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Inflation and Inflation Uncertainty Nexus in Kuwait: A Generalized Autoregressive Conditional Heteroscedasticity Modeling Approach

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ABSTRACT

In the this paper, we analyze the causality between inflation and inflation uncertainty in Kuwait. The monthly consumer price index during the period from January 1992 to September 2016 has been used to measure inflation. The inflation uncertainty is estimated by the conditional variances of inflation obtained using the Akaike, Schwarz information criteria and Hannan–Quinn criteria. In order to ensure the robustness of the results, the Granger-causality technique is performed. The study findings show that the inflation significantly Granger-causes inflation uncertainty, supporting Friedman–Ball hypothesis. However, no empirical evidence is found to support the Cukierman–Meltzer hypothesis (1986) and only unidirectional relation is evident with causality running from inflation to inflation uncertainty. High volatility persistence for inflation is also confirmed. The findings of the study may be useful for policymakers at central bank to apply more efficient monetary measures.

Keywords: Inflation, Inflation Uncertainty, Generalized Autoregressive Conditional Heteroscedasticity model, Granger Causality, Kuwait
JEL Classifications: D8, E31

1. INTRODUCTION

The first scholar who analyzed the relationship between inflation and inflation uncertainty was Friedman (1977), who eventually received the Nobel prize for his research on the topic. He claimed that rise in inflation might instigate an inconsistent and even erroneous monetary policy response that could lead to the increase in inflation uncertainty in future periods. Later on, Ball (1992) proposed a model in which higher inflation leads to increasing uncertainty over the monetary policy stance. The possibility of a negative effect of inflation on inflation uncertainty has been discussed also, by Pourgerami and Maskus (1987), who pointed out that in a world of accelerating inflation agents (e.g. firms and households) may invest more resources in inflation forecasting, and thereby reducing uncertainty. The same view was further developed by Ungar and Zilberfarb (1993). This first hypothesis is usually denoted the Friedman–Ball hypothesis.

In the second hypothesis is usually referred to as the Cukierman–Meltzer hypothesis, it is postulated that inflation uncertainty causes inflation. This means that causality relation might also run in the opposite direction, from inflation uncertainty to average inflation (Cukierman and Meltzer, 1986). According to this hypothesis central banks differ when it comes to the priority of their objectives, such as high output growth and low inflation. In such a manner, less conservative monetary authorities may have a greater tendency towards discretionary policy to create inflation surprises in the presence of more inflation uncertainty. This "opportunistic" act is an attempt of the central bank to incite higher short-term economic growth. It has been concluded that inflation and inflation uncertainty have positive correlation that runs from inflation uncertainty to inflation. The same causality, but with a negative relationship between variables, was proposed by Holland (1995) postulating that the increase in inflation uncertainty can bring a reduction in inflation rate as an outcome of the stabilization policy pursued in times of greater inflation uncertainty. This is sometimes denoted the "stabilizing fed hypothesis." In this context it has been suggested that the stabilizing behavior of the monetary authorities is related to the level of central bank independence, in particular the higher the level of central bank independence, the lesser the rate of inflation (Grier and Perry, 1998).

The purpose of the present paper is to fill the gap in the literature through examining the relationship between inflation and inflation uncertainty empirically for Kuwait. As the econometric studies in MENA region on the subject are still sparse, Sharaf (2015), this paper contributes to inflation literature in several aspects. Firstly, it is the first attempt to model the impact of inflation on inflation uncertainty in Kuwait using generalized autoregressive conditional heteroscedasticity (GARCH) modeling. Secondly, and more importantly, amid unprecedented higher inflation rate in this work has greater policy relevance. Furthermore, the paper investigates the relationship between inflation and inflation uncertainty by using granger causality technique.

For the purpose of this paper, inflation is measured by means of the consumer price index (CPI), while the inflation uncertainty is modeled by the GARCH model. The data series is compounded of the monthly data for the period 1992:1-2016:9 on the CPI as provided by International Financial Statistics of IMF.

The paper is structured as follows: Section 2 provides a review of literature on inflation and inflation uncertainty nexus, data and methodology is presented in Section 3. The empirical analysis in Section 4. The obtained results are discussed in Section 5.

