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MASTER IN ECONOMICS

THE EFFECTS OF INFLATION AND INFLATION UNCERTAINTY ON STOCK INDICES: EVIDENCE FROM 8 COUNTRIES

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Abstract

In this paper, I investigate the ambivalent role of inflation and inflation uncertainty on stock indices. Most specifically, I examine the effects of inflation and inflation uncertainty on stock indices, using evidence from eight industrialized countries (Canada, France, Germany, Israel, Spain, the United Kingdom, the United States of America and Greece). To do so I firstly extract a measure of inflation uncertainty using exponential generalized autoregressive conditional heteroscedasticity models (E-GARCH models). Then I examine the influence of inflation and inflation uncertainty using VAR model analysis and test for the existence of Granger-causality. Finally, I use impulse responses to examine how a sudden change in inflation and inflation uncertainty affects stock indices. The results indicate that a shock in inflation negatively affects stock returns in 6 out of 8 countries (Canada, Germany, Israel, Spain, UK, USA) and a shock in inflation uncertainty affects only 4 out of 8 eight countries (some positively and others negatively). Furthermore, I find evidence that stock returns strongly affect the inflation.

Contents

Introduction

The first stock trading was created in Amsterdam by the Dutch East India Company, which was the first company that in order to raise its capital, decided to pay dividends of the shares to investors by selling stocks. Later the Amsterdam stock exchange was created. Soon after, other countries, following this example, began creating similar companies and buying shares of stock became a must do thing for investors. That excitement that surrounded the stock market, blinded most investors which led them to carelessly buy into any company that was available at the time without further consideration. This behavior led to financial instability, which in 1720 brought fear to the investors and tried in their turn to sell all their shares in a hurry. However, since there was no investor willing to buy, the market soon crashed and one of the first contemporary stock market crashes occurred. Since then, many contemporary stocks market crashes have occurred all over the world and investors nowadays are constantly trying to analyze and anticipate the factors that impact stock indices. Despite the fact that many and advanced methods have been implemented no one is able to answer with certainty what really affects stock indices. Surely there are some factors which have greater impact on stock indices than others but there are also some which their role is controversial. For this purpose, in this paper, I will investigate the ambivalent role of inflation and inflation uncertainty on stock indices. Most specifically, I will examine the effects of inflation and inflation uncertainty on stock indices, using evidence from eight industrialized countries (Canada, France, Germany, Israel, Spain, United Kingdom, United States of America and Greece).

To do so I firstly extract a measure of inflation uncertainty. Although there are many different ways, of extracting the inflation uncertainty, such as, R.Bhar (Sep.2010) who used in his paper a structural model for inflation with time varying parameters that helped him decompose inflation uncertainty in two components (structural and impulse), or autoregressive conditional heteroscedasticity and generalized autoregressive conditional heteroscedasticity techniques (ARCH, GARCH models) which most researchers employ, for the purposes of this paper I extract inflation uncertainty as Fountas, Ioannidis, Karanasos (2004) did in their paper. That means that I also use exponential generalized autoregressive conditional heteroscedasticity models (E-GARCH models), because they have the advantage to capture the potential asymmetric behavior of inflation. Then I examine the influence of inflation and inflation uncertainty using vector autoregression model analysis (VAR model analysis), which helps me to test the existence of Granger – causality among my variables. This statistical hypothesis test helps me to casually determine whether one of my time series is useful in forecasting another. Lastly, I use impulse responses to examine how a sudden change in inflation and inflation uncertainty affects stock indices.

The rest of this paper is structured as follows. Firstly, in Chapter I is the literature review where I summarize related researches that others have done. Secondly in Chapter II, I present my data and their sources. Then follows the methodology part, where I explain how I use my data and present the theoretical econometric model. Then in Chapter III are the empirical results which are divided in two sections. In the first are the results of one country that has been chosen in order to showcase the whole process of analyzing our data and in the second I interpret the result for the rest of the countries. After that follows Chapter IV, where I relate my results to other empirical studies. Finally in Chapter V I conclude.

Chapter I

Literature Review

According to **Eugene F. Fama (1981)**, there is a negative relation between real stock returns and inflation during the post 1953 period. This negative relation exists due to the fact that real stock returns are positively related to measures of real activity whereas on the other hand there is evidence of negative relations between inflation and real activity.

Fred C. Graham (2010), using OLS estimation found that the relationship of real stock returns and inflation are positive during the time period 1976-1982 and negative before and after this time.

P. Balduzzi (1995), using time series techniques and collecting data for the 1954-1976, 1977-1990 periods found that inflation and the rate of interest are responsible for the existing negative correlation between stock returns and inflation.

Lifang Li, Paresh K. Narayan and Xinwei Zheng (2010), examined the relationship between stock returns and inflation for the UK aggregate stock market and found out that unexpected inflation negatively affects stock returns while expected inflation can have either positive or negative impact on them.

Jeffrey Oxman (2012), in his article “Price inflation and stock returns”, using data from 1966-2009 period for the S&p500, found that price inflation doesn’t have any effect on stock returns after 1983 but during 1966-1983 it may have an effect depending on the inflation measure used in the analysis.

Kaul G. (1987), using data for four countries (the US, Canada, the UK, and Germany) from the period of 1951-1983, accepts the main hypothesis of Fama (Sep. 1981) that there is a negative relationship between stock returns and inflation and he furthermore supports that this relation can be explained by the equilibrium process in the monetary sector, thus it may vary if supply factors or money demand undergo a systematic change.

Christos Floros (2008), using monthly data, of the Athens stock exchange price index and the Greek consumer price index, found out, using various econometric methods such as OLS model, Granger causality test, Johansen cointegration, that there is no significant effect of inflation to stock returns in case of Greece.

Yakov Amihud (1996), using OLS models for Israel came to the conclusion that there is a negative and strongly significant relationship between unexpected inflation and stock prices.

In **Mark Crosby (2002)** paper, this relationship is examined for the country of Australia and by using shocks he found that there is a negative relationship between inflation and stock returns in the short run and not in the long run.

N. Bullent Gultekin (1983), investigates the relationship between stock returns and inflation in 26 countries using time series regressions for the period 1/1947 - 12/1979. He then came to the conclusion that there is no positive relation between these variables and also that stock return-inflation relation is not stable over time and varies among countries.

Samih Antoine Azar (2013), examines the relation between inflation, inflation uncertainty and stock returns. In his paper he used two proxies for inflation uncertainty (absolute value and the square inflation) and found that there is a negative relation between inflation and inflation uncertainty, taken separately with the stock returns. Despite that when he entered both inflation uncertainty and inflation in the regressions of stock returns, inflations coefficient became statistically insignificantly different from zero while inflations uncertainty coefficient remained statistically important and negative.

SC Lin (2009), in his article, he measured inflation uncertainty using different models such as GARCH, EGARCH and CGARCH models respectively. In his analysis he used panel data for industrialized countries over the period 1957 – 2000(Q1), and found that despite the fact that anticipated inflation uncertainty has no significant effects on stock returns in the short run, in the long run they appear to have significant and negative effects.

E Cakan (2012), in his study analyzes the relationship between inflation uncertainty and stock returns for the US and the UK. To do so he employed in his study linear and non-linear Granger causality tests and used a GARCH model to extract the inflation uncertainty of these two countries. In his findings contrary to linear Granger causality test results, the non-linear appeared to have a bi-directional causality between inflation uncertainty and stock returns.

CT Albulescu, C Aubin and D Goyeau (2016), examined the relationship between stock prices, inflation uncertainty and inflation over the period 2002 (7^{th} Month) – 2015 (10^{th} Month) for different US sector stock indexes. They assessed inflation uncertainty using a time varying unobserved component model and they also used cointegration analysis with one structural break concerning the crisis effect. They conclude that in the long run, inflation uncertainty and inflation, negatively impact the stock prices, whereas in the short run while inflation uncertainty still has a negative impact in stock prices, inflations influence becomes insignificant.

R. Bhar (2010), reexamined the relation between real stock returns and inflation uncertainty for the US over a period of four decades. In his article in order to estimate the inflation uncertainty despite using a GARCH type model for inflation he used a structural model for it with time varying parameters that helped him decompose inflation uncertainty in two components. With these two components he later proved the hypothesis that high inflation leads to high inflation uncertainty which results in lower stock returns

Ali Anari, James Kolari (2014), in their study they used monthly data for six national stock price indexes (S&P500 for the United States, TSE300 Composite for Canada, FTSE100 for the United Kingdom, SBF250 for France, DAX for Germany and Nikkei for Japan). In their paper they found that while stock prices have initially a negative response to a shock on inflation, this negative relation turns to positive over longer horizons.

George Hondroyiasnnis, Evangelia Papapetrou (2006), studied the dynamic relationship between real stock returns and expected and unexpected inflation utilizing a Markov Switching vector autoregressive model (MS-VAR) for the country of Greece. They used (MS-VAR) because it has the advantage to capture the dependence structure of the series both in terms of mean and variance. Furthermore, they separated inflation into two components the expected and the unexpected by using univariate and multivariate innovation decompositions. The empirical analysis was carried out using quarterly data for Greece for the period 1984: Q1- 2002: Q4, using the value of the Athens general stock index. The results from their empirical analysis suggested that real stock returns are not related to expected and unexpected inflation, no matter of the method used to separate inflation.

Mohammad S. Hassan (2008), examined the Fisherian theory of interest asserts that a fully perceived change in inflation would be reflected in stock returns in the same direction in the long run. To do so he used linear regression, and vector error correction models to examine the nature of the relationship between stock returns and inflation in the UK. His empirical analysis was consistent with the Fisherian hypothesis, more specifically his empirical evidence model suggests a positive and statistically significant relationship between stock returns and inflation, which regards common stock as a good hedge against inflation. Its also noteworthy that he found a bidirectional relationship between stock returns and inflation.

C. Geetha, R. Mohidin, VV. Chandran (2011), examined the relationship between inflation and stock returns by also separating inflation to expected and unexpected for the countries of Malaysia, the USA and China using monthly time series data from January 2000 to November 2009. Their analysis, revealed that there is a long run relationship between stock returns and inflation but there is no relation in the short run.

Rapach (2002), measured the long run response of real stock prices to a permanent inflation shock for 16 industrialized countries (Australia, Austria, Belgium, Canada, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Spain, United Kingdom and the USA), by using recent developments in the testing of long run neutrality propositions. In his study using a structural bivariate approach found that an inflation shock significantly increases long run output levels (Austria, Finland, Germany and the United Kingdom), which real output increase in its turn anticipated earnings and thus real stock prices.

S. Kim, F. In (2004), used a new approach on the Fisher hypothesis. The new approach was based on a wavelet multiscaling method that decomposes a given time series on a scale-by-scale basis. The evidence suggests that there is positive relationship between stock returns and inflation at the shortest scale (1-month period) and at the longest scale (128-month period), while a negative relationship is shown at the intermediate scales. They also found that time-scale decomposition provides a valuable means of testing the Fisher hypothesis.

