Asymmetric Effects Of Inflation On Stock Market Prices: New Empirical Evidence Using Greek Data

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ABSTRACT

Since economic theory establishes a relationship between stock market returns and inflation rate, we attempt to re-evaluate the above relationship for Greece considering the possibility of nonlinearities. In particular, empirical analysis is based upon the nonlinear cointegration framework and applies the asymmetric ARDL cointegration methodology, following previous work by Shin, Yu and Greenwood-Nimmo (2011). In doing so, we permit a much richer degree of flexibility in the dynamic adjustment process toward equilibrium, than in the classical case of a linear model. Our findings present evidence of asymmetric adjustment around a unique long-run equilibrium.

Keywords: Greek Inflation; Greek Stock Market Returns; Asymmetric ARDL Cointegration

1. INTRODUCTION

Economic theory suggests that the nominal expected return on any asset is composed of the expected real interest rate and the expected inflation rate. A positive relationship between inflation and the stock market returns is rooted on the idea that equities operate as a hedging tool against inflation as they represent claims on real assets. This idea has been suggested by Geske and Roll (1983). However, empirical evidence shows that in many cases this relationship does not hold (Bodie, 1976; Fama, 1981).

In this paper we attempt to examine the relationship between inflation and stock market returns due to lack of consensus of the results in the vast majority of the literature. Moreover, the existence of mixed evidence in the majority of the relevant studies led us to re-examine for possible asymmetric effects in order to extract safe and sound conclusions. More particularly, as the stock market index is driven by the economic activity, it is expected to exhibit nonlinearities. In such a case, a conventional linear specification would provide misleading evidence in the presence of asymmetries. The response of the stock market returns to positive shocks in the long-run, may differ from the response to negative ones. The case of Greece, which has thoroughly been examined, is of particular interest as the interest rate setting regime has changed during the examined period. More specifically, the Greek Central bank's ability to set its intervention interest rate has passed to the European Central bank since 1998 and inflation pressures are centrally stabilized. Those central banks that joined the exchange rate mechanism (ERM) abolished their ability to correspond to possible asymmetric shocks.

This paper contributes to the international literature as it undertakes a detailed analysis of the stock returns-inflation nexus, in a nonlinear framework. Specifically, we do not treat our data set as one concrete time series piece but, instead, we examine the relationship under different inflation regimes as well as over two time horizons: short-term and long-term. We assume that investors, during the investment period, change their stock holdings and attempt to reposition in order to hedge against inflation.

In this direction, the potential asymmetric relationship between stock market returns and inflation is investigated by means of the ARDL cointegration methodology making further steps regarding the nonlinear framework. In particular, the asymmetric Autoregressive Distributed Lag (ARDL) cointegration technique (Shin et al., 2011) is further deployed, to test for a possible nonlinear relationship between stock market returns and inflation. To our knowledge, this represents an enrichment of the existing literature on stock market modelling, and for the Greek stock market in particular.

The rest of the paper is structured as follows: the second section overviews the relevant literature on the relationship between stock market returns and inflation. In the third section we briefly present the applied econometric methodology while, in the fourth section the empirical findings are reported. Finally, the last section provides a summary and conclusions.

2. LITERATURE REVIEW

The relationship between inflation and the stock market returns has been examined extensively in the literature. Empirical evidence is rather mixed and could be classified into three categories. Some studies support the existence of a positive relationship between the two variables, some other support a negative relationship, and finally there are studies which do not find any relationship between the two variables.

Firth (1979), and Gultekin (1983), conclude that the relationship between nominal stock returns and inflation in the United Kingdom is relatively positive, a finding consistent with the generalized Fisher hypothesis. In particular, Gultekin (1983) highlights the fact that countries with higher inflation generally have higher nominal stock market returns, while real assets in most countries have been declining since the mid 1960's. Both Firth (1979) and Gultekin (1983) have examined the Fisher effect by regressing the stock market returns on anticipated rates of inflation. Gultekin has used two models of inflation. Using contemporaneous inflation rates as proxies for expected inflation, he decomposed inflation to expected and unexpected inflation with, ARIMA models. The principal method employed by Gunasekarage et al. (2004), to analyse inflation and stock market returns behavior involves cointegration and the estimation of a vector error correction model (VECM). Since the VECM was established, they employed two short-run dynamic analyses allowing them to investigate the behavior of an error shock to each variable on its own future dynamics as well as on the future dynamics of other variables in the VECM system. According to Gunasekarage et al. (2004) a possible explanation for the positive relationship might be the government's active role in preventing prices escalation as the economy continued to improve after the 1997 crisis. Ioannidis and Katrakilidis (2004) found evidence of a positive correlation between inflation and the stock market returns in Greece between 1985 and 2000. They used both the Autoregressive Distributed Lag approach (ARDL) and the Granger causality methodology. Kessel (1956) suggests that unexpected inflation increases the firm's equity values if the firm is a net debtor.

