Inflation Uncertainty and Economic Growth: what does the Data Say for Transition Countries Under the Russia-Ukraine Conflict Period

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Abstract: This study examines the influence of inflation uncertainty on output growth in selected transition economies from Commonwealth of Independent States (CIS), namely Russian Federation, Kazakhstan, and Ukraine over the period from 2000M01 to 2022M08. The study uses multivariate GARCH–in–mean model (MGARCH-M) the nonlinear autoregressive distributed lag (NARDL) models to examine the inflation uncertainty with long-run and short-run asymmetric effects on output under concern. We found that, the conditional standard deviation of inflation uncertainty has a significant negative impacts on output growth of the the all selected transition economies. Firstly, the statistical significant coefficients for all selected transition economies imply that the inflation uncertainty and output growth of these economies are affected by the shocks from their own returns, respectively. Secondly, we found an evidence of bi-directional shock transmissions between the inflation uncertainty and output growth of Russia, Kazakhstan and Ukraine. Secondly, the results of NARDL model estimation reveal that the adjustment to the inflation uncertainty is moving in the direction of a constant increase in the short-run with respect to a considerably significantly negative influence on output growth. In sum, results of the GIRF analysis provided that the innovation shocks of inflation uncertainty have negative steady-state effects on output growth in pandemic period, and inflation uncertainty has a ambiguous effect on output growth Russia-Ukraine conflict periods in Russia, Kazakhstan and Ukraine. Consequently, we further recommend that policymakers should pursue policies that stimulate economic development, while allowing the responsible body for monetary and economic policy to commit to fighting inflation and inflation uncertainty.

Keywords: Inflation, inflation uncertainty, economic growth, transition economies, asymmetric analysis, MGARCH-M model, NARDL approach.

JEL classification: E31, O47, O55.

1. INTRODUCTION

The significance of inflation, inflation uncertainty coupled with the effect it exerts on an economy has been acknowledged by policy-makers for a long time. Dating from the 1980s, this recognition has reinforced the increasing curiosity of investigations into economic uncertainty which results from variability in growth output or business cycles and the impacts it has on macroeconomic variables (Easterly, Islam, & Stiglitz, 2001; Blackburn & Pelloni, 2005; Fountas & Karnasos, 2007; etc).

The stagflation of the 1970s, stemming mainly from increases in prices, debunked the ideas and casted doubts on the existence of a positive relationship between inflation and economic growth. Theoretical studies took a different trajectory, with studies from Okun (1971), Friedman (1977), Stockman (1981) and Ball (1992), explaining that price instability inhibits economic growth. The debate spills over to empirical studies which have contrasting conclusions. For instance, among others, Judson and Orphanides (1999), Grier and Perry (2000), Grier, Henry, Olekalns and Shields (2004), Apergis (2005) as well as Iyke and Ho (2019) documented a negative relationship between either inflation, or inflation uncertainty or both, and economic growth. In contrast, Coulson and Robins (1985), Jansen (1989) and Fountas (2010) reported a positive relationship among the variables. The debate also extends to empirical results between and within industrialised countries and emerging economies.

In some countries which are in transition, the problem of inflation has been persistent. The probable effects of inflation on the capability of the economies of these countries to grow has piqued interest, seeing that the attainment of greater levels of economic growth is a common objective. Strong evidence exists, from panel and time-series data, which shows that inflation produces a damaging effect on economic growth in developing countries (Gillman, et al., 2004, Fountas, Karanasos, and Kim 2006); however, there is not much clarity regarding the effects which inflation has on transition countries. In comparison with more developed countries, transition countries may still be liberalism its economy, and organizing its market institutions; however, none of these factors has been proven to nullify the impact

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which inflation exerts on the return to capital. Moreover, there may be difficulties when attempting to ascertain the influence inflation has on growth, particularly in periods when the stationary rate of inflation experiences shock.

As the war in Ukraine grinds on, the physical destruction and the effects of sanctions are causing additional shocks to the global economy. The effects will be higher energy prices and weaker confidence in the economy and financial markets in a world already suffering from pandemic-driven inflation. Overall, our analysis suggests the war in Ukraine will add about 2% to global inflation in 2022 and 1% in 2023, compared to our pre-war forecast in Winter 2022. While these inflationary pressures might well persist, slower growth and higher policy rates are expected to contribute to slower inflation in 2023, but still perhaps uncomfortably above central banks' target. We estimated that the combined effects would result in U.S. personal Consumer Expenditure Deflator inflation increasing by 1.4% in 2022 and 0.5% in 2023, compared with our pre-war forecast. In the euro area, inflation would increase by 2% in 2022 and 0.3% in 2023, as against our pre-war forecasts (Corrado Macchiarelli, 2022).

The fact that the processes involved in inflation encompass all sectors of the economy, food, products manufacturing and sales inclusive, is one the most hard-hitting challenges which transition economies have encountered over past decades. From common knowledge, inflation is an umbrella term which encompasses a general rise in the level of prices within a country, not just the increase in prices which occurs within specific sectors of the economy; the general price level is dictated by steady and lasting imbalance which exists between the aggregate supply and demand (Suslova et al, 2015).

Although the relationships among inflation, inflation uncertainty and output growth have been investigated extensively in the empirical literature for developed countries (e.g., Grier and Perry 1998; Davis and Kanago, 2000; Fountas et al. 2006; Fountas and Karanasos 2007), a limited research was done done for transition economies Europe. Few exceptions are Gillman and Nakov (2004), Dibooglu and Kutan (2005), Gillman and Harris (2008), Mladenovic (2007), Thornton (2007), Erkam and Cavusoglu (2008), and Susjan and Redek (2008). Gillman and Nakov (2004) examined the relationship between inflation and output growth in Hungary and Poland, and found that inflation affects growth negatively in both countries. Gillman and Harris (2008) also found a robust negative effect of inflation on growth in a panel of 13 transition countries. Dibooglu and Kutan (2015) studied the sources of inflation and output movements in Poland and Hungary, and found that monetary shocks affect output in Hungary, while supply shocks dominate output movements in Poland. Mladenovic (2019) examined the relationship between inflation and inflation uncertainty in Serbia, and concluded that high inflation invokes high uncertainty, while high uncertainty negatively affects average level of inflation in the long run. Thornton (2010) studied the inflation and inflation uncertainty relationship for 12 emerging economies including Hungary, and found that there is positive bidirectional causality between inflation and inflation uncertainty in the case of Hungary.

It should be noted that, Dejan Živkov et al. (2022) explored the influence of inflation and its attendant uncertainty on the growth of GDP in eight countries in Central and Eastern Europe. The results ratified the Friedman hypothesis as they indicated that the impeding impact of inflation on the growth of GDP is much less than that exerted by inflation uncertainty. What this means is that in the countries under review, inflation indirectly influences the growth of GDP by way of inflation uncertainty. Also, it proves that the negative influence due to inflation uncertainty which occurs in upturn and downturn circumstances, is more keenly felt in countries where the economy is smaller, among which are Latvia and Estonia, and this is possibly the result of their vulnerability to external inflationary shocks.

Moreover, Saša Obradović et al (2022) investigated the Rate Of inflation in Western Balkan Countries: Evidence from Panel Time Series. The panel data was used from 2006 to 2020. The objectives of the their research is to look at the unit root features of inflation in Western Balkan nations. The findings indicate that inflation in Albania and Montenegro is a nonstationary process with structural interruptions. If the inflation rate is nonstationary, macroeconomic shocks will have a longer lasting influence on it. Serbia's and Bosnia and Herzegovina's inflation rates exhibit nonlinear mean reversion behavior. This suggests that the declared monetary plan will be implemented at a lower cost.

The using nonlinear autoregressive distributed lag (NARDL) approach Tuğay (2021) investigated the impact of inflation volatility on economic development from 1970 to 2018 in Turkiye. The findings reveal that inflation volatility has both symmetric and asymmetric effects on economic growth in the long and short run. To put it another way, the link between inflation volatility and economic growth is non-linear. As a result, in both negative and positive shocks, the long-term direction of the connection between inflation volatility and economic growth is negative. Similarly, Nadabo et al. (2021) studied the asymmetric impact of inflation on economic development in Nigeria using the Nonlinear Autoregressive Distributed Lag (NARDL) technique. In the long run, the consequences of inflation on economic growth are negative and unbalanced, according to the findings. In the long run, the consequences of inflation on economic growth are negative and unbalanced, according to the findings. The study also provides empirical information for policymakers to use in planning monetary policies and controlling inflation rates in order to achieve long-term economic growth and development.

On other hand, Gurkan Bozma et. al (2021) investigated the links between economic growth, inflation, and oil prices using a multivariate GARCH-in-mean with asymmetric BEKK approach. Authors achieved that economic growth uncertainty is significantly impacted by inflation uncertainty rather than its own. Furthermore, they demonstrate that the Holland hypothesis holds true for Turkiye. Hoang at. el (2022) examined the inflation-to-GDP growth threshold in Vietnam. It is expected that inflation has a nonlinear connection with GDP growth. The findings demonstrated that the existence of the 6% inflation point, as well as the detrimental effects on GDP growth of hyperinflation over the threshold and too low inflation beyond the threshold. When the whole impact of inflation on GDP growth is considered, the impacts are negative. This research shows that Vietnam's policymakers should aim towards 6% inflation to boost GDP growth.

In addition, other empirical studies investigated the nexus between inflation uncertainty and output growth (Sadorsky,1999; Choi and Hammoudeh, 2010; Salisu and Oloko, 2015), while other researchers examined the influence of inflation on economic growth (Wang et al., 2013; Aloui et al., 2018; Avazkhodjaev et. al., 2022, Bekiros et al., 2016; Perez-Liston et al., 2016; Dash and Maitra, 2017; Hasanov and Avazkhodjaev, 2022; Shakhabiddinovich et.al., 2022; Avazkhodjaev et. al., 2022).