2. LITRATURE REVIEW

The empirical research on the topic stems from the pioneer preoccupations of Okun (1971), who found, for 17 OECD countries, a positive relationship between inflation rate and inflation variability. But Friedman's contribution (1977) on the real effects of inflation was the one that generated extensive debates in the literature. For example, Baillie et al. (1996) found evidence supporting the Cukierman–Meltzer hypothesis for UK. However, Fountas and Karanasos (2007) in their study confirmed Friedman–Ball hypothesis for G7 countries excluding UK. A positive impact of inflation uncertainty on inflation was also reported by Golob (1994) for US. Grier and Mark (1998) found evidence supporting Friedman and Ball hypothesis by using GARCH models for G-7 countries, but a week evidence was found for Cukierman and Meltzer hypothesis.

Kontonikas (2004) used a proxy for the inflation uncertainty using conditional volatility modeling from symmetric, asymmetric and component GARCH in mean models, the result supported the Friedman-Ball model. Broto (2008) found for the Latin American countries that inflation targeting lowers inflation and inflation uncertainty. However, Hasanov and Omay (2011) analyzed the relationship between inflation, output and their uncertainties in Central and Eastern European countries suggesting that inflation induces uncertainty both in inflation and growth. Similar study was conducted by Daal et al. (2005), for developed and emerging countries.

Zivkov et al. (2014) used GARCH type model and quantile regression to test the linkage between inflation and inflation uncertainty in 11 Eastern European countries. The results of the study show a mixed evidence on the direction of causality between inflation and inflation uncertainty. Caporale et al. (2010) analyzed the relationship between inflation and inflation uncertainty for the EURO zone, using an AR-GARCH model for inflation. The study results supported Friedman–Ball hypothesis, suggesting that by focusing on long-run price stability a lower inflation uncertainty can be achieved.

Jemna et al. (2012) analyzed the causality between inflation and inflation uncertainty in Romania. They found that the inflation significantly Granger-causes inflation uncertainty supporting Friedman-Ball hypothesis. Also Javed et al. (2012) examined the relationship between inflation and inflation uncertainty for Pakistan by applying autoregressive, moving average (ARMA)-GARCH model to estimate the conditional volatility of inflation. The results of the study supported Friedman–Ball hypothesis for Pakistan as Granger-causality test revealed that inflation affects inflation uncertainty positively.

In the MENA region, Sharaf (2015) studied the inflation an inflation uncertainty relationship in Egypt by using various of the GARCH-M models. The main findings of his study indicate a statistically significant bi-directional positive relationship between inflation and inflation uncertainty, supporting both the Friedman–Ball and the Cukierman–Meltzer hypotheses. Ananzeh (2015), found a unidirectional relationship between inflation and inflation uncertainty in the case Jordan supporting Friedman–Ball hypothesis. Hachicha and Lean (2013) conducted a study on Tunisian inflation by using GARCH-in-mean model. The study concluded that inflation uncertainty has a positive and significant effect on the level of inflation only in the real term.

Samimi et al. (2012) used the full information maximum likelihood method to investigate the relationship between inflation and inflation uncertainty in five MENA countries including Iran, Egypt, Morocco, Syria and Jordan. Their study demonstrated that there is an asymmetric relationship between inflation and inflation uncertainty for these countries. Also the study supports the Friedman–Ball hypothesis that inflation increases inflation uncertainty.

3. DATA AND METHODOLOGY

3.1. Data

This paper uses monthly time series data on the Kuwaiti CPI during the period January 1992-September 2016. Data on the CPI are provided by International Financial Statistics. In compliance with the literature (Chris, 2008) the data are transformed, and we obtained the variable inflation.

$$\pi = 100 * d_{log}(CPI)$$

3.2. Methodology

3.2.1. Stationarity

In order to be able to estimate any kind of time series model the stationarity of the series must be evaluated. If the stationarity hypothesis is not con-firmed for the series, then the series must be transformed into a stationary series through one of the known traditional procedures, such as the first order difference of the series. Taking into account the limits of the most used stationarity test, the augmented Dickey–Fuller (ADF) test, in this paper for testing the stationarity, we used in parallel other two tests: Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. If the tests do not allow the rejection of the hypothesis of the existence of a unit root (the non-stationarity property) the data series must be traditional methods until a stationary series is obtained.

