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Do stock returns lead real economic activity? Evidence from seasonal cointegration analysis

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Abstract

This paper investigates the causal relationship between the stock returns and real economic activity in seasonal unit roots and seasonal cointegration framework by taking into account of seasonal behaviors of the stock returns and industrial production as a proxy of real economic activity. We use seasonally unadjusted quarterly Turkish data series that covers the period from first quarter of 1987 to the third quarter of 2009. The empirical results support evidence for the existence of the causal relationship between stock returns and real economic activity. We determine unidirectional causality running from the real economic activity to the stock returns in the six-monthly term. The empirical findings support that only the real economic activity provides the forecasting ability for the stock returns and there is no feedback relationship between the stock returns and the real economic activity.

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1. Introduction

The discounted-cash-flow valuation model assumes that stock prices operate as signaling for the investors' expectations on future real economic activity. The fundamental value of a firm's stock is measured as the expected present value of its future dividends and the real economic activity (industrial production or gross domestic product) should be reflected by the future dividends. The relationship between financial sector and real economic activity has gained importance particularly following the financial liberalization policies. The liberalization of real interest swamps the "financial repression" leading to increase in the amount of loanable funds in markets. The growth of supply of loanable funds influences the investment decisions in financial sector and real sector.

The relationship between stock returns and real economic activity is frequently documented on both theoretical and empirical grounds so that various papers focused of this issue using different econometric techniques. In his seminal paper examining 35 countries, Goldsmith (1969), among others, was the first who determined the positive linkage between stock returns and real economic activity.

Fama (1990), Schwert (1990), Gallinger (1994) and Duffee and Prowse (1996) also analyze the relationship between stock returns and real economic activity and find that the stock returns reflect to the real economic activity and as one of significant economic tools for explaining the future real activity for the USA. The empirical evidence on the causal relationship running from the stock returns to real economic activity is suggested for the USA and Canada by Barro (1990), for G-7 countries by Choi et al. (1999), for ten selected European countries by Asprem (1989), for European countries by Canova and De Nicolo (1995).

Binswanger (2004) explores the breakdown in the causal relationship between stock returns and economic activity and finds out conflicted results since breakdown in G-7 countries influence the stability of the linkage between stock returns and economic activity. On the other hand, Lee (1992) reports that the real economic activity does not cause the stock returns and the response of the stock returns to shocks in the real economic activity is negative for the USA. Hassapis and Kalyvitis (2002) and Hassapis (2002) provide the same results for the G-7 countries and Canada, respectively. Domian and Louton (1997) explore the causality between the stock returns and economic activity considering the business cycle asymmetry and find that the sharp decreases in economic activity follow negative stock returns and that the positive stock returns are followed by increases in real economic activity.

Hamori et al. (2002) find the bidirectional causality between the stock returns and real economic activity for the USA and unidirectional causality running from the stock returns to economic activity for the Japan. In the same vein, Padhan (2007) reports the empirical evidence on the bidirectional causal relationship between the stock returns and economic activity for India. Tsouma (2009) investigates the same causality for the 22 countries of Mature Markets (MMs) and 19 countries of Emerging Markets (EMs). The empirical results of this study which, to the best of our knowledge, is the only study investigating the Turkish case as an emerging market support strong positive unidirectional causality running from the stock returns to economic activity.

The goal of this paper is to investigate the causal relationship between stock returns and real economic activity in seasonal unit roots and seasonal cointegration framework by taking into account of seasonal behaviors of the stock returns and industrial production growth as a proxy of real economic activity. For this purpose, we use the seasonal unit roots test developed by Hylleberg, Engle, Granger and Yoo (henceforth HEGY) (1990), seasonal cointegration test and error correction model developed by Lee (1992). Although most of the studies on the relationship between stock returns and real economic activity use monthly and/or quarterly data, none of these studies takes into account the seasonal behaviors of stock returns and economic activity. In these studies the authors use seasonally adjusted data sets and do not handle deterministic and/or stochastic features of seasonality in the stock returns and real economic activity. Especially the variables such as industrial production or gross domestic product used as proxies of economic activity contain noteworthy seasonal components and the features of seasonal fluctuations are omitted by the studies on extant empirical literature.

In fact, usage of seasonally adjusted data has proved to be a well-established practice in most empirical work. However, seasonal adjustment might lead to mistaken inference on economic relationships among time series data and also a significant loss of valuable information on important seasonal behavior in economic time series if seasonal fluctuations are important sources of variation in the system (Lee, 1992, p. 2).

