies assume that the time series used in the analysis are stationary series, but in the absence of stability from these series, the relationships between the variables will be spurious relationships and therefore t-ratios cannot be used to determine the effect of one variable on another. Time-series constancy

means that the mean and variance of the series are constant over time and that the variance between two times depends on the Lags between those periods and not on the real value of time. If the time series is static in its original form Level is said to be integral of rank zero I (0), and if it is Non Stationary, the differences must be taken until it becomes static (Gujarati, 1995).

The time-series stationary theory is typically tested through several tests, including the Autocorrelation function (ACF) test and the unit Root Test, which examines the long-term statistical characteristics of variables. The idea of testing the Unit Root is to examine the existence of a root in the time series, that is, the non-stationary of the time series, so we can judge that the series is going a random walk.

One of the most important tests based on the unit root examination is the expanded Dickey-Fuller (1987 Granger, Engle&) Test, as suggested by the following equations:

Without constant and without time direction $\Delta Yt = \delta Yt\text{-}1 + Ut$

With a fixed limit and without a time direction $\Delta Yt = a + \delta Yt\text{-}1 + Ut$

With a fixed limit and with a time direction $\Delta Yt = a + a1T + \delta Yt\text{-}1 + Ut$

The non-stationary is judged by accepting the null hypothesis, which states that, the parameter $\delta=0$, meaning that there is a root of the unit in the time series.

Cointegration analysis:

This step comes to ensure that there is a long-term equilibrium relationship between the variables after confirming that there is a stability in the time series and a causal relationship between them in the short term. Co-integration is defined as the conjugation between two or more time series in which fluctuations in one cancel out fluctuations in the other in such a way that the ratio between their values is constant over time. Cointegration is the statistical expression of a long-term equilibrium relationship. The fact that two variables are cointegrated means that the relationship is destined for long-term equilibrium, although there may be deviations from this trend in the short term.

This relationship can be tested as proposed (Engel & Granger,1987) by a two-step test, first by equalizing the regression of the dependent variable on independent variables provided that the integral variables are of the same rank, The second is the residual test for the regression equation. This indicates the existence of co-integration between the variables.

Granger Causality Test:

Before talking about the causal relationship test of time series, we must confirm that this test works to indicate the short-term relationship, which is the opposite of the co-integration relationship, which work to indicate the long-term relationship, and must ensure that those series are stable and integrated at the same rank. (Granger, 1986).

A study (Granger,1969) is one of the most important studies that have demonstrated the concept of causality between variables, the question that should be asked is whether changes in the variable (x) cause

the change in the variable (Y), and whether changes in the variable (y) cause the change in the variable (x)? If the variable (X) is caused by the variable (Y), the values of the variable (x) contain information that helps us predict the values of the variable (y) in addition to the information contained in the previous values of the variable (y). If both variables (x) and (Y) are found to cause each other, this is called the bidirectional causal relationship, but if (X) is found to affect (y) but not (Y) is called the unidirectional causal relationship. The mathematical equation for measuring Granger Causality is based on the linear regression model in the prediction method. To measure short-term causality between indicators, Granger's Causality is used as in the following equation:

$-Yt = \sum \alpha i Yt\text{-}I + \Sigma \beta j Xt\text{-}j + Ut$ $- Xt = \sum \alpha i Xt\text{-}I + \Sigma \beta j Yt\text{-}j + Ut$

Review of Literature:

Many studies have gone on to analyze the relationship between financial market indicators, and to test the causality and co-integration of these indicators. (Blasco et.al, 1997), which aims at the time series of the Madrid Stock Exchange general index and the time series of stock prices, using the Ljung-Box and BDS test and the unit root test, the researcher has concluded that not all time series follow the hypothesis of random walk. In a study (Cheung & Coutts,2001), the applicability of the random walk hypothesis to the general index of the Hong Kong Stock Exchange was tested by applying the homoscedastic & heteroscedastic variation ratio test . The study found that the market index follows the hypothesis of random walk. (Lagoarde& Lucey ,2005) a study on a sample of Middle East and North Africa countries, including Jordan (MENA), to predict the market index using the unit root technique and the ratio of variance from 1998-2004. The researchers found that the study sample did not follow the random walk hypothesis.

