RELATIONSHIP BETWEEN INDIAN FOREX RESERVES AND RUSSIA-UKRAINE CRISIS: AN EMPIRICAL STUDY

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Abstract: This paper empirically investigates the relationship between the foreign exchange (Forex) reserves of India and the Russia-Ukraine crisis. To pursue this study, we have considered weekly data of Forex reserves of India and have constructed a dummy on the Russia-Ukraine crisis from January 1, 2021, to October 14, 2022, with 92 observations where January 1, 2021, to February 18, 2022, represents the time period before the crisis denoted by '0' and February 25, 2022, to October 14, 2022, is considered as the time period during the crisis denoted by '1'. The descriptive statistics indicate the normality of the data. The Phillips-Perron (PP) unit root test further indicates the non-existence of unit root within the select variables. Further, the dummy regression model indicates that there persists in a negative relationship between Forex reserves and the Russia-Ukraine crisis. Moreover, there remains a noteworthy short-run and long-run causality between Forex reserves and the Russia-Ukraine crisis. As a result, it is argued that as India is one of Russia's and Ukraine's main trading partners, any unrest there will undoubtedly have an influence on bilateral commerce, which will then have an impact on India's foreign income receipts. This would cause difficulties for India's foreign currency (Forex) reserves, as shown in this analysis. In order to lessen the effects of the crisis and put a check on the balance of payments, it is advised that India look for alternative nations trading in comparable goods and services and that sufficient steps be taken to produce those goods and services locally that are imported from Russia and Ukraine.

Keywords: Forex Reserves, Russia-Ukraine Crisis, Dummy Regression, Causality

Introduction

The entire world is currently dealing with difficult problems, a great deal of uncertainty, and changes in the global environment that have an influence on many industries. Due to its sensitivities brought on by the exposure of foreign currencies to the worldwide market, the foreign exchange (Forex) reserve is also experiencing the impact supported by several studies such as Nikolova (2021),

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Hattori (2021), and others. The crisis between Russia and Ukraine commenced on February 24, 2022, to prohibit Ukraine from joining the Western defensive alliance, NATO. War has always had a negative effect on the economies of countries fighting the war and its neighbouring countries because of the influx of refugees from war-torn countries. So, it is quite certain that any ethnic tension in both these countries certainly affects trade relations with India and its foreign exchange reserves. So, the authors empirically investigate the relationship between the foreign exchange (Forex) reserves of India and the Russia-Ukraine crisis along with short-run and long-run causality.

Past Studies

The authors have made an attempt to study the existing literature from both national and international contexts where some motivating outcomes were prominent that are provided below:

Chortane and Pandey (2022) stated that using event research techniques and market model projections, they look at how the Russia-Ukraine conflict has affected the value of various world currencies relative to the US dollar (USD). The authors demonstrate that the Russia-Ukraine conflict had a detrimental effect on the value of the world's currencies; however, a region-by-region analysis reveals that while European currencies (particularly the Russian rouble, Czech koruna, and Polish zloty) depreciated against the USD, Pacific currencies significantly appreciated, and the currencies of the Middle East and Africa (ME&A) are insignificant, the latter experienced little change. They also demonstrate that Poland and the Czech Republic's currencies have experienced significant depreciation against the US dollar as a result of the financial and economic sanctions placed on Russia as well as the countries' closeness to the conflict area. The announcement by the Russian Central Bank to peg the rouble to gold has also greatly benefited the currencies of ME&A, Europe (especially the Russian rouble and the Polish zloty), and North America. A group of currencies that are immune to exogenous shocks was identified by the analysis. The danger of volatile currencies would be decreased by including these stable currencies in a portfolio. By merging them with other important currencies like the Chinese yuan, Japanese yen, British pound, and euro, future studies can assist acquire further insights.

