STOCK RETURNS AND INFLATION IN GREECE

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Abstract

This paper examines the relationship between stock returns and inflation. We focus on various econometric techniques to test this relationship, using monthly values of the Athens Stock Exchange Price index and the Greek Consumer Price index over the period 1988-2002. The results from a simple OLS model show evidence of a positive but not significant relationship, while when we consider a system of equations including lagged values of inflation we find a negative but not significant effect of lagged inflation to stock returns. Using the Johansen cointegration test, we find that there is no long-run relationship between stock returns and inflation in Greece. The results indicate that the inflation rate is not correlated with stock returns. Finally, from a dynamic point of view, the Granger-Causality tests indicate evidence of no causality among these variables.

JEL Classification: G10, G15, E44
Keywords: Stock Returns, Inflation, Athens Stock Exchange, Cointegration

1. Introduction

Fisher (1930) argues that the expected rate of return is composed of a real return plus an expected rate of inflation. The *'Fisher effect hypothesis'* assumes no relationship between real rate and monetary sector. Applying this to stocks, several studies report an inverse relation of returns to expected and unexpected inflation (Nelson, 1976; Geske and Roll, 1983). Previous literature suggests a negative short-run relationship between stock returns and inflation (Fama and

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Schwert, 1977; Fama, 1981). Fama (1981) argues that stock returns are negatively related to inflation because stock returns are positively related to real activity and real activity is negatively related to changes in the level of prices. However, the theory suggests that equities are a good hedge against inflation[1], and so, the real rate of returns may be unaffected by inflation.

Bakshi and Chen (1996) argue that a negative correlation between inflation and stock prices has become one of the most commonly accepted empirical facts. However, Caporale and Jung (1997) test for a causal relationship between both expected and unexpected inflation and real stock prices, and find that a positive relationship does exist. As they conclude, the negative effects of inflation on stock prices do not disappear after controlling for output shocks. This is contrary to Fama's view.

Choudhry (1998) investigates the relationship between stock returns and inflation in four high inflation countries (Argentina, Chile, Mexico and Venezuela) and finds a positive relationship between stock market returns and inflation rate. Therefore, stock returns act as a hedge against inflation. Also, Chatrath *et al.* (1997) test whether the negative stock return-inflation relationship is explained in the Indian economy. The results show a partial support to Fama's hypothesis.

On the other hand, Zhao (1999) finds that the relationship between stock prices and inflation from Chinese economy is significantly negative. This result is consistent with Fama (1981). Hess and Lee (1999) argue that the sign of the correlation between stock prices and inflation depends on the nature of the shock creating inflation. They find that a positive monetary shock has a positive effect on stock prices and inflation. Also, Graham (1996) finds a positive relationship between inflation and stock returns.

Furthermore, Spyrou (2001) analyses the relationship between Greek stock returns and inflation rate using monthly data from

[1] See Bodie (1976) for more details.

January 1990 to June 2000. For the period 1995-2000 the results show a negative but insignificant relationship, while for the period 1990-1995 there is a significantly negative relationship. A possible explanation is that there is a negative correlation between inflation and real output growth (Fama, 1981).

Omran and Pointon (2001) employ the cointegration analysis and ECM to analyse the impact of the inflation rate on the Egyptian stock market. The results show that the inflation rate has a definite impact on the stock market. Finally, Gallagher and Taylor (2002) explain further the hypothesis of Fama (1981) by looking at the relationship between stock return and inflation using multivariate innovation decomposition. The results show a strong support to the hypothesis in the US.

This paper examines the relationship between stock returns and inflation for Greece. Also, in this study we test for cointegration and causality among these variables. The main goal of this paper is to analyse the above relationship for a recent period, considering data before and after the date of Greece's entry into EMU[2] (i.e. January 1st, 2001). So, we employ monthly values of the Athens Stock Exchange (ASE) General Price Index and the Greek Consumer Price Index for the period October 1988 to December 2002. All data are collected from *DATASTREAM*.

2. Methodology and Results

Let *GPI* be the ASE General Price index and let *CPI* be the Consumer Price index. Table 1 contains the descriptive statistics for the rate of change in the *GPI* and *CPI*, i.e. *DGPI* and *DCPI*. It is observed that both *DGPI* and *DCPI* have positive skewness, high positive kurtosis and high value of Jarque-Bera (J-B) statistic test. This means that the distribution is skewed to the right, and that the pdf is leptokurtic. Also, the J-B statistic test suggests that the null hypothesis of normality is rejected. Graphical plots of *CPI*, *GPI*, *DGPI* and *DCPI* are presented in Appendix 1.

[2] EMU stands for European Monetary Union.