The present paper extends the existing literature in the following way: it is the first study that considers the seasonal fluctuations on the causal relationship between stock returns and economic activity using the framework of seasonal unit roots and seasonal cointegration tests and seasonal error correction models. The paper differs from the extant literature since in this study seasonal co-movements of the stock returns and real economic activity in causality framework is firstly investigated by seasonal error correction models developed by Lee (1992).

The remainder of the paper is organized as follows: in section 2 we discuss the econometric methodology used in the study, section 3 contains the data description and empirical results. The 4th and last section includes conclusions.

2. Econometric Methodology

The seasonal fluctuations in economic time series can be investigated by three different cases in an empirical framework. Firstly, seasonality may have deterministic features and in this case seasonality is included in models using seasonal dummy variables. The second case is that seasonality may follow stationary stochastic process and the third case is that seasonality may follow non-stationary stochastic process depending on seasonal unit roots.

HEGY (1990) present a procedure for quarterly data that allows for testing seasonal and non-seasonal unit roots together. The procedure of HEGY test is based on the following model and transformations for the quarterly data of series x_t:

$$y_{4t} = \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-1} + \pi_4 y_{3,t-2} + \sum_{i=1}^{n} \beta_i y_{4,t-i} + \varepsilon_t \tag{1}$$

$$y_{1t} = (1 + L + L^2 + L^3)x_t \tag{2}$$

$$y_{2t} = -(1 - L + L^2 - L^3)x_t \tag{3}$$

$$y_{3t} = -(1 - L^2)x_t \tag{4}$$

$$y_{4t} = (1 - L^4)x_t = \Delta_4 x_t \tag{5}$$

In addition, the deterministic components such as an intercept, seasonal dummy variables and a linear trend variable can be incorporated into the model (1). The lagged values $y_{4,t-i}$ are also added to model (1) to eliminate autocorrelation problem in residual terms and ensuring “white noise” errors. L denotes the lag operator shown in the equations (2), (3), (4) and (5). The y_{1t} transformation is applied for removing the all seasonal unit roots at semi-annual (π) and annual ($\pi/2, 3\pi/2$) frequencies and detecting the non-seasonal unit root at zero (0) frequency. The y_{2t} transformation is applied for removing the non-seasonal unit root at zero (0) frequency and seasonal unit roots at annual ($\pi/2, 3\pi/2$) frequencies which detects the seasonal unit root at semi-annual (π) frequency. Lastly, the y_{3t} transformation is applied for removing the non-seasonal unit root at zero (0) frequency and the seasonal unit root at semi-annual (π) frequency which detects the seasonal unit roots at annual ($\pi/2, 3\pi/2$) frequencies.

The null hypothesis of $\pi_1 = 0$ is tested for exploring whether x_t contains a non-seasonal (long-run) unit root at zero (0) frequency and the null hypothesis of $\pi_2 = 0$ is tested for exploring whether x_t contains a seasonal unit root at semi-annual (π) frequency using standard t-type test. The joint F-type test is used for testing the null hypothesis of $\pi_3 = \pi_4 = 0$ whether x_t contains seasonal unit roots at annual ($\pi/2$, $3\pi/2$) frequency.

In the existence of seasonal unit roots, it is not appropriate to perform the standard cointegration tests. If the series are integrated of order one at any frequencies 0, π and/or $\pi/2$, the linear combination of the series are stationary also at the frequencies 0, π and/or $\pi/2$. For instance, if the series are integrated of order one at zero (0) frequency, the cointegrating relation(s) should be examined at zero (0) frequency. The same circumstance is valid for the frequencies π and $\pi/2$ frequencies, respectively.

Lee (1992) presents maximum likelihood estimation method for quarterly data to determine cointegrating relations at zero ($\omega = 0$) (long-run), semi-annual (six-monthly) ($\omega = 1/2$) and annual ($\omega = 1/4$) frequencies. The cointegrating relations determined at zero frequency are the same as the cointegrating relations determined at the approach of Johansen (1996) standard multivariate cointegration. The seasonal error correction model (SECM) based on VAR specification proposed by Lee (1992) takes following form:

