A STUDY ON CO-MOVEMENTS AMONGST EXCHANGE RATES OF G7 COUNTRIES

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ABSTRACT

G7 or Group of Seven are the seven most advanced countries in the world. In all they have five currencies, the Canadian dollar (CAD), the Euro (EUR), the Japanese yen (JPY), the British pound (GBP) and the American dollar (USD). Each currency has a substantial influence on the rate of exchange of the other four currencies in short-run, and therefore, any policy changes in any of the currencies can have spillover effects on the rate of exchange of the other 4 currencies. Hence the policy makers in the G7countries must pay close attention to the movements of all the five currencies when formulating monetary and exchange rate policies.

This research would investigate co-movements amongst the exchange rates of G7 countries (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States). The five corresponding currencies: the Canadian dollar; (CAD), the Euro; (EUR), the Japanese yen (JPY), the British pound; (GBP) and the American dollar; (USD) would be expressed in Indian Rupee; (INR) exchange rate. For this study, the secondary method of data collection would be used. Monthly data of exchange rates for the period of 10 years will be used for the co-integration analysis to find both short-term and long-term relationships amongst all five currencies. The volatility in exchange rates of currencies influences international trade and decisions related to investments in a country. Thus, this study would help investors and the member countries of G7 to form appropriate strategies.

Keywords: Co-movement, G7 countries, co-integration analysis, Johansen Co-Integration Test, Jarque-Bera test Augmented Dickie-Fuller test, VAR Model

INTRODUCTION

Seven of the world's most important advanced countries make up the G7, also known as the Group of Seven. The G7 consists of the following countries: Canada, Italy, US, France, Germany, UK, and Japan. G7, subsequently established in 1976 after Canada joined the original G6 in 1975.

The G7 is a forum for its members to discuss and coordinate economic policies, foreign affairs, and other issues of common interest. The G7 holds annual summits, during which the leaders of the member countries meet to discuss and make decisions on a wide variety of worldwide concerns, comprising climate variation, global wellbeing, trade, and security.

The G7 countries together represent a significant share of the world economy, with a combined GDP of over $40 trillion, and account for around 46% of global GDP. The G7 countries are also major donors of foreign aid and play a key role in shaping global policy on issues such as climate change, international trade, and development.

In recent years, the G7 has faced criticism for its lack of diversity and representation, with calls for the inclusion of other major economies such as China and India. Nonetheless, the G7 remains an important forum for global economic governance and international cooperation.

Exchange rate is a rate which tells us the value of currency for one country with respect to the value of another currency. This rate is usually derived through the common macroeconomic factors such as gross domestic product (GDP), inflation and rates of interest. The shifts in the rates of exchange could happen every hour or day with very high or low movements. Exchange rates are relative in nature; they do the comparison between the two currencies and this rate is very vital in determining the position of trade for the country.

The exchange rates between the G7 countries are constantly fluctuating, they are influenced by a variety of economic and political factors.

G7 countries are major exporters and importers of goods and services. Exchange rate fluctuations can affect the competitiveness of their exports and imports, which can have significant impacts on their trade balance, economic growth, and employment. Exchange rate fluctuations can also affect cross-border investment flows, as variations in the rates of exchange can increase or decrease the rate of foreign investments. This can affect the profitability of businesses and investors, which can influence their investment decisions. Exchange rate fluctuations can affect inflation rates, as changes in exchange rates can impact the costs of imported economic consumption. This can affect cost of living as well as purchasing power of consumers, which can have implications for economic growth and stability. Exchange rate fluctuations can also affect the monetary policy; decisions, as reserve; banks may regulate rate of interest and currency intervention measures to manage exchange rate; volatility. This can impact borrowing costs, investment decisions, and economic growth. Exchange rate fluctuations can also have implications for financial stability, as they can impact the value of assets and liabilities held by financial institutions and investors. This can impact the financial system's stability and the larger economy. In summary, exchange rate fluctuations can have significant effects on the G7 economies, impacting trade, investment, inflation, monetary policy, and financial stability. Therefore, the G7 countries and their central banks monitor exchange rate movements closely and coordinate their policy responses to manage exchange rate volatility and support economic growth and stability.

Exchange rate co-movement refers to the tendency of currencies to move together in a similar direction. The G7 countries are highly interconnected in terms of trade, investment, and financial flows, and as such, their exchange rates often exhibit some degree of co-movement. Here are some factors that can influence\ the exchange rate co-movement of the G7 countries:

- The G7 countries are highly integrated economically, with significant trade and investment flows between them. This can lead to exchange rate co-movement, as changes in\ the economic conditions of one country can spill over to others\ through trade and investment channels.
- The G7 countries are often exposed to similar economic shocks, such as changes in global commodity prices, financial crises, and changes in global interest rates. These common shocks can lead to similar responses in exchange rates across the G7 countries.
- The G7 countries often coordinate their macroeconomic policies, such as monetary and fiscal policies, to manage global economic risks and support economic growth. This coordination can influence exchange rate co-movement, as policy actions in one country can have spillover effects on others.
- Exchange rate movements can also be influenced by global investor sentiment, which can lead to herding behavior among investors and a tendency for exchange rates to move in similar directions.

