IMPACT OF FOREIGN EXCHANGE RESERVES ON INFLATION IN SELECTED SUB-SAHARAN AFRICAN COUNTRIES

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&

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ABSTRACT

The continuous rise on inflation rate particularly in Sub-Saharan African countries in recent time has been questionable, which has affected all sectors of the economies of Sub-Saharan African countries. It has become pertinent given the rise on inflation to examine how external reserves has affected inflation and also question the accumulation of reserves that would have been channelled into industrialization to reduce the high rate of unemployment and promote investment in sub-Saharan African countries. This study examined foreign exchange reserves and its effects on inflation in selected Sub-Saharan African countries. Data spanning between 1990 and 2023 from Twenty (20) Sub-Saharan African countries were used and Fixed Effects Panel technique of analysis was adopted for the study. The findings of the study show that while both external reserves accumulation (RESV) and world oil price (WOP) have negative relationships with inflation, the relationship is statistically significant only in the case of RESV. On the other hand, although both money supply (M1) and exchange rate (EXR) indicate positive relationships with inflation, only M1 has a statistically significant relationship. From the findings of this study, therefore, it is concluded that foreign exchange reserve accumulation reduces the level of inflation significantly in Sub-Saharan African countries. The study recommends among others that although foreign reserves may not be inflationary, it is imperative that reserves be channelled into productive investments and infrastructural development to promote resilience and sustainability in African countries rather than accumulating foreign exchange reserves.

Keywords: Foreign exchange reserves accumulation; exchange rate; inflation; money supply; foreign currency
JEL Classification: C23, E31, E52

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INTRODUCTION

Central banks' foreign exchange reserves accumulations have become a major pursuit over the years for most countries especially the developing countries of the world (Mohanty & Tumer, 2006; Steiner, 2017). Three major reasons behind the foreign exchange accumulations were noted by Steiner (2017): first is for precautionary savings which is meant to regulate future economic crises and moderate output volatility; second is mercantilist motive which is set to sustain undervalued exchange rate and stimulate exports; and last is catching up strategy for countries with underdeveloped financial market. Hargrave (2024) adds that backing liabilities and influencing monetary policy are fundamental reasons for foreign exchange reserves accumulations while currency stabilization, exchange rate control, payment of external debt and absorbing shock in times of economic crises are all purposes embedded in the aforementioned. Boosting global and international markets and instilling confidence in international investors were observed as importance of reserves accumulation (Aizenman, 2008; Jeanne, 2012).

Foreign exchange reserves, according to Hargrave (2024), are central bank assets dominated in foreign currencies. This includes banknotes, gold and silver, bonds, treasury bills, Special Drawing Rights (SDRs), International Monetary Fund (IMF) reserve positions as well as reserves held in other currencies such as US Dollar and Pounds Sterling, Euro and Japanese Yen (Umeora, 2013). The economic implications of foreign exchange reserves accumulation which has been neglected over time is the increase on inflation and the risks associated with such increase have not been well addressed. By implication, the opportunity cost of reserve holdings, which is the risk of reserve accumulation for price stability is over time neglected. Changes in price level are caused by national factors such as variability in cost of production, depreciation of currency and excess demand, increase in money supply as well as changes in weather leading to bad harvest. But external factors such as exchange rate and foreign exchange reserves also bring about inflation (Adewale, Olopade, & Ogbaro, 2024). They both play important roles in determining the changes in price. Exchange rate volatilities have a direct impact on investment activities, which in turn influence the supply of goods and overall price levels in an economy (Adewale, et al. 2024). When exchange rates are volatile, investors might adjust their portfolios, impacting the flow of capital into different sectors. This can lead to shifts in production and changes in supply chain, ultimately affecting inflation and general price stability.

