



Exchange and Interest Rate Volatility Effect on Economic Growth in Nigeria under various ARCH Model families: ARDL Approach

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Abstract

This study investigates the impact of exchange rate volatility and interest rate volatility on economic growth. The Autoregressive Distributed Lag (ARDL) cointegration techniques were used to conduct an empirical investigation from 1981 to 2021. The data for the period investigated were extracted from the statistical bulletin of the Central Bank of Nigeria, 2021. The study examined the impact of exchange rate and interest rate volatility on economic growth in Nigeria. To capture volatility, we proposed GARCH, (TGARCH), power autoregressive conditional heteroscedasticity (PARCH), and exponential-GARCH (EGARCH) models. GARCH (1, 1) and PARCH were discovered to have the best forecasting performance among all models. According to the findings, interest (IRV) and exchange (EXV) rate volatility have a significant negative impact on economic growth. It raised the level of risk and uncertainty in international transactions. Domestic credit to the private sector (DOM), trade openness (OPN), and gross fixed capital formation (GFC) was found to be statistically significant and promote the economic growth of Nigeria (GDP). This paper recommends that the federal government must pursue an exchange rate policy aimed primarily at stabilizing exchange rates. Also the monetary authorities adopt and implement policies that will stabilize interest rate fluctuations in the economy for boosting economic growth.

Keywords: Exchange Rate, Interest Rate, Volatility, Economic growth, ARDL

JEL Classification: E43, F31, F43

Contribution to/Originality Knowledge To the best of our knowledge, there is scant literature that has estimated the Exchange and interest rate volatility in Nigeria using ARIMA and GARCH models; however, the addition of the ARDL model in fulfilling the goals of this study.

1.0 Introduction

International trade is essential to the economic progress of any country with an open economy and promotes bilateral trade relationships between countries. Through international trade, the country's exchange rate becomes a critical measure of international trade competitiveness, which has a significant impact on the country's economy. Currency conversion is required for trade deals involving more than one country. Exchange rate policies are key economic indicators because their success directly impacts foreign trade performance, resulting in a reduction in trade deficits (World Bank, 2018).



Foreign exchange rates have fluctuated, especially since the disruption of the Bretton Woods system, which adopted the fixed exchange rate regime in 1973 (Fofanah, 2020). Since then, countries' exchange rate systems have shifted from fixed to floating. Because of less government intervention, the floating system causes the exchange rate to fluctuate more and increases its uncertainty (Umaru *et al.* 2018).

The natures of the fixed exchange rate system and the floating exchange rate system are distinct. In a fixed exchange rate system, government intervention is required to control the exchange rate, and good foreign reserves are also required to take good government intervention. The floating exchange rate system is unrestricted by government control and swings freely. Exchange rate instability is characterized by the appreciation or depreciation of the exchange rate. The movement of the exchange rate implies risk in terms of the magnitude of the changes in a currency (Cristina Terra, 2015). According to Garner (1986), one channel through which interest rate volatility affects economic performance and monetary policy decisions is through demand for money. A factor that raises the demand for money can have a negative impact on economic performance by raising nominal income and the velocity of money circulation (Arslan & Celikoz, 2011). Similarly, it is argued that it is possible and likely that uncertainty will increase demand for cash balances, resulting in reduced velocity Bahmani-Oskooee *et al.* (2013). This implies that as money demand rises, financial investors will be less inclined to hold securities. Prospective bond issuers will have an incentive to raise their bond interest rates.

Furthermore, interest rate volatility may have an impact on monetary policy because an increase in money demand caused by high volatility in interest rates may necessitate the central bank raising its target growth ranges for monetary aggregates (Garner, 1986). The high nominal interest rate causes the real exchange rate to overvalue, resulting in a loss of exports. The difference between the international and domestic interest rates attracts speculative capital, which most likely leads to exchange rate valuation (Sonaglio *et al.* 2016). The interest rate has become a financial market reference point, reflecting competitiveness (Bostan & Firtescu, 2019).