Marshall (1992) stated that if inflation is caused by money shock, it would lower the rate of interest and investors would shift their cash holdings to stocks and bonds in order to maximize potential capital gains. The increase in demand would in turn raise stock prices. Increases in expected inflation may also signal a potential increase in real activity, production and hence higher stock returns (Fama and Gibbons, 1982). Finally, Lee (1992) among other conclusions about interest rates and real activity, suggests that there exists a positive relation between the two variables and that the stock market may be used as a hedge against inflation. These findings are based on post war US data.

The counter cyclical monetary policy has been examined by Kaul (1987). He shows that a counter cyclical monetary policy during the postwar period led to strong negative relation between stock returns and inflation. Geske and Roll (1983) argue that the counter cyclical monetary policy in the post war period is a result of debt-monetarization. The evidence in Kaul supports the Geske and Roll reverse causality linkage between stock returns and inflation. Bodie (1976), using annual, quarterly and monthly data for the period between 1953 and 1972, suggests that inflation and stock market returns are negatively correlated and that through this relation one could hedge his position by short selling his equities. The results of studies by Jaffe and Mandelker (1976), Nelson (1976), Fama and Schwert (1977) and Chen et al. (1986) pointed to a negative relation between inflation and stock prices. The common hypothesis is that an increase in the rate of inflation is likely to lead to economic tightening policies, which in turn increases the nominal risk-free rate.

Finally, Pearce and Rolley (1988) found mixed empirical evidence. The results indicated that time-varying characteristics related to inflation predominately, determine the effects on stock rate of return. Moreover, the net effect could be either positive or negative. It is suggested that the results are accounting related since a firm's debt-equity ratios and its inventories, when FIFO (First In, First Out) inventory accounting is used appear to be particularly important in determining the response. Moreover, they suggest that a firm's market beta is also a significant factor, but the associated effect is smaller in comparison. Anary and Kollari (2001), report negative correlations between stock prices and inflation in the short run which are followed by positive correlations in the long run. Similarly, Jaffe and Mandelker (1976), found negative relationship between the stock market returns and the inflation rate over the period 1975-1955, whilst they found a positive relationship over a longer period 1876-1970. Taking into account the data limitations prior to 1954 they replicated some results using yearly data.

3. METHODOLOGY AND MODEL STRUCTURE OF THE ASYMMETRIC ARDL COINTEGRATION

The issue of cointegration refers to the existence of possible comovements among certain variables in the long-run. In this context, if stock market returns and inflation are found cointegrated, means that, although they may temporarily drift apart from each other, in the long-run they tend to return to equilibrium. We can discriminate between three possible cases; the existence of linear cointegration, the existence of nonlinear cointegration and, lack of cointegration.

The conventional cointegration approach initially adopted in this paper, is based on the linear ARDL model (Pesaran and Shin, 1999; Pesaran et al., 2001) which performs better for determining cointegrating relationships in small samples (Romilly et al. 2001). It also maintains the additional advantage that it can be applied without pre-testing for the regressors' order of integration thus allowing for statistical inferences on long-run estimates, which are not possible under alternative cointegration techniques. However, the linear ARDL cointegration technique is not valid in the presence of I(2) variables.

The general form of the ARDL model is defined as:

$$\Phi(L)y_t = \alpha_0 + \alpha_1 w_t + \beta^{'}(L)x_{it} + u_t \,, \tag{1}$$

where: $\Phi(L) = 1 - \sum_{i-1}^{\infty} \Phi_i L^i$ and $\beta(L) = \sum_{j=1}^{\infty} \beta_j L^j$,

with (L) being the lag operator and (w_t) being a vector of deterministic variables such as the intercept, seasonal dummies, time trends or other exogenous variables (with fixed lags).