Kasem, M. A. (2022) introspected that foreign exchange reserves are currently the topic of greatest discussion in the world's emerging nations. As a result, an economic analysis of the factors that determine foreign exchange reserve and their impact on foreign reserves has been done. In this research, the 38 years of secondary data from 1984 to 2021 are used to calculate the factors that affect foreign exchange reserves and how they relate to them. Using Phillips and Augmented Dicky Fuller (ADF), determinants are investigated. To determine whether the determinants are stationary or not, perform the Perron unit

root test. Similarly, to this, the Granger co-integration technique is utilized to show the co-integrating connection between the variables. The ARDL model is also used to determine if the relationship between the foreign exchange reserve, current account balance, external debt, and the exchange rate persists in the long or short-term dimension. Additionally, the model is tested for seasonality using the Kusum and Square Kusum tests to see if it falls below the 5 per cent level of significance or not. The experimental findings support the existence of a powerful relationship between the current account balance, foreign exchange reserves, and exports and imports currency rate and remittance. On the other hand, external factors did not significantly affect debts owed on reserves of foreign currency. Drawing conclusions from these findings, it is possible to indicate that the exchange rate, effective remittance-related initiatives, expansion of export, and limited import of opulent items can all contribute to a healthy economy.

Ozili, P. K. (2022) examines how the Russian-Ukrainian conflict affected the world economy during the month of the invasion. Ukraine was attacked by Russia on February 24, 2022. Multiple international sanctions were placed on Russia as a result of the Russia-Ukraine conflict to force Russia to defuse the situation. Despite being designed to harm Russia, the sanctions imposed had unintended consequences for the global economy, primarily through the disruption of global supply chains. The results demonstrate that there was an increase in the worldwide PMI and an increase in the price of food and food ingredients globally using global data as well as data from the Euro Area, Ukraine, and Russia. On the day of the invasion, the index of stock markets around the world fell. In the month following the invasion, the purchasing managers' index (PMI) for manufacturing in the Euro Area fell. Additionally, the consumer price index's transportation component increased in the month of the invasion as a result of a lack of energy and fuel supplies, which increased the cost of gasoline for transportation in the Euro Area. The invasion had a more severe impact on Ukraine than on Russia or the entire Eurozone. During the invasion, there was a strong correlation between the core consumer prices in Ukraine and the Eurozone. Inflation rates for food were closely tied in Russia and the Euro Area. Additionally, throughout the invasion month, there is a strong and positive association between the world food price index, the world oil price index, the world dairy price index, and the world cereal price index. Global prices increased as a result of the battle, driving up inflation globally. Israel mediated the peace between Russia and Ukraine, but the economic fallout from the crisis continued to be felt throughout much of Europe and beyond.

Sanusi et al. (2019) tried to ascertain whether a country's foreign reserve holdings are influenced by a "fear of floating" or a "fear of capital mobility." Studies on international finance and

economics has yet to answer this problem. By examining the factors that influence the foreign exchange reserves in Southern African nations, this study seeks to add to the continuing discussion. This study applies the ARDL approach inside a panel econometric framework and utilizes annual data sets collected over a 26-year span, from 1990 to 2015. Foreign reserves, capital inflows, exports, inflation, exchange rate, and imports are among the variables in the model. The empirical results demonstrate that the variables under study are co-integrated. According to the data, except for import demand, all of the variables that affect foreign reserve holdings positively over the long term include exports, inflation, currency rates, and imports. In contrast, it was discovered that capital input had no long-term significance in determining reserve holdings. The short-run study provides evidence that none of the independent variables — aside from exchange rate — significantly affect reserve holdings. According to the study, "fear of floating" rather than "fear of capital" is a key factor influencing or determining foreign exchange reserves in Southern African nations.