Thomas C Chiang (2022), tests the real stock return−inflation relationship based on data from 12 advanced countries (USA, Canada, EU, United Kingdom, China, South Korea, Indonesia, India, South Africa, Turkey, Mexico) from January 1990 to June 2022. His findings support the notion that real stock returns and (expected) inflation are negatively correlated. He also verified his findings by conducting further tests of two indirect relationships which support the notion that a real stock return negatively correlates with US equity market volatility, which in turn positively correlates with inflation.

Diaz and Jareno (2005), in their study analyze the short run response of daily stock prices on the Spanish market to the announcement of inflation news. Their results indicate that there is a positive and significant response of the stock returns in case of total inflation rate being higher than the expected one ("bad news") in recession, and also in case of negative inflation surprises ("good news") in non-economic recession. They also support that most of this pattern can be explained by the response of the growth expectations to inflation surprises.

Chapter II

Data

The sample period that I examine in this paper is from 1/1/1999 – 9/1/2022, with the data being monthly observations for the countries of Canada, France, Germany, Israel, Spain, USA, Greece and the United Kingdom, with the exception that in case of the UK I use monthly data from 2/1/2001 – 9/1/2022. The variables that will be used are the inflation, the inflation uncertainty and the prices of the stock indices. For the inflation, I use the inflation measured by consumer price index (inflation cpi) which is, as defined by the OECD (Organization for Economic Cooperation and Development), the change in the prices of a basket of goods and services that are typically purchased by specific groups of households. The data for inflation have been taken from OECD database. The inflation uncertainty has been extracted from the variable of inflation. The data for the stock indices have been taken from investing.com. As stock indices I used the S&P / TSX composite for Canada, the CAC 40 for France, the DAX 40 for Germany, the TA 125 for Israel, the IBEX 35 index for Spain, the FTSE 100 index for the United Kingdom, the NYSE index for the USA and finally the ATHEX index for the country of Greece.

Methodology

First of all, I measure the inflation uncertainty using the same method as Fountas, Ioannidis, Karanasos (2004) did in their paper. That means that I also model the time – varying residual variance as an EGARCH (1,1) process, which can be written as:

$$\varepsilon_t = e_t h_{\pi t}^{1/2} \qquad (1)$$

$$(1 - bL)\ln(h_{\pi t}) = a + d\,\frac{\varepsilon_{t-1}}{(h_{\pi,t-1})^{1/2}} + c\left|\frac{\varepsilon_{t-1}}{(h_{\pi,t-1})^{1/2}}\right| \qquad (2)$$

In equations (1) and (2) e_t is a sequence of independent, normally distributed random variables with mean zero and variance 1. The variable c denotes the ARCH effects, a is a constant, b denotes the GARCH effects and d shows the asymmetric effects. In case that d is statistically significant and equals to zero then the model is symmetric. On the other hand, if d < 0 and statistically significant, then that means that negative shocks generate larger volatility than positive and vice versa. Finally, in the EGARCH models I use the conditional variance $h_{\pi t}$ as a measure of inflation uncertainty. Then before I begin the VAR analysis, I make sure that my data are stationary. To do so I implement the augmented dickey fuller test (ADF test) and the Phillips – Perron test (PP test) at the levels and in the first differences, to examine whether or not my data are stationary and where. The equation for the ADF test is:

$$\Delta y_t = a + \delta y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad (3)$$

$$t_\delta = \frac{\hat{\delta}}{se(\hat{\delta})} \qquad (4)$$

In equation (3) ρ augmentations are used to correct for correlation up to order ρ in the series. In equation (4) $\hat{\delta}$ is the estimate of δ and $se(\hat{\delta})$ is the coefficient standard error. The null hypothesis H_0: δ=0 is evaluated using the t-ratio. If the calculated test statistic is less (more negative) than the critical value, then the null hypothesis δ=0 is rejected and no unit root is present. The PP test builds on the Dickey–Fuller test of the null hypothesis ρ=1. The null hypothesis for both of these tests is that a unit root is present and the time series are not stationary. Rejection of the null hypotheses means that our time series are stationary. Then I proceed with the VAR analysis which equation can be written as

$$Y_t = A_0 + A_1Y_{t-1} + \ldots + A_mY_{t-m} + u_t \qquad (5)$$

Where A_0 is a constant coefficient vector mX1, A_m is a coefficient vector mXm, u_t is a residual vector mX1 and Y_t is a variable vector mX1 for period t and m is the number of lags that are used for its VAR analysis. The number of lags is determined by the LR criterium because it eliminates autocorrelation from my model. Then I make the following tests to examine the relationship of my variables.

1. Granger causality test which helps me determine whether one of my time series is useful in forecasting another. The null hypothesis for the Granger causality test is that the excluded variables don't explain the variation in my depended. Rejection of the null hypothesis means that the excluded variable does Granger cause the depended variable.

We can test for the absence of Granger causality by estimating the following VAR model:

$$Y_t = a_0 + a_1Y_{t-1} + \ldots\ldots + a_pY_{t-p} + b_1X_{t-1} + \ldots\ldots + b_pX_{t-p} + u_t \qquad (6)$$

$$X_t = c_0 + c_1X_{t-1} + \ldots\ldots + c_pX_{t-p} + d_1Y_{t-1} + \ldots\ldots + d_pY_{t-p} + v_t \qquad (7)$$

Then, testing H_0: $b_1 = b_2 = \ldots\ldots = b_p = 0$, against H_A: 'Not H_0', is a test that X does not Granger-cause Y. Similarly, testing H_0: $d_1 = d_2 = \ldots\ldots = d_p = 0$, against H_A: 'Not H_0', is a test that Y does not Granger-cause X (https://davegiles.blogspot.com/)

2. Impulse response function analysis in order to trace out the responsiveness of the dependent variables in the VAR, to shocks to the error term. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. In this paper I use generalized impulse response functions so the ordering of my variables is not important. The coefficient interval for the IRF analysis is 90%.

Chapter III

Empirical results

Canada's results

In order to test the relationship between the stock indices and inflation and its uncertainty, firstly, I make sure that my data are stationary. To do so, I make ADF and PP tests (table 1).

Table 1

Unit root tests for Canada

CANADA	**AUGMENTED DICKEY FULLER** t-statistic		**PHILLIPS-PERRON** t-statistic	
	inflation	Dinflation	inflation	Dinflation
	-1.062141	-7.035364***	-2.407368	-14.78361***
	logprice	Dlogprice	logprice	Dlogprice
	-2.733238	-15.88831***	-3.146924*	-15.88831***

Notes: * Rejection of unit root null hypothesis at 0.1 level of significance

** Rejection of unit root null hypothesis at 0.05 level of significance

*** Rejection of unit root null hypothesis at 0.01 level of significance

Table 1 shows that both tests reject the null hypothesis at 0.01 level of significance. That means that both the inflation and logprice (logarithm of stock price) are stationary in first differences (Dinflation and Dlogprice respectively). Then I estimate an AR (13)-EGARCH (1,1) model, for the Canada inflation rate.

$$\Pi_t = 1.071\Pi_{t-1} - 0.55\Pi_{t-12} + 0.452\Pi_{t-13} + \varepsilon_t \quad \textbf{(8)}$$

(0.00) (0.00) (0.00)

$$\ln(h_{\pi t}) = -0.65 + 0.785\ln\left(h_{\pi,t-1}\right) + 0.32|e_{t-1}| + 0.078e_{t-1} \quad \textbf{(9)}$$

(0,035) (0,00) (0,017) (0,241)

$Q(4) = 2.958\ (0.560)$

$Q^2(4) = 2.4506\ (0.654)$

Equation (8) represents the estimated conditional mean of the autoregressive model AR (13). The figures in the parentheses under the coefficients of equation (9) shows the probability values. For Canada I chose an AR (13) model for the inflation and an EGARCH (1,1) model for the variance equation which were based on the minimum AIC (Akaike Information Criterium). Equation 9 also shows the residual diagnostics for this model. More specifically it includes Ljung-Box(Q) test for residual correlation and Ljung-Box diagnostics for serial dependence in the squared residuals (Ljung-Box (Q^2)). These tests shows that the Ljung-Box tests for serial correlation in the levels and squares of the standardized residuals do not reject the hypothesis of no autocorrelation. That means that the estimated model fits the data very well. In equation (8) the coefficients that were statistically insignificant have been eliminated. In equation (9) b denotes the persistence of volatility which is, in our case positive and highly significant. Asymmetry in inflation uncertainty is measured by examining the sign of d. In case of Canada d is not statistically significant which implies that there is no asymmetry in this case. Next, I employ VAR analysis using the inflation, inflation uncertainty and stock prices, to check how those variables affect each other. In case of Canada, I employ 4 lags in the VAR analysis due to the LR criterium. Next, I employ Granger causality test, to test for causality between my variables.

Table 2

Granger causality test for Canada

	Dependent variable	**Probability excluded variables**
Canada	Inflation uncertainty	Stock returns = 0.8499
	Inflation	Stock returns = 0.0426 **
	Stock returns	Inflation uncertainty = 0.0236 ** Inflation = 0.0018 ***

Notes: * Rejection of unit root null hypothesis at 0.1 level of significance

** Rejection of unit root null hypothesis at 0.05 level of significance

*** Rejection of unit root null hypothesis at 0.01 level of significance

Table 2 represents the results from the Granger causality test. The results that can be derived from table 2 are the following. Firstly, if I have as dependent variable the inflation uncertainty, due to the fact that p-value > 0.8499, I fail to reject the null hypothesis of no Granger – causality. On the other hand, when I have as dependent variable the inflation, because p-value < 5%, for the stock prices, then I reject the null hypothesis of no Granger – causality. Furthermore, when I consider stock returns as the dependent variable then I reject the null hypothesis for both inflation uncertainty and inflation, for 5% level of significance. That means that both inflation uncertainty and inflation Granger – cause the stock returns.

Next, I employ Impulse response function analysis in order to trace out the responsiveness of the dependent variables in the VAR, to shocks to the error term. The coefficient interval for the IRF analysis is 90%.