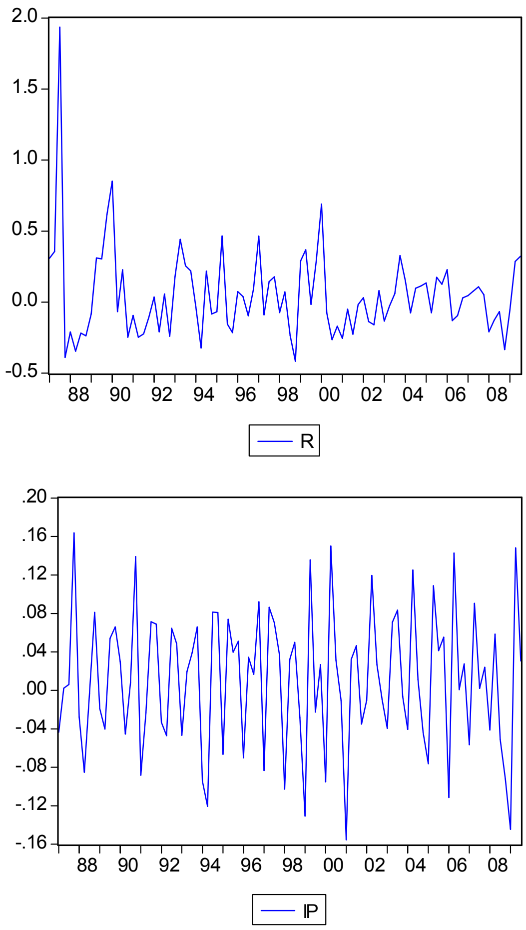
$$\Delta_4 X_t = \Pi_1 Y_{1,t-1} + \Pi_2 Y_{2,t-1} + \Pi_3 Y_{3,t-2} + \Pi_4 Y_{3,t-1} + \sum_{j=1}^{p} \Gamma_j \Delta_4 X_{t-j} + \varepsilon_t \tag{6}$$

The representation (6) is similar to the representation of HEGY seasonal unit roots test shown at (1). The representation (1) corresponds to univariate processes while the representation (6) denotes multivariate processes. $\Pi_i = \alpha_i \beta_i'$ ($i = 1,2,3,4$) are the long-run coefficient matrices and estimated using canonical correlations. If the ranks of Π_1 and Π_2 are different from zero, it is implied that there is cointegrating relation at zero ($\omega = 0$) and seasonal cointegrating relation at semi-annual ($\omega = 1/2$) frequencies, respectively. If the rank of Π_3 is different from zero, it is implied that there is seasonal cointegrating relation at annual ($\omega = 1/4$) frequency. The test of seasonal frequency at $\omega = 1/4$, as noted by Lee (1992), is tested on the matrix Π_3 only on assuming $\Pi_4 = 0$ when cointegration is contemporaneous (Shen and Huang, 1999, p. 109).

3. Data and Empirical Results

In this section, we investigate the causality between the stock returns and real economic activity in Turkey, over the period from the first quarter of 1987 to the third quarter of 2009. The data set includes the nominal stock price (Istanbul Stock Exchange National-100) index, industrial production index (2005=100) as a proxy for real economic activity and consumer price index (2005=100). Stock price index (Istanbul Stock Exchange National-100) is obtained from the Central Bank of Republic of Turkey Electronic Delivery Data System and the data on industrial production and consumer price indices are obtained from International Financial Statistics (IFS). The nominal stock price index is deflated by consumer price index to obtain the real stock price index. Finally, we calculate the real stock return (R) from the real stock price index and the growth rate of industrial production index (IP) using $\left[(x_t - x_{t-1})/x_{t-1}\right]\times 100$ formula where x_t is the value of the real stock price index or industrial production index at time t.

Figure 1: The Graphs of Real Stock Returns (R) and the Growth Rate of Industrial Production Index (IP) Series



In the first step we explore the integration order of R and IP series at 0, π and $\pi/2$ ($3\pi/2$) frequencies by employing the HEGY seasonal unit roots test. The results of HEGY seasonal unit roots test are shown in Table 1.

Table 1: The Results of HEGY Seasonal Unit Roots Test

Variables	Deterministic Components	Lag Length	$t(\pi_1)$	$t(\pi_2)$	$F(\pi_3 \cap \pi_4)$
R	-	8	-3.18659*	-1.61529	5.16002*
	I	8	-3.55115*	-1.60245	5.35004*
	I.SD	8	-3.59946*	-1.74182	6.63191*
	I,TR	8	-3.46254	-1.59503	5.23402*
	I,SD,TR	3	-4.86777*	-5.36762*	16.76095*
IP	-	4	-1.94257	-0.84683	2.08793
	I	8	-2.25490	-0.42026	2.59584
	I.SD	6	-3.14248*	-2.59940	2.52188
	I,TR	8	-2.17269	-0.41887	2.55345
	I,SD,TR	6	-3.08503	-2.58059	2.43513

Notes: * significant at the 5% level. The lagged values of $y_{4,t}$ in the auxiliary regressions are determined through Akaike Information Criterion (AIC). I, SD and TR represent the deterministic components such as Intercept, Seasonal Dummy Variables and Linear Trend, respectively. The critical values are taken from HEGY (1990).

