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Modelling the relationship between inflation and uncertainty with existence of structural break: evidence from Azerbaijan

Vugar RAHIMOV
Azerbaijan State University of Economics (UNEC), Azerbaijan
vugar.m.rahimov@gmail.com

Abstract. *In this paper, I examine the relationship between inflation and uncertainty with the existence of a structural break using inflation data for Azerbaijan over 1996:01-2024:04. Applying conventional structural break tests, I identify a structural breakpoint in the series. I construct an appropriate autoregressive model using the structural break dummy variable. To obtain inflation uncertainty, I estimate an autoregressive conditional heteroskedasticity (ARCH) model and generate conditional variance used as a proxy for the uncertainty. I then analyse the Granger causality relationship between the actual inflation and the inflation uncertainty derived from the ARCH. The results suggest a unidirectional causal relationship between these two indicators, indicating that high inflation leads to high uncertainty, which supports the Friedman-Ball hypothesis for Azerbaijan. The primary practical importance of the study is that the results can be considered in the policy decision-making process, as targeting and achieving the inflation rate at a low and stable level would lead to lower economic uncertainty and support economic activity.*

Keywords: ARCH, GARCH, inflation, structural break, uncertainty, volatility of inflation.

JEL Classification: C32, C22, C51, E31.

1. Introduction

Inflation is a general increase in the price of products in the consumer basket during a given period. In contrast, prices can also decrease, which is called deflation. However, inflation is observed more often than price decreases, and the price increase directly affects the population's purchasing power. At the same time, high inflation negatively affects business and economic activity. Therefore, inflation, its formation, and its consequences are among the most important topics in macroeconomics. Hence, inflation is modelled and analysed in academia, international organisations, and policymaking institutions. Governments strive to achieve price stability primarily through central banks coordinating with other government institutions. The mechanism of influence of central banks on inflation is implemented through the interest rate channel. Therefore, adequately modelling inflation expectations is essential for the policymaking institutions. However, since the consequences of unpredictable external factors often influence inflation, it is very variable, or in other words, “volatile”, as used in economic and financial literature. Volatility can also be expressed as the variability of observations around its mean. Volatility, in turn, leads to uncertainty. Inflation uncertainty implies the unpredictability of the future price level, that is, the unpredictability of the inflation forecast (Göktaş and Dişbudak, 2014).

The primary standard models for modelling the volatility or uncertainty of inflation are autoregressive conditional heteroscedasticity (ARCH), generalised autoregressive conditional heteroscedasticity (GARCH) models, or their modified forms. For analysing the direction of the relationship between inflation and its uncertainty, I employ a Granger (1969) causality method.

In addition to volatility, observing structural breaks in the time series sometimes complicates the modelling and forecasting process. Structural breaks in inflation may be due to regime changes, such as the transition to inflation targeting or other structural changes in the economy. Detecting structural breaks and addressing them in modelling is crucial to achieving better model results.

Thus, in this paper, using the monthly inflation indicator over the period 1996:01-2024:04, I examine the direction of the relationship between inflation and its uncertainty in Azerbaijan. Moreover, I also investigate the effects of the structural break on the model's results.

The results show that ARCH (1, 0) model is the most appropriate ARCH-type model for the inflation of Azerbaijan. The Granger test supported the hypothesis that inflation causes higher inflation uncertainty in Azerbaijan. Furthermore, I attempt to test the hypothesis of whether uncertainty causes inflation, but I fail to obtain a statistically significant result. In other words, in the case of Azerbaijan, the relationship between inflation and uncertainty is unidirectional; the causality runs from inflation to uncertainty, supporting the Friedman-Ball hypothesis.

The structure of the article is organised as follows. The second section is devoted to a brief literature summary related to the topic. Section 3 provides information on the time data and methodology used. The following section presents and discusses the results. Finally, the fifth section concludes the study.

2. Literature review

The relationship between inflation and uncertainty was investigated first by Okun (1971), who stated that there was a positive correlation between inflation and volatility. Using the inflation (gross national product deflator) of 17 OECD(1) countries for the years 1951-1968, he analysed the relationship between its mean and standard deviation. The author showed a positive relationship between inflation and inflation volatility, concluding that uncertainty was associated with the rise in the inflation rate.

