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The Effects of Inflation Uncertainty on Economic Growth Rates in Inflation Targeting Emerging Markets[1]

Abstract. Since the 2008-09 global financial crisis, both emerging and developed economies have encountered increased economic uncertainty. Despite substantial research on macroeconomic uncertainties, there remains a significant gap in understanding asymmetric causal relationships between inflation uncertainty and economic growth in inflation-targeting emerging markets. This study addresses this gap by exploring both symmetric and asymmetric causality between inflation uncertainty and economic growth in selected countries: Brazil, Bulgaria, Czech Republic, Greece, India, Korea, Mexico, Russia, and Türkiye. Asymmetric causality tests are crucial as they offer a more nuanced view of how inflation uncertainty and economic growth impact each other in distinct ways, which is vital for enhancing macroeconomic stability and policy effectiveness. The research employs the ARMA-GARCH model to estimate inflation uncertainty and applies both symmetric and asymmetric causality tests. The findings reveal a unidirectional causality from inflation uncertainty to economic growth in Brazil and Bulgaria, and from economic growth to inflation uncertainty in Russia and Türkiye. Furthermore, asymmetric shock analysis shows that negative shocks in inflation uncertainty lead to negative shocks in economic growth in Russia and Korea, while positive shocks in inflation uncertainty correspond with positive shocks in economic growth in India. These insights can help policymakers in emerging markets develop more effective monetary policies. Future research should include a broader range of countries and additional macroeconomic variables to validate these findings and explore inflation uncertainty dynamics further.

Keywords: Inflation Uncertainty, Economic Growth, ARMA-GARCH, Symmetric and Asymmetric-Causality, Emerging Economies

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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ВОЗДЕЙСТВИЕ ИНФЛЯЦИОННОЙ НЕОПРЕДЕЛЕННОСТИ НА ТЕМПЫ ЭКОНОМИЧЕСКОГО РОСТА В РАЗВИВАЮЩИХСЯ СТРАНАХ С ТАРГЕТИРОВАНИЕМ ИНФЛЯЦИИ

Аннотация. После глобального финансового кризиса 2008–2009 гг. страны как с развивающейся, так и с развитой экономикой столкнулись с ростом макроэкономической неопределенности. Несмотря на то, что макроэкономическим рискам посвящено множество исследований, существует заметный пробел в понимании асимметричных причинно-следственных связей между инфляционной неопределённостью и экономическим ростом в развивающихся странах с инфляционным таргетированием. Настоящее исследование направлено на восполнение этого пробела с помощью анализа симметричной и асимметричной причинно-следственной связи между инфляционной неопределённостью и темпами экономического роста в Бразилии, Болгарии, Чехии, Греции, Индии, Республике Корея, Мексике, России и Турции. Тесты на асимметричную причинно-следственную связь выявляют более тонкие взаимосвязи между показателями, что, в свою очередь, позволяет выработать меры по укреплению макроэкономической стабильности и усилению эффективности экономической политики. В исследовании используется модель ARMA-GARCH для оценки инфляционной неопределённости, а также применяются тесты на симметричную и асимметричную причинно-следственную связь. Установлено наличие однонаправленной причинной связи между инфляционной неопределенностью и экономическим ростом в Бразилии и Болгарии, а также между экономическим ростом и инфляционной неопределённостью в России и Турции. Кроме того, анализ асимметричных шоков показывает, что отрицательные шоки инфляционной неопределённости сопровождаются снижением темпов экономического роста в России и Республике Корея, тогда как положительные шоки инфляционной неопределённости связаны с ускорением экономического роста в Индии. Данные результаты могут использоваться для формирования более эффективной денежно-кредитной политики в развивающихся странах. Дальнейшие исследования могут быть связаны с расширением географии анализа и включением дополнительных макроэкономических переменных для верификации результатов и более глубокого понимания динамики инфляционной неопределённости.

Ключевые слова: инфляционная неопределённость, экономический рост, модели ARMA-GARCH, симметричная и асимметричная причинно-следственная связь, экономика развивающихся стран

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Introduction

Since the 2008–09 global financial crisis, both emerging markets and developed countries have experienced a rise in uncertainty affecting their overall performance (Bloom, 2014). During this time, expansionary monetary policies in advanced economies led to substantial capital inflows into emerging markets. These inflows boosted domestic demand and investment, stimulating economic growth (Aizenman et al., 2011; Lim et al., 2014). However, they also drove up exchange rates and asset prices, making these economies more vulnerable to financial risks (Fratzscher et al., 2013). Traditional economic policy tools proved inadequate in addressing these risks, as they failed to prevent imbalances such as current account deficits, rapid credit growth, and rising debt levels (Akar & Çiçek, 2016). As a result, these tools were insufficient to mitigate the negative effects of growing uncertainty.

In mid-2013, the U.S. Federal Reserve's decision to scale back its asset purchases heightened uncertainty, triggering significant volatility in growth and inflation across several emerging markets, including Türkiye, India, and Brazil (Meinusch & Tillmann, 2017). These countries tend to experience sharper declines in investment and private consumption after external shocks compared to more developed ones (Carrière-Swallow & Céspedes, 2013). In the early 2000s, growth was strong in Brazil, India, and Türkiye, but by the mid-2010s, it had slowed considerably. For example, World Bank data show that the annual average growth rates for Brazil, India, and Türkiye between 2002 and 2013 were about 3.7 %, 7.5 %, and 7.57 %, respectively. Between 2014 and 2019, these figures dropped to 0.7 %, 6.7 %, and 4.27 %. Similarly, although countries like the Czech Republic, Greece, Korea, Mexico, and Russia experienced varying growth rates from 2002 to 2013, each of them registered slower growth in 2014–2019. In addition, inflation rates in these countries have fluctuated notably since the 2000s, shaped by domestic conditions, global influences, and monetary policy decisions.

Many studies have attempted to explain the relationship between macroeconomic uncertainty and growth. There is evidence that macroeconomic uncertainty is one of several key factors influencing growth, alongside inflation uncertainty, economic policy uncertainty (Wen et al., 2022), exchange rate volatility (Din et al., 2024), and uncertainty related to growth itself. The primary goal of these studies is to examine how macroeconomic uncertainty affects real economic outcomes.

This paper focuses specifically on inflation uncertainty within emerging market contexts. It investigates how inflation uncertainty influences growth and how these effects vary in response to positive and negative shocks. There is an ongoing debate about the relationships among inflation, inflation uncertainty, and growth. Typically, this debate is divided into two parts: the first concerns how inflation relates to inflation uncertainty; the second addresses how inflation and/or its uncertainty affect economic growth.

This study adopts a methodological approach that differs from previous work in several ways. First, it explores potential bidirectional relationships—for example, how inflation uncertainty affects growth, and vice versa—rather than assuming a one-way causality. Second, the analysis accounts for the direction of shocks, examining how positive or negative changes in inflation uncertainty relate to corresponding changes in growth. By distinguishing between positive and negative shocks, the study offers a more detailed and nuanced perspective than traditional symmetric causality analyses, aiming for a deeper understanding of how economic events unfold.

To capture time-varying inflation uncertainty, the analysis uses ARMA-GARCH models, which are well suited to identifying fluctuations in the data over time. ARMA models were first established for the inflation variable to determine the most appropriate structure for the mean equations using standard information criteria. After deriving the uncertainty series, causality analysis was conducted.

To assess both symmetric and asymmetric causal relationships, the study employs the Hacker and Hatemi-J (Hacker, 2006) and Hatemi-J (Hatemi-J, 2012) causality tests, which are widely used to evaluate causality among time series. While Granger causality is commonly applied in empirical research, this study emphasizes the importance of separating variables into positive and negative shocks to uncover patterns of "hidden" causality often overlooked in literature. In addition, both symmetric and asymmetric impulse-response functions are used to assess the direction and strength of these causal relationships.

The countries selected for the analysis are Brazil, Bulgaria, the Czech Republic, Greece, India, Korea, Mexico, Russia, and Türkiye. These countries were chosen because they are classified as emerging markets, follow inflation-targeting strategies, and were significantly impacted by the global financial crisis and the U.S. Federal Reserve's tapering announcements.

The paper is organized as follows. The theoretical and empirical background is presented in Section 2; Section 3 provides detailed information on the ARMA-GARCH (1,1) and symmetric and asymmetric causality methodologies, our models, data and uncertainties; Section 4 presents the estimation results obtained from our models; and, finally, Section 5 outlines our conclusions.