According to the National Bureau of Statistics NBS, Nigeria's foreign trade increased as imports increased significantly while exports increased marginally, resulting in an unfavourable trade balance in the third quarter of 2021. Nigeria is currently experiencing troubling macroeconomic variables, such as a rising poverty rate of more than 40%. In addition to double-digit inflation and deficit financing, the country's debt burdens have increased in the context of slow economic recovery, shrinking fiscal space, and weak resource mobilization. The countries' long-term deficits have become unsustainable, crowding out domestic savings and causing economic instability (Opoku-Afari, 2021; Osakwe & Verik, 2022).

According to the (Marshall Lerner, 1944) condition, higher exchange rate fluctuations impede trade, resulting in risk and uncertainty, which deters investor confidence. However, the majority of the empirical literature on the effects of exchange rate volatility and interest rate instability on economic growth is contradictory. Some empirical researchers (Aghion *et al.*,

2009, Anyanwuet *al*, 2017) contend that exchange rate volatility and interest rate volatility have a negative impact on the level of economic growth.

The current study intends to investigate the nature of volatility spillover and determine factors explaining the pattern of foreign exchange and interest rate volatility on economic growth using dynamic multivariate models such as GARCH family-data analyses, which have been lacking in previous studies in the country. Because increased volatility not only reduces output but also increases various aspects of inequality and poverty, understanding of volatility transmission and potential determinants is critical for political leaders and multinational corporations considering the diversification benefits of producing in the country. The objective of this paper is to provide empirical evidence on Exchange and interest Rate Volatility Effect on Economic Growth in Nigeria in both short and long-run using the Autoregressive Distributed Lag (ARDL) approach. The rest of the paper is structured as follows. Section 2 is the literature review, Section 3; data and methodology, Section 4 discusses the results and findings while Section 5 concludes the paper.

2.0 Literature Review

Empirical evidence on the impact of exchange rate volatility on growth is mixed; several studies have found significant adverse effects on growth. Other studies have found that exchange rate volatility have positively affected economic growth. This study focuses on the impact of exchange and interest rate volatility on growth with autoregressive conditional heteroskedasticity (ARCH) families and Autoregressive Distributed Lag (ARDL) model.

Bahmani-Oskooee and Gelan (2018) used the Autoregressive Distributed Lag (ARDL) model to investigate the effects of exchange rate risk on trade flows in the short and long run for twelve African countries from 1971Q1 to 2015Q4. When compared to other co-integration-based forecasting techniques, the ARDL method has advantages. Exchange rate volatility improves or degrades exports and imports, but the effect is more pronounced in the short run (Senadza&Diaba, 2018).

2.1 Empirical Review

The empirical literature on the effect of exchange rate volatility on economic growth is unresolved, and it is critical to review literature on the channels through which exchange rate volatility affects the real economy. The exchange rate has been shown in economic literature to be a significant component in determining both short and long-run macroeconomic growth and development objectives (Ehikioya, 2019; Alagidede& Ibrahim, 2017; Iyke&Odhiambo, 2014).

Tarawalie *et al*. (2012) investigate the effects of exchange rate volatility on output growth and inflation in the West African Monetary Zone (Ghana, The Gambia, Guinea, Liberia, Nigeria, and Sierra Leone). According to their findings, while exchange rate volatility is inflationary in all countries, its effect on output growth varies. Volatility and depreciation, in particular, have a negative impact on real GDP growth in Liberia and Sierra Leone, but have a marginally positive impact on output in the other countries. The differences in direction and



magnitude of effect are not surprising given the differences in macroeconomic conditions in each country.

According to Alagidede and Ibrahim (2017), exchange rate volatility is found to be detrimental to economic growth; however, this is only up to a point as growth-enhancing effect can also emanate from innovation, and more efficient resource allocation. Adeniyi and Olasunkanmi (2019) used ARDL model to investigate the impact of exchange rate volatility on Nigerian economic growth. The findings revealed that there is co-integration among the variables. The findings also revealed that export has a significant impact on GDP, whereas import is insignificant in both the short and long run. The study discovered an insignificant positive relationship between exchange rate volatility and Nigerian economic growth.

Sabina, Manyo, and Ugochukwu (2017), on the other hand, discovered a negative relationship between exchange rate volatility and economic growth in Nigeria. Manyo, and Ugochukwu (2017) used the Generalized Method of Moments (GMM) to estimate the impact of volatility on Nigerian economic growth, and the results show that volatility and FDI have a negative and significant impact on Nigerian economic growth. Government spending and external reserves have a positive and significant impact on Nigerian economic growth during the study period.