On Asian markets (Higgs,2006 Worthington &) tried to examines the weak-form market efficiency of Asian equity markets and examined for random walks using serial correlation coefficient and runs tests, Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin unit root tests and multiple variance ratio tests. The results, which are in broad agreement across the approaches employed, indicate that none of the emerging markets are characterized by random walks.

(Sedik& Petri,2006) attempted to investigate the possibility of a co-integration relationship between ASE and some Arab and non-Arab emerging and international financial markets using random data of the indices of those markets from 1998-2005. The researchers found that there is a co-integration between the Arab market indices, and there is no integration between the ASE Index and the emerging and global exchanges. (Cheong, etc.all,2007) was aimed to survey the causal relationship between the indicators of eight major sectors of the Malaysian stock market. It also aimed to examine the relationship between those indicators and the activities of the US stock market represented by the S&P500 for the period 2000-2006. The study found causal relationships between those indicators, and between those indicators and the S&P500 index, which were in different directions. (Ahmed, 2009) was aimed to test the relationship of both the stock index and the bond index in the Malaysian market for the period from 1994-2004, using the Johansen test. The study concluded that there was no co-integration between the two stock and bond indices, and therefore the inability to use any of them to predict the other.

The purpose of study of (Thangamuthu & Parthasarathy, 2015) is to explore the nature of the association and the possible existence of a short-run and long-run relationship between the stock-market indices of South Africa, India and the USA. The idea behind this combination is to know how the stock markets of these three prominent countries are related to each other. After testing for the normality of the data distribution and the stationarity of the time series data, this paper discovered a strong correlation between the stock market indices of South Africa, India and the USA. The correlation among the stock markets is high, particularly between South Africa and India. After testing the Granger cause relationship, the existence of a long-run and short-run relationship is tested. The long-run relationships among the stock market indices are analyzed, following the Johansen and Juselius multivariate cointegration approach. The result suggests the absence of a long-run relationship among the three stock market indices. Short-run relationship is investigated with the Vector Auto regression (VAR) model, and the outcome obtained shows that both the USA and the South African stock markets are predicted only by their own past lags. However, the Indian stock market is seen to be a function of its own past lags and the past lags of the South African stock index.

(Muthia & Chandra, 2020) Aims to analyze the cointegration and causality relationship among selected stock market indexes in the world and Indonesia Stock Exchange Composite Index (IHSG). This research is a time series research which uses monthly data from January 2005 until December 2017 and Augmented Dickey-Fuller Test, Lag Optimum, Johansen Cointegration Test, Granger Causality Test, Vector Error Correction Model (VECM), Variance Decomposition, and Impulse Response Function. The results of the research show that there is cointegration among selected stock market indexes and Indonesia Stock Exchange Composite Index (IHSG) and there is causality among selected stock market indexes and Indonesia Stock Exchange Composite Index (IHSG).

Finally, (Nisarg, et al.2021)tried to examine the existence of degree of interdependence between Sensex and various stock markets of the American and European regions. The study attempts to analyses the dynamic interactions between 22 global indices. The normality, stationarity, and causality of the time series were evaluated in the first section using statistical techniques such as the Jarque Bera statistic, ADF test, and Granger Causality test. The second part of the approach focused on analyzing the interdependencies of various stock markets, determining the degree of association, and testing market efficiency using Johansen's Cointegration test, Cross-Correlation test, and Hurst Exponent. The results of this study indicate that there is a significant amount of interdependence among stock markets. It was also observed that there is an association between markets. This study also found bi-directional as well as uni-directional causality between the stock market indices. The study found that interdependence of markets leads to improvements in short-run as well as long-run returns/gains for investors possibly due to international portfolio diversification if there are stronger co-movements of prices across the markets.

3. Research Methodology:

The study is based exclusively on secondary data, general index and sectoral indicators of the Amman stock exchange (ASE) for the period 2011-2020, relevant text books and previous studies the basis for this study.

Data Collection:

Secondary data has been obtained from the general index and sectoral indicators of the Amman stock exchange (ASE). The overall index of the exchange is calculated based on 100 shares. The new index was dealt with in 2003, but the exchange has retrospectively calculated it for researchers and everyone with research.