The recently developed asymmetric ARDL model, applied in this paper, is a new technique for detecting nonlinearities focusing on the long-and short-run asymmetries among economic variables. The technique was advanced by Shin et al. (2011) and is an asymmetric expansion of the above mentioned linear ARDL model.

Following Pesaran and Shin (1999), Pesaran et al. (2001), Schorderet (2003) and Shin et al. (2011), we consider the following nonlinear asymmetric cointegrating regression:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t \,, \tag{2}$$

where β^+ and β^- are the associated long-run parameters and x_t is a k×1 vector of regressors decomposed as:

$$x_t = x_0 + x_t^+ + x_t^- \,, \tag{3}$$

where, x_t^+ and x_t^- are partial sum processes of positive and negative changes in x_t :

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0) \text{ and } x_t^- = \sum_{j=1}^{t} \Delta x_i^- = \sum_{j=1}^{t} \min(\Delta x_j, 0) \,, \tag{4}$$

By associating (2) to the ARDL(p, q) case, we obtain the following asymmetric error correction model (AECM):

$$\Delta y_t = \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q} (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{t-j}^-) + e_t , \quad (5)$$

for $j = 1,...,q$ where $\theta^+ = -\rho\beta^+$ and $\theta^- = -\rho\beta^-$.

This empirical analysis follows three steps; namely step one concerns the estimation of model (5) by standard OLS. Step two is the establishment of the long-run relationship between the levels of the variables y_t, x_t^+, x_t^-, by means of a modified F-test using the bounds-testing procedure advanced by Pesaran et al. (2001) and Shin et al. (2011), which tests the joint null that $\rho = \theta^+ = \theta^- = 0$ in (5). In step three, using the Wald test, we examine for long-run symmetry with null $\theta = \theta^+ = \theta^-$ and for short-run symmetry which can take one of the following forms (i) $\pi_i^+ = \pi_i^-$ for all $i = 1,...,q$ or (ii) $\sum_{i=0}^{q} \pi_i^+ = \sum_{i=0}^{q} \pi_i^-$.

4. EMPIRICAL RESULTS

The data employed in the empirical analysis are quarterly, covering the period from 1987 up to the first quarter of 2011 and collected from the database of the International Monetary Fund. The variables examined are the Greek stock market index (SP) and the consumer price index (CPI). Both variables are used in logarithmic form.

The analysis is performed on the following general empirical model:

$$lnSP_i = f(lnCPI_i^+, lnCPI_i^-) \quad (6)$$

where $lnCPI^+$ and $lnCPI^-$ are the partial sums of positive and negative changes in lnCPI, respectively.

Regarding the application of the ARDL method although it can be applied irrespective of the regressors' order of integration, it is necessary to initially test the integration properties of the involved variables to ensure that the series used are not I(2). In such a case the computed F-statistics for cointegration turn invalid (Ouattara, 2004).

Consequently, we apply the Augmented Dickey-Fuller (1979) unit root test. The findings presented in Table 1, suggest that all examined variables are nonstationary in levels while, they turn stationary in first differences and thus we can proceed with testing for cointegration in the ARDL framework.

Table 1: Augmented Dickey-Fuller Unit Root tests

	Include an intercept, but not a trend			Include an intercept and a trend		
Series in logarithms	Test Statistic	k	Critical Value	Test Statistic	k	Critical Value
lnSP	-1.9125	0	-2.9237	-1.4116	0	-3.4458
lnCPI	-2.7726	2	-2.8657	-2.8970	2	-3.4030
Series in first differences	Test Statistic	k	Critical Value	Test Statistic	k	Critical Value
ΔlnSP	-10.2372	0	-2.8239	-10.1360	0	-3.5508
ΔlnCPI	-11.6758	1	-2.8081	-11.9614	1	-3.5240
The optimal lag structure of the ADF test is chosen based on the Akaike Information Criterion, while k denotes lag order. The critical values are 95% simulated critical values using 83 obs. and 1000 replications						

Next, we test for cointegration, using the conventional linear ARDL specification below:

$$\Delta lnSP_t = cons + \sum_{i=1}^{p} b_i \Delta lnSP_{t-i} + \sum_{i=0}^{p} c_i \Delta lnCPI_{t-i} + \delta_1 lnSP_{t-i} + \delta_2 lnCPI_{t-i} + e_t \quad (7)$$

The optimal lag structure of the above unrestricted error correction model is chosen based on the Akaike Information Criterion (1981). The estimates, presented in Table 2 ($F_{PSS\text{-}Linear}$), provide evidence in favor of the non-rejection of the null hypothesis of no cointegration. The reported F-value is 4.573 and is smaller than the lower bound critical value (5.104). A possible reason for the non-detection of a causal long-run relationship might be the existence of nonlinearities among the variables.