Theoretical and Empirical Background

Researchers offer different theoretical perspectives on how inflation uncertainty affects growth. Some early studies argue that inflation uncertainty impedes economic growth. For instance, Friedman (1977) suggests that, first, monetary authorities may respond inconsistently to rising inflation, thereby increasing uncertainty about future inflation, and, second, that such uncertainty can negatively affect growth. In contrast, Cukierman and Meltzer (1986) argue that inflation uncertainty could boost growth if central banks generate inflation surprises through unexpected changes in the money supply.

Pindyck (1991) offers another view, emphasizing that inflation uncertainty raises doubts about the returns on investment, leading firms to delay investment decisions and thereby dampening output growth. Similarly, Holland (1995) argues that when inflation uncertainty is high, central banks adopt tighter monetary policies, which may reduce inflation but also suppress growth.

Other studies highlight potential positive effects of inflation uncertainty. Using a cash-in-advance model, Dotsey and Sarte (2000) demonstrate that greater inflation uncertainty can stimulate growth, as it encourages households to save more, increasing investment and, ultimately, economic output. Moreover, some studies evaluate how growth itself might influence inflation uncertainty. According to the logic of the short-run Phillips curve, stronger growth can contribute to higher inflation uncertainty. In line with this, Brunner (1993) argues that a decline in output growth can generate uncertainty about policy responses, potentially heightening inflation uncertainty.

On the empirical side, these hypotheses have been widely investigated. Most empirical studies focus either on the relationship between inflation and inflation uncertainty or on the link between inflation uncertainty and output growth. A substantial body of work finds strong evidence supporting a connection between inflation and its uncertainty (Grier & Perry, 1998; Nas & Perry, 2000; Berument & Dinçer, 2005; Berument et al., 2009, 2012; Daal et al., 2005; Fountas, 2010; Wilson, 2006; Özdemir & Fisunoğlu, 2008; Karahan, 2012; Baharumshah & Soon, 2014; Heidari et al., 2013; Thornton, 2007; Baharumshah et al., 2011a; Daniela et al., 2014; Jiang, 2016; Hajamini, 2019).

However, evidence on the relationship between inflation uncertainty and growth is less consistent and more mixed (Darrat & Lopez, 1989; Bredin & Fountas, 2005; Fountas & Karanasos, 2007; Bredin & Fountas, 2009; Fountas, 2010; Hasanov & Omay, 2011; Khan et al., 2013; Köse & Terzioğlu, 2014; Pintilescu et al., 2014; Baharumshah et al., 2016; Berger & Grabert, 2018; Chowdhury, 2024). This inconsistency is partly attributable to differences in the frequency of the data used across studies, but more significantly to variations in methodological approaches.

Alongside studies that emphasize the negative effects of inflation uncertainty on growth (Wilson & Culver, 1999; Grier & Perry, 2000; Nas & Perry, 2001; Fountas et al., 2002, 2006; Apergis, 2004; Grier et al., 2004; Grier & Grier, 2006; Wilson, 2006; Narayan et al., 2009; Bhar & Mallik, 2010; Baharumshah et al., 2011b; Jiranyakul & Opiela, 2011; Çağlayan et al., 2012, 2016; Mohd et al., 2012; Heidari et al., 2013; Chowdhury et al., 2018), some studies suggest a potential positive relationship (Paksha Paul, 2013). For instance, Fountas et al. (2004) argue that inflation uncertainty does not lead to a decline in output. In contrast, Chang and He (2010) and Neanidis and Savva (2013) find that high inflation uncertainty tends to lower growth rates, especially in high-inflation environments.

Achiyaale et al. (2023) report that inflation volatility does not significantly affect growth, while Artan (2008) links inflation uncertainty to long-term growth decline. Mandeya and Ho (2021), on the other hand, conclude that the impact is limited to the short term. Regarding causality, Artan (2008) identifies a bidirectional relationship between inflation uncertainty and growth, whereas Ahmad et al. (2014) find no causal link. Hachicha and Lean (2013) suggest that inflation uncertainty does, in fact, drive economic growth.

Overall, this body of research highlights the need for more precise methods to assess the impact of inflation uncertainty on growth.

Methodology and Data

Methodology

Measuring economic uncertainty has long been a challenge for economists, often leading to conflicting approaches. Therefore, there is a wide range of methods for quantifying uncertainty. Bloom (2014) notes that there is no perfect measure of uncertainty—only a variety of proxies. Among these, ARCH/GARCH models are commonly used to analyse the impact of inflation uncertainty on real economic growth, as they can both generate time-varying measures of uncertainty and estimate its effect on actual values simultaneously.

In this paper, we follow the approach of Grier and Perry (1998), Nas and Perry (2000), and Karahan (2012) by estimating the conditional mean and variance equations of the inflation series to construct a measure of inflation uncertainty. To obtain time-varying estimates, we estimate ARMA-GARCH (1,1) models using the following equations. Equation (1) presents the general ARMA specification for the inflation series.

$$\pi_{i,t} = \alpha_{10} + \sum_{j=1}^{n} \alpha_j \pi_{i,t-j} + \sum_{p=1}^{r} \theta_p \epsilon_{i,t-p} + \epsilon_{i,t} \quad (1)$$

where

$$\epsilon_{i,t} = \mu_{i,t} \sqrt{h_t} \quad (2)$$

and inflation uncertainty is derived through the following equations:

$$h_{i,t}^2 = \alpha_{10} + \sum_{m=1}^{n} \alpha_m \epsilon_{i,t-m}^2 + \sum_{p=1}^{r} \theta_p h_{i,t-p}^2 \quad (3)$$

In Equation 1, π denotes the dependent variable (inflation) in period *t* for country *i*, which follows an autoregressive process augmented by the uncertainty series defined in terms of the conditional variance. In Equation 2, μ is a sequence of independent, identically distributed random variables with zero mean and the conditional variance of *h* which is shown in Equation 3.

We have employed symmetric (Hacker, 2006) and asymmetric (Hatemi, 2012) causality tests to determine the impact of inflation uncertainty on growth in the countries under investigation, as shown in equations 4–9. At the first stage, Hacker (2006) examine the causality between the two series with the help of the Vector Autoregressive (VAR) model. The VAR model is represented by the equation given below.

$$y_t = \alpha + A_1 y_{t-1} + \ldots + A_p y_{p-1} + v_t \quad (4)$$

where y_t is identified as the vector of k independent variables, α is a constant vector, A is a parameter vector, and v_t is an error term vector. The main hypothesis, which asserts no Granger causality between the series, was tested using Modified Wald (MWALD) statistics. To obtain MWALD statistics, the VAR model shown in Equation 4 is expressed as Equation 5.

$$Y = \hat{D}Z + \hat{\delta} \quad (5)$$

$Y := (y_1, \ldots, y_t)$, $(n x T)$ matrix;

$\hat{D} := (\hat{\alpha}, \hat{A}_1, \ldots, \hat{A}_p, \ldots \hat{A}_{p+d})$, $(n x (1 + n(p+d)))$ matrix;

$$Z_t := \begin{bmatrix} 1 \\ Y_t \\ Y_{t-1} \\ . \\ . \\ . \\ Y_{t-p-d+1} \end{bmatrix} \quad ((1+n(p+d))x1 \text{ matrix for } t = 1, \ldots, T;$$

$Z := (Z_0, \ldots, Z_{T-1})$ $((1 + n(p + d))xT)$ matrix;

$\hat{\delta} := (\hat{v}_1, \ldots, \hat{v}_T)$ $(n x T)$ matrix

The main hypothesis can be tested using MWALD test statistics as shown in Equation 6.

$$\text{MWALD} = (C\hat{\beta})' \left[C\left((Z'Z)^{-1} \otimes S_U \right) C' \right]^{-1} (C\hat{\beta}) \quad (6)$$

where $\otimes$ signifies the Kronecker product, the term C represents a matrix with dimensions $pxn(1 + n(p + d))$, $\hat{\beta}$ indicates $vec(\hat{D})$, and S_U refers to the variance-covariance matrix of the residuals ($S_U = \hat{\delta}'_U \hat{\delta}_U$).