Later, Friedman (1977) hypothesised that high inflation causes high uncertainty. Ball (1992) explored this topic more thoroughly and confirmed Friedman's (1977) hypothesis. Thus, he proposed a monetary policy model showing that the increase in inflation leads to a rise in uncertainty about future inflation. Therefore, the positive relationship between inflation and uncertainty is also called the Friedman-Ball hypothesis in literature.

Another hypothesis on the relationship between inflation and uncertainty is the Cukierman-Meltzer hypothesis. Cukierman and Meltzer (1986) argued that there is an opposite causal relationship between these two concepts: causality runs from uncertainty to inflation. They suggested that during times of uncertainty, the central bank increases the money supply to stimulate economic growth, which leads to an increase in the inflation rate.

Later, this topic was studied by many economists in the case of different countries, and new approaches were introduced. Kontonikas (2004) studies the relationship between inflation and uncertainty using inflation data from the United Kingdom for the period 1972–2002. He uses the conditional volatility derived from the GARCH model for uncertainty. The result of the study supports the Friedman-Ball hypothesis.

Caporale et al. (2012) analyse the relationship between inflation and uncertainty by applying an AR-GARCH model based on monthly data for the period 1990:01-2009:02. They also use dummy variables for that period to account for the structural change with the introduction of the euro currency in 1999. They then apply the Granger causality test based on the vector autoregressive (VAR) model established between the actual inflation and the series output from the GARCH model, and the obtained result was consistent with the Friedman-Ball hypothesis.

Using monthly data from 2002 to 2011, Karahan (2012) concludes that high inflation causes uncertainty in the case of Türkiye. Khatır et al. (2021) also support the argument that the Friedman-Ball hypothesis is dominant by conducting an assessment from 2005 to 2020 for Türkiye. However, Göktaş and Dişbudak (2014) emphasise the importance of paying attention to structural break issues when studying the volatility of Türkiye's inflation. So, they test the inflation for 1994-2013 and find a break in the volatility and mean of inflation in June 2001 and February 2002, respectively. They then continue the evaluation through ARCH/GARCH models. The results show that although the Friedman-Ball hypothesis existed in the period before the structural break, in the period after 2002, there was a bidirectional, that is, a mutual causal relationship between inflation and uncertainty.

Moradi (2006) investigates the relationship between inflation and uncertainty in the case of Iran, a resource-rich country. The author analyses the inflation for the period 1959:03-2005:12 and identifies the structural break for the period after 1972. In the estimation made considering the structural break, he concludes that high inflation causes uncertainty, which causes high inflation. Thus, the results suggest that both Friedman-Ball and Cukierman-Meltzer hypotheses hold for Iran. Al-Zuhd and Saleh (2017), utilising the GARCH model, show that there is a one-way relationship between inflation and uncertainty in another resource-rich country- Kuwait. In other words, high inflation causes uncertainty.

Regarding modelling inflation volatility in Azerbaijan's case, Erkam and Çavuşoğlu (2008) study the inflation of seven transitional economies of the former Soviet Union. The article covers a relatively short period, starting from 1996-1997, depending on the countries. The main reason is that these countries' stabilisation of inflation processes mainly falls in those periods. The inflation series for Azerbaijan covers the period of 1996:01 to 2004:09. Uncertainty was obtained with ARCH/GARCH models. Through the Granger-causality test, they find that inflation causes uncertainty in Azerbaijan for those periods.

