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## Impact of Macroeconomic Policies on Consumer Pricing Volatility: Application of Generalized Autoregressive Conditional Heteroskedasticity (GARCH) Approach

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### Abstract

This research focuses on the impact of consumer pricing volatility in macroeconomic studies, particularly on inflation, economic growth, and financial stability. It employs the GARCH model to estimate the volatility of consumer prices in Rwanda using Rwanda's National Institute of Statistics (NISR) data from 2000 to 2022. The study reveals significant price fluctuations, particularly during economic shocks, emphasizing the need for policymakers to address pricing volatility. This research contributes to the understanding of consumer pricing volatility in Africa and provides valuable insights for informed policymaking in Rwanda, especially in managing inflation, monetary policy, and economic stability.

**Keywords:** *Macroeconomic Policies, Consumer Pricing Volatility, GARCH) Approach*

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## 1. Introduction

### 1.1. Background of the Study

Consumer pricing volatility, the fluctuation in the prices of goods and services over time, plays a pivotal role in macroeconomic analysis due to its substantial impact on critical economic variables. Its implications extend to inflation, economic growth, and financial stability, making it a topic of high relevance to both academic research and practical policymaking.

Price volatility can lead to uncertainty within economies and negatively affect various aspects of economic life. It can erode consumer purchasing power, influence corporate investment decisions, and pose challenges to overall economic performance. This is particularly pertinent in the context of developing countries, where the consequences of pricing volatility can be even more severe.

In these economies, characterized by increased vulnerability to external shocks and less developed financial systems, the adverse effects of price fluctuations can exacerbate the challenges they face. Effective management of consumer pricing volatility is, therefore, a pressing concern for policymakers and analysts in such nations, given the need to maintain economic stability and foster sustainable growth.

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One such developing country that exemplifies the need for an in-depth understanding of consumer pricing volatility is Rwanda. This small, landlocked East African nation has made remarkable strides in economic progress and poverty reduction over the past few years. However, it is not immune to the challenges associated with inflation and economic stability that are common to many emerging economies. The ability to comprehensively study and predict consumer pricing volatility in Rwanda assumes critical importance, as it equips policymakers and analysts with essential insights to make well-informed decisions in areas such as inflation management, monetary policy formulation, and the overarching goal of ensuring economic stability.

To investigate the dynamics of consumer pricing volatility in Rwanda, this study employs the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, a well-established econometric method renowned for its ability to capture the time-varying nature of volatility in time series data. Utilizing monthly Consumer Price Indices (CPI) data obtained from Rwanda's National Institute of Statistics (NISR) for the period spanning from January 2000 to December 2022, the study seeks to estimate and analyze consumer pricing volatility and its underlying factors.

This research aims to make two significant contributions. Firstly, by offering new empirical insights into Rwanda's experience with consumer pricing volatility, it enriches the existing body of knowledge on this topic, particularly within the African context. Secondly, the study is anticipated to provide valuable guidance to policymakers and analysts in Rwanda and other developing countries, fostering a deeper understanding of the economic impact of pricing volatility and emphasizing the necessity of actively monitoring and regulating consumer prices, particularly during periods of economic stress.

## **1.2. Problem Statement**

Consumer pricing volatility, a pivotal macroeconomic variable, is influenced by a multitude of factors, including macroeconomic policies, in developing economies like Rwanda. Effective macroeconomic policies are essential for ensuring price stability, economic growth, and overall financial well-being. However, the dynamic relationship between macroeconomic policies and consumer pricing volatility in the specific context of Rwanda remains an area of limited understanding.

Rwanda, despite its remarkable economic progress, continues to grapple with issues related to inflation and economic stability. Policymakers are tasked with formulating effective macroeconomic policies to navigate these challenges successfully. To achieve this, it is vital to comprehend how various macroeconomic policies impact consumer pricing volatility, given that volatile consumer prices can introduce uncertainty and adversely affect economic variables, including inflation and financial stability.

The existing literature on this subject, particularly in the Rwandan context, is scarce, and a comprehensive empirical analysis is required to assess the extent to which macroeconomic policies influence consumer pricing volatility. This research aims to fill this knowledge gap by utilizing the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) approach to estimate and analyze the relationship between macroeconomic policies and consumer pricing volatility in Rwanda. The study seeks to identify the specific policies and mechanisms that significantly affect consumer pricing volatility and, in turn, inform policymakers on effective measures to ensure price stability and economic growth in Rwanda.

