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MASTER IN ECONOMICS

THE EFFECTS OF ECONOMIC POLICY UNCERTAINTY AND INFLATION UNCERTAINTY ON G.D.P. AND INFLATION IN INDUSTRIAL COUNTRIES

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ABSTRACT

In this paper, I examine the effects of inflation uncertainty and economic policy uncertainty on G.D.P. and inflation in 9 industrial countries (Australia, Canada, France, Germany, Greece, Japan, Spain, U.K., U.S.). In the first part of my paper, I examine the effects of inflation uncertainty, in order to extract a measure of inflation uncertainty, I employ exponential generalized autoregressive conditional heteroscedasticity models (E-GARCH). Then, I use Granger-causality tests. These tests allow me to investigate the causal relationships between inflation uncertainty, GDP and inflation. Lastly, I use impulse responses and I examine how a change in inflation uncertainty affects GDP and inflation. The results show that a shock in inflation, affects inflation uncertainty in 7 of 9 countries that are used in my analysis (Japan, Canada, Australia, France, Greece, U.K., U.S.) and a shock in inflation uncertainty affects inflation in 5 of 9 countries (Japan, Canada, Spain, U.K., U.S.). Also, a shock in inflation uncertainty affects GDP in 4 of the 9 countries (Canada, Spain, U.K., U.S.). Lastly, I notice that the effects of inflation uncertainty are somewhat weaker in comparison with the effects of inflation. The second part of this paper shows the possible effects of economic policy uncertainty on GDP and inflation. I examine the influence of economic policy uncertainty to the other two variables (inflation, GDP) using VAR analysis. Subsequently, using again impulse responses I investigate how my variables (GDP, inflation) are reacting to possible shocks of economic policy uncertainty and the time, which they need, in order to adjust to those changes. The results show that, an impulse on e.p.u. seem to have a weak effect in GDP in 5 of the 9 countries (Japan, Canada, France, Spain, U.S.), but I found that those impulses have no effects on inflation.

CONTENTS

INTRODUCTION

In this paper, I will examine the possible effects of inflation uncertainty and economic policy uncertainty on G.D.P. and inflation in 9 industrial countries (Australia, Canada, France, Germany, Greece, Japan, Spain, U.K., U.S.). In the first part of my paper, I examine the effects of inflation uncertainty, in order to extract a measure of inflation uncertainty, I employ exponential generalized autoregressive conditional heteroscedasticity models (E-GARCH). I choose EGARCH models instead of GARCH models, due to the fact that, EGARCH captures potential asymmetric behavior of inflation and avoids imposing non-negativity constrains in GARCH modelling by determining the natural logarithm of the conditional variance ($\ln\sigma^2$). Then, I use Granger-causality tests. These tests allow me to investigate the causal relationships between inflation uncertainty, GDP and inflation. Lastly, I use impulse responses and I examine how a change in inflation uncertainty affects GDP and inflation. The second part of this paper shows the possible effects of economic policy uncertainty on GDP and inflation. I examine the influence of economic policy uncertainty to the other two variables using VAR analysis. Subsequently, using again impulse responses I investigate how my variables (GDP, inflation) are reacting to possible shocks of economic policy uncertainty and the time, which they need, in order to adjust to those changes.

LITERATURE REVIEW

In the first part of the literature, I will present some studies, which are investigating the relationship between inflation uncertainty, G.D.P. and inflation and the results in which they conclude.

According to **Friedman's (1977) Nobel Lecture**, a rise in the average rate of inflation leads to more inflation uncertainty and lower output. **Cukierman and Meltzer (1986)** analyzed the causal effect of inflation uncertainty on inflation, using the Barro-Gordon model they deduce that higher inflation uncertainty leads to more inflation. **Ball (1990)** in his paper <<*Why does high inflation raise inflation uncertainty?*>> presents a model of monetary policy in which a rise in inflation raises inflation uncertainty. **Grier, Perry (1998)** used GARCH models in the G7 countries in order to create a measure of inflation uncertainty and then Granger methods to test for causality between inflation uncertainty and average inflation. They found strong evidence that inflation Granger-causes inflation uncertainty and weaker evidence of the opposite. In US, UK and Germany they showed that increased inflation uncertainty lowers inflation, while in France and Japan increased inflation uncertainty raises inflation. **Fountas, Karanasos, Kim (2001)** using a bivariate GARCH model of output growth and inflation in the Japanese economy, they came to the conclusion that higher inflation uncertainty and inflation leads to lower output growth. **Fountas, Ioannidis, Karanasos (2004)** used E-GARCH models in six European countries to generate a measure of inflation uncertainty and then Granger methods to test for causality between inflation and inflation uncertainty. The results showed that in all European countries except U.K. inflation uncertainty does not cause negative output effects. Weaker evidence is found regarding on how inflation uncertainty affects inflation, in Italy, Germany, Spain and Netherlands increased inflation uncertainty lowers inflation, while in France increased inflation uncertainty raises inflation. **Robin Grier and Kevin B. Grier (2004)** using an augmented multivariance GARCH-M model of inflation and output growth in the Mexican economy, they found that inflation uncertainty has a negative and significant effect on growth and that higher inflation raises inflation uncertainty, also they estimate that the effect of average inflation on output growth is negative. **Daal, Naka and Sanchez (2004)** examined the relationship between inflation uncertainty and inflation using the asymmetric power GARCH model in emerging and developed countries, they found evidence that positive shocks on inflation have stronger impacts on inflation uncertainty for the Latin American countries. Lastly, they found that inflation causes inflation uncertainty for most countries, but causality of the opposite is mixed. **Grier, Henry, Olekalns and Shields (2004)** studied the asymmetric effects of uncertainty on inflation and output growth, among their results, they found that higher inflation uncertainty is significantly negatively correlated with lower average inflation and lower output growth. **Kontonikas** in his paper, examines the relationship between inflation and inflation uncertainty in the United Kingdom using GARCH-M models. The results point out a positive relationship between current uncertainty and past inflation **Bhar, Mallik** employed a multivariate EGARCH-M model, their results show that inflation uncertainty has positive and significant effect on inflation and negative and significant effect on output growth.

In the second part, I will display some papers, which are examining the relationship between economic policy uncertainty, inflation and G.D.P. and the results that arose from them.

Aizenman and Marion (1991) in their paper <<*Policy uncertainty, persistence and growth*>>, they explored links between per capita real G.D.P. and policy uncertainty for 46 developing countries over the 1970-1985 period. Their study showed that growth and policy uncertainty are correlated. **Stockhammar and Osterholm (2014)** studied the effects of US policy uncertainty on Swedish GDP growth using Bayesian VAR models. The results reveal that increasing US economic policy uncertainty has significant negative effects on Swedish GDP. **Istiak and Serletis (2018)** used monthly data from 1985 to 2015 and impulse response functions to check how the G7 countries react to negative and positive economic policy uncertainty shocks of different magnitude. They found that the responses of real output to those shocks differs from country to country. **Christou, Gabauer and Gupta (2019)** used macroeconomic variables of the United Kingdom over the monthly period of 1855 to 2016 and using a TVP-VAR they analyzed how those variables respond to uncertainty shocks. Among their results, they found that positive uncertainty shocks results in declines in the inflation. **Balcilar, Ike and Gupta (2019)** employed time series data to investigate the causal relationship between GDP growth and economic policy uncertainty of seven emerging economies. Using a multi-horizon mixed frequency VAR model, they deduce that there is strong evidence for direct causality from economic policy uncertainty to GDP in Mexico, India and Chile, while weaker evidence is found for Colombia, Russia and Brazil.

THE E-GARCH MODEL

I model the time-varying residual variance as an E-GARCH(1,1) process. This can be written as:

$$(1\text{-}bL)\ln(h_{\pi t}) = a + de_{t-1}/(h_{\pi,t-1})^{1/2} + c|e_{t-1}/(h_{\pi,t-1})^{1/2}| \qquad \textbf{(1)}$$

Where e_t is a sequence of independent, normally distributed random variables with mean 0 and variance 1. In the EGARCH models, which I estimate below, I use the conditional variance $h_{\pi t}$ as a measure of inflation uncertainty.

Now a= a constant, c= ARCH effects, d= asymmetric effects, b= GARCH effects

If d=0 and statistically significant the model is symmetric. But if d<0 and statistically significant, it implies that negative shocks generate larger volatility than positive shocks.

JAPAN RESULTS

I first test the relationship between inflation uncertainty, GDP and inflation using quarterly data of inflation and GDP from 1994Q1 through 2019Q4. The data are obtained from the OECD database and Fred database. To establish that the GDP data and inflation data is stationary, I use both the augmented Dickey-Fuller (ADF) and Phillips-Perron test (table 1) and I find that both tests, in first differences, reject the null hypothesis of a unit root at the 0,01 significance level. This means that GDP rate and inflation rate of UK is stationary in first differences.

TABLE 1

DInflation and DlogGDP unit root tests

UK	ADF t statistic	Phillips-Peron t statistic
DINFLATION	-6,740926***	-11,82983***
DGDP	-5,648368***	-8,805001***

Then I estimate an AR(5)-EGARCH(1,1) model for the Japan inflation rate:

$$\Pi_t = 0{,}991\Pi_{t-1} - 0{,}549\Pi_{t-4} + 0.316\Pi_{t-5} + \varepsilon_t$$

(0,000) (0,000) (0,000)

$$\ln(h_{\pi t}) = -2{,}855 - 0{,}929\ln(h_{\pi,t-1}) - 0{,}178|e_{t-1}| - 0{,}395e_{t-1}$$

(0,000) (0,000) (0,405) (0,000)

$Q(4) = 2{,}493\ (0{,}646)$
$Q^2(4) = 1{,}304\ (0{,}861)$

Notes: The first equation shows the conditional mean of the autoregressive model (AR). The numbers under the coefficients represent the probability values.
***Rejection of the unit root null hypothesis at the 0,01 level of significance.

I chose an AR(5) model for the inflation rate and an EGARCH(1,1)[1] model for the variance equation according to the minimum Akaike information criterion (AIC). In table 1, I also report the residual diagnostics for this model, those include the Ljung-Box(Q) tests for residual correlation and the Ljung-Box(Q) tests for serial dependence in the squared residuals. From both of those tests for serial correlation in the levels and squares of standardized residuals, I can deduce that, there is no rejection of the hypothesis of no autocorrelation. This means that the estimated model suits the data satisfactorily. The results which can derive from the EGARCH model are that, b which shows the persistence of past volatility and how past volatility helps to predict volatility in the future, is highly significant and the negative and statistically significant sign of d shows that, there is asymmetry in inflation uncertainty and also that negative inflation shocks generate larger inflation uncertainty than positive shocks.

Next, I employ VAR analysis in order to check how those variables (inflation, inflation uncertainty and GDP) affects with each other. The VAR I use is of this form:

[1] At the end of the paper are cited the ARCH effect tests for all countries.

$$Y_t = A_0 + A_1Y_{t-1} + A_2Y_{t-2} + A_3Y_{t-3} + A_4Y_{t-4} + A_5Y_{t-5} + A_6Y_{t-6} + e_t$$

where A_0 is a 6x1 vector of fixed terms, A_i is a matrix 6x6 which consists of coefficients, Y_t is a 6x1 vector of variables at the time t and e_t is a 6x1 vector, which consists of the residuals. I chose 6 lags in my VAR analysis according to LR criterium due to the fact that it eliminates autocorrelation[2].

Next, I use Granger-causality methods to test the causality between inflation, inflation uncertainty and GDP. The results are the following:

TABLE 2

DEPENDENT VARIABLE: INFLATION UNCERTAINTY

Excluded	Probability
DLOGGDP	0,8296
DINFLATION	0,0000
ALL	0,0000

DEPENDENT VARIABLE: DLOGGDP

Excluded	Probability
INFLATION UNCERTAINTY	0,9877
DINFLATION	0,5802
ALL	0,3708

DEPENDENT VARIABLE: DINFLATION

Excluded	Probability
INFLATION UNCERTAINTY	0,0050
DLOGGDP	0,2442
ALL	0,0120

[2] At the end of this paper is cited the autocorrelation tests, the heteroskedasticity tests and the normality of the residuals tests for all countries.

The results that arise from table 2 are that, in case where I have as dependent variable the inflation uncertainty, there is a Granger-causality between inflation uncertainty and inflation, because p-value<5%, the same applies where the dependent variable is inflation and the excluded variable is inflation uncertainty. So, I am rejecting the null hypothesis of no Granger-causality. On the other hand, when I have as dependent variable the GDP, p-value>5%. So, I accept the null hypothesis of no Granger-causality. This means that there is no Granger-causality between my excluded variables with my dependent variable.

Now, I will investigate the possible effects of a shock on inflation uncertainty, on GDP and inflation, using generalized impulse responses.

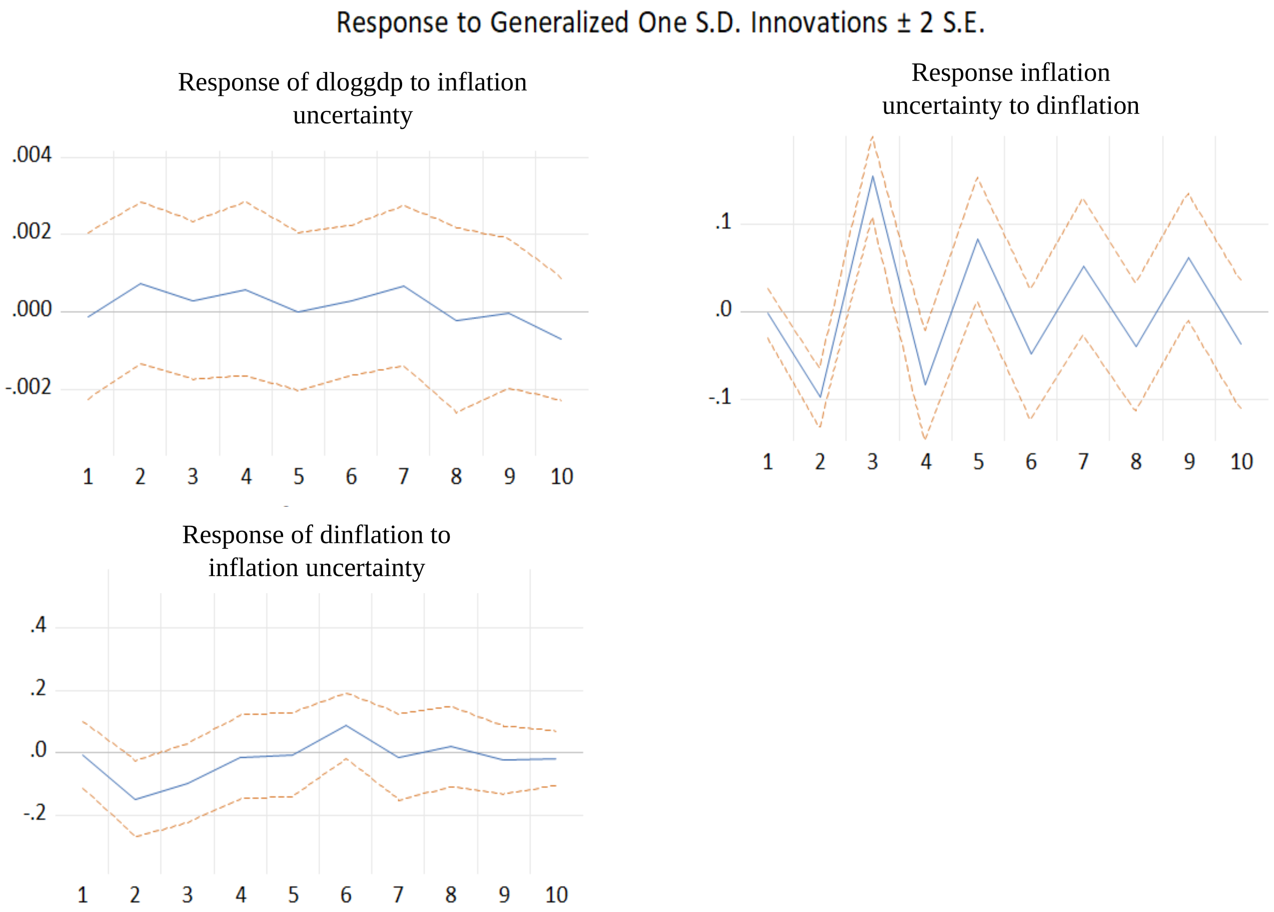


FIGURE 1

The reported results in figure 1 indicate that a shock in inflation uncertainty doesn’t seem to have an effect on GDP and it seem to have a negative effect on inflation approximately in the second quarter, but the effect is somewhat weak. On the other hand, a shock in inflation affects negatively inflation uncertainty in the first 2,5 quarters and then has a positive effect until 3,5 quarters. After 3,5 quarters the shock seems to be absorbed.