3. Data and Methodology

3.1. Descriptive statistics

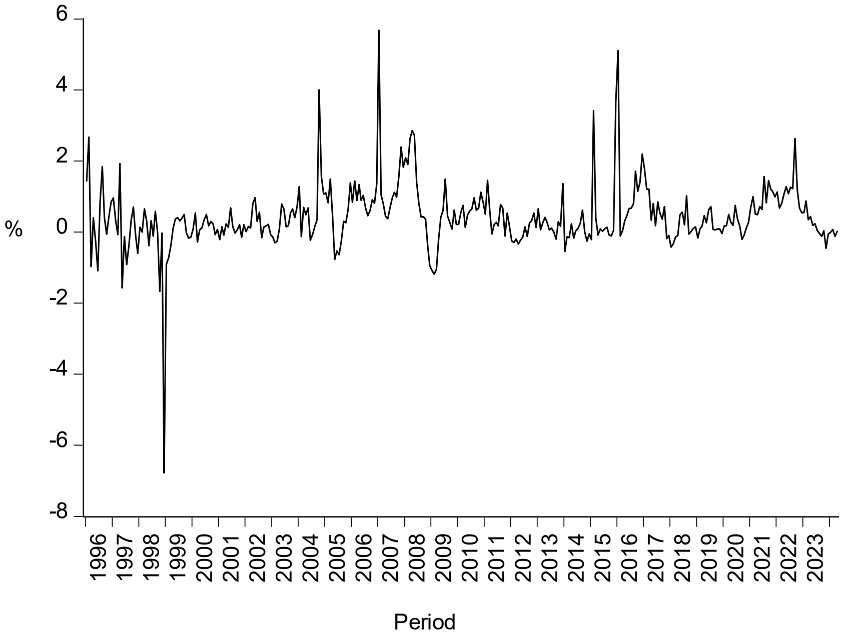
In this study, I use the consumer price index (CPI) data of Azerbaijan for the period 1996:01-2024:04. The CPI series has been retrieved from the database of the State Statistics Committee (SSC) of the Republic of Azerbaijan. The SSC has been compiling CPI statistics on monthly frequency since January 1995. However, as the inflation rate was very high in 1995 (average annual inflation was 411.8%), I take the year 1996 - the year inflation began to stabilise - as the beginning of the estimation period. The series is seasonally adjusted using the TRAMO-SEATS technique. I apply the following logarithmic transformation to calculate the inflation rate:

$$infl = ln\frac{CPI_t}{CPI_{t-1}} * 100 \qquad (1)$$

With this transformation, I obtain the monthly inflation rate. It should be noted here that the period 1995:12 is taken as the base period, and the index is set to 100. Thus, the first observation of the inflation rate is obtained from January 1996.

Chart 1 presents the monthly inflation rate for the period 1996:01-2024:04. As can be seen from the graph, Azerbaijan's inflation was volatile during the period. Looking at the descriptive statistics of inflation before starting the estimation is essential. In particular, although the inflation rate, which began to decelerate in 1996, experienced significant deflation in some months of 1998, it jumped by 4% month-on-month in some periods of 2004, 2007, and 2016.

Chart 1. *Monthly inflation rate (1996:01-2024:04)*



Source: State Statistics Committee of the Republic of Azerbaijan.

Table 1 gives the descriptive statistics of inflation. Volatility is also clearly observed in the table. So, while the average monthly inflation during the period is 0.43%, the standard deviation is more than twice higher than the mean and is equal to 0.91%. In addition, as the skewness is greater than zero, it indicates right-skewed asymmetry. On the other hand, a kurtosis coefficient higher than 3 indicates that the distribution is not normal. Deviation from normality is also confirmed by the Jarque-Bera test.

Table 1. *Descriptive statistics (1996:01-2024:04)*

Mean	0.43
Median	0.30
Standard deviation	0.91
Maximum	5.68
Minimum	-6.78
Skewness	0.12
Kurtosis	20.08
Jarque-Bera test	4135.2 (p-value = 0.000)

Source: Author's calculation.

3.2. Unit root test

To model volatility, the series is required to be stationary. In order to check the stationarity of the data, I apply augmented Dickey-Fuller (ADF) (1979), Phillips-Perron (PP) (1988), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (1992) tests. In the first two procedures, the null hypothesis assumes the existence of a unit root; that is, the series is non-stationary. In contrast, in the last procedure, the null hypothesis assumes that the series is stationary. Table 1 presents the unit root results.

Table 1. *ADF and PP unit root test results for inflation (1996:01-2024:04)*

Method	Model	Test statistics	Result
ADF	Constant	-8.40***	Stationary
	Trend and Constant	-8.55***	Stationary
	None of them	-7.27***	Stationary
PP	Constant	-12.40***	Stationary
	Trend and Constant	-12.45***	Stationary
	None of them	-11.43***	Stationary
KPSS	Constant	0.25***	Stationary
	Trend and Constant	0.12*	Stationary

Note: * and *** denote stationarity at a significance level of 10% and 1%, respectively.
Source: Author's calculation.