This present research was conducted to investigate the influence of inflation and inflation uncertainty on output growth in selected transition economies namely, Russia, Ukraine and Kazakhstan from Commonwealth of Independent States (CIS).

This paper generally differs from the other studies in several ways. Firstly, despite the fact of necessity, a limited number of empirical studies seem to have focused on inflation, inflation uncertainty and economic growth in transition economies from Southeast European countries. Indeed, a methodological approach adopted in this paper relies on advances in the field of financial modeling and empirical finance. Especially, we apply the MGARCH-M model suggested by Bauwens et al. (2006) to assess effects of Inflation and inflation uncertainty on economic growth. As suggested by Grier et al. (2004) this research identifies and projects a particularly universal model of inflation uncertainty on output growth. In comparison with previous investigations carried out within this context, this present model gives room for the likelihood of spillover effects and asymmetries in the variance-covariance structure of output and inflation growth series. Secondly, we applied mean non–causality tests developed by Hafner and Herwartz (2008) among the selected variables, which is achieved by estimating parameters for variance-covariance matrix specifications (BEKK) proposed by Engle and Kroner (1995). Thirdly, we argue that analyses of the relationship between the variables in a nonlinear setting have at least two important reasons: (1) a time series can have hidden cointegration if positive and negative components of a series are cointegrated (Granger and Yoon, 2002) and (2) asymmetry is types of nonlinearities that affect the indicator dynamic. To achieve these purposes, we employ the Nonlinear Autoregressive Distributed Lag (NARDL) approach proposed by Shin et al. (2014) which allows testing the long-run and short-run asymmetries. Moreover, unlike the standard cointegration techniques, this method permits time series to have different orders of integration (Shin et al., 2014). Lastly, we examine the time mode of the effects of iflation uncertainty shocks on future behavior of economic growth, we employ the Generalized impulses response function analysis (GIRF) proposed by Koop et al. (1996). This type of analysis has the potential to support future policy recommendations.

The remainder of this paper is structured as follows. Section 2 describes of economic and monetary policy developments of transition economies, Section 3 discusses a brief review of the literature, Section 4 describes the data and the descriptive statistics. Section 5 introduces the empirical methodology, including model specifications. In section 6, we report and analyze the empirical results and discussion. Finally, section 7 provides conclusions and policy implications.

2. AN OVERVIEW OF ECONOMIC AND MONETARY POLICY DEVELOPMENTS OF TRANSITION ECONOMIES IN CIS COUNTRIES

In the areas of macroeconomics and monetary policy modelling, there exists substantial curiosity regarding the correlation which exists between inflation and economic growth. The precise correlation that exists between the inflation rate and economic growth is not distinct, even though it has been examined in-depth. The outcomes of assessments of the direct correlation reported in literature as regards the subject lack uniformity. Various countries and country groups have been studied by different investigations which have applied a plethora of proxy variables and procedures in determining the association between inflation and economic growth. Variations and, in some cases, conflicts exist in the experimental outcomes and policy recommendations. Investigations conducted in the past have not been convincing in the provision of policy recommendation which can be effectively implemented in different countries. These variations may be attributed to factors such as dissimilarity in data sets, conditions which are country-specific, and the application of varying research approaches.

Russia

In Russia, the changeover from a centralised command economy to a market economy in Russia began in the aftermath of the Soviet Union’s collapse, and the first decade during this process was a dreadful time for the country: there was a significant decrease in the nominal gross domestic product (GDP) from USD 516 billion in 1990 to USD 196 billion in 1999, and this was a massive drop-off of over 60%. During the 1990s, the Soviet government then, with the view of mitigating the economic meltdown and acting based on suggestions made by the IMF, proceeded to implement the privatization of several Russian industries. Only a few vital sectors were exempted from these actions, and these were the energy and defense sectors.

In April 2023, the inflation rate in Russia stood at 2.3 percent compared to the same month of the previous year. The figure marked a decrease from April 2022, when it stood at almost 18 percent. The term inflation means the devaluation of money caused by a permanent increase of the price level for products (consumer goods, investment goods). Consumer Price Index (CPI) shows the price development for private expenses and shows the current level of inflation when increasing. The Russian economy was forecast to shrink by 4.5 percent in 2022 as a result of the war in Ukraine that began in February of that year. Furthermore, the county's gross domestic product (GDP) was expected to decline in 2023. Consumer prices were projected to grow by around 14 percent in 2022. To compare, in 2021, the inflation rate was below seven percent. Russia’s economy is highly dependent on and affected by the price of oil. The price of Urals crude oil stood at approximately 52.2 U.S. dollars per barrel in January 2023, having followed a downward trend from October that year. The highest producer price index (PPI) was recorded in the water supply and management sector, with a price growth rate of 10 percent in December 2022.[1]

Ukraine

The position which the National Bank of Ukraine (NBU) holds concerning the present and future economic condition of Ukraine with emphasis placed on inflationary developments that constitute the foundation for monetary policy decision-making are mirrored in the Inflation Report. The Inflation Report is a quarterly publication which the NBU releases in congruence with the forecast cycle. The attainment and sustenance of price stability in the country is the principal goal for which the monetary policy is implemented. Price stability is used to refer to a modest increment in prices, not necessarily their fixed level. Inflation which is little and steady aids in the conservation of the real value of income and savings of Ukrainian households, and gives room for entrepreneurs to make long-term investments within the local economy, and this promotes the creation of more jobs. Moreover, as long as the price stability objective is not made vulnerable, the stimulation of financial stability and sustainable economic growth is carried out by the NBU.

The consequences of the full-scale Russian invasion are causing significant losses to the economy of Ukraine and generating a strong inflationary pressure. As a result, in 2022, inflation will slightly exceed 30%, and GDP will decrease by a third. In Q3 2022 Inflation Report, NBU expects a decrease in inflation dynamics and the return of the economy to growth in 2023. By the end of 2022, inflation will accelerate and reach 31%, given the persistence of most supply shocks impact. It refers, in particular, to the consequences of military actions and high energy costs. In Q1 2023, inflation is expected to slow down due to expectations improvement, logistics enhancement and gradual harvests growth. The decrease in global inflation and NBU tight monetary policy will have further dis-inflationary effect. Instead, high energy cost and the need to gradually increase energy tariffs for the population to market levels will restrain the slowdown of inflation. As a result, consumer inflation will decline to nearly 20% in 2023 and slow down to single-digit levels only at the end of 2024.

The consequences of the war will lead to a significant economic decline in Ukraine in 2022, but in 2023 the economy will return to growth. Economic activity has picked up since April, primarily due to the liberation of the northern regions and a reduction in the number of regions with active hostilities. But the economy is working at a much lower capacity as compared to pre-war level. As a result, real GDP will contract by a third in 2022. In 2023, provided that security risks are reduced, the economy is expected to return to growth due to the revival of consumer demand, the establishment of technological and logistics processes, and the recovery of investment activities, in particular due to the prospects of European integration. At the same time, significant losses of production and human potential will hold back the recovery of the economy. In 2023-2024, GDP will grow at a rate of nearly 5-6% per year.[2]

Kazakhstan

Over the period of the last two decades, the most awful recession experienced in Kazakhstan occurred in 2020. As a result of the loss of jobs and the reduced levels of disposable income, there was a drastic decrease in local demand. In comparison with similar crises which took place in the past, the restriction of movement and the lessened undertakings in the mining industry were the factors which impacted services the most. The inflation target range which was set by the National Bank of Kazakhstan (NBK) has been exceeded due to the rise in the cost of food.

The National Bank held its key interest rate at 16.75% on Friday, leaving it within a quarter-percentage point of the highest ever, matching the expectations of all economists surveyed by Bloomberg. Inflation is now projected to be within a range of 9%-12% in 2023, from a previous forecast of 11%-13%, falling to 6%-8% next year and to 4%-6% in 2025."The forecast range has been expanded due to uncertainty about fiscal stimulus in Kazakhstan and inflation dynamics in Russia," the bank said in the statement. "Under these conditions, maintaining the base rate in the first half of 2023 at current values will help stabilize inflation and gradually reduce it in the medium term." [3] Inflation is expected to remain high in 2023 due to elevated food prices and prices of imported intermediate goods. Inflation has surged to its highest level since the late 1990s due in part to wage increases across sectors and crisis-related fiscal measures. Prices rose broadly but food prices have been a major contributor to the surge. Inflation is projected to remain beyond the target range of 4-6 percent in 2023 and return to it in 2024. Although supply disruptions are likely to dissipate in 2023, tight monetary policy will need to be maintained to rein in inflation expectations.[4]

Considering two aspects: first, a main source of risk seems to be originated from inflation uncertainty; and second, a economic growth has been becoming more significant, an effect of inflation uncertainty on economic growth should be assessed in transition economies from Europe. It is important to emphasize that the inflation fluctuations are the only source of countries under investigation. In should be noted that, we found out more about the study, Fig. (**1**). illustrates visual inspections that Russian Federation produced a strong performance in inflation uncertainty dynamics and that the conditional standard deviation was highly volatile for the first half of 2022's, reaching the highest level during the Russia-Ukraine conflict period. The inflation uncertainty performances of Kazakhstan's display exceedingly frequent fluctuations over the sample period, also highest volatiles are during the 2015 to 2016 years. Similarly, inflation fluctuations also seem in the during the Russia-Ukraine conflict period respectively.