Now, in the second part of my analysis, I will use another VAR[3], only this time I will use as variables[4] inflation, GDP and economic policy uncertainty. The economic policy uncertainty data, are also quarterly and are obtained from www.policyuncertainty.com. Like in the first part I'm using Granger-causality methods to test the causality between inflation, economic policy uncertainty and GDP. The results are presented below:

TABLE 3

DEPENDENT VARIABLE: DLOGEPU

Excluded	Probability
DLOGGDP	0,0206
DINFLATION	0,0608
All	0,0177

DEPENDENT VARIABLE: DLOGGDP

Excluded	Probability
DLOGUNCERTAINTY	0,0008
DINFLATION	0,0013
All	0,0001

DEPENDENT VARIABLE: DINFLATION

Excluded	Probability
DLOGUNCERTAINTY	0,9369
DLOGGDP	0,4318
All	0,7723

The results that arise from table 3 are that, in cases where I have as dependent variables the economic policy uncertainty and GDP, there is a Granger-causality between my excluded variables with my dependent variable, because p-value all<5%

[3] The number of lags, which I will use are again according to LR criterium.

[4] At the end of the paper are cited the figures of inflation, G.D.P. and E.P.U. for all countries.

(except, where I have as dependent variable e.p.u. and as excluded variable inflation, where p-value=6%). So, I am rejecting the null hypothesis of no Granger-causality. On the other hand, when I have as dependent variable the inflation, the p-value>5%. So, I accept the null hypothesis of no Granger-causality. This means that there is no Granger-causality between my excluded variables with my dependent variable.

Next, as in the first part of my analysis, I will investigate the possible effects of a shock on economic policy uncertainty, on GDP and inflation, using generalized impulse responses. The results are the following:

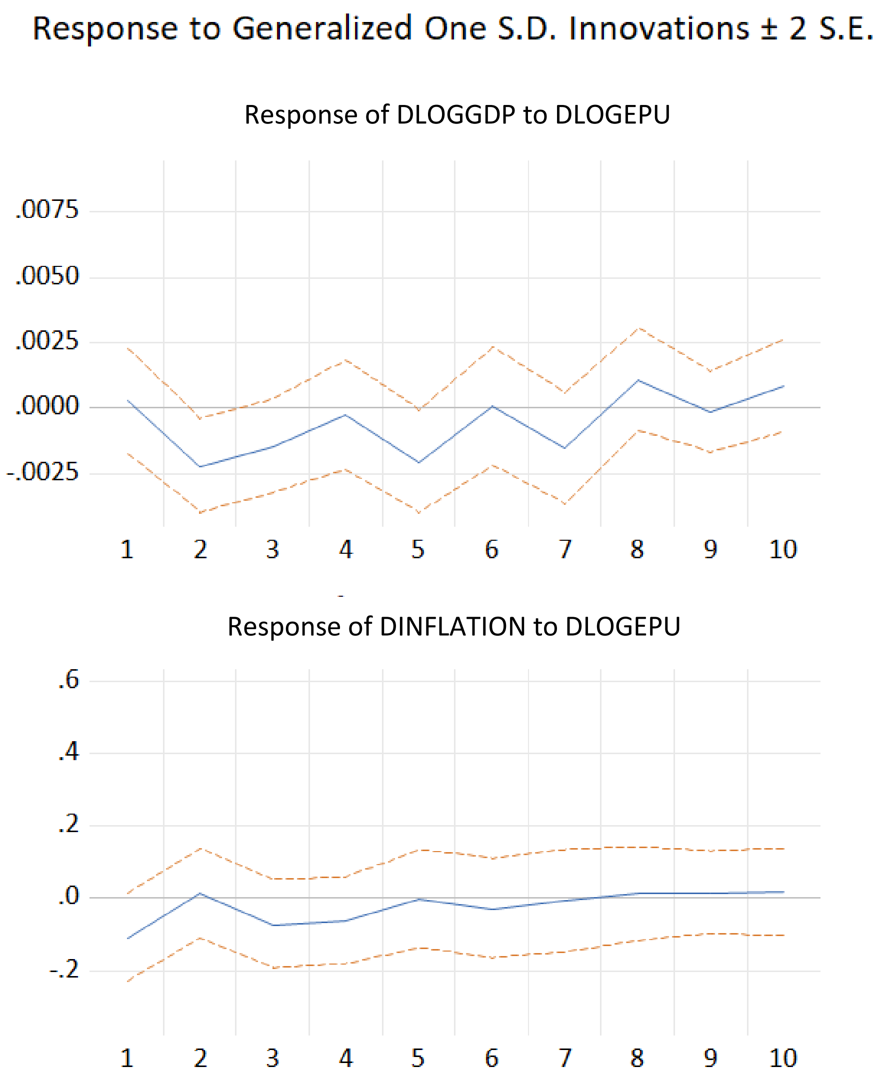


FIGURE 2

The reported results in figure 2 indicate that a shock in economic policy uncertainty doesn’t seem to have an effect on inflation and it seem to have a negative effect on GDP approximately in the second quarter, but the effect seems to be somewhat weak.

EVIDENCE FOR THE REST COUNTRIES

I apply the above empirical approach to 8 countries (Canada, Australia, France, Greece, Spain, U.K., U.S., Germany) using quarterly data of inflation and GDP. The data are obtained from the OECD database and Fred database.

TABLE 4

Inflation and GDP unit root tests

DINFLATION

COUNTRY	**ADF** t statistic	**PHILLIPS-PERRON** t statistic
CANADA	-9.228179***	-16.52183***
AUSTRALIA	-4.873578***	-8.411814***
FRANCE	-4.376863***	-9.027873***
GREECE	-6.941556***	-7.195479***
SPAIN	-3.554901**	-7.246319***
JAPAN	-6.740926***	-11.82983***
U.K.	-4.949692***	-6.157494***
U.S.	-4.173850***	-7.395736***
GERMANY	-5.556111***	-9.552570***

DLOGGDP

COUNTRY	**ADF** t statistic	**PHILLIPS-PERRON** t statistic
CANADA	-6.946487***	-5.471013***
AUSTRALIA	-6.999436***	-6.854554***
FRANCE	-4.442563***	-5.687836***
GREECE	-1.648156	-8.013505***
SPAIN	-2.984956**	-3.014480*
JAPAN	-5.648368***	-8.805001***
U.K.	-4.544037***	-4.557104***
U.S.	-4.325088***	-6.580023***
GERMANY	-8.362691***	-8.476885***

Notes: These tests are made in first differences of GDP and inflation.
***Rejection of the unit root null hypothesis at the 0,01 level of significance.
** Rejection of the unit root null hypothesis at the 0,05 level of significance.
* Rejection of the unit root null hypothesis at the 0,10 level of significance.

Table 4 presents ADF and Phillips-Perron tests of the unit root hypothesis for each country. The inflation ADF and Phillips-Perron tests reject the null hypothesis of a unit root for all countries at the 0,01 level of significance. Except Spain, in which the ADF test shows a rejection of the null hypothesis at the 0,05 level of significance. The GDP ADF tests reject the null hypothesis of a unit root for all countries at the 0,01 (0,05 Spain) level of significance, except Greece, which fail to reject the null hypothesis of a unit root. The GDP Phillips-Perron tests reject the null hypothesis of a unit root for all countries at the 0,01 (0,10 Spain) level of significance. For Greece I will consider my inflation and data series stationary, taking into account the Phillips-Perron results. Now, like Japan, the best fitted model is chosen according to the minimum Akaike information criterion (AIC). I choose an EGARCH(1,1) model for the conditional variance and an AR(9) model for Canada, an AR(16) model for Australia, an AR(14) for France, an AR(5) for Greece, an AR(3) for Spain, an AR(9) for U.K., an AR(2) for U.S. and an AR(9) for Germany. Table 5 shows the estimated results for each country.

TABLE 5

THE ESTIMATED AR(p)-EGARCH(1,1) MODELS[5]

Parameter	Canada	Australia	France	Greece	Spain	U.K.	U.S.	Germany
Π_{t-1}	0,836***	1,211***	1,2***	1,18***	1,2***	1,21***	1,14***	0,84***
Π_{t-2}	0,01	-0,512***	0,09	-0,167	-0,3***	-0,268	-0,44***	
Π_{t-3}	-0,01	-0,061	0,031	-0,056	0,015	0,06		0,15
Π_{t-4}	-0,41***	-0,224***	-0,1***	-0,4***		-0,51***		-0,59***
Π_{t-5}	0,413***	0,403***	1***	0,37***		0,383		0,43***
Π_{t-6}	-0,838	-0,062	-0,023			0,205		-0,07
Π_{t-7}	0,13	0,057	0,216			-0,003		0,11
Π_{t-8}	-0,247**	-0,261***	-1,1***			-0,49***		-0,45***
Π_{t-9}	0,09	0,217***	0,7***			0,256***		0,28***
Π_{t-10}		0,083	0,005					
Π_{t-11}		-0,122*	0,134					
Π_{t-12}		0,076	-0,6***					
Π_{t-13}		-0,041	0,27					
Π_{t-14}		0,056	0,059					
Π_{t-15}								
Π_{t-16}		0,005						
b	0,63***	-0,09	-0,9***	-0,8***	0,91***	0,51*	0,98***	0,734***
c	1,067***	-2,05***	0,468*	0,111	-0,37***	0,99**	-0,03	0,552*
d	0,15	1,651***	-0,25**	0,254**	-0,02***	0,06	0,23***	0,072

Notes: 1) The estimated conditional variance equation has the form
$\ln(h_{\pi t}) = -a - b\ln(h_{\pi,t-1}) - c|e_{t-1}| - de_{t-1}$.

2) *** 0,01 level of significance
** 0,05 level of significance
* 0,10 level of significance

[5] At the end of the paper are cited the residual diagnostics for those countries, those include the Ljung-Box(Q) tests for residual correlation and the Ljung-Box(Q) tests for serial dependence in the squared residuals

In all countries except Canada, U.K. and Germany the estimated coefficient d is statistically significant and positive or negative, indicating evidence of asymmetry in the conditional variance. More specifically, d is negative, it means that negative inflation shocks lead to more inflation uncertainty than positive shocks and if d is positive, it means that positive inflation shocks generate more inflation uncertainty than negative shocks. For Canada, U.K. and Germany the estimated coefficient of asymmetry is positive is positive, implying that a positive inflation surprise leads to more inflation uncertainty.

GRANGER-CAUSALITY TESTS

Table 6 contains the Granger-causality tests for the following countries: Canada, Australia, France, Greece, Spain, U.K, U.S. and Germany.

TABLE 6

COUNTRIES	DEPENDENT VARIABLE	PROBABILITY (excl. variables)
Canada	inflation	Inflation uncertainty=0.03** GDP=0.001***
	Inflation uncertainty	Inflation=0,005*** GDP=0,253
	GDP	Inflation=0.029** Inflation uncertainty=0.044**
Australia	inflation	Inflation uncertainty=0.749 GDP=0.638
	Inflation uncertainty	Inflation=0.009*** GDP=0.309
	GDP	Inflation=0.0587* Inflation uncertainty=0.703
France	inflation	Inflation uncertainty=0.066* GDP=0.031**
	Inflation uncertainty	Inflation=0.000*** GDP=0.851
	GDP	Inflation=0.019** Inflation uncertainty=0.149
Greece	inflation	Inflation uncertainty=0.61 GDP=0.386
	Inflation uncertainty	Inflation=0.000*** GDP=0.013**
	GDP	Inflation=0.438 Inflation uncertainty=0.912
Spain	inflation	Inflation uncertainty=0.035** GDP=0.101
	Inflation uncertainty	Inflation=0.721 GDP=0.414
	GDP	Inflation=0.000**** Inflation uncertainty=0.000***
U.K.	inflation	Inflation uncertainty=0.001*** GDP=0.358

	Inflation uncertainty	Inflation=0.024** GDP=0.199
	GDP	Inflation=0.813 Inflation uncertainty=0.09*
U.S.	inflation	Inflation uncertainty=0.000*** GDP=0.107
	Inflation uncertainty	Inflation=0.000*** GDP=0.139
	GDP	Inflation=0.279 Inflation uncertainty=0.006***
Germany	Inflation	Inflation uncertainty=0.186 GDP=0.116
	Inflation uncertainty	Inflation=0.015** GDP=0.12
	GDP	Inflation=0.103 Inflation uncertainty=0.064*

Notes:1) inflation uncertainty, inflation and GDP, when needed, are taken in first differences, in order to ensure stationarity. 2) Where p-value<5% there is a Granger-causality between my excluded variables with my dependent variable So, I am rejecting the null hypothesis of no Granger-causality
***Rejection of the unit root null hypothesis at the 0,01 level of significance.
** Rejection of the unit root null hypothesis at the 0,05 level of significance.
* Rejection of the unit root null hypothesis at the 0,10 level of significance.

The table above show that, in the cases of Canada, France, Spain, U.K., U.S., there is a Granger-causality when my dependent variable is inflation and my excluded variable is inflation uncertainty. Also, in cases of Canada, France, Greece, U.K., U.S., Australia, Germany, there is a Granger-causality when my dependent variable is inflation uncertainty and my excluded variable is inflation. Finally, in cases of Canada, Spain, U.K., U.S., there is a Granger-causality when my dependent variable is G.D.P. and my excluded variable is inflation uncertainty.

IMPULSE RESPONSES

Next, I will present how a shock on inflation uncertainty affects inflation and GDP and how a shock on inflation affects inflation uncertainty. In order to do that I use generalized impulse responses in the following countries: Canada, Australia, France, Greece, Spain, U.K, U.S. and Germany.

CANADA

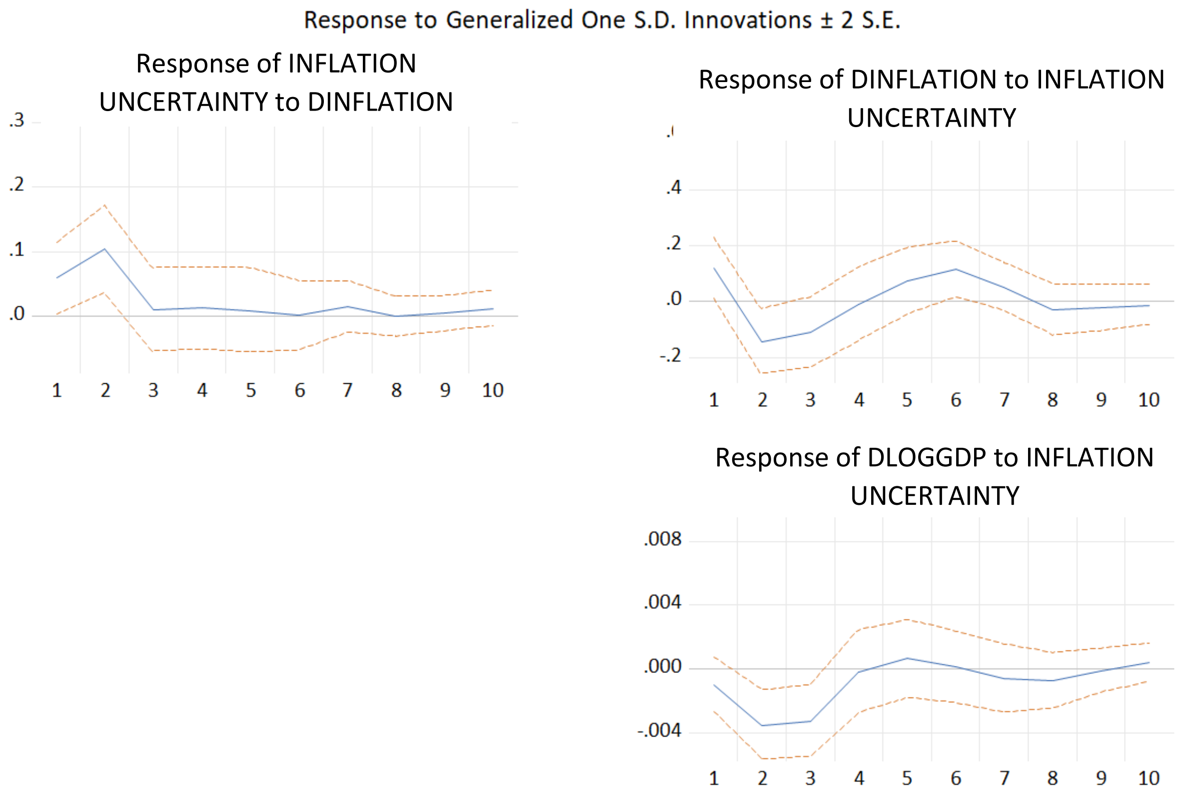


FIGURE 3

The reported results in figure 3 indicate that a shock in inflation uncertainty seem to have a negative effect on GDP in the first approximately 3 quarters and a negative effect on inflation approximately in the second quarter, but the effect is somewhat weak. On the other hand, a shock in inflation affects positively inflation uncertainty in the first 2,5 quarters. After 2,5 quarters the shock seems to be absorbed.