Table 1. Descriptive Statistics for price indexes

	ΔGPI	ΔCPI
Mean	0.010206	-0.007667
Median	0.001360	-0.008030
Maximum	0.409667	0.379837
Minimum	-0.251423	-0.281344
Std. Dev	0.104373	0.084149
Skewness	0.965453	0.489920
Kurtosis	5.447873	6.259737
Jarque-Bera	68.85339	85.92928
Prob.	0.000000	0.000000

Note: This Table presents the summary statistics for *DGPI* and *DCPI*.

Next, our concern is to test whether log-*GPI* and log-*CPI* are stationary[3] processes or not. We employ the ADF test for testing for non-stationarity in our data. The ADF test will be employed on the log-levels and the first differences. The null hypothesis is that the series are non-stationary (i.e., presence of a unit root), and the alternative hypothesis is that they are stationary (i.e., absence of a unit root). We first should test the optimal lag number of each differenced series by using the AIC value. For both series we should add 1 lag of level and 1st diff. (ADF test). Table 2 presents the stationarity test results for log-*GPI* and log-*CPI*.

Table 2. Stationarity Test Results

Index	Lags	Critical Values	ADF Test Statistic
GPI	1	1%: -3.4701; 5%: -2.8786 10%: -2.5758	-2.150422 (Level) -7.548949 (1st Diff.)
CPI	1	1%: -3.4684; 5%: -2.8778 10%: -2.5754	-0.531355 (Level) -9.051378 (1st Diff.)

Notes: ADF regressions include an intercept.We employ ADF test on the logarithms of *GPI* and *CPI*.

[3] A series is said to be stationary if displacement over time does not alter the characteristics of a series in the sense that the probability distribution remains constant over time.

The ADF results show that the null hypothesis is accepted. Therefore, both *GPI* and *CPI* series are integrated of order one, I(1). In other words, there may or may not be a long-run stationary relationship between the stock returns and the inflation rate. The existence of the long-run relationship depends on whether or not the two series are cointegrated.

We are now able to proceed using a range of regressions to test for a significant relationship between stock returns and inflation. First, we test the relationship between stock returns and inflation using a simple OLS regression of the form:

$$\Delta GPI = a + b\Delta CPI \qquad (1)$$

The results obtained from equation (1) are presented in Table 3. In contrast with previous empirical studies, we find a positive *b* coefficient. However, this relationship, although positive, is not statistically significant. Graham (1996) also finds a positive relationship, and explains that this is due to the fact that inflation is caused by money rather than real activity.

Table 3. Relationship Between Stock Returns and Inflation (Eq. 1)

Dependent Variable: ΔGPI			
Method: Least Squares			
Variable	Coefficient	Std. Error	t-Statistic
a	0.010274	0.008175	1.256791
b	0.008095	0.084034	0.096329

Note: Model: $\Delta GPI = a + b\Delta CPI$

We then test for a significant relationship between inflation and stock returns by estimating the following system of equations:

$$\Delta GPI = a + b\Delta CPI_{t-1} \qquad (2)$$

$$\Delta GPI = a + b\Delta CPI_{t-1} + g\Delta CPI_{t-2} + d\Delta CPI_{t-3} + f\Delta CPI_{t-4} e_{1t} \qquad (3)$$

$$\Delta GPI = a + b\Delta CPI_{t-1} + g\Delta CPI_{t-2} + d\Delta CPI_{t-3} + f\Delta CPI_{t-4} + a_1\Delta CPI_t + b_1\Delta CPI_{t+1} + g_1\Delta CPI_{t+2} + d_1\Delta CPI_{t+3} + f_1\Delta CPI_{t+4} + e_t \quad (4)$$

The results from the above equations are presented in Tables 4, 5 and 6, respectively. Table 4 and Table 5 report a negative effect of lagged inflation to sock returns. However, this effect is not significant. Table 6 show the results observed from Equation (4). The only positive and significant parameter is $DCPI_{t+2}$.

Table 4. Relationship Between Stock Returns and Inflation (Eq. 2)
Dependent Variable: ΔGPI
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic
a	0.009315	0.008250	1.129113
ΔCPI_{t-1}	-0.107479	0.093260	-1.152472

Note: Model: $\Delta GPI = a + b\Delta CPI_{t-1}$

Table 5. Relationship between stock returns and inflation (Eq. 3)
Dependent Variable: ΔGPI
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic
a	0.008215	0.008644	0.950384
ΔCPI_{t-1}	-0.103281	0.092887	-1.111895
ΔCPI_{t-2}	-0.079908	0.069596	-1.148172
ΔCPI_{t-3}	-0.107395	0.076469	-1.404424
ΔCPI_{t-4}	0.047036	0.088239	0.533047

Note: Model $\Delta GPI = a + b\Delta CPI_{t-1} + g\Delta CPI_{t-2} + d\Delta CPI_{t-3} + f\Delta CPI_{t-4} e_{1t}$