1 Russia inflation monthly 2023 | Statista

2 National Bank of Ukraine forecasts a decrease in inflation and economy return to growth in 2023 – UkraineInvest (ukraineinvest.gov.ua)

3 Kazakhstan Holds Rates Again as Inflation Seen Close to Peak (yahoo.com)

4 Kazakhstan Economic Update – Spring 2023 (worldbank.org)

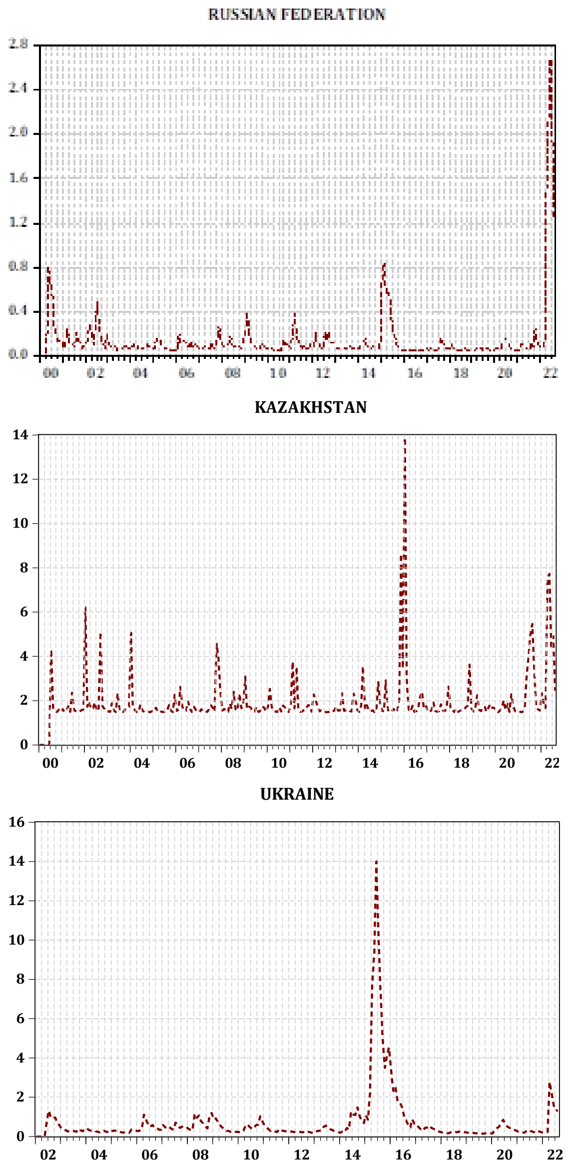

Fig. (1). Estimated conditional variances of growth for the sample periods.

Likewise, Ukraine's economies also exhibit highly volatile performances of inflation uncertainty in 2014 and 2015, but estimated standard deviations are quite high compared to other selected economies for the whole sample period. Finally, Russia's inflation variability trend gradually increased and grasped it's the highest level ongoing Russia-Ukraine conflict period; the inflation uncertainty performances are more abnormal in Kazakhstan. Ukraine's inflation uncertainty consequently, its impact on the economy for the sample periods, 2014, 2015, 2016 and 2022's during the Russia-Ukraine conflict period, respectively.

3. LITERATURE REVIEW

Literature shows that the debate on the relationship between inflation and growth dates back from the classical school of thought through to the new classical school of thought. The classical school reasons that competition for labor by capitalists increases the cost of labor as well as the costs of production which exert pressure on prices in the economy. The increase in costs of production erodes the capitalists' profits, discouraging them from production. Accordingly, this implies a negative relationship between inflation and economic growth in both the short and the long run (Tinbergen, 1935; and Haberler, 1946). In contrast, the Keynesians argue that demand for labor reduces unemployment while increasing economic growth, and it results in higher nominal wages and inflation as its by-products, hence a positive relationship in the long run (Aaron, 1967). Monetarists offer a distinguished view: They deduce that workers suffer from money illusion temporarily in that any increase in nominal wages (and inflation) induces workers to increase their supply of labor (and economic growth) temporarily before reverting to the original supply of labor – hence, inflation has no relationship with economic growth in the long run, but a positive one in the short run (Leeson, 1967). The new classicals, whose theory rests on the tenet of rational expectations, stress that inflation is not related to economic growth in both the short and the long run (Lucas, 1996). The bone of contention extends to different scholars and bodies of theory. The debate surrounding the theory is still ongoing and inconclusive. Although these economic schools of thought explain the relationship between inflation and economic growth, they do not explain the role of inflation uncertainty in the determination of economic growth.

The influence of inflation uncertainty on inflation has been tested using data retrieved from the United States (Grier & Perry, 2000; Grier, Henry, Olekalns & Shields, 2004; Karansos, Karanassou & Fountas, 2004) as well as data for other first world economies (Baillie, Chung, & Tiesau, 1996; Grier & Perry, 1998; Fountas et al., 2004a; Wilson, 2006; Fountas & Karansos, 2007). The deductions from these survey are mixed. Some countries singled out for this study provide evidence to uphold the Holland hypothesis (Grier et al., 2004); while others reinforce the Cukierman–Meltzer hypothesis (Karansos et al., 2004). However, the results of others show that no statistically significant correlation exists between inflation uncertainty and inflation (Grier & Perry, 2000). Mixed conclusions have also been arrived at by multi-country studies such as those carried out for the G7 nations by Grier and Perry (1998) and Fountas and Karansos (2007); and for some countries, their results reinforced the Holland hypothesis, while for other countries, it reinforced the Cukierman–Meltzer hypothesis.

Siti Hamizah Mohd at al. (2019) have investigated inflation, inflation uncertainty and economic output for five emerging ASEAN nations such as Philippines, Thailand, Singapore, Malaysia and Indonesia. In order to explore the causal correlations among the three variables involved, the authors applied the Exponential GARCH (EGARCH) model. The general findings in the paper reveal that firstly, the presence of inflation enhances inflation uncertainty in the five countries studied; and also that inflation is a negative determinant of growth output, both directly and indirectly (through the impact it has on inflation uncertainty) for the countries under study. Secondly, they found no indication that inflation uncertainty has a significant effect on inflation. Therefore, the Cukierman–Meltzer or the Holland hypothesis lacked support. Thirdly, the effects of positive shocks to inflation on inflation uncertainty are greater than the effects of negative shocks, in all the five countries studied, thereby rendering support for the asymmetric GARCH specification. Also fourthly, inflation acts as a negative determinant of growth output, both directly and indirectly (through the impact it exerts on inflation uncertainty). Nevertheless, the indirect effect appears greater than the direct effect, for all the countries that they studied.

Furthermore, Ndiaye and Konte (2017) have examined an assessment of the role of uncertainty arising from the volatility of inflation on the economic output of WAEMU member nations over the period (1970-2015). The results suggest the persistence of inflation volatility and a significant degree of inflation uncertainty for some countries such as Guinea-Bissau. They also reveal differences in the mechanisms of transmission of uncertain inflation on economic output between countries. The negative impact of uncertain inflation on economic output only Guinea Bissau and Togo, while non-significant effects have been found in the majority of countries (Burkina Faso, Benin, Mali, Côte d'Ivoire, Senegal, Niger). Indeed, Ananzeh (2021) investigated the correlation between the rate of inflation and inflation uncertainty in Jordan covering the years, 1976-2019. For the research, the author used two different approaches to examine this relation, namely the GARCH process, and granger causality technique. His findings reveal a positive correlation between inflation and inflation uncertainty, thereby lending credence to the Friedman-Ball hypothesis. His study also expressed that in the face of increasing levels of inflation, the response of the Central Bank not predictable and also not reliable; and this in turn produces future inflation uncertainty because the growth of money supply cannot be predicted. For the second hypothesis that inflation uncertainty Granger-causes inflation, he rejected the null hypotheses at level of significance 1%, and suggesting a positive causal relation from inflation uncertainty to inflation. Our finding support the hypothesis of Cukierman and Meltzer (1986).

On other hand, Heidari at al. (2021) studied the nature of the link between the conditional means and conditional variance of inflation and economic output in Iran covering the years 1988-2019. The VAR-GARCH-M model was the model employed in explaining the conditional means of the two series. The results indicated that inflation produces inflation uncertainty, thereby lending credence to the Friedman-Ball hypothesis. This reveals that a change in inflation reduces the certainty of future expectations for inflation, as in the case of the economy of Iran. Furthermore, inflation uncertainty influences economic output, thereby lending credence to the Friedman (1977) hypothesis. This reveals that actual economic output rates have no statistically relationship with uncertainties about future economic output rates. Also, this vital revelation implies uncertainties regarding the anticipated levels of economic activity and growth rate in Iran, would affect the rate of inflation (producing a growth in inflation) in the economy.

Moreover, Khalil et al. (2022) investigates the inflation uncertainty and growth output over the period 1972-2020, in Pakistan. Also, the estimates of EGARCH estimates showed that negative shocks to the error term cast produce greater effects on the conditional variance in comparison with positive shocks. Having calculated the inflation volatility, their study carried out a Granger Causality test to verify the presence of causal relations among inflation, growth output and uncertainty of inflation. The results of Granger Causality test showed that inflation positively influenced inflation uncertainty while negatively influencing growth output in Pakistan. No evidence has been found in favor of the causal effect running from growth to inflation, from inflation uncertainty to growth, from growth to inflation uncertainty or from inflation uncertainty to inflation in Pakistan.

Similarly, Mesbah Fathy Sharaf (2015) has studied the causal correlation between inflation and inflation uncertainty in Egypt covering the years (1974-2015). The estimated conditional variance from an ARMA-GARCH model was employed as a measure of inflation uncertainty, and a Granger-causality test was carried out to ascertain the causal correlation between the two variables. The results showed that a due to infationary shocks, a high level of inflation volatility persisted. The Granger-causality test along with symmetric and asymmetric GARCH-M models revealed a statistically significant bi-directional positive correlation between inflation and inflation uncertainty, thereby lending credence to both the Friedman–Ball and the Cukierman–Meltzer hypotheses respectively. Results of the EGARCH and TGARCH models are that the previous levels of inflation have an effect on inflation uncertainty that is both positive and statistically significant, and again this lends credence to the Friedman–Ball hypothesis. Also, inflation uncertainty has a statistically significant positive influence on the levels of inflation, which is in tandem with the Cukierman–Meltzer hypothesis. These results obtained, are in agreement with the earlier results obtained from the Granger causality test, which show that a two-way positive causal correlation exists between inflation and its uncertainty in Egypt during the period under investigation.