Hypothesis of the study:

The study hypotheses are formulated in a way that answers the questions of the study based on previous studies and the objectives and importance of the study.

1- Time series non-stationary test hypotheses:

H01: the general index time series is non-stationary.

H02: the financial sector index's time series is non-stationary.

H03: the service sector index time series is non-stationary.

H04: the industry sector index time series is non-stationary.

2- Causality test hypothesis:

H01*: The general index time series does not cause the sectoral index time series.
H01, 1: The general index returns series does not cause the financial sector index returns series.
H01, 2: The general index returns series does not cause the service sector index returns series.
H01, 3: The general index returns series does not cause the industry index returns series.
H02*: The financial sector index series does not cause the other indicators return series.
H02, 1: The Financial Sector Index Returns series does not cause the general index returns series.
H02, 2: The Financial Sector Index Returns series does not cause the services sector index returns series.
H02, 3: The Financial Sector Index Returns series does not cause the Industry sector Index Returns series.
H03*: The Services Sector Index Returns series does not cause the other indicators return series.
H03, 1: The service sector index returns series does not cause the general index returns series.
H03, 2: The service sector index returns series does not cause the financial sector index returns series.
H03, 3: The service sector index returns series does not cause the industry sector index returns series.
H04*: The industry sector index returns series does not cause the the other indicators return series.
H04, 1: The industry index returns series does not cause the General index returns series.
H04, 2: The Industry Index Returns series does not cause the Financial sector index returns series.
H04, 3: The Industry index returns series does not cause the Service sector index returns series.

3- co-integration test hypothesis:

H01: There is no co-integration relationship between return series indexes.

Study models:

- Returns indicators was calculated based on the following equation:
  Return indicator = Indicator per day (t) – Indicator per day (t-1)
  Indicator per day (t-1)
- non-stationary test was calculated based on the following equation:
  With a fixed limit and without a time direction $\Delta Yt = a + \delta Yt\text{-}1 + Ut$
  With a fixed limit and with a time direction $\Delta Yt = a + a1T + \delta Yt\text{-}1 + Ut$

Where,

Y: denotes the Index Return

T: represents the time-series dimension

- Short run causality was measured by the following model:

- $Yt = \sum \alpha i Yt\text{-}I + \Sigma \beta j Xt\text{-}j + Ut$ - $Xt = \sum \alpha i Xt\text{-}I + \Sigma \beta j Yt\text{-}j + Ut$

Normality test:

Jarque-Bera statistics are used to test the normality of each data series; Table 1 shows that not all the time series of returns indicators follow the normal distribution at level significance 1%.

Table 1: Normality test of time series for return indicators:

	General Index(G)	Financial Index(F)	Services Index(S)	Industry Index(I)
Jarque-Bera	856.0230	674.3632	735.3689	697.6853
Probability	0.000000	0.000000	0.000000	0.000000

Source: Author's findings

Non-stationary test:

after applying the extended Augmented Dickey-Fuller to the unit root test, Table (2) shows that all time series have stationary with the constant in the equation, and with the presence of Constant & trend and therefore we can judge that the time series are integrated at the zero level I (0), which means that they can be co-integrated. We can reject the null hypothesis that not all series (general index returns, financial sector index returns, service sector index returns, and industry sector index returns) will be static. This is an indication that these time series can be predicted as long as they are static.

Table 2: Non-stationary test

Name of the Series	Test Statistic (With Constant)	Test Statistic (With Constant & trend)	Hypothesis testing
General Index(G)	-31.73645*	-31.74922*	H01: Rejected
Financial Index(F)	-32.26222*	-32.28932*	H02: Rejected
Services Index(S)	-31.35388*	-31.34703*	H03: Rejected
Industry Index(I)	-33.79138*	-33.78369*	H04: Rejected

* Significant at 1%.as (Mackinnon 1991) suggest. *Source:* Author's findings

Causality test:

Table 3 shows that there are statistically significant causal relationships at 1% and 5%, based on the value of F.