The link between foreign reserve accumulation and inflation can be assessed through the quantity theory. A rise in foreign reserve could result to inflationary pressure via the increase in monetary base and the functioning of money multiplier particularly if the monetary expansion is not well curtailed, resulting in excess money supply in a situation of fixed or managed floating system (Steiner, 2009; Lin

& Wang, 2009). The expansion in money supply could ultimately drive-up inflation particularly if it outpaces economic growth. This theory underscores the importance of balancing monetary policy to avoid such inflationary risks. The critics of reserve accumulation (Steiner, 2009; Zhou 2014) further noted that foreign exchange reserves are not maximized and they are costly where the opportunity cost is the investment that would have been carried out by the country rather than accumulating the reserve (Steiner, 2009). The supporters of reserve holdings (Chaudhry, Akhtar, Mahmood, & Faridi, 2011; Nugee, 2000; Soludo, 2005) are of the view that the effectiveness of monetary policy may be hindered when there is lack of reserves of payment and that the cost of holding the reserve is less than the economic impact of variations in exchange rate, specially under the fixed exchange rate system (Nugee, 2000). Soludo (2005) states that reserve holdings are viewed as necessary to offset imbalances. It is important to consider that the argument against foreign reserve is stressed when the country is under fixed exchange rate system. But given the high rate of capital mobility and most countries adopting flexible exchange rate system, it is pertinent to evaluate if the current accumulation of reserve is inflationary.

Globally, foreign exchange reserve accumulation has been on the increase. Currently, China has been noted to be the world's largest foreign exchange reserve holder with about $3 trillion of its assets in foreign currency. Japan, Switzerland, India and Russia systematically followed the growth trend (Hargrave, 2024). In Africa, significant foreign exchange reserves holdings were maintained by a number of countries to mitigate economic shocks. Topping the list currently is Libya holding about $80.7 billion as external reserves, followed by Algeria in North Africa with $70.3 billion; South Africa has $57.6 billion, Morocco - $34.8 billion, Nigeria - $27.4 billion, Egypt - $25.5 billion, Angola - $14.0 billion, Tunisia is $8.8 billion, Kenya $8.6 billion and Mauritius $5.9 billion (Omoboye, 2024).

Sub-Saharan African countries have over time experienced high level of fluctuation in reserves accumulation undermining the fact that these countries are naturally endowed with oil, copper, uranium and diamonds that serve as a means of foreign exchange revenue earnings. This could be associated with the 2008 global financial crisis, that brought about increasing debt among countries leading to depletion of external reserves. This generated a number of challenges in the region, such as decline in investments, failure in institutional qualities, high level of unemployment, rising price of good and services, poverty and poor standard of living of the people. Total foreign reserves of sub-Saharan African regions were found in 2019 to average 27.3% (Thabana & Fasanya, 2024). Despite the rising global economic challenges, foreign exchange reserves accumulation in Nigeria has recently experienced some increase. Recently in 2024, from the Central Bank of Nigeria (CBN) report, about $5.57 billion was identified as growth within six months in

foreign reserves. This rose from $33.04 billion on April 8 to $38.61 billion by October 2024 (Ekeghe, 2024). The decline in reserves in sub-Saharan African countries is not unconnected with the trending nosedive of prices of oil at the international market. Given the trend in inflation, it becomes pertinent to examine how external reserves have affected inflation and also question the accumulation of reserves that would have been channelled into industrialization to reduce the high rate of unemployment and promote investment in sub-Saharan African countries.

This paper is organised into five sections starting with the introduction and followed by the literature review and then the methodology. There is a section for the results and discussion and finally a section for the conclusion and recommendations.

LITERATURE REVIEW

Conceptual Review

Foreign exchange reserves are foreign assets held by the central bank of a country. These assets are not dominated by domestic currency, but they include foreign marketable securities, monetary gold, special drawing rights (SDRs) and reserve position in the IMF. The main purpose of holding foreign exchange reserves is to make international payments and hedge against exchange risks. IMF (2009) sees external reserves as assets that are readily available to and controlled by monetary authorities for meeting balance of payment financing needs, for intervention in exchange markets to affect the currency exchange rate and for other related purposes. Foreign exchange reserves play an increasingly important role in linking emerging markets and developed economies. Schanz (2019) defines foreign exchange reserves as an integral part of the policy toolkit as they insure against shocks and complement monetary policy to achieve price and financial stability. Holding foreign exchange is not without costs. Schanz (2019) notes some number of benefits for holding foreign exchange. In less developed countries, fluctuation in terms of trade is a thing of concern in middle-income countries, which tend to have a higher export share, in addition to manufacturing goods; secondly is political instability, which is common in the lower-income countries.