Using Nigeria as a case study, Muhammad (2022) used the GARCH model to reveal the correlation between inflation uncertainty and inflation. The data utilized was the monthly data covering the period of 1960-2021. Furthermore, the framework utilized for the inflation uncertainty was the EGARCH; and as a complement, the seasonal ARIMA was utilized for model of inflation uncertainty. Also, performing the Bivariate Granger on inflation and inflation uncertainty, it was revealed that inflation umcertainty was caused by inflation in Nigeria. Furthermore, using Pakistan as a case study, the correlation between inflation and inflation uncertainty was underscored by Javed et al., (2012). For their study, they retrieved from the International Financial Statistics, the monthly data of the consumer price index covering the period from 1957-2007. In a bid to estimate the conditional volatility of inflation, the ARMAGARCH framework was employed. The outcomes gave credence to the Friedman ball hypothesis by showing that inflation influenced inflation uncertainty in Pakistan.

Likewise, Adaramola and Dada (2020) examined the effects that inflation produces on the prospects of growth for the economy of Nigeria. Their study utilized the autoregressive distributed lag on the selected variables, i.e. real gross domestic product (GDP), interest rate, inflation rate, exchange rate, money supply, degree of economy's openness, and government consumption expenditures covering the years 1980–2018. As a result, they recommended that more functional

Table 1. Descriptive Statistics for Selected Variables.

Variable	Mean	Max.	Min.	St. Dev.	Skew.	Kurtosis	J-B
Russia							
$R_{cpi,t}$	4.5742	5.4291	3.3464	0.5635	-0.4349	2.0451	18.90***
$R_{ipi,t}$	4.6434	5.1472	4.2110	0.2109	-0.3735	2.3035	11.82***
Ukraine							
$R_{cpi,t}$	4.6149	5.3766	3.7480	0.5060	-0.1280	1.7014	19.85***
$R_{ipi,t}$	4.5185	4.7417	3.9748	0.1543	-1.0670	3.2752	52.47***
Kazakhstan							
$R_{cpi,t}$	4.7506	5.9742	3.6594	0.7023	-0.0401	1.7148	17.13***
$R_{ipi,t}$	4.5336	4.8464	4.2422	0.1456	-0.1697	1.6875	18.99***

Notes: *******, ******, ***** indicate 1%, 5% and 10% significance level, respectively. The data are presented as seasonally adjusted. Here, $R_{cpi,t}$ and $R_{ipi,t}$ denote log changes of inflation and output growth, respectively.

efforts are required by the monetary authorities to vigorously tackle inflation in order to mitigate its negative effects by ensuring a bearable inflation rate, which would serve as a catalyst for growth in the Nigerian economy.

Using specifications are estimated to provide the measure for inflation uncertainty, Zorica Mladenovic (2009) utilized the GARCH technique in their investigation of the links between inflation and its uncertainty. Their study was adapted to the economy of Serbia, which was particularly susceptible to shocks in the rate of inflation, during the transition period that spanned 2001-2007. The variables derived were incorporated into the VAR process to test for Granger-causality between inflation and inflation uncertainty. The main result the study shows that high inflation stimulates high inflation uncertainty; while high inflation uncertainty adversely influences the level of inflation at long horizon.

Erkam and Çavusoglu (2020) have investigated the relationship between inflation and its uncertainty in seven transition economies such as Georgia, Kyrgyz republic, Armenia, Azerbaijan, Ukraine, Kazakhstan and Russia in their post-hyperinflation periods The result they obtained which were centered on conditional-variance estimates show proof that inflation itself gives rise to its uncertainty in Ukraine, Russia and Azerbaijan; while over the same period higher inflation was preceded by inflation uncertainty the Kyrgyz Republic and in the Russian Federation. Moreover, for Azerbaijan, causality running from inflation uncertainty towards lower inflation rates was found.

4. DATA AND DESCRIPTIVE STATISTICS

The data utilized was retrieved from the International Monetary Fund's (IMF) International Financial Statistics databases. The monthly sample periods for all three variables from 2000M01 to 2022M08. Monthly inflation and output growth volumes of selected transitions countries are available in IMF. The selected research methods is not acceptable for high-frequency data like weekly, daily, etc. We use the index of industrial production for the proxy of output growth and CPI for proxy of inflation. Table **1** reports the descriptive statistics for inflation and output growth in over the entire period. The monthly series have structured as the first differences of the natural logarithm, where denotes Inflation $(R_{cpi,t})$ and output growth $(R_{ipi,t})$, respectively. According to the table entries, the averages of monthly series are smaller than their computed standard deviations in all cases.

In addition, we observed the standard deviation of inflation is less than the standard deviation of output growth. The kurtosis and skewness of the selected variables are significant. The series was negative for all selected variables by skewness. Jarque-Bera statistics confirmed nor normality series in selected variables. Finally, for the sample size eloborated in the study, the variables seem to be conditionally heteroskedastic. Therefore, MGARCH-M model emerges to be appropriate in empirical estimation.

In Table **2**, the Ljung–Box Q test statistics of Ljung and Box (1978) for serial correlation of the return series and the squared returns series of $R_{cpi,t}$ and $R_{ipi,t}$ are thoroughly detailed. In sum, the all tests reject the null hypothesis of the existence of unit root at one percent significance level, and thus the returns follow a stationary process regardless of whether a trend variable or/and incorporated in the model.

5. EMPIRICAL METHODOLOGY

The main prupose of the paper was to investigate the uncertainty effects of inflation on output growth employing the contemporary single-step procedure. Using the multivariate GARCH-in-mean model with the single-step approach for time series properties of the series under study. With this regards, the paper follows to Grier et al., (2004, 2013), and VAR–MGARCH-M–BEKK econometric approaches will be jointly employed in model estimation. Model measurements rely on various BEKK specifications proposed by Engle and Kroner (1995) to achieve most robust results. The next objective was to examine the non-causality between the inflation uncertainty and output growth. With third objective, we employ the nonlinear autoregressive distributed lag

Table 2. Serial Correlation, ARCH and Unit Root Tests.

Variable	Q-Stat(4)	Q-Stat(8)	Q^2-Stat(4)	Q^2 –Stat(8)	BDS(8)	ARCH(4)	No. obs
Russia							
$R_{cpi,t}$	15.627**	42.152***	19.601**	60.091***	0.6430***	29.278***	272
$R_{ipi,t}$	33.855***	36.235***	33.362***	35.869***	0.5947***	17.280***	272
Ukraine							
$R_{cpi,t}$	6.9253***	7.8905***	11.472***	13.304***	0.6403***	9.679***	272
$R_{ipi,t}$	40.137***	41.826***	40.830***	42.423***	0.5534***	1.839	272
Kazakhstan							
$R_{cpi,t}$	184.04***	220.89***	182.51	220.85	0.6273***	29.987***	272
$R_{ipi,t}$	5.4556***	12.302***	5.4213	12.504	0.5189***	14.472***	272

Notes: ***, **, * indicate 1%, 5% and 10% significance level, respectively. The data are presented as seasonally adjusted. Here, $R_{cpi,t}$ and $R_{ipi,t}$ denote log changes of inflation and output growth, respectively.

(NARDL) model to examine the long-run and short-run asymmetric effects. The nonlinear ARDL (hereafter, NARDL) approach proposed by Shin et al. (2014) allows testing the long-run and short-run asymmetries. NARDL approach provides robust empirical results even for the small sample sizes (Chatak and Siddiki, 2001; Narayan and Narayan, 2007; Pesaran et.al, 2001) and can be applied regardless of the order of integration with the exception that the series is integrated with the maximum order of one. The order of integration can be verified using unit root tests. Indeed, when the time series are noted to have cointegration using their positive and negative components (Granger and Yoon, 2002), the case of nonlinear cointegration is implied. Finally, we used generalized impulse response function analysis among variables, and vice versa.

5.1. Multivariate GARCH-in-Mean Model

It is obvious that the assessing of MGARCH–M model of Bollerslev et al. (1988) with Vector Autoregression framework of Sims (1980) has become one of the empirical generality in macroeconomic variability and uncertainty related research works (Elder, 2004). As mentioned in above context, Engle and Kroner (1995) have provided some theoretical and comceptual frameworks related to generating MGARCH–M and the recent empirical works which are based on them (see, Grier & Perry, 1998; Grier & Perry, 2000). It seems to works that the exploitation of MGARCH–M model which is jointly with p^{th} orders structural Vector Autoregression depends on the dynamic interactions between the selected variables. Based on this context, the general equation of the study is detailed as follows

$$Y_t = M + \sum_{i=1}^{p} \Gamma^{(i)} Y_{t-1} + \Psi H_t + U_t (1)$$

$$U_t|\Omega_{t-1} \sim \mathrm{N}(0, H_t)$$

where, Y_t is $n \times 1$ dimensional matrix of dependent variable, and M is $n \times 1$ dimensional matrix that denotes the coefficient of constant in the equation. $\Gamma^{(i)} (i = 1, \ldots, p)$ is $n \times n$ dimensional matrix that presented the slope coefficients of the lagged form for dependent variables, Y_{t-1}. Ψ presented a polynomial matrix. H_t $(t = 1, \ldots, T)$ is an asymmetric conditional BEKK specification. Noted that H_t was assumed as a diagonal that the structural errors were serially not correlated. In turn, U_t is stochastic error terms of the main equation and it is normally distributed with all t. Ω_{t-1} is the available set of information at the time $t-1$, and H_t is explained through the asymmetric BEKK approach. In below, the dependent and explanatory variables as well as other coefficients of the model in order to explain clearly are expressed in matrix form.