Table 6. Relationship Between Stock Returns and Inflation (Eq. 4)
Dependent Variable: ΔGPI
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic
a	0.010413	0.009565	1.088655
ΔCPI_{t-1}	-0.108450	0.095452	-1.136173
ΔCPI_{t-2}	-0.058630	0.071565	-0.819257
ΔCPI_{t-3}	-0.107378	0.076687	-1.400197
ΔCPI_{t-4}	0.055571	0.098065	0.566676
ΔCPI	0.004562	0.084682	0.053867
ΔCPI_{t+1}	0.051296	0.107038	0.479236
ΔCPI_{t+2}	0.170128	0.086267*	1.972116*
ΔCPI_{t+3}	-0.113782	0.094383	-1.205530
ΔCPI_{t+4}	-0.016597	0.096540	-0.171917

Notes: *indicates significance at the 5% level. Model:

$$\Delta GPI = a + b\Delta CPI_{t-1} + g\Delta CPI_{t-2} + d\Delta CPI_{t-3} + f\Delta CPI_{t-4} + a_1\Delta CPI_t + b_1\Delta CPI_{t+1} + g_1\Delta CPI_{t+2} + d_1\Delta CPI_{t+3} + f_1\Delta CPI_{t+4} + e_t$$

Since ADF tests conclude that log-*GPI* and log-*CPI* series follow nonstationary random process and are integrated of order one, I(1), then we are able to conduct cointegration tests. We test for cointegration between the two series using the Johansen approach. Details of the Johansen procedure are provided in Appendix 2. In brief, the cointegrating vector is based on a Vector Autoregressive (VAR) model. The AIC and *LR* test statistic selected a one-lag VAR, i.e. VAR(1)[4]. The estimation of the cointegration equation is obtained via the methodology developed by Johansen and Juselius (1990).

According to the cointegration results, both the maximal-eigenvalue and trace statistic support $r = 0$ cointegrating vector.

[4] The results obtained from the VAR(1) model are available upon request.

Results of the cointegration test are given in Table 7. The null hypothesis of no cointegration is accepted, and the *LR* test accepts the hypothesis of no cointegration, and rejects that of at most one cointegration relation. Hence, in our case there is no cointegrating equation among the two variables. That means, stock returns and inflation are not affected by any force. Overall, we find evidence of no long-run equilibrium relationship between stock returns and inflation rate in Greece.

Table 7. Johansen Test

Lags interval: 1 to 1				
	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.053887	9.881862	15.41	20.04	None
0.003074	0.520346	3.76	6.65	At most 1

Note:* L.R. rejects any cointegration at 5% significance level

Finally, we examine the causal relationship between stock returns and inflation following the Granger-Causality (G-C) test. We check for causality and test whether *GPI* does Granger cause *CPI* or *CPI* does Granger cause *GPI*. In brief, causality tests seek to answer simple questions of the type *'Do changes in x cause changes in y*?'. A series x is said to Granger cause another series y, if the present values of x can be predicted more accurately by using past values of x. Table 8 reports the results from G-C tests. The Granger Causality tests indicate that the null hypothesis is accepted for both *CPI* and *GPI*. From dynamic point of view, we find that there is no causal relationship from *CPI* to *GPI*, and *GPI* to *CPI*. So, we conclude that Greek inflation does not Granger cause ASE stock returns, and ASE stock returns do not Granger cause Greek inflation over the period 1988-2002.

Table 8. Granger Causality Tests

Pairwise Granger Causality Tests			
Sample: 1988:10 2002:12. Lags: 1			
Null Hypothesis:	Obs	F-Statistic	Probability
CPI does not Granger Cause GPI	170	1.73553	0.18951

GPI does not Granger Cause CPI	0.04507	0.83213

3. Summary

It is crucial for a financial investor to know whether stock returns follow inflation rate. There is a large empirical literature showing that stock returns are negatively correlated with inflation (Fama, 1981). Fama (1981) argues that stock returns are negatively related to inflation because stock returns are positively related to real activity and real activity is negatively related to changes in the level of prices. The analysis of this paper is focused on the empirical relation between the stock returns and the inflation rate in Greece. In particular, we examine the behaviour of stock returns and inflation in Greece by employing various econometric methods, which include: the traditional regression model (OLS), the Johansen method and Granger-Causality tests.

First, the results from a simple OLS model show evidence of a positive but not significant slope coefficient. However, when we consider a system of equations including lagged values of inflation, we find a negative but not significant effect of lagged inflation to stock returns. According to Spyrou (2001), when inflation in Greece is not significant, it is caused by monetary fluctuations. Also, as Graham (1996) argues, a possible explanation of this result may be that during that period Greek inflation was caused by money.