AUSTRALIA

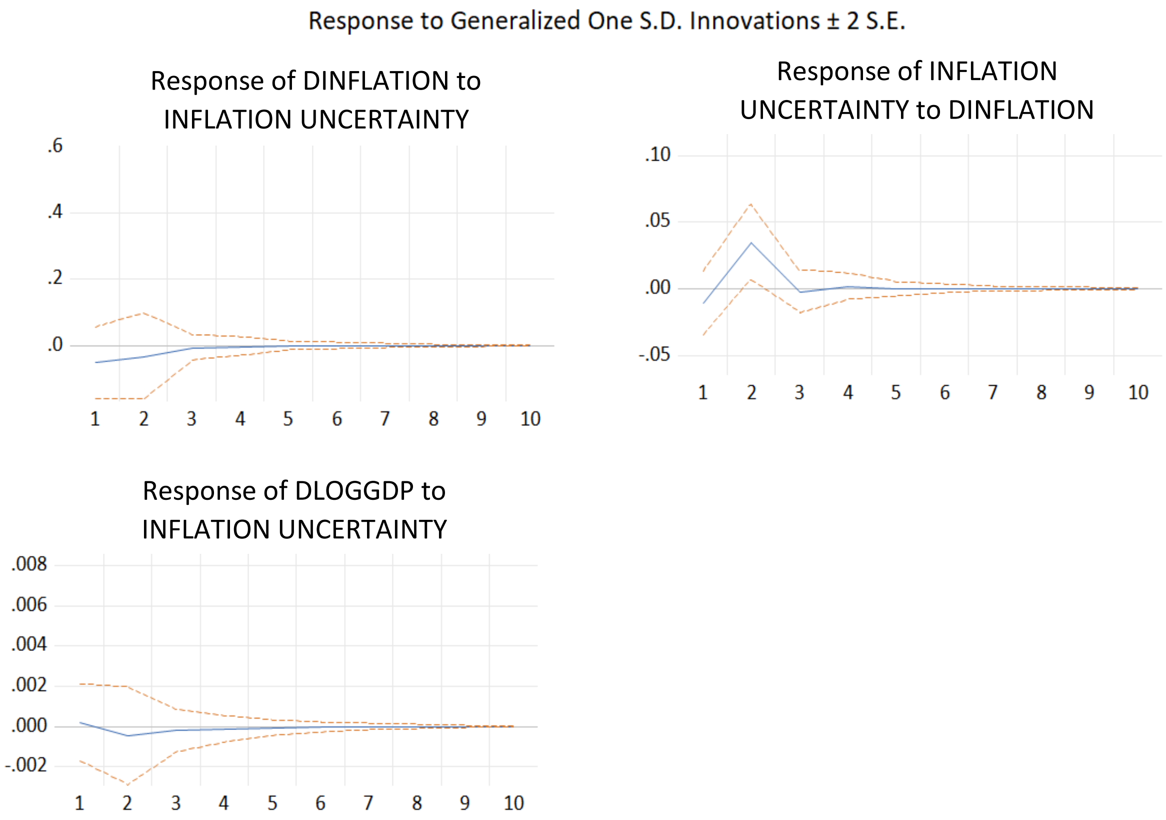


FIGURE 4

The reported results in figure 4 indicate that a shock in inflation uncertainty seem to have no effect on GDP and inflation. On the other hand, a shock in inflation affects positively inflation uncertainty in the 2 quarter, but the effect is weak.

FRANCE

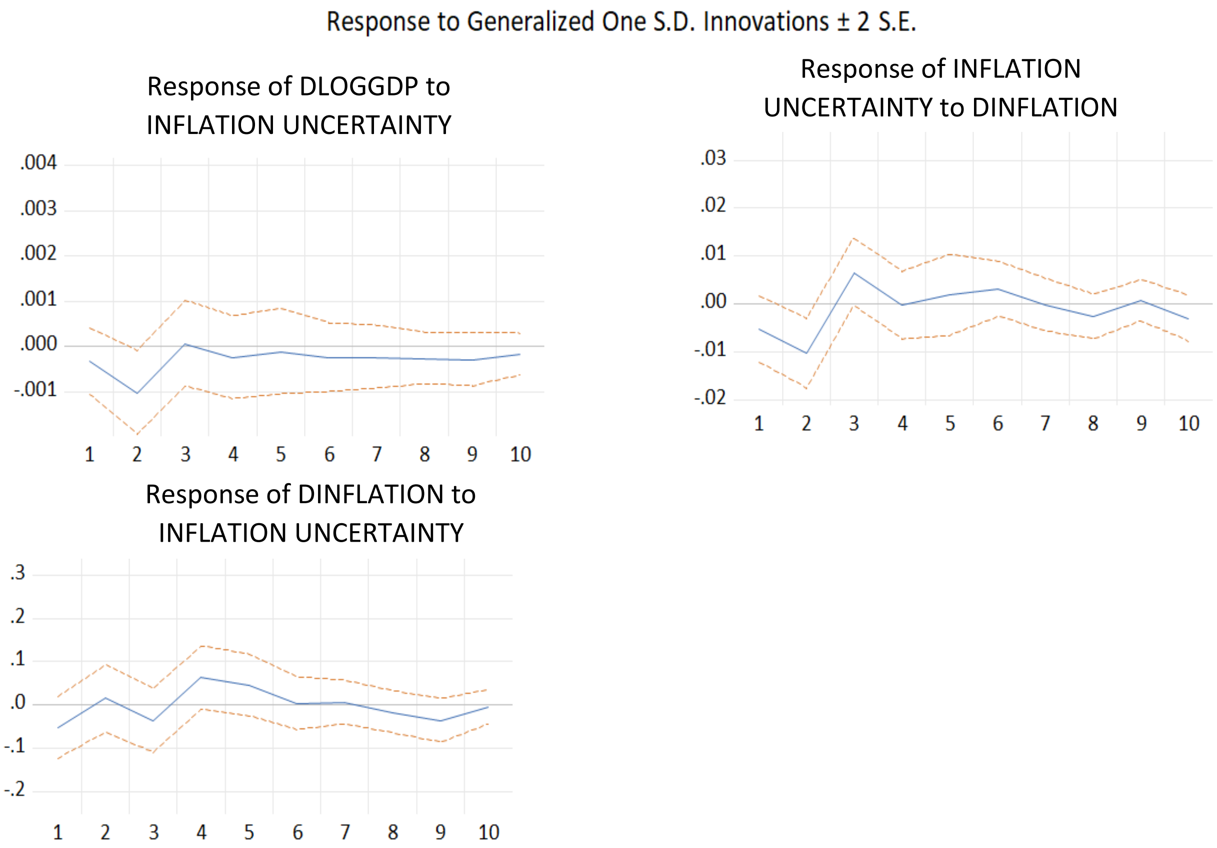


FIGURE 5

The reported results in figure 5 indicate that a shock in inflation uncertainty seem to have no effect on GDP and inflation. On the other hand, a shock in inflation affects negatively inflation uncertainty in the 2 quarter, but the effect is weak.

GREECE

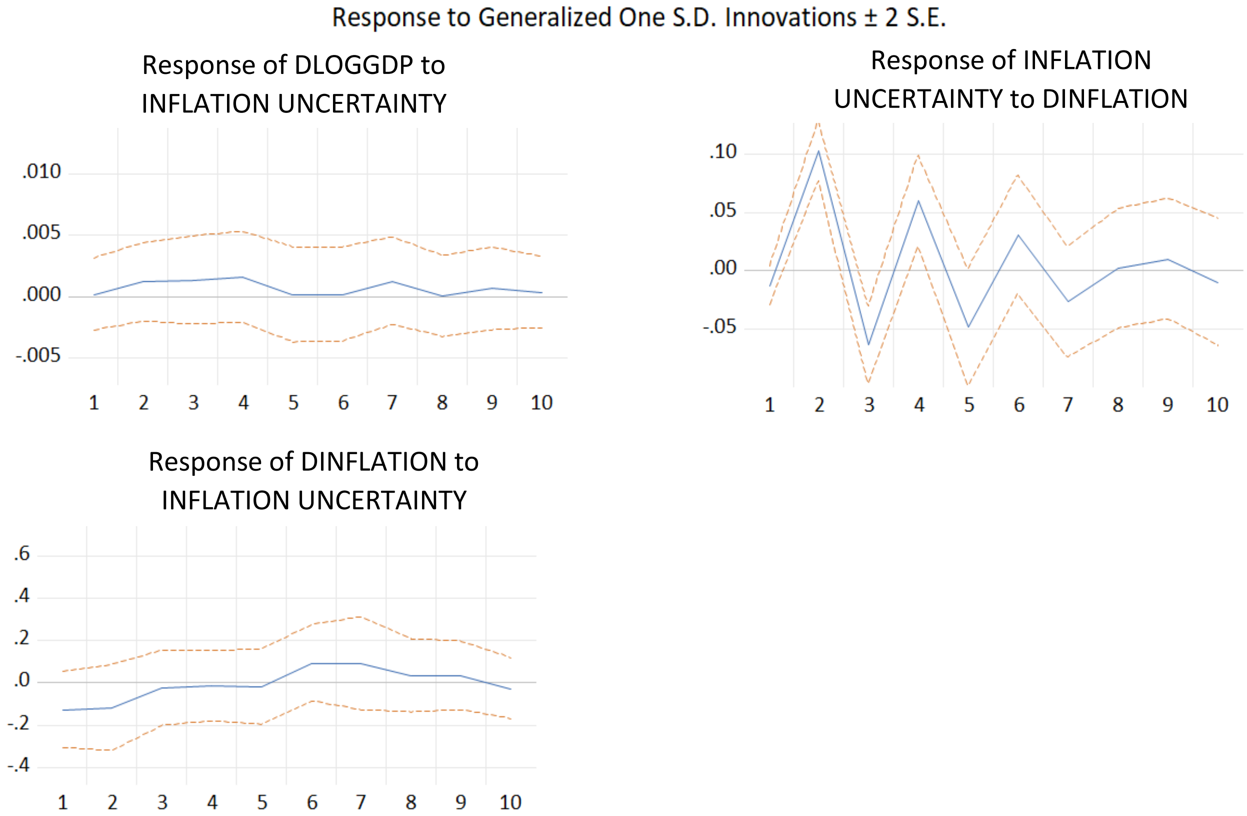


FIGURE 6

The reported results in figure 6 indicate that a shock in inflation uncertainty seem to have no effect on GDP and inflation. On the other hand, a shock in inflation affects positively inflation uncertainty in the first 2,5 quarters and negatively from 2,5 until 3,5 quarter. Then the shock seems to be absorbed.

SPAIN

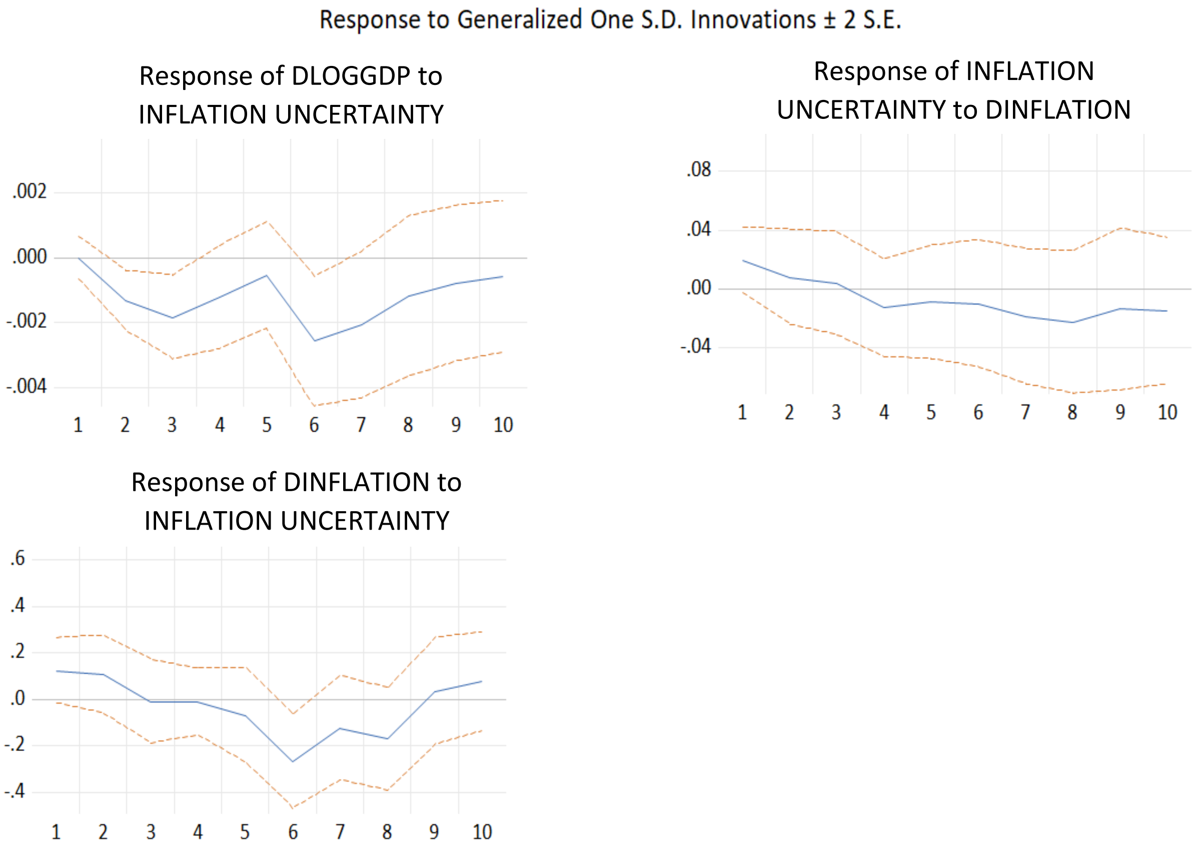


FIGURE 7

The reported results in figure 7 indicate that a shock in inflation uncertainty seem to have a negative effect on GDP from 1,5 quarter until 3,5 quarter and from 6 until 6,5 quarter. Now, a shock on inflation uncertainty seems to have a weak negative effect on inflation approximately in the sixth quarter. On the other hand, a shock in inflation doesn't seem to affect inflation uncertainty.

U.K.

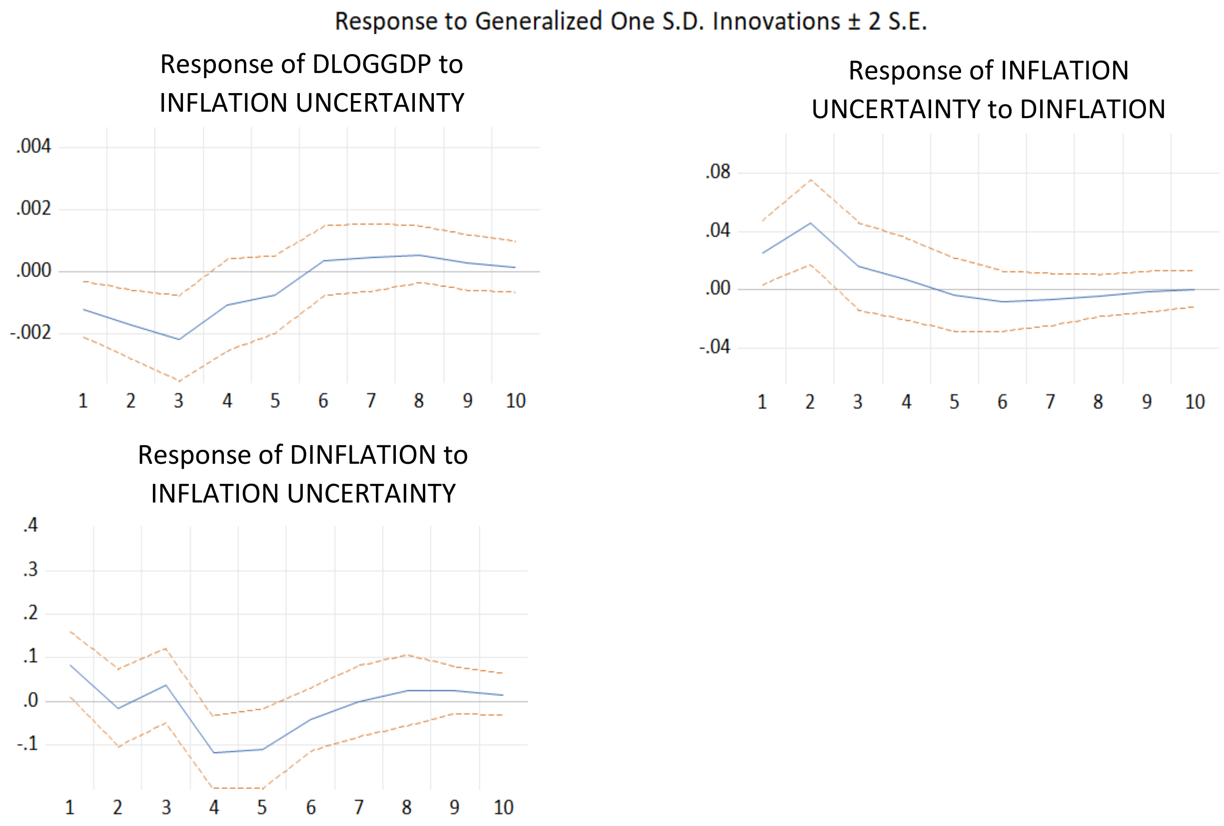


FIGURE 8

The reported results in figure 8 indicate that a shock in inflation uncertainty seem to have a negative effect on GDP in the first 3,5 quarters. Now, a shock on inflation uncertainty seems to have a somewhat weak negative effect on inflation from 4th quarter till 5,5th quarter. On the other hand, a shock in inflation seem to affect positively inflation uncertainty in the first 2 and a half quarters. Then the shock seems to be absorbed.