Ali and Medhekar (2012) stated that one of the least developed nations is Bangladesh. Both supply-side and demand-side issues plague Bangladesh's economy. The goal of this study is to examine how the country's macroeconomic conditions have been managed over the course of two sub-periods: (1) Macroeconomic policy under administrative control, from 1980–81 to 1993–94; and (2) Macroeconomic policy under reform measures, from 1994–95 to 2009–10. The study concludes that neither the Keynesian nor the Monetarist macro models are fully applicable to Bangladesh. A coordinated approach to the fiscal, monetary, exchange rate and debt management policy is necessary to achieve the long-term goal of sustainable economic growth with inflation under control, according to authors, who also claim that Bangladesh's economic performance is a mix of success and failure, not significantly different from that of the majority of poor, less developed countries. Though the nation has experienced some success since independence, authors note that Bangladesh's economic record is a mix of success and failure, not notably different from that of the rest of impoverished third-world nations. According to them, the World Bank and other international donors should be proud of their contributions to the nation's development processes.

Chassang and Miquel (2009) stated that the connection between income per capita and civil unrest is discussed once more in this article. They started by stating that there are two distinct patterns identified in the empirical research. First, civil war is more likely to occur in underdeveloped countries. Second, civil war happens when nations experience adverse income shocks. In a formal model, we look at an explanation that is frequently put forth in the informal literature: civil wars happen in developing nations because there is little opportunity cost to fighting.

They demonstrate that although this explanation is unable to explain the first empirical pattern, it offers a logical theoretical foundation for the second. They then extended the model to include imperfect private information about the status of the economy and demonstrate how mutual anxieties worsen the issue brought on by negative income shocks.

Giuliano and Arranz (2009) stated that despite remittances' growing significance in terms of overall foreign capital flows, the connection between remittances and growth has not been sufficiently investigated. This study examines one of the connections between remittances and growth, namely how the growth of the local financial sector affects a nation's ability to benefit from remittances. The authors discover that remittances stimulate growth in nations with less developed financial systems by providing an alternate method of financing investment and assisting in the removal of liquidity limitations using a newly created dataset for remittances covering around 100 developing countries. This result is robust to a number of robustness tests, including threshold estimation, and controls for the endogeneity of remittances and financial development. It is also independent of the specific financial sector development indicator utilized. They also offer proof that there might be an investment channel via which remittances can foster growth, particularly in cases when the financial sector is unable to meet the population's credit demands.

Kang and Meernik (2005) investigated how civil conflicts affect economies. According to the "war rejuvenation" school of thinking, fighting can promote human capital, bring about technological innovation, and increase economic efficiency by weakening the influence of special interests. According to the "war ruin" school of thought, conflict primarily has negative impacts. The authors aim to respond to two important queries, which viewpoint is more accurate regarding wars and economic growth, first? Second, how much do domestic and international policy decisions have an impact on economic expansion? They created a number of hypotheses to evaluate these claims and tested them using data from all countries between 1960 and 2002 using a 2SLS model. They discover that, in general, wars have detrimental economic effects and that both the fundamentals of the economy and the international community's response to civil wars have a significant impact on economic growth.

Koubi, V. (2005) examines the effects of inter and intra-state wars on economic growth in a wide range of nations between 1960 and 1989. It proves that variations in economic growth among nations are systematically correlated with the intensity and length of the war. The combined pre-war, contemporaneous, and post-war associations between growth and war are negative; as a result, countries that engaged in a serious and/ or protracted conflict have seen the inferior economic performance. War, however, has a beneficial causal impact on post-war economic performance.

Particularly, the longer or more severe the war, the faster the economy will grow in the long run. These results could mean that wars are more likely to occur in underdeveloped nations and/or to have a detrimental direct influence on growth right away. However, over the long term, combat opens up opportunities for growth. It's interesting to note that these consequences, which are quantitatively significant, primarily result from civil wars. For instance, a 10% increase in the length of war causes the average growth rate to rise by 2.1%. Thus, the conclusions of this study are in line with what Organski, Kugler, and Olson's hypotheses predicted.