In Eq. (1), the Ψ matrix of uncertainty parameter is also incorporate to analysis the uncertainty effects of inflation on the conditional variations of output growth.

$$\begin{bmatrix} cpi_t \\ ipi_t \end{bmatrix} = \begin{bmatrix} \mu_{cpi} \\ \mu_{ipi} \end{bmatrix} + \begin{bmatrix} \gamma_{11}^{(i)} & \gamma_{12}^{(i)} \\ \gamma_{21}^{(i)} & \gamma_{22}^{(i)} \end{bmatrix} \begin{bmatrix} cpi_{t-i} \\ ipi_{t-i} \end{bmatrix} + \begin{bmatrix} \psi_{11} & \psi_{12} \\ \psi_{21} & \psi_{22} \end{bmatrix} \begin{bmatrix} h_{11,t} \\ h_{22,t} \end{bmatrix} \begin{bmatrix} u_{cpi,t} \\ u_{ipi,t} \end{bmatrix} \quad (2)$$

from Eq. (3), the equations can be draw as follows:

$$\begin{cases} cpi_t = \mu_s + \gamma_{11}^{(i)} cpi_{t-i} + \gamma_{12}^{(i)} ipi_{t-i} + \psi_{11} h_{11,t} + \psi_{12} h_{22,t} + u_{cpi,t} \\ ipi_t = \mu_g + \gamma_{21}^{(i)} cpi_{t-i} + \gamma_{22}^{(i)} ipi_{t-i} + \psi_{21} h_{11,t} + \psi_{22} h_{22,t} + u_{ipi,t} \end{cases} \quad (3)$$

In Eq. 3, the independent variable cpi_t denotes inlation, while cpi_{t-i}, are lagged forms of it $(i = 1, \ldots, n)$. μ_{cpi} is the coefficient of intercept, and $\gamma_{11}^{(i)}, \gamma_{12}^{(i)}$ specify the slope coefficients of the equation $(i = 1, \ldots, n)$. ψ_{12} is denoted the coefficient of interest that indicates the volatility impact of inflation in frequent fluctuations of output growth series. Furthermore, h_{22} is denoted the output growth on inflation uncertainty.

5.2. Asymmetric BEKK Variance–covariance Structure

As aforementioned, this paper attempts to estimate inflation and output growth equations jointly by exploiting VAR–MGARCH–M–BEKK (see. section 5.3) econometric approaches, and it included the asymmetric, and non–diagonality in the conditional BEKK specification. The advantage of asymmetric BEKK approach is that the conditional variance–covariance process makes sure about the positivity of parameters. Here, an overview of the structure for the study is specified as follows:

$$H_t = C'C + A'u_{t-1}u'_{t-1}A + B'H_{t-1}B + D'\zeta_{t-1}\zeta'_{t-1}D \quad (4)$$

In below, the cubic form of asymmetric BEKK approach is given to confirm the positive definiteness of the variance-covariance process.

$$H_t = \begin{bmatrix} h^2_{cpi,t} & h_{cpi,ipi,t} \\ h_{ipi,cpi,t} & h^2_{ipi,t} \end{bmatrix} = \begin{bmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{bmatrix}' \begin{bmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{bmatrix}$$
$$+ \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} u_{t-1} \\ u_{t-1} \end{bmatrix} \begin{bmatrix} u_{t-1} \\ u_{t-1} \end{bmatrix}' \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$$
$$+ \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \begin{bmatrix} h^2_{cpi,t-1} & h_{cpi,ipi,t-1} \\ h_{ipi,cpi,t-1} & h^2_{ipi,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$$
$$+ \begin{bmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{bmatrix}' \begin{bmatrix} \zeta_{t-1} \\ \zeta_{t-1} \end{bmatrix} \begin{bmatrix} \zeta_{t-1} \\ \zeta_{t-1} \end{bmatrix}' \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \quad (5)$$

Eq. (5) is the conditional BEKK appoach with the absolute form that contains asymmetry and non–diagonality. Besides, it considers lagged conditional variances and co-variances, H_{t-1}, as well as lagged form of $u_{t-1}\, u'_{t-1}$ and $\zeta_{t-1}\, \zeta'_{t-1}$, in joint estimations of inflation uncertainty on the conditional variations of output growth.

5.3. Non–causality Test

Regarding the one of the objective of the paper, we employ non–causality test of Hafner and Herwartz (2008), which is attin by estimating parameters for BEKK approach of Engle and Kroner (1995). We bare two conditionally heteroskedastic and stationary series such as $Y_{1,t}\ and\ Y_{2,t}$ for $Y = cpi\ and\ ipi$ where we indicate the series of Inflation uncertainty and output growth, respectively. Here, we consider that $Y_{2,t}\ and\ Y_{3,t}$ doesn't Granger cause $Y_{1,t}$ in variance, designated by $Y_{2,t} \nrightarrow Y_{1,t}$ if,

$$Var(Y_{1,t}|F_{t-1}) = Var(Y_{1,t}|F_{t-1})|\forall t \in Z \qquad (6)$$

Eq. (6) outlines any causality relationships; if $Y_{1,t}$ does Granger cause $Y_{2,t}$ in variance, the conditional variance of $Y_{2,t}$ can be predicted more accurate by dimention the information set of $Y_{1,t}$. Here, the null hypothesis of Granger causality from the inflation uncertainty (cpi) on output growth (ipi) in the second moment equation of the economies under concern is stated as follows

$$\mathrm{H}_0: a_{12} = b_{12} = 0 \ (7)$$

To test these hypotheses, following to the provided approach by Hafner and Herwartz (2008), the standard Wald-test statistics are proposed as follows

$$W_t = T(Q\vartheta)'(Q\Sigma_\vartheta Q')^{-1}(Q\vartheta \ (8)$$

where $Q = [0, Q, Q],\ \vartheta = (vech\ (C)', vech\ (A)', vech\ (B)')',\ \Sigma_\vartheta = E[u_t u'_t] < \infty$ and asymptotic chi-square (χ^2) distribution has a degree of freedom that equal to the number of limited parameters of the statistic, as given by

$$W_t \rightarrow \chi^2_{k\,(K-k)} \ (9)$$

In sum by this section, we employ Wald test statistics to carry out non–causality test on estimated model of the paper.

5.4. Nonlinear Autoregressive Distributed Lag (NARDL) Model

The NARDL approach allows modelling asymmetric cointegration using positive and negative partial sum decompositions and detecting the asymmetric effects both in the short- and long-run. It also allows the joint analysis of the issues of non-stationarity and nonlinearity in the context of an unrestricted error correction model. The nonlinear cointegration regression (Shin et al., 2014) is specified as follows:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \mu_t \ (10)$$

were β^+ and β^- are long-term parameters of $kx1$ vector of regressors x_t, decomposed as:

$$x_t = x_0 + x_t^+ + x_t^- \ (11)$$

where $x_t^+ and\ x_t^-$ are the partial sums of positive or negative changes in x_t as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0) \qquad (12)$$

$$x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} \min(\Delta x_j, 0) \qquad (13)$$

5.5. Nonlinear ARDL–ECM model

The NARDL (p,q) from Eq.(11), in the form of an asymmetric error correction model (ECM) (Raza et. al, 2016) can be presented as follows:

$$\Delta y_t = \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j\, \Delta y_{t-j} + \sum_{j=0}^{p} (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{j-t}^-) + \varepsilon_t \qquad (14)$$

where $\theta^+ = -\rho\beta^+$ and $\theta^- = -\rho\beta^-$. In a nonlinear framework, the first two steps to ascertain cointegration between the variables are the same as in linear ARDL bound testing procedure i.e. estimation Eq. (14) using OLS and conduction of the joint null ($\rho = \theta^+ = \theta^-$=0) hypothesis test of no asymmetric relationship. However, in NARDL, the Wald test is used to examine the long-run ($\theta^+ = \theta^-$) and short-run ($\pi^+ = \pi^-$) asymmetries in the relationship.

Finally, the asymmetric cumulative dynamic multiplier effects of a unit change in $x_t^+ and\, x_t^-$ on y_t can be calculated as follows:

$$v_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial x_t^+}, v_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial x_t^-}, h = 0,1,2, (15)$$

whereas $h = \infty$, the $v_h^+ \to \beta^+$ and $v_h^- \to \beta^-$. A mentioned above β^+ and β^- are the asymmetric long-run coefficients and here can be examined as $\beta^+ = -\theta^+ / \rho$ and $\beta^- = -\theta^- / \rho$, respectively.

5.6. Generalized Impulses Response Function Analysis (GIRF)

To examine the time mode of the effects of inflation uncertainty on future behavior of output growth, we employ the GIRF proposed by Koop et al. (1996). We created an analytical framework of impulse responses of inflation uncertainty to one unit of output growth under the VAR process. As given in Grier et al. (2004) the GIRF of the paper is detailed as follows:

$$GIRF_K(n, \varrho_t, \omega_{t-1}) = E[K_{t+n}|\varrho_t, \omega_{t-1}]$$
$$-E[K_{t+n}|\omega_{t-1}] \ (16)$$

where n = 0,1,2,3..., thus the GIRF is conditional on ϱ_t and ω_{t-1} and constructed the responses by average future shocks given in the previous and present. Giving it, a natural reference point for GIRF is the conditional expectation of K_{t+n} given only the history ω_{t-1}, and in this shock response, the current shock is also averaged out.