Odili (2015) used vector error correction model and time series data from 1971 to 2012 to examine the impact of real exchange rate volatility and economic growth on Nigerian exports and imports. The study discovered that exchange rate volatility, real exchange rates, real foreign income, real gross domestic product, terms of trade, and exchange rate policy switch influenced Nigeria's trade flows in both the short and long run. The findings also show that exchange rate volatility reduced trade flows in the long run. Ahiabor and Amoah (2019) examined the effect of real effective exchange rate volatility on economic growth in Ghana using the Fully Modified Ordinary Least Squares (FMOLS) model on annual time series data from 1980 to 2015. According to the regression results, real effective exchange rate volatility has a negative and statistically significant effect on Ghanaian economic growth. Furthermore, they estimated models with both traditional control variables and a novel measure of financial market fragility and obtained consistent results.

Using data from Sub-Saharan African (SSA) countries, this study investigates the relationship between financial deepening, interest rate spread, and economic growth. The findings show that, while financial deepening stimulates growth, interest rate spreads have a negative impact on growth in the countries studied. Jalloh and Guevera, (2017). Harswari and Hamza (2017) investigated the impact of interest rates on the economies of selected countries. This study's target population is 48 countries, and the sample of 20 companies was chosen using a convenient sampling technique. The findings indicated that interest rates had a negative and statistically significant impact on GDP in Asian countries.

Exchange rate volatility is caused by changes in macroeconomic factors and the dynamic nature of the business environment Anyanwu *et al.*, (2017). Real options theory, interest rate parity theory, purchasing power parity theory, traditional flow theory, and other theories

explain the up-and-down movement of the exchange rate. Thus, the volatility of the exchange rate as an indicator of uncertainty explains the decision-making behaviour of investors. Firms that decide to increase their investments find stable exchange rates more attractive.

3.0 Methodology

Another variant of the GARCH model is the exponential general autoregressive conditional heteroskedastic (EGARCH). Nelson (1991) proposed the EGARCH model to address the shortcomings of GARCH's handling of financial time series. Allowing for asymmetric effects between positive and negative asset returns, in particular. For this conditional heteroskedasticity, the Exponential GARCH (EGARCH) model takes on a specific parametric form. The EGARCH model, like the GARCH model, captures other stylized facts in financial time series, such as volatility clustering, in addition to leptokurtic returns. If volatility was high at time $t-1$, it is more likely to be high at time $t-2$. Another way to look at this is to consider how a shock at time $t-1$ affects the variance at time t . The EGARCH model does not require any parameter restrictions because the equation is based on log variance rather than variance itself, the positivity of the variance is automatically satisfied, which is the main advantage of the EGARCH model. In general, no-restrictions likelihood maximization results in faster and more reliable optimizations.

ARDL was not mentioned here but was specified and estimated as the method of estimation, this need to be corrected.

3.1 Data and Source.

The study relies on the Obstfeld and Rogoff (1998) theory on uncertainty about exchange rates and the nominal interest rate volatility that monetary policies pursued by the government, which causes the home currency to appreciate, at detrimental to the domestic economy. Based on this model, exchange rate and interest rate volatility is the key determinant of economic growth and other variables. Therefore, the study has adopted and modified the work of Bahmani-Oskooee and Gelan (2018) to allow for the inclusion of the control variable. The ARDL model specification is expressed as an unrestricted error correction model (UECM) by Pesaran et al. (2001) to test for cointegration between the variables under study as in Equation [1]

$$\begin{aligned} \Delta \ln GDP_t = & \delta_0 + \delta_1 \ln GDP_{t-1} + \delta_2 \ln DOM_{t-1} + \delta_3 GFC_{t-1} \\ & + \delta_4 \ln EXV_{t-1} + \delta_5 \ln IRV_{t-1} + \delta_6 \ln OPN_{t-1} + \sum_{i=0}^q \phi_1 \Delta \ln GDP_{t-i} \\ & + \sum_{i=0}^q \phi_2 \Delta \ln DOM_{t-i} + \sum_{i=0}^q \phi_3 \Delta \ln GFC_{t-i} + \sum_{i=0}^q \phi_4 \Delta \ln EXV_{t-i} \\ & + \sum_{i=0}^q \phi_5 \Delta \ln IRV_{t-i} + \sum_{i=0}^q \phi_6 \Delta \ln OPN_{t-i} + ECM_{t-1} + \mu_t \end{aligned} \quad (1)$$

