EXCHANGE RATE GAP AND MACROECONOMIC INSTABILITY IN BRICS COUNTRIES

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Abstract

The research examined the impact of the exchange rate differential on the level of inflation among BRICS countries using daily series from January 1, 2000 to August 30, 2024. The variable of FDI flows was included in the model as a control. The study adopted Markov Switching regression and quantile regression analysis. Results from the study revealed that at regimes 1 and 2, using Markov Switching technique, exchange rate gap revealed significant impact inflation. The result further revealed that in all the countries with the exception of INDIA, witnessed positive and significant relationship existing between exchange rate gap and inflation rate especially in regime 1. This result varies for the five countries in regime 2. The quantile regression results revealed similar trends in the quantile movement and effects from the 10^{th} through 90^{th} quantile and these effects were largely significant. The greater part of the analysis shows a rising divergence between the official and the parallel market exchange rates which stimulated inflation rate in Russia, India, Brazil, and South Africa. Only in China we had negative and significant inflation effects of exchange rate gap throughout the quantile periods. By inferences, it follows that the gap between the official exchange rate and the parallel exchange rate in China is very small and this connects to a high level of macroeconomic policy stability which in turn added up to crowd in FDI flows to China from the 10th through the 90th quantiles. The policy import of the analysis is that governments of Russia, India, Brazil, and South Africa ought to administratively close the gap between the official and parallel market exchange rates through a strategic policy intervention in the foreign exchange market that minimizes the parallel exchange rate. This is advocated to achieve macroeconomic stability in BRICS.

Keywords: Exchange rate gap, inflation, Markov-switching regression, quintile regression, BRICS

JEL Classification: G23, D20, A42

1. INTRODUCTION

The exchange rate gap refers to the difference between the official exchange rate and the effective exchange rate, which considers various factors such as inflation and trade balances. Fluctuations in the exchange rate can significantly influence a nation's economic performance, affecting trade, inflation, and overall economic stability. When there is deviation of the official exchange rate over a period of time from the benchmark rate, it indicates exchange rate misalignment (Kalu & Anyanwaokoro, 2020). Problem arises when the sharp contrast between the official exchange rate and the parallel market rate is adjudged to have double effect on the economy. While some scholars have stated that such rates will make the economy thrive in the face of increasing demand for foreign exchange, others have stated that it has the tends to give the currency rate an unrealistic value as unhealthy speculations tends to make the currencies have unrealistic face value in an economy. The depletion of the foreign reserves of a country is part of the problems that will emanate from such gaps, while also making planning rather difficult to exercise due to significant gaps existing among the various rates.

While a depreciating currency can boost exports and potentially stimulate economic activity, it may also lead to higher inflation. Conversely, a strengthening currency may contribute to price stability but may pose challenges for export-led growth. The objective of this study is to evaluate how the difference/variation between the official exchange rate and the parallel market rate affect inflation rate among BRICS countries**.** The rate of inflation in Brazil is branded by high volatility. At an average of over 5%, it is persistently high. Brazil's annual inflation rate stood at 4.62% in 2023. In February 2024, it became 4.5%, the lowest since July 2023 but still beat market expectations of a slowdown. Specifically, consumer prices accelerated from January's seasonally adjusted 0.42% to 0.83% in February, 2024 (World Bank, 2024). Wage indexation is one of the combined factors responsible for higher inflation level in Brazil. In March 2024, the annual inflation rate in Russia was reported as 7.7%. This follows an 8.3% rise, 8.1% rise, 6.7% rise in the prices of services, food, and non-food products, respectively. In India, the yearly retail inflation rate stood at 4.85% in March 2024 compared to 5.09% of February 2024, having forecasted the inflation rate to be 4.91%. Russia has the highest level of inflation and this is attributed to the financial crisis of 2008, and after 2014 when its economy was affected by the fall in global oil prices. Of course, the sanctions imposed on the Russian government for the annexation of Crimea is not left out. The relative share of the output growth of India to global GDP has shrunk and this has drastically reduced the size her economy compared to that of China (Kennedy, 2016). In February 2024, the retail inflation rate of India plummeted to 5.09% (National Statistics Office, 2024). In effect, the current inflation rate India lies within the tolerance band of 2 to 6% fixed by the Reserve Bank of India (RBI). China has generally had the most stable inflation rate of the BRICS amongst the BRICS nations, with yearly change fluctuating between -1 and 6% (World Bank, 2024). The 2022 average inflation rate was reported to be 2.0% in ten years. In 2023, the average yearly inflation rate in China ranged at around 0.2% compared to 2022 figure. The

growth and development of China's economy has been persistent over a long-time period (Bishop, 2016). China's GDP is more than twofold that of the other four BRICS pooled. It is almost $18 trillion, which is equivalent to $400 billion for South Africa, $1.8 trillion for Russia, $3.2 trillion for India, and $1.6 trillion for Brazil. In South Africa, the 2022 ten-year average inflation rate was 6.9%. In March 2024, the annual inflation rate of South Africa dropped to 5.3% from a four-month high of 5.6% in February 2024. On a monthly basis, the CPI in South Africa rose by 0.8% in March, afterwards a 1% increase in February 2024.

Analyzing the historical data of exchange rate gaps and the level of inflation as a measure of macroeconomic stability in BRICS nations can provide valuable insights into these dynamics. The exchange rate gap has far-reaching implications for the macroeconomic performance of BRICS nations. By examining its impact on trade balances, inflation, FDI flows, and economic growth, policymakers can gain a comprehensive understanding of the challenges and opportunities posed by exchange rate fluctuations. As these countries continue to shape the global economic landscape, addressing the complexities of exchange rate dynamics will be crucial for sustaining stable and resilient economies within the BRICS bloc. As these countries navigate the complexities of international trade and finance, one crucial aspect that demands attention is the exchange rate gap and its impact on various macroeconomic indicators. A depreciated currency makes exports more competitive in international markets, potentially boosting a nation's exports. Conversely, a strengthening currency may make imports cheaper but can pose challenges for domestic industries. Analyzing the exchange rate gap's impact on trade balances provides insights into how BRICS nations manage their international trade dynamics. A depreciating currency often leads to higher import costs, contributing to inflation. On the other hand, a strengthening currency may help contain inflation but could pose challenges for export-oriented industries. Understanding the link between the exchange rate gap and inflation rates, and FDI is crucial for policymakers seeking to maintain price stability.

2. LITERATURE REVIEW

Empirically, various scholars have examined the effects of variations in the exchange rate on foreign trade, economy, and other macroeconomic variables Umoru & Oseni (2023), Umoru, et al. (2023) examined fluctuations in daily exchange rate returns, Umoru, Effiong, Umar, Okpara, Iyaji, Oyegun, Iyayi, & Abere (2023) investigated exchange rate volatility and their effects on the overall economy, Ogadi, Amakor & Anyanwu (2023), Kayani, Aysan, Gul, Haider & Ahmad (2023), Fasanya & Akinwale (2022), Velic (2022), Kanu & Nwadiubu (2020), Kalu & Anyanwaokoro (2020) etc. Jelilov et al. (2020) employed a VAR model to investigate current concerns regarding the currency rate and the economic growth of Nigeria. They found that the rise in output and the exchange rate were correlated only in one way. Additionally, Oseni et al. (2021) used monthly data from 1986 through 2017 to assess the link between exchange rate volatility and growth in

Nigeria's industrial production. They confirmed that exchange rate volatility hinders Nigeria's production growth using the EGARCH and ARDL models.