Dooley et al. (2003) researched that since the U.S. dollar became the most important foreign currency, history demonstrates that the United States has consistently prevailed in wars of exchange rates. The costs of preserving the current model of the international division of labour (IDL going forward) are also certain to rise as a result of the ongoing exchange rate conflict for emerging nations. The defensive strategies of the Renminbi exchange rate policy are consistent with China's modes of economic growth and gradual reform, as well as with the asymmetric international financial system and trading system, in light of the rigid paradigm of IDL and dollar-dominated international monetary system. Therefore, the fundamental strategy for managing the RMB exchange rate over the coming years will continue to be utilizing defensive strategies to cut the costs of preserving the current paradigm of IDL.

After minutely examining the existing studies, it can be stated that though there are several studies persisting on Forex reserves, studies on the Russia-Ukraine crisis are hard to find. Very few pieces of literature have made an attempt to study the crisis, but have failed to capture the relationship and causality over diverse time periods which can be cited as the research gaps within the existing studies.

On the basis of the existing research gaps, the authors decide to study the relationship and causality between the Russia-Ukraine crisis and Indian Forex reserves empirically.

Research Methodology

Dataset and Econometric Tools

This study is based on weekly closing data of the total foreign exchange (Forex) reserve of India (rupees in billion and crores). The total foreign exchange reserve includes foreign currency assets, gold, SDRs, and the reserve status in the IMF. The Forex reserve data of India is collected from the database of the Reserve Bank of India (RBI) *(https://rbi.org.in/scripts/ WSSviewDetail.aspx?PARAM1 =2&type =section)*. All the data are converted into corresponding log natural returns to exclude the innate difficulties associated with time-series data. A dummy is also constructed to represent the Russia-Ukraine crisis.

The period of the study is considered from January 1, 2021, to October 14, 2022, with 93 observations where January 1, 2021, to February 18, 2022, represents the time period before the crisis denoted by

'0' and February 25, 2022, to October 14, 2022, is considered as the time period during the crisis denoted by '1' *(https:// www.cfr.org/global-conflict-tracker/conflict/ conflict-ukraine)*. In fact, the authors more frequently use a time period that includes five years before and after the occurrence of a crisis in order to analyze its economic impact *(Chen et al. 2018)*. But since the crisis between Russia and Ukraine started a few months back, we could not follow the existing conventions which is also a limitation of the study.

In order to study the relationship between the Russia-Ukraine crisis and Indian Forex reserves, we applied a dummy regression model. Moreover, the Phillips-Perron (PP) unit root test is applied to study the non-existence of unit root within the data, and finally, the Johansen Co-integration test and Wald statistics confirm the existence of long-run and short-run causality between the variables. Apart from the above tests, descriptive statistics is also applied. E-views 12 statistical packages is used for computation.

Dummy Linear Regression Model

$$y = \mathsf{S}_0 + \mathsf{S}_1 X + \mathsf{v} \qquad \ldots (1)$$

where y is termed as the dependent variable and X is termed as the independent or explanatory

variable. The terms S_0 and S_1 are the parameters of the model. The parameter is termed an intercept term, and the parameter is termed the slope parameter. These parameters are usually called regression coefficients. The unobservable

error component accounts for the failure of data to lie on a straight line and represents the difference between the true and observed realization of y *(https:// home.iitk.ac.in/~shalab/regression/Chapter2-Regression-SimpleLinearRegression Analysis.pdf)*.

Phillips-Perron Unit Root Test

When it comes to handling serial correlation and heteroscedasticity, this test differs from the ADF test. The test regression disregards the serial correlation. The non-parametric adjustment of t-test statistics is taken into account by the Phillips-Perron test. In time-series analysis, the assumption that a time-series integrates with order 1 must be tested. Here is the test regression:

$$\Delta y_t = \mathsf{S}' D_t + f y_{t-1} + u_t \qquad \ldots (2)$$

Where, is I(0) and may be heteroskedastic. This test also provides the advantage that the researcher has not mandated to state the extent of the lag within the model *(Phillips and Perron, 1988)*.