The results shown in Table 1 indicate that the null hypothesis of seasonal unit root at semi-annual frequency cannot be rejected at 5% significance level for both of R and IP series. On the other hand, the null hypothesis of non-seasonal unit root at zero frequency and the null hypothesis of seasonal unit root at annual frequency are rejected at 5% significance level for R series but not for IP series. Consequently, the integration order of R would be determined to be $I(1)$ for semi-annual frequency and $I(0)$ for zero and annual frequencies. However, the integration order of IP series would be determined to be $I(1)$ for all frequencies. The existence of seasonal unit roots exposes that seasonality in R and IP series follow non stationary stochastic process.

Once determining R and IP series as integrated of order one at semi-annual frequency, we carry out the cointegrating relation between R and IP series for semi-annual ($\omega = 1/2$) frequency using Lee's (1992) seasonal cointegration test which is based on maximum likelihood estimation method. We specify a convenient VAR model for the raw R and IP series and construct the VAR model including a linear trend variable and seasonal dummy variables following Cubadda (1999). We select the order of VAR model as 4 using Akaike information criterion (AIC) and the diagnostic tests indicate that VAR(4) model has no misspecification problem. The results of trace (LR) test at semi-annual ($\omega = 1/2$) frequency and the results of estimation of normalized coefficients at frequency of interest are reported in Table 2.

Table 2: The Trace (LR) Test Results of Seasonal Cointegration and Estimates of Normalized Coefficients

Frequency	$H_0: r=0$	$H_0: r=1$
$\omega = 1/2$	27.72973*	5.15998

Normalized Coefficients	R	IP
$\omega = 1/2$	1	0.07561

Notes: * denotes the rejection of null hypothesis of no seasonal cointegration at the 5% significance level. The critical values are taken from Lee and Siklos (1995).

According to the trace (LR) test results of Lee's (1992) seasonal cointegration procedure, the null hypothesis of no seasonal cointegration at semi-annual ($\omega = 1/2$) frequency is rejected at 5% significance level. The LR test results provide the existence of a unique seasonal cointegrating vector at the semi-annual frequency. The seasonal cointegrating vector belongs to semi-annual frequency $\left(SEC_{1/2,t}\right)$ denoting that the equilibrium error process can be shown as following:

$$SEC_{1/2,t} = -\left(1 - L + L^2 - L^3\right)\left(R_t + 0.07561IP_t\right) \tag{7}$$

The cointegrating vector at semi-annual frequency supports that there is a cointegrating relationship between R and IP series in two cycles per year and also represents the causal relationship which runs at least one direction between R and IP. After determining the cointegrating relation at semi-annual frequency, we examine the causality between the stock returns and real economic activity constructing SECMs as following:

$$\Delta_4 R_t = \alpha_1 + \sum_{i=1}^{m} \beta_{1i} \Delta_4 R_{t-i} + \sum_{i=1}^{m} \phi_{1i} \Delta_4 IP_{t-i} + \theta_1 SEC_{1/2,t-1} + \varepsilon_{1t} \tag{8}$$

$$\Delta_4 IP_t = \alpha_2 + \sum_{i=1}^{n} \beta_{2i} \Delta_4 IP_{t-i} + \sum_{i=1}^{n} \phi_{2i} \Delta_4 R_{t-i} + \theta_2 SEC_{1/2,t-1} + \varepsilon_{2t} \tag{9}$$

The direction of causality between stock returns and real economic activity can be determined by estimating the equations (8) and (9) using OLS method. We determine the lag lengths of m and n as 2 and 4, respectively through Akaike information criterion (AIC) and then estimate the equations (8) and (9). The estimation results of SECMs are shown at Table 3.

Granger (1988) reveals that the causal influence of one variable on the other one in an error correction model can be determined in two ways: first, through the error correction term and second, through the lagged values of independent variable. After estimating the SECMs we examine the causality which runs from the economic activity to stock returns by testing null hypothesis of $\phi_{1i} = 0$ for the lagged values of $\Delta_4 IP_t$ via joint F test and the null hypothesis of $\theta_1 = 0$ via t test for equation (8). In addition, we investigate the causality which runs from the stock returns to real economic activity by testing the null hypothesis of $\phi_{2i} = 0$ for the lagged values of $\Delta_4 R_t$ via joint F test and the null hypothesis of $\theta_2 = 0$ via t test for equation (9). The results of causality test are reported in Table 4.