3.3. Modeling Inflation and Inflation Uncertainty

3.3.1. Checking autoregressive conditional heteroskedasticity (ARCH) effects

The first step of modeling inflation and inflation uncertainty is modeling of the mean equation of inflation by using an autoregressive, moving average ARMA (p,q) model. The equation may be presented as follows:

$$\pi = \alpha_0 + \sum_{i=0}^{p}\alpha_i\, \pi_{t-i} + \sum_{j=0}^{q}\beta_j\, \varepsilon_{t-j} + \varepsilon_t \qquad (1)$$

In which, $(\varepsilon_t \backslash \alpha_{t-1}) = 0$; var $(\varepsilon_t \backslash \alpha_{t-1}) = \sigma_t^2$

Prior modeling inflation uncertainty, it is also essential to check whether the conditional variance of the error terms $\hat{\varepsilon}^2$ in equation (1) has ARCH effects, and the residuals are serially uncorrelated. For these purposes, a set of diagnostic tests are used. These include: Engle's (1982) Lagrange multiplier test (LM) for the existence of ARCH effects; the Ljung–Box test for detecting serial correlation in the residuals.

For the stationary series an AR (*p*) autoregressive model was built. The order of this model takes values within 1 and 12, according to the monthly frequency of the available data. For the estimated models the significance of parameters is tested and out of all the possible models the model that admits the minimum value for the Akaike and Schwartz information criteria is chosen. An AR (*p*) model for inflation has the form:

$$\pi = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \ldots + \alpha_p\pi_{t-p} + \varepsilon_t \qquad (2)$$

After the explanatory model of inflation was chosen, a heteroscedastic model is estimated, enabling the estimation of inflation uncertainty. In this paper, taking into account the limits and advantages suggested by the literature (Viorica et al., 2014), we estimate GARCH (1,1) for modeling inflation uncertainty in Kuwait.

3.3.2. GARCH model

The ARCH model pioneered by Engle (1982) and its subsequent extensions have generated a vast literature on modeling conditional volatility in empirical literature. The ARCH model can represented as follows:

$$h_t = \alpha_0 + \sum_{j=1}^{q}\alpha_j \varepsilon_{t-j}^2 \qquad (3)$$

Where the conditional variance, h_t ($\sigma^2 = h_t$) of an ARCH model of order q, $\alpha_0 \geq r$, $\alpha_j \geq 0$ and there is a condition for h_t to be always positive.

Bollerslev (1986), introduced the GARCH (*p*,*q*) generalized model for which the conditional variance has an equation which takes into consideration the previous conditional variances:

$$h_t = \alpha_0 + \sum_{j=1}^{q}\alpha_j \varepsilon_{t-j}^2 + \sum_{i=1}^{p}\beta_i h_{t-i} \qquad (4)$$

For the estimation of inflation uncertainty, GARCH (1,1) model is usually used following most of the studies in literature. The variance in equation (4) represent conditional variances by means of the square errors and the variances from the previous moment. The equation of GARCH (1,1) can be presented as follows:

$$h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \qquad (5)$$

4. EMPERICAL STUDY

4.1. Data Description

The trend of inflation in Kuwait indicates some volatile characteristic inside the investigation period. This is also highly evident from the facts in Table 1. The inflation rates have a high standard deviation nearly equal to 2 times and half to its mean value. In Table 1, we observe that the mean of inflation is 0.236. Skewness is a measure of asymmetry of the distribution of the series around its mean, and the skewness of a symmetric distribution, such as the normal distribution, would be zero. Descriptive statistics reveal that quarterly inflation data are biased to the right and has a right tail. Kurtosis measures the flatness of the distribution of the series, and the kurtosis of the normal distribution is 3.

If the kurtosis exceeds 3, the distribution would be peaked relative to the normal. An excess kurtosis can easily be noticed in the inflation series as shown in Table 1. Jarque–Bera is a test statistic for testing whether the series is normally distributed under the null hypothesis. The test statistic measures the weighted average of the squared differences of the skewness and kurtosis of the series with those from the normal distribution. In our case study, a significant departure from normality due to the excess kurtosis that is also found in the inflation under investigation period. Figures 1 and 2 describe the CPI and inflation series.