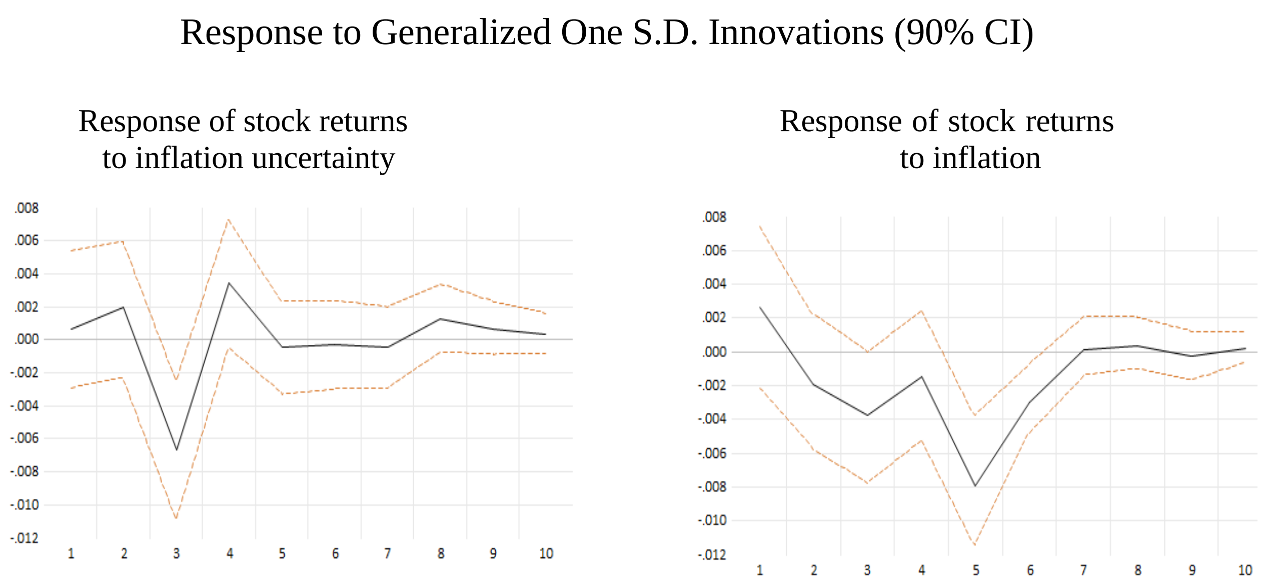


Figure 1

Response to Generalized One S.D. Innovations (90% CI)

Response of inflation uncertainty to stock returns

Response of inflation to stock prices

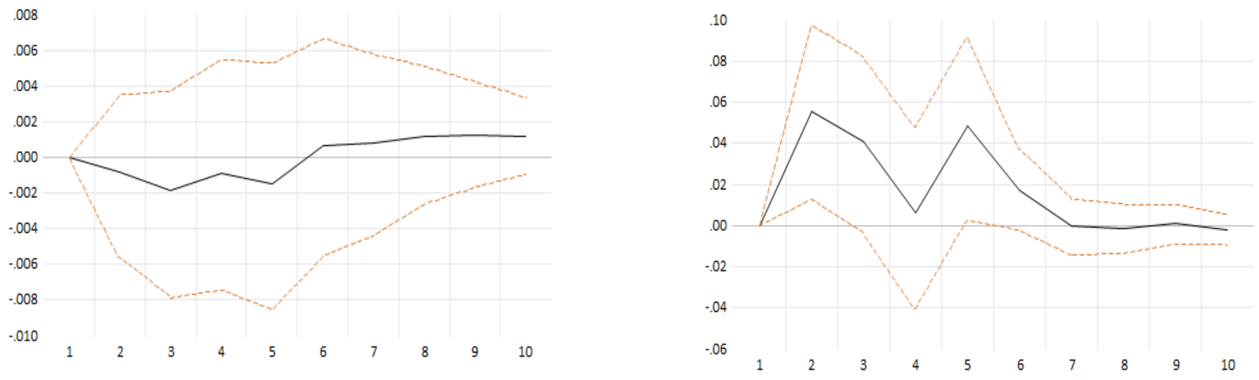


Figure 2

Figure 1 shows the response of the stock indices to a shock in inflation uncertainty (on the left side) and the response of the stock indices to a shock in inflation (on the right side). Figure 2 shows the response of inflation uncertainty to a shock in stock returns (on the left side) and the response of the inflation to a shock in stock returns (on the right side). The reported results in Figure 1 indicate that a shock in inflation uncertainty has a negative effect on the stock returns, which negative effects are mostly observed during the third period. The shock seems to be absorbed during the fourth period. Furthermore Figure 1 show that a shock in inflation also has a negative effect on stock returns which is mostly observed during the fifth period and is being absorbed at the end of the sixth. The reported results in Figure 2 indicate that a shock in stock returns has no effect on the inflation uncertainty. Finally Figure 2 show that a shock in stock returns positively affects inflation at least for two periods and the sock is fully absorbed after 6 periods (the effects are not appearing during the fourth period and reappear during the fifth). From the Granger – causality tests and the impulse response function analysis it is observed that both ways correspond with each other.

Evidence from all the eight countries

The same empirical approach is now applied in all of the chosen countries (Canada, France, Germany, Israel, Spain, USA, United Kingdom and Greece).

Table 3

Unit root test for inflation and Dinflation

	AUGMENTED DICKEY FULLER t-statistic		**PHILLIPS-PERRON** t-statistic	
COUNTRY	inflation	Dinflation	inflation	Dinflation
CANADA	-1.062141	-7.035364 ***	-2.407368	-14.78361 ***
FRANCE	-1.357265	-6.671763 ***	-1.641692	-13.81649 ***
GERMANY	-1.4959446	-2.132851	-1.631846	-17.25975 ***
ISRAEL	-3.330209 *	-5.467445 ***	-3.586068 **	-11.09821 ***
SPAIN	-1.616033	-12.23451 ***	-1.429462	-12.39548 ***
UK	-0.576477	-8.570960 ***	-0.188429	-13.44546 ***
USA	-1.871802	-6.583907 ***	-1.866401	-10.26854 ***
GREECE	-1.582957	-14.54419 ***	-0.097231	-15.36682 ***

Notes: * Rejection of unit root null hypothesis at 0.1 level of significance

** Rejection of unit root null hypothesis at 0.05 level of significance

*** Rejection of unit root null hypothesis at 0.01 level of significance

Table 4

Unit root test for logprice and Dlogprice

	AUGMENTED DICKEY FULLER t-statistic		**PHILLIPS-PERRON** t-statistic	
COUNTRY	logprice	Dlogprice	logprice	Dlogprice
CANADA	-2.733238	-15.88831 ***	-3.146924 *	-15.88831 ***
FRANCE	-2.04094	-15.73353 ***	-2.436342	-15.82430 ***
GERMANY	-2.382588	-16.07252 ***	-2.600671	-16.08792 ***
ISRAEL	-2.750830	-14.74459 ***	-3.019113	-14.73385 ***
SPAIN	-2.369825	-16.5503 ***	-2.504034	-16.54737 ***
UN	-3.132857	-15.79854 ***	-3.377400*	-15.81245 ***
USA	-2.648164	-15.43663 ***	-3.033278	-15.49281 ***
GREECE	-1.85703	-15.73039 ***	-2.278126	-15.91519 ***

Notes: * Rejection of unit root null hypothesis at 0.1 level of significance

** Rejection of unit root null hypothesis at 0.05 level of significance

*** Rejection of unit root null hypothesis at 0.01 level of significance

Table 3 and Table 4 presents the ADF and PP tests of the unit root hypothesis for each country for the variables of inflation and stock returns respectively. The Phillips Perron tests reject the null hypothesis of a unit root for all eight countries for both variables at the 0.01 significance level. The ADF tests also reject the null hypothesis of a unit root for all eight countries for both variables at the 0.01 significance level with the exception of the inflation of Germany. The ADF tests for inflation about Germany fail to reject the null hypothesis of a unit root both at levels and first differences, but for the purposes of this paper the inflation series of Germany will be considered stationary in our analysis based upon the Phillips Perron results. Also, in case of Israel, based upon the Table 3 results I consider the inflation series stationary at levels taking into consideration also the PP results.

Then similar to the procedure that I follow in case of Canada, I choose the best fitted model according to the minimum values of the augmented information criterium (AIC). I chose an EGARCH (1,1) specification for the conditional variance and an AR (2) model for France, an AR (3) model for Germany, an AR (16) model for Israel, an AR (14) model for the United Kingdom and Spain, an AR (18) model for the USA and an AR (16) model for Greece. Table 5 presents the estimated results for each country. In all cases d is positive which means that positive inflation shocks generate more inflation uncertainty than negative shocks when d is statistically significant (such as in case of the USA). The residual diagnostics are also reported at the end of Table 5. Those include the Ljung-Box(Q) test for residual correlation and Ljung-Box diagnostics for serial dependence in the squared residuals (Ljung-Box (Q^2)).

Table 5

E-GARCH models

Regressors	Canada	France	Germany	Israel	Spain	United Kingdom	USA	Greece
Π_{t-1}	1.071 ***	1.133 ***	0.939 ***	1.438 ***	1.48 ***	1.165 ***	1.48 ***	1.056 ***
Π_{t-2}	-0.134	-0.175 ***	0.175 **	-0.564 ***	-0.555 ***	-0.086	-0.686 ***	0.040
Π_{t-3}	0.028		-0.102	0.249 **	0.022	-0.072	0.256 *	-0.034
Π_{t-4}	-0.058			-0.143	0.064	0.023	-0.024	0.015
Π_{t-5}	0.064			0.175	0.07	-0.015	-0.095	-0.119
Π_{t-6}	-0.092			-0.416 ***	-0.087	0.011	0.067	0.106
Π_{t-7}	0.049			0.287 **	0.03	-0.041	-0.011	-0.095
Π_{t-8}	-0.099			-0.077	-0.058	-0.021	-0.023	0.064
Π_{t-9}	0.145 **			0.050	0.085	0.027	-0.039	-0.001
Π_{t-10}	0.036			0	-0.045	0.074	0.077	-0.161 **
Π_{t-11}	0			0.054	0.054	-0.05	0.087	0.104
Π_{t-12}	-0.55 ***			-0.497 ***	-0.554 ***	-0.353 ***	-0.694 ***	-0.362 ***
Π_{t-13}	0.452 ***			0.59 ***	0.651 ***	0.409 ***	0.716 ***	0.456 ***
Π_{t-14}				-0.208 *	-0.17 ***	-0.115	-0.193	0.028
Π_{t-15}				-0.015			0.185	-0.155
Π_{t-16}				0.02			-0.133	0.034
Π_{t-17}							0.059	
Π_{t-18}							-1.280	
a	-0.65 **	-0.254 **	-4.274 ***	-3.997 ***	-0.718 ***	-0.35 **	-0.004	-1.143 ***
b	0.785 ***	0.942 ***	-1.014 ***	-0.989 ***	0.862 ***	0.948 ***	0.98 ***	0.624 ***
c	0.32 **	0.138 **	-0.143 ***	0.082	0.548 ***	0.24 ***	-0.05	0.664 ***
d	0.078	0.05	0.057 *	0.065 **	0.139 *	0.161 *	0.117 ***	0.016
Q	2.96 (0.56)	3 (0.557)	1.19 (0.87)	0.856 (0.931)	0.49 (0.974)	0.37 (0.984)	0.52 (0.971)	1.02 (0.906)
Q^2	2.46 (0.675)	5.66 (0.225)	4.82 (0.306)	1.87 (0.758)	2.39 (0.663)	1.41 (0.842)	4.80 (0.308)	2.36 (0.669)