As can be seen from Table 1, the ADF and PP tests reject the hypothesis that the series is non-stationary at the 1% significance level. That is, inflation can be assumed to be stationary. However, when the KPSS test includes a trend and a constant, the non-stationarity hypothesis is rejected at the 1% significance level, while the non-stationarity is rejected at the 10% significance level when there is only a constant. Therefore, assessing whether there is a structural break in the series is important. I carry out several tests for this. The results of the tests are presented in Table 2. First, I apply the Bai-Perron (1998) test. The Bai-Perron test suggests the period 2003:05 as a structural break at the 5% significance level. The Quandt-Andrews (1993) test, where the null hypothesis is the absence of breakpoints in the series, also suggests May 2003 as a structural break. Besides, Chow's (1960) test, in which the null hypothesis states there is no break in the specified period, confirms the existence of a structural break in the date indicated by the above two tests. In addition, I also perform a structural break test on the squared residuals to find a possible break in the variance, but no break has been detected.

Table 2. *Structural break tests*

Bai-Perron test				
Structural break test	F statistics	Critical threshold	Detected break period	
0 vs. 1*	20.46	8.58	2003:05	
Quandt-Andrews test				
Null hypothesis		Statistics	Value	Probability
There are no breakpoints in the sequence		Maximum likelihood F-statistic (2003:05)	20.46	0.00
Chow test				
The null hypothesis		Statistics	Value	Probability
There are no breaks in the specified period (2003:05)		The F-statistic	20.46	0.00

Source: Author's calculation.

3.3. Estimation methodologies

3.3.1. Modelling inflation uncertainty (ARCH/GARCH)

The use of the autoregressive conditional heteroskedasticity (ARCH) model in modelling uncertainty was proposed in a seminal paper by Engle (1982). He employed this method to find the relationship between the inflation rate and the variance of inflation in the case of the United Kingdom and expressed the conditional variance as the inflation uncertainty. Engle (1982) summarised ARCH as "*…mean zero, serially uncorrelated processes with* *nonconstant variances conditional on the past, but constant unconditional variances"* (p.1). For such processes, the most recent past period provides information on the subsequent forecast variance.

The first step in building an ARCH model is constructing an autoregressive (AR) univariate model (2). In this model, the inflation variable, denoted by inf, depends on its past values. Then volatility is modelled (4).

$$inf_t = \theta_0 + \sum_{i=1}^{q} \theta_i inf_{t-i} + d_{03}D_{03} + \varepsilon_t \tag{2}$$

$$\varepsilon_t \mid I_{t-1}\ N(0, h_t) \tag{3}$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i\, \varepsilon_{t-i}^2 \tag{4}$$

Here σ_t^2 represents the estimated conditional variance in the period t. α_0 denotes mean, parameters α_i are the conditional volatility, ε_t is white noise representing the residuals and d_{03} is the coefficient of the dummy variable created to measure structural break effects. It is worth noting that the dummy variable D_{03} is equal to 1 in the period $t \geq 2003{:}05$ and 0 otherwise. To guarantee a positive variance in equation (4), all parameters must be positive, and to achieve a stationary process, the sum of parameters α_i must be less than one.

Later, Bollerslev (1986) extended the ARCH modelling and proposed the generalised autoregressive conditional heteroskedasticity (GARCH) model. The general (p, q) form of this model is a rearranging of the conditional variance model as follows:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i\, \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j\, \sigma_{t-j}^2 \tag{5}$$

where $p \geq 0$, $q > 0$, and $\alpha_0 > 0$. To ensure that the conditional variance σ_t^2 is always positive, also $\alpha_i \geq 0$ when $i = 1, \dots, q$ and $\beta_j \geq 0$ when $j = 1, \dots, p$.