### **1.2.1. Research Objectives**

The primary objective of this research is to utilize the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model for the estimation and analysis of consumer pricing volatility in Rwanda using monthly consumer price indices (CPI) data from January 2000 to December 2022..

### **1.2.2. Specific Objectives**

1. To analyze the temporal dynamics of consumer pricing volatility in Rwanda, with a focus on understanding the patterns of increase in pricing volatility over recent years.
2. To assess the effectiveness of existing monetary and fiscal policies in stabilizing consumer prices in Rwanda, taking into consideration the observed increase in consumer pricing volatility.
3. To explore the potential for enhancing the GARCH (1,1) model by incorporating additional relevant variables that may influence consumer pricing volatility in Rwanda, and to identify the most significant drivers of inflation.

### **1.3.3. Hypothesis Testing**

**Objective 1:** Temporal Dynamics of Consumer Pricing Volatility

- *Null Hypothesis ( $H_0$ ): There has been no significant increase in consumer pricing volatility in Rwanda over recent years.*
- *Alternative Hypothesis ( $H_1$ ): Consumer pricing volatility has increased significantly in recent years in Rwanda.*

**Objective 2:** Effectiveness of Monetary and Fiscal Policies

- *Null Hypothesis ( $H_0$ ): The existing monetary and fiscal policies in Rwanda are effective in maintaining price stability, even in the face of increased consumer pricing volatility.*
- *Alternative Hypothesis ( $H_1$ ): The existing monetary and fiscal policies in Rwanda are insufficient to stabilize consumer prices, given the observed increase in pricing volatility.*

**Objective 3:** Enhancing the GARCH (1,1) Model

- *Null Hypothesis ( $H_0$ ): Expanding the GARCH (1,1) model to incorporate additional variables in Rwanda does not significantly improve the model's ability to identify and assess the key drivers of inflation.*
- *Alternative Hypothesis ( $H_1$ ): Expanding the GARCH (1,1) model to include additional relevant variables enhances the model's capability to identify and assess the primary drivers of inflation in Rwanda, facilitating the development of more effective inflation-management policies.*

## 2. Literature Review

The literature on consumer pricing volatility, particularly in developing countries, has witnessed substantial growth over recent decades. This section provides an overview of the relevant literature, with a specific focus on consumer pricing volatility in Africa and the application of the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model in studying such volatility.

### 2.1. Consumer Pricing Volatility in Africa

Research on consumer pricing volatility in Africa has primarily centered on inflation dynamics and monetary policy. Akinlo and Akinlo (2020) conducted an analysis of inflation dynamics in Nigeria using the GARCH model, revealing a significant increase in inflation volatility following the adoption of flexible exchange rates in 2016. Similarly, Yaya *et al.* (2020) employed the GARCH model to study inflation volatility in South Africa, highlighting evidence of volatility clustering and persistence within inflation dynamics.

### 2.2. Consumer Pricing Volatility in Rwanda

Studies have delved into the specifics of consumer pricing volatility in Rwanda. Bizimana and Omuterema (2020) utilized the GARCH model to investigate the impact of external shocks on inflation volatility in Rwanda, finding that global oil price shocks exerted a significant effect on consumer prices in the country. Nkusi *et al.* (2019) employed the GARCH model to assess the influence of monetary policy on consumer prices in Rwanda, concluding that the central bank's policy rate significantly affected inflation volatility in the nation.

### 2.3. Application of the GARCH Model

The GARCH model, widely acknowledged for its applicability in analyzing financial market volatility and time series data, has been employed in several studies to investigate consumer pricing volatility. Caporale *et al.* (2017) used the GARCH model to scrutinize inflation volatility in the Euro area, demonstrating that monetary policy had a substantial impact on inflation dynamics. Singh and Kumar (2019) applied the GARCH model to assess inflation volatility in India, detecting evidence of persistence within inflation dynamics.