U.S.

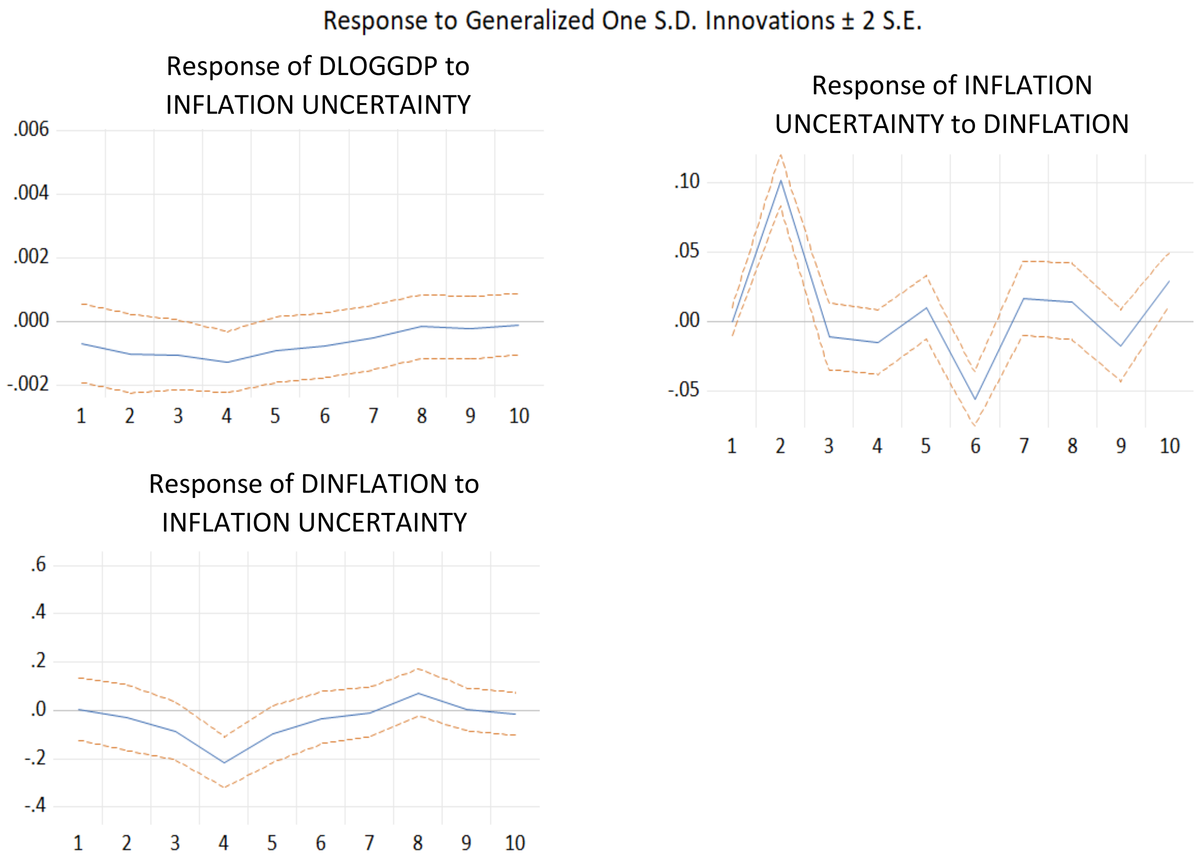


FIGURE 9

The reported results in figure 9 indicate that a shock in inflation uncertainty seem to have a weak negative effect on GDP approximately from 3,5 quarter till 4,5 quarter. Now, a shock on inflation uncertainty seems to have a negative effect on inflation from 3,5 quarter till 4,5 quarter. On the other hand, a shock in inflation seem to affect positively inflation uncertainty in the first 2 and a half quarters and negatively from 6th till 6,5th quarter.

GERMANY

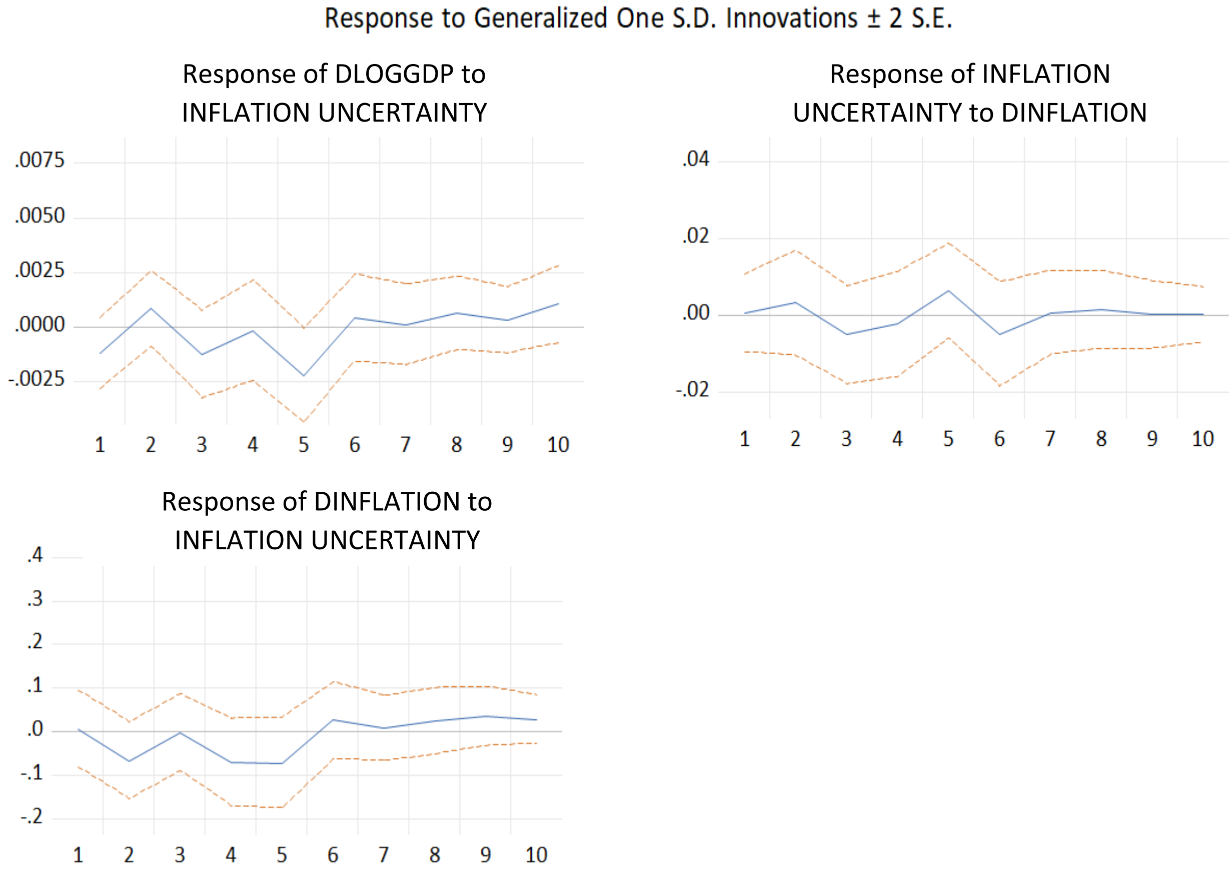


FIGURE 10

The reported results in figure 10 indicate that a shock in inflation uncertainty don't affect inflation and GDP and a shock in inflation has no effect on inflation uncertainty.

To sum up, I can deduct from figures 1,3,4,5,6,7,8,9,10 that a shock in inflation, affects inflation uncertainty in 7 of 9 countries that I used in this model (Japan, Canada, Australia, France, Greece, U.K., U.S.). Also, a shock in inflation uncertainty affects inflation in 5 of 9 countries (Japan, Canada, Spain, U.K., U.S.). Lastly, a shock in inflation uncertainty affects GDP in 4 of the 9 countries (Canada, Spain, U.K., U.S.). By and large, the results above show that the effects of inflation uncertainty are somewhat weaker in comparison with the effects of inflation.

Now I'm going to present how economic policy uncertainty affects inflation and GDP to the rest of my countries. First, I will investigate the causality between economic policy uncertainty, GDP and inflation using Granger-causality tests. The results are the following:

GRANGER-CAUSALITY TESTS

Table 7 contains the Granger-causality tests for the following countries: Canada, Australia, France, Greece, Spain, U.K, U.S. and Germany.

TABLE 7

COUNTRIES	DEPENDENT VARIABLE	PROBABILITY (excl. variables)
Canada	inflation	Economic policy uncertainty=0.86 GDP=0.009***
	Economic policy uncertainty	Inflation=0.064* GDP=0.105
	GDP	Economic policy uncertainty=0.09* Inflation=0.037**
Australia	inflation	Economic policy uncertainty=0.29 GDP=0.552
	Economic policy uncertainty	Inflation=0.231 GDP=0.797
	GDP	Economic policy uncertainty=0.9 Inflation=0.139
France	inflation	Economic policy uncertainty=0.46 GDP=0.009***
	Economic policy uncertainty	Inflation=0.579 GDP=0.409
	GDP	Economic policy uncertainty=0.03** Inflation=0.245
Greece	inflation	Economic policy uncertainty=0.34 GDP=0.063*
	Economic policy uncertainty	Inflation=0.682 GDP=0.668
	GDP	Economic policy uncertainty=0.05** Inflation=0.486
Spain	inflation	Economic policy uncertainty=0.48 GDP=0.232
	Economic policy uncertainty	Inflation=0.799 GDP=0.249
	GDP	Economic policy uncertainty=0.21 Inflation=0.000***
U.K.	inflation	Economic policy uncertainty=0.59 GDP=0.05*
	Economic policy uncertainty	Inflation=0.341 GDP=0.514
	GDP	Economic policy uncertainty=0.20 Inflation=0.815
U.S.	inflation	Economic policy uncertainty=0.92 GDP=0.092*

	Economic policy uncertainty	Inflation=0.728 GDP=0.697
	GDP	Economic policy uncertainty=0.29 Inflation=0.284
Germany	Inflation	Economic policy uncertainty=0.72 GDP=0.247
	Economic policy uncertainty	Inflation=0.192 GDP=0.013**
	GDP	Economic policy uncertainty=0.02** Inflation=0.14

Notes: 1) economic policy uncertainty, inflation and GDP, when needed, are taken in first differences, in order to ensure stationarity. 2) Where p-value<5% there is a Granger-causality between my excluded variables with my dependent variable So, I am rejecting the null hypothesis of no Granger-causality
***Rejection of the unit root null hypothesis at the 0,01 level of significance.
** Rejection of the unit root null hypothesis at the 0,05 level of significance.
* Rejection of the unit root null hypothesis at the 0,10 level of significance.

The table above show that, in the cases of Canada, France, Greece, Germany there is a Granger-causality when my dependent variable is G.D.P. and my excluded variable is economic policy uncertainty.

IMPULSE RESPONSES

Next, I will present how a shock on economic policy uncertainty affects inflation and GDP. In order to do that I use generalized impulse responses in the following countries: Canada, Australia, France, Greece, Spain, U.K, U.S. and Germany.

CANADA

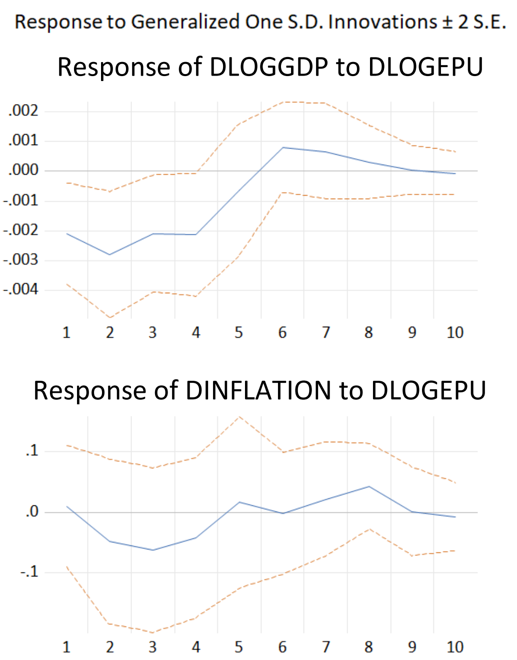


FIGURE 11

AUSTRALIA

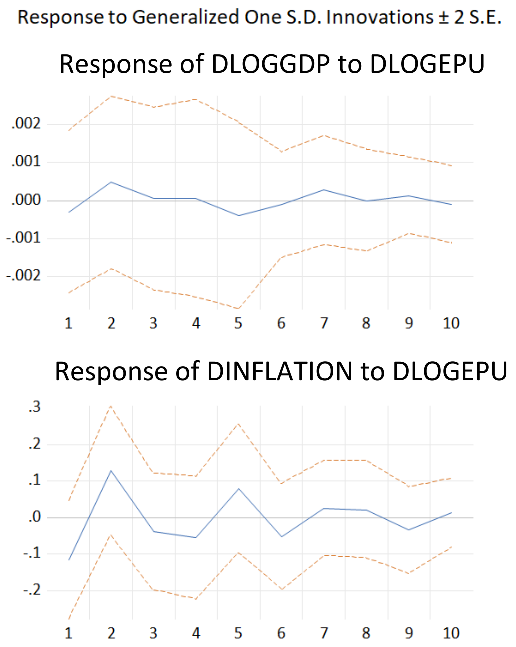


FIGURE 12

FRANCE

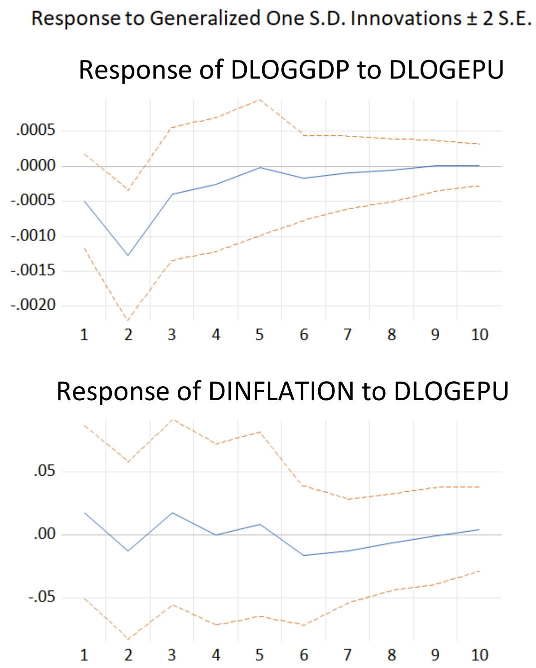


FIGURE 13

GREECE

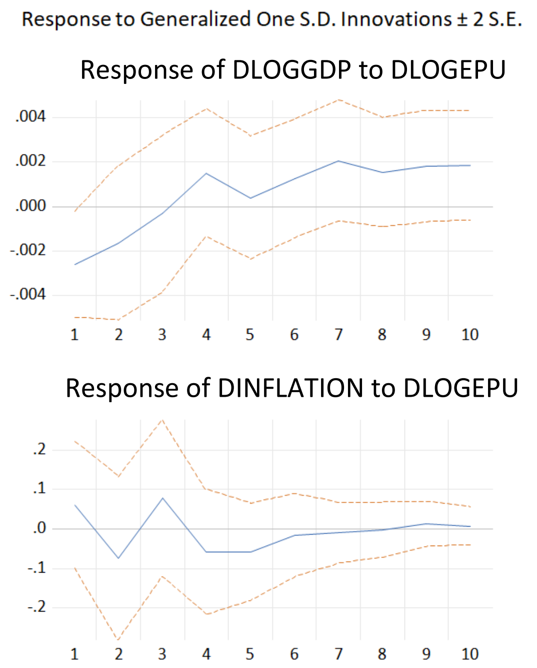


FIGURE 14

SPAIN

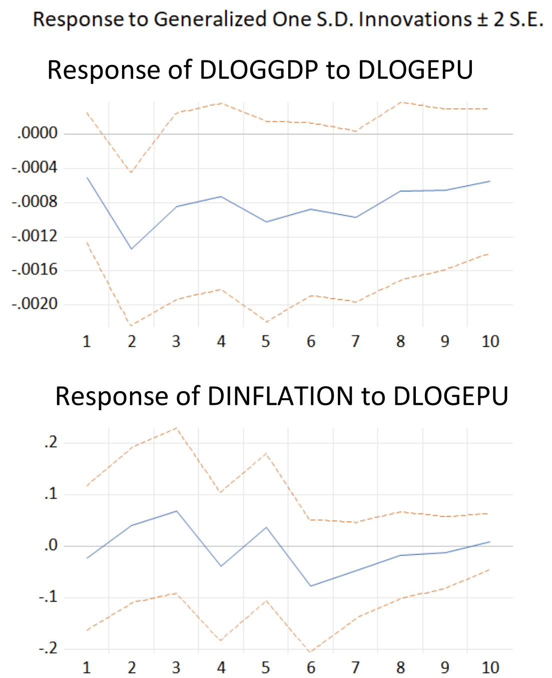


FIGURE 15

U.K.