According to the symmetric causality test proposed by Hacker (2006), the effects of a positive shock are considered to be the same as those of a negative shock. However, the asymmetric causality test developed by HJ (2012) separates these shocks to examine their asymmetric effects. According to the model, positive and negative shocks present in each variable are presented in cumulative form within Equation 7 and 8.

$$Y_{1t}^{+} = \sum_{i=1}^{t} \varepsilon_{1i}^{+} \quad \text{and} \quad Y_{1t}^{-} = \sum_{i=1}^{t} \varepsilon_{1i}^{-} \quad (7)$$

$$Y_{2t}^{+} = \sum_{i=1}^{t} \varepsilon_{2i}^{+} \quad \text{and} \quad Y_{2t}^{-} = \sum_{i=1}^{t} \varepsilon_{2i}^{-} \quad (8)$$

where positive and negative shocks are defined as follows: $\varepsilon_{1i}^{+} = \max(\varepsilon_{1i}, 0)$, $\varepsilon_{2i}^{+} = \max(\varepsilon_{2i}, 0)$, $\varepsilon_{1i}^{-} = \min(\varepsilon_{1i}, 0)$ and $\varepsilon_{2i}^{-} = \min(\varepsilon_{2i}, 0)$. Therefore, ε_{1i} equals $(\varepsilon_{1i}^{+} + \varepsilon_{1i}^{-})$ and ε_{2i} represents $(\varepsilon_{2i}^{+} + \varepsilon_{2i}^{-})$. The causality test in Hatemi (2012), under the assumption that $y_t^{+} = (y_{1t}^{+}, y_{2t}^{+})$, is conducted using a p-lag VAR model as depicted in Equation 9. [1]

$$y_t^{+} = \alpha + A_1 y_{t-1}^{+} + \ldots + A_p y_{p-1}^{+} + v_t^{+} \quad (9)$$

where y_t^{+} and v_t^{+} respectively denote the vector of variables and the vector of error terms.

The causality models constructed based on the above-mentioned models are presented in equations 10 to 13 below.

$$g_{i,t} = a_{i,0} + \sum_{s=1}^{p} a_{i,s} g_{i,t-s} + \sum_{r=1}^{v} b_{i,r} \sqrt{h_{i,t-r}} + \varepsilon_{(g)i,t} \quad (10)$$

$$\sqrt{h_{i,t}} = c_{i,0} + \sum_{s=1}^{p} c_{i,s} g_{i,t-s} + \sum_{r=1}^{v} d_{i,r} \sqrt{h_{i,t-r}} + \varepsilon_{(h)i,t} \quad (11)$$

Equations 10 and 11 show the symmetric relationship between the variables. Equations 12 and 13, on the other hand, express the asymmetric relationship described in Equation 10.

$$g_{i,t}^{+} = e_{i,0} + \sum_{s=1}^{p} e_{i,s} g_{i,t-s}^{+} + \sum_{r=1}^{v} f_{i,r} \left(\sqrt{h_{i,t-r}} \right)^{+} + \varepsilon_{(g^{+})i,t} \quad (12)$$

$$g_{i,t}^{-} = j_{i,0} + \sum_{s=1}^{p} j_{i,s} g_{i,t-s}^{-} + \sum_{r=1}^{v} k_{i,r} \left(\sqrt{h_{i,t-r}} \right)^{-} + \varepsilon_{(g^{-})i,t} \quad (13)$$

where g is the growth rate and $\sqrt{h}$ is inflation uncertainty.

Data

The data used in our analysis covers the period from January 2010 to February 2023 for developing economies such as Bulgaria (BUL), Greece (GRE), India (IND), Korea (KOR), and Türkiye (TUR), while for Brazil (BRA), the Czech Republic (CZE), Mexico (MEX), and Russia (RUS), it covers the period from January 2010 to October 2021. The different periods selected for each country reflect data availability and the consistency of macroeconomic records across these economies. Moreover, for most countries, reliable post-crisis data becomes consistently available starting in January 2010, marking a period of economic stabilization after the 2008–09 financial crisis.

The dataset includes the domestic inflation rate (π) and growth rate (g) computed as the log differences in the seasonally adjusted (if needed) consumer price index (CPI) and industrial

[1] The vector $y_t^{-} = (y_{1t}^{-}, y_{2t}^{-})$, is used to test the causality among negative cumulative shocks. Additionally, other combinations can also be used.

Table 1

Descriptive Statistics for the Variables

	BRA	BUL	CZE	GRE	IND	KOR	MEX	RUS	TUR
Inflation Rates									
Mean	0.484	0.269	0.177	0.105	0.496	0.162	0.336	0.532	1.255
Median	0.449	0.219	0.158	0.044	0.455	0.159	0.329	0.458	0.848
Maximum	1.341	2.279	1.426	1.516	2.226	0.898	1.546	3.329	12.763
Minimum	–0.381	–0.849	–0.299	–1.276	–0.786	–0.504	–0.561	–0.096	–1.385
Std. Dev.	0.343	0.505	0.237	0.408	0.473	0.261	0.249	0.428	1.635
Skewness	0.284	1.034	1.543	0.386	0.618	0.178	0.453	2.989	3.881
Kurtosis	3.019	4.976	8.452	4.491	4.688	3.258	7.501	17.452	22.977
JB Test	1.89	53.51	230.59	18.43	28.64	1.26	123.86	1437.00	3004.75
Growth Rates									
Mean	–0.140	0.211	0.175	0.057	0.286	0.129	0.024	0.260	0.511
Median	–0.153	0.337	0.112	0.774	0.227	0.154	0.045	0.402	0.588
Maximum	11.510	10.344	22.052	9.360	47.589	10.209	18.919	6.435	32.018
Minimum	–29.720	–11.912	–34.287	–12.642	–66.057	-16.641	–29.929	–6.558	–42.014
Std. Dev.	3.033	3.373	5.307	4.081	7.364	2.597	3.362	1.823	4.846
Skewness	–5.929	–0.100	–1.407	–0.368	–3.059	-1.218	–3.775	–0.664	–2.611
Kurtosis	67.612	3.534	16.044	2.950	54.466	17.193	52.731	6.081	50.676
JB Test	25352.68	2.12	1046.03	3.56	17571.87	1356.57	14864.91	66.10	15047.86

Source: Authors' calculations

production index (IPI) over the previous month, respectively. All data are obtained from the IMF's International Financial Statistics. On the other side for the uncertainty series, two kind proxies are used. Uncertainties of the rates of inflation derived from the best ARMA(p,q)-GARCH(1,1) models of inflation as shown in Eq. 1 and 3, respectively. Descriptive statistic is presented in Table 1, respectively.

Table 1 presents the descriptive statistics of the data used in the analysis. It shows that the Turkish economy has experienced the highest average monthly inflation rate, while Greece has the lowest. Additionally, Türkiye's inflation rate exhibits a high standard deviation, indicating greater fluctuations in inflation in the given period compared to the other countries. Interestingly, the standard deviations of inflation rates in the remaining eight countries are quite similar.

Regarding economic growth, Table 1 highlights that Greece and Mexico have the lowest average monthly growth rates, approximately 0.05 % and 0.02 %, respectively. In contrast, Türkiye records the highest average monthly growth rate at 0.51 %. Notably, Türkiye combines this relatively high growth rate with a high level of inflation.

To test for unit roots, we performed Augmented Dickey-Fuller (ADF) tests, with the results presented in Table 2. The data show that none of the series contain a unit root and that all are trend-stationary.

The analysis also uses the LM unit root test with two structural breaks (Lee and Strazicich, 2003). Table 3 shows that all test statistics are significant at the 5 % level. 1

Estimation Results

Estimation Results of ARMA(p,q) GARCH (1,1) *Models*

Prior to generating the uncertainty series for inflation growth, we first estimated OLS regressions for ARMA models, as shown in Equation 1. After identifying the best-fitting ARMA(p,q) model for each country, we tested the residuals for the presence of ARCH effects using both the Lagrange Multiplier (LM) test and the Ljung–Box (LB) test. Table 4 presents the selected ARMA(p,q) models along with the corresponding LM and LB test results. The LM test provides evidence of ARCH effects in the inflation series of Brazil, Greece, India, and Russia. Regarding the LB test results, there is no indication of autocorrelation in the inflation data. The presence of conditional heteroskedasticity in these series motivated the use of the GARCH methodology to estimate volatility measures for inflation

To address the presence of ARCH effects in the residuals, we implemented the GARCH methodology and estimated ARMA(p,q)-

[1] The inflation rate is significant at the 10 % level in the crash model for Türkiye.