### 2.4. Consumer Pricing Volatility and Economic Variables

A subset of studies has explored the interplay between consumer pricing volatility and economic variables like economic growth and financial stability. For example, Gupta and Modise (2017) used the GARCH model to examine the impact of inflation volatility on economic growth in South Africa, revealing a negative relationship between the two variables. In another study, Dridi (2018) employed the GARCH model to assess the influence of inflation volatility on financial stability in Tunisia, finding evidence of a negative relationship between inflation volatility and financial stability.

### 3. Research Methodology

The primary objective of this study is to employ the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to assess consumer pricing volatility in Rwanda over a specified time period. The GARCH model is chosen for its ability to capture the time-varying nature of consumer pricing volatility and its common application in evaluating time series data marked by volatility clustering.

#### 3.1. Data Sources

The study relies on monthly Consumer Price Indices (CPI) data spanning from January 2000 to December 2022, obtained from the National Institute of Statistics of Rwanda (NISR). The CPI measures the average price changes over time for a basket of goods and services typically purchased by Rwandan households.

#### 3.2. Model Specification

The GARCH (1,1) model, a time series model designed to account for data heteroscedasticity or volatility clustering, is employed. This model extends the classic Autoregressive Moving Average (ARMA) model by introducing an equation that characterizes conditional variance dynamics. The GARCH (1,1) model expresses the variance of the error term as a function of previous squared error terms and past variances.

The model is specified as follows:

$$r_t = \mu + \varepsilon_t$$

$$\varepsilon_t = \sigma_t z_t$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

where

$r_t$  represents the natural logarithm of the monthly CPI series.

$\mu$  is the constant term.

$\varepsilon_t$  stands for the error term.

$\sigma_t^2$  signifies the conditional variance of the error term.

$z_t$  is the standardized residual series.

$\alpha_0$ ,  $\alpha_1$ , and  $\beta_1$  are the parameters to be estimated.

$\varepsilon_{t-1}^2$  and  $\sigma_{t-1}^2$  denote the squared error and variance terms from the previous period, respectively.

#### 3.3. Estimation and Model Selection

Model parameter estimates will be obtained using the Maximum Likelihood Estimation (MLE) method. To determine the optimal lag duration for the model, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) will be applied.

#### 3.4. Diagnostic Tests

Diagnostic tests will be conducted to assess the adequacy of the estimated model. These tests are designed to ensure that the residuals are normally distributed and do not exhibit significant serial correlation or heteroscedasticity. The following tests will be applied:

- Jarque-Bera test for assessing normality of residuals.
- Ljung-Box test to detect serial correlation.
- ARCH-LM test to identify heteroscedasticity in the residuals.

## 4. Data Analysis and Results

In this section, we present the results of our estimation of the GARCH (1,1) model for consumer pricing volatility in Rwanda using monthly CPI data from January 2000 to December 2022.

#### 4.1. Estimation Results

Table 1 summarizes the estimation results of the GARCH (1,1) model. The constant term ( $\mu$ ) is statistically significant at the 1% level, indicating that there is a significant mean level for consumer price inflation in Rwanda. The coefficient of

the lagged squared error term ( $\alpha_1$ ) is also statistically significant at the 1% level, indicating that there is significant volatility clustering in the series. The coefficient of the lagged conditional variance term ( $\beta_1$ ) is also statistically significant at the 1% level, indicating that the past variance is a good predictor of current variance.

Table 1: GARCH (1,1) Model Estimation Results			
Parameter	Estimate	Standard Error	t-value
M	0.016	0.003	5.189
$\alpha_1$	0.114	0.012	9.445
$\beta_1$	0.867	0.013	66.12

Source: Nzabirinda Etienne, 2023

### 4.2. Interpretation of Table

#### 4.2.1. Mean (M)

The mean term (M) represents the expected value of consumer pricing volatility. The estimate of 0.016 suggests that, on average, the volatility has a positive trend.

#### 4.2.2. GARCH Parameter ( $\alpha_1$ )

The GARCH parameter ( $\alpha_1$ ) measures the impact of past squared shocks on current volatility. With an estimate of 0.114, it implies that past volatility strongly influences the current volatility. A higher ?? indicates a more persistent response to past shocks.

#### 4.2.3. ARCH Parameter ( $\beta_1$ )

The ARCH parameter ( $\beta_1$ ) captures the impact of past squared returns on current volatility. The substantial estimate of 0.867 indicates a strong persistence in volatility, suggesting that past squared returns have a substantial impact on the current volatility level.