One of the properties of standard GARCH models is that they assume a symmetric response of uncertainty regardless of the direction (sign) of inflation shocks. Therefore, possible asymmetric responses of inflation uncertainty to positive and negative inflation shocks can be measured using the exponential GARCH (EGARCH) model proposed by Nelson (1991):

$$log(\sigma_t^2) = \alpha_0 + \sum_{i=1}^{q} \alpha_i \left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} + \sum_{j=1}^{p} \beta_j\, log\left(\sigma_{t-j}^2\right) \tag{6}$$

In this model, there is no need to impose a non-negativity constraint on the parameters as in the standard symmetric GARCH model because the logarithmic form provides a non-negative conditional variance. γ_k measures the asymmetry effect. If the coefficient is different from zero, it means asymmetry exists.

3.3.2. Granger causality test

I perform a Granger causality analysis to measure the relationship between inflation (inf) and inflation uncertainty (inf_unc). The Granger causality test is based on a bivariate vector autoregression (VAR) model constructed using actual inflation series and the one generated from the volatility model. Thus, the model is built as follows:

$$inf_t = c_0 + \sum_{i=1}^{n} \lambda_i inf_{t-i} + \sum_{i=1}^{n} \varphi_i inf\_unc_{t-i} + \varepsilon_t \tag{7}$$

$$inf\_unc_t = c_0 + \sum_{i=1}^{n} \varphi_i inf\_unc_{t-i} + \sum_{i=1}^{n} \lambda_i inf_{t-i} + \varepsilon_t \quad (8)$$

In equations (7) and (8), c_0 denotes the constant in Granger regression while n denotes the number of lags. The null hypothesis in equation (7) is that inflation uncertainty does not cause inflation. Similarly, the null hypothesis in equation (8) assumes that inflation does not cause uncertainty.

4. Results and Discussion

In order to model volatility, first of all, I build an autoregressive model for inflation. Models with different numbers of lags of inflation, as well as moving average components, have been tested to identify appropriate model specifications. Considering the removal of serial correlation on top of what the Akaike and Schwarz information criteria show, the autoregressive model consisting of 3 lags is deemed suitable for inflation.

Besides, the contribution of the structural break dummy variable to the performance of the selected model has been evaluated. Table 3 presents two autoregressive models. Column (1) shows the AR model without a dummy variable, and column (2) shows the results of the AR model with the dummy variable included. As can be seen, the coefficients of the first and second lags in both models are statistically significant. The coefficient of the dummy variable is also statistically significant. Although the third lag is not statistically significant, it plays a crucial role in removing serial correlation.

However, when comparing the two models, it turns out that the model with the dummy variable is superior to the other model. In fact, the adjusted R^2 in the model that includes the dummy variable is higher. In addition, the fact that both Akaike and Schwarz information criteria values are smaller than those of the information criteria in other models indicates that the model performs better. Finally, the root mean square of the errors (RMSE) also shows that the inclusion of the dummy variable has a lower prediction error, suggesting a better performance. Thus, model 2 is considered more suitable for estimations.

On the other hand, Ljung-Box Q tests show that the models do not suffer from a serial correlation problem. The ARCH-LM (1) test detects heteroskedasticity in the residuals at the 5% significance level.

Table 3. *Specification and diagnosis of the autoregressive model (mean equation)*

	(1) Model with no dummy variable included	(2) A model in which a dummy variable is included
Model	Coefficient	Coefficient
θ_0	0.188***	0.016
θ_1	0.364***	0.342***
θ_2	0.158***	0.143**
θ_3	0.038	0.022
d_{03}		0.260**
Diagnostics of the model		
Adj. R^2	0.22	0.23
Akaike IC	2.39	2.38
Schwarz IC	2.44	2.43
RMSE	0.90	0.87

Q test and heteroskedasticity test		
Q(1)	0.000 [0.980]	0.006 [0.937]
Q(6)	2.164 [0.904]	1.697 [0.945]
Q(12)	10.144 [0.603]	8.43 [0.674]
ARCH-LM test ($n*R^2$)	3.899 [0.05]	4.232 [0.04]

Notes: ** and *** denote significance at 5% and 1% levels, respectively. [.] represents probability.
Source: Author's calculation.

After determining the appropriate mean equation, the next step is variance specification, i.e. building ARCH/GARCH models. Both ARCH and GARCH methods have been tested because, in economic literature or economic theory, there is no consensus about which of these models should be preferred. Table 4 presents the estimation of the ARCH and GARCH models. It is worth noting that since the necessary conditions mentioned above are not satisfied when running the standard GARCH model, only the results of the ARCH (1, 0) and EGARCH (1, 1) models are presented.