6. EMPIRICAL RESULTS AND DISCUSSION

In this section, the empirical results from model estimation is detailed discussed. A mentioned above in introduction section, our main purpose was to investigate uncertainty effects of inflation on output growth. We employed test of non-causality between series under concern. With third objective, we employ the nonlinear autoregressive distributed lag (NARDL) model to examine the long-run and short-run asymmetric effects. Finally, we conducted the generalized impulse response function analysis for inflation uncertainty to a one unit of output growth of the respective transition economies under the VAR process.

6.1. Estimation results of VAR–MGARCH–M–BEKK model

As mentioned earlier, we exploit five widely–used criteria which are given in Lütkepohl (2005) namely Akaike information criterion of Akaike (1973) (hereinafter, AIC), the Schwarz Bayesian criterion (henceforth, SBC), the Hannan–Quinn criterion (henceforward, HQC), the final prediction error (hereafter, FPE), and the log–likelihood (henceforth, LL) value. These criteria are used to select the optimal lag length in employed model, and they include a vector autoregression process in a single equation. As far as the multivariate model is concerned, the used selection criteria show a vector autoregression order of lag three for Russia, lag five for Kazkhstan, lag four for Ukraine as the most favored estimated models. To select the most preferred model, we further relied on LL values and residual diagnostic checks. In terms of selection criteria and robustness tests as well as with the distribution of the explanatory variables (inflation and output growth) for the available sample sizes, the maximum vector autoregression order is set to ensure sufficient degrees of freedom and to avoid numerical convergence problems.

Table 3. Parameter Estimates for VAR (p)-MGARCH-M-BEKK Model.

PANEL A: RUSSIA			
	cpi_t		$ipi_{,t}$
Mean specification			
μ_{cpi}	0.0123	μ_{ipi}	1.2809***
$\gamma_{cpi,ipi}^{(1)}$	0.7383***	$\gamma_{ipi,cpi}^{(1)}$	0.2932
$\gamma_{cpi,cpi}^{(1)}$	0.0019	$\gamma_{ipi,ipi}^{(1)}$	-0.5303***
$\gamma_{cpi,ipi}^{(2)}$	-0.0559	$\gamma_{ipi,cpi}^{(2)}$	-0.6028**
$\gamma_{cpi,cpi}^{(2)}$	0.0064	$\gamma_{ipi,ipi}^{(2)}$	-0.1595
$\gamma_{cpi,ipi}^{(3)}$	0.0972*	$\gamma_{ipi,cpi}^{(3)}$	0.4030**
$\gamma_{cpi,cpi}^{(3)}$	0.0072	$\gamma_{ipi,ipi}^{(3)}$	-0.0494
$\Psi_{cpi,ipi}$	-0.4052***	$\Psi_{ipi,cpi}$	0.2486
$\Psi_{cpi,cpi}$	0.0016	$\Psi_{ipi,ipi}$	-0.4758*
Shape	4.3847	AIC	4.427
LogL	-559.18	SBC	4.882
HQC	4.610	FPE	4.428
Variance-covariance specification			
$c_{1,1}$	0.1471***	$c_{1,2}$	-
$c_{2,1}$	0.2827*	$c_{2,2}$	1.3641***
$a_{1,1}$	0.6254 ***	$a_{1,2}$	0.0972
$a_{2,1}$	-0.0069	$a_{2,2}$	-0.1486*
$b_{1,1}$	0.6164	$b_{1,2}$	-1.0966
$b_{2,1}$	-0.0520	$b_{2,2}$	0.0938
$d_{1,1}$	-0.0543	$d_{1,2}$	-3.1444
$d_{2,1}$	0.0193	$d_{2,2}$	0.8500

Notes: ***, **, * indicate 1%, 5% and 10% significance level, respectively. AIC, SBC, HQC and FPE are acronyms for the Akaike information criterion, Schwarz Bayesian criterion, Hannan-Quinn criterion and Final prediction errors, respectively. LogL stands for log-likelihood value.

In Table **3**, the results for estimated mean equations of Inflation and output growth for the selected transition economies are reported. Here, μ_{cpi} and μ_{ipi} are the coefficient of intercept that carry the positive values of inflation and output growth equations for all selected transition economies under concern.

Moreover, we consider matrices $\Gamma^{(i)}$ $(i = 1,2,3)$ for Russia, $\Gamma^{(i)}$ $(i = 1,2,3,4,5)$ for Kazakhstan, $\Gamma^{(i)}$ $(i = 4)$ for Ukraine, which are used in the mean equations and captured by the parameters $\gamma_{r,j}^{(i)}$ to realize the relationship across the selected series of the study. All the diagonal parameters of $\gamma_{cpi,cpi}^{(i)}$ and $\gamma_{ipi,ipi}^{(i)}$ for Russia's and Kazakhstan's economies are statistically significant, the diagonal parameters for Ukraine (Panel C) are statistically insignificant. These equations depend on their first order lag and up to three lag for Russia, up to five lag for Kazakhstan, up to four lag for Ukraine, respectively. It should be noted that the cross variable logarithmic change links between the variables under concern and it can be examined by the off-diagonal elements, and the results are noteworthy.

As mentioned above, the main objectives of the paper was to determine the impact of inflation and inflation uncertainty on output growth, it can be concluded from the sign and significance of $\Psi_{cpi,ipi}$ that the point estimates of these inflation and output growth series are equal to -0.4052 in Russia (Panel A), -0.0203 in Kazakhstan (Panel B), and -0.1680 in Ukraine (Panel C), respectively. As a result, relying on model estimation, the conditional standard deviation of inflation uncertainty has a significant negative impacts on output growth of the the all selected transition economies. Additionally, the tail parameters (i.e., shape) of all models show that these results are statistically significant.

Panels A,B and C in Table **3**, further inform the estimated parameters of matrices C,A,B, and D which are detailed in the conditional second moment equation. In the equation, the diagonal elements of matrix A, a_{11} and a_{22} capture own ARCH effects, while the off-diagonal elements a_{12} and a_{21} evaluate the effects of shock to inflation lagged uncertainty on the contemporaneous output growth of the transition economies under study.

Referring on the table entries, a set of results are worth mentioning. Firstly, the statistical significant coefficient of a_{11} and a_{22} for all selected transition economies imply that the inflation uncertainty and output growth of these economies are affected by the shocks from their own returns, respectively. Secondly, we found an evidence of bi-directional shock transmissions between the inflation uncertainty and output growth of all selected economies are Russia, Kazakhstan and Ukraine.

PANEL B: KAZAKHSTAN			
	cpi_t		ipi_t
Mean specification			
μ_{cpi}	0.2717***	μ_{ipi}	0.3327***
$\gamma_{cpi,ipi}^{(1)}$	0.6043***	$\gamma_{ipi,cpi}^{(1)}$	0.2232
$\gamma_{cpi,cpi}^{(1)}$	-0.0048	$\gamma_{ipi,ipi}^{(1)}$	-0.2796***
$\gamma_{cpi,ipi}^{(2)}$	0.0034	$\gamma_{ipi,cpi}^{(2)}$	0.3977***
$\gamma_{cpi,cpi}^{(2)}$	0.0004	$\gamma_{ipi,ipi}^{(2)}$	-0.1667***
$\gamma_{cpi,ipi}^{(3)}$	-0.0496	$\gamma_{ipi,cpi}^{(3)}$	-0.2802*
$\gamma_{cpi,cpi}^{(3)}$	0.0023	$\gamma_{ipi,ipi}^{(3)}$	-0.1273*
$\gamma_{cpi,ipi}^{(4)}$	0.0255	$\gamma_{ipi,cpi}^{(4)}$	0.3560*
$\gamma_{cpi,cpi}^{(4)}$	-0.0009	$\gamma_{ipi,ipi}^{(4)}$	-0.0868*
$\gamma_{cpi,ipi}^{(5)}$	-0.0213	$\gamma_{ipi,cpi}^{(5)}$	-0.0904*
$\gamma_{cpi,cpi}^{(5)}$	-0.0019	$\gamma_{ipi,ipi}^{(5)}$	-0.0680*
$\Psi_{cpi,ipi}$	-0.0203***	$\Psi_{ipi,cpi}$	0.0394
$\Psi_{cpi,cpi}$	-0.0003	$\Psi_{ipi,ipi}$	0.0154
Shape	2.0268***	AIC	5.280
LogL	-660.27	SBC	5.846
HQC	5.508	FPE	5.283
Variance-covariance specification			
$c_{1,1}$	1.1677***	$c_{1,2}$	-
$c_{2,1}$	1.6725	$c_{2,2}$	0.1166
$a_{1,1}$	1.3745***	$a_{1,2}$	-3.9658
$a_{2,1}$	-0.0537	$a_{2,2}$	3.3248***
$b_{1,1}$	-0.2735*	$b_{1,2}$	1.9340**
$b_{2,1}$	-0.0045	$b_{2,2}$	0.8016***
$d_{1,1}$	-2.5259***	$d_{1,2}$	2.9936
$d_{2,1}$	0.0050	$d_{2,2}$	0.8638*

Notes: ***, **, * indicate 1%, 5% and 10% significance level, respectively. AIC, SBC, HQC and FPE are acronyms for the Akaike information criterion, Schwarz Bayesian criterion, Hannan-Quinn criterion and Final prediction errors, respectively. LogL stands for log-likelihood value.

Similar to the interpretation of the elements of matrix *A,* the diagonal elements, $b_{11}$and in matrix *B*, capture own GARCH effects, while off-diagonal elements, b_{12} and b_{21} measure the effects of lagged inflation uncertainty on output growth for the respective transition economies under study. Since the diagonal elements of the matrix *B*, b_{11} and b_{22} generally express a strong GARCH(1,1) process, which drives from the conditional standard deviations, all these statistical elements for the respective transition economies showing the highly heteroscedasticity in residual terms of the employed model. Moreover, we found the bi-directional adverse uncertainty spillover effect from the inflation to output growth for Kazakhstan and Ukraine, except Russia. Indeed, all off-diagonal elements for Russia's economy b_{12} and b_{21} are statistically insignificant. It should be noted that, the inflation uncertainty does have an impact on the current instability of output growth of Kazakhstan and Ukrane's economies. However, the inflation uncertainty does not have an impact on the current instability of output growth of Russia.