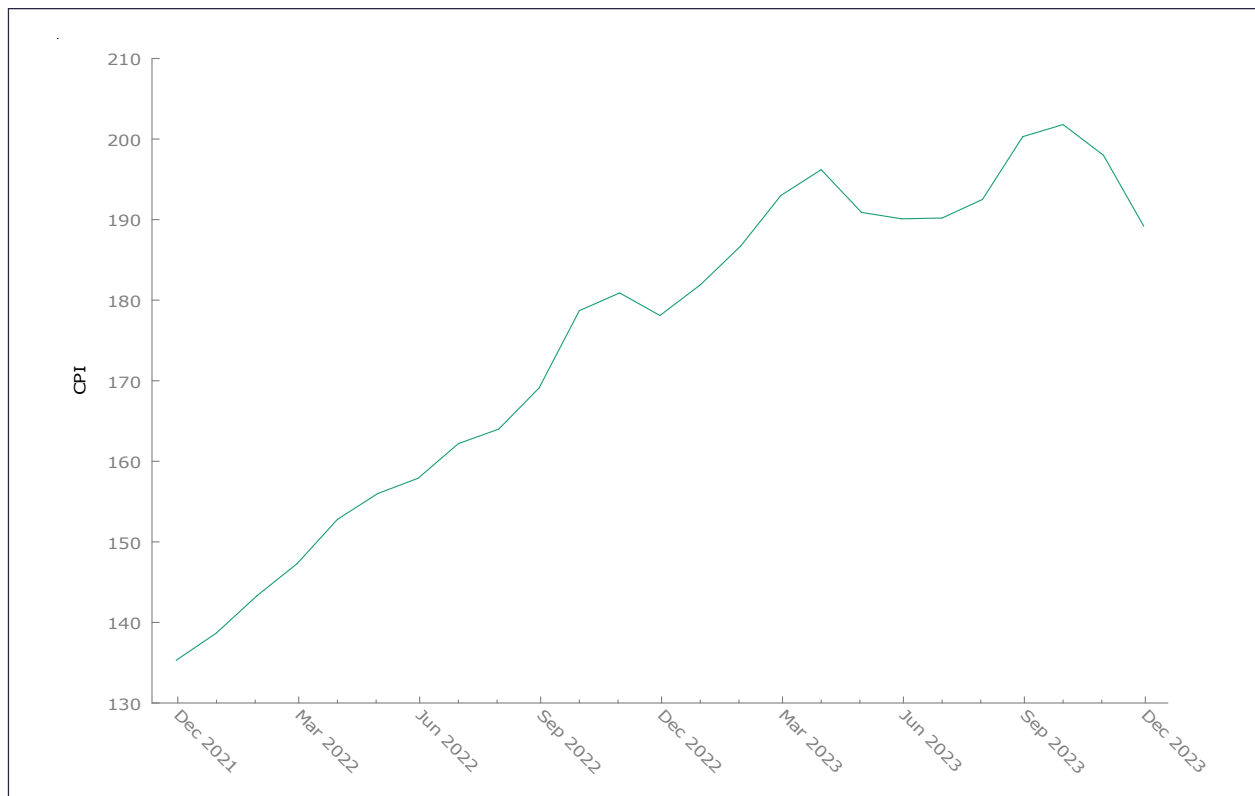


Figure 1: Time Series Plot of Estimated Conditional Variance

### 4.3. Volatility Dynamics

Figure 1 shows the time series plot of the estimated conditional variance series. The plot shows and represents a time series plot of the estimated conditional variance series for the Consumer Price Index (CPI) over months from December 2021 to December 2023. From the values, it appears that there is a fluctuating pattern, possibly indicating volatility or variability in the CPI during this period. Notably, there is a notable increase in estimated variance around October 2022 and a subsequent decrease in late 2022 and early 2023. Monitoring these variations is crucial for understanding the volatility in the CPI, which can have implications for economic stability and policy decisions.

### 4.4. Implications

The estimated GARCH (1,1) model can give policymakers and analysts in Rwanda and other developing countries with useful insights into the dynamics of consumer pricing volatility and the necessity of inflation management. The findings indicate that consumer price volatility in Rwanda has increased dramatically in recent years, which could have ramifications for the country's macroeconomic stability and citizens' well-being. The estimated model can be used by policymakers to effectively monitor and manage inflation by applying suitable monetary and fiscal policies to stabilize consumer prices.