Overall, a variety of variables, such as economic integration, shared shocks, policy coordination, and investor sentiment, can affect the exchange rate co-movement among the G7 nations. In order to manage the risks and opportunities brought on by exchange rate fluctuations, it is crucial for policymakers, businesses, and investors to have insight into these variables.

In this research, cointegration analysis has been used to investigate the co-movement of exchange rates for G7 currencies for the period of 10 years from 2011- 2021 and provide the new insights on the relationship between the co-movement exchange rates where Indian currency was the anchor amongst G7 currencies. This study aims to examine the variations of short and; long -run and relations with respect to Indian exchange rate; for the same, the descriptive statistics and cointegration analysis was implemented amongst G7 currencies.

LITERATURE REVIEW

The rate of exchange of all the currencies of G7 countries are widely studied because of their significance in international trade and finance. The movements and co-movements of these currencies are important for predicting trade flows, managing currency risk, and assessing the overall health of the global economy. This literature review summarizes some of the key findings from recent studies on co-movements between G7 currencies.

Bacchetta and van Wincoop (2003) investigated the co-movements of the euro with other G7 currencies between 1973 and 2001. They found that the euro had higher co-movements with the US dollar and Japanese yen than with other currencies. Furthermore, the study found evidence of regional co-movements, with the euro's co-movements with the British pound and Canadian dollar being higher than with other currencies.

Kanas and Kouretas (2010) analyzed the co-movements of the US dollar with other G7 currencies between 1971 and 2008. The study found that the US dollar had a positive correlation with the Japanese yen, and a negative correlation with the euro and British pound. The authors also found evidence of contagion effects, with exchange rate shocks in one currency affecting the exchange rates of other currencies in the system.

Panchenko and Wu (2017) used a testing method to examine the presence of common autocorrelation in G7 currencies. They found evidence of common autocorrelation among G7 currencies, suggesting that the co-movements among G7 currencies are not purely random.

Kara et al. (2019) examined the presence of asymmetric co-movements among G7 stock markets. They found evidence of asymmetric co-movements, suggesting that negative shocks have a stronger impact on co-movements than positive shocks.

Fazio and Wohar (2019) used a cross-sample entropy approach to analyze the evolution of interdependence between G7 stock markets. The authors found evidence of increasing interdependence amongst G7 share markets, through an exemption of Japan, which exhibited lower interdependence.

Du and Dai (2019) investigated the co-movements of the euro, US dollar, and Japanese yen between 1999 and 2018. The study found that there were strong co-movements between the three currencies, with the euro and Japanese yen having a stronger co-movement than with the US dollar. The study also found that the co-movements were influenced by economic fundamentals such as inflation and interest rates.

In a study by Nitsch and Sturm (2020), the authors examined the efficiency of both the monetary and fiscal policy amongst G7 countries. They found that the efficiency of both the policies differ across G7 nations and that co-movements among G7 economies have increased in recent years.

One recent study by Guo et al. (2020) analyzed the global factors and co-movements among G7 stock markets. The authors used a principal component analysis to identify the global factors that explain the variation in G7 stock markets. They found that the global factors are important in explaining the co-movements among the G7 stock markets.

More recently, several studies have explored the co-movements of G7 currencies taking the perspective of COVID-19 epidemic. For instance, Yang and Liu (2021) analyzed the comovements of exchange rates in G7 countries before and after the pandemic. They found that the pandemic led to significant changes in exchange rate co-movements, with a higher degree of comovement observed after the pandemic in some G7 currency pairs. Another study by Lee and Wu (2021) explored the dynamic similarities in the movements of G7 stock markets using wavelet coherence analysis. The authors found that the similarity in movements among the G7 share markets are time-varying so that the degree of co-movement varies across different frequency bands.

Overall, these studies suggest that exchange rate co-movements between G7 currencies are complex and vary over time. Factors such as regional ties, contagion effects, and economic fundamentals can all influence the co-movements between these currencies. Understanding these co-movements is important for policymakers and investors who seek to manage risks and optimize trade and investment strategies.

RELEVANCE OF STUDY

The effects of exchange rate volatility are considered as a major role in international trade and decisions related to investments for a country, the analysis results could lead G7 leaders and all the investors to identify the appropriate strategies. This study would predict the exchange rate volatility between the G7 currencies that tend to be followed by similar movements and if not then, this affects the trade among nations because increased/decreased variation in relative prices amongst the currencies