Johansen Co-Integration Test

The co-integration test admits the existence of a long-run connection between a number of variables in an empirical inquiry, in line with the theory advanced by Johansen in 1988. This model considers the maximum eigenvalue and trace tests even if the data series may have an upward or downward trend. The null hypothesis states that there are no co-integrating equations. The alternative hypothesis states that there must be at least one co-integrating equation. A

likelihood ratio test is used to identify the greatest (remaining) eigenvalue. The test statistic is as follows:

$$LR(r_0, r_0 + 1) = -T \ln(1 - \}_{r0+1}) \qquad ...(3)$$

Where, $LR(r_0, r_0 + 1)$ is the likelihood ratio test statistic for testing whether rank (Π) = r_0 versus the alternative hypothesis that rank (Π) = r_0 + 1. The likelihood ratio test statistic is:

$$LR(r_0, n) = -T \sum_{i=r_0+1}^{n} \ln(1 - \}_i) \qquad ...(4)$$

Where, $LR(r_0, n)$ is the likelihood ratio statistic for testing whether rank (Π) = r versus the alternative hypothesis that rank (Π) $\leq$ n *(Dwyer, G.P., 2015)*.

Wald Test

The Wald test is used to determine a test statistic based on unconstrained regression. The unconstrained estimates' compliance with the null hypothesis's conditions is evaluated using the Wald statistic *(Banumathy & Azhagaiah, 2015)*.

The Wald test often uses an estimate that is asymptotically normal. i.e. $\hat{\,}_{\,}$, which under the null satisfies the property that:

$$\hat{\,}_{\,} \xrightarrow{d} N(\,_0, \dagger^2_0) \qquad ...(5)$$

Where, $\dagger^2_0$ is the variance of the estimator under the null. The canonical example is when $\hat{\,}_{\,}$ is considered to be the MLE. The test statistic is:

$$T_n = \frac{\hat{\,} - \,_0}{\dagger_0} \qquad ...(6)$$

if $\dagger_0$ is not known, an estimate to obtain the statistic can be made:

$$T_n = \frac{\hat{\,} - \,_0}{\hat{\dagger}_0} \qquad ...(7)$$

The null hypothesis is $H_0 : \, = \,_0$ and the alternate hypothesis is $H_0 : \, \neq \,_0$

(http://www.stat.cmu.edu/~siva/705/ lec21.pdf)

Empirical Evidence

Descriptive Statistics

	Forex Reserves	Russia-Ukraine Crisis
Mean	0.0002	0.3586
Median	-0.0005	0
Maximum	0.0293	1
Minimum	-0.0247	0
Std. Dev.	0.0081	0.4822
Skewness	0.3332	0.5892

Kurtosis	2.5256	1.3472
Jarque-Bera	1.6252	1.7954
Probability	0.060	0.081
Sum	0.0253	33
Sum Sq. Dev.	0.006	21.163
Observations	92	92

The probability value of the Jarque-Bera test shows that the data are normal in nature with 92 sample observations. Kurtosis and skewness are also within the acceptable levels.

Phillips-Perron Unit Root Test

	At Level (Trend and Intercept)		At First Difference (Trend and Intercept)	
	Adj. t-Stat	**Prob.***	**Adj. t-Stat**	**Prob.***
Forex Reserves	-8.8215	0.00*	-35.1574	0.0001*
Russia-Ukraine Crisis	-2.0832	0.5478	-9.4576	0.00*
(* indicates significance at 1 per cent level)				

The above table indicates that Forex reserves of India are free from the unit root at both level and first difference. However, the Russia-Ukraine crisis suffers from the problem of unit root at level, but at the first difference there is no problem of unit root and hence the data is free from a random walk.