where; C_0 is Constant term, $\delta_1, \delta_2, \delta_3, \dots, \delta_6$ represent Short-run dynamic coefficients of the respective variables, $\phi_1, \phi_2, \dots, \phi_6$ stand for long-run coefficients to be estimated, ECM is the Error correction term which measures the speed of adjustment, μ_t is Error term, t is Time



trend which consists of years spanning from 1981 to 2021, i is Lag indicator, and Δ means The first difference operator respectively.

Table 1: Description of the variables and A-priori expectation

S/n	Variables	Notation	Measurement	A-Priori- expectation
1	Economic growth	GDP	Year-on-year growth rate of real gross domestic product.	Dependent variable
2	Exchange rate volatility	EXV	Nominal exchange rate use GARCH model	-
3	Domestic credit to private sector	DOM	Credit to private sector as a proportion of nominal GDP	+
4	Trade openness	OPEN	(exports + imports)/GDP	+
5	Gross fixed capital	GFC	Gross net investment less disposals in fixed assets	+
6	Interest rate volatility	INV	Nominal interest rate using PARCH	-

Source: Author's compilation (2022)

4.0 Results/ Findings and Discussion

4.1 Descriptive Statistics

The descriptive statistics for the variables of interest are shown in Table 2. The average GDP growth rate is 1.2%, with a maximum of 2.7%. Skewness results show that domestic credit and foreign exchange volatility are positively skewed, while other model variables are negatively skewed. The results also revealed that all of the variables have a Kurtosis value greater than one. The descriptive statistics, on the other hand, show that INV has the highest variability among other variables, with a standard deviation of 2.9428, which is greater than the standard deviation of the remaining variables in the model.

Table 2; Descriptive statistics

	DOM	EXV	GDP	GFC	INV	OPN
Mean	2.1565	0.0662	1.1759	1.8382	-0.2862	3.3763
Median	2.1003	-0.0241	1.6126	1.9859	0.2902	3.5271
Maximum	2.9768	1.3426	2.7298	3.6985	2.4067	3.9755
Minimum	1.6009	-0.1563	-2.7978	-1.5196	-16.7171	2.2122
Std. Dev.	0.3527	0.2877	1.2497	1.1261	2.9428	0.4937
Skewness	0.5045	2.8210	-1.6510	-0.8571	-4.5896	-1.1048
Kurtosis	2.4850	11.7010	5.7064	3.7197	26.3239	3.2198
Jarque-Bera	2.0852	174.7526	29.6195	5.6169	1020.9200	8.0128
Probability	0.3525	0.0000	0.0000	0.0603	0.0000	0.0182

Source: Author's compilation (2022)

Table 3 shows the correlation between independent variables, and the results show that all coefficients are less than the 0.8 threshold, indicating that there is no problem with variable

multicollinearity. The relationship between currency and interest rate volatility and economic growth was inverse.

Table 3: *Correlation matrix.*

Variables	GDP	EXV	GFC	INF	INV	OPN	DOM
GDP	1.00000						
EXV	-0.02238	1.00000					
GFC	0.47641	-0.00875	1.00000				
INV	-0.11294	0.38260	0.04572	-0.02877	1.00000		
OPN	0.49908	-0.26054	0.22837	-0.05646	-0.08637	1.00000	
DOM	0.28312	-0.18736	0.13169	-0.31296	-0.03462	0.23764	1.00000

Source: Author's compilation (2022)

Table 4 shows that two variables are integrated at order one, while the remaining variables are stationary at level. This condition necessitates the use of ARDL methods that can accommodate series that are either I(1) or I(0) processes, or a combination of both.