4.2. Unit Root Test

In order to investigate the stationary of the data, the paper uses the ADF, Philips–Perron for which the null hypothesis is unit root, and KPSS tests, for which the null hypothesis is the stationarity one. The results of the statistical testing for the Kuwaiti inflation series are presented in Table 2.

As can be seen from the tabulated value the series is stationary in level or I (0) process. This is due inflation construction as it is derived by taking the logarithmic difference of CPI data and CPI

Table 1: Descriptive statistics of inflation series

Mean±SD	Skewness	Kurtosis	Jarque–Bera	P value
0.23825±0.661023	0.012634	6.697551	168.6278	0.00000

SD: Standard deviation

data is I (1) data meaning it will be stationary when we difference it once. And the logarithmic first difference of CPI gives as Inflation data as a result it is stationary.

4.3. Modeling Inflation

Selection criteria assess whether a fitted model offers an optimal balance between the goodness-of-fit and parsimony. This will help identify candidate models in determination of the inflation series or uncertainty inflation series.

Figure 1: Consumer price index in Kuwaiti economy

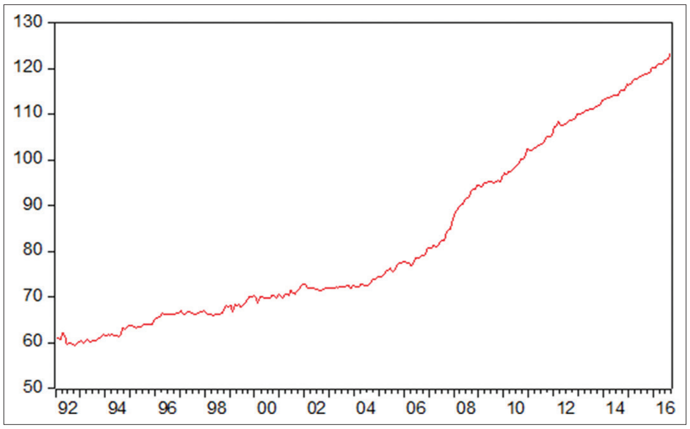

Figure 2: Inflation in Kuwaiti economy

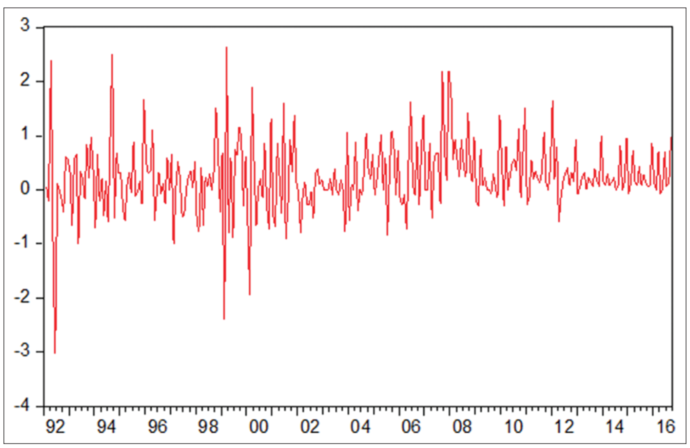

Table 2: Unit root tests results for inflation series in Kuwait

ADF	PP	KPSS
−19.57133	−19.50826	0.766937

A constant and 15 lagged difference terms are used for the ADF test. The MacKinnon critical value for the rejection of the unit root null hypothesis at the 1% significance level is−3.452366. The PP critical values for the rejection of the unit root null hypothesis at the 1%, 5% and 10% significance levels are−3.452366, −2.871128 and−2.571950, respectively. The KPSS critical values for the rejection of the unit root null hypothesis at the 1%, 5% and 10% significance levels are 0.739, 0.463 and 0.347, respectively. ADF: Augmented Dickey–Fuller, PP: Philips–Perron, KPSS: Kwiatkowski-Phillips-Schmidt-Shin

The first task in modeling the volatility of inflation is appropriately specifying the mean equation. There are certain economic and financial variables believed as important determinants of inflation in Kuwait. However, in this study inflation will be modeled dynamically through an autoregressive process. The reason for including an autoregressive term is because inflation, like many other economic variables has its own interia that determine its dynamics. There may be many reasons for this inertia, such as the inability of market agents to interpret and respond in a timely manner after the arrival of a particular announcement or news, or the probability of uncertainty linked to that news, or the high income in the country which instigates the consumers not to respond the overreaction of market participants following herd behavior. In case of the presence of strong inflationary inertia, as is evident from many studies, we expect the autoregressive term to be positive and highly significant" (Rizvi et al., 2008).