As can be seen in Table 4, the rejection of the null hypothesis of $\theta_1 = 0$ indicates that the growth rate of industrial production has causal influence on the stock returns through the significant error correction term that belongs to semi-annual frequency. Thus, the significance of error correction term pertaining to semi-annual frequency indicates that there is a causal relationship running from the growth rate of industrial production index to the stock returns in the six-monthly term. On the other hand, the null hypothesis of $\phi_{1i} = 0$ cannot be rejected at 5% significance level implying that there appears to be no causality running from the growth rate of industrial production to stock returns in the short-run.

Also as can be seen in Table 4 the null hypothesis of $\theta_2 = 0$ cannot be rejected at 5% significance level. The error correction term that pertaining to semi-annual frequency is not significant at 5% significance level implying that the stock returns have no causal influence on the growth rate of industrial production through the error correction term pertaining to semi-annual frequency. On the other hand, the null hypothesis of $\phi_{2i} = 0$ also cannot be rejected at 5% significance level revealing that there appears to be no causality running from the stock returns to the growth rate of industrial production in the short-run.

Table 3: The Estimation Results of Seasonal Error Correction Models

	$\Delta_4 R_t$		$\Delta_4 IP_t$	
Regressors	Coefficients	t-statistics	Coefficients	t-statistics
Constant	0.00791	0.22087	-0.00227	-0.45680
$\Delta_4 R_{t-1}$	-0.01013	-0.10314	0.03465	1.88522
$\Delta_4 R_{t-2}$	0.19759	2.03768*	-0.01913	-1.33271
$\Delta_4 R_{t-3}$	-	-	0.02461	1.63401
$\Delta_4 R_{t-4}$	-	-	-0.01197	-0.83316
$\Delta_4 IP_{t-1}$	-0.25440	-0.36985	-0.04320	-0.43148
$\Delta_4 IP_{t-2}$	-0.53939	-0.81028	-0.04916	-0.50002
$\Delta_4 IP_{t-3}$	-	-	-0.09568	-0.97617
$\Delta_4 IP_{t-4}$	-	-	-0.51066	-5.29871*
$SEC_{1/2,t-1}$	-0.66468	-7.48261*	-0.03030	-1.59699
Serial Correlation $\left(\chi^2_{LM}\right)$	6.73498[a]		5.31615[b]	
Heteroskedasticity $\left(\chi^2_{WHITE}\right)$	11.55876[b]		14.96163[b]	
Normality $\left(\chi^2_{JARQUE-BERA}\right)$	8.73877[a]		0.61177[b]	
Stability $\left(F_{RAMSEY-RESET}\right)$	2.73674[b]		4.61669[a]	

Notes: * denotes statistically significance at 5% level. a and b denote that the null hypotheses of tests of interest can not be rejected at 1% and 5% significance levels, respectively.

Table 4: The Results of Causality Test

	$\phi_{1i} = 0$	$\theta_1 = 0$	$\phi_{2i} = 0$	$\theta_2 = 0$
$IP \not\Rightarrow R$	0.34939	-7.48261*	-	-
$R \not\Rightarrow IP$	-	-	1.49531	-1.59699

Note: * denotes rejection of null hypothesis of non-causality at 5% significance level.

4. Conclusions

In this paper, we investigate the causal relationship between the real economic activity and stock returns in seasonal unit roots and seasonal cointegration framework by taking into account of seasonal behaviors of the stock returns and industrial production as a proxy of real economic activity. We use seasonally unadjusted quarterly Turkish data series that covers the period from first quarter of 1987 to the third quarter of 2009. The paper presents that both of the stock returns and industrial production growth follow non-stationary stochastic seasonal behaviors according to the results of HEGY seasonal unit roots test. Furthermore, the seasonal cointegration test results indicate that the stock returns and the industrial production growth are cointegrated only at semi-annual frequency.

The empirical findings based on seasonal error correction models support evidence for the existence of the causal relationship between stock returns and real economic activity. We find empirical evidence for the causality running from the real economic activity to the stock returns in the six-monthly term, but there do not appear to be causality running from the real economic activity to the stock returns in the short-run. We also find no empirical evidence for the causality running from the stock returns to real economic activity. The empirical findings obtained from this study differ from the findings of Tsouma (2009) for Turkish economy. Tsouma (2009) applies the approach of Johansen (1996) standard multivariate cointegration and finds out strong positive unidirectional causality running from the stock returns to economic activity.

The results indicate that only the real economic activity provides the forecasting ability for the stock returns and also indicate that real economic activity leads to stock returns implying that there is no feedback relationship between the stock returns and the real economic activity.

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