Table 2

ADF Unit Root Test Results

		Levels			Differences	
		c	**c + t**		**c**	**c + t**
BRA	p	–0.0771	–1.5875	π	–5.8232**	–5.7777**
	y	–2.0172	–3.9226	g	–12.3397**	–12.2959**
BUL	p	2.9841	1.7578	π	–5.3479**	–5.9244**
	y	–1.5248	–2.6619	g	–13.8175**	–13.7727**
CZE	p	3.6840	2.1766	π	–8.8454**	–9.3540**
	y	–2.3880	–5.7265**	g	–12.5484**	–12.541**
GRE	p	–0.5511	–0.7895	π	–3.4151*	–3.6335*
	y	–1.4241	–2.4343	g	–14.5653**	–14.6950**
IND	p	–2.5034	–1.9116	π	–10.2831**	–10.5738**
	y	–1.6274	–5.8909**	g	–11.6867**	–11.6642**
KOR	p	0.1363	–1.0422	π	–9.5022**	–9.4829**
	y	–2.5084	–3.7794*	g	–19.3975**	–19.4175**
MEX	p	1.4111	–1.5524	π	–8.5679**	–8.7377**
	y	–3.4147	–3.3768	g	–11.1570**	–11.1338**
RUS	p	–1.2107	–1.3516	π	–5.1661**	–5.2499**
	y	–1.1188	–5.3201**	g	–15.25**	–15.4731**
TUR	p	3.8120	1.7807	π	–3.1820*	–6.5450**
	y	–1.6250	–4.1071**	g	–13.2310**	–13.2146**

Note: *n*, *c* and *t* refer to none, constant and trend, respectively. * and ** show significance at 5 %, and 1 %, respectively.
Source: Authors' calculations

Table 3

LM Unit Root Test Results with Two Structural Breaks

			Model: Crash (A)			Model: Break (C)		
			Lag	**Breaks**	τ_{LM}	**Lag**	**Breaks**	τ_{LM}
BRA	π		[0]	2016:05 – 2017:12	–6.4268*	[0]	2016:02 – 2020:03	–6.8124*
	g		[0]	2015:11 – 2016:12	–11.5045*	[16]	2016:07 – 2020:03	–31.6876*
BUL	π		[0]	2016:12 – 2021:09	–7.1801*	[0]	2020:01 – 2021:10	–8.1193*
	g		[1]	2012:11 – 2021:02	–11.8422*	[1]	2012:09 – 2021:08	–13.3182*
CZE	π		[0]	2013:04 – 2020:10	–8.7002*	[0]	2013:03 – 2020:07	–11.0503*
	g		[0]	2012:08 – 2020:09	–12.4330*	[15]	2019:03 – 2020:03	–17.5442*
GRE	π		[11]	2016:01 – 2020:04	–4.2131*	[11]	2013:11 – 2021:07	–6.9925*
	g		[2]	2012:09 – 2019:12	–4.5192*	[0]	2012:09 – 2021:06	–19.4107*
IND	π		[0]	2014:07 – 2016:07	–10.1078*	[0]	2013:03 — 2019:01	–10.6320*
	g		[0]	2018:11 – 2021:03	–11.6764*	[0]	2018:09 – 2020:01	–12.2751*
KOR	π		[0]	2018:08 – 2019:09	–9.9818*	[0]	2017:03 — 2021:06	–10.4050*
	g		[0]	2020:06 – 2021:10	–17.0223*	[0]	2018:08 – 2021:01	–18.2895*
MEX	π		[0]	2016:08 – 2020:09	–8.6972*	[0]	2016:07 – 2019:08	–9.1105*
	g		[1]	2019:06 – 2020:08	–10.4150*	[15]	2018:12 – 2020:03	–19.9588*
RUS	π		[1]	2014:01 – 2015:01	–4.6105*	[1]	2014:10 – 2016:06	–6.8697*
	g		[0]	2015:01 – 2020:04	–15.2871*	[0]	2013:10– 2020:06	–14.7841*
TUR	π		[2]	2020:10 – 2021:12	–3.5662	[13]	2016:06 – 2021:10	–9.4267*
	g		[1]	2015:05 – 2018:12	–11.9323*	[12]	2020:03 – 2021:04	–13.8402*

Note: * show significance at 5 %.
Source: Authors' calculations

Table 4

Best ARMA(p,q) Models, LM Test Results and LB Test Results

		AR(p)	*MA(q)*	*LM Test*	*Prob*	*LB — Q(1) Test*	*Prob*
BRA	π	1	0	10.9501[a]	[0.001]	0.0830	[0.773]
BUL	π	1	2	0.9834	[0.322]	0.0264	[0.871]
CZE	π	1	1	0.0181	[0.893]	0.1120	[0.738]
GRE	π	1	2	7.9756[a]	[0.005]	0122	[0.912]
IND	π	0	1	8.6267[a]	[0.003]	0.0018	[0.966]
KOR	π	2	1	0.0253	[0.873]	0.0243	[0.876]
MEX	π	0	1	1.5678	[0.212]	0.0190	[0.890]
RUS	π	2	0	56.2280[a]	[0.000]	0.0414	[0.839]
TUR	π	1	2	0.2803	[0.597]	0.0393	[0.843]

Note: The best ARMA(p,q) models were selected using the Akaike Information Criterion (AIC), allowing for a maximum of six lags. The symbol a indicates the presence of ARCH effects in the residuals at the 1 % significance level.
Source: Authors' calculations

GARCH(1,1) models, using the previously identified best ARMA(p,q) specifications. Table 5 presents the results of the ARCH-LM tests, indicating that the residuals from all models are free from ARCH effects.

Therefore, the conditional variance series from the ARMA(p,q)-GARCH(1,1) models represent the unanticipated component of inflation, commonly interpreted as inflation uncertainty. These uncertainty series are illustrated in Figure 1.

Our empirical models are estimated using the OLS methodology as expressed in Equation 1 and 2. In these equations, the uncertainty series are added as the explanatory variables of the inflation and growth models. The estimation results for inflation and growth are presented in Table 6 and 7, respectively.

Estimation Results of Symmetric and Asymmetric Causality

Table 5

ARCH-LM Test Results of ARMA(p,q)GARCH(1,1) Models

		ARCH — LM Test	*Prob*
BRE	π	0.8780	0.3504
BUL	π	0.0079	0.9290
CZE	π	0.1444	0.7045
GRE	π	0.4902	0.4849
IND	π	0.0594	0.8077
KOR	π	0.1130	0.7372
MEX	π	0.0155	0.9010
RUS	π	0.6640	0.4166
TUR	π	0.0788	0.7792

Source: Authors' calculations

There is an ongoing discussion about the cross effects of inflation uncertainty and growth uncertainty on actual inflation and growth, respectively, vice versa. In this study, we focus on the impact of inflation uncertainty on economic growth. To search for these effects, we have employed symmetric and asymmetric causality tests.

Table 6 provides symmetric causality test results between the inflation uncertainty and economic growth. The null hypothesis in each case cannot be rejected without some exceptions. While inflation uncertainty causes economic growth, economic growth does not cause inflation uncertainty in Brazil and Bulgaria. While economic growth causes inflation uncertainty in Russia and Türkiye, vice versa is not supported. For the Czech Republic, Greece, India, Korea and Mexico, our findings revealed that for two macroeconomic indicators, there is no symmetric causality.

When comparing our findings with those of previous studies, both similarities and differences emerge. For example, consistent with our results, Hasanov and Omay (2011) found that inflation uncertainty causes output growth in Bulgaria, but not vice versa. They also found no evidence of a causal relationship—either direction—between inflation uncertainty and output growth in the Czech Republic. Similarly, Khan et al. (2013) concluded that output growth does not cause inflation uncertainty in the Czech Republic. Fountas (2010) reported that inflation uncertainty does not lead to output growth in Greece, and Pintilescu et al. (2014) reached the same conclusion for Türkiye. In contrast, however, Artan (2008) identified a bidirectional causal relationship between inflation uncertainty