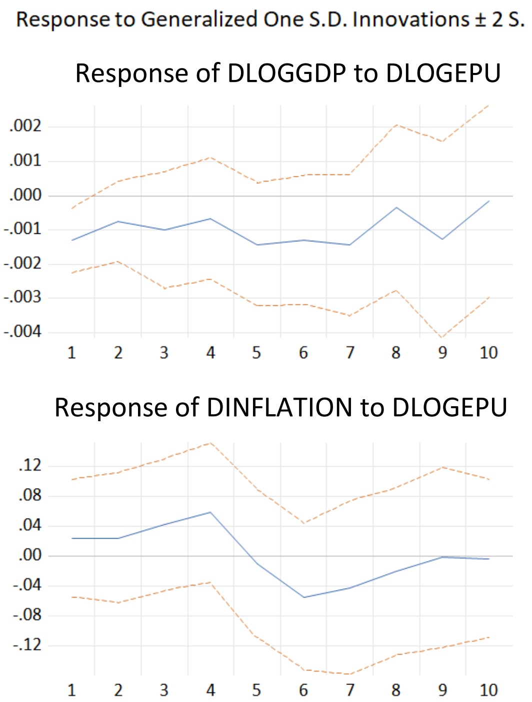


FIGURE 16

U.S.

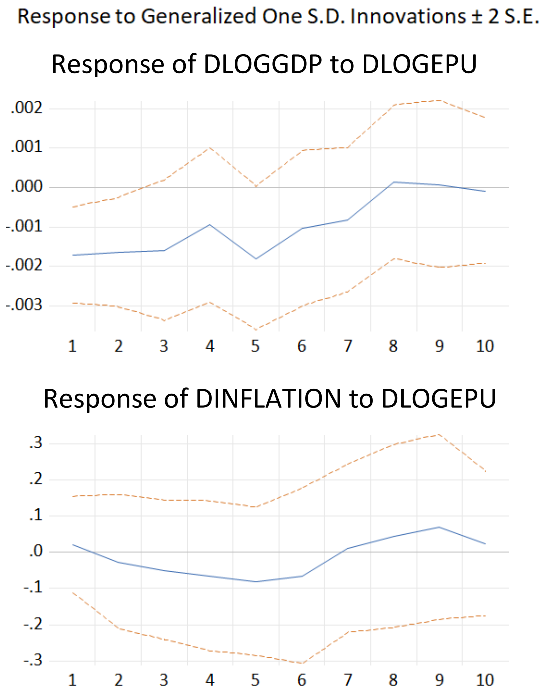


FIGURE 17

GERMANY

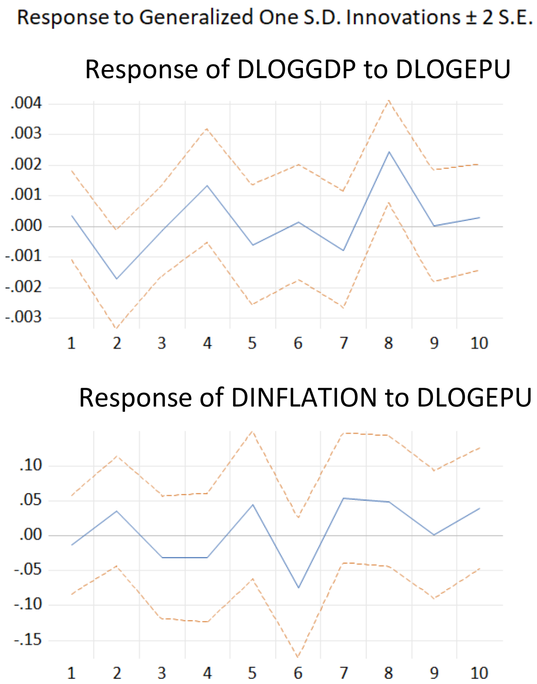


FIGURE 18

The reported results in figure 11 indicate that a shock in economic policy uncertainty seem to have no effect on inflation, but seems to have a positive effect on GDP the first 3 and a half quarters. Then the shock seems to be absorbed. The results in figure 13 indicate that a shock in economic policy uncertainty have no effect on inflation, but seems to have a negative effect on GDP from 1,5 quarter to 2,5 quarter. The reported results in figure 15 indicate that a shock in economic policy uncertainty seem to have no effect on inflation, but seems to have a positive effect on GDP from 1,5 quarter to 2, quarter. Then the shock is absorbed. The reported results in figure 17 indicate that a shock in economic policy uncertainty seem to have no effect on inflation, but seems to have a positive effect on GDP the first two quarters. The reported results in figures 12,14,16,18 indicate that a shock in economic policy uncertainty have no effect on GDP and inflation. Summarizing, an impulse on e.p.u. seem to have a weak effect in GDP in 5 of the 9 countries (Japan, Canada, France, Spain, U.S.), which I used, but I found that those impulses have no effects on inflation of those countries.

CONCLUDING REMARKS

The relationship of inflation uncertainty and economic policy uncertainty on G.D.P. and inflation has been investigated in 9 industrial countries (Australia, Canada, France, Germany, Greece, Japan, Spain, U.K., U.S.). At first, I examine the effects of inflation uncertainty, in order to extract a measure of inflation uncertainty, I employ exponential generalized autoregressive conditional heteroscedasticity models (E-GARCH). Then, I use Granger-causality tests. These tests allow me to investigate the causal relationships between inflation uncertainty, GDP and inflation. Lastly, I use impulse responses and I examine how a change in inflation uncertainty affects GDP and inflation. The results show that a shock in inflation, affects positively inflation uncertainty in 6 of 9 countries that are used in my analysis (Japan, Canada, Australia, Greece, U.K., U.S.), confirming Friedman's (1977) Nobel Lecture and the studies of Ball (1990), Daal, Naka, Sanchez (2004) R. Grier and K. B. Grier (2004), and negatively France. The inflation uncertainty in Germany, Spain and Australia shows no reaction to inflation impulses. Now, a shock in inflation uncertainty affects negatively inflation in 5 of 9 countries (Japan, Canada, Spain, U.K., U.S.), confirming the studies of Grier, Perry (1998), Grier, Henry, Olekalns and Shields (2004), the rest of the countries (Germany, Greece, Australia, France) show no reaction to those shocks. Also, a shock in inflation uncertainty affects negatively GDP in 4 of the 9 countries (Canada, Spain, U.K., U.S.), confirming the studies of Bhar, Mallik (2013), Grier, Henry, Olekalns and Shields (2004), Robin Grier and Kevin B. Grier (2004), for the rest of the countries, those inflation uncertainty impulses have no effects on their GDP. Fountas, Ioannidis, Karanasos (2004) showed that in U.K. inflation uncertainty does cause negative output effects. Lastly, I notice that the effects of inflation uncertainty on inflation are somewhat weaker in comparison with the effects of inflation on inflation uncertainty like Fountas, Ioannidis, Karanasos (2004). The final part of this paper shows the effects of economic policy uncertainty on GDP and inflation. I examine the influence of economic policy uncertainty to the other two variables (inflation, GDP) using VAR analysis. Afterwards, using again impulse responses I investigate how my variables (GDP, inflation) are reacting to possible shocks of economic policy uncertainty and the time, which they need, in order to adjust to those changes. The results show that, an impulse on economic policy uncertainty seem to have a weak negative effect on GDP in 5 of the 9 countries (Japan, Canada, France, Spain, U.S.), confirming the studies of Aizenman and Marion (1991), Balcilar, Ike and Gupta (2019), but I found that those impulses have no effects on inflation of those countries. Unlike Christou, Gabauer and Gupta (2019) , who found that positive uncertainty shocks results in declines in the inflation.

APPENDIX

Heteroskedasticity Test: ARCH

COUNTRIES	**T*R^2**	**PROBABILITY**
CANADA	72.96	0.000
AUSTRALIA	37.30	0.000
FRANCE	68.57	0.000
GREECE	57.78	0.000
SPAIN	49.19	0.000
JAPAN	46.26	0.000
U.K.	43.23	0.000
U.S.	27.68	0.000
GERMANY	81.85	0.000

The table above contain tests for ARCH effects and it shows there is a rejection of the null hypothesis of having no ARCH effects, due to the fact that p<5%

Ljung-Box(Q) tests for residual correlation and the Ljung-Box(Q) tests for serial dependence in the squared residuals (4 lags).

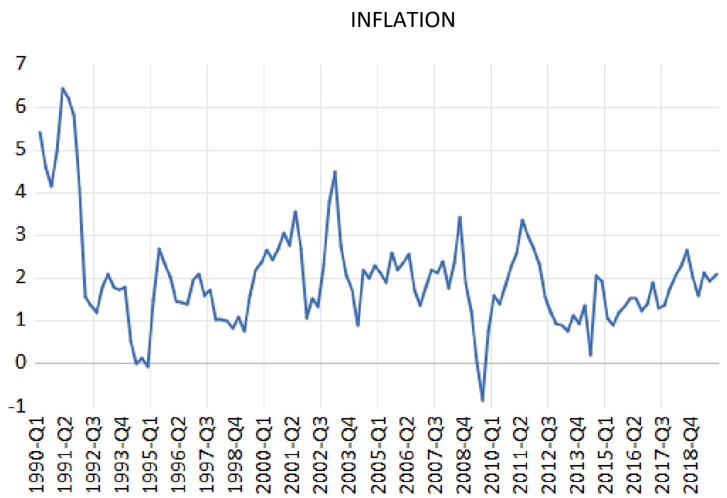
COUNTRIES	**Q**	**Q^2**
CANADA	0.388(0.983)	1.226(0.874)
AUSTRALIA	1.201(0.878)	1.381(0.847)
FRANCE	1.813(0.770)	6.197(0.185)
GREECE	0.673(0.955)	3.395(0.494)
SPAIN	9.384(0.052)	4.438(0.350)
U.K.	1.396(0.845)	1.794(0.774)
U.S.	10.131(0.038)	6.222(0.183)
GERMANY	2.589(0.630)	3.437(0.488)

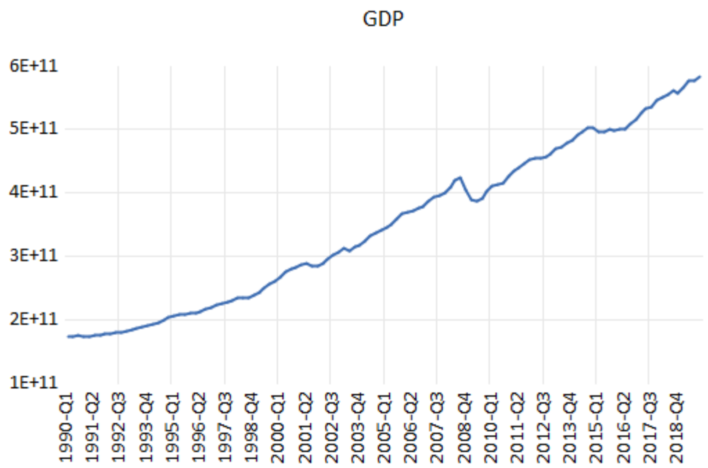
NOTES: The numbers in parenthesis show the p values.

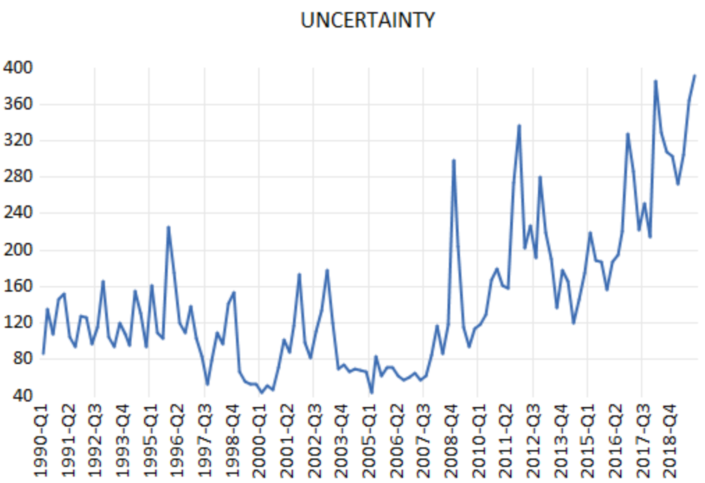
The table above for serial correlation in the levels and squares of standardized residuals, show that, there is no rejection of the hypothesis of no autocorrelation, due to the fact that, p>5%.

Figures of inflation, G.D.P. and E.P.U. for all countries.

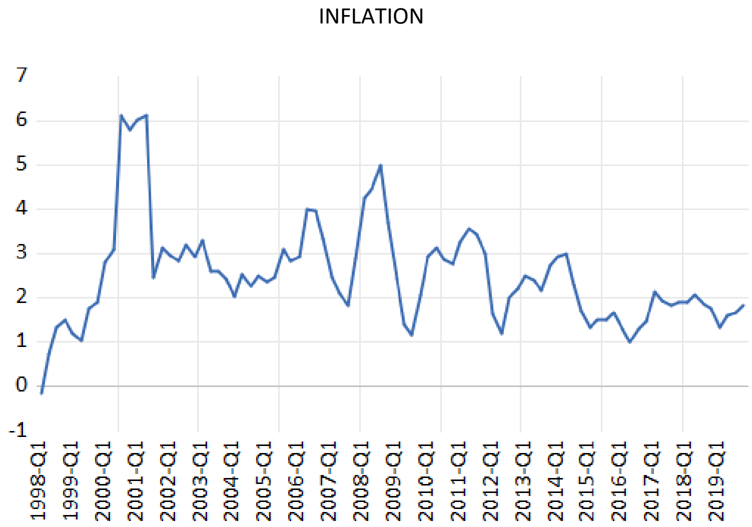
CANADA







AUSTRALIA


INFLATION
7
6
5
4
3
2
1
0
-1
1998-Q1
1999-Q1
2000-Q1
2001-Q1
2002-Q1
2003-Q1
2004-Q1
2005-Q1
2006-Q1
2007-Q1
2008-Q1
2009-Q1
2010-Q1
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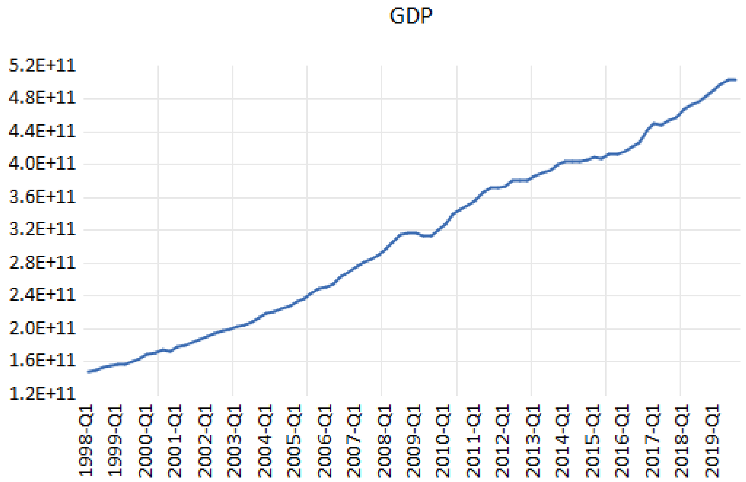
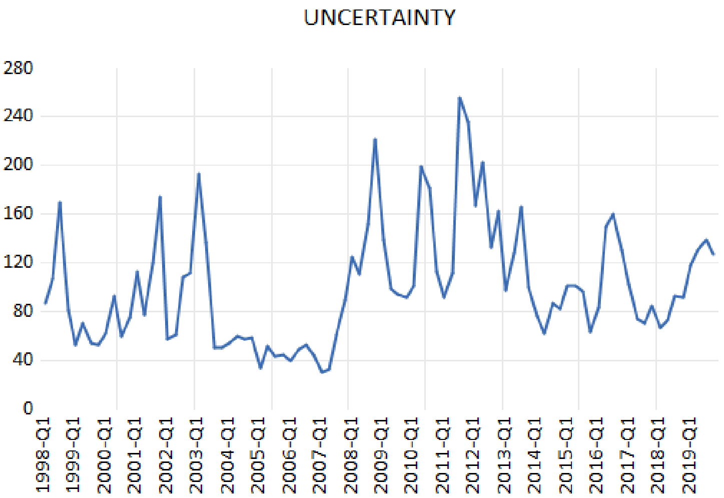
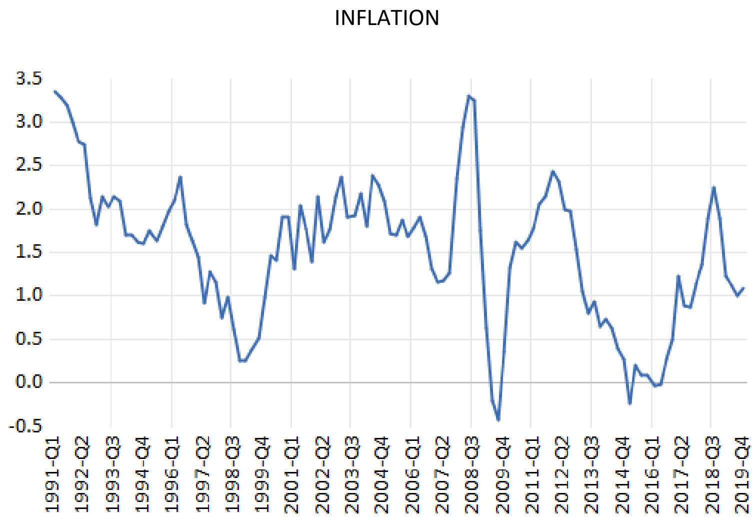
2014-Q1
2015-Q1
2016-Q1
2017-Q1
2018-Q1
2019-Q1