Various lag length criteria is considered to choose the appropriate lag length for the autoregressive process in the mean equation. These criteria include the Akaike's information criteria, Schwarz information criteria, and Hannan–Quinn criteria. The values of the different criteria for each model are presented in Table 3. On their basis we believe that for modelling the inflation rate for the period January 1992-September 2016 the best fitted model is the autoregressive one of order 12 (i.e., most negative). In this model we considered only the variables with significant coefficients, meaning those of order 1, 6, 9 and 12. The estimated equation of this model is:

$$\pi = 0.155377 - 0.148620\pi_{t-1} + 0.122168\pi_{t-6} + 0.115621\pi_{t-9} + 0.258774\,\pi_{t-12}$$

(0.056272) (0.058361) (0.058183) (0.054690) (0.053636)

From the above mean equation lagged value of the inflation is highly significant at 1% or 5% critical value demonstrating the fact that there is high inflation inertia effect in the economy. It is usually interpreted as measuring the effect of indexation or inflation expectation. The squared residual obtained from the above regression has got an ARCH (1) effect as can be seen from the LM test in Table 4. Under the null hypothesis we have "no ARCH (q) effects." In our case the estimated value of LM is 13.73824 that is significant at 1%. So, we are going to reject the null hypothesis of no ARCH (1) effect. This means that the inflation series exhibit volatility.

4.4. Estimating Inflation Uncertainty

After the mean equation is specified we can move on to the specification for the variance equation, or in other words the

Table 3: The values of AIC, and SIC and H-Q criteria for the tested autoregressive models

Criterion	Lag											
	1	2	3	4	5	6	7	8	9	10	11	12
AIC	2.005	2.009	1.961	1.962	1.872	1.856	1.866	1.876	1.852	1.860	1.861	1.790
SIC	2.030	2.047	2.012	2.025	1.948	1.945	1.967	1.990	1.980	2.001	2.015	1.957
H-Q	2.015	2.024	1.982	1.987	1.902	1.891	1.907	1.922	1.903	1.917	1.923	1.857

The bold figures show the best result for the information criteria. AIC: Akaike informational criteria, SIC: Schwarz informational citeria, H-Q: Hannan-Quinn criteria

Table 4: Results of ARCH LM test

Lag	N^*R^2	P value
1	13.73824	0.0002
4	21.12670	0.0003
8	23.07753	0.0033
12	29.99564	0.0028

Null hypothesis in the ARCH LM test is "no ARCH effects". ARCH: Autoregressive conditional heteroscedasticity

Table 5: Estimated coefficients for GARCH (1,1)

Coefficients	Mean equation					Variance equation		
	μ	Ψ_1	Ψ_6	Ψ_9	Ψ_{12}	ω	α_1	β_1
	0.151756***	−0.115610***	0.152387**	0.181799**	0.257670***	0.000685	0.061039***	0.934695***
	(0.039843)	(0.048262)	(0.061925)	(0.046258)	(0.046456)	(0.002254)	(0.015374)	(0.017057)

Robust standard errors in parentheses. Significant levels: ***P<0.01, ** P<0.05, *P<0.1. The bold figures show the best result for the forecasting measures, GARCH: Generalized autoregressive conditional heteroscedasticity

Table 6: Diagnostics for GARCH (1,1) model

Ljung-box test on standardized residuals			Ljung-box test on standardized squared residuals			ARCH LM test		
Q (1)	*Q* (4)	*Q* (12)	Q^2 (1)	Q^2 (4)	Q^2 (12)	ARCH LM (1)	ARCH LM (4)	ARCH LM (12)
0.0137	0.9030	2.3470	1.7204	5.8675	10.425	1.719116	5.658575	10.46563
[0.907]	[0.924]	[0.999]	[0.190]	[0.209]	[0.579]	[0.1898]	[0.2261]	[0.5752]

Q: Ljung-box test statistic for residual serial correlation. The numbers in brackets present significance levels. (.) represents lag number. Null hypothesis in the ARCH LM test is "no ARCH effect" and the null hypothesis in the Ljung-box test is "no serial correlation". GARCH: Generalized autoregressive conditional heteroscedasticity, ARCH: Autoregressive conditional heteroscedasticity