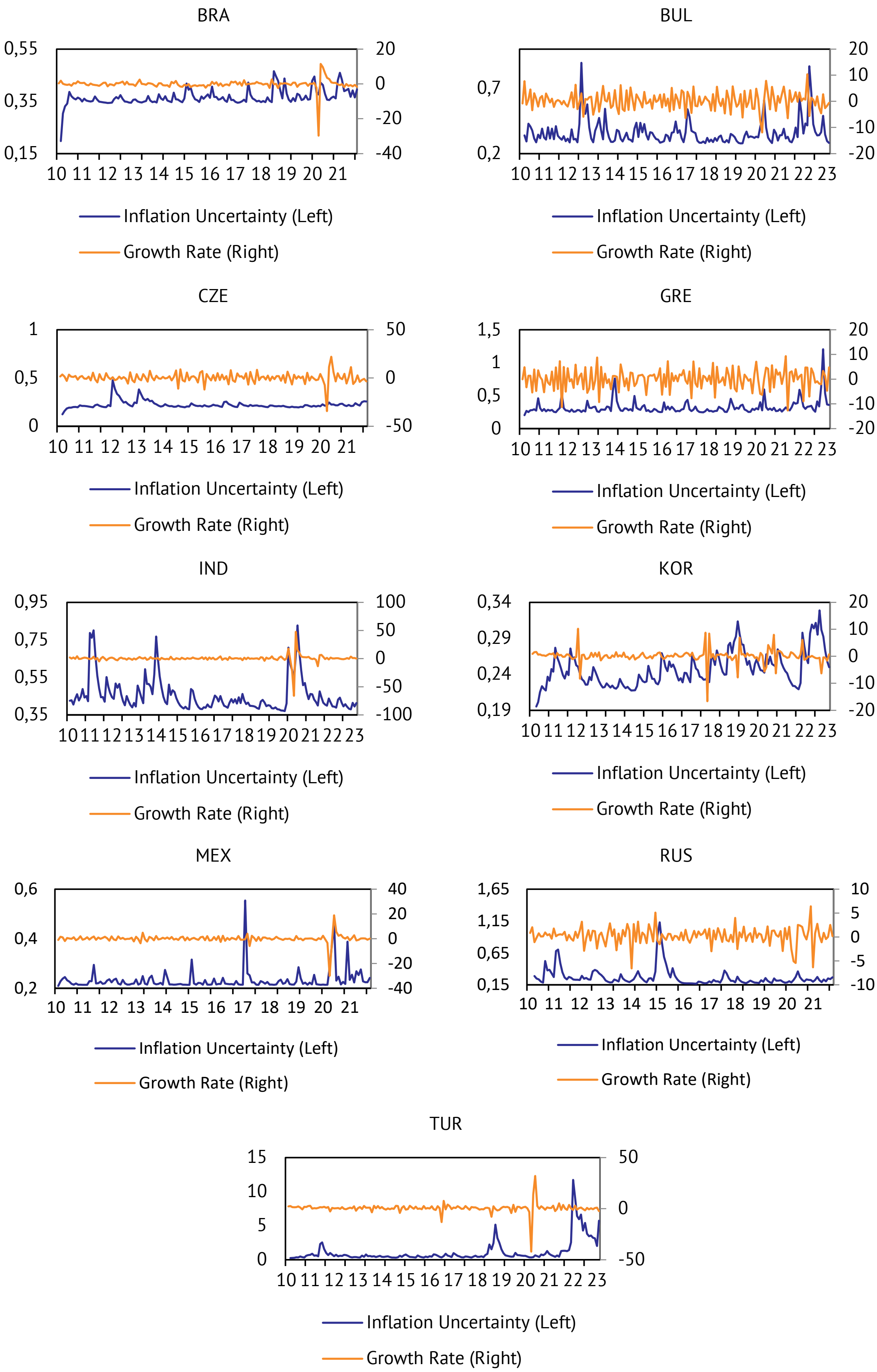

Fig. 1. *Conditional Variances of Inflation Series*
Source: Derived from ARMA(p,q)-GARCH (1,1) models for each country and variable.

Table 6

Symmetric causality test results for emerging economies

Country	Causal directions / Test null (H_0)	Wald Stat.	Bootstrap critical values (c_{α}^{*}) % 1	% 5	% 10	Lag	Symmetric Causality
BRA	$\sqrt{h}$ -> g	2.912*	6.971	4.293	2.803	1	Yes
	g -> $\sqrt{h}$	0.208	6.518	3.949	2.987	1	No
BUL	$\sqrt{h}$ -> g	3.064*	7.136	3.823	2.741	1	Yes
	g -> $\sqrt{h}$	0.686	7.087	3.685	2.652	1	No
GRE	$\sqrt{h}$ -> g	1.124	7.534	3.981	2.784	1	No
	g -> $\sqrt{h}$	0.092	5.967	3.625	2.482	1	No
IND	$\sqrt{h}$ -> g	0.051	8.049	4.129	2.885	2	No
	g -> $\sqrt{h}$	0.305	7.032	4.216	2.745	2	No
KOR	$\sqrt{h}$ -> g	2.241	9.805	4.642	2.967	1	No
	g -> $\sqrt{h}$	0.499	9.327	4.207	2.751	1	No
CZE	$\sqrt{h}$ -> g	2.027	6.803	4.146	2.718	1	No
	g -> $\sqrt{h}$	0.197	6.416	3.890	2.689	1	No
MEX	$\sqrt{h}$ -> g	0.535	10.061	6.537	4.478	2	No
	g -> $\sqrt{h}$	0.747	10.769	6.305	4.758	2	No
RUS	$\sqrt{h}$ -> g	1.300	7.450	4.553	2.955	2	No
	g -> $\sqrt{h}$	3.785*	7.509	4.051	2.602	2	Yes
TUR	$\sqrt{h}$ -> g	0.049	8.279	4.540	2.959	2	No
	g -> $\sqrt{h}$	3.753**	11.387	3.748	2.264	2	Yes

Note: * and ** show significance at 10 % and 5 %, respectively. The bootstrapped critical values were obtained by conducting 1 000 simulations. If the Wald statistic > Bootstrap critical values (c_{α}^{*}), H_0 is rejected.
Source: Authors' calculations

and growth in Türkiye. Our findings are, in part, consistent with those of Artan (2008).

Table 7 presents the results of asymmetric causality tests between inflation uncertainty and economic growth, specifically examining whether positive or negative shocks in inflation uncertainty lead to corresponding shocks in economic growth. For India, the results indicate that positive shocks in inflation uncertainty cause positive shocks in economic growth, while no such relationship is observed for negative shocks. In the case of Korea, the null hypothesis cannot be rejected, suggesting that positive shocks in inflation uncertainty do not lead to positive shocks in growth. However, the results support the hypothesis that negative shocks in inflation uncertainty lead to negative shocks in economic growth. The findings for Russia mirror those for Korea: positive shocks in inflation uncertainty do not have a significant effect on growth, while negative shocks do result in negative shocks in economic growth. For the remaining countries—Brazil, Bulgaria, the Czech Republic, Greece, Mexico, and Türkiye—the results show no evidence of causality in either direction between positive or negative shocks in inflation uncertainty and economic growth. To the best of our knowledge, the existing literature does not include studies applying this specific methodology to the topic. Therefore, the asymmetric findings presented here cannot be directly compared with previous research.

Additionally, Figures 2 and 3 present the estimated values of the asymmetric generalized impulse response functions developed by Hatemi (2014), along with 95 % confidence intervals. 1 The

[1] This study presents the impulse response values for the models that captured causal relationships between the variables.

Table 7

Asymmetric causality test results for emerging economies

Country	Causal directions / Test null (H_0)	Wald Stat.	Bootstrap critical values (c^*_α) % 1	% 5	% 10	Lag	Asymmetric Causality
BRA	$\sqrt{h}^+ \to g^+$	0.681	6.915	3.393	2.512	1	No
	$\sqrt{h}^- \to g^-$	3.167	10.792	6.578	4.657	1	No
BUL	$\sqrt{h}^+ \to g^+$	0.820	8.997	5.582	4.312	1	No
	$\sqrt{h}^- \to g^-$	1.008	11.565	8.510	6.208	1	No
CZE	$\sqrt{h}^+ \to g^+$	0.324	10.206	5.384	3.724	1	No
	$\sqrt{h}^- \to g^-$	0.407	14.579	8.263	6.642	1	No
GRE	$\sqrt{h}^+ \to g^+$	0.110	8.500	4.876	3.479	1	No
	$\sqrt{h}^- \to g^-$	0.252	9.460	5.200	3.419	1	No
IND	$\sqrt{h}^+ \to g^+$	6.871**	8.281	5.298	3.723	2	Yes
	$\sqrt{h}^- \to g^-$	4.277	9.470	6.611	5.238	2	No
KOR	$\sqrt{h}^+ \to g^+$	2.715	8.903	4.226	2.907	1	No
	$\sqrt{h}^- \to g^-$	7.979*	15.652	10.573	7.599	1	Yes
MEX	$\sqrt{h}^+ \to g^+$	0.326	9.527	5.214	3.516	2	No
	$\sqrt{h}^- \to g^-$	0.554	9.037	4.961	3.258	2	No
RUS	$\sqrt{h}^+ \to g^+$	0.845	7.300	4.848	3.375	2	No
	$\sqrt{h}^- \to g^-$	6.438*	14.154	8.142	6.095	2	Yes
TUR	$\sqrt{h}^+ \to g^+$	2.084	10.304	5.688	4.135	2	No
	$\sqrt{h}^- \to g^-$	0.233	11.343	7.647	5.811	2	No

Note: * and ** show significance at 10 % and 5 %, respectively. The bootstrapped critical values were obtained by conducting 1000 simulations. If the Wald statistic > Bootstrap critical values (c^*_α), H_0 is rejected.
Source: Authors' calculations