Notes: the estimated conditional variance equation has the form

$$\ln(h_{\pi t}) = a + b\ln(h_{\pi,t-1}) + c|e_{t-1}| + de_{t-1}$$

* 0.1 level of significance

** 0.05 level of significance

*** 0.01 level of significance

Table 6

Granger causality test for the 8 countries

Countries	Dependent variable	Probability excluded variables
Canada	Inflation uncertainty	Stock returns = 0.8499
	Inflation	Stock returns = 0.0426 **
	Stock returns	Inflation uncertainty = 0.0236 ** Inflation = 0.0018 ***
France	Inflation uncertainty	Stock returns = 0.4998
	Inflation	Stock returns = 0.0530 *
	Stock returns	Inflation uncertainty = 0.2322 Inflation = 0.8965
Germany	Inflation uncertainty	Stock returns = 0.9745
	Inflation	Stock returns = 0.5250
	Stock returns	Inflation uncertainty = 0.0561 * Inflation = 0.2936
Israel	Inflation uncertainty	Stock returns = 0.6964
	Inflation	Stock returns = 0.4163
	Stock returns	Inflation uncertainty = 0.8705 Inflation = 0.0922 *
Spain	Inflation uncertainty	Stock returns = 0.3011
	Inflation	Stock returns = 0.0172 **
	Stock returns	Inflation uncertainty = 0.8835 Inflation = 0.1959
United Kingdom	Inflation uncertainty	Stock returns = 0.1475
	Inflation	Stock returns = 0.0035 ***
	Stock returns	Inflation uncertainty = 0.2486 Inflation = 0.8081
USA	Inflation uncertainty	Stock returns = 0.0031 ***
	Inflation	Stock returns = 0.0001 ***
	Stock returns	Inflation uncertainty = 0.0064 *** Inflation = 0.5377
Greece	Inflation uncertainty	Stock returns = 0.0373 **
	Inflation	Stock returns = 0.0699 *
	Stock returns	Inflation uncertainty = 0.3869 Inflation = 0.5548

Notes: stock returns inflation and inflation uncertainty are taken in first differences when necessary to ensure stationarity

*** Rejection of null hypothesis of no Granger - causality at the 0.01 level of significance

** Rejection of null hypothesis of no Granger - causality at the 0.05 level of significance

* Rejection of null hypothesis of no Granger - causality at the 0.1 level of significance

Table 6 portraits the Granger – causality tests for all the eight countries together. By analyzing Table 6 it is observed that when the inflation uncertainty is the dependent variable then we fail to reject the null hypothesis of no Granger – causality for all the countries except for the USA and Greece, where stock returns Granger – cause the inflation uncertainty (at least at 5% level of significance).

When inflation is considered as the dependent variable then I reject the null hypothesis for the countries of Canada, Spain, the UK and the USA (in cases of France and Greece I reject the null hypothesis only at 1% level of significance). That means that for these four countries stock returns Granger – cause the inflation. For the countries of Germany and Israel there is no Granger causality when the inflation is considered to be the depended variable. In case of the stock returns being considered as the dependent variable and the inflation uncertainty as the excluded variable then I reject the null hypothesis for the USA and Canada (for Germany I reject the null hypothesis only at 1% level of significance). That means that I accept that there is no Granger causality for the rest of the countries (France, Israel, Spain, Greece and the UK).

When stock returns are being considered as the depended variable and the inflation as the excluded variable then I reject the null hypothesis of no Granger causality only for Canada (in case of Israel I reject the null hypothesis only for 1% level of significance). That means that there is no Granger causality for France, Germany, Spain, the UK, the USA and Greece, when stock returns are considered to be the depended variable and inflation the excluded.

Next the impulse responses for the countries of France, Germany, Israel, Spain, UK, the USA and Greece are presented in order. The impulse response function analysis for Canada has been presented in the previous section.

France

Response to Generalized One S.D. Innovations (90% CI)

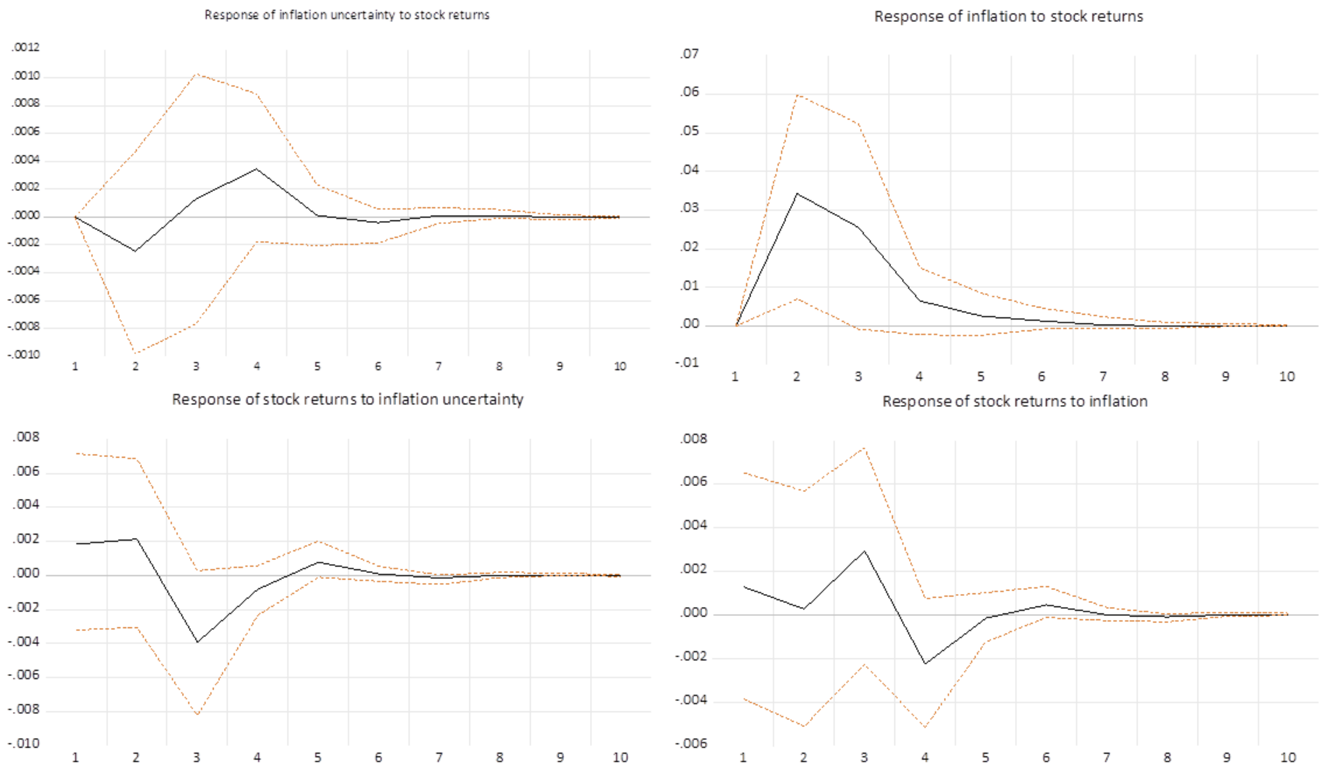


Figure 3

Figure 3 demonstrates the impulse response function analysis for France. The reported results indicate that a shock in stock returns has no effect on inflation uncertainty and little effect on inflation (top left and right diagram). More specifically, a shock in stock returns affects positively the inflation for the first two periods and that shock is absorbed within the third period. As far as, the response of the stock returns to a shock on the inflation uncertainty or the inflation, is concerned, it seems that those variables have no effect on stock returns (there is a slightly chance that a shock on inflation uncertainty has a small negative effect on stock returns during the third period).

Germany

Response to Generalized One S.D. Innovations (90% CI)

Figure 4

Figure 4 shows the IRF analysis for Germany. From the above analysis it is obvious that a shock in stock returns has no effect on inflation and inflation uncertainty. On the other hand, if shock on the inflation uncertainty is applied, that has a negative impact on stock returns for the first period but during the third period it has a positive effect, on the fourth period the shock is absorbed. If a shock on inflation is applied then stock returns react negatively to that shock after 4 periods and then the shock is absorbed.

Israel

Response to Generalized One S.D. Innovations (90% CI)

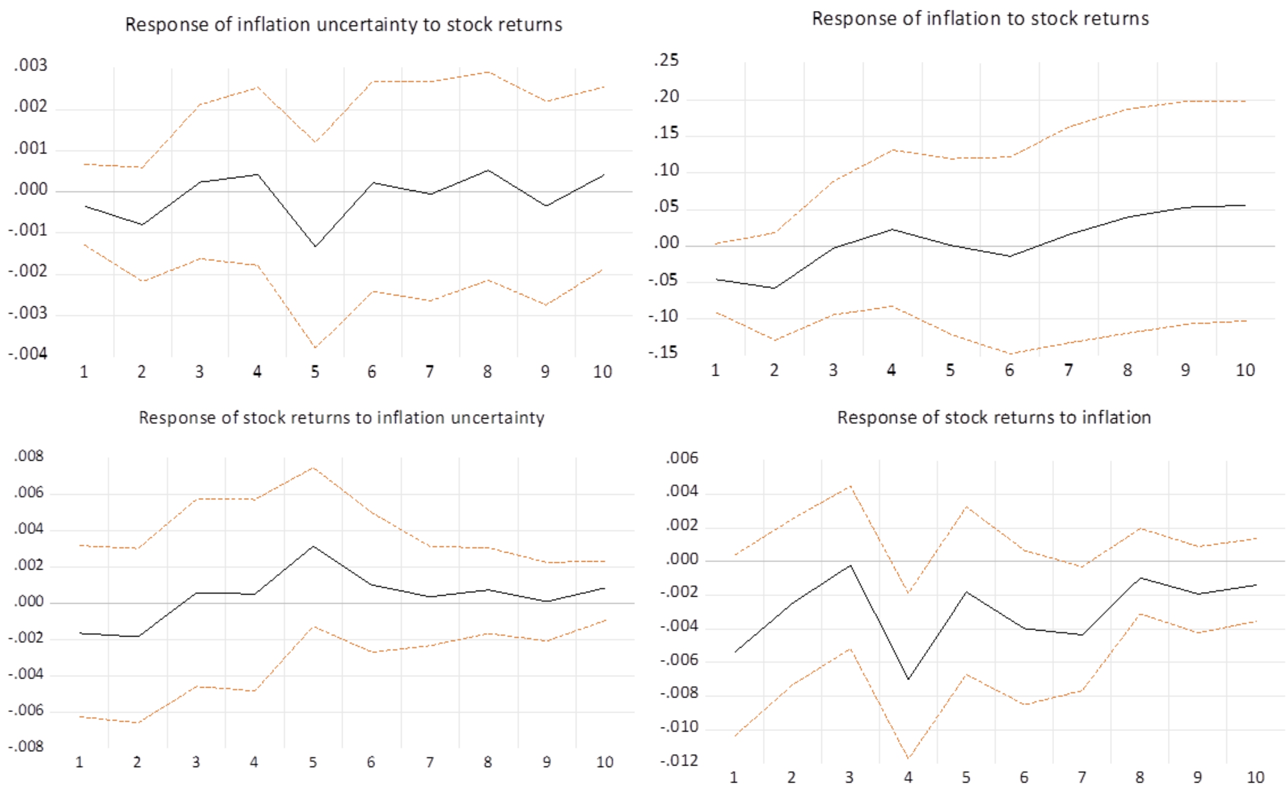


Figure 5

Figure 5 demonstrates the IRF analysis for Israel. From Figure 5 we can see that a shock in stock returns has no effect on inflation and inflation uncertainty. Also, a shock in inflation uncertainty has no effect on stock returns. On the other hand, a shock in inflation has a negative effect on stock returns which negative effect is more obvious four months after the shock is applied. The shock seems to lose its effects after seven periods.