Jibrin et al. (2019) study looked at how changes in exchange rates affected the GDP and other macroeconomic ECOWAS aggregates. For a sample of nine (9) West African nations, the study period ran from 1990 to 2018. Burkina Faso, Ghana, Guinea, Guinea Bissau, Liberia, Sierra Leone, Benin Republic, and Cape Verde were among the nine (9) nations. The findings indicated that the exchange rate significantly affected the GDP of Benin, Guinea Bissau, Liberia, and Brini. Jemmali & Farroukh (2020) did a cross-sectional research for MENA. Due to price subsidies, they saw a little adjustment in the CPI in the studied nations in response to the shock to the price of oil. Long-term real exchange rates for oil-importing countries like Morocco and Tunisia were impacted by such shocks. The authors emphasized that the presence of price subsidies in these nations absorbed the inflationary pressure brought on by the shock to oil prices. Therefore, a shock to the price of oil does not result in increased domestic prices. Aziz (2021) examined the impact of fluctuating currency rates on Nigeria's macroeconomic performance based on secondary data between 1986 and 2020. The variables comprised the following: Oil Revenue (OREV), Balance of Payment (BOP), Exchange Rate (EXR), and Real GDP as the dependent variable. It used Johansen co-integration and Ordinary Least Square (OLS) to evaluate for the long- and short-term impacts, respectively. The findings showed that whereas BOP had a negative relationship with GDP, EXR and OREV had positive relationships with GDP.

Jakpa, Ezi, and Egbon (2024) deployed the ARDL method and found that exchange rate pass-through had a positive and substantial effect on inflation in Nigeria. Based on this outcome, the study suggests that monetary authorities should exercise caution when using the devaluation of the domestic currency to promote economic growth. According to Kemoe, Mbohou, Mighri, and Quayyum (2024), exchange rate depreciations were the basis for sizable escalations in inflation in the SSA region. In addition, the authors established that exchange rate pass-through was more persistent for enormous depreciation shocks, while the asymmetric effect of pass-through was eight times stronger for the duration of currency depreciations.

With a structural vector auto-regression model, Abdullahi (2023) found a low and incomplete influence of exchange rate pass-through on inflation in Nigeria. Valogo, Duodu, Yusif, and Baidoo (2023) utilized the threshold autoregressive (TAR) method and shown that depreciation of the exchange rate exceeding a monthly threshold of 0.70% significantly and positively impacted inflation in the ERPT pass-through model. The authors also found that, notwithstanding the threshold level of 0.51%, the exchange rate positively induced the monetary policy rate with considerable momentum in the monetary policy rule model. With a VECM, Nuhu (2021) obtained a positive and significant impact of the nominal exchange rate on inflation in Nigeria. Aisen et al. (2021) and Ha et al. (2019) reported that exchange rate pass-through was higher on average in SSA countries than in advanced countries.

Mensah, Mensah, and Danquah (2024) obtained two different thresholds of inflation in the growth-FDI nexus. These include 7.26 percent and 16.49 percent. According to the authors, when inflation falls below the threshold level of 7.26%, FDI substantially contributes to economic growth in SSA countries, while if inflation exceeds 16.49%, the size of the favourable impact of FDI on economic growth falls. In related research, Bénétrix et al. (2023) reported that the relationship between FDI and GDP growth rate is not stable over time. According to Arestis et al. (2023), the endogenous growth model explains FDI spillover to local firms, which, according to Rao et al. (2023), leads to a favourable influence on productivity and growth. On their part, Bénétrix, Pallan, and Panizza (2023) did not find any considerable relationship between inflation and FDI inflows in China. Using the VECM, Muhammad (2020) reported that the exchange rate and FDI have a significantly positive relationship in the long-run and short-run. Hong & Ali (2020), deploying the VECM, found a negative nexus between the inflation rate and foreign direct investment in Malaysia and Iran.

3. METHODOLOGY

The theoretical methodology of this study is anchored on the structuralism theory. According to structuralists, inflation in emerging countries can be explained by structural rigidities rather than merely an increase in the money supply. According to theory, the existence of fiscal budgetary constraints, and the depletion of foreign exchange are the main factors influencing inflation in developing nations. The model for the study is as follows:

$$BRINF = \alpha_1 + \alpha_2 BREXRGAP + \alpha_3 BRFDI \quad (1)$$

$$RUSINF = \alpha_1 + \alpha_2 RUSEXRGAP + \alpha_3 RUSFDI \quad (2)$$

$$INDINF = \alpha_1 + \alpha_2 INDEXRGAP + \alpha_3 INDFDI \quad (3)$$

$$CHINF = \alpha_1 + \alpha_2 CHEXRGAP + \alpha_3 CHFDI \quad (4)$$

$$SOUAINF = \alpha_1 + \alpha_2 SOUAEXRGAP + \alpha_3 SOUAFDI \quad (5)$$

where *BRINF, RUSINF, INDINF, CHINF, SOUAINF* are the inflation rate of Brazil, Russia, Indian, China, and South Africa, *BREXRGAP, RUSEXRGAP, INDEXRGAP, CHEXRGAP, SOUAEXRGAP* are the exchange rate gap of Brazil, Russia, Indian, China, and South Africa, *BRFDI, RUSFDI, INDFDI, CHFDI, SOUAFDI* are the *FDI* of Brazil, Russia, Indian, China, and South Africa. The quantile regression method is implemented in this study. A quantile regression estimates, and conduct inference about conditional quantile function. The predictor quantile regression models ($k = 1$) of the form:

$$\varphi_\tau(Q_{t+1}|Z_{it}) = \vartheta_i^{(\pi)} + \alpha_i^{(\pi)} Z_{it} \quad (6)$$

According to equation (6), the intercept and the regression coefficients depend on q, and Z is the vector of predictor indicators and this include, *EXRGAP* and *FDI*. the quantile representation of the model is formulated in equations (7) to (11).

$$BRINF\tau = \vartheta_0^{(\pi)} + \vartheta_1^{(\pi)} RUSEXRGAP_{it} + \vartheta_2^{(\pi)} BRFDI_{it} + e_{it}, \;\; i = 1, \cdots, K \quad (7)$$

$$RUSINF\tau = \vartheta_0^{(\pi)} + \vartheta_1^{(\pi)} EXRGAP_{it} + \vartheta_2^{(\pi)} RUSFDI_{it} + e_{it}, \;\; i = 1, \cdots, K \quad (8)$$

$$INDINF\tau = \vartheta_0^{(\pi)} + \vartheta_1^{(\pi)} INDEXRGAP_{it} + \vartheta_2^{(\pi)} INDFDI_{it} + e_{it}, \;\; i = 1, \cdots, K \quad (9)$$

$$CHINF\tau = \vartheta_0^{(\pi)} + \vartheta_1^{(\pi)} CHEXRGAP_{it} + \vartheta_2^{(\pi)} CHFDI_{it} + e_{it}, \;\; i = 1, \cdots, K \quad (10)$$

$$SOUAINF\tau = \vartheta_0^{(\pi)} + \vartheta_1^{(\pi)} SOUAEXRGAP_{it} + \vartheta_2^{(\pi)} SOUAFDI_{it} + e_{it}, \;\; i = 1, \cdots, K \quad (11)$$

The values of the coefficient vector denoted as $\vartheta_i^{(\pi)}$ vary across the different quantiles of inflation and it reveals the effect of exchange rate volatility and FDI. The coefficient vectors were estimated through the minimization of the following sum loss function:

$$\sum_{i=0}^{T} \omega_\pi (Q_{t+1} . \vartheta_i^{(\pi)} . \vartheta_i^{(\pi)} EXRGAP, FDI_{it}) \quad (12)$$

The associated loss function for equation (3) is given in equation (4) as follows:

$$\omega_\pi(.) = u\big(\pi \cdot I(\mathrm{q} < 0)\big) = 0.5[|q| + (2\pi \cdot 1)q] \quad (13)$$

In the symmetric estimation of the loss function, the median quantile regression coefficient was estimated. However, with an asymmetric Laplace error distribution, the coefficient vector was obtained through the minimization of the asymmetric loss function using the ML estimator of $\sigma^{(\pi)}$ given in equation (5):

$$\hat{\sigma}^{(\pi)} = \frac{1}{T} \sum_{i=0}^{T} \omega_\pi \left(Q_{t+1} \cdot \vartheta_i^{(\pi)} \cdot \vartheta_i^{(\pi)} EXRGAP, FDI_{it} \right) \quad (14)$$

The Markov-Regime switching empirical equations for inflation rate in BRICS countries are specified in equations (6) through (10) respectively.

$$BRINF_j = \omega_0 + \sum A_1 + \varphi_2 log_1(Sigma) + \omega_1 BREXRGAP + \sum A_2 + log_1(Sigma) + \omega_2 BRFDI + \sum A_n + \varphi_3 log_n(Sigma) + e_{it} \quad (15)$$

$$RUSINF_j = \omega_0 + \sum A_1 + \varphi_2 log_1(Sigma) + \omega_1 RUSEXRGAP + \sum A_2 + \varphi_2 log_1(Sigma) + \omega_2 RUSFDI + \sum A_n + \varphi_3 log_n(Sigma) + e_{it} \quad (16)$$

$$INDINF_j = \omega_0 + \sum A_1 + \varphi_2 log_1(Sigma) + \omega_1 INDEXRGAP + \sum A_2 + \varphi_2 log_1(Sigma) + \omega_2 INDFDI + \sum A_n + \varphi_3 log_n(Sigma) + e_{it} \quad (17)$$

$$CHIINF_j = \omega_0 + \sum A_1 + log_1(Sigma) + \omega_1 CHIEXRGAP + \sum A_2 + \varphi_2 log_1(Sigma) + \omega_2 CHIFDI + \sum A_n + \varphi_3 log_n(Sigma) + e_{it} \quad (18)$$

$$SOUINF_j = \omega_0 + \sum A_1 + log_1(Sigma) + \omega_1 SOUEXRGAP + \sum A_2 + \varphi_2 log_1(Sigma) + \omega_2 SOUFDI + \sum A_n + \varphi_3 log_n(Sigma) + e_{it} \quad (19)$$

where: INF is the dependent variable (inflation) which measures macroeconomic instability of individual countries *j*, $\sum A_1$, $\sum A_2$ and $\sum A_n$ are the autoregressive terms which are most often described as the sum of non-switching regressors in regimes 1,

2 and n that may be included in the equation, ω_1, ω_2, and ω_n are the constant coefficients of each regression, $Log_1(Sigma)$, $Log_2(Sigma)$ and $Log_n(Sigma)$ are the volatility coefficients of regime 1, 2 to regime n, and e_{it} is the error term of the individual regimes.

This study used daily dataset for the 5 countries making up the BRICS from 2000 to 2023. The econometric view package (E-view version 13) was used to analyze data. The study employed daily time series data for the period of 36months. The time coverage of the investigation was from January 1, 2000 to August 30, 2024. Data on daily official and parallel exchange rates, inflation rate and FDI were sourced from the database of the World Bank. The exchange rate gap was calculated as the difference between the official and the parallel market rates. The choice of years is based on availability of data.

4. RESULT AND DISCUSSION

The descriptive data shown in Table 1 indicate that the average inflation rate, exchange rate difference, and FDI for Brazil, Russia, India, China, and South Africa are 7898.75, 0.392, 3.282, 9343.24, 5.807, 1.968, 1314.5, 6.827, 1.648, 5723, 0.923, 2.879, 6129, 1.37 and 1.797 respectively It is a clear indication, that the inflation rate within the BRICS equally varies largely from continents. Almost all the variables adopted are normally distributed with the exception of RUSEXRGAP and SOUAINF.

Table 1: *Descriptive statistics of variables*

Statistics	BRAINF	BRAEXRGRAP	BRAFDI	RUSINF	RUSEXRGAP	RUSFDI	INDINF
Mean	7898.749	0.392729	3.28238	9343.44	5.807417	1.9684	1314.496
Median	8680.736	0.307748	3.34	10194.44	3.84	2.03	1434.018
Maximum	13200.56	1.07888	5.02	15974.62	14.73087	4.5	2410.88
Minimum	2824.715	0.097353	1.73	1771.594	1.28	-1.7873	442.034
Std. Dev.	3149.844	0.274019	0.90023	4380.002	1.884.209229	1.37314	600.9814
Skewness	-0.138814	1.165526	-0.1763	-0.316925	0.987241	-0.44	0.050257
Kurtosis	1.971222	3.442944	2.39676	1.999112	2.558833	3.66622	1.81401
Jarque-Bera	397.4587	1970.736	170.874	491.2992	1432.794	426.391	495.8951
Probability	0.2555	0.85211	0.1254	0.7751	0.0251	0.8522	0.7214
Sum	66357389	3299.318	27575.3	78492596	48788.11	16536.5	11043083
Sum Sq. Dev	8.33E+10	630.7241	6807.45	1.61E+11	148827.9	15838.4	3030000000

Source: *Authors' estimations (2024)*

Table 2 *Cont.: Descriptive statistics of variables*

Statistic	INDEXRGAP	INDFDI	CHIINF	CHIEXRGAP	CHIFDI	SOUINF	SOUEXRGAP	SOUFDI
Mean	6.827211	1.64847	5723.525	0.923772	2.87953	6129.595	1.378352	1.79795
Median	5.21	1.55822	5614.386	0.83	3.03986	6444.187	1.085266	1.14631.0866

Maximum	15.7209	3.62	12720.22	1.66	4.55	2708.423	3.271171	9.67795
Minimum	3.521017	0.61	959.3604	0.345038	1.0029	1564.789	0.338577	0.20513
Std. Dev.	3.956015	0.67605	3802.653	0.42949	1.08118	-0.785399	0.885649	2.02215
Skewness	1.277536	0.8482	0.293149	0.189881	-0.1513	3.05025	0.885325	2.71599
Kurtosis	2.931801	4.08391	1.802532	1.554076	1.7652	864.5788	2.433008	10.5241
Jarque-Bera	2286.839	1418.58	622.26	782.3133	565.771	0.0112	1209.981	30145.2
Probability	0.5241	0.2514	0.2896	0.6525	0.0524	51494730	0.7541	0.8544
Sum	57355.4	13848.8	48083330	48083330	24191	11579.53	11579.53	15104.6
Sum sq.Dev.	131460.5	3839.17	1.21E=11	1549.48	9819.25	2.06E=10	6588.741	34348.3

Source: *Authors' estimations (2024)*

Table 3 revealed that exchange rate gap inversely and significantly impacted inflation rate of Brazil in the first three quantiles namely, 10th, 20th and 30th. Beginning from the 40th through the 90th quantile, the gap between the official and parallel market rates positively influenced inflation rate. Hence, a 1% increase in the exchange rate gap led to 2.37348%, 2.97114%, 1.52599%, 2.96964%, 3.19846%, and 3.62579% increase in inflation in Brazil during the 40th, 50th, 60th, 70th, 80th, and 90th quantile, respectively. Contrarily, Brazil FDI has a strong and positive correlation with inflation rate. The coefficients of BRAEXRGAP and BRAFDI were all significant in Brazil throughout the 10th to the 90th quartiles. However, while the positivity that heralded the long run quantile results repeated itself throughout the measured quartiles for FDI, the same could not be said of the inflation effect of exchange rate gap at the 1st, 2nd and 3rd quantile. The graph equally represents the movement of FDI; gap in exchange rate and inflation rate during the various quantiles.

Table 3: *Quantile Process Estimate for Brazil*

Variable	Quantile	Coefficient	t-Statistic	Prob.
C	0.1	7.013454	464.1474	0.0000
	0.2	7.508065	634.5823	0.0000
	0.3	8.148919	1249.425	0.0000
	0.4	8.313321	570.3452	0.0000
	0.5	8.326151	561.6828	0.0000
	0.6	8.668193	203.4158	0.0000
	0.7	8.765538	615.1483	0.0000
	0.8	8.726241	779.7377	0.0000
	0.9	8.652854	1081.358	0.0000
BRAEXRGAP	0.1	-1.088163	-194.8808	0.0000
	0.2	-1.017846	-137.9573	0.0000
	0.3	-0.195375	18.1191	0.0000
	0.4	0.237348	10.95785	0.0000

	0.5	0.297114	3.18428	0.0015
	0.6	0.152599	5.86022	0.0000
	0.7	0.296964	51.21743	0.0000
	0.8	0.319846	76.83011	0.0000
	0.9	0.362579	98.83542	0.0000
BRAFDI	0.1	0.201131	62.00176	0.0000
	0.2	0.11258	60.56555	0.0000
	0.3	0.241035	77.10811	0.0000
	0.4	0.222529	32.2382	0.0000
	0.5	0.211557	28.04436	0.0000
	0.6	0.11975	11.15983	0.0000
	0.7	0.178823	39.66668	0.0000
	0.8	0.201551	59.92553	0.0000
	0.9	0.243997	93.76966	0.0000

Source: Authors' estimations (2024)

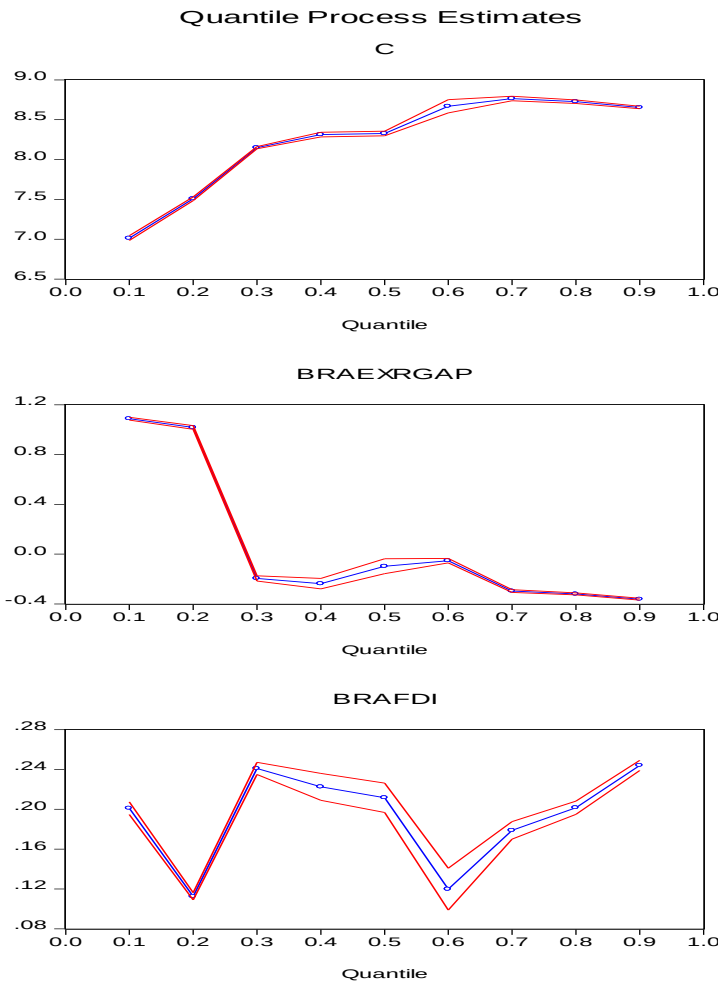

Figure 1: *Quintile Process Graphical Analysis - BRAZIL*
Source: *Authors' estimations (2024)*

The Markov Switching results of Table 4 revealed that in regime 1 and 2, there exists a notable correlation between the exchange rates gap, FDI and inflation rate. However, the relationship is positive only in the first regime while it becomes negative in the second regime. The result revealed further of a consistent dependence in the transition probabilities as it revealed a higher probability of it stationed at the origin at 0.99981 with expected duration of 5267.568. Also, at regime 2, there exists a probability of 0.9999 and expected duration of a record 8271.

Table 4: *Markov Regime switching equation - BRAZIL*

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Transition Probability	Constant expected duration
Regime 1						
C	7.854331	0.023263	337.6257	0.0000	0.99981	5267.568
BRAEXRGAP	0.64357	0.033477	19.22423	0.0000		
BRAFDI	0.026533	0.00437	6.071721	0.0000		
Regime 2						
C	8.597867	0.009916	867.0795	0.0000	0.9999	8271.248
BRAEXRGAP	-0.211562	0.008097	-26.12708	0.0000		
BRAFDI	0.185304	0.003219	57.57118	0.0000		
Common						
LOG(SIGMA)	-1.766904	0.00772	-228.8836	0.0000		

Source: *Authors' estimations (2024)*

The quintile process results for Russia are reported in Table 5 below. The estimates reveal that from the 10^{th} to the 90^{th} quartiles, the coefficients of RUSEXRGAP were all significant with positive effects on the inflation rate of Russia apart from the 80^{th} quantile where a negative coefficient of -1.22800 was reported. In other words, only at the 80th quantile, the effect of exchange rate gap was negative on inflation with the implication that 1 percent rise in the deviation between the official and parallel market exchange rate stimulated a reduction in inflation rate by 1.228 percent. The results show that exchange rate gap had positive and significant influence on the inflation rate of Russia in the other quantiles. Largely, a 1% increase in the exchange rate gap increases Russian inflation rate by 1.00459%, 1.984%, 1.98147%, 1.48445%, 1.2862%, and 1.21208% and 1.9194% in the 10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, and 70^{th} quantile, respectively. At the 90^{th} quantile, exchange rate gap had a larger sizable effect of about 1.019941 on inflation in Russia. Accordingly, the higher the gap between the official exchange rate and the black market rate, the higher the level of macroeconomic instability in Russia. Fluctuations in the exchange rate gap dissuade foreign investors from seeing Russia as a viable investment destination. A stable and predictable exchange rate environment is often preferred by investors, as it reduces uncertainty and minimizes currency related risks. In a similar vein, Russian FDI had positive and significant relationship with inflation rate from the 20^{th} through the 50^{th} quantile. This could not be said of the RUSFDI which was not significant at the 10^{th} quantile but positive. It showed that the effect of exchange rate gap on FDI in Russia was considerably favorable only at the 20^{th},

30th, 40th, and 50th quantiles. The relationship between FDI and inflation turned negative at the 60th, 70th, 80th, and 90th quartile, respectively. The adverse sizable effects are -0.016558, -0.050009, -0.047054, and -1.040794. These sizable effects are negative.

Table 5: *Quintile process estimate for Russia*

Variable	Quintile	Coefficient	t-Statistic	Prob.
C	0.100	6.936239	240.7477	0.0000
	0.200	7.004190	835.7229	0.0000
	0.300	7.012563	698.7597	0.0000
	0.400	8.660561	108.9724	0.0000
	0.500	8.950225	438.3146	0.0000
	0.600	9.164052	567.8752	0.0000
	0.700	9.414681	621.2349	0.0000
	0.800	9.576136	756.2637	0.0000
	0.900	9.429776	521.1042	0.0000
RUSEXRGAP	0.100	0.100459	29.68663	0.0000
	0.200	0.198400	163.0208	0.0000
	0.300	0.198147	132.5353	0.0000
	0.400	0.148445	12.52580	0.0000
	0.500	0.128620	24.16580	0.0000
	0.600	0.121208	24.19281	0.0000
	0.700	0.19194	8.271463	0.0000
	0.800	-1.22800	-2.362847	0.0182
	0.900	1.019941	10.16385	0.0000
RUSFDI	0.100	0.308475	1.686455	0.0917
	0.200	0.447891	154.4141	0.0000
	0.300	0.445778	130.0301	0.0000
	0.400	0.029883	12.29523	0.0000
	0.500	0.030963	6.577897	0.0000
	0.600	-0.116558	-4.003994	0.0001
	0.700	-0.150009	-20.28510	0.0000
	0.800	-0.147054	-25.77571	0.0000
	0.900	-1.040794	-10.45024	0.0000

Source: *Authors' estimations (2024)*

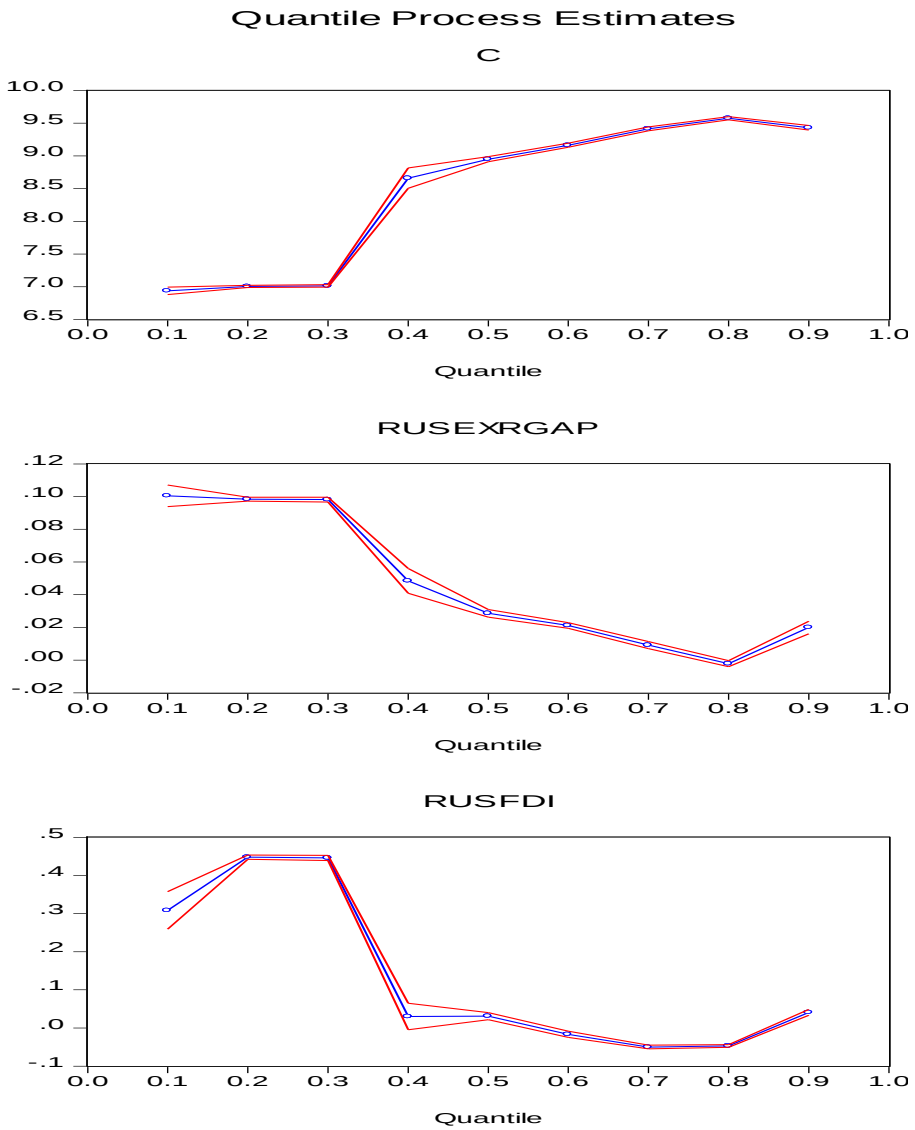

Figure 2: *Quantile process graphical analysis – RUSSIA*
Source: *Authors' estimations (2024)*

In Table 6, the Markov Switching model for RUSSIA revealed that in regime 2, there exists a significant relationship between gap in exchange rate, FDI and inflation rate. In regime 1, it is only significant between exchange rate gap and inflation rate. However, these relationships are positive in all these cases. The results revealed further of a consistent dependence in the transition probabilities as it shown a higher probability of it stationed at the origin at 0.999712 with expected duration of 3469.412 Also, at regime 2, there exists a probability of 0.9996 and expected duration of a record 2244.

Table 6: *Markov regime switching regression results - RUSSIA*

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Transition Probability	Constant expected duration
Regime 1						
C	9.342863	0.006422	1454.81	0.0000	0.999712	3469.412
RUSEXRGAP	0.007645	0.000616	12.41307	0.0000		
RUSFDI	0.00044	0.001557	0.282428	0.7776		
Regime 2						
C	7.014405	0.007419	945.4235	0.0000	0.9996	2244.032
RUSEXRGAP	0.066168	0.000824	80.292	0.0000		
RUSFDI	0.456162	0.002586	176.4267	0.0000		
Common						
LOG (SIGMA)	-1.775914	0.007721	-230.0026	0.0000		

Source: *Authors' estimations (2024)*

Table 7 revealed that exchange rate gap has a noteworthy and favorable impact on inflation rate of India. Specifically, a 1% increase in the exchange rate gap increases Indian inflation rate by 0.113082%, 0.127385%, 0.112632%, 0.103255%, 1.097868%, 1.080052%, 1.066412%, 1.056883%, and 1.046789% at the 10^{th} , 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th}, and 90^{th} quantile, respectively. The quantile effects became larger beginning from the 50^{th} through the 90^{th} quantile. In a similar vein, Russian FDI had significant and positive connection with inflation rate. The quantile process result for India reveals that from the 10^{th} to the 90^{th} quartiles, the coefficients of INDEXRGAP and INDFDI were all significant with their effects on the inflation rate of India. It showed that the exchange rate gap and FDI level in India have positively significant link with inflation rate for the whole quintiles. While the relationship could be termed to be evenly reducing for the exchange rate gap, such assertion could not be made for the level of FDI in India.

Table 7: *Quantile process results for India*

Variable	Quantile	Coefficient	t-Statistic	Prob.
C	0.100	5.460253	1841.025	0.0000
	0.200	5.463215	1108.306	0.0000
	0.300	5.702004	551.7877	0.0000
	0.400	5.798480	536.3764	0.0000
	0.500	5.753262	575.8262	0.0000
	0.600	5.704135	601.9415	0.0000
	0.700	5.869271	68.26154	0.0000
	0.800	6.195746	122.0542	0.0000
	0.900	6.541542	272.5374	0.0000
INDEXRGAP	0.100	0.113082	251.7380	0.0000
	0.200	0.127385	408.7730	0.0000
	0.300	0.112632	199.5246	0.0000
	0.400	0.103255	177.3800	0.0000
	0.500	1.097868	155.6885	0.0000
	0.600	1.080052	160.7565	0.0000

	0.700	1.066412	28.61345	0.0000
	0.800	1.056883	42.16590	0.0000
	0.900	1.046789	68.85932	0.0000
INDFDI	0.100	0.240934	223.9738	0.0000
	0.200	0.220241	156.5030	0.0000
	0.300	0.215554	27.66989	0.0000
	0.400	0.250401	52.47945	0.0000
	0.500	0.339281	34.03512	0.0000
	0.600	0.564511	75.80224	0.0000
	0.700	0.598229	16.36751	0.0000
	0.800	0.477370	21.37554	0.0000
	0.900	0.349357	33.35406	0.0000

Source: *Authors' estimations (2024)*

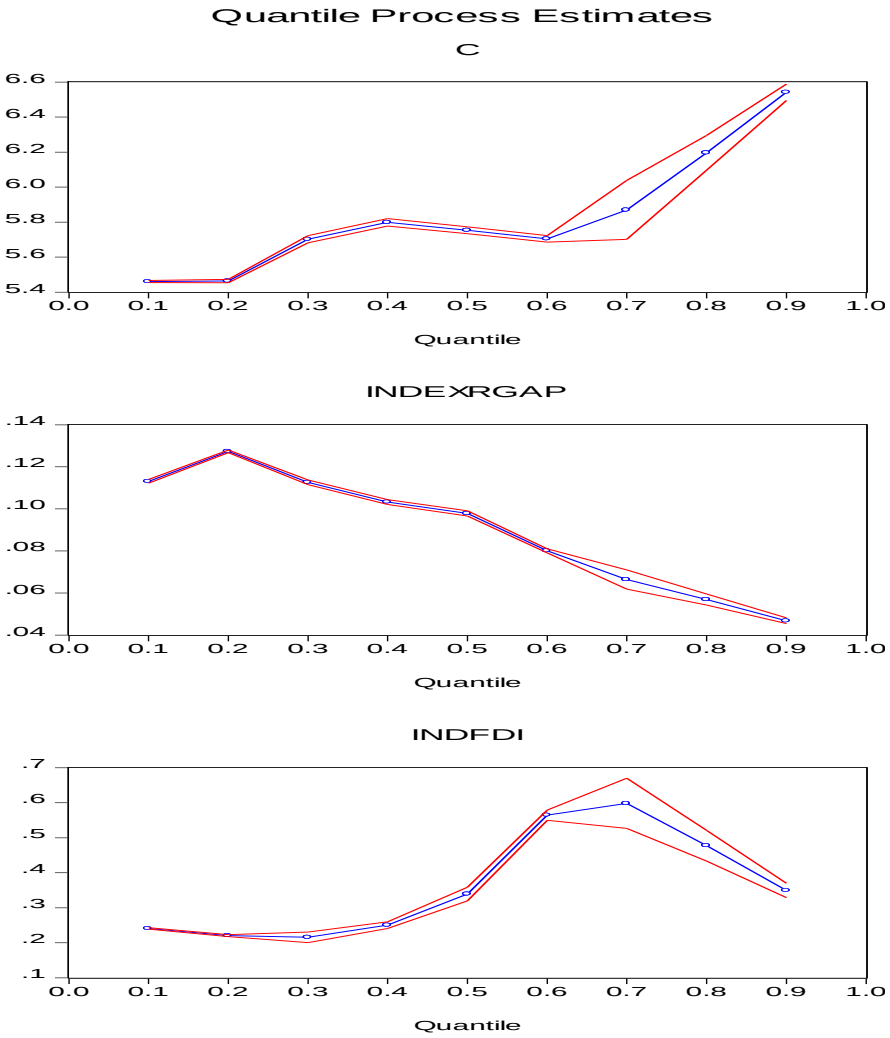

Figure 3: *Quantile process graphical analysis – INDIA*
Source: *Authors' estimations (2024)*

In Table 8, the Markov Switching model for INDIA revealed that in regimes 1 and 2, there exists a significant link between difference in the exchange rates, FDI and inflation rate. The result revealed that a negative association exists between exchange rate gap and inflation rate. However, a positive association exists between the two in the regime 2. The result revealed further of a consistent dependence in the transition probabilities as it revealed a higher probability of it stationed at the origin at 0.9992 with expected duration of 1424.51. Also, at regime 2, there exists a probability of 0.9997 and expected duration of a record 3213.

Table 8: *Markov Regime switching regression results – INDIA*

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Transition Probability	Constant expected duration
Regime 1						
C	6.970451	0.014251	489.1105	0.0000	0.9992	1424.51
INDEXRGAP	-0.004528	0.000817	-5.541265	0.0000		
INDFDI	0.237933	0.007173	33.17244	0.0000		
Regime 2						
C	5.628202	0.004707	1195.615	0.0000	0.9997	3213.088
INDEXRGAP	0.119009	0.000395	301.1172	0.0000		
INDFDI	0.232165	0.002206	105.2313	0.0000		
Common						
LOG(SIGMA)	-2.057645	0.00772	-266.5187	0.0000		

Source: *Authors' estimations (2024)*

Table 9 revealed that exchange rate gap had negative and significant relationship with per inflation of China. The coefficients of exchange rate gap are -0.333176, -0.179287, -0.037032, -0.129116, -0.190061, -0.066166, -0.340067, -0.333209, and -0.306829. The quintile process result for China in Table 12 reveals that from the 10^{th} to the 90^{th} quartiles, the coefficients of CHIEXRGAP and CHIFDI were all significant with their effects on the inflation rate of China. By deductions, it follows that the gap between the official exchange rate and the parallel exchange rate in China is very small. Hence, it is not substantial to warrant macroeconomic instability. Conversely, the results show a significant positive inflation effect of FDI from the 10^{th} through the 90^{th} quantiles. It implies that the macroeconomic environment of China is stable and magnificent enough to guarantee considerable inflows of FDI to China.

Table 9: *Quantile process results for CHINA*

Variable	Quantile	Coefficient	t-Statistic	Prob.
C	0.100	9.816862	494.8961	0.0000
	0.200	10.09532	335.4664	0.0000
	0.300	10.35942	1107.215	0.0000
	0.400	9.944304	1262.576	0.0000
	0.500	10.25166	1393.115	0.0000
	0.600	10.16521	420.6737	0.0000
	0.700	9.906432	936.2124	0.0000
	0.800	9.983014	1220.456	0.0000

	0.900	9.953263	1326.792	0.0000
CHIEXRGAP	0.100	-0.333176	27.50306	0.0000
	0.200	-0.179287	9.498318	0.0000
	0.300	-0.037032	-2.537140	0.0112
	0.400	-0.129116	-22.65383	0.0000
	0.500	-0.190061	-30.44832	0.0000
	0.600	-0.066166	-3.422725	0.0006
	0.700	-0.340067	-48.56482	0.0000
	0.800	-0.333209	-61.50485	0.0000
	0.900	-0.306829	-37.45012	0.0000
CHIFDI	0.100	0.876710	302.2292	0.0000
	0.200	0.883321	261.5981	0.0000
	0.300	0.856025	85.34460	0.0000
	0.400	0.497414	287.9838	0.0000
	0.500	0.542997	263.9829	0.0000
	0.600	0.517639	96.58162	0.0000
	0.700	0.485548	140.3256	0.0000
	0.800	0.502357	185.2473	0.0000
	0.900	0.469326	103.0030	0.0000

Source: Authors' estimations (2024)

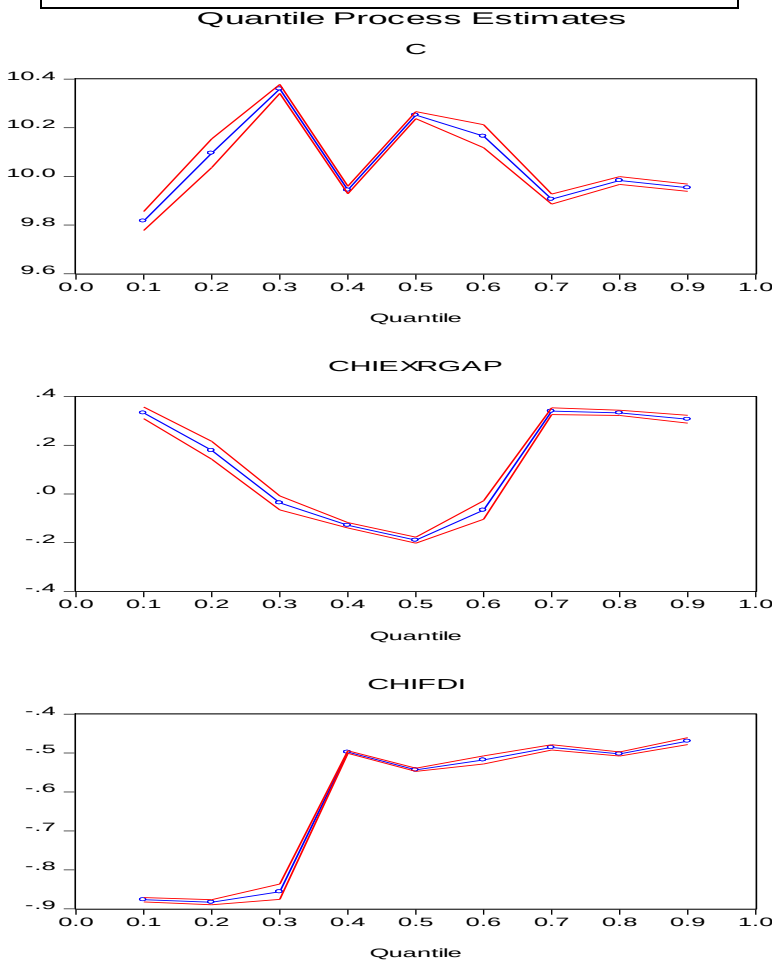

Figure 4: Quantile process graphical analysis – CHINA
Source: *Authors' estimations (2024)*

In Table 10, the Markov Switching model for CHINA revealed that in regimes 1 and 2, there exists a significant relationship between exchange rate gap, FDI and inflation rate. The result revealed that a negative association exists between FDI and inflation rate at regimes 1 and 2. However, a positive connection exists between exchange rate gap and inflation rate at both regimes 1 and 2. The result revealed further of a consistent dependence in the transition probabilities as it revealed a higher probability of it stationed at the origin at 0.9991 with expected duration of 1058.79. Also, at regime 2, there exists a probability of 0.9990 and expected duration of a record 1029.237.

Table 10: *Markov Regime switching regression results for CHINA*

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Transition Probability	Constant expected duration
Regime 1						
C	10.39836	0.011117	935.323	0.0000	0.999056	1058.795
CHIEXRGAP	0.054341	0.007116	7.636605	0.0000		
CHIFDI	-0.951991	0.002788	-341.4672	0.0000		
Regime 2						
C	10.22573	0.00938	1090.202	0.0000	0.9990	1029.237
CHIEXRGAP	0.125792	0.005709	22.03289	0.0000		
CHIFDI	-0.556603	0.00245	-227.2049	0.0000		
Common						
LOG(SIGMA)	-1.753759	0.007723	-227.0838	0.0000		

Source: *Authors' estimations (2024)*

Table 11 revealed that exchange rate gap and the inflation have positive and significant relationship in South Africa. With exchange rate gap coefficients of 0.240127, 0.250505, 0.069067, 0.036501, 0.039164, 0.026228, 0.027599, 0.070839, and 0.024866, it thus follows that a 10% increase in the exchange rate gap increases South Africa's inflation rate by 2.40127, 2.50505, 0.69067, 0.36501, 0.39164, 0.26228, 0.27599, 0.70839, and 0.24866 respectively. The relationship between FDI and inflation rate was positive at the 30^{th} quantile and from the 70^{th} through the 90^{th} quantiles. This portrays some level of macroeconomic instability in South Africa. Hence, the inflows of FDI into South Africa are not robust enough due to unfavorable macroeconomic policy environment.

Table 11: *Quantile process results for SOUTH AFRICA*

variables	Quantile	Coefficient	t-Statistic	Prob.
C	0.100	7.970190	1243.069	0.0000
	0.200	8.155355	1047.939	0.0000
	0.300	8.573542	1535.593	0.0000
	0.400	8.683218	2978.341	0.0000
	0.500	8.708405	3834.644	0.0000
	0.600	8.742654	2324.453	0.0000
	0.700	8.791520	3887.670	0.0000
	0.800	8.811199	2872.812	0.0000
	0.900	9.040424	681.3371	0.0000

SOUEXRGAP	0.100	0.240127	103.0358	0.0000
	0.200	0.250505	115.8026	0.0000
	0.300	0.069067	29.93067	0.0000
	0.400	0.036501	30.47411	0.0000
	0.500	0.039164	37.67192	0.0000
	0.600	0.026228	20.65085	0.0000
	0.700	0.027599	18.43358	0.0000
	0.800	0.070839	14.13078	0.0000
	0.900	0.024866	-1.753114	0.0796
SOUFDI	0.100	-0.032531	-26.18756	0.0000
	0.200	-0.068346	-48.37072	0.0000
	0.300	0.008932	17.45079	0.0000
	0.400	-0.007545	-23.81176	0.0000
	0.500	-0.004129	-13.06041	0.0000
	0.600	-0.004541	-15.64989	0.0000
	0.700	0.000927	2.039389	0.0414
	0.800	0.016166	11.48462	0.0000
	0.900	0.010622	3.553459	0.0004

Source: *Authors' estimations (2024)*

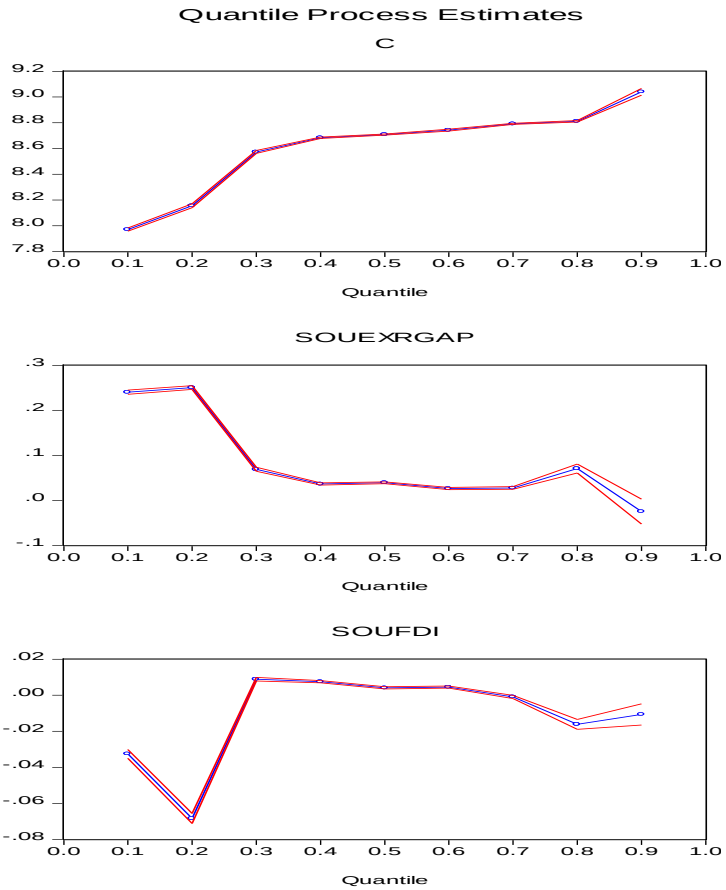

Figure 5: *Quantile process graphical analysis – SOUTH AFRICA*
Source: *Authors' estimations (2024)*

In Table 12, the Markov Switching results for SOUTH AFRICA revealed that in regimes 1 and 2, there exists a significant link between difference between the official and unofficial exchange rates, FDI and inflation rate. In Regime 1, the result revealed a positive link existing between exchange rate gap and FDI and inflation rate while the reverse becomes the case in the second regime. The result revealed further of a consistent dependence in the transition probabilities as it revealed a higher probability of it stationed at the origin at 0.9999 with expected duration of 9694.439. Also, at regime 2, there exists a probability of 0.9998 and expected duration of a record 4266.789.

Table 12: *Markov Regime switching regression results – SOUTH AFRICA*

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Transition Probability	Constant expected duration
Regime 1						
C	8.782989	0.002911	3016.957	0.0000	0.9999	9694.439
SOUEXRGAP	0.008602	0.001703	5.050075	0.0000		
SOUFDI	0.006643	0.000776	8.56559	0.0000		
Regime 2						
C	8.463531	0.015016	563.6257	0.0000	0.9998	4266.789
SOUEXRGAP	-0.410394	0.018225	-22.51777	0.0000		
SOUFDI	-0.044135	0.001614	-27.34629	0.0000		
Common						
LOG(SIGMA)	-2.089091	0.007717	-270.7253	0.0000		

Source: *Authors' estimations (2024)*

5. CONCLUSION

The study estimated the impact of exchange rate gap on inflation rate among BRICS with FDI as a control variable using data from 2000 to 2023. The study adopted quantile regression and Markov Switching regression and quantile regression methodologies. The study heralds the succinct implications of exchange rate gap on selected macroeconomic variables in the BRICS countries. It succinctly analyzes the effects of the gap in BRICS. It laid credence to the distortions that the dichotomy often results in as well as the effects it has on inflation rate of these countries. It revealed that at regimes 1 and 2, using Markov Switching technique, exchange rate gap revealed significant impact on inflation rate. The result further revealed that in all the countries with the exception of India, witnessed positive and significant relationship existing between exchange rate gap and inflation rate especially in regime 1. This result varies for the five countries in regime 2. The quantile regression results revealed that exchange rate gap positively and significantly influenced inflation rate in Russia, India, Brazil and South Africa. The movement in the quintiles from 10th to 90th revealed the same trends which are largely significant. By implication, for the larger period, there was a rising divergence between the official and the parallel market exchange rates which has led

to significant inflation rate in BRICS. Only in China we had negative and significant inflation effects of exchange rate gap throughout the quantile periods. By inferences, it follows that the gap between the official exchange rate and the parallel exchange rate in China is very small. Also, there is a high level of macroeconomic policy stability which added up to culminate in a significant positive inflation effect of FDI from the 10th through the 90th quantiles. It implies that the macroeconomic environment of China is stable and magnificent enough to guarantee considerable inflows of FDI to China.

The study recommends as follows: Exchange rate gap resulting from the disparity between official and parallel exchange rate should be reduced significantly as the gap from the results obtained is indeed significant. Also, foreign investment continuously revealed a positive and significant nexus with inflation rate, hence the need to boost FDI for development and economic prosperity. The various trends obtained in the result clearly indicate that for semi developed economies of BRICS, near zero parallel exchange rate is advocated to achieve macroeconomic stability in an economy. Specifically, the research finding is situated around the empirical fact that insignificant variations in the exchange rate gap influence the inflow and outflow of FDI to BRICS. This is because a stable and predictable exchange rate environment is often preferred by investors, as it reduces uncertainty and minimizes currency related risks. Developing nations have to establish macroeconomic stability in order to mitigate the impact of exchange rate fluctuations on inflation.

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