PANEL C: UKRAINE			
	cpi_t		$ipi_{,t}$
Mean specification			
μ_{cpi}	0.0916***	μ_{ipi}	0.1212
$\gamma^{(1)}_{cpi,ipi}$	0.6670***	$\gamma^{(1)}_{ipi,cpi}$	0.3403
$\gamma^{(1)}_{cpi,cpi}$	-0.0121	$\gamma^{(1)}_{ipi,ipi}$	-0.1766
$\gamma^{(2)}_{cpi,ipi}$	0.0279	$\gamma^{(2)}_{ipi,cpi}$	-0.1558
$\gamma^{(2)}_{cpi,cpi}$	-0.0111	$\gamma^{(2)}_{ipi,ipi}$	0.0229
$\gamma^{(3)}_{cpi,ipi}$	0.0201	$\gamma^{(3)}_{ipi,cpi}$	0.2478
$\gamma^{(3)}_{cpi,cpi}$	0.0158	$\gamma^{(3)}_{ipi,ipi}$	0.0570
$\gamma^{(4)}_{cpi,ipi}$	0.0212	$\gamma^{(4)}_{ipi,cpi}$	-0.3121
$\gamma^{(4)}_{cpi,cpi}$	0.0182	$\gamma^{(4)}_{ipi,ipi}$	0.0153
$\Psi_{cpi,ipi}$	-0.1680**	$\Psi_{ipi,cpi}$	0.5141*
$\Psi_{cpi,cpi}$	0.0039	$\Psi_{ipi,ipi}$	-0.1786
Shape	5.7903	AIC	6.726
LogL	-779.26	SBC	7.273
HQC	6.946	FPE	6.729
Variance-covariance specification			
$c_{1,1}$	0.1949***	$c_{1,2}$	-
$c_{2,1}$	-0.2819	$c_{2,2}$	1.7828***
$a_{1,1}$	0.4406***	$a_{1,2}$	-0.1021
$a_{2,1}$	-0.0514*	$a_{2,2}$	0.2982*
$b_{1,1}$	0.8267***	$b_{1,2}$	0.1342
$b_{2,1}$	-0.0098	$b_{2,2}$	0.1865*
$d_{1,1}$	0.0185	$d_{1,2}$	-0.5038
$d_{2,1}$	0.0167	$d_{2,2}$	1.1349

Notes: ***, **, * indicate 1%, 5% and 10% significance level, respectively. AIC, SBC, HQC and FPE are acronyms for the Akaike information criterion, Schwarz Bayesian criterion, Hannan-Quinn criterion and Final prediction errors, respectively. LogL stands for log-likelihood value.

In addition, as far as asymmetric parameter matrix *D* is concerned, there is evidence of an asymmetric response to positive shocks for returns, as a diagonal parameters d_{11} and d_{22} are statistically significant of the Kazakhstan's economy. For Russia and Ukraine's series are statistically insignificant. Based on model estimation, the significance of d_{11} and d_{22} implies that inflation uncertainty and output growth display their own variance asymmetry to positive shocks. Therefore, a positive growth shock leads to more uncertainty on growth series, but negative shock of a similar magnitude does not. The statistically insignificant off-diagonal elements of the matrix *D*, specially d_{12} and d_{21} for all transition economies, respectively. Finally, the inflation uncertainty of them responses asymmetrically towards to the shocks of output growth of the selected transition economies under concern.

6.2. Robustness Checks and Model Specification Tests

The entries of Table **4**, present the results for robustness checks: Univariate and multivariate tests for the standardized residuals of Inflation ($z_{cpi,t}$) and output growth ($z_{ipi,t}$) equations for the respective transition economies. In addition, the results of the diversity test show that there are no inconsistencies in the standard errors, as well as many other cases and other studies. The tests' statistics with null hypotheses are reported in Table **4** and Table **5**, they are noteworthy.

First, relying on preliminary data analysis, there is significant conditional heteroscedasticity in the series under study. It can be also confirmed that the parameter matrices A, B and D provide the jointly statistically significant parameter estimates. As given in Table **5**, all the entries of the elements of parameter matrices are jointly significant, and express well–specified second moment equation. Second, the jointly statistical significant off–diagonal elements of these parameter matrices express that the lagged conditional variances in inflation uncertainty have an impact on output growth.

As stated, the asymmetric responses are detected for the specified model on the linkage between inflation uncertainty and output growth of the selected transition economies. Moreover, the significance of a_{11} and d_{11} shows evidence of variance asymmetry in inflation, and it expresses that the negative innovations in inflation for the respective economies lead to more inflation uncertainty than positive shocks. Likewise, the significance of a_{22} and d_{22} also displays the response of own variance asymmetry in output growth, and it implies that negative output growth shocks on based under estimation M-GARCH-M-BEKK model. Finally, the estimated models of the respective transition economies under investgiation are found with sound specification.

Table 4. Results of Univariate and Multivariate Tests.

	Univariate	$Z_{cpi,t}$	$Z_{ipi,t}$	Multivariate	Statistic
Russia	Ljung-Box Q(8)	10.391	7.2097	Multivariate Q(8)	x^2 (72) = 25.14
	Mc-Leod-Li (8)	2.3577	4.9252	Multivariate ARCH(288)	73.62
	ARCH LM (8)	0.0148	0.7713		
Kazakhstan	Ljung-Box Q(8)	1.7062	4.8693	Multivariate Q(8)	x^2 (72) = 6.679
	Mc-Leod-Li (8)	0.2404	0.6216	Multivariate ARCH(288)	13.09
	ARCH LM (8)	0.9999	0.9998		
Ukraine	Ljung-Box Q(8)	4.7921	15.927	Multivariate Q(8)	x^2 (72) = 5.003
	Mc-Leod-Li (8)	5.7741	19.373	Multivariate ARCH(288)	20.31
	ARCH LM (8)	0.7213	0.0034		

Notes: ***, **, * indicate 1%, 5% and 10% significance level, respectively. Here, $Z_{cpi,t}$ and $Z_{ipi,t}$ denote log changes for inflation and output growth, respectively.

Table 5. Specification Tests of Multivariate GARCH-in-mean Model.

	Specification Tests		
Russia	Diaganal VAR	$H_0 := \gamma_{12}^{(i)} = \gamma_{21}^{(i)} = 0, i = 1,2,3$	x^2 (6) = 113.10***
	Diaganal GARCH	$H_0 := a_{ij} = b_{ij} = d_{ij} = 0, \text{if } i \neq j;\ i,j = 1,2$	x^2 (6) = 18.54***
	No GARCH	$H_0 := a_{ij} = b_{ij} = d_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (12) = 36.85***
	No GARCH-M	$H_0 := \Psi_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (4) = 13.89 ***
	No Asymmetry	$H_0 := d_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (4) = 12.54***
Kazakhstan	Diaganal VAR	$H_0 := \gamma_{12}^{(i)} = \gamma_{21}^{(i)} = 0, i = 1,2,3,4,5$	x^2 (10) = 71.69***
	Diaganal GARCH	$H_0 := a_{ij} = b_{ij} = d_{ij} = 0, \text{if } i \neq j;\ i,j = 1,2$	x^2 (6) =5.02 ***
	No GARCH	$H_0 := a_{ij} = b_{ij} = d_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (12) = 130.59***
	No GARCH-M	$H_0 := \Psi_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (4) = 2.67*
	No Asymmetry	$H_0 := d_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (4) =5.13 ***
Ukraine	Diaganal VAR	$H_0 := \gamma_{12}^{(i)} = \gamma_{21}^{(i)} = 0, i = 1,2,3,4$	x^2 (8) = 106.36***
	Diaganal GARCH	$H_0 := a_{ij} = b_{ij} = d_{ij} = 0, \text{if } i \neq j;\ i,j = 1,2$	x^2 (6) = 1.47***
	No GARCH	$H_0 := a_{ij} = b_{ij} = d_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (12) = 114.7***
	No GARCH-M	$H_0 := \Psi_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (4) = 4.23***
	No Asymmetry	$H_0 := d_{ij} = 0, \text{for all } i,j = 1,2$	x^2 (4) = 12.62***

Notes: ***, **, * indicate 1%, 5% and 10% significance level, respectively.

6.5. Results of Non-causality Test

As mentioned in section 5, we apply Wald test statistics proposed by Hafner and Herwartz (2008) to carry out non-causality analysis on estimated model. Table **6** presents non–causality test results in conditional variances, and they follow the asymptotic chi–squared (χ^2) distribution with a degree of freedom that is unrestricted in parameter estimation.

Referring to the table entries, there are a bi-directional variance transmissions inflation uncertainty and the conditional variations of output growth for all selected transition economies under investigation.

6.6. Results of Nonlinear ARDL–ECM model

We employ the NARDL model to examine the long-run and short-run asymmetric effects of inflation uncertainty on output growth in selected transition economies. After confirmation of cointegration between the variables, we proceed with the estimation results of the long-run and short-run asymmetric impact of inflation uncertainty on output growth. In Table 7, the estimation results illustrated that inflation uncertainty have a significant long-run positive effect on output growth in the transition economies under study. From a different point of view, it can be estimated that the inflation uncertainty have an significant negative effect on the output growth of all Russia, Kazakhstan and Ukraine's economy for long-run.

Table 6. Wald Test Statistics: Non-Causality Test Results.