GDP
5.2E+11
4.8E+11
4.4E+11
4.0E+11
3.6E+11
3.2E+11
2.8E+11
2.4E+11
2.0E+11
1.6E+11
1.2E+11
1998-Q1
1999-Q1
2000-Q1
2001-Q1
2002-Q1
2003-Q1
2004-Q1
2005-Q1
2006-Q1
2007-Q1
2008-Q1
2009-Q1
2010-Q1
2011-Q1
2012-Q1
2013-Q1
2014-Q1
2015-Q1
2016-Q1
2017-Q1
2018-Q1
2019-Q1


UNCERTAINTY
280
240
200
160
120
80
40
0
1998-Q1
1999-Q1
2000-Q1
2001-Q1
2002-Q1
2003-Q1
2004-Q1
2005-Q1
2006-Q1
2007-Q1
2008-Q1
2009-Q1
2010-Q1
2011-Q1
2012-Q1
2013-Q1
2014-Q1
2015-Q1
2016-Q1
2017-Q1
2018-Q1
2019-Q1

FRANCE


INFLATION
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
1991-Q1
1992-Q2
1993-Q3
1994-Q4
1996-Q1
1997-Q2
1998-Q3
1999-Q4
2001-Q1
2002-Q2
2003-Q3
2004-Q4
2006-Q1
2007-Q2
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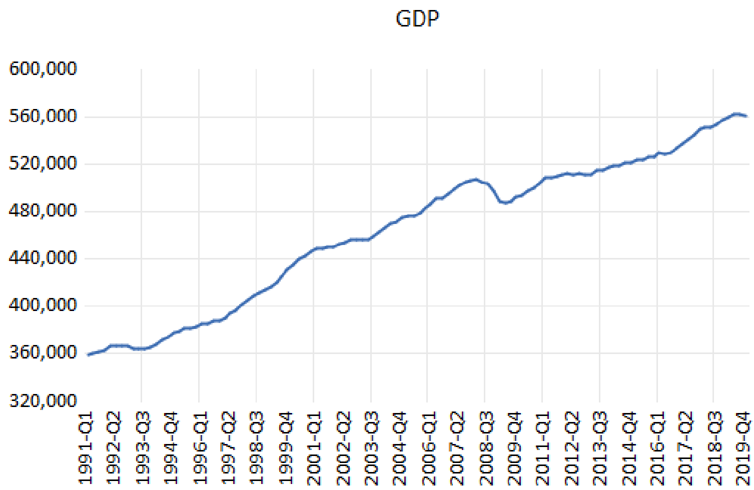
2018-Q3
2019-Q4


GDP
600,000
560,000
520,000
480,000
440,000
400,000
360,000
320,000
1991-Q1
1992-Q2
1993-Q3
1994-Q4
1996-Q1
1997-Q2
1998-Q3
1999-Q4
2001-Q1
2002-Q2
2003-Q3
2004-Q4
2006-Q1
2007-Q2
2008-Q3
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2011-Q1
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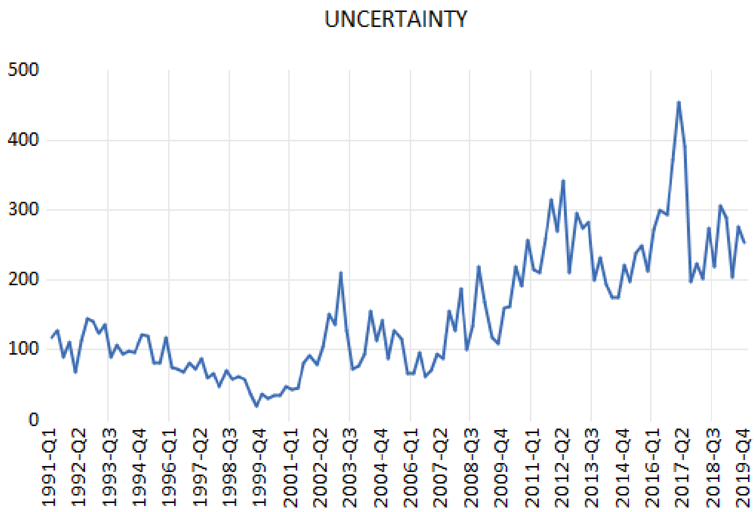
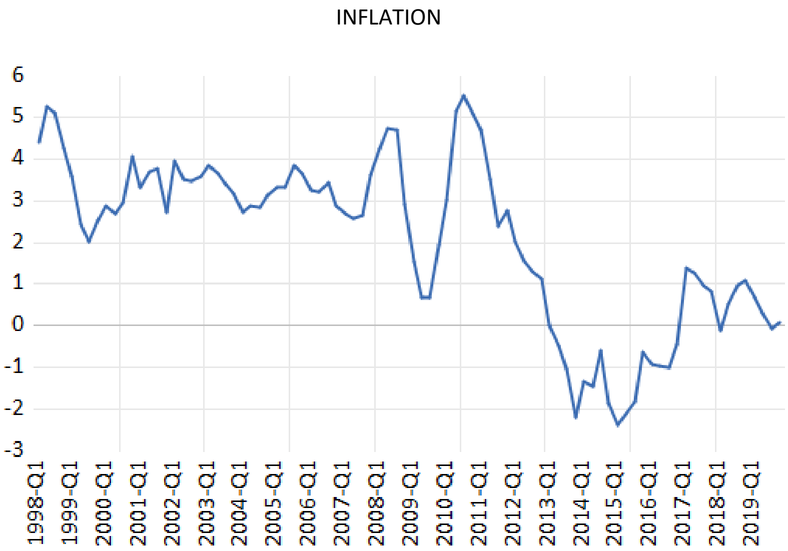
2014-Q4
2016-Q1
2017-Q2
2018-Q3
2019-Q4


UNCERTAINTY
500
400
300
200
100
0
1991-Q1
1992-Q2
1993-Q3
1994-Q4
1996-Q1
1997-Q2
1998-Q3
1999-Q4
2001-Q1
2002-Q2
2003-Q3
2004-Q4
2006-Q1
2007-Q2
2008-Q3
2009-Q4
2011-Q1
2012-Q2
2013-Q3
2014-Q4
2016-Q1
2017-Q2
2018-Q3
2019-Q4

GREECE


INFLATION
6
5
4
3
2
1
0
-1
-2
-3
1998-Q1
1999-Q1
2000-Q1
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2002-Q1
2003-Q1
2004-Q1
2005-Q1
2006-Q1
2007-Q1
2008-Q1
2009-Q1
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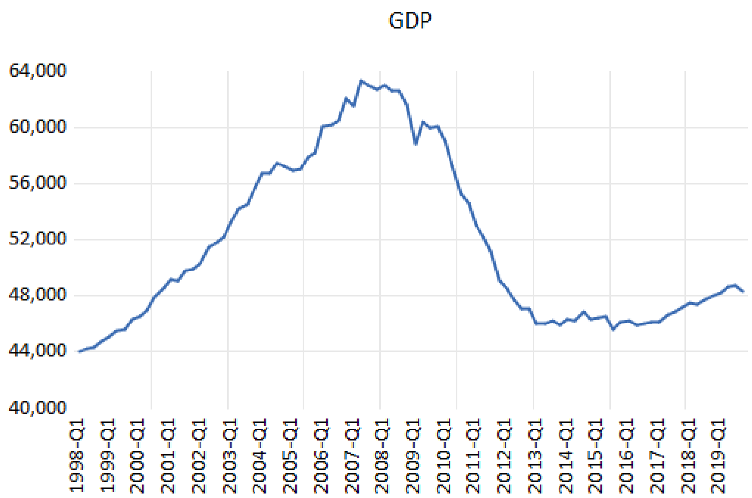
2018-Q1
2019-Q1


GDP
64,000
60,000
56,000
52,000
48,000
44,000
40,000
1998-Q1
1999-Q1
2000-Q1
2001-Q1
2002-Q1
2003-Q1
2004-Q1
2005-Q1
2006-Q1
2007-Q1
2008-Q1
2009-Q1
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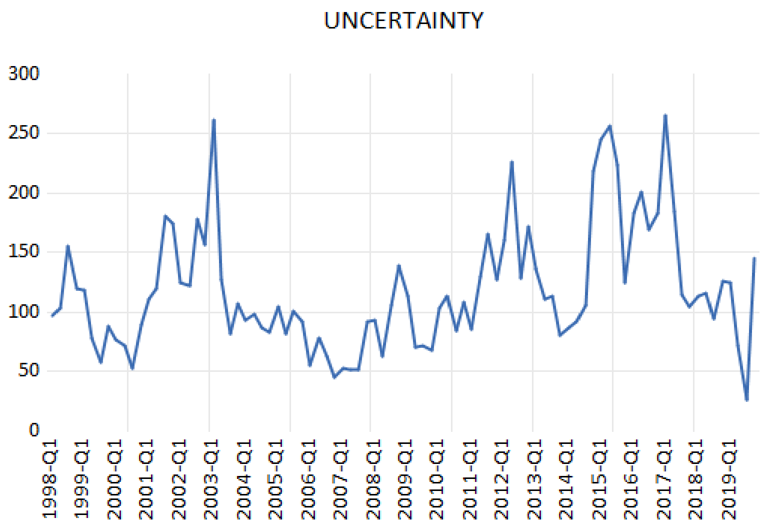
2018-Q1
2019-Q1


UNCERTAINTY
300
250
200
150
100
50
0
1998-Q1
1999-Q1
2000-Q1
2001-Q1
2002-Q1
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2004-Q1
2005-Q1
2006-Q1
2007-Q1
2008-Q1
2009-Q1
2010-Q1
2011-Q1
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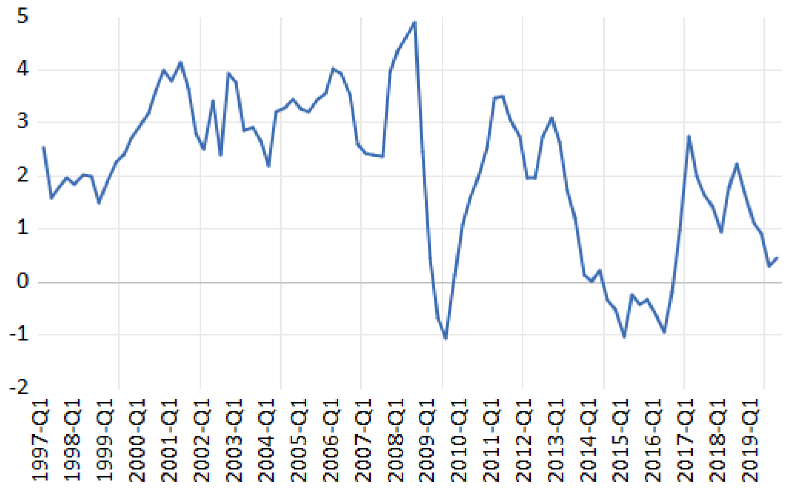
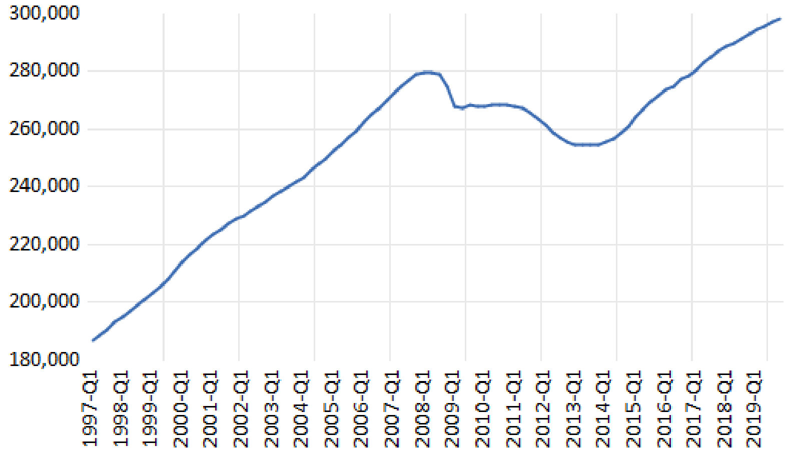
2014-Q1
2015-Q1
2016-Q1
2017-Q1
2018-Q1
2019-Q1

SPAIN

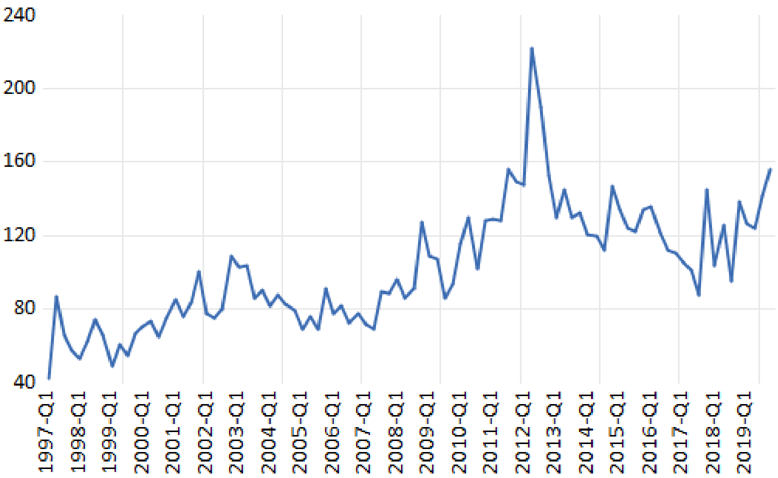
INFLATION



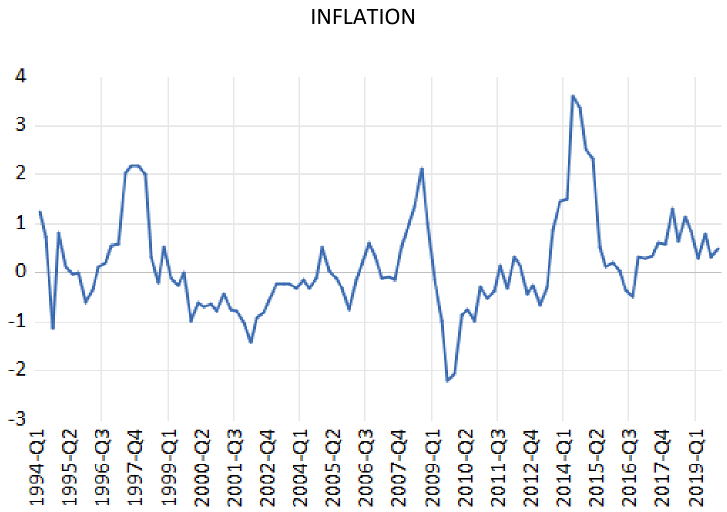
GDP



UNCERTAINTY



JAPAN



INFLATION
4
3
2
1
0
-1
-2
-3
1994-Q1
1995-Q2
1996-Q3
1997-Q4
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2000-Q2
2001-Q3
2002-Q4
2004-Q1
2005-Q2
2006-Q3
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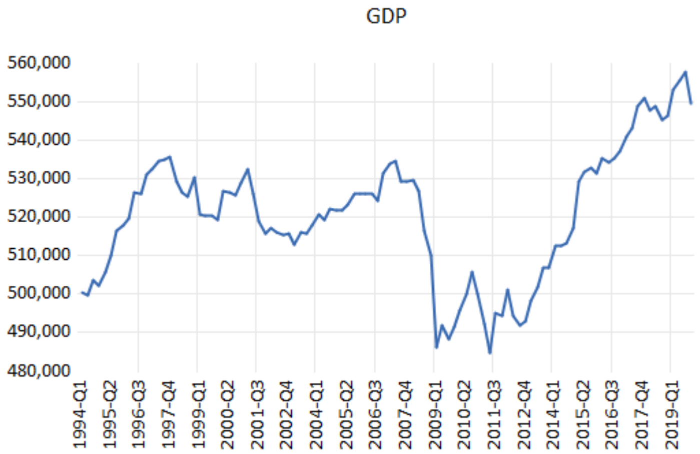
2017-Q4
2019-Q1