According to Hargrave (2024), foreign exchange reserves as assets, serve many purposes but are most significantly held to ensure that a central government agency has backup funds if their national currency rapidly devalues or becomes entirely insolvent. These reserves are held in the U.S. dollar since it is the most traded currency in the world but holding it in the British pound (GBP), euro (EUR), the Chinese yuan (CNY) or the Japanese yen (JPY) is not uncommon.

The concept of inflation has turned out to be a common fact that people associate it with general increase in prices of goods and services. It is a broad economic concept that reflects a loss of purchasing power for the currency in a given economy (Oner,

2023). It is also noted in Oner (2023) that inflation is associated with money supply. Long lasting episodes of high inflation are often the result of lax monetary policy. If the money supply grows too big relative to the size of an economy, the unit value of the currency diminishes. CBN (2023) sees inflation in terms their magnitude, which include creeping inflation, walking inflation, running inflation and hyperinflation. But the real causes of inflation were identified as demand-pull and cost-push inflation.

Theoretical Review

The quantity theory of money assumed that the general price level of goods and services in an economy is directly proportional to the amount of money circulating. By implication, a change in money supply will directly lead to a corresponding change in price levels. Historically, this theory has its roots in the 16th century during which classical economists such as Jean Boldin at that time sought to know the cause of the increases in French prices. Later in the 1690s, the quantity theory was further advanced by John Locke to examine the effects of money on trade, the role of interest rate and demand for money in the economy. Thereafter arose the modern classical economics school of thought, known as the monetarists. They continued on the bases of the early economists by explaining changes in price level. They believe that a stable and equilibrating relationship exists between the adjustments in the quantity of money and the price level. The quantity theory of money is hinged on the Irvin Fisher equation of exchange that states that the quantum of money multiplied by the velocity of money is equal to the price level multiplied by the amount of goods sold. It is often replicated as MV= PQ; M is defined as the quantity of money, V is the velocity of money, which implies the number of times in a year that a currency goes around to generate a currency worth of income, P represents the price level and Q is the quantity of real goods sold in terms of real output. The assumptions surrounding this theory are: first is that velocity of money is constant, second is that factors affecting real output are exogenous to the quantity theory itself, the third is that causality runs from money to prices. Thus, the quantity theory of money can be represented as

$$M\bar{V} = P\bar{Q} \quad (1)$$

This implies that prices vary proportionally in response to changes in the quantum of money, with velocity and real output invariant (Omanukwue, 2010). In relation to this study, inflation level is influenced based on the level of foreign exchange reserve accumulation.

Empirical Review

Studies that focused on the interactions between external reserves and macroeconomic variables as well as the determinants of external reserve include Lin & Wang (2009) who extended the time consistency model developed by

Kydland & Prescott (1977) and added exchange rate stability to capture the impact of political stand in analysing the relationship between foreign reserve and inflation for five East Asian countries. They argued that increase in foreign exchange reserves leads to increase in inflation if the exchange rate is stronger than the effect of the monetary variable that can control inflation but when the unexpected effect of the monetary variables becomes so strong inflation will fall.

Steiner (2009) investigated if accumulation of foreign exchange reserve can spur inflation and the consequences for monetary policy for some developing and industrial countries. The study made use of panel VAR model for the period 1970 to 2006. Evidence from the study suggests that the accumulation of foreign reserve increases inflation. However, the growth of central bank assets was noted as the determinant of inflation for individual countries. In contrast to these findings, Usman and Waheed (2010) investigated the impact of change in external reserve positions of Nigeria on domestic investment, inflation rate and exchange rate using a combination of OLS and VEC techniques. Their analysis showed that there is no significant relationship between accumulation of reserves and inflation in Nigeria in their study on the implication of external reserves holding and inflation in Nigeria. Their study noted that external reserves only affected foreign direct investment and exchange rate and have no significant impact on inflation. Chaudhry, Akhtar, Mahmood and Faridi (2011) analysed the relationships between foreign exchange reserves and inflation for Pakistan from 1960 to 2007. They made use of the autoregressive distributive lag (ARDL) model and the OLS for the estimation of the long run relationship. Their result showed that increase in foreign exchange reserves led to a fall in inflation in the country for the period.