Countries	Series	$cpi_t \downarrow$	$ipi_t \downarrow$	Result
Russia	$cpi \rightarrow$	63.011***	19.617***	bi-directional
	$ipi_t \rightarrow$	2.2578*	6.6160**	bi-directional
Kazakhstan	$cpi \rightarrow$	22.339***	9.3959***	bi-directional
	$ipi_t \rightarrow$	2.3194*	202.08***	bi-directional
Ukraine	$cpi \rightarrow$	588.15***	0.2219*	bi-directional
	$ipi_t \rightarrow$	3.3358*	8.3135***	bi-directional

Notes: Significance level *, **, *** indicated 10%, 5% and 1%, respectively, The sign → and ↓ denote causative in the derection of the arrows.

Table 7. Long-Run Coefficient Estimates of the NARDL Model.

Countries	Variable	Coefficient	Probability
Russia	LIPI_POS	0.1747	0.0000
	LIPI_NEG	0.6026	0.0000
	C	0.2008	0.0000
Kazakhstan	LIPI_POS	-0.0418	0.0000
	LIPI_NEG	0.0004	0.9448
	C	0.0065	0.7115
Ukraine	LIPI_POS	-0.0682	0.0000
	LIPI_NEG	0.0302	0.0001
	C	0.0693	0.0080

Notes: Here, LIPI represent output growth, respectively.

Table 8. Short-run coefficient estimates of the NARDL Model.

Countires	Variable	Coefficient	Probability
Russia	C	-0.0001	0.9358
	DLIPI _POS	-0.2212	0.2000
	DLIPI _NEG	-0.0009	0.0773
	DLIPI_NEG (-1)	-0.1087	0.0006
	ECT (-1)	-0.0347	0.0000
Kazakhstan	C	-0.0001	0.9698
	DLIPI _POS	-0.0428	0.1254
	DLIPI _NEG	0.0010	0.0410
	ECT (-1)	0.0004	0.0051
Ukraine	C	0.0060	0.0010
	DLIPI_ POS	0.0481	0.3586
	DLIPI _NEG	-0.0645	0.0294
	ECT (-1)	-0.0141	0.0112

Notes: Here, DLIPI represent output growth, respectively. ECM (-1) is the error correction term, that is, the residual with a one-period lag, respectively.

The short-run dynamics are provided in the following Table 8. empirical estimation results summarized that the short-run coefficients of inflation uncertainty have a significant negative effect on output growth of all selected economies for the study period. In addition, we applied the Wald test to verify the suitability of a nonlinear model. The Wald tests reject the null hypothesis of long-run and short-run symmetry of positive and negative components of all examined variables. Findings demonstrated that the adjustment to the inflation uncertainty is moving in the direction of a constant increase in the short-run with respect to a considerably significantly negative influence on output growth. These show the unequal influence that long-term and short-term factors have on output growth throughout a range of time periods. According to what we know, the effects of the inflation uncertainty on output growth in all transition economies have been negatively asymmetric in the short run; the coefficients of the inflation uncertainty's impacts on output growth for all selected economies are significantly asymmetric positive effect in the long-run.

6.7. Results of Generalized impulse response function analysis (GIRF)

As mentioned above, we exploit in section of empirical models that the analytical framework of the GIRF of inflation uncertainty to one standard deviation shocks of output growth under the vector autoregression process of the respective transition economies under study are illustrated in Fig. (**1**). We used GIRF analysis for monthly sample periods for both variables to start on September 01, 2020, for the proxy pandemic and ongoing Russia-Ukraine conflict periods. Referring to Fig. (**1**), the dashed solid blueline is the response to a unit of shock innovations, while the dashed redlines are the confidence intervals; each unit time horizon denotes a monthly series.

The analytical framework of impulse responses for the periods starts from September 2020

The results in Fig. (**1**), suggests that the innovation shocks of inflation uncertainty have negative steady-state impact on output growth in the all transition economies from selected CIS countries. Though inflation uncertainty have a ambiguous effect on output growth in pandemic and Russia-Ukaraine conflict periods.

In Russia, inflation uncertainty harms to output growth, full recovery requires up to 8 to 10 months. After negative impacts, inflation uncertainty has had a negative impact on economic growth in Kazakhstan's and similarly, the innovation shocks of inflation uncertainty have had a steady state negative impact on output growth for Ukraine's economy from august 2020. The negative effects takes around 10 to 12 months for fully dissipate in the sample periods for Kazakhstan and Ukraine. However, since Septemeber 2021 innovation shocks of inflation uncertainty have an unsteadily positive effect on output growth in all selected economies under study.

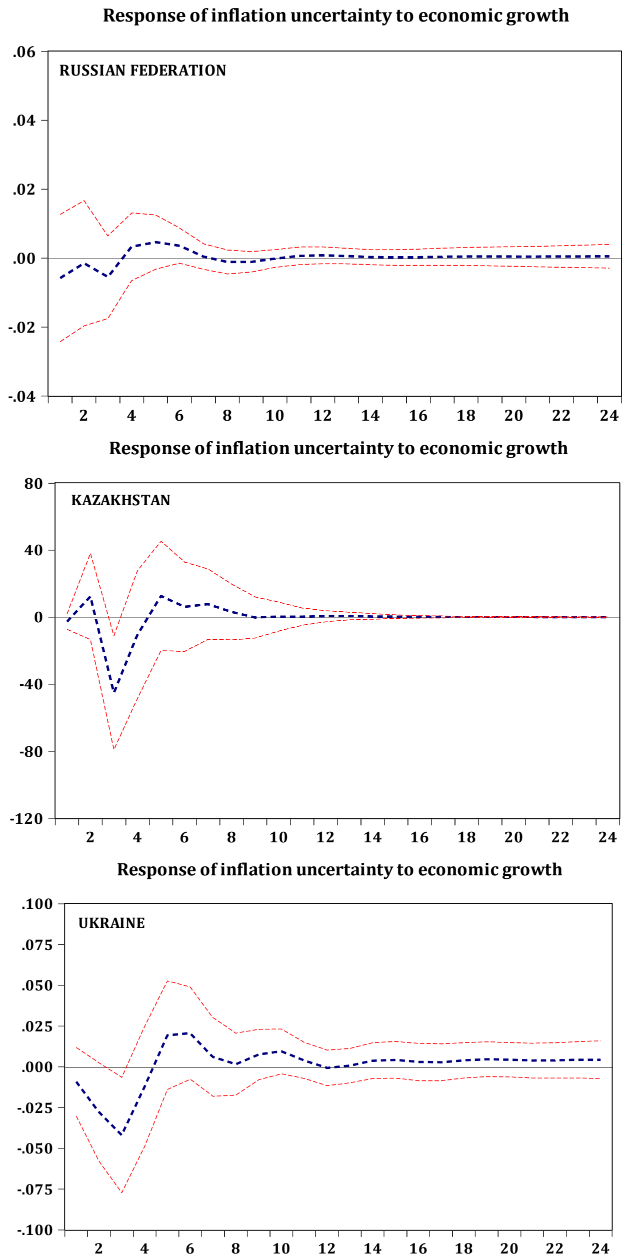

Fig. (1). GIRF of inflation uncertainty under VAR process to a unit shock of output growth.

CONCLUSION AND POLICY RECOMMENDATIONS

In last decasdes, the theoretical and empirical literatures on the relationship between inflation, inflation uncertainty and output growth is ambiguous. Therefore, the main impact of one variable on another depends on relative importance of direct and indirect causal effects as well as economic environment and economic policies to a great extent. Although the causal nexus between economic and various uncertainties have been examined in the empirical literature extensively for developed and developing countries, only a limited work is done for transition economies. In view of both the theoretical and empirical significance of impact of inflation, inflation uncertainty on output growth, and with the aim to fill a gap in the literature, in this paper we examine such relationships for selected transition economies from CIS countries. Based on our empirical analysis, main findings can be summarized as follows.

Firstly, ss a result, relying on multivariate GARCH–in–mean model estimation, As a result, relying on model estimation, the conditional standard deviation of inflation uncertainty has a significant negative impacts on output growth of the the all selected transition economies. Firstly, the statistical significant coefficients for all selected transition economies imply that the inflation uncertainty and output growth of these economies are affected by the shocks from their own returns, respectively. Secondly, we found an evidence of bi-directional shock transmissions between the inflation uncertainty and output growth of all selected economies are Russia, Kazakhstan and Ukraine.

Secondly, the results of NARDL model estimation reveal that the adjustment to the inflation uncertainty is moving in the direction of a constant increase in the short-run with respect to a considerably significantly negative influence on output growth. In sum, the effects of the inflation uncertainty on output growth in all transition economies have been negatively asymmetric in the short run; the coefficients of the inflation uncertainty's impacts on output growth for all selected economies are significantly asymmetric positive effect in the long-run.

Lastly, the computed Generalized impulse response function analysis suggest that the innovation shocks of inflation uncertainty have negative steady-state effects on output growth in all transtion economies under study. Though inflation uncertainty has a ambiguous effect on output growth in pandemic and Russia-Ukraine conflict periods in Russia, Kazakhstan and Ukraine.

In sum, we recommend as a future developments that policymakers should pursue economic and monetary policies that ensure consumer price stagnation to create a conducive environment for both short- and long term growth. Consumer rrice stability is a important condition for output growth and economic development; however, it is not a adequate factor for determining economic growth and development. Consequently, we further recommend that policymakers should pursue policies that stimulate economic development, while allowing the responsible body for monetary and economic policy to commit to fighting inflation and inflation uncertainty.

ACKNOWLEDGEMENTS

The first author acknowledges the financial support provided by the “El-Yurt Umidi” Foundation of under the PhD scholarship.

The authors would like to gratefully acknowledge many helpful and constructive comments of the anonymous referee that help improve the quality of the paper; however, any remaining errors are solely ours.

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Received: July 21, 2023 Revised: July 24, 2023 Accepted: July 26, 2023