GARCH model. As there exist no consensus based on neither previous studies nor economic theory over which GARCH model is to be used for modeling inflation (Akesson, 2016), GARCH (1,1) is estimated. The estimated coefficients are presented in Table 5. As can be seen from Table 5, in GARCH (1,1) model coefficient β_1 is quite high (more than 0.90 and statistically significant at 1% level). This means that the volatility in the inflation series in Kuwait is very persistent. Since volatility is our measure for inflation uncertainty, this indicates that if there is a shock to the Kuwait inflation process it will take a long time for this uncertainty to die out. This result is consistent with the finding of several studies i.e. Fountas et al. (2004).

As shown in Table 6, diagnostic checks of estimated GARCH(1,1) reveal the absence of serial autocorrelation amongst the residuals. Additionally, ARCH LM test indicates no existence of ARCH effects in the residuals. Therefore, the estimated GARCH(1,1) model is appropriate in modelling inflation in Kuwait.

Following this estimation, we obtain the equation of the conditional variance that will measure the uncertainty for the period January 1992-September 2016:

$$h_{\pi t} = \underset{(0.002254)}{0.000685} + \underset{(0.015374)}{0.061039}\varepsilon^2_{\pi,t-1} + \underset{(0.017057)}{0.934695}\, h_{\pi,t-1}$$

4.5. Causality between Inflation and Inflation Uncertainty

By means of the Granger test, we analyzed the endogeneity position of the variables inflation and inflation uncertainty. The results from Table 7 allow us to ascertain that we do not have reasons to accept the hypothesis according to which inflation does not Granger cause inflation uncertainty. This means that the results found in Table 7 do not support the Cukierman-Meltzer hypothesis (1997), which further supported by Holland (1995).

Table 7: Pairwise granger causality tests

Null hypothesis	F-statistics		
	Lag-2 (+)	Lag-4 (+)	Lag-8 (+)
Inflation does not granger cause inflation uncertainty	3.70313	2.06541	2.09611
	[0.0259]	[0.0856]	[0.0366]
Inflation uncertainty does not granger cause inflation	0.93610	0.78107	1.15532
	[0.3934]	[0.5383]	[0.3268]

The numbers in brackets epresent significance levels. (.) represents the relationship between inflation and inflation uncertainty

Regarding the Friedman–Ball hypothesis which further developed by Ball (1992), the results seem to support this hypothesis.

5. CONCLUSION REMARKS

This is first attempt to investigate the relationship between inflation and inflation uncertainty for Kuwait. GARCH modeling is applied on monthly data over a period of 1992:1-2016:9 to estimate inflation uncertainty.

In the present paper, we tested two hypotheses, first one saying that Inflation causes inflation uncertainty, exposed by Friedman (1977), Ball (1992), Pourgerami and Maskus (1987) and Ungar and Zilberfarb (1993) and the other one, assuming that inflation uncertainty causes inflation, proposed by Cukierman and Meltzer (1986) and Holland (1995).

The findings of this paper support Friedman-Ball hypothesis. The study, also, finds a positive association between level of inflation and inflation uncertainty i.e. higher inflation rate causes higher rates of uncertainty, and this may render the credibility of anti-inflationary program to be applied in Kuwait. Moreover, there is no evidence for inflation uncertainty affecting inflation rates as suggested by Cukierman and Meltzer (1986).That is only unidirectional relation is established with causality running from inflation to inflation uncertainty. The results of this paper will help monetary authorities (i.e. Central Bank of Kuwait) to formulate policies to control inflation so that uncertainty can be minimized. Furthermore, based on findings of this work, and in consistent with Friedman hypothesis, we can conclude that a stable inflation will result in degenerating inflation uncertainty which in turn can effect positively the performance of Kuwaiti economy.

Future research, may focus on the Kuwaiti Central Bank measures against inflation (i.e. anti-inflationary measures applied in Kuwait in 2007). This might be done by using another econometric methods for modeling uncertainty in Kuwait. Furthermore, researchers may also study the causal relationship between inflation and its uncertainty on some other variables that can influence the economic policy decisions, such as the exchange rate.

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