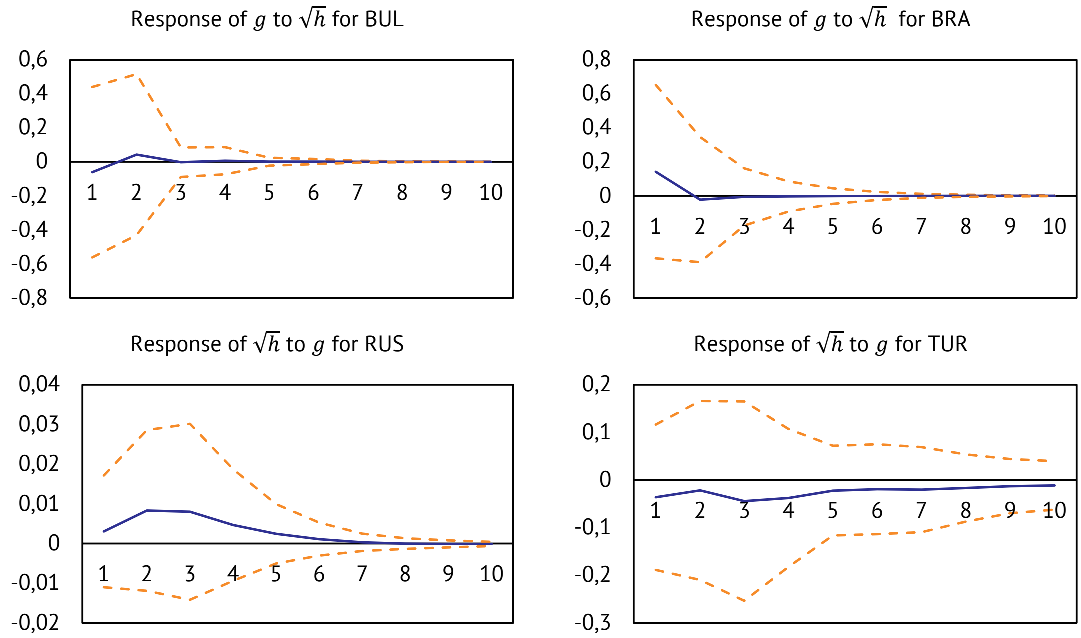

Fig. 2. *Symmetric generalized responses for inflation uncertainty and growth*

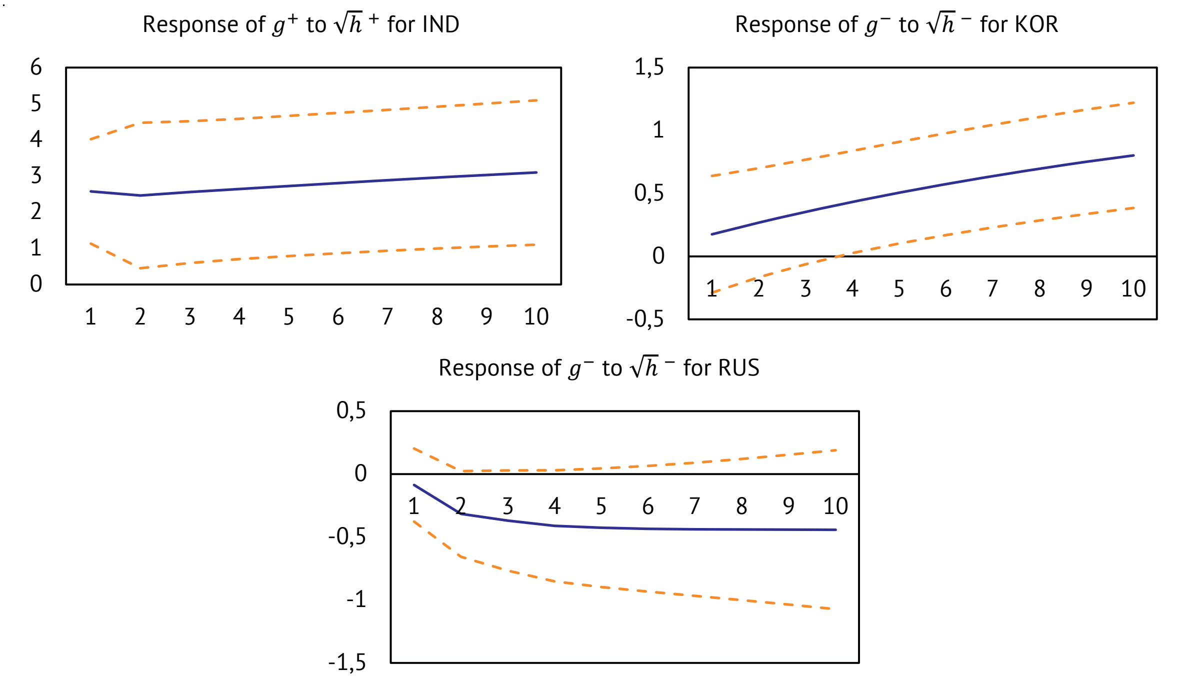

Fig. 3. *Asymmetric generalized responses for cumulative positive and negative shocks*

symmetric effects between inflation uncertainty and growth for Bulgaria, Brazil, Russia, and Türkiye are presented in Figure 2. The response of inflation uncertainty to a symmetric shock in economic growth is not statistically significant over a ten-period timeframe. Similarly, the impact of economic growth on inflation uncertainty in response to a symmetric shock is statistically insignificant.

The asymmetric effects between positive/negative shocks in inflation uncertainty and positive/negative shocks in growth for India, Korea and Russia are presented in Figure 3. The results from these estimates demonstrate that in India, cumulative positive shocks in economic growth significantly respond to cumulative positive shocks in inflation uncertainty.

Conclusion

Since the global financial crisis, macroeconomic uncertainties have increased sharply around the world, hitting emerging markets especially hard. In light of this, our study investigated the effects of inflation uncertainty on economic growth in a selection of emerging economies. The analysis was conducted in two stages: first, using ARMA-GARCH models to estimate inflation uncertainty; and second, applying symmetric and asymmetric causality tests to assess the directional relationships between inflation uncertainty and economic growth.

The influence of inflation uncertainty on economic growth is found to be weaker than initially expected. Nonetheless, the results indicate a unidirectional causality from inflation uncertainty to economic growth in Brazil and Bulgaria. Conversely, for Türkiye, the analysis revealed a unidirectional causality from economic growth to inflation uncertainty. Thus, symmetric causality tests suggest that in seven of the nine countries examined, the relationship between inflation uncertainty and economic growth is not statistically significant in either direction.

These findings have important policy implications. In Brazil and Bulgaria, it is vital for policymakers to adopt effective communication strategies to anchor inflation expectations. Enhancing the predictability of inflation may support sustainable economic growth.

In Türkiye, economic growth appears to influence inflation uncertainty. Therefore, growth-oriented policies must also account for their potential impact on inflation. Stimulating economic activity, for example, through investment incentives, should go hand in hand with measures to manage inflationary pressures. We would recommend investing in infrastructure development and expanding production capacity to help ease inflationary pressures and support price stability.

In Russia, both symmetric and asymmetric causality tests reveal a bidirectional relationship:

economic growth affects inflation uncertainty, while negative shocks in inflation uncertainty are associated with negative shocks in growth. The asymmetric findings for Russia mirror those for Korea. In contrast, in India, the results point to an asymmetric relationship in which positive shocks in inflation uncertainty are followed by positive shocks in economic growth.

These outcomes underline the importance of adaptive and responsive policy frameworks in Russia and Korea. Policymakers in these countries must be prepared to manage inflation shocks in order to safeguard economic growth. In India, the observed positive effect of inflation uncertainty on growth during high-growth periods suggests that uncertainty can, under certain conditions, act as a stimulus. However, to maintain the long-term viability of such dynamics, robust measures must be taken to prevent inflation from becoming unmanageable.

In conclusion, our findings demonstrate that the relationship between inflation uncertainty and economic growth is particularly relevant in Brazil, Bulgaria, Russia, Korea, and India. In the remaining countries, growth appears to be shaped by other factors. For the former group, macroeconomic stability and sustained growth require careful attention to inflation dynamics.

