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Causal Relations among Stock Prices and Macroeconomic Variables in the Small, Open Economy of Jordan

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ABSTRACT. The purpose of this study is to investigate the long run relationship between the Jordanian stock prices and selected macroeconomic variables by using Johansen's methodology in cointegration analysis and monthly time series data over for the period from January 1987 to December 2000.
This study finds that macroeconomic variables-that is, exports, foreign reserves, interest rates, inflation, and industrial production are reflected in stock prices in the Jordanian capital market.

1. Introduction

The relation between stock market returns and fundamental economic activities in advanced countries is well documented (see for example, Fama and Schwert, 1977; Fama, 1990; 1991). Numerous Studies (Chen, 1991; Wei and Wong, 1992; Cheung and Ng, 1998.) modeled the relation between stock prices and real economic activities in terms of production rates, productivity, unemployment, inflation, interest rates, and so forth. However, the economic role of stock markets in relatively less developed countries is less clear. Specifically, how do less developed markets respond to changes in their fundamental economic variables, compared with the well-developed and more efficient markets?

In the past two decades, the Jordanian capital market (Amman Stock Exchange, ASE) has experienced an impressive development in terms of trading volume and market value, and has become an important force in financing investment in Jordan. Together with the Istanbul Stock Exchange, the ASE has become one of the leading capital markets in the Middle East. El-Erian and Kumar (1995) point out that, "*Jordan has a relatively highly developed equity market which plays an important part in the economic life of the country*" (p.146).

Because the structure of the ASE differs from that of the developed countries, ASE price movements may be different. This market may be more subject to speculative activities, manipulations, and especially government interventions than well-developed markets. Owing to different investor participations, it is possible that the ASE respond to economic variables differently from markets in well-developed countries.

The main purpose of this study is to examine the long run relationships between the Jordanian stock market prices and selected macroeconomic variables. Such evidence provides an insight about if there is a fundamental link between stock market and real economic activity. To our knowledge, this is the first attempt to study this issue for Jordan or for a country in the Middle East and North Africa region.

This study adopts the cointegration technique, originally developed by Engle and Granger (1987), to investigate the long run comovement of the stock market level and aggregate economic variables. If these variables are cointegrated, they tend to move together in the long run, while experiencing short run transitory deviations from their long run relationship. From a cointegration system, we can derive an error correction model (ECM) that allows us to study both the short run dynamics and the effect of long run restrictions on stock price variations. The Johansen (1991) procedure, which is more efficient than the Engle-Granger two-step method, is used to test for the existence of cointegration.

The findings of this paper suggest that the stock price index is cointegrated with a set of macroeconomic variables-that is, exports, foreign reserves, interest rate, inflation, and industrial production- provide a direct long-run equilibrium relation with the stock price index. Additionally, the paper concludes that macroeconomic variables are significant in predicting changes in stock prices. Thus, it can be claimed that stock price variability is fundamentally linked to economic variables, through the change in stock price lags behind those economic activities, and this is consistent with the previous findings in large economies like the U.S. and Japan.

The rest of the paper is organized as follows. In Section 2, we provide a detailed description of our approach based on the cointegration and vector error correction model framework. In Section 3, we define our variables and describe the data set. In Section 4, we present our results, while Section 5 contains concluding remarks.

2. Framework of Analysis

Using Johansen's vector error-correction model, this paper examines the dynamic long run relations between macroeconomic variables and the ASE. Although the Engle and Granger's (1987) two-step error-correction model may also be used in a multivariate context, the Johansen vector error-correction yields more efficient estimators of cointegrating vectors. This is because of the following reasons: (i) the Johansen procedure does not, a priori, assume the existence of at most a single cointegration vector; rather it explicitly tests for the number of cointegrating relationships; (ii) unlike the Engle-Granger procedure which is sensitive to the choice of the dependent variable in the cointegration regression, the Johansen procedure assumes all variables to be endogenous; (iii) the Johansen procedure is established on a unified framework for estimating the testing cointegrating within the ECM formulation; (iv) the Johansen procedure is a full information maximum likelihood estimation model, which allows for testing for cointegration in a whole system of equations in one step and without requiring a specific variable to be normalized. The ECM is of the form