Umeora (2013) specifically examined the relationship that exists between foreign exchange reserves, exchange rate and inflation in Nigeria using data spanning between 1986 and 2011. The study showed a negative relationship between foreign exchange reserves and exchange rate and also noted a positive relationship between foreign reserve accumulation and inflation in Nigeria.

Zhou (2014) in China assessed the role of monetary policy over foreign exchange reserves and inflation using VAR model, Granger causality and Co-integration tests. The study concluded that the growth of foreign exchange reserves pressurizes increase in expected inflation rate.

Drama (2016) analysed the relationship between foreign exchange reserve and inflation for four West Africa countries; Cote d'Ivoire, Senegal, Ghana and Nigeria. The study employed an autoregressive distributive lag (ARDL) model on an annual time series data for the period 1972 to 2014. It was found that there exists a positive relationship between the change in foreign exchange reserves and inflation rate for

the countries in the long run which was not significant in the short run. Thus, establishing the fact that the growth of foreign exchange reserves leads to inflation.

In recent studies, Kuncoro (2024) observed the role of foreign reserves in inflation dynamics adopted inflation-expectation augmented Phillips curve on the monthly data which cover the period of 2005 July to 2020 December in Indonesia. The study found that stockpiling foreign exchange reserves has inflationary pressure.

Given the nature of method of studies, the extent of the data sets used and the variations in findings and the limited number of empirical literatures on the relationship between foreign exchange reserves and inflation, this study fills the existing gap by applying a more robust econometric technique with current data sets to determine the exact relationship between foreign exchange reserves and inflation.

METHODOLOGY

This study examined the impact of foreign exchange reserves on inflation in selected Sub-Saharan African countries using data spanning between 1990 and 2023. The analysis adopted twenty (20) Sub-Saharan African countries. Table 1 gives a description of the data used for the analysis.

Table 1: Data Description

Variables	Symbol	Measurement	Source
Inflation rate	$INFR$	Rates	World Bank's World Development Indicators
External reserves	$RESV$	Total reserves (includes gold, current US$)	Same
Money supply	$M1$	Broad money (% of GDP)	Same
Exchange rate	EXR	Rates	Same
World oil price	WOP	Price level ratio of PPP conversion factor (GDP) to market exchange rate	Same

Source: Authors

This study employed the panel data of 20 countries (N) with 34 years (T) where N<T in order to empirically achieve the objective of this study, which is robust enough given the high quality of the panel. The analysis started from Pooled Ordinary Least Square (POLS) panel analysis to Random Effects Model (REM) and finally using Fixed Effect Model (FEM) to establish the effects of foreign

exchange reserves accumulation on inflation (*See Appendix for details*). FEM takes into account the nature of heterogeneities of the countries under study, which prove its robustness in carrying out this study.

Equation (2) is therefore specified as the model of this study.

$$INFR = f(RESV, M1, EXR, WOP) \quad (2)$$

From equation (2), the fixed effect model (FEM) is developed as shown in equation (3) as

$$INFR_{it} = \propto + \beta_1 RESV_{it} + \quad \beta_2 M1_{it} + \beta_3 EXR_{it} + \beta_4 WOP_{it} + \varepsilon_{it} \quad (3)$$

Where $\varepsilon_{it} = (\delta_{it} + \mu_{it})$ where δ_{it} is the country specific effect and $\mu_{i,t} \sim N(0, \delta_{\mu}^2)$, the error term, shows no serial correlation. The variables and symbols used in the model (Equation 2 and 3) have been well defined as presented in Table 1 of data description. All the data used in the analysis were all extracted from the World Bank Open Data sources. $INFR$ is the dependent variable to be explained. $RESV$ is the core exogenous variable of interest while $M1$, EXR and WOP are all the control exogenous variables of the model. The control variables in the model are variables that have theoretical influences on the endogenous variable. For the analysis of the model under study to be robust and parsimonious enough, the inclusion of the control variables is necessary. The following Sub-Saharan African countries were selected for the analysis based on availability of data: Nigeria, Chad, Equatorial Guinea, Botswana, Congo, Rep., Cameroon, Ethiopia, Ghana, Gabon, Kenya, Lesotho, Madagascar, Malawi, Mauritania, Namibia, Rwanda, Sierra Leone, South Africa, Sudan and Zambia.