As seen in Table 4, the coefficient of α_1 in the variance equation of the ARCH (1, 0) model is statistically significant at the 5% level and is smaller than one, which points to the stationarity of the model. In addition, Ljung-Box Q tests show that there is no serial correlation in the residuals. The ARCH-LM test indicates that the ARCH effect has been removed from the residuals. Similarly, in the EGARCH model, all the parameters of the variance equation meet the necessary conditions and are statistically significant. A positive coefficient of asymmetry suggests that a surge in the inflation rate increases uncertainty. This result indicates the presence of the Friedman-Ball hypothesis for Azerbaijan. A similar conclusion was reached by Jiranyakul and Opiela (2010) in the case of ASEAN-5 (namely, Indonesia, Malaysia, Philippines, Singapore, and Thailand) countries.

Table 4. *The most appropriate ARCH/GARCH models for inflation*

Mean equation		
Parameters	ARCH (1, 0)	EGARCH (1,1)
θ_0	0.0601	0.0770*
θ_1	0.5681***	0.5458***
θ_2	0.0107**	0.1296***
θ_3	-0.0116	-0.0131
d_{03}	0.0723	0.0535
Variance equation		
α_0	0.2931***	-0.8600***
α_1	0.8837**	0.6332***
γ_1		0.2349**
β_1		0.4389***
Criteria		
Adj. R^2	0.184	0.189
Logarithmic likelihood	-247.8	-246.4
Akaike IC	1.518	1.522
Schwarz IC	1.609	1,635
Q test and heteroskedasticity test		
Q test (1)	2.28 [0.59]	0.55 [0.46]
Q test (6)	3.67 [0.72]	3.51 [0.74]
Q test (12)	12.93 [0.37]	14.04 [0.30]
ARCH-LM test ($n*R^2$)	0.1335 [0.7158]	0.1004 [0.7522]

Notes: *, ** and *** denote significance at 10%, 5% and 1% levels, respectively. [.] represents probability.
Source: Author's calculation.

However, based on the maximum likelihood, as well as the Akaike and Schwarz information criteria, I decide that the ARCH model is more adequate. In this regard, the relationship between inflation and uncertainty is also evaluated using the Granger causality test. Since I choose the ARCH model as more appropriate, in the Granger causality test, I use the uncertainty variable obtained from the ARCH model as the conditional variance (Table 5).

Table 5 shows that inflation causes high uncertainty in Azerbaijan. Column (1) rejects the null hypothesis that inflation does not cause uncertainty at lags 2 and 4 at the 5% significance level and at lags 6 at the 10% significance level. This result is supportive of the Friedman-Ball hypothesis for Azerbaijan. However, column (2) fails to reject the null hypothesis that uncertainty does not cause inflation, suggesting that the Cukierman-Meltzer hypothesis does not hold in the case of Azerbaijan. Hence, the results align with the Friedman-Ball hypothesis argument found by Erkam and Çavuşoğlu (2008).

Table 5. *Granger causality results*

	(1)	(2)
Lags	H_0: Inflation does not cause uncertainty	H_a: Uncertainty does not cause inflation
2	3.49**	1.77
4	2.86**	1.15
6	1.99*	0.75
8	1.50	0.69

Note: * and ** denote significance at 10% and 5%, respectively.

5. Conclusion

This paper examines the relationship between inflation and uncertainty with the existence of a structural break in the case of Azerbaijan. To this end, I apply a two-step method using the inflation rate indicator covering the period 1996:01-2024:04. Firstly, I construct an appropriate autoregressive model to model the inflation process using a dummy variable that considers the period of structural break proposed by various tests and estimating ARCH/GARCH models, I derive a conditional variance which is used as a proxy for the uncertainty of inflation. In the next step, I apply a Granger causality analysis between the actual inflation rates and the inflation uncertainty generated by the model. The Granger test supports the hypothesis that inflation causes higher inflation uncertainty in Azerbaijan. I also test the hypothesis of whether uncertainty causes inflation, but I fail to obtain a statistically significant result. In other words, in the case of Azerbaijan, the relationship between inflation and uncertainty is unidirectional; the causality runs from inflation to uncertainty, supporting the Friedman-Ball hypothesis.