GDP
560,000
550,000
540,000
530,000
520,000
510,000
500,000
490,000
480,000
1994-Q1
1995-Q2
1996-Q3
1997-Q4
1999-Q1
2000-Q2
2001-Q3
2002-Q4
2004-Q1
2005-Q2
2006-Q3
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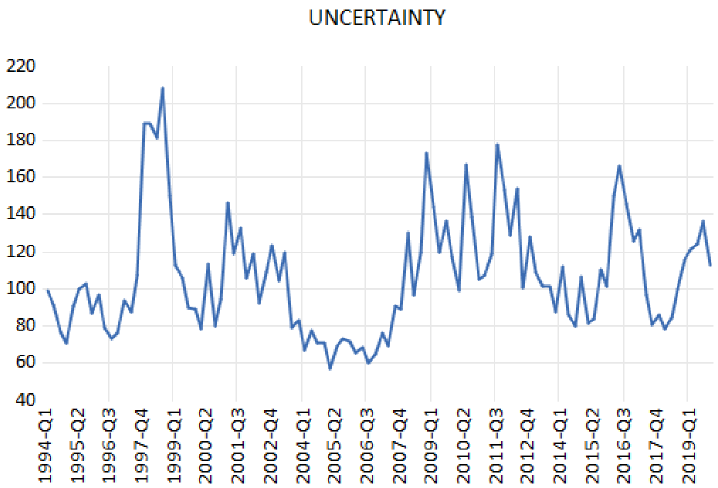
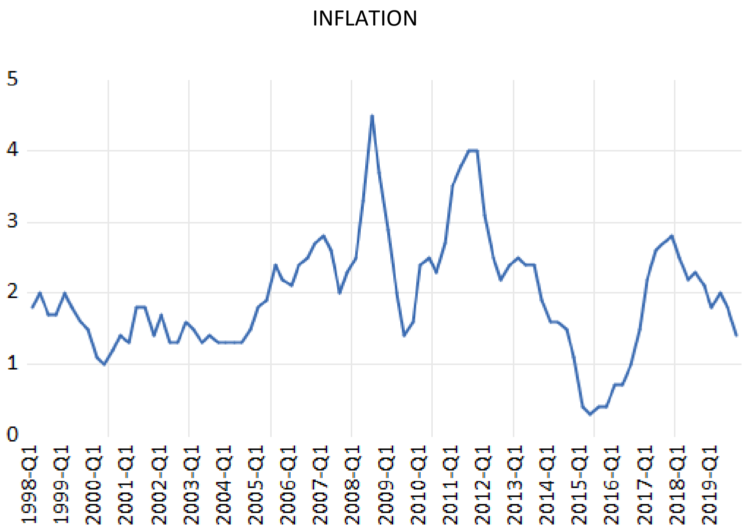
2017-Q4
2019-Q1



UNCERTAINTY
220
200
180
160
140
120
100
80
60
40
1994-Q1
1995-Q2
1996-Q3
1997-Q4
1999-Q1
2000-Q2
2001-Q3
2002-Q4
2004-Q1
2005-Q2
2006-Q3
2007-Q4
2009-Q1
2010-Q2
2011-Q3
2012-Q4
2014-Q1
2015-Q2
2016-Q3
2017-Q4
2019-Q1

U.K.


INFLATION
0
1
2
3
4
5
1998-Q1
1999-Q1
2000-Q1
2001-Q1
2002-Q1
2003-Q1
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2005-Q1
2006-Q1
2007-Q1
2008-Q1
2009-Q1
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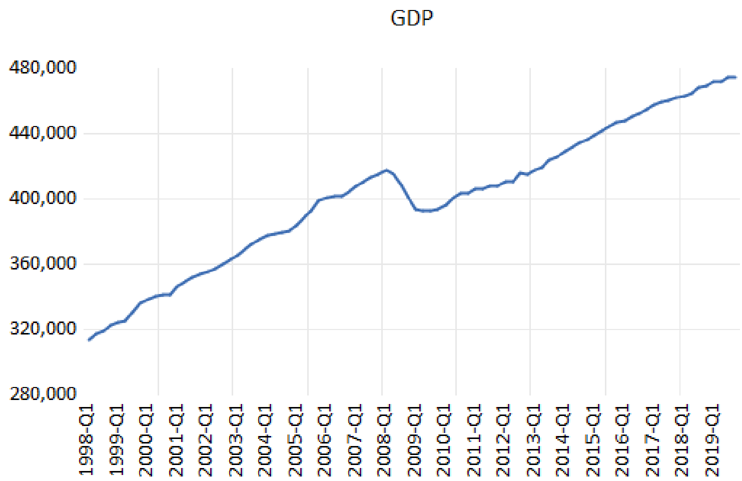
2018-Q1
2019-Q1


GDP
280,000
320,000
360,000
400,000
440,000
480,000
1998-Q1
1999-Q1
2000-Q1
2001-Q1
2002-Q1
2003-Q1
2004-Q1
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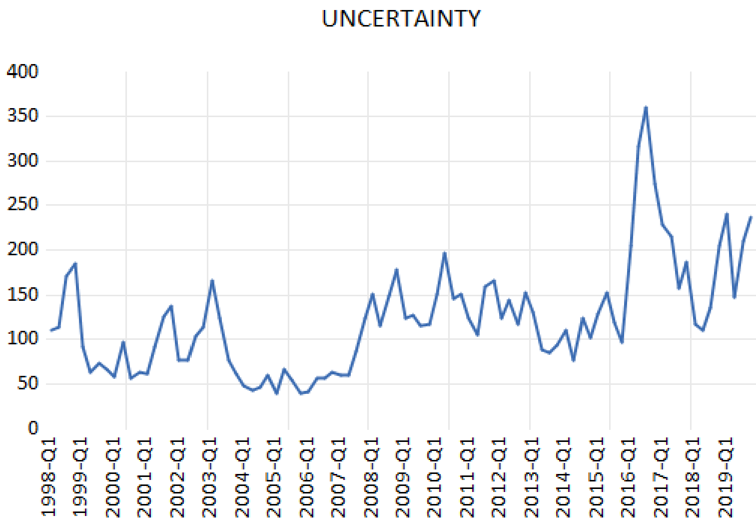
2019-Q1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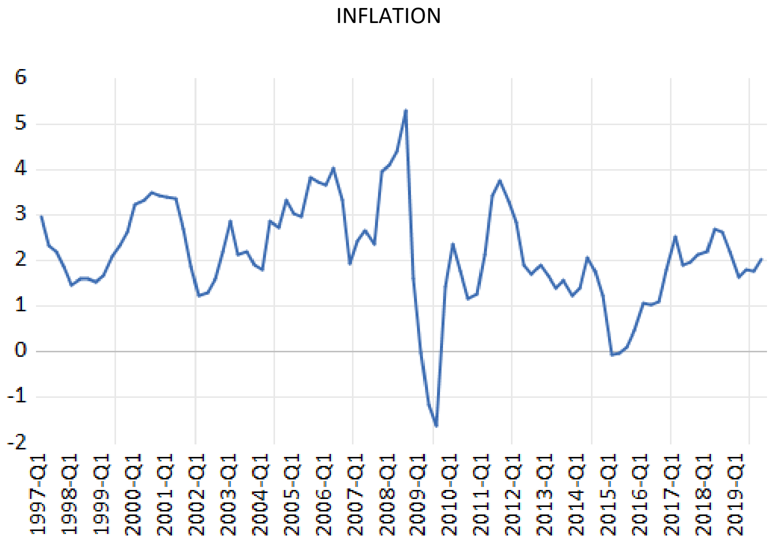
2019-Q1

U.S.



INFLATION
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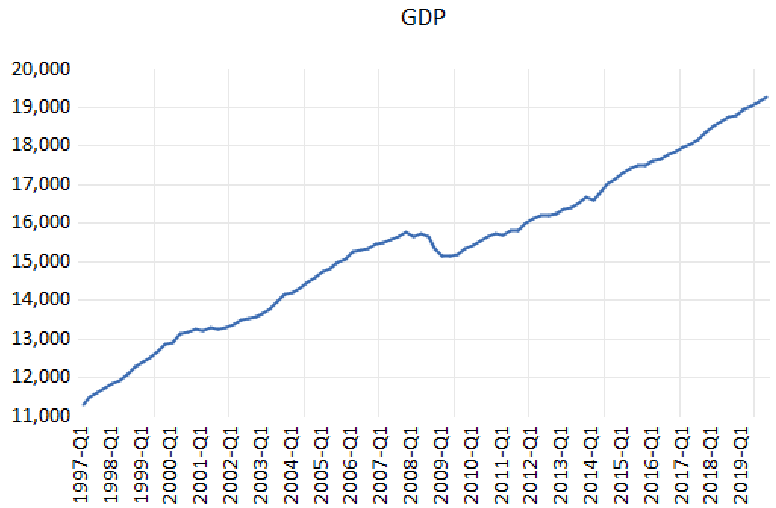

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11,000
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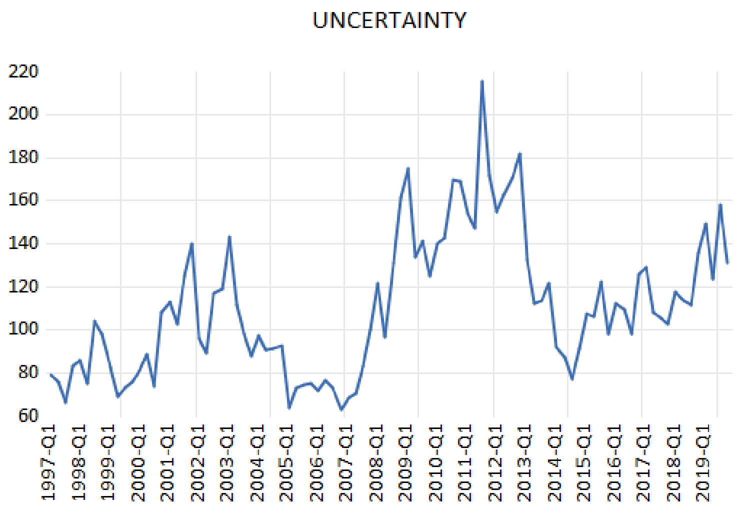
2019-Q1



UNCERTAINTY
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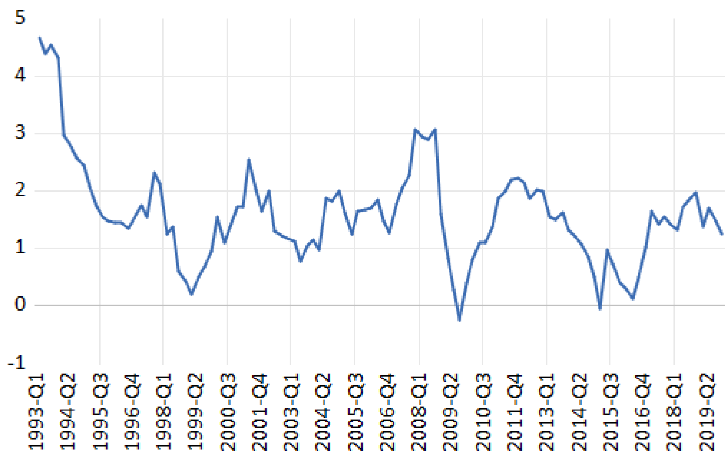
2019-Q1

GERMANY

INFLATION



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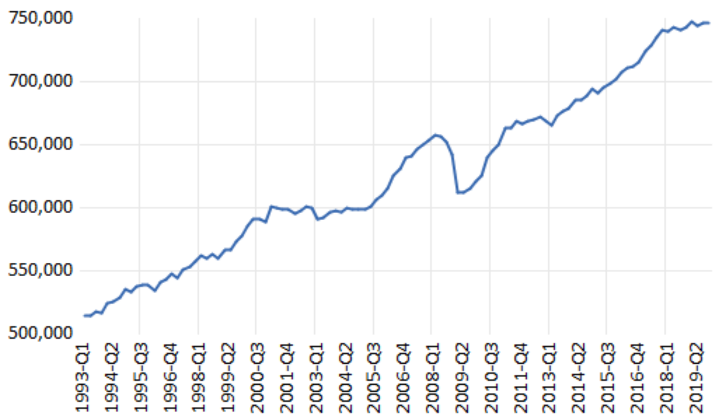

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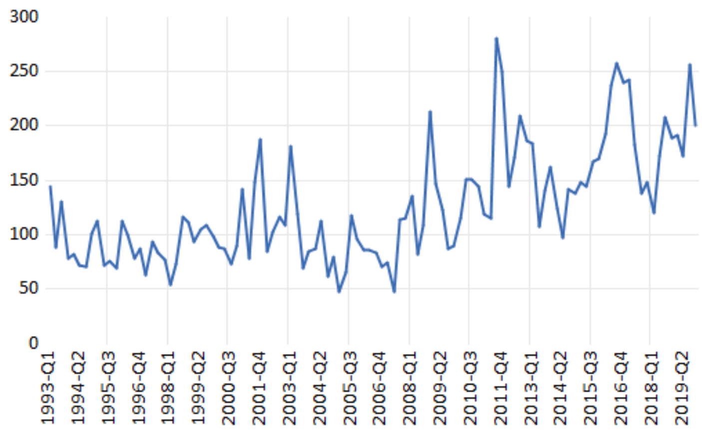

When I am using, as variables in VAR analysis, inflation uncertainty, GDP and inflation.

VAR Residual Serial Correlation LM Tests

CANADA

Sample: 1 120
Included observations: 107

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	7.989255	9	0.5352	0.889626	(9, 216.8)	0.5353
2	7.243333	9	0.6118	0.805193	(9, 216.8)	0.6119
3	4.051603	9	0.9080	0.447124	(9, 216.8)	0.9080
4	4.891149	9	0.8437	0.540808	(9, 216.8)	0.8437
5	10.05430	9	0.3461	1.124872	(9, 216.8)	0.3462

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	7.989255	9	0.5352	0.889626	(9, 216.8)	0.5353
2	11.59052	18	0.8676	0.638030	(18, 243.7)	0.8678
3	15.69599	27	0.9585	0.570230	(27, 243.0)	0.9587
4	21.39373	36	0.9744	0.578524	(36, 237.1)	0.9747
5	43.00251	45	0.5569	0.953069	(45, 229.5)	0.5616

*Edgeworth expansion corrected likelihood ratio statistic.

AUSTRALIA

Sample: 1 88
Included observations: 71

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	15.58899	9	0.0760	1.781209	(9, 151.0)	0.0761
2	9.491501	9	0.3932	1.063037	(9, 151.0)	0.3934

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	15.58899	9	0.0760	1.781209	(9, 151.0)	0.0761
2	26.31636	18	0.0927	1.505460	(18, 167.4)	0.0933

*Edgeworth expansion corrected likelihood ratio statistic.

FRANCE

Sample: 1 116
Included observations: 98

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	16.33306	9	0.0602	1.858219	(9, 194.8)	0.0603
2	11.38025	9	0.2505	1.278485	(9, 194.8)	0.2507

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	16.33306	9	0.0602	1.858219	(9, 194.8)	0.0603
2	28.60219	18	0.0535	1.633923	(18, 218.3)	0.0537

*Edgeworth expansion corrected likelihood ratio statistic.

GREECE

Sample: 1 88
Included observations: 77

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	10.76603	9	0.2921	1.213233	(9, 129.1)	0.2924
2	17.13198	9	0.0467	1.978337	(9, 129.1)	0.0468
3	17.96561	9	0.0356	2.081276	(9, 129.1)	0.0357
4	9.369650	9	0.4039	1.050260	(9, 129.1)	0.4042
5	6.784610	9	0.6595	0.753049	(9, 129.1)	0.6597
6	12.68952	9	0.1772	1.440551	(9, 129.1)	0.1774
7	11.87193	9	0.2206	1.343525	(9, 129.1)	0.2209

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	10.76603	9	0.2921	1.213233	(9, 129.1)	0.2924
2	25.38572	18	0.1147	1.454756	(18, 141.9)	0.1155
3	36.94018	27	0.0962	1.421924	(27, 137.9)	0.0983
4	43.06527	36	0.1946	1.229049	(36, 130.7)	0.2012
5	51.11011	45	0.2462	1.159884	(45, 122.6)	0.2596
6	74.82927	54	0.0318	1.491653	(54, 114.0)	0.0383
7	84.36292	63	0.0375	1.439449	(63, 105.3)	0.0493

*Edgeworth expansion corrected likelihood ratio statistic.