$$\Delta Y_t = m + \sum_{j=1}^{k-1} \Gamma_j \Delta Y_{t-k} + ab' Y_{t-k} + e_t \qquad (1)$$

where $\sum_{j=1}^{k-1} \Gamma_j \Delta Y_{t-j}$ and $ab' Y_{t-k}$ are the vector autoregressive (VAR) component in first differences and error-correction components, respectively. $Y_t \equiv (s_t X_t)'$, s_t is the real stock index, X_t is a vector of macro variables. m is a $p\times 1$vector of constant. k is lag structure, while e_t is a $p\times 1$vector of white noise error terms. Γ_j is a $p\times p$matrix that represents short run adjustment among variables across p equations at the jth lag. b' is a $p\times r$ matrix of cointegrating vectors, and Δ denotes first differences. a is a $p\times r$ matrix of speed of adjustment parameters representing the speed of error correction mechanism. A larger a suggests a faster convergence toward long run equilibrium in cases of short run deviations from this equilibrium.

In estimating the ECM, the first step in our methodology involves the pre-testing for unit roots *i.e.* the investigation must first establish that the series of interest are non-stationary. In other words, the unit root tests are aimed at establishing the order of integration of each variable. Both the augmented Dickey-Fuller (1979) and the Phillips-Perron (1988) unit root tests are herein used to investigate the stationary status of each variable.

One determines the order of integration for the variables under consideration; cointegration tests using Johansen approaches are employed to test for the possibility of cointegration among I(1) variables. The Johansen procedure focuses on the rank of matrix ab', which determines the number of distinct cointegrating vectors. Johansen and Juselives (1990) describe two likelihood ratio tests, trace and maximal eigenvalue tests, which provide the cointegration rank and estimate the long-run parameter matrix ab'. The trace test is based on the stochastic matrix and is defined as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{k} \log(1-\hat{\lambda}_i) \qquad (2)$$

for r=0,1,…k-1, where T is the number of useable observations, and l_i is the estimated value of the characteristic roots. The null hypothesis of this test is that the number of distinct cointegrating vectors is less than or equal to r *(i.e.,* no cointegration vector) against the alternative r > 0 (one or more cointegrating vectors).

The second test, which is the so-called maximal eigenvalue test, is based on the following:

$$\lambda_{\max}(r_1, r+1) = -T \sum_{i=r+1}^{k} \log(1-\hat{\lambda}_{r+1}) \qquad (3)$$

for r=0,1,..k-1, where T is the number of useable observations; r is the number of cointegrating vectors; and λ_{r+1} is the estimated value of characteristic roots (called eigenvalues) from the estimated ab' matrix. This statistic tests the null hypothesis that the number of cointegration vectors is r against a specific alternative of (r+1) cointegrating vectors. The distribution of these statistics depends on the number of nonstationary components (*i.e.,* the number of variables we are testing for cointegration) defined by (n-r).

Since these tests are sensitive to the choice of the lag length in various model specifications, we must determine the appropriate lag length of various model specifications in VAR. Appropriate lag length selection is important because if the lag lengths included are too few, the models may be miss-specified whereas if the number of lag lengths included are too large, the degrees of freedom are wasted (Hsiao, 1981).

Unfortunately, a generally test method for choosing the lag length does not exist. One test statistic used in the literature is the likelihood ratio (LL) statistics recommended by Sims *et al.,* (1990). However, this statistic is based on asymptotic theory that is not very useful for the small size sample which is available for this study. The approach taken here is the Akaike information criterion (AIC)(1). This information criterion has been widely used in the time series analysis to determine appreciative length of the distributed lag (Maddala and Kim, 2000). The basic methodology involves selecting the models with the lowest AIC values. Specifically, the methodology involves first calculating the AIC values for a lag length of one, then increasing the lag length by one *i.e.* calculating the AIC value for the new lag length: if the higher lag length yields a lower number repeat step two, if increasing the lag length yields a higher number, stop and choose the lag length that yields the lowest value, which indicates that this length leaves the residuals approximately independently identically normally distributed (NIID)(2).

When the evidence of cointegration is optioned, the VAR with an error cointegration constraint is set up, and then we analyze the relevant cointegrating vector and speed of adjustment coefficients. Assuming that ab' does not have a full rank and there are more than cointegrating vectors, we will choose the first eigenvector based on the largest eigenvalue, which is probably the most useful. Since we consider the price index of ASE to be the dependent variable, we will normalize b' with respect to the coefficient for the price index of ASE.