Implications from the paper may be helpful for policymakers as high inflation increases uncertainty; it can hurt the effectiveness of the economic policy implemented under these conditions. In this regard, achieving a low inflation level can lead to lower economic uncertainty and an increase in economic activity. On the other hand, low inflation targeting during the expected transition to an inflation targeting regime is essential from the point of view of leading to low inflation expectations and low uncertainty.

Note

(1) Organization for Economic Co-operation and Development.

References

Al, T.A. and Saleh, M.H., 2017. Inflation and Inflation Uncertainty Nexus in Kuwait: A GARCH Modeling Approach. *International Journal of Economics and Financial Issues*, *7*(5), p. 198.

Andrews, D.W., 1993. Tests for parameter instability and structural change with unknown change point. *Econometrica: Journal of the Econometric Society*, pp. 821-856.

Bai, J. and Perron, P., 1998. Estimating and testing linear models with multiple structural changes. *Econometrica*, pp. 47-78.

Ball, L., 1992. Why does high inflation raise inflation uncertainty? *Journal of Monetary Economics*, *29*(3), pp. 371-388.

Bollerslev, T., 1986. Generalized autoregressive conditional heteroskedasticity. *Journal of econometrics*, *31*(3), pp. 307-327.

Caporale, G.M., Onorante, L. and Paesani, P., 2012. Inflation and inflation uncertainty in the euro area. *Empirical Economics*, *43*, pp. 597-615.

Chow, G.C., 1960. Tests of equality between sets of coefficients in two linear regressions. *Econometrica: Journal of the Econometric Society*, pp. 591-605.

Cukierman, A. and Meltzer, A.H., 1986. A theory of ambiguity, credibility, and inflation under discretion and asymmetric information. *Econometrica: journal of the econometric society*, pp. 1099-1128.

Dickey, D.A. and Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, *74*(366a), pp. 427-431.

Engle, R.F., 1982. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the econometric society*, pp. 987-1007.

Erkam, S. and Cavusoglu, T., 2008. Modelling Inflation Uncertainty in Transition Economies: The Case of Russia and the Former Soviet Republics. *Economic Annals*, *53*(178-179), pp. 44-71.

Friedman, M., 1977. Nobel lecture: inflation and unemployment. *Journal of political economy*, *85*(3), pp. 451-472.

Göktaş, P. and Dişbudak, C., 2014. Modelling inflation uncertainty with structural breaks case of Turkey (1994-2013). *Mathematical Problems in Engineering*, *2014*(1), p. 284161.

Granger, C.W., 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: journal of the Econometric Society*, pp. 424-438.

Jiranyakul, K. and Opiela, T.P., 2010. Inflation and inflation uncertainty in the ASEAN-5 economies. *Journal of Asian Economics*, *21*(2), pp. 105-112.

Karahan, Ö., 2012. The relationship between inflation and inflation uncertainty: evidence from the Turkish economy. *Procedia economics and finance*, *1*, pp. 219-228.

Khatir, A.Q., Güvenek, B. and Mangir, F., 2021. The relationship between inflation and inflation uncertainty: Empirical evidence from Turkey. *Journal of Academic Value Studies*, *6*(4), pp. 331-340.

Kontonikas, A., 2004. Inflation and inflation uncertainty in the United Kingdom, evidence from GARCH modelling. *Economic modelling*, *21*(3), pp. 525-543.

Kwiatkowski, D., Phillips, P.C., Schmidt, P. and Shin, Y., 1992. Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of econometrics*, *54*(1-3), pp. 159-178.

Moradi, M.A., 2006. A GARCH model of inflation and inflation uncertainty in Iran. *The Quarterly Journal of the Economic Research*, *6*(1), pp. 121-148.

Okun, A.M., 1971. The mirage of steady inflation. *Brookings papers on economic activity*, *1971*(2), pp. 485-498.

Phillips, P.C. and Perron, P., 1988. Testing for a unit root in time series regression. *Biometrics*, *75* (2), pp. 335-346.