To test for this possibility, we proceed with the estimation of the asymmetric ARDL model of the form (5) as below:

$$\Delta lnSP_t = cons + \rho lnSP_{t-1} + \theta_i^+ lnCPI_{t-1}^+ + \theta_i^- lnCPI_{t-1}^- + \sum_{i=1}^{p-1} \pi_i lnSP_{t-i} + \sum_{i=0}^{q} \pi_i^+ \Delta lnCPI_{t-i}^+ + \sum_{i=0}^{q} \pi_i^- \Delta lnCPI_{t-i}^- + e_t \quad (8)$$

The cointegration test applied on the unrestricted model is an F-test on the joint hypothesis that the coefficients of the lagged level variables are jointly equal to zero. The F-statistic ($F_{PSS\text{-}Nonlinear}$) is found 3.615 and lies between the lower and upper bound critical values at the 5% significance level (3.219 and 4.378). Because of the inconclusive inference from the F_{PSS} test, we apply the t_{BDM} test (Banerjee et al., 1998), which is clearly in favor of a long-run causal relationship between the involved variables. The estimates of the unrestricted ARDL regression of the form (5) are presented in Table 2.

Table 2: Dynamic Asymmetric Estimation of Stock Markets Adjustments

Dependent Variable: ΔlnSP			
Variable	**Coefficient**	**Standard Error**	**T-Ratio[Prob]**
Constant	0.84933	0.26516	3.2031 [0.002]
lnSP(-1)	-0.13511	0.044119	-3.0625 [0.003]
lnCPIP(-1)	0.16925	0.087569	1.9327 [0.057]
lnCPIN(-1)	0.10434	0.12516	0.8336 [0.407]
ΔlnSP(-3)	0.30573	0.095279	3.2087 [0.002]
ΔlnSP(-11)	0.20669	0.085197	2.4260 [0.018]
ΔlnCPIP(-4)	-0.81366	0.23423	-3.4738 [0.001]
ΔlnCPIP(-11)	-0.46212	0.25116	-1.8400 [0.070]
ΔlnCPIP(-12)	-0.59798	0.26478	-2.2584 [0.027]
ΔlnCPIN(-12)	1.3685	0.40344	3.3920 [0.001]
$L_{CPI}+$	1.2526 *		
$L_{CPI}-$	0.7722 **		
$F_{PSS\text{-}Linear}$	4.5738	$F_{PSS\text{-}Nonlinear}$ t_{BDM}	3.6155 -3.062 [0.001]
R^2	0.36995	R-bar^2	0.29333
X^2_{SC}	5.6216 [0.229]	X^2_{FF}	11.1122 [0.001]
X^2_{NORM}	10.9751 [0.004]	X^2_{HET}	5.7778 [0.016]
W_{LR}	3.9369 [0.047]	W_{SR+}	74.6235 [0.000]
W_{SR}	60.452 [0.000]	W_{SR-}	19.5931 [0.000]

where L^+ and L^- are the estimated long-run coefficients defined by $\hat{\beta} = -\hat{\theta}/\hat{\rho}$

$F_{PSS\text{-}Linear}$ and $F_{PSS\text{-}Nonlinear}$ denote the PSS F-statistic testing the null hypothesis $\rho=\theta=0$ and $\rho=\theta^+=\theta^-=0$ respectively
t_{BDM} denotes the test for a long-run relationship defined by the null of $\rho=0$ against $\rho<0$
X^2_{SC}, X^2_{NORM}, X^2_{FF} and X^2_{HET} denote LM tests for serial correlation, normality, functional form and heteroscedasticity, respectively.
W_{LR} refers to the Wald test of long-run symmetry defined by $-\hat{\theta}^+/\hat{\rho} = -\hat{\theta}^-/\hat{\rho}$
W_{SR} refers to the Wald test of the additive short-run symmetry condition defined by $\sum_i^c \pi_i^+ = \sum_i^c \pi_i^-$
$W_{SR}+$ ($W_{SR}-$) refers to the Wald test for positive (negative) changes
* (**) denotes 5% (10%) significance level