References

Achiyaale, R.A., Adaletey, J.E., Mbilla, S.A.E., & Tsorhe, D.K. (2023). Economic Growth Implications of Inflation Targeting and Inflation Volatility: An Emerging Economy's Perspective. *Journal of Economics, Management and Trade, 29*(9), 134–149. http://dx.doi.org/10.9734/jemt/2023/v29i91134

Ahmad, K., Khalil, S., & Riaz, U. (2014). Inflation, Inflation Uncertainty and Economic Growth Nexus in Pakistan: A Granger Causality Test. *International Journal of Management Research and Emerging Sciences, 3*(1), 24–36. https://doi.org/10.56536/ijmres.v3i1.7

Aizenman, J., Jinjarak, Y., & Park, D. (2013). Capital Flows and Economic Growth in the Era of Financial Integration and Crisis, 1990–2010. *Open Economies Review, 24,* 371–396. https://doi.org/10.1007/s11079-012-9247-3

Akar, C., & Çiçek, S. (2016). "New" Monetary Policy Instruments and Exchange Rate Volatility. *Empirica, 43*(1), 141–165. https://doi.org/10.1007/s10663-015-9298-y

Apergis, N. (2004). Inflation, Output Growth, Volatility and Causality: Evidence from Panel Data and the G7 Countries. *Economics Letters, 83*(2), 185–191. https://doi.org/10.1016/j.econlet.2003.11.006

Artan, S. (2008). Inflation, Inflation Uncertainty and Growth in Türkiye. *International Journal of Economics and Administrative Studies, 1*(1), 113–138.

Baharumshah, A.Z., & Soon, S.-V. (2014). Inflation, Inflation Uncertainty and Output Growth: What Does the Data Say for Malaysia? *Journal of Economic Studies, 41*(3), 370–386. https://doi.org/10.1108/JES-05-2012–0073

Baharumshah, A.Z., Hasanov, A., & Fountas, S. (2011a). Inflation and Inflation Uncertainty: Evidence from Two Transition Economies. *Discussion Paper,* (05/2011. 1-29).

Baharumshah, A.Z., Hamzah, N.A., & Sabri, S.R.M. (2011b). Inflation Uncertainty and Economic Growth: Evidence from the LAD ARCH Model. *Journal of Applied Statistics, 38*(1), 195–206. https://doi.org/10.1080/02664760903406397

Baharumshah, A.Z., Slesman, L., & Wohar, M.E. (2016). Inflation, Inflation Uncertainty, and Economic Growth in Emerging and Developing Countries: Panel Data Evidence. *Economic Systems, 40*(4), 638–657. https://doi.org/10.1016/j.ecosys.2016.02.009

Berger, T., & Grabert, S. (2018). International Output and Inflation Uncertainty and Their Impact on Countries' Macroeconomic Performance. Evidence from A Dynamic Factor Garch-in-Mean Model. *Macroeconomic Dynamics, 22*(5), 1113–1133. https://doi.org/10.1017/S1365100516000596

Berument, H., & Dincer, N.N. (2005). Inflation and Inflation Uncertainty in the G-7 Countries. *Physica A: Statistical Mechanics and its Applications, 348,* 371–379. https://doi.org/10.1016/j.physa.2004.09.003

Berument, H., Yalcin, Y., & Yildirim, J. (2009). The Effect of Inflation Uncertainty on Inflation: Stochastic Volatility in Mean Model within a Dynamic Framework. *Economic Modelling, 26*(6), 1201–1207. https://doi.org/10.1016/j.econmod.2009.05.007

Bhar, R., & Mallik, G. (2010). Inflation, Inflation Uncertainty and Output Growth in the USA. *Physica A: Statistical Mechanics and its Applications, 389*(23), 5503–5510. https://doi.org/10.1016/j.physa.2010.06.063

Bloom, N. (2014). Fluctuations in Uncertainty. *Journal of Economic Perspectives, 28*(2), 153–176. https://doi.org/10.1257/jep.28.2.153

Bredin, D., & Fountas, S. (2005). Macroeconomic Uncertainty and Macroeconomic Performance: Are they Related? *The Manchester School, 73*(s1), 58–76. https://doi.org/10.1111/j.1467–9957.2005.00461.x

Bredin, D., & Fountas, S. (2009). Macroeconomic Uncertainty and Performance in the European Union. *Journal of International Money and Finance, 28*(6), 972–986. https://doi.org/10.1016/j.jimonfin.2008.09.003

Brunner, A.D. (1993). Comment on Inflation Regimes and the Sources of Inflation Uncertainty. *Journal of Money, Credit and Banking, 25*(3), 512–520. https://doi.org/10.2307/2077720

Çağlayan, M., Kandemir, O., & Mouratidis, K. (2012). The Impact of Inflation Uncertainty on Economic Growth: A MRS-IV Approach. *Working Papers* (2012025).

Çağlayan, M., Kocaaslan, O. K., & Mouratidis, K. (2016). Regime Dependent Effects of Inflation Uncertainty on Real Growth: A Markov Switching Approach. *Scottish Journal of Political Economy, 63*(2), 135–155. https://doi.org/10.1111/sjpe.12087

Carrière-Swallow, Y., & Céspedes, L. F. (2013). The Impact of Uncertainty Shocks in Emerging Economies. *Journal of International Economics, 90*(2), 316–325. https://doi.org/10.1016/j.jinteco.2013.03.003

Chang, K.-L., & He, C.-W. (2010). Does the Magnitude of the Effect of Inflation Uncertainty on Output Growth Depend on the Level of Inflation? The *Manchester School, 78*(2), 126–148. https://doi.org/10.1111/j.1467–9957.2009.02162.x

Chowdhury, K. B. (2024). Relationships between Inflation, Output Growth, and Uncertainty in the Era of Inflation Stabilization: A Multicountry Study. *Empirical Economics, 66*(2), 623–650. https://doi.org/10.1007/s00181-023-02473-z

Chowdhury, K. B., Kundu, S., & Sarkar, N. (2018). Regime-Dependent Effects of Uncertainty on Inflation and Output Growth: Evidence from the United Kingdom and the United States. *Scottish Journal of Political Economy, 65*(4), 390–413. https://doi.org/10.1111/sjpe.12168

Cukierman, A., & Meltzer, A. H. (1986). A Theory of Ambiguity, Credibility, and Inflation under the Discretion and Asymmetric Information. *Econometrica, 54*(5), 1099–1128. https://doi.org/10.2307/1912324

Daal, E., Naka, A., & Sanchez, B. (2005). Re-Examining Inflation and Inflation Uncertainty in Developed and Emerging Countries. *Economics Letters, 89*(2), 180–186. https://doi.org/10.1016/j.econlet.2005.05.024

Daniela, Z., Mihail-Ioana, C., & Sorina, P. (2014). Inflation Uncertainty and Inflation in the Case of Romania, Czech Republic, Hungary, Poland and Türkiye. *Procedia Economics and Finance, 15*(2014), 1225–1234. https://doi.org/10.1016/S2212–5671(14)00582-6

Darrat, A. F., & Lopez, F. A. (1989). Has Inflation Uncertainty Hampered Economic Growth in Latin America? *International Economic Journal, 3*(2), 1–15. https://doi.org/10.1080/10168738900000008

Din, S., Din, H., Khan, I., & Naheed, S. (2024). Nexus among Exchange Rate Volatility, Inflation, and Economic Growth: A Panel Data Analysis. *Pakistan Journal of Humanities and Social Sciences, 12*(1), 200–206. https://doi.org/10.52131/pjhss.2024.v12i1.1815

Dotsey, M., & Sarte, P. D. (2000). Inflation Uncertainty and Growth in a Cash-in-advance Economy. *Journal of Monetary Economics, 45*(3), 631–655. https://doi.org/10.1016/S0304–3932(00)00005-2

Fountas, S. (2010). Inflation, Inflation Uncertainty and Growth: Are they Related? *Economic Modelling, 27*(5), 896–899. https://doi.org/10.1016/j.econmod.2010.06.001

Fountas, S., & Karanasos, M. (2007). Inflation, Output Growth, and Nominal and Real Uncertainty: Empirical Evidence for the G7. *Journal of International Money and Finance, 26*(2), 229–250. https://doi.org/10.1016/j.jimonfin.2006.10.006

Fountas, S., Ioannidis, A., & Karanasos, M. (2004). Inflation, Inflation Uncertainty and a Common European Monetary Policy. *The Manchester School, 72*(2), 221–242. https://doi.org/10.1111/j.1467–9957.2004.00390.x

Fountas, S., Karanasos, M., & Kim, J. (2002). Inflation and Output Growth Uncertainty and Their Relationship with Inflation and Output Growth. *Economics Letters, 75*(3), 293–301. https://doi.org/10.1016/S0165–1765(02)00009-5

Fountas, S., Karanasos, M., & Kim, J. (2006). Inflation Uncertainty, Output Growth Uncertainty and Macroeconomic Performance. *Oxford Bulletin of Economics and Statistics, 68*(3), 319–343. https://doi.org/10.1111/j.1468–0084.2006.00164.x

Fratzscher, M., Lo Duca, M., & Straub, R. (2013). On the International Spillovers of US Quantitative Easing. *European Central Bank Working Paper Series* (1557).