Augmented Dickey-Fuller (ADF) Phillip Perron (PP)

Table4: *Unit Root test results*

Variable	Level	1 st Diff.	Remarks	Level	1 st Diff.	Remarks
DOM	-2.246259	-5.827536	1(1)	-1.638428	-7.698895	1(1)
EXV	-5.304640	-9.410262	1(0)	-5.304640	-13.38869	1(0)
GDP	-3.020806	-10.07167	1(0)	-4.081936	-10.40261	1(0)
GFC	-5.490811	-6.239646	1(0)	-6.149975	-13.64992	1(0)
INV	-6.843991	-10.84790	1(0)	-6.843585	-14.79355	1(0)
OPN	-2.341314	-7.540400	1(1)	-2.252801	8.189579	1(1)

Source: Author's compilation (2022)

Stationarity tests are required to prevent spurious regression and to ensure that no variable is integrated into order two. The tests were based on augmented Dickey-Fuller and Phillip Perron tests that were selected automatically using the Akaike information criterion (AIC). The results confirm the ARDL-bound test's suitability for co-integration.

Table 5: *VAR Lag order Selection Criteria*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-238.7037	NA	0.022372	13.22723	13.48846	13.31932
1	-169.6603	111.9623*	0.003855*	12.44110	13.26971*	12.08577*
2	-147.0525	29.32905	0.009329	11.16500*	15.56099	13.36224
3	-108.1013	37.89847	0.012600	12.00547	16.96884	13.75529

AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn criterion

Source: Author's compilation using E-views 10 (2022)



The Akaike information method is used to find the optimal lag length, and the lowest configuration (AIC) is chosen, which Lag 2 is. The results are shown in Table 4.

Table 6: *ARDL Bound Test of Cointegration Results*

Test Statistic	Value	K
F-statistic	8.234667	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Source: Author's compilation (2022)

Table 6 shows that long-run relationships exist among the variables of the study because the F-Statistic (8.234667) is greater than the lower I (0) and upper I (1) bounds of the critical values at 5% critical value.

Table 7: *ARDL Cointegrating and Short Run Form*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DOM)	-1.487558	0.985383	-1.509623	0.1476
D(DOM(-1))	-1.697820	1.065212	-1.593881	0.1275
D(DOM(-2))	1.804035	0.811336	2.223535	0.0385
D(EXV)	-0.408214	0.587073	-0.695338	0.4953
D(EXV(-1))	1.633531	0.650976	2.509358	0.0213
D(EXV(-2))	1.304839	0.565738	2.306437	0.0325
D(GFC)	-0.334719	0.134471	-2.489161	0.0222
D(INV)	-0.367142	0.292415	-1.255553	0.2245
D(INV)	1.420269	0.370183	3.836666	0.0011
D(INV)	1.061628	0.338633	3.135037	0.0055
D(OPN)	0.855763	0.592913	1.443319	0.1652
CointEq(-1)	-1.455069	0.127385	-11.422596	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOM	2.435769	0.513462	4.743814	0.0001
EXV	-4.191737	0.892433	-4.696977	0.0002
GFC	0.230037	0.096720	2.378381	0.0280
INV	-2.127481	0.271075	-7.848308	0.0000
OPN	1.328312	0.238149	5.577662	0.0000
C	8.234848	1.714832	4.802130	0.0001

Source: Author's compilation (2022)

R-Square	0.843637	Adjusted R-square	0.711963	F- Statistics	6.407003
Durbin Waston Stat	1.98109			Prob. (F-statistic)	0.000114

Table 7 shows that exchange rate volatility has a significant positive effect on economic growth in Nigeria from 1981 to 2021 in the short run, which corroborated Adeniyi and Olanekanmi (2019). However, exchange rate volatility has a significant negative impact on economic growth in the long run. The findings concerning the inverse relationship between exchange rate volatility and economic growth are consistent with previous theories and empirical studies (Ahiabor&Amoah, 2019). Domestic credit has a negative effect on economic growth that is statistically significant over time. The fact that increasing domestic credit can be costly for economic growth explains this effect.

After one period, it was discovered that the short-run impact of the exchange rate on economic growth is significant, which was corroborated by the findings of Haoudi and Rabhi (2020). Trade openness is positive and statistically significant in both the short and long run, and it boosts economic growth, according to previous research by Feruni and Hysa (2020), and Mundell (1963). The level of international trade determines a country's economic performance. According to foreign economic theories, trade openness promotes economic growth. The expansion of international trade encourages capital formation and accelerates technological progress, which increases factor productivity (Romer 1986; Rodrik 1988).