3. Definitions of Variables and the Data

It is an empirical question whether principle economic indicators such as industrial production, inflation, interest rates, trade balance, foreign exchange, oil price, and money supply are significant explanatory factors of stock market prices. In addition, if economic variables are significantly and consistently priced in the stock market, they should be cointegrated. If there are no significant relations between macroeconomic variables and stock market prices, we can conclude that ASE does not signal changes in real activities.

The used data are monthly stock prices of the Amman Stock Price Index (SPI) for the period from January 1987 to December 2000 (168 monthly observations), obtained from ASE database. The stock prices are the closing prices of the last trading day in each month.

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(1) AIC information criterion of VAR is defined as: $-2\tau/T+2n/T$, where $n = \kappa(d+p\kappa)$ is the total number of estimated parameters in VAR, T is the number of observation, τ is the log-likelihood value is computed assuming a multivariate normal (Gaussian) distribution as: $\tau=(T\kappa/2)(1+\log 2\pi)-(T/2)\log|\Omega|$, where Ω is the estimated residual covariance.

(2) The presence of autocorrelation in the residual vector is an indicator of model mis-specification (see **Inder**, 1993)

The macroeconomic variables used are monthly data for the same time period as the stock market data (January 1987 to December 2000), selected from the IMF publication *International Financial Statistics* (CD-ROM, December-2001). Because the purpose here is to identify the long run causality relation of economic variables with stock prices, this study selects macroeconomic state variables closely related to the Jordanian economy, which heavily relies on international factors, such as domestic exports (EX), and foreign reserves (FR). In addition, principal economic indicators such as money supply (M1), interest rates (R), inflation (INF), and industrial production (IP) are also used. Interest rate is the weighted average interest rate on licensed banks loans. Inflation is calculated as the change in the consumer price index. The Jordan industrial production is represented by the index of industrial production for mining, quarrying, manufacturing and electricity supply. Table (1) provides summary statistics for all the variables in levels.

Table (1)
Summary Statistics

	SPI_t	EX_t	FR_t	$M1_t$	R_t	INF_t	IP_t
Mean	122.61	74.38	1049.49	1518.60	9.96	0.0056	82.37
Median	131.15	72.32	891.030	1623.07	8.50	0.0056	79.89
Maximum	180.20	157.58	2200.3	1861.82	12.25	0.0649	113.43
Minimum	71.30	13.46	27.30	891.88	9.35	-0.0232	48.22
Std. Dev.	35.91	31.33	672.72	276.32	0.9139	0.0139	12.971
Skewness	-0.00045	0.06182	0.08196	-0.8855	-1.2279	1.1152	0.3649
Kurtosis	1.3363	2.2273	1.6088	2.4933	2.7494	6.3967	2.7722
Jarque-Bera	16.6067	3.4954	11.6919	20.2185	36.3115	97.7015	3.4826
Probability	(0.0002)	(0.1741)	(0.0028)	(0.00004)	(0.0000)	(0.0000)	(0.1752)

Notes: SPI_t is the month-end stock price index of the Amman Stock Exchange. EX_t is the month-end total domestic export (million JD). FR_t is the month-end of total foreign reserve (million JD). $M1_t$ is the month-end M1 money supply (million JD). R_t is the month-end of weighted average interest rate on licensed banks loans (%). INF_t is the month-end of inflation rate. IP_t is the month-end of industrial production index.

4. Results

4.1 Unit Root Tests

Before we examine cointegration, the order of integration of the variables must be determined. As is well known, the cointegration relationship exists within a set of nonstationary time series when a linear combination of the variables that yields stationary results can be identified. For this purpose, we perform a unit root test using both the augmented Dickey-Fuller test (1979) and Phillips-Peron test (1988) with a truncated lag of 11. These tests are applied to the level variables as well as to their first differences in logarithm terms. The null hypothesis tested that the variable under investigation has a unit root, against the alternative that they do not. The results of these two tests are reported in Table (2).