Having established the existence of cointegration, in order to examine the appropriateness of an asymmetric model we apply the Wald tests for both long- (W_{LR}) and short-run (W_{SR}) symmetry. Regarding the long-run time horizon, the results, reported in the lower panel of Table 2, suggest the rejection of the null hypothesis of long-run symmetry between the positive and negative components of the consumer price index. More specifically, the Wald test is found 3.936 (p-value=0.047).

Before we examine the magnitude of these long-run asymmetric effects, we proceed with the analysis of the short-run dynamics. The null hypothesis of symmetry in the short-run impacts against the alternative of asymmetry is tested using the Wald statistic with null: H_{SR}: $\sum_i^c \pi_i^+ = \sum_i^c \pi_i^-$. The results (Table 2, W_{SR}), suggest the rejection of the null hypothesis of a weak form summative symmetric adjustment in the short-run. The Wald test is found 60.452 (p-value=0.000).

Then, we proceed with the examination of the significance of the detected asymmetric short-run causal effects (W_{SR}+ and W_{SR}-). The results of the applied Wald test, reported in Table 2 (lower panel), indicate that for the consumer price index, both the positive and negative components cause significant impacts on share prices.

Next, we turn again to the analysis of the long-run dynamics, presented in Table 2. Focusing on the estimated long-run coefficients of the asymmetric ARDL model, we note that for the consumer price index, significance is confirmed at the 5% and 8% level for the positive (L_{CPI}+) and negative (L_{CPI}-) long-run coefficients respectively, with the signs being positive and in line with the reported literature (Firth, 1979; Geske and Roll, 1983; Gultekin, 1983). The estimated long-run coefficients on $lnCPI^+$ and $lnCPI^-$ are 1.2526 and 0.7722 respectively. Therefore, we may conclude that a 1% increase in the consumer price index results in a 1.25% rise in share prices. Similarly, a 1% decrease in the consumer price index leads to a 0.77% decrease in share prices. Hence, our results indicate that the greater effect is sourcing from the positive changes.

5. SUMMARY AND CONCLUSION

The impact of inflation shocks on the stock market has been the focus of research since many years ago. The international literature has attempted to interpret the effects on stocks as an indication of the real effects of monetary policy, as it is adjusted in accordance to the inflation levels (Thorbecke, 1997). Other researchers, like Patelis (1997), have attempted to show that money supply shocks affect equity prices via the risk premium. However, empirical evidence about the impact of macroeconomic surprises on the stock market is not conclusive because different models produce conflicting results. We believe that the existing literature in this field neglects the important issue of the existence of asymmetric dynamics.

In this context, since standard methods may yield erroneous results due to the omission of asymmetric dynamics in the relationship, we examined for possible asymmetric effects of inflation on stock market prices. Following the findings of our empirical analysis, we detected a positive relationship in the long-run between stocks and inflation. Loose monetary policy boosts both the stock market and inflation (Thorbecke, 1997; Bordo and Wheelock, 2004). The asymmetric effects in the long run, further suggest that an anti-inflationary intervention causes a smaller impact on the stock market returns than on inflation. Investors use the stock market as a hedge against inflation. A falling inflation rate causes portfolio adjustments leading to stock sales and hence we observe a negative return of the stock market index. The investment community estimates the magnitude of inflationary pressures and proceeds to stock purchases in order to get protected against the loss of the value of their wealth.

Tight monetary policy, which is used as an anti-inflationary tool, affects negatively the stock market returns (Conover, 1999; Durham, 2001). The reason for this is that, given the benefits of international diversification, active portfolio managers should sell stocks in countries where the central bank is tightening its monetary policy.

We found that a 1% increase in the consumer price index results in a 1.25% rise in the share prices while a 1% decrease in the consumer price index leads to a 0.77% decrease in the share prices. Taking into account the detected asymmetric nature of the effects, it seems that a passive portfolio management would produce higher returns than the inflation rate and the investment manager would avoid the loss of value on his/her wealth.

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