When the Johansen approach is considered, empirical results show that there is no cointegration between stock returns and inflation in Greece. Hence, we find evidence of no long-run relationship between the two variables. The results for the Johansen approach are in contrast with Spyrou (2001). He shows that both stock returns and inflation seem to share a common stochastic trend in Greece over the period 1990-2000. Furthermore, Spyrou (2002, p. 450) finds that Greek inflation is related to the log level of money supply and real activity. Finally, from a dynamic point of view, the Granger-Causality tests confirm that there is no evidence of causality for both variables. So, we conclude that there is no correlation between the current value and the past values, and therefore, the stock returns and inflation are characterised as independent factors in Greece. Future research needs to examine the short- and long-run Fisher relationships for US, UK and other European countries.

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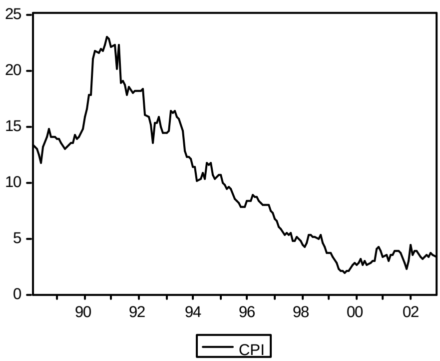
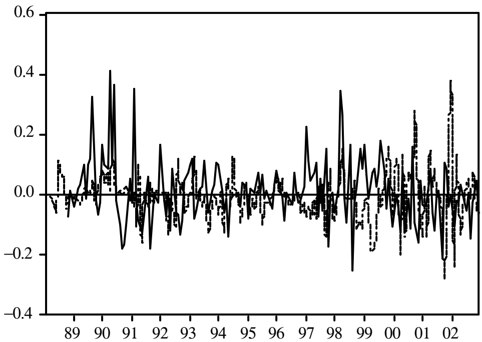
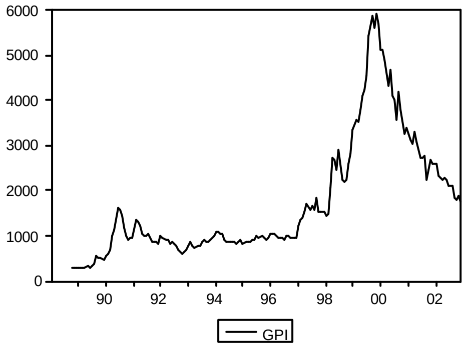
APPENDIX 1: Graphs







* *Graphical plots of CPI, GPI, DCPI* and *DGPI (1988-2002).*

APPENDIX 2: Cointegration methodology

Several tests have been developed to test for cointegration; the main two being the bivariate approach developed by Engle and Granger (1987), and the multivariate vector autoregression (VAR) approach developed by Johansen (1988, 1991), and Johansen and Juselius (1990)). As a result, the multivariate approach to testing for cointegration will be taken here to study the relationship between prices.
The multivariate approach starts by defining a vector of *n* potentially endogenous variables Z_t. It is assumed that Z_t is an unrestricted VAR system with up to *k*-lags:

$$Z_t = A_1 Z_{t-1} + ... + A_k Z_{t-k} + \Phi D_t + m + e_t$$

where A_i is an *n* x *n* matrix of coefficients, μ is a constant, D_t are seasonal dummies orthogonal to the constant term μ and ε_t is assumed to be an independent and identically distributed Gaussian process.
The latter equation can be reformulated in vector error-correction (VECM) form by subtracting Z_{t-1} from both sides:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + ... + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + \Phi D_t + m + e_t$$

where, $\Gamma i = -(I - A_1 - \ldots - A_i)$, (i =1, … ,k-1), and $\Pi = -(I - A_1 - \ldots - A_k)$.

The system of equations specified in VECM now contains information on both the short-run and the long-run adjustment to changes in Z_t. The rank of Π, denoted as *r*, determines how many linear combinations of Z_t are stationary. If r=N, the variables in levels are stationary; if r=0 so that Π=0, none of the linear combinations are stationary. When 0<r<N, *r* cointegration vectors, or *r* stationary linear combinations of Z_t exist. In this case one can factorise Π; $\Pi=\alpha\beta'$, where α represents the speed of adjustment to dis-equilibrium and β is a matrix of long-run coefficients and contains the cointegration vectors. Determining how many cointegration vectors exist in β consequently amounts to testing for cointegration.

Johansen and Juselius (1990) show that after undertaking appropriate factorising and by solving an eigenvalue problem it is possible to test for the number of significant cointegration vectors using two different tests. The first is the trace test (ηr), which is a likelihood ratio test for at most *r* cointegration vectors using

$h_r = T \cdot \sum_{i=r+1}^{N} \ln(1 - l_i)$, where T is the number of observations and λ_i are the eigenvalues which solve the eigenvalue problem. The second is the maximum eigenvalue test (ξ), which is a test of the relevance of column *r+1* in β using $\xi r = - T \ln (1-\lambda r+1)$.