Friedman, M. (1977). Nobel Lecture: Inflation and Unemployment. *Journal of Political Economy, 85*(3), 451–472. https://doi.org/10.1086/260579

Grier, K. B., & Perry, M. J. (1998). On Inflation and Inflation Uncertainty in the G7 Countries. *Journal of International Money and Finance, 17*(4), 671–689. https://doi.org/10.1016/S0261–5606(98)00023-0

Grier, K. B., & Perry, M. J. (2000). The Effects of Real and Nominal Uncertainty on Inflation and Output Growth: Some GARCH-M Evidence. *Journal of Applied Econometrics, 15*(1), 45–58. https://doi.org/10.1002/(SICI)1099–1255(200001/02)15:1<45::AID-JAE542>3.0.CO;2-K

Grier, K. B., Henry, Ó. T., Olekalns, N., & Shields, K. (2004). The Asymmetric Effects of Uncertainty on Inflation and Output Growth. *Journal of Applied Econometrics, 19*(5), 551–565. https://doi.org/10.1002/jae.763

Grier, R., & Grier, K. B. (2006). On the Real Effects of Inflation and Inflation Uncertainty in Mexico. *Journal of Development Economics, 80*(2), 478–500. https://doi.org/10.1016/j.jdeveco.2005.02.002

Hachicha, A., & Hooi, L. H. (2013). Inflation, inflation Uncertainty and Output in Tunisia. *Economics Discussion Papers,* (2013-1).

Hacker, R. S., & Hatemi-J, A. (2006). Tests for Causality between Integrated Variables Using Asymptotic and Bootstrap Distributions: Theory and Application. *Applied Economics, 38*(13), 1489–1500. https://doi.org/10.1080/00036840500405763

Hajamini, M. (2019). Asymmetric Causality Between Inflation and Uncertainty: Evidence from 33 Developed and Developing Countries. *Journal of Quantitative Economics, 17*(2), 287–309. https://doi.org/10.1007/s40953-019-00165-z

Hasanov, M., & Omay, T. (2011). The Relationship between Inflation, Output Growth, and Their Uncertainties: Evidence from Selected CEE Countries. *Emerging Markets Finance and Trade, 47*(sup3), 5–20. https://doi.org/10.2753/REE1540-496X4704S301

Hatemi-j, A. (2012). Asymmetric Causality Tests with an Application. *Empirical Economics, 43,* 447–456. https://doi.org/10.1007/s00181-011-0484-x

Hatemi-j, A. (2014). Asymmetric Generalized Impulse Responses with an Application in Finance. *Economic Modelling, 36,* 18–22. https://doi.org/10.1016/j.econmod.2013.09.014

Heidari, H., Katircioglu, S. T., & Bashiri, S. (2013). Inflation, Inflation Uncertainty and Growth in the Iranian Economy: An Application of BGARCH-M Model with BEKK Approach. *Journal of Business Economics and Management, 14*(5), 819–832. https://doi.org/10.3846/16111699.2012.670134

Holland, A. S. (1995). Inflation and Uncertainty: Tests for Temporal Ordering. *Journal of Money, Credit and Banking, 27*(3), 827–837. https://doi.org/10.2307/2077753

Jiang, D. (2016). Inflation and Inflation Uncertainty in China. *Applied Economics, 48*(41), 3935–3943. https://doi.org/10.1080/00036846.2016.1148258

Jiranyakul, K., & Opiela, T. P. (2011). The Impact of Inflation Uncertainty on Output Growth and Inflation in Thailand. *Asian Economic Journal, 25*(3), 291–307. https://doi.org/10.1111/j.1467–8381.2011.02062.x

Karahan, Ö. (2012). The Relationship between Inflation and Inflation Uncertainty: Evidence from the Turkish Economy. *Procedia Economics and Finance, 1,* 219–228. http://dx.doi.org/10.1016/S2212–5671(12)00026-3

Khan, M., Kebewar, M., & Nenovsky, N. (2013). Inflation Uncertainty, Output Growth Uncertainty and Macroeconomic Performance: Comparing Alternative Exchange Rate Regimes in Eastern Europe.

Köse, N., & Terzioğlu, N. (2014). Effects of Inflation Uncertainty on Inflation, Growth, Interest Rate and Exchange Rate in Türkiye. In *International Conference on Eurasıan Economies*.

Lee, J., & Strazicich, M. C. (2003). Minimum Lagrange Multiplier Unit Root Test with Two Structural Breaks. *The Review of Economics and Statistics, 85*(4), 1082–1089. https://doi.org/10.1162/003465303772815961

Lim, J. J., Mohapatra, S., & Stocker, M. (2014). Tinker, taper, QE, bye? The Effect of Quantitative Easing on Financial Flows to Developing Countries. *World Bank Policy Research Working Paper,* (6820).

Mandeya, S. M. T., & Ho, S. Y. (2021). Inflation, Inflation Uncertainty and the Economic Growth Nexus: An Impact Study of South Africa. *MethodsX, 8,* 101501. https://doi.org/10.1016/j.mex.2021.101501

Meinusch, A., & Tillmann, P. (2017). Quantitative Easing and Tapering Uncertainty: Evidence from Twitter. *Discussion Paper Series in Economics,* (09-2015), 227–258.

Mohd, S. H., Baharumshah, A. Z., & Fountas, S. (2012). Inflation, Inflation Uncertainty and Output Growth: Recent Evidence from ASEAN-5 Countries. *Discussion Paper Series,* (07/2012).

Narayan, P. K., Narayan, S., & Smyth, R. (2009). Understanding the Inflation–output Nexus for China. *China Economic Review, 20*(1), 82–90. https://doi.org/10.1016/j.chieco.2008.10.012

Nas, T. F., & Perry, M. J. (2000). Inflation, Inflation Uncertainty, and Monetary Policy in Türkiye: 1960–1998. *Contemporary Economic Policy, 18*(2), 170–180. https://doi.org/10.1111/j.1465–7287.2000.tb00015.x

Nas, T., & Perry, M. J. (2001). Turkish Inflation and Real Output Growth, 1963–2000. *Russian & East European Finance and Trade, 37*(6), 31–46.

Neanidis, K. C., & Savva, C. S. (2013). Macroeconomic Uncertainty, Inflation and Growth: Regime-dependent Effects in the G7. *Journal of Macroeconomics, 35,* 81–92. https://doi.org/10.1016/j.jmacro.2012.10.005

Özdemir, Z. A., & Fisunoğlu, M. (2008). On the Inflation-Uncertainty Hypothesis in Jordan, Philippines and Türkiye: A Long Memory Approach. *International Review of Economics & Finance, 17*(1), 1–12. https://doi.org/10.1016/j.iref.2005.10.003

Paksha Paul, B. (2013). Inflation–growth Nexus: Some Bivariate EGARCH Evidence for Bangladesh. *Macroeconomics and Finance in Emerging Market Economies, 6*(1), 66–76. https://doi.org/10.1080/17520843.2012.695385

Pindyck, R. (1991). Irreversibility, Uncertainty, and Investment. *Journal of Economic Literature, 29*(3), 1110–1148.

Pintilescu, C., Jemna, D. V., Viorică, E. D., & Asandului, M. (2014). Inflation, Output Growth, and Their Uncertainties: Empirical Evidence for a Causal Relationship from European Emerging Economies. *Emerging Markets Finance and Trade, 50*(sup4), 78–94. https://doi.org/10.2753/REE1540-496X5004S405

Thornton, J. (2007). The Relationship between Inflation and Inflation Uncertainty in Emerging Market Economies. *Southern Economic Journal, 73*(4), 858–870. https://doi.org/10.1002/j.2325–8012.2007.tb00808.x

Wen, J., Khalid, S., Mahmood, H., & Yang, X. (2022). Economic Policy Uncertainty and Growth Nexus in Pakistan: A New Evidence using NARDL Model. *Economic Change and Restructuring, 55,* 1701–1715. https://doi.org/10.1007/s10644-021-09364-2

Wilson, B. K. (2006). The Links between Inflation, Inflation Uncertainty and Output Growth: New Time-Series Evidence from Japan. *Journal of Macroeconomics, 28*(3), 609–620. https://doi.org/10.1016/j.jmacro.2004.11.004

Wilson, B. K., & Culver, S. E. (1999). On Measuring the Response of Real GDP Growth to Changes in Inflation Volatility. *Quarterly Journal of Business and Economics, 8*(4), 3–15.

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