Spain

Response to Generalized One S.D. Innovations (90% CI)

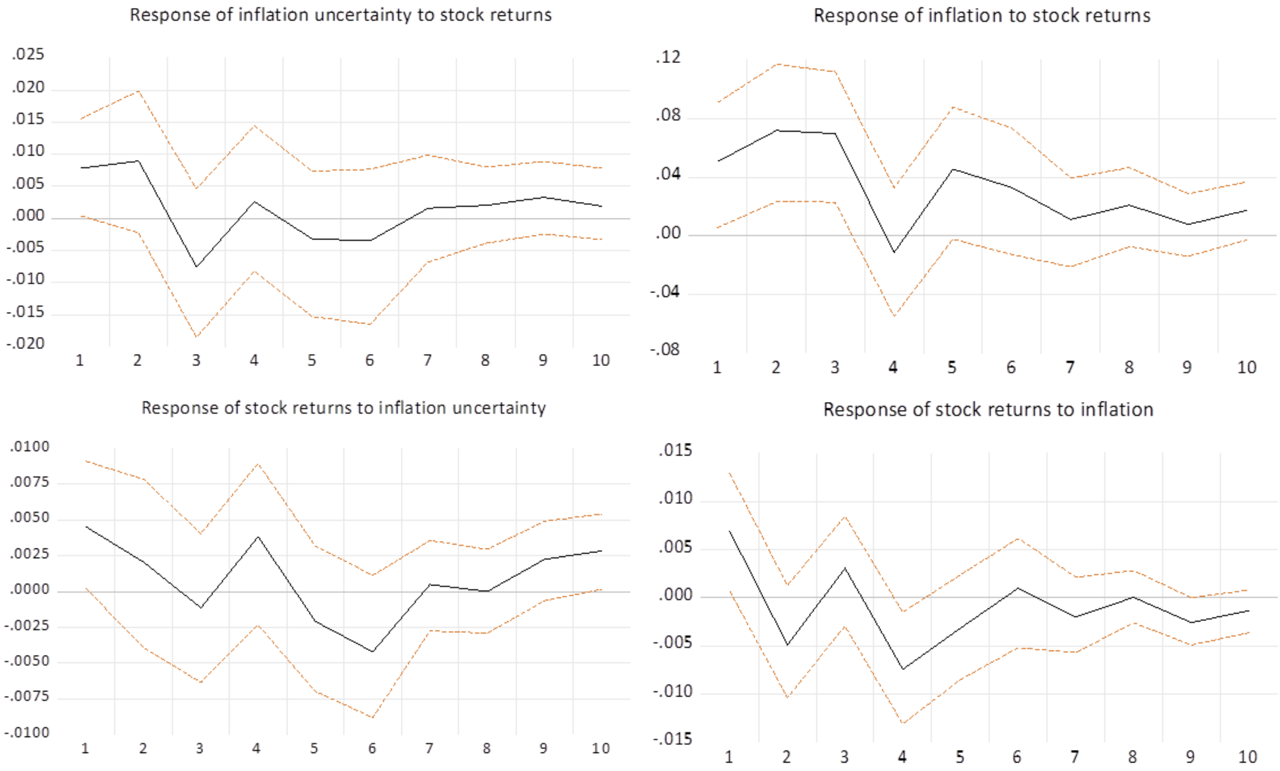


Figure 6

In Figure 6 we see the IRF analysis in case of Spain. From analyzing the results, it seems that stock returns are not affected by either a shock in inflation or a shock in inflation uncertainty. Perhaps there is a positive effect at the first period but its very short, when a shock occurred in inflation. Furthermore, a unit shock in stock returns has no effect on inflation uncertainty. At the other end of the spectrum, inflation responds positively, to a shock in stock returns, which positive effects are mostly seen for the first three periods after the shock is being applied, after the third month inflation slowly come to balance.

United Kingdom

Response to Generalized One S.D. Innovations (90% CI)

Figure 7

Figure 7 represents the IRF analysis for the United Kingdom. The reported results in Figure 7 indicate that a shock in stock returns has no effect on inflation uncertainty. On the other hand, a shock in stock returns seems to affect positively the inflation. The positive effects start two periods after the shock is applied and its seems that inflation never really absorb the shock. For instance, despite the fact that on the fourth period the inflation seems to be in balance, the next period we see that it responds positively again to the shock that happened five months ago (the same thing happens at the eighth period as well, with the exception that the effects become weaker every time). The reported results in Figure 7 also indicate that a shock to inflation uncertainty negatively affects stock returns especially eight periods after the shock has been occurred but on the next period this negative effect turns to positive. Furthermore, a shock in inflation seems to have a negative impact on stock returns with the results being more obvious during the eighth and the nineth period.

USA

Response to Generalized One S.D. Innovations (90% CI)

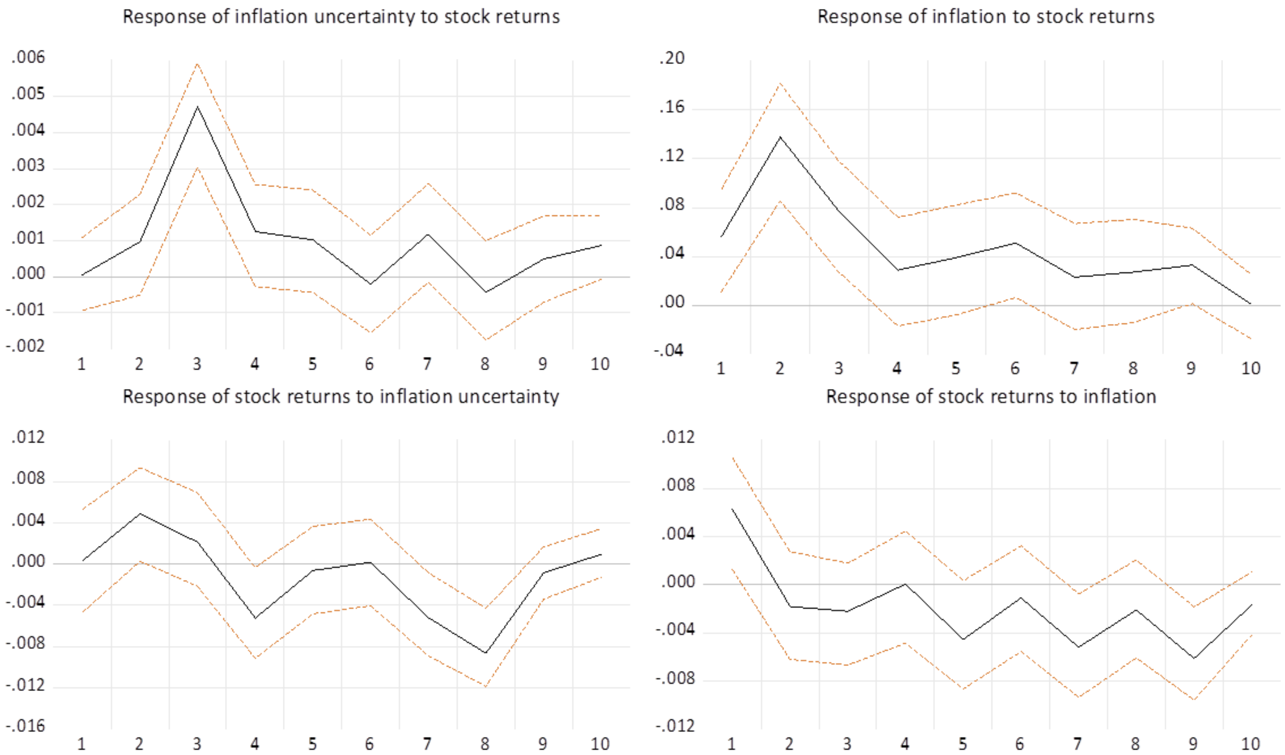


Figure 8

Figure 8 illustrates the results from the IRF analysis for the USA. The reported results indicate that, firstly, inflation uncertainty responds positively to a shock in stock returns mostly during the second, the third and the fourth period. After these periods the effects still exist but are very weak so its safe to consider that after four periods the shock is absorbed. From the top right diagram of Figure 8, we see that a shock in stock returns also affects positively the inflation especially for the first three periods (during the second period is the maximum positive effect observed). Additionally, a shock in inflation uncertainty seems to have a negative effect on stock returns with this negative effect firstly being observed during the fourth period, despite the fact that it is very weak, and it is mostly observed during the eighth period (during the second period this shock has a positive effect but it’s very weak and doesn’t last for too long). After that the shock seems to be absorbed. Lastly a shock in inflation seems to have a positive effect on stock returns during the first period but after that it seems that, that shock has a negative effect especially during the seventh and the nineth period.

Greece

Response to Generalized One S.D. Innovations (90% CI)

Figure 9

Lastly Figure 9 illustrates the impulse response function analysis for the country of Greece. The reported results indicate that a shock in stock returns affects negatively the inflation uncertainty during the third and the fourth period (the fourth period the effects are weaker). After that the shock is gradually absorbed. Also Figure 9 indicate that a shock in stock returns has a positive effect on inflation mostly during the third period. After the third period the shock is also gradually absorbed (the positive effects of this shock reappear during the sixth period but are very weak and don’t last). In the end stock returns in case of Greece seems to be not affected from shocks to either inflation or the inflation uncertainty.