SPAIN

Sample: 1 92
Included observations: 81

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	10.86000	9	0.2854	1.224933	(9, 124.3)	0.2857
2	6.904681	9	0.6470	0.766701	(9, 124.3)	0.6473
3	4.843007	9	0.8478	0.533417	(9, 124.3)	0.8479
4	15.90117	9	0.0690	1.829905	(9, 124.3)	0.0691
5	14.49197	9	0.1059	1.658381	(9, 124.3)	0.1061
6	8.154935	9	0.5186	0.910015	(9, 124.3)	0.5189
7	12.92920	9	0.1658	1.470365	(9, 124.3)	0.1661
8	9.468925	9	0.3952	1.062154	(9, 124.3)	0.3955
9	5.799887	9	0.7598	0.641222	(9, 124.3)	0.7599

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	10.86000	9	0.2854	1.224933	(9, 124.3)	0.2857
2	18.87259	18	0.3997	1.058033	(18, 136.2)	0.4012
3	21.59322	27	0.7577	0.787983	(27, 132.1)	0.7604
4	44.99140	36	0.1447	1.294439	(36, 124.8)	0.1509
5	52.06559	45	0.2181	1.186527	(45, 116.6)	0.2321
6	55.34556	54	0.4237	1.022783	(54, 108.1)	0.4516
7	61.05466	63	0.5460	0.946669	(63, 99.3)	0.5880
8	67.58047	72	0.6256	0.896737	(72, 90.5)	0.6833
9	76.66427	81	0.6157	0.889950	(81, 81.6)	0.6997

*Edgeworth expansion corrected likelihood ratio statistic.

U.K.

Sample: 1 88
Included observations: 76

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	10.16679	9	0.3372	1.141369	(9, 148.6)	0.3374
2	10.60450	9	0.3038	1.192242	(9, 148.6)	0.3040
3	9.180478	9	0.4208	1.027270	(9, 148.6)	0.4210
4	7.200823	9	0.6162	0.800479	(9, 148.6)	0.6164

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	10.16679	9	0.3372	1.141369	(9, 148.6)	0.3374
2	18.87109	18	0.3998	1.056508	(18, 164.5)	0.4008
3	27.04571	27	0.4613	1.005886	(27, 161.3)	0.4642
4	31.10512	36	0.7005	0.853429	(36, 154.4)	0.7051

*Edgeworth expansion corrected likelihood ratio statistic.

JAPAN

Sample: 1 104
Included observations: 93

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	3.939823	9	0.9153	0.433790	(9, 168.1)	0.9154
2	11.66473	9	0.2329	1.313796	(9, 168.1)	0.2330
3	5.301745	9	0.8073	0.586074	(9, 168.1)	0.8073
4	11.15409	9	0.2653	1.254394	(9, 168.1)	0.2655
5	8.052346	9	0.5289	0.897346	(9, 168.1)	0.5290
6	5.296886	9	0.8077	0.585529	(9, 168.1)	0.8078
7	4.510410	9	0.8747	0.497443	(9, 168.1)	0.8748

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	3.939823	9	0.9153	0.433790	(9, 168.1)	0.9154
2	13.09042	18	0.7862	0.721357	(18, 187.2)	0.7866
3	15.43542	27	0.9629	0.556953	(27, 184.6)	0.9632
4	21.94844	36	0.9684	0.589057	(36, 178.0)	0.9690
5	27.17018	45	0.9836	0.575900	(45, 170.1)	0.9842
6	39.85260	54	0.9246	0.708322	(54, 161.7)	0.9285
7	51.39987	63	0.8518	0.785109	(63, 153.1)	0.8623

*Edgeworth expansion corrected likelihood ratio statistic.

U.S.

Sample: 1 92
Included observations: 86

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.09930	9	0.2690	1.247622	(9, 172.9)	0.2691
2	8.713038	9	0.4642	0.972731	(9, 172.9)	0.4643
3	5.302701	9	0.8072	0.586267	(9, 172.9)	0.8072
4	11.19834	9	0.2624	1.259112	(9, 172.9)	0.2625

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.09930	9	0.2690	1.247622	(9, 172.9)	0.2691
2	19.74093	18	0.3476	1.106525	(18, 192.8)	0.3483
3	26.59898	27	0.4856	0.987788	(27, 190.5)	0.4876
4	38.41659	36	0.3606	1.076472	(36, 183.9)	0.3649

*Edgeworth expansion corrected likelihood ratio statistic.

GERMANY

Sample: 1 108
Included observations: 94

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	12.48914	9	0.1871	1.408860	(9, 177.8)	0.1872
2	12.01734	9	0.2123	1.353855	(9, 177.8)	0.2125
3	8.862335	9	0.4501	0.989686	(9, 177.8)	0.4502
4	15.92020	9	0.0686	1.813204	(9, 177.8)	0.0686
5	13.39704	9	0.1454	1.515111	(9, 177.8)	0.1456
6	8.167737	9	0.5173	0.910359	(9, 177.8)	0.5175

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	12.48914	9	0.1871	1.408860	(9, 177.8)	0.1872
2	20.49208	18	0.3058	1.150486	(18, 198.5)	0.3065
3	26.41331	27	0.4958	0.980410	(27, 196.3)	0.4977
4	38.41433	36	0.3607	1.076209	(36, 189.8)	0.3648
5	54.68932	45	0.1526	1.246982	(45, 182.0)	0.1580
6	61.53057	54	0.2245	1.160763	(54, 173.6)	0.2351

*Edgeworth expansion corrected likelihood ratio statistic.

The reported results in tables above indicate that P>5%, so there is no autocorrelation in my analysis.

VAR Residual Normality Tests (Doornik-Hansen)

COUNTRY	JARQUE-BERA	P-JOINT
CANADA	92.38	0.000
AUSTRALIA	6.13	0.409
FRANCE	24.31	0.000
GREECE	47.24	0.000
SPAIN	6.11	0.410
U.K.	88.49	0.000
JAPAN	64.24	0.000
U.S.	29.75	0.000
GERMANY	49.18	0.000

The reported results in the table above indicate that p-value joint<5%, so residuals are not normal (except AUSTRALIA and SPAIN).

VAR Residual Heteroskedasticity Tests (Levels and Squares)

COUNTRY	CHI-SQ	PROBABILITY
CANADA	135.12	0.689
AUSTRALIA	46.97	0.104
FRANCE	168.76	0.077
GREECE	196.03	0.831
SPAIN	353.05	0.005
U.K.	116.59	0.269
JAPAN	253.35	0.041
U.S.	200.61	0.000
GERMANY	208.21	0.073

The reported results in the table above indicate that P-value >5%, so there is no heteroskedasticity (except JAPAN and U.S.).

When I am using, as variables in VAR analysis, economic policy uncertainty, GDP and inflation.

VAR Residual Serial Correlation LM Tests

CANADA

Sample: 1 120
Included observations: 115

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	13.08289	9	0.1589	1.472239	(9, 236.2)	0.1590
2	19.85165	9	0.0189	2.266068	(9, 236.2)	0.0189
3	7.726364	9	0.5619	0.859731	(9, 236.2)	0.5620
4	7.256100	9	0.6105	0.806608	(9, 236.2)	0.6105
5	9.385882	9	0.4024	1.048033	(9, 236.2)	0.4025

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	13.08289	9	0.1589	1.472239	(9, 236.2)	0.1590
2	27.58001	18	0.0687	1.564882	(18, 266.4)	0.0689
3	30.69533	27	0.2838	1.147921	(27, 266.4)	0.2849
4	37.60726	36	0.3955	1.050202	(36, 260.7)	0.3978
5	46.47513	45	0.4114	1.037215	(45, 253.3)	0.4155

*Edgeworth expansion corrected likelihood ratio statistic.

AUSTRALIA

Sample: 1 88
Included observations: 83

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	4.091122	9	0.9053	0.450407	(9, 158.3)	0.9054
2	5.371792	9	0.8008	0.593757	(9, 158.3)	0.8009
3	5.949089	9	0.7450	0.658748	(9, 158.3)	0.7451
4	12.05599	9	0.2102	1.360634	(9, 158.3)	0.2103
5	6.015531	9	0.7384	0.666243	(9, 158.3)	0.7385

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	4.091122	9	0.9053	0.450407	(9, 158.3)	0.9054
2	11.96103	18	0.8492	0.656717	(18, 175.8)	0.8496
3	18.18777	27	0.8977	0.660055	(27, 173.0)	0.8985
4	33.22399	36	0.6013	0.917973	(36, 166.2)	0.6061
5	37.61486	45	0.7747	0.818565	(45, 158.2)	0.7809

*Edgeworth expansion corrected likelihood ratio statistic.

FRANCE

Sample: 1 116
Included observations: 111

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	14.17614	9	0.1162	1.599959	(9, 226.5)	0.1163
2	5.286179	9	0.8087	0.585113	(9, 226.5)	0.8087
3	21.46223	9	0.0107	2.461466	(9, 226.5)	0.0108

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	14.17614	9	0.1162	1.599959	(9, 226.5)	0.1163
2	21.38760	18	0.2603	1.200195	(18, 255.0)	0.2607
3	35.17788	27	0.1344	1.327393	(27, 254.7)	0.1352

*Edgeworth expansion corrected likelihood ratio statistic.

GREECE

Sample: 1 88
Included observations: 84

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	17.16568	9	0.0462	1.965049	(9, 168.1)	0.0463
2	7.844884	9	0.5499	0.873694	(9, 168.1)	0.5500
3	16.85217	9	0.0511	1.927370	(9, 168.1)	0.0512
4	10.71361	9	0.2959	1.203296	(9, 168.1)	0.2960

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	17.16568	9	0.0462	1.965049	(9, 168.1)	0.0463
2	23.67915	18	0.1658	1.341310	(18, 187.2)	0.1664
3	32.88569	27	0.2009	1.241427	(27, 184.6)	0.2027
4	38.84316	36	0.3428	1.089858	(36, 178.0)	0.3474

*Edgeworth expansion corrected likelihood ratio statistic.

SPAIN

Sample: 1 92
Included observations: 87

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	5.961928	9	0.7437	0.660329	(9, 168.1)	0.7438
2	8.470091	9	0.4876	0.945058	(9, 168.1)	0.4877
3	4.634463	9	0.8649	0.511310	(9, 168.1)	0.8650
4	9.356666	9	0.4050	1.046703	(9, 168.1)	0.4052
5	7.351692	9	0.6006	0.817582	(9, 168.1)	0.6007

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	5.961928	9	0.7437	0.660329	(9, 168.1)	0.7438
2	12.84548	18	0.8007	0.707410	(18, 187.2)	0.8011
3	13.82571	27	0.9829	0.496812	(27, 184.6)	0.9830
4	32.50564	36	0.6356	0.896896	(36, 178.0)	0.6396
5	33.87082	45	0.8878	0.730929	(45, 170.1)	0.8910

*Edgeworth expansion corrected likelihood ratio statistic.

JAPAN

Sample: 1 104
Included observations: 97

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	4.517384	9	0.8742	0.498426	(9, 177.8)	0.8742
2	6.668992	9	0.6715	0.740225	(9, 177.8)	0.6716
3	13.20065	9	0.1537	1.492082	(9, 177.8)	0.1539
4	11.00814	9	0.2752	1.236678	(9, 177.8)	0.2753
5	8.540318	9	0.4807	0.952872	(9, 177.8)	0.4809
6	13.56969	9	0.1385	1.535377	(9, 177.8)	0.1386
7	4.623382	9	0.8658	0.510271	(9, 177.8)	0.8659

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	4.517384	9	0.8742	0.498426	(9, 177.8)	0.8742
2	13.14433	18	0.7829	0.724772	(18, 198.5)	0.7833
3	26.26643	27	0.5039	0.974608	(27, 196.3)	0.5058
4	28.18039	36	0.8207	0.769693	(36, 189.8)	0.8229
5	41.18612	45	0.6342	0.907265	(45, 182.0)	0.6408
6	45.92163	54	0.7748	0.831632	(54, 173.6)	0.7830
7	57.27541	63	0.6795	0.891529	(63, 165.0)	0.6953

*Edgeworth expansion corrected likelihood ratio statistic.

U.K.

Sample: 1 88
Included observations: 79

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.24517	9	0.2593	1.271147	(9, 119.4)	0.2596
2	8.563212	9	0.4785	0.957336	(9, 119.4)	0.4788
3	18.22322	9	0.0327	2.120461	(9, 119.4)	0.0328
4	5.097167	9	0.8258	0.561793	(9, 119.4)	0.8259
5	3.441938	9	0.9442	0.376798	(9, 119.4)	0.9442
6	5.088643	9	0.8265	0.560834	(9, 119.4)	0.8267
7	14.64287	9	0.1012	1.678667	(9, 119.4)	0.1014
8	7.050738	9	0.6318	0.783361	(9, 119.4)	0.6321
9	13.33653	9	0.1480	1.520651	(9, 119.4)	0.1482

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.24517	9	0.2593	1.271147	(9, 119.4)	0.2596
2	24.73396	18	0.1324	1.417520	(18, 130.6)	0.1335
3	39.69733	27	0.0547	1.548843	(27, 126.2)	0.0564
4	43.73074	36	0.1761	1.253698	(36, 118.9)	0.1836
5	53.81634	45	0.1726	1.235974	(45, 110.7)	0.1863
6	61.16592	54	0.2343	1.157163	(54, 102.1)	0.2610
7	70.91077	63	0.2308	1.145079	(63, 93.4)	0.2733
8	76.06981	72	0.3489	1.044514	(72, 84.5)	0.4217
9	84.10579	81	0.3847	1.004851	(81, 75.6)	0.4925

*Edgeworth expansion corrected likelihood ratio statistic.

U.S.

Sample: 1 92
Included observations: 83

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	5.546667	9	0.7843	0.612757	(9, 129.1)	0.7844
2	8.827942	9	0.4533	0.987497	(9, 129.1)	0.4536
3	13.64356	9	0.1356	1.554531	(9, 129.1)	0.1358
4	8.920835	9	0.4446	0.998241	(9, 129.1)	0.4449
5	11.71866	9	0.2296	1.325402	(9, 129.1)	0.2299
6	13.67797	9	0.1343	1.558656	(9, 129.1)	0.1345
7	5.439718	9	0.7944	0.600698	(9, 129.1)	0.7946
8	10.04467	9	0.3469	1.128827	(9, 129.1)	0.3472
9	7.876321	9	0.5467	0.877860	(9, 129.1)	0.5469

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	5.546667	9	0.7843	0.612757	(9, 129.1)	0.7844
2	12.75932	18	0.8057	0.700407	(18, 141.9)	0.8064
3	26.37946	27	0.4976	0.979178	(27, 137.9)	0.5013
4	45.40303	36	0.1354	1.306575	(36, 130.7)	0.1409
5	46.60694	45	0.4061	1.040372	(45, 122.6)	0.4213
6	59.37667	54	0.2861	1.115181	(54, 114.0)	0.3099
7	74.89084	63	0.1451	1.229866	(63, 105.3)	0.1731
8	79.73440	72	0.2489	1.117411	(72, 96.5)	0.3035
9	84.85207	81	0.3631	1.026934	(81, 87.6)	0.4505

*Edgeworth expansion corrected likelihood ratio statistic.

GERMANY

Sample: 1 108
Included observations: 94

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	12.48914	9	0.1871	1.408860	(9, 177.8)	0.1872
2	12.01734	9	0.2123	1.353855	(9, 177.8)	0.2125
3	8.862335	9	0.4501	0.989686	(9, 177.8)	0.4502
4	15.92020	9	0.0686	1.813204	(9, 177.8)	0.0686
5	13.39704	9	0.1454	1.515111	(9, 177.8)	0.1456
6	8.167737	9	0.5173	0.910359	(9, 177.8)	0.5175

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	12.48914	9	0.1871	1.408860	(9, 177.8)	0.1872
2	20.49208	18	0.3058	1.150486	(18, 198.5)	0.3065
3	26.41331	27	0.4958	0.980410	(27, 196.3)	0.4977
4	38.41433	36	0.3607	1.076209	(36, 189.8)	0.3648
5	54.68932	45	0.1526	1.246982	(45, 182.0)	0.1580
6	61.53057	54	0.2245	1.160763	(54, 173.6)	0.2351

*Edgeworth expansion corrected likelihood ratio statistic.

The reported results in tables above indicate that P>5%, so there is no autocorrelation in my analysis.

VAR Residual Normality Tests (Doornik-Hansen)

COUNTRY	JARQUE-BERA	P-JOINT
CANADA	38.29	0.000
AUSTRALIA	49.06	0.000
FRANCE	7.44	0.282
GREECE	24.94	0.000
SPAIN	51.44	0.000
U.K.	7.144	0.31
JAPAN	19.36	0.004
U.S.	13.09	0.042
GERMANY	30.08	0.000

The reported results in the table above indicate that p-value joint<5%, so residuals are not normal (except FRANCE and U.K.).

VAR Residual Heteroskedasticity Tests (Levels and Squares)

COUNTRY	CHI-SQ	PROBABILITY
CANADA	145.63	0.446
AUSTRALIA	134.92	0.694
FRANCE	194.38	0.003
GREECE	119.57	0.210
SPAIN	184.30	0.013
U.K.	288.33	0.483
JAPAN	201.96	0.745
U.S.	302.44	0.268
GERMANY	272.43	0.737

The reported results in the table above indicate that P-value >5%, so there is no heteroskedasticity (except FRANCE and SPAIN).

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