Dummy Linear Regression Model

Regression Statistics	
Multiple R	0.4329
R Square	0.1542
Adjusted R Square	0.0437
Standard Error	0.0079
Observations	92

The multiple R is the multiple correlation coefficient that measures the goodness of fit of the regression model. Here, the value is 0.4329 indicating 43.29 per cent

goodness of the model in terms of fit. The R squared value explains how the response of the dependent variable i.e., Forex Reserves of India varies to the independent variable i.e., Russia-Ukraine crisis. Here, the value is 0.1542 indicating an explanation of a 15.42 per cent variability in Forex Reserves of India due to the Russia-Ukraine crisis. The standard error is another yardstick to the goodness of fit of the model. The value is 0.0079

i.e., negligible per cent deviation is noted from the trend line.

The regression equation of the study is:

Forex Reserves = -0.390 Russia-Ukraine crisis + 0.0017 ...(8)

This indicates that a change in Russia-Ukraine crisis by 1 per cent will lead to a negative change in Forex Reserves of India by 39 per cent. So, there remains a negative relationship.

Johansen Co-Integration Test

Forex Reserves & Russia-Ukraine Crisis							
Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
None *	0.2630	27.7767	15.4947	0.0005	27.1703	14.2646	0.0003
At most 1	0.0067	0.6063	3.8414	0.4362	0.6063	3.8414	0.4362
(Trace test and Max-Eigen value indicates 1 co-integrating eqn(s) at the 0.05 level)							

Here, the null hypothesis and alternate hypothesis are taken as:

✓ Null Hypothesis (H_0): The number of co-integration vectors is r = r*<k

✓ Alternate Hypothesis (H_1): The number of co-integration vectors is r = k

From the above table, both trace statistics and max-eigen value indicate that there is a noteworthy long-run association between Forex Reserves and Russia-Ukraine Crisis. So, there remains long-run causality between Forex Reserves and Russia-Ukraine Crisis across a long-run time horizon.

Wald Test

Dependent variable	Independent variable	f -statistic	t-statistic	Chi-square	Probability
Forex Reserves	Russia-Ukraine Crisis	2.5820	2.5820	-1.6068	0.100***

(*** indicates significance at 10 per cent level)

Here, the null hypothesis and alternate hypothesis are taken as:

✓ Null Hypothesis (H_0): C(1) = 0

✓ Alternate Hypothesis (H_1):C(1)≠0

It is found that there remains a short-run association between Forex Reserves and the Russia-Ukraine Crisis at a 10 per cent level of significance with a 90 per cent confidence interval. Hence, it can be concluded that there remains short-run causality between Forex Reserves and Russia-Ukraine Crisis.

Concluding Annotations

The recent advent of the conflict between Russia and Ukraine led to a disturbance within the Forex reserves of India as confirmed in this study. A negative relationship is noted between the Forex reserves of India and the Russia-Ukraine crisis. There also remains significant long-run causality confirmed from the results of the Johansen Co-Integration test. There is also a notable short-run causality at a 10 per cent level. From the above results, it can be concluded that the conflict between Russia and Ukraine is affecting the forex reserves not only across a short-run time period, but also across a long-run time horizon. Moreover, it can be concluded that since India is one of the key trading associates with Russia and Ukraine, any uncertainty arising in those countries is certain to affect the bilateral trade leading to an effect on the foreign revenue earnings of India. This will lead to interruptions in the foreign exchange (Forex) reserves of India which is marked in this study. However, it is recommended that India explore other nations that trade in comparable commodities and services. To lessen the effects of the crisis and put a check on the balance of payments, sufficient efforts should be done to manufacture those goods and services that are imported from Russia and Ukraine domestically.

Limitations of the Study

Five years before and five years after the occurrence of any crisis are often chosen by the authors in order to analyze its economic impact *(Chen et al. 2018)*. But we were unable to adhere to the customs because of the Russia and Ukraine conflict occurring a few months back.

Conflict of Interests

The authors declare that there is no conflict of interest that are directly or indirectly related to this research work.

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