The reported results in Table (2) indicate the presence of a unit root in log levels of all variables *i.e.*, the null hypothesis that each of the time series has a unit root cannot be rejected except for EX_t and IP_t for both tests. The Phillips-Peron test statistics for these two measures of real economic activity are significant at the 1% and 5% levels, respectively. However, as we can see from the second half of Table (1), there is no evidence from either test to support a unit root in first difference of all the variables. These results are broadly consistent with the hypothesis that all the variables under investigation are individually integrated of order one I(1).

Table (2)
Test Results for Unit Roots

Variable	ADF	PP
Level		
SPI_t	-0.975	-1.204
EX_t	-1.225	-7.255***
FR_t	-1.116	-1.235
$M1_t$	-1.655	-1.084
R_t	-2.142	-1.747
INF_t	-2.564	-2.462
IP_t	0.501	-3.195**
1st Difference		
SPI_t	-2.985**	-11.654***
EX_t	-5.575***	-13.902***
FR_t	-2.594*	-12.577***
$M1_t$	-4.868***	-9.627***
R_t	-2.936**	-11.919***
INF_t	-4.017***	-11.805***
IP_t	-4.679***	-23.015***

Notes: The variables are as defined in the text. All the variables are in logarithm term. The null hypothesis tested is that the relevant series contains a unit root against the alternative that it does not. ADF is the Augmented Dickey-Fuller test. PP is the Phillips-Perron test. *** indicates significance at the 1% level, ** at the 5% level and * at the 10% level.

4.2 The Impact of Economic Forces

In building the ECM that captures the impact of economic forces on the Jordanian stock market, we construct ECMs with transacted lags of $k = 2$ to $k = 15$. The model with the lowest AIC is the one for $k = 10$. Using this lag specification, diagnostic checking tests for normality and absence of serial correlation were performed on the residuals of each equation in VAR. The results of these tests (not reported here) indicate that this lag length left the residuals approximately in an independently identically normal distribution.

Table (3) reports the results and critical values of the l_{trace} and $l_{\max}$ tests for $k = 10$. The Johansen cointegration test results under both the maximum eigenvalue and trace statistics suggest that no more than four cointegrating vectors exist. More specifically, that both tests reject $r \leq 3$ in favor of $r = 4$ at the 5% level of significance. Therefore, we conclude that there are four cointegrating vectors, or $r = 4$. As mentioned earlier, when there is more than on cointegrating vector, the first eigenvector, which is based on the largest eigenvalue, is regarded as the most useful.

Table (3)

The Johansen Cointegration Tests (Testing the Rank of Π)

H_0	H_1	l	$CV_{(5\%)}$
	Maximal Eigenvalue Test $(l_{\max})$		
$r = 0$	$r = 1$	52.608**	43.610
$r \le 1$	$r = 2$	45.089**	37.860
$r \le 2$	$r = 3$	38.041**	31.790
$r \le 3$	$r = 4$	27.187**	25.420
$r \le 4$	$r = 5$	13.016	19.220
$r \le 5$	$r = 6$	7.945	12.390
	Trace Test (l_{trace})		
$r = 0$	$r = 1$	183.888**	115.850
$r \le 1$	$r = 2$	131.280**	87.170
$r \le 2$	$r = 3$	86.191**	63.000
$r \le 3$	$r = 4$	48.149**	42.340
$r \le 4$	$r = 5$	20.962	25.770
$r \le 5$	$r = 6$	7.945	12.390

Notes: H_0 and H_1 are the null and alternative hypotheses, respectively. CV is the critical values of the l_{trace} and $l_{\max}$ at the 5% level. The Johansen Cointegration tests were performed with lag lengths (k=10) based on the Akaike's Information (AIC) criterion. Using these lag lengths, the residuals in each of the VAR equations were checked for normality and absence of serial correlation. ** indicates significance at the 5% level,

Table (4) presents the estimated error-correction terms (a) and cointegration vectors (b') based on the largest eigenvalue. From the significance test of the a-coefficient in the SPI, we can conclude that there is long run co-movements between the selected real economic variables and stock market prices. The estimated cointegration vectors, which are normalized so that the coefficient of SPI is unity, show that the

Table (4)

The α and β Vectors

Variables	b'	a
SPI	1.000	0.182** (2.741)
EX	0.472*** (3.197)	-2.081*** (-3.694)
RE	0.259*** (6.331)	-0.808* (-1.635)
M1	-0.008 (-0.105)	-0.010 (-0.176)
R	-1.363*** (-5.018)	-0.077 (-1.043)
INF	-0.678** (-2.801)	0.087*** (2.986)
IP	2.209*** (3.829)	0.053*** (3.447)
Constant	-3.391*** (-7.968)	