Chapter IV

Comparison with other studies

In this paper, I investigated the role of inflation and inflation uncertainty on stock indices. Most specifically, I examined the effects of inflation and inflation uncertainty on stock indices, using evidence from eight industrialized countries (Canada, France, Germany, Israel, Spain, United Kingdom, United States of America and Greece). The methods that were used to test this relationship using VAR analysis were, Granger causality tests to determine whether one of my time series is useful in forecasting another and Impulse response function analysis in order to trace out the responsiveness of the dependent variables in the VAR, to shocks to the error term.

The results from the Granger causality were that, in case of the stock returns being considered as the dependent variable and the inflation uncertainty as the excluded variable then I rejected the null hypothesis for the USA and Canada (for Germany I reject the null hypothesis only at 1% level of significance). That means that I accepted the null hypothesis that there is no Granger causality for the countries of France, Israel, Spain, Greece and the UK. When stock returns are being considered as the dependent variable and the inflation as the excluded variable then I reject the null hypothesis of no Granger causality only for Canada (in case of Israel I reject the null hypothesis only for 1% level of significance). That means that there is no Granger causality for France, Germany, Spain, the UK, the USA and Greece, when stock returns are considered to be the depended variable and inflation the excluded.

The results from the Granger causality tests seems to align with the study of E. Cakan (Dec. 2012), who also found that inflation does not Granger cause stock returns in case of the USA and UK. The results also confirm the findings of Christos Floros (2008) and George Hondroyiasnnis, Evangelia Papapetrou (2006), who in their studies for Greece found no Granger causality between stock returns and inflation. Furthermore, the Granger causality tests of this paper, agrees partly with the results of Mohammad S. Hassan (2008) and E Cakan (2012), who support in their studies that there is a bi-directional relationship between stock returns and inflation (most specifically E Cakan (2012), found a bi-directional relationship only in nonlinear Granger causality tests). This idea is supported only in case of Canada.

The results from the impulse response analysis from this paper indicate that a shock in inflation negatively affects stock returns in case of Canada, Germany, Israel, UK, the USA and Spain, confirming the studies which had been made for the first five countries by Kaul G. (June 1987) and Yakov Amihud (Feb 1996) and going against the results of Diaz and Jareno (2005) (regarding Spain). Furthermore, these results support the theory of, Eugene F. Fama (Sep. 1981), P. Balduzzi (1995), that there is a negative relation between stock returns and inflation and they also support the studies of, R. Bhar (Sep. 2010) Thomas C Chiang (2022) and Samih Antoine Azar (Aug.2013) against those of Jeffrey Oxman (Sep. 2012). What is really noteworthy is that only the findings for the USA agrees with S. Kim, F. In (2004), findings which suggests that there is positive relationship between stock returns and inflation at the shortest scale (1-month period) and then this relation turns to negative, up until the 128-month period. Additionally, a shock in inflations seems to have no effect in case of France and Greece which agrees with the studies of Christos Floros (Aug. 2008) and George Hondroyiasnnis, Evangelia Papapetrou (2006). It is also noteworthy that the impulse response analysis also agrees with N. Bullent Gultekin (March 1983), who found that stock returns – inflation relation is different for each country despite the fact that his research was conducted for 26 countries using time series regressions for the period 1/1947 - 12/1979. As far as the inflation uncertainty's relation with stock returns is concerned, I found out that a shock in inflation uncertainty positively affects Germany and UK (only nine months after a shock has happened). On the other hand, there is a negative relation in case of Canada, UK (eight months after a shock has happened which aligns with Lifang Li, Paresh K. Narayan and Xinwei Zheng (Dec. 2010)) and the USA (which partly agrees with the research of CT Albulescu, C Aubin and D Goyeau (Sep. 2016) and Samih Antoine Azar (Aug.2013)). Inflation uncertainty seems to have no effect in stock returns of France, Spain, Greece and Israel. This evidence confirms the studies conducted by SC Lin (Oct. 2009) concerning the countries of Spain and France, who found that inflation uncertainty has no significant effects on stock returns in the short run.

Chapter V

Conclusion

In this paper, I investigated the ambivalent role of inflation and inflation uncertainty on stock indices. Most specifically, I examined the effects of inflation and inflation uncertainty on stock indices, using evidence from eight industrialized countries (Canada, France, Germany, Israel, Spain, United Kingdom, United States of America and Greece). To do so I firstly extracted a measure of inflation uncertainty as Fountas, Ioannidis, Karanasos (2004) did in their paper. That means that I also used exponential generalized autoregressive conditional heteroscedasticity models (E-GARCH models), because they have the advantage to capture the potential asymmetric behavior of inflation. Then I examined the influence of inflation and inflation uncertainty using vector autoregression model analysis (VAR model analysis), in order to test the existence of Granger – causality among my variables which helped to examine the casual relationship between inflation uncertainty inflation and stock returns. Lastly, I used impulse response function analysis, to examine how a sudden change in inflation and inflation uncertainty affects stock indices.

The results from the Granger causality indicate that I reject the null hypothesis that the excluded variables don't explain the variation in my dependent in case of the USA and Canada (for Germany I reject the null hypothesis only at 1% level of significance), when stock returns are being considered as the dependent variable and inflation uncertainty as the excluded variable. That means that I accepted the null hypothesis that there is no Granger causality for the countries of France, Israel, Spain, Greece and the UK. The results also indicate that I reject the null hypothesis of no Granger causality only for Canada (in case of Israel I reject the null hypothesis only for 1% level of significance), when stock returns are being considered as the dependent variable and the inflation as the excluded variable. That means, that in this case, there is no Granger causality for France, Germany, Spain, the UK, the USA and Greece. Furthermore, by taking the analysis one step forward I found that there is Granger causality between inflation uncertainty and stock returns (when I consider as the dependent variable the inflation uncertainty and as excluded the stock returns), for the countries of the USA and Greece. That means that there is a bi-directional relationship between those variables in case of the USA. Lastly when I consider inflation as my dependent variable and stock returns as the excluded, the Granger causality test indicates that I reject the null hypothesis for the countries of Canada, Spain, UK and the USA (France and Greece also reject the null hypothesis only at 0.1 level of significance). That means that there is a bi-directional relationship between those variables in case of the Canada.

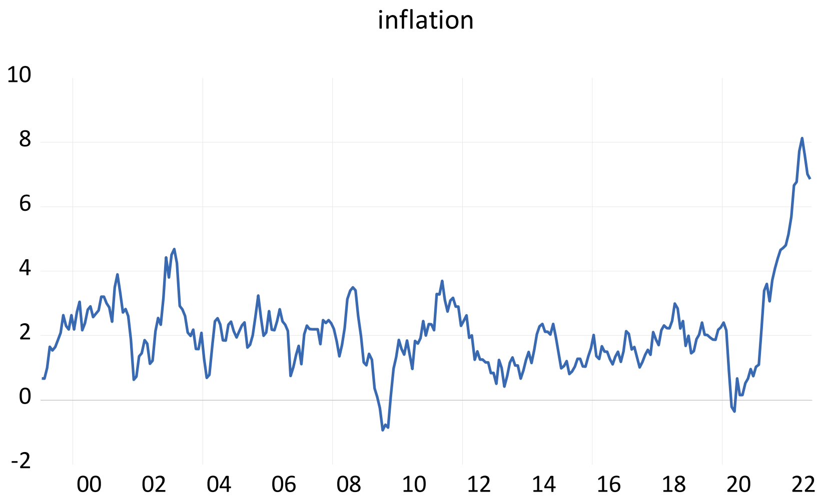
The results from the impulse response analysis indicate that a shock in inflation negatively affects stock returns in case of Canada, Germany, Israel, UK, the USA and Spain. Additionally, a shock in inflation seems to have no effect in case of France and Greece. As far as the inflation uncertainty's relation with stock returns is concerned, I found out that a shock in inflation uncertainty positively affects Germany and UK (only nine months after a shock has happened). On the other hand, it has a negative effect in case of Canada, UK (eight months after a shock has happened) and the USA. Inflation uncertainty seems to have no effect on stock returns of France, Spain, Greece and Israel.

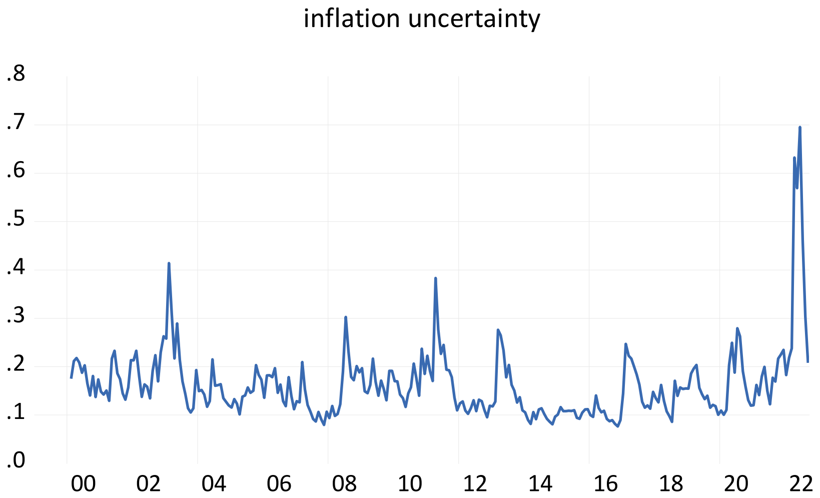
Finally, something that is really important is that while inflation uncertainty seems to be not affected by stock returns (it is affected only positively in the USA and negatively in case of Greece), the same cannot be said for inflation. More specifically from the impulse response analysis I found that a shock to stock returns positively affects inflation in most countries (Canada, France, Spain, UK, USA and Greece).

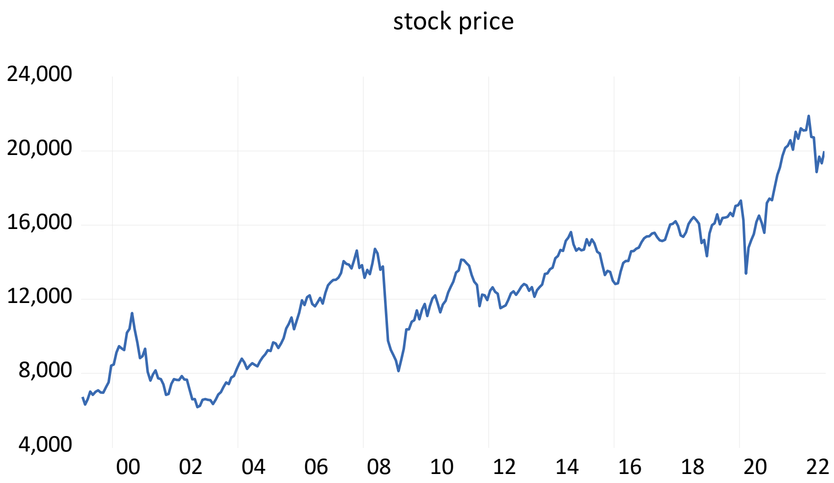
To sum up, this study fails to reject the Eugene F. Fama (1981) hypothesis that there is a negative relation between real stock returns and inflation, which negative relation exists due to the fact that real stock returns are positively related to measures of real activity whereas on the other hand there is evidence of negative relations between inflation and real activity. It also fails to reject the Fisherian theory of interest asserts that a fully perceived change in inflation would be reflected in stock returns in the same direction. That means that this study mainly agrees with N. Bullent Gultekin (1983) in respect that stock return-inflation, inflation uncertainty relation varies among countries. It's also important to note that the relationship between inflation and stock indices is complex and can be influenced by a variety of factors, such as government policies and global economic conditions. Also, the effect of inflation on stock market can vary depending on the stage of business cycle and the country's specific economic situation. Which means that obvious questions for future research include extending our analysis to other periods and samples (such as Asian or African countries, pre and post war time periods) and inserting more variables to our research (such as economic policy uncertainty) to further understand how stock indices will react to different sudden changes. We then can also investigate what economic changes and policy actions can be done to turn this expected reaction of the stock returns to our advantage.