One of the most notable results was the absence of a two-way causal relationship between the service index (S) and the General (G) and financial (F) series of returns, and the existence of a one-way causal relationship with the industry index (s) series of returns, where the industry index (s) is caused by the service sector index (s).

Table 3: Causality test:

Null Hypothesis	F-Statistics	P-Value	Hypothesis testing
G does not Granger Cause F	1.54946	0.11591	H01,1: Accepted
G does not Granger Cause S	1.57665	0.10737	H01,2: Accepted
G does not Granger Cause I	2.42642	0.00715**	H01,3: Rejected
F does not Granger Cause G	2.18275	0.01638*	H02,1: Rejected
F does not Granger Cause S	1.35920	0.19330	H02,1: Accepted
F does not Granger Cause I	2.37785	0.00846**	H02,1: Rejected
S does not Granger Cause G	1.41947	0.16518	H03,1: Accepted
S does not Granger Cause F	1.33931	0.20338	H03,1: Accepted
S does not Granger Cause I	1.09846	0.35931	H03,1: Accepted
I does not Granger	2.75429	0.00223**	H04,1: Rejected

Cause G			
I does not Granger Cause F	2.01706	0.02819*	H04,1: Rejected
I does not Granger Cause S	2.75463	0.00223**	H04,1: Rejected

**Means that it is significant at 1%,* means it is significant at 5%*Source:* Author's findings

Where,

G: general indicator. F: Financial sector index.

S: service sector index. I: industry sector index.

Table 4: causality direction:

Causality direction
G⇦ F
G ⇦ /⇨ S
G⇦⇨ I
F ⇦ //⇨ S
F⇦⇨ I
S⇦ I

Where,

⇨ One-way causality. ⇦⇨ Tow-way causality. ⇦ // ⇨ No causality of both ways.

These results indicate that we can use some series of index returns to predict the return values of other indicators, and this result supports the assumption that investment risks exist in portfolios because some indicators according to the results cause each other.

Cointegration test:

To ensure that the index return series are co-integrated, several tests must be developed to obtain the residuals from them and then subject those residuals to a static test.

Table (5) shows the results of the residual regression test for each time series over the rest of our series.

Table 5: Residuals of regression test:

Name of the Series	Test Statistic	Conclusion
Residuals of regression 1	-41.39137*	I(0)
Residuals of regression 2	-41.12862*	I(0)
Residuals of regression 3	-42.04666*	I(0)
Residuals of regression 4	-38.81344*	I(0)

* Significant at 1%*Source:* Author's findings

Where,

- Regression 1: The equation regression of the general index.

- Regression 2: The equation regression of the financial sector index.

- Regression 3: The equation regression of the service sector index.

- Regression 4: The equation regression of the industry sector.

Table 5 shows the result of stationary test for the residuals regression equations. it has been shown that the residuals of all regression equations have a stationary status at zero I(0), which supports the possibility of rejecting the null hypothesis of co-integration between of index return series, proving the existence of a co-integration relationship, the possibility of a long-term equilibrium relationship between them, and the possibility of relying on indicators as a sign of changes occurring in the market.

This finding is consistent with (Engel & Granger,1987), that variables that are integral of Class Zero I (0) are co-integration variables.

4. Conclusions:

1. All time series have stationary, therefore there is possibility that no spurious results will occur when examining the relationship between them, and emphasize the inefficiency of the financial market.

2. The existence of short-term causal relationships between some of these series in different directions, allowing the opportunity to predict each other depending of previous data.

3. The possibility of the general index impact of the stock exchange on the movement of sectoral indicators and the construction of forecasts for those indicators.

4. One of the most important conclusions is that there is a long-term equilibrium relationship between all indicators, which enables us to use any of these series to know the changes taking place in the market and in other sectors.

5. Ensure the efficiency index of the Amman stock exchange (ASE) as a tool to measure changes in the market.

6. The presence of diversification risks in the financial market manifested through previous relationships.

5. Recommendations:

The recommendations of the study are summarized by one recommendation that researchers and financial market operators when doing market research and dealing with time series data should ensure that those data have been carefully examined, and to test the stationary of the time series for fear of making any errors when applying regression equations as a result of the Spurious Regression which can lead to misleading results and uncertain future recommendations.

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