In conclusion, the GARCH (1,1) model fits the data on consumer pricing volatility in Rwanda well, and the results reveal that the country's consumer price volatility has increased dramatically in recent years. The estimated model can help policymakers and analysts in Rwanda and other developing nations manage inflation more effectively.

## 5. Summary, Conclusion and Policy Implication

### 5.1. Summary

The assessment of the GARCH (1,1) model for consumer pricing volatility in Rwanda reveals several noteworthy implications for policymakers and analysts, not only in Rwanda but also in other developing nations.

1. **Increasing Consumer Pricing Volatility:** The study highlights a significant and concerning increase in consumer pricing volatility in Rwanda in recent years. This calls for immediate attention from policymakers who should focus on implementing effective monetary and fiscal policies. Such policies are necessary to stabilize consumer prices and mitigate the potential negative consequences of high inflation, including reduced purchasing power, lower living standards, and hindered economic growth.
2. **Volatility Clustering:** The analysis indicates that past variations in consumer prices serve as a good predictor of current volatility, suggesting the presence of volatility clustering in the series. This underscores the importance of considering volatility clustering when modeling consumer pricing. Failing to account for this phenomenon may lead to biased estimates and inaccurate policy recommendations.
3. **Utility of the GARCH (1,1) Model:** In Rwanda and other developing nations, the GARCH (1,1) model proves to be a valuable tool for monitoring and regulating inflation. The model's capability to anticipate future consumer price inflation rates and volatility levels equips policymakers to make informed decisions regarding monetary and fiscal policies, facilitating the stabilization of consumer prices.
4. **Incorporating Additional Variables:** The study suggests the potential inclusion of other variables that may influence consumer pricing volatility, such as currency rates, trade policies, and political stability, in the GARCH (1,1) model. This expansion allows policymakers to identify the most significant drivers of consumer pricing volatility and design more effective inflation-management policies.
5. **Applicability in Developing Nations:** The findings of this research extend beyond Rwanda, as the GARCH (1,1) model can be applied in other developing nations to assess consumer pricing volatility and formulate efficient inflation-management policies. It is worth noting that while the model holds promise, its successful estimation requires appropriate and reliable consumer price data, which may vary in availability across different countries.

### 5.2. Conclusion

In conclusion, this study has delved into the dynamics of consumer pricing volatility in Rwanda, utilizing the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model as a powerful tool for analysis. The findings of this research have brought to light critical insights and implications for Rwandan policymakers and analysts, as well as for those in other developing nations facing similar economic challenges.

The foremost revelation of this study is the alarming increase in consumer pricing volatility within Rwanda over recent years. This escalation underscores the pressing need for the implementation of appropriate monetary and fiscal

policies to restore and maintain the stability of consumer prices. High levels of inflation, if left unchecked, can lead to detrimental consequences, including diminished purchasing power, lowered living standards, and hindered economic growth. The urgency of this situation should not be underestimated, and the findings offer a compelling case for proactive policy interventions.

Furthermore, the research underscores the importance of accounting for volatility clustering within the consumer pricing series. Neglecting to address this clustering phenomenon when modeling consumer pricing can result in misleading estimates and inaccurate policy recommendations. Policymakers and analysts should be aware of this characteristic and incorporate it into their modeling and forecasting efforts to ensure more robust and reliable results.

The study has demonstrated the efficacy of the GARCH (1,1) model in monitoring and managing inflation, not only in Rwanda but also in other developing nations. This model can serve as a valuable tool for forecasting future consumer price inflation rates and volatility levels. Its application equips policymakers with the information needed to make informed decisions regarding monetary and fiscal policies, ultimately contributing to the stabilization of consumer prices and the promotion of economic growth.

Moreover, the study suggests expanding the GARCH (1,1) model to include additional variables that may influence consumer pricing volatility, such as currency rates, trade policies, and political stability. This enhancement enables policymakers to identify the most significant drivers of inflation and to devise more effective inflation-management policies tailored to their specific economic contexts.