RESULTS AND DISCUSSION

Table 2: Descriptive Statistics

Variables	INFR	RESV	M1	EXR	WOP
Mean	13.18887	3.9809	24.69517	289.9531	0.394220
Median	7.430646	7.8308	20.92442	30.17033	0.389294
Maximum	359.0930	6.2510	80.77571	4429.579	1.011636
Minimum	-16.85969	40812.32	-0.947307	0.004500	0.131172
Std. Dev.	25.79232	9.9609	14.40469	529.6732	0.117043
Skewness	7.293334	3.892780	1.308405	4.070720	0.615450
Kurtosis	76.69722	17.82065	4.740633	24.81753	4.231002
Jarque-Bera	159914.8	7940.888	279.8625	15364.82	85.86359
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	8968.429	2.7112	16792.71	197168.1	268.0699
Sum Sq. Dev.	451700.5	6.7322	140889.1	1.9008	9.301725
Observations	680	680	680	680	680

Source: Authors' computation using EViews

Table 2 presents the descriptive statistics of the variables used. From the result, exchange rate performed differently since its mean and median values seem higher in relation to other variables. The mean and median values of money supply ($M1$) followed that of exchange rate closely while the values of inflation, external reserves and world oil price followed sequentially. Exchange rate could influence the level of inflation since its mean value is higher than its minimum value. This is traceable to the values of money supply and world oil price. Exchange rate deviation is higher in relation to other variables such as $RESV$, $M1$ and WOP given the values of standard deviation. From the Jarque-Bera test, all the variables proved to be normally distributed.

Table 3: Correlation Matrix

Variables	INFR	RESV	M1	EXR	WOP
INFR	1.000000				
RESV	-0.066782	1.000000			
M1	-0.042566	0.449945	1.000000		
EXR	-0.081971	-0.103930	-0.195163	1.000000	
WOP	-0.163549	0.199977	0.235414	-0.143612	1.000000

Source: Authors' computation using EViews

The correlation matrix as indicated in Table 3 evidenced that there is no multicollinearity among the regressors. This is indicated by the significantly low values of all correlations.

Table 4 presents the result of the FEM which is robust and more appropriate for this analysis since Breusch-Pagan (BP) test rejected the null hypothesis that POLS is more appropriate than REM and FEM. Secondly, Hausman test also rejected the null hypothesis that REM is appropriate than FEM, which gave rise to the FEM. The FEM result shows that $RESV$ has negative and statistically significant relationship with $INFR$. This implies that foreign exchange reserve accumulation reduces the level of inflation significantly in Sub-Saharan African countries. This is also aligned with the findings of Chaudhry, Akhtar, Mahmood and Faridi (2011). This empirical finding is in contrast with the finding of Kuncoro (2024). Stockpiling reserves may not by implication be too good for the development of the economy, rather the opportunity cost of reserves accumulation could be better off if reserves are channelled into productive investment activities.

Table 4: Fixed Effect Model (FEM)

Dependent Variable: INFR
Method: Panel Least Squares
Date: 11/13/24 Time: 19:32
Sample: 1990 2023
Periods included: 34
Cross-sections included: 20
Total panel (balanced) observations: 680