Notes: The cointegration vector (b') is normalised on SPI. The Box-Pierce-Ljung Q-test performed on the residuals indicates no autocorrelation in the model. The numbers in parentheses are t-statistics. "*", "**" and "***" indicates statistically significant at 10%, 5% and 1%, respectively.

exports (EX), foreign reserves (FR), and industrial production (IP) are positively and significantly related to the stock prices. In addition, the results suggest that the relations between interest rates (R), inflation (INF), and stock prices are negative and statistically significant at the 1% and 5% level, respectively. The coefficient of money supply (M1) has the same sign but not statistically significant at the 10 % level. The intercept term is negative and significant at the 1% level.

The positive relationship between the level of real economic activity, as proxied by both domestic exports and industrial production, and the stock market in Jordan can explain through the effect of these factors on companies expected future cash flows. Fama (1990) and Geske and Roll (1983) also suggested such a positive relationship between real economic activity and stock prices.

The negative relationship between price levels and stock market levels is consistent with Fama and Schwert (1977), Chen et al. (1986) and Caporale and Jung's (1997) findings for the U.S. The relationship between stock returns and inflation has been the focus of many studies. The fisherian relation between rates of return on assets and expected inflation lead us to expect that one of the reasons people hold various assets is to hedge against inflation. Therefore, stock returns should be positively correlated with inflation. However, Fama (1981) proposed that the negative relation between stock returns and inflation could be traced to the fact that the more important determinants of stock returns are real activity measures. A negative relationship exists between inflation and real activity because the nominal quantity of money does not vary sufficiently with real activity. As such, the negative relation between stock returns and inflation is a spurious one. This may be the possible explanation in Jordan's case.

Interest rate changes and stock prices in Jordan are negatively related, and this is also consistent with the findings in Chen et al. (1986) and Grerde and Saettem (1999) for the U.S. and Norway, respectively. An increase in the rate of interest raises the opportunity cost of holding cash and likely to lead to a substitution effect between stocks and other interest instruments.

In general, the results indicate that the money supply factor is not significant in the ASE. It appears that the ASE responds in a consistent way to the small and open nature of the country's economy. The most important factors affecting the ASE are exports, foreign reserves, interest rates, inflation and industrial production, where these factors are closely related to with the international environment especially with the economic and political environments in neighboring Arab countries.

5. Conclusions

Using Johansen's methodology for multivariate cointegration analysis and monthly time-series data, this paper investigates the long run relationships between the Jordanian stock prices and selected macroeconomic variables. The cointegration test and the vector error correction model illustrate that the stock price index is cointegrated with a set of macroeconomic variables-that is, exports, foreign reserves, interest rates, inflation, and industrial production- which provide a direct long-run equilibrium relation with the stock price index. Additionally, the paper concludes that macroeconomic variables are significant in predicting changes in stock prices. Thus, it can be claimed that stock price variability is fundamentally linked to economic variables, through the change in stock price lags behind those economic activities, and this is consistent with the previous findings in large economies like the U.S. and Japan. Finally, the results show that investors' perceptions of stock price movements in the ASE are highly sensitive to the international environment especially to the economic and political environments in the neighboring Arab countries.

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العلاقات السببية بين أسعار الأسهم والمتغيرات الاقتصادية الكلية في الاقتصاد الأردني

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المستخلص : تهدف هذه الدراسة إلى اختبار العلاقة بين أسعار الأسهم الأردنية وعدد من المتغيرات الاقتصادية الكلية المختارة وذلك باستخدام منهجية جوهنسن (Johansen) في تحليل الـ (Cointegration) وباستخدام بيانات شهرية خلال الفترة من كانون ثاني ١٩٨٧ إلى تشرين ثاني ٢٠٠٠. وتبين من نتائج هذه الدراسة أن المتغيرات الاقتصادية الكلية– الصادرات، الاحتياطيات الأجنبية، أسعار الفائدة، التضخم والإنتاج الصناعي– تنعكس في أسعار الأسهم في سوق رأس المال الأردني.