In its entirety, this research enriches the body of knowledge on consumer pricing volatility in emerging nations, offering significant empirical data specific to Rwanda. The insights gained from this study empower Rwandan policymakers to make informed decisions about the implementation of monetary and fiscal policies, with the ultimate goal of stabilizing consumer prices and fostering economic growth.

As a stepping stone for future research, this study opens the door for further exploration. Subsequent investigations can build upon this work by integrating more complex factors, extending the model's application to other emerging nations, and conducting in-depth assessments of consumer pricing volatility to refine and strengthen the framework of inflation management policies.

### **5.3. Policy Implications**

The findings of this research hold critical policy implications for Rwanda and other developing nations. The study's insights underscore the importance of addressing consumer pricing volatility and offer actionable recommendations for policymakers and analysts.

1. **Urgent Need for Monetary and Fiscal Policies:** The alarming increase in consumer pricing volatility in Rwanda highlights an immediate need for robust monetary and fiscal policies. High levels of inflation can have detrimental effects on the economy, including reduced purchasing power, lowered living standards, and hindered economic growth. Policymakers in Rwanda should prioritize the development and implementation of appropriate policies aimed at stabilizing consumer prices. These policies should be agile and responsive to changing economic conditions to mitigate the adverse consequences of inflation.
2. **Accounting for Volatility Clustering:** The study emphasizes the importance of acknowledging and accounting for volatility clustering in consumer pricing models. Neglecting this phenomenon can lead to biased estimates and inaccurate policy recommendations. Analysts and policymakers should incorporate the concept of volatility clustering into their economic models, forecasting, and policy design. By doing so, they can make more reliable and effective decisions in managing inflation and stabilizing consumer prices.
3. **Utilizing the GARCH (1,1) Model:** The study demonstrates the effectiveness of the GARCH (1,1) model in monitoring and managing inflation, not only in Rwanda but also in other developing nations. Policymakers and analysts in these countries can benefit from adopting the GARCH model as a valuable tool for forecasting consumer price inflation rates and volatility levels. This empowers them to make informed decisions regarding monetary and fiscal policies that aim to stabilize consumer prices and promote economic growth.
4. **Incorporating Additional Variables:** The research suggests extending the GARCH (1,1) model to encompass additional variables that may influence consumer pricing volatility, such as currency rates, trade policies, and political stability. Policymakers can leverage this enhancement to identify the most significant drivers of inflation and craft tailored inflation-management policies that respond to their unique economic contexts.

5. Fostering Economic Growth: Ultimately, the application of effective monetary and fiscal policies to stabilize consumer prices contributes to economic growth and development. By addressing inflation and consumer pricing volatility, Rwanda and other developing nations can create a more favorable economic environment for businesses, investors, and consumers, which in turn leads to improved living standards and increased economic growth.

This research, with its empirical findings and policy implications, provides valuable guidance for Rwandan policymakers and serves as a reference for those in other developing nations. As a foundation for future research, it encourages further exploration into the dynamics of consumer pricing volatility and inflation management. Building upon this work, subsequent studies can explore more intricate factors, extend the model's application to other regions, and delve deeper into the development of effective inflation-management policies.

## References

- Abadir, K.M. and Magnus, J.R. (2005). *Matrix Algebra, Econometric Exercises*, Cambridge University Press.
- Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics*, 31(3), 307-327.
- Chou, R.K. (1988). Volatility Persistence and Stock Valuations: Some Empirical Evidence Using GARCH. *Journal of Applied Econometrics*, 3(4), 279-294.
- Engle, R.F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, 50(4), 987-1007.
- Engle, R.F. and Kroner, K.F. (1995). Multivariate Simultaneous Generalized ARCH. *Econometric Theory*, 11(1), 122-150.
- Hlalefang, M. and Ndlela, N. (2016). Modelling Inflation Volatility in South Africa Using GARCH Models. *International Journal of Economics and Financial Issues*, 6(1), 18-26.
- Karmakar, M. and Chaudhuri, K. (2013). Estimating Volatility of Inflation in India: A GARCH Approach. *International Journal of Economics and Financial Issues*, 3(3), 626-631.
- Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992). Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root. *Journal of Econometrics*, 54(1-3), 159-178.
- McLeod, A.I. and Hipel, K.W. (1981). Preservation of Higher-order Moments in ARMA Time Series Models by Recursive Residuals. *Journal of the American Statistical Association*, 76(374), 698-704.
- Moutinho, V. and Santinha, G. (2019). The Impact of Oil Price Volatility on Inflation Uncertainty in Angola. *Journal of Economic Studies*, 46(5), 1205-1219.
- Nguyen, T.T. and Nguyen, C.V. (2020). Estimating Inflation Volatility in Vietnam: A GARCH Approach. *Journal of Economics and Development*, 22(2), 135-152.
- Rukundo, E. (2017). Inflation Dynamics in Rwanda: An Empirical Analysis. *Journal of Economics and Sustainable Development*, 8(18), 1-16.
- Siti-Nabiha, A.K. and Ali, R.M. (2016). Modelling and Forecasting Inflation Volatility in Malaysia. *Jurnal Ekonomi Malaysia*, 50(1), 61-72.
- Tsay, R.S. (2010). *Analysis of Financial Time Series*, John Wiley & Sons.
- Zakoian, J.M. (1994). Threshold Heteroskedastic Models. *Journal of Economic Dynamics and Control*, 18(5), 931-955.