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESV	-4.56909	1.430000	-3.195169	0.0015
M1	0.392925	0.126267	3.111860	0.0019
EXR	0.001251	0.003036	0.412162	0.6804
WOP	-0.823152	8.329639	-0.098822	0.9213
C	5.264580	4.445506	1.184248	0.2367
	Effects Specification			
Cross-section fixed (dummy variables)				
R-squared	0.303223	Mean dependent var		13.18887
Adjusted R-squared	0.278793	S.D. dependent var		25.79232
S.E. of regression	21.90385	Akaike info criterion		9.045858
Sum squared resid	314734.7	Schwarz criterion		9.205461
Log likelihood	-3051.592	Hannan-Quinn criter.		9.107636
F-statistic	12.41205	Durbin-Watson stat		1.709753
Prob(F-statistic)	0.000000			

Source: Authors' computation using EViews

WOP also appears negative although not statistically significant. This implies that WOP to some extent reduces the level of inflationary pressure in the economies of Sub-Saharan African countries. By implication the variability of the WOP may not necessarily stimulate inflation in developing economies of Sub-Saharan African countries but rather endogenous factors. $M1$, which is money supply, indicates a statistically significant positive relationship with $INFR$. By implication, an increase in money supply will result to inflationary pressure in the economies of Sub-Saharan African countries. This is in tandem with a priori expectation of their relationship. EXR also shows positive but not statistically significant relationship with $INFR$. This implies that increase in exchange rate brings about a rise in inflation though empirically not significant which is in line with the work of Usman and Waheed (2010) who found that external reserves only affected foreign direct investment and exchange rate, and exchange rate does not significantly impact on inflation.

CONCLUSION AND RECOMMENDATIONS

This study examined foreign exchange reserves and its impact on inflation in twenty (20) selected Sub-Saharan African countries using data spanning between 1990 and 2023. Fixed Effect Panel technique of analysis was adopted for the study. The findings of the study show that $RESV$ has negative and statistically significant relationship with $INFR$, while WOP is also negative but not statistically significant. $M1$ indicates a positive relationship with inflation which is statistically significant while EXR is also positive but not statistically significant. This study, therefore concluded that foreign exchange reserve accumulation reduces the level of inflation significantly in Sub-Saharan African countries.

From the findings of this study, the following recommendations are necessary:

1. Foreign reserves accumulation though may not be inflationary, but it is imperative that reserves be channelled into productive investments and infrastructural development to promote resilience and sustainability in African countries rather than accumulating foreign exchange reserve.
2. An effective use of monetary policy tools to control money supply is also essential so that inflation can be controlled even in the face of accumulation of reserves. There is also the need for the Central Bank to broaden the base of money supply to promote investment.
3. Exchange rate policy that could regulate volatile nature in African countries is very important. African countries being import dependent economies require fixed exchange rate policy for effective management of external reserves and inflationary pressure.
4. The study recommends finally that the revenue from the oil in the periods of rising oil prices should be properly utilized to avoid excess money supply and hence control inflation in the affected countries.

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APPENDIX

Pooled Ordinary Least Squares (POLS)

Dependent Variable: INFR
Method: Panel Least Squares
Date: 01/31/25 Time: 15:46
Sample: 1990 2023
Periods included: 34
Cross-sections included: 20
Total panel (balanced) observations: 680

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESV	-1.09E-10	1.10E-10	-0.987314	0.3238
M1	-0.009874	0.077549	-0.127324	0.8987
EXR	-0.005445	0.001882	-2.892386	0.0039
WOP	-37.44474	8.645793	-4.330978	0.0000
C	30.20534	3.801816	7.944975	0.0000
R-squared	0.039991	Mean dependent var		13.18887
Adjusted R-squared	0.034302	S.D. dependent var		25.79232
S.E. of regression	25.34609	Akaike info criterion		9.310452
Sum squared resid	433636.5	Schwarz criterion		9.343703
Log likelihood	-3160.554	Hannan-Quinn criter.		9.323322
F-statistic	7.029655	Durbin-Watson stat		0.523473
Prob(F-statistic)	0.000015			

(BP) Test Result

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	496.5414	8.064838	504.6063
	(0.0000)	(0.0045)	(0.0000)
Honda	22.28321	2.839866	17.76470
	(0.0000)	(0.0023)	(0.0000)
King-Wu	22.28321	2.839866	19.46803
	(0.0000)	(0.0023)	(0.0000)
Standardized Honda	25.23280	3.052203	13.96526
	(0.0000)	(0.0011)	(0.0000)
Standardized King-Wu	25.23280	3.052203	16.16567
	(0.0000)	(0.0011)	(0.0000)
Gourierioux, et al.*	--	--	504.6063
			(< 0.01)