Appendix

Canada



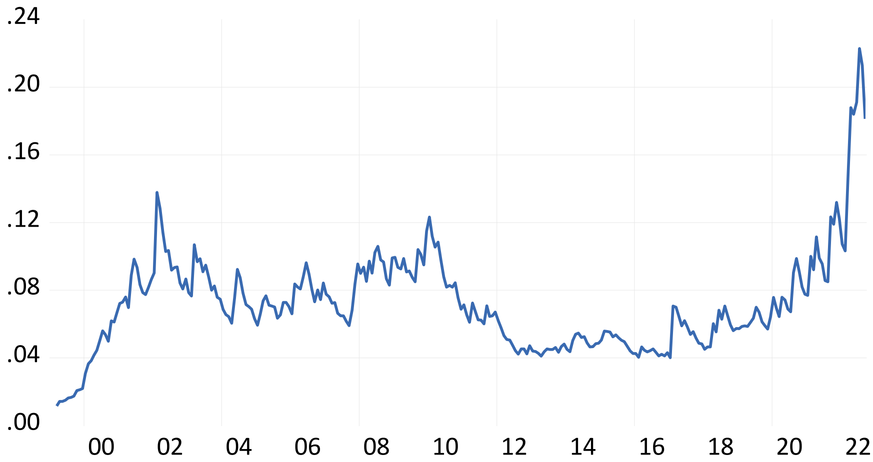




France

inflation

inflation uncertainty

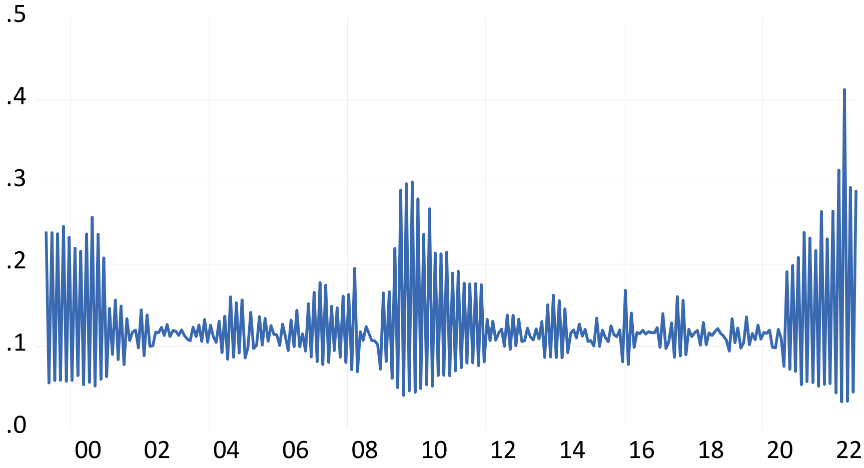


stock price

Germany

inflation

inflation uncertainty

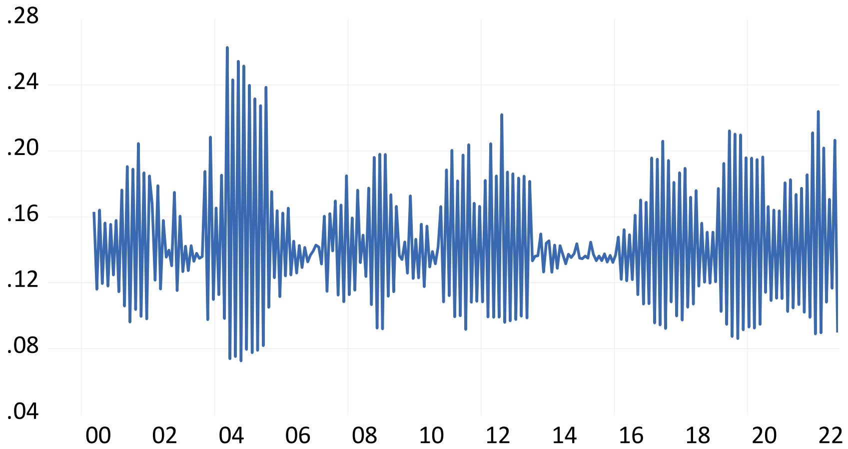


stock price

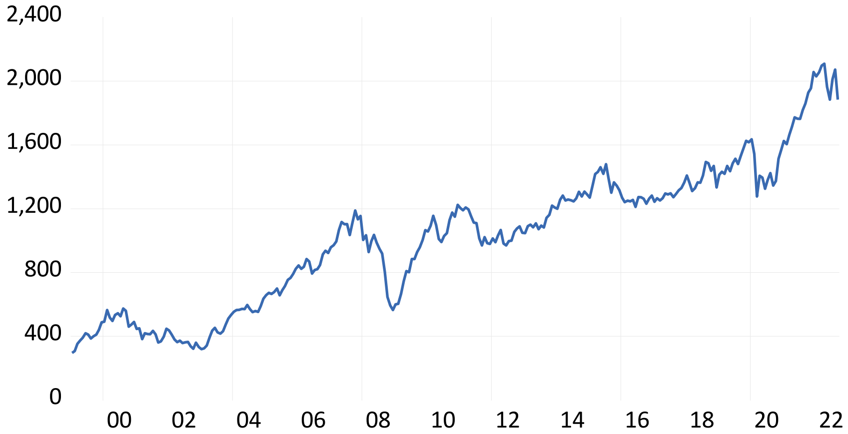
Israel

inflation

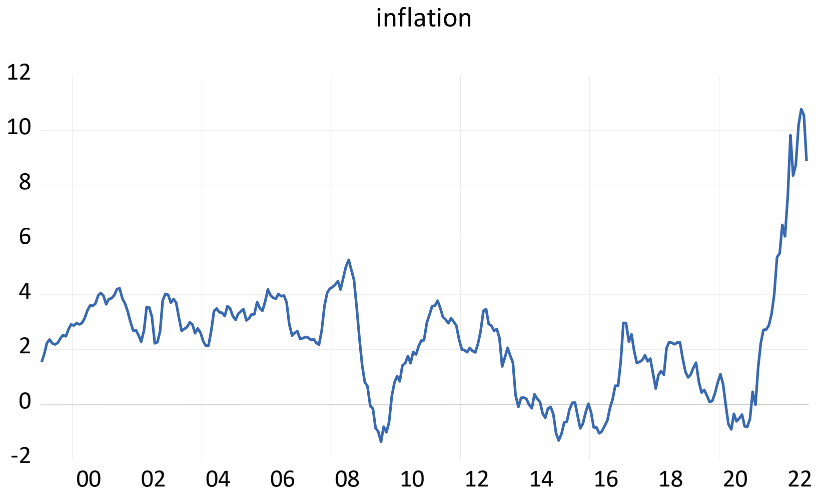
inflation uncertainty



stock price



Spain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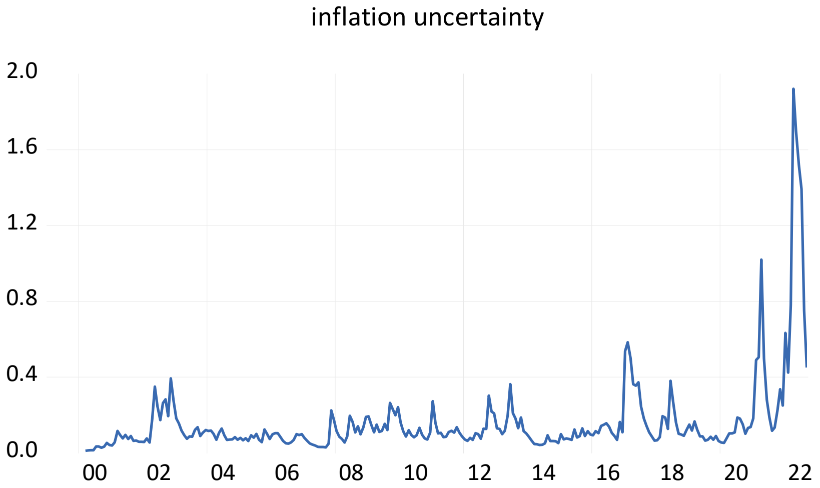
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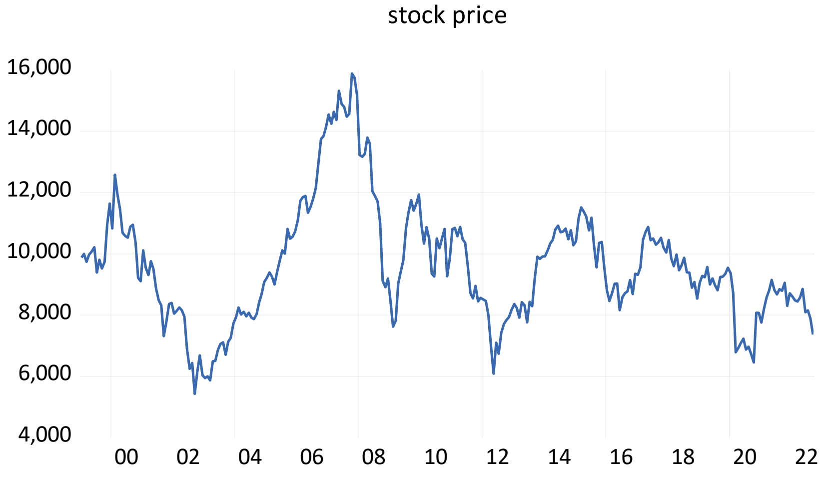
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00
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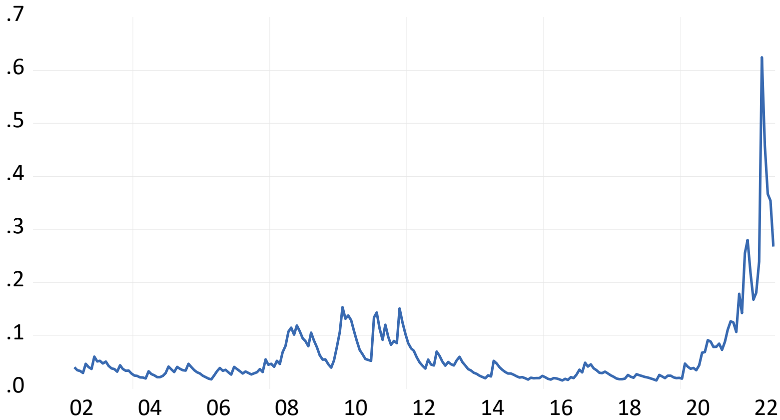
16
18
20
22