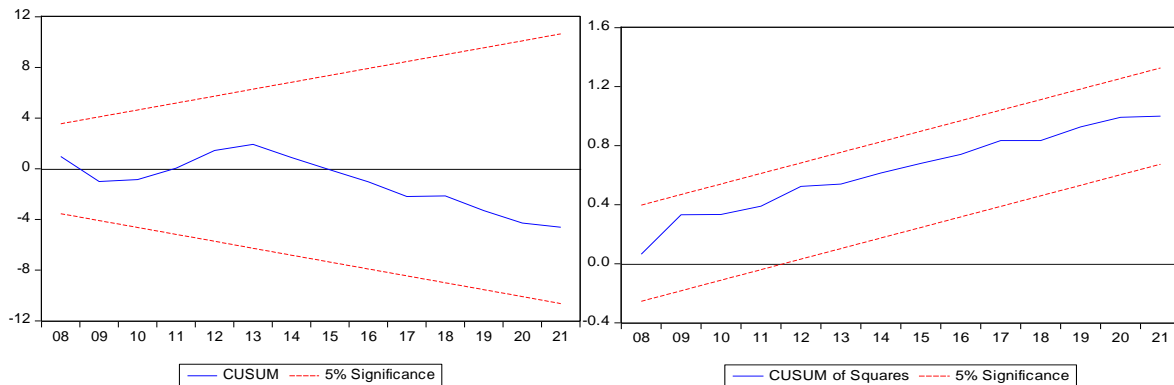
The coefficients of gross fixed capital, domestic credit, and trade openness have a significant positive effect on economic growth in the long run. The coefficient of gross fixed capital is significant at 5%, while the other long-run model coefficients are significant at 1%. Capital in this model had the predicted effect based on previous research explained by works such as the Solow model explained in Gärtner (2016). In the regression, it was statistically significant and had a positive impact on economic growth. The coefficient of interest and exchange rate volatility has a significant negative effect on economic growth. Free capital movement contributes to an increase in exchange rate volatility, which has a negative impact on economic growth. It means that economic operators operating in such a macroeconomic environment may be afraid of the uncertainty surrounding the evolution of future exchange rates and may choose to postpone trade and investment operations, which may be detrimental to economic growth.

The error correction model's coefficient is negative and statistically significant. This demonstrates that in the long run, the variables adjust towards equilibrium. For autocorrelation, the Lagrange Multiplier (LM) test was used, and for specification error, the Ramsey RESET test was used. Both prob values are greater than 0.05, indicating that there is no autocorrelation and no specification error in the model. The size of the adjusted R^2 also demonstrates an excellent fit of the model.

To determine the stability of the model and the estimated parameters, the cumulative sum of Residual Test (CUSUM) and Cumulative Sum of Squares of Residual Test (CUSUMSQ)



were conducted on the model and shown in (Figure 1). The CUSUM depicts that the model and the estimated parameters are largely stable. Closer scrutiny of the CUSUMSQ also shows that the model and the estimated parameters are stable given that the graph moves within the 0.05 critical values.



Source: Author's compilation (2022)

Figure 1: Cumulative Sum of Residual Test & Cumulative Sum of Squares of Residual Test

5.0 Conclusion and Policy Recommendations

Using the Autoregressive Distributed Lag (ARDL) Model, this study examined the impact of exchange rate and interest rate volatility on economic growth in Nigeria between 1981 and 2021. Estimated results show that nominal exchange and interest rate volatility has a negative and statistically significant impact on Nigerian economic growth. Domestic credit and trade openness have a significant positive effect on economic growth in the long run; interest and exchange rate volatility have a significant negative effect on economic growth. Interest and exchange rate volatility increased the risk and uncertainty in international transactions, reducing foreign trade and growth. Because of the production structure's reliance on imported inputs, production and growth rates fell during periods of high volatility.

As a result, exchange rate stability is the primary source of economic growth, and the country's monetary authorities and government must pay attention to exchange rates by implementing an exchange rate policy that leads to stable exchange rates. Given the significance of international trade and investment in the process of economic growth, government must pursue an exchange rate policy aimed primarily at stabilizing exchange rates. A relatively stable and predictable exchange rate appears to be critical for boosting economic growth.

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