## Appendices

### Appendix A: Data Sources

The data used in this study were obtained from the National Institute of Statistics of Rwanda (NISR) and the Central Bank of Rwanda (BNR). The data cover the period from January 2000 to December 2022, and include monthly observations of the consumer price index (CPI), as well as other macroeconomic variables such as the exchange rate and money supply.

### Appendix B: Model Estimation

The GARCH (1,1) model was estimated using the maximum likelihood method. The model parameters were estimated using the rugarch package in R software. The model was tested for autocorrelation, stationarity, and normality of residuals. The results indicate that the model is a good fit for the data.

### Appendix C: Descriptive Statistics

<b>Table A1: Descriptive Statistics of Consumer Price Index (CPI) in Rwanda (2000-2022)</b>	
Statistics	CPI
Mean	2.77
Median	2.17
Maximum	27.1
Minimum	-2.11
Std. Dev.	5.12
Skewness	1.92
Kurtosis	9.74

The descriptive statistics of the CPI in Rwanda indicate that the mean inflation rate over the period is 2.77%, with a standard deviation of 5.12%. The data exhibit positive skewness and high kurtosis, indicating the presence of fat tails in the distribution.

### Appendix D: Augmented Dickey-Fuller (ADF) Test

<b>Table A2: Results of the ADF Test for CPI in Rwanda</b>			
Test Statistic	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)
-4.859***	-3.436	-2.864	-2.568

The ADF test results show that the CPI series is stationary at the 1% significance level, indicating that the series does not have a unit root and is suitable for time series analysis.

### Appendix E: Model Diagnostics

<b>Table A3: Model Diagnostics for GARCH (1,1) Model</b>	
Statistic	Value
Log Likelihood	-706.85
AIC	1421.69
BIC	1436.48
Ljung-Box $Q$ (10)	9.06
Jarque-Bera	122.42

The model diagnostics show that the GARCH (1,1) model fits the data well. The log-likelihood value is negative, and the AIC and BIC values are low, indicating that the model fits the data well. The Jarque-Bera statistic suggests that

Appendices (Cont.)

the residuals are regularly distributed, whereas the Ljung-Box  $Q$  statistic reveals no evidence of residual autocorrelation.

**Appendix F: Price Volatility Dynamics Time Series Data**

<b>Table A4</b>	
<b>Period</b>	<b>CPI</b>
Dec-21	135.3
Jan-22	138.7
Feb-22	143.3
Mar-22	147.3
Apr-22	152.8
May-22	156.0
Jun-22	157.9
Jul-22	162.2
Aug-22	164.0
Sep-22	169.1
Oct-22	178.7
Nov-22	180.9
Dec-22	178.1
Jan-23	181.9
Feb-23	186.7
Mar-23	193.0
Apr-23	196.2
May-23	190.9
Jun-23	190.1
Jul-23	190.2
Aug-23	192.5
Sep-23	200.3
Oct-23	201.8
Nov-23	198.0
<b>Dec-23</b>	<b>189.2</b>

The provided data reflects the Consumer Price Index (CPI) over the period from December 2021 to December 2023. It shows a trend of CPI increasing over this time frame, with fluctuations in some months. Notably, there is a rise in CPI around October 2022, followed by a decline in late 2022 and early 2023.

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