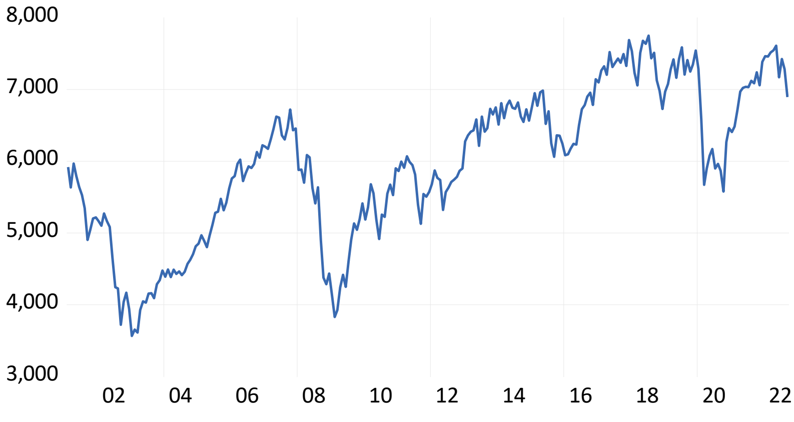
UK

inflationUK

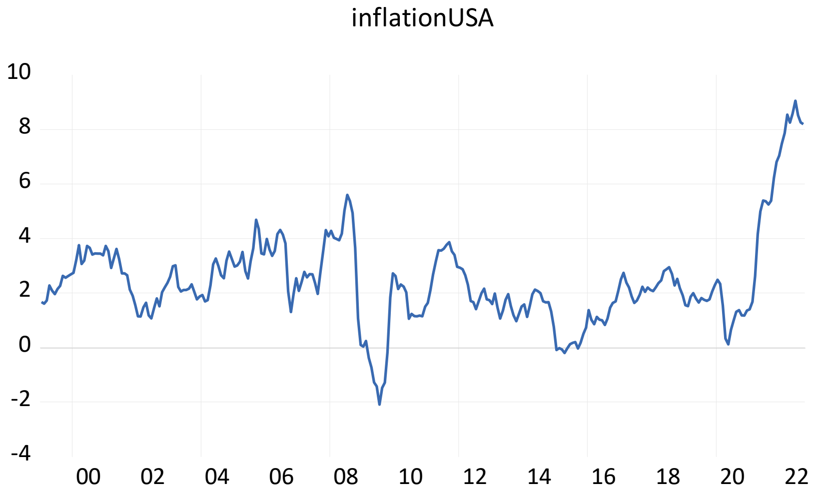
inflation uncertainty



stock price



USA



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-4
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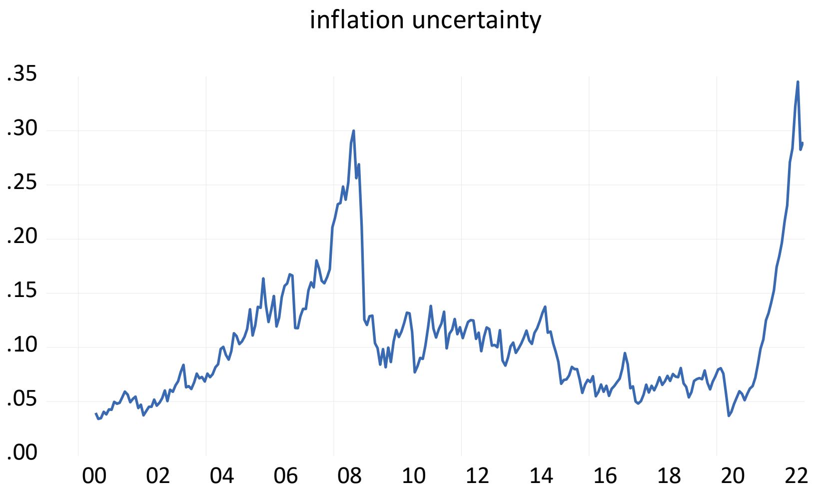

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.20
.15
.10
.05
.00
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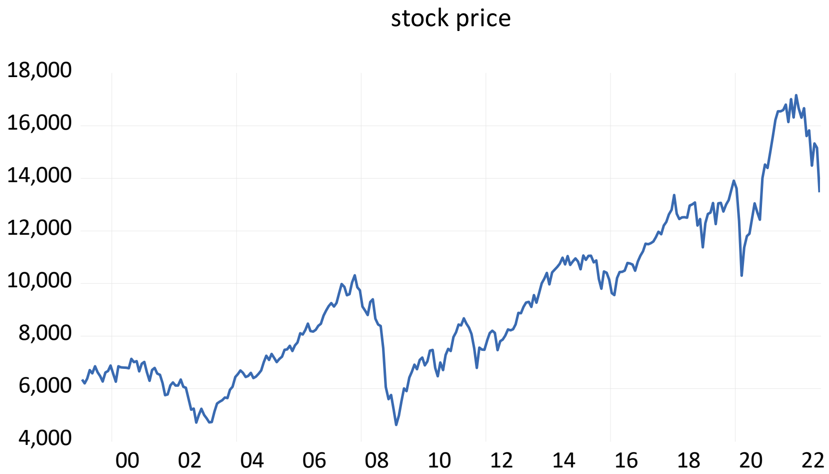

stock price
18,000
16,000
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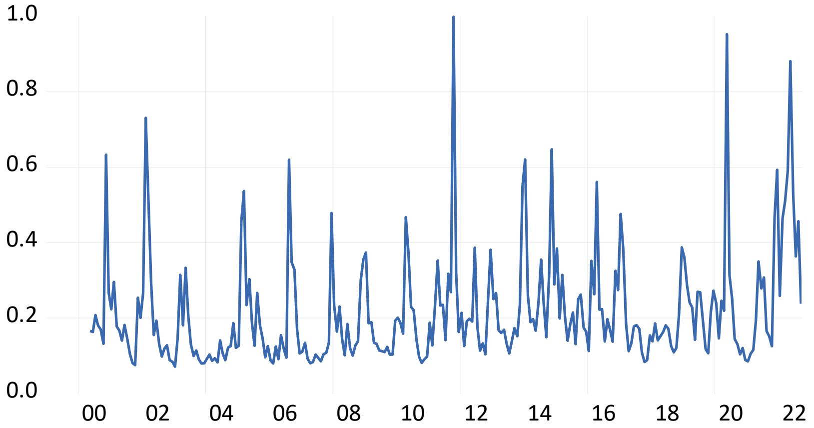
10,000
8,000
6,000
4,000
00 02 04 06 08 10 12 14 16 18 20 22

Greece

inflationGRE

inflation uncertainty



stock price

Descriptive statistics for inflation

	Canada	France	Germany	Israel	Spain	UK	USA	Greece
Mean	2.087	1.466	1.639	1.685	2.666	2.208	2.433	2.045
Median	2.00	1.479	1.444	1.418	2.380	2	2.146	2.527
Maximum	8.133	6.00	9.990	7.714	10.770	8.8	9.057	12.092
Minimum	-0.949	-0.725	-0.502	-2.801	-1.369	0.2	-2.097	-2.853
Std. dev.	1.291	1.045	1.348	2.107	2.022	1.363	1.705	2.541
Skewness	1.644	1.204	2.843	0.591	0.977	2.299	1.219	0.784
kurtosis	8.210	6.714	14.541	2.904	5.924	10.961	6.264	5.367
Jarque-Bera	450.9	232.68	1965.93	16.702	146.45	915.83	197.20	95.804
Observations	285	285	285	285	285	260	285	285

Έλεγχος KPSS (Kwiatkowski-Phillips-Schmidt-Shin) for inflation

Countries	LM-Stat
Canada	0.171
France	0.159
Germany	0.237
Israel	0.360
Spain	0.344
UK	0.186
USA	0.167
Greece	0.520

In each country we fail to reject the null hypothesis which means that our time series are stationary.

ARCH effects (Heteroskedasticity test)

The table below presents the tests for ARCH effects. From this table there is a rejection of the null hypothesis of having no ARCH effects because p-value<5%.

Countries	$T*R^2$	Probability
Canada	258.32	0.00
France	265.40	0.00
Germany	257.39	0.00
Israel	242.78	0.00
Spain	246.49	0.00
UK	248.31	0.00
USA	268.72	0.00
Greece	268.22	0.00

Ljung-Box

The table below contains the Ljung-Box(Q) tests for residual correlation and the Ljung-Box(Q) tests for serial dependence in the squared residuals (using 4 lags). The numbers in the parenthesis presents the p-values. From this table we deduct that there is no rejection of the null hypothesis of no autocorrelation due to the fact that p-value<5%.

Countries	Q	Q^2
Canada	2.96 (0.56)	2.46 (0.675)
France	3 (0.557)	5.66 (0.225)
Germany	1.19 (0.87)	4.82 (0.306)
Israel	0.856 (0.931)	1.87 (0.758)
Spain	0.49 (0.974)	2.39 (0.663)
UK	0.37 (0.984)	1.41 (0.842)
USA	0.52 (0.971)	4.80 (0.308)
Greece	1.02 (0.906)	2.36 (0.669)

Residual serial Correlation LM tests

Countries	Lags	LRE* stat	Probability
Canada	5	7.933	0.5409
France	3	12.762	0.1737
Germany	5	7.324	0.6034
Israel	7	20.982	0.0127
Spain	6	12.549	0.1841
UK	8	10.776	0.2914
USA	8	5.949	0.7450
Greece	4	12.697	0.1768

The reported results indicate that there is no autocorrelation in my analysis because p-value > 5%. The lags for each country have been calculated automatically from Eviews.

Normality test Doornik-Hansen

Countries	JARQUE-BERRA	Probability
Canada	258.5964	0.00
France	79.35944	0.00
Germany	209.6423	0.00
Israel	45.30669	0.00
Spain	332.3387	0.00
UK	153.0939	0.00
USA	98.05959	0.00
Greece	310.6284	0.00

The reported results indicate that the residuals are not normal because p-value < 5%.

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