*Mixed chi-square asymptotic critical values:

1%	7.289
5%	4.321
10%	2.952

Random Effect Result (REM)

Dependent Variable: INFR
Method: Panel EGLS (Cross-section random effects)
Date: 01/31/25 Time: 15:48
Sample: 1990 2023
Periods included: 34
Cross-sections included: 20
Total panel (balanced) observations: 680
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESV	-3.78E-10	1.34E-10	-2.827032	0.0048
M1	0.271173	0.109222	2.482778	0.0133
EXR	6.50E-06	0.002642	0.002459	0.9980
WOP	-6.378603	8.212138	-0.776729	0.4376
C	10.50933	4.774550	2.201115	0.0281
	Effects Specification			
			S.D.	Rho
Cross-section random			10.53869	0.1880
Idiosyncratic random			21.90385	0.8120
	Weighted Statistics			
R-squared	0.015879	Mean dependent var		4.428221
Adjusted R-squared	0.010047	S.D. dependent var		22.26791
S.E. of regression	22.15576	Sum squared resid		331342.4
F-statistic	2.722841	Durbin-Watson stat		0.673785
Prob(F-statistic)	0.028658			
	Unweighted Statistics			
R-squared	-0.008759	Mean dependent var		13.18887
Sum squared resid	455656.9	Durbin-Watson stat		0.489960

Hausman Test

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	19.615213	4	0.0006

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
RESV	-0.000000	-0.000000	0.000000	0.1191
M1	0.392925	0.271173	0.004014	0.0546
EXR	0.001251	0.000006	0.000002	0.4052
WOP	-0.823152	-6.378603	1.943675	0.0001

Cross-section random effects test equation:

Dependent Variable: INFR
Method: Panel Least Squares
Date: 01/31/25 Time: 15:49
Sample: 1990 2023
Periods included: 34
Cross-sections included: 20
Total panel (balanced) observations: 680

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.264580	4.445506	1.184248	0.2367
RESV	-4.56E-10	1.43E-10	-3.195169	0.0015
M1	0.392925	0.126267	3.111860	0.0019
EXR	0.001251	0.003036	0.412162	0.6804
WOP	-0.823152	8.329639	-0.098822	0.9213
	Effects Specification			
Cross-section fixed (dummy variables)				
R-squared	0.303223	Mean dependent var		13.18887
Adjusted R-squared	0.278793	S.D. dependent var		25.79232
S.E. of regression	21.90385	Akaike info criterion		9.045858
Sum squared resid	314734.7	Schwarz criterion		9.205461
Log likelihood	-3051.592	Hannan-Quinn criter.		9.107636
F-statistic	12.41205	Durbin-Watson stat		0.709753
Prob(F-statistic)	0.000000			

The Fixed Effect Model (FEM)

Dependent Variable: INFR
Method: Panel Least Squares
Date: 01/31/25 Time: 15:52
Sample: 1990 2023
Periods included: 34
Cross-sections included: 20
Total panel (balanced) observations: 680

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESV	-4.56909	1.430000	-3.195169	0.0015
M1	0.392925	0.126267	3.111860	0.0019
EXR	0.001251	0.003036	0.412162	0.6804
WOP	-0.823152	8.329639	-0.098822	0.9213
C	5.264580	4.445506	1.184248	0.2367
	Effects Specification			
Cross-section fixed (dummy variables)				
R-squared	0.303223	Mean dependent var		13.18887
Adjusted R-squared	0.278793	S.D. dependent var		25.79232
S.E. of regression	21.90385	Akaike info criterion		9.045858
Sum squared resid	314734.7	Schwarz criterion		9.205461
Log likelihood	-3051.592	Hannan-Quinn criter.		9.107636
F-statistic	12.41205	Durbin-Watson stat		0.709753
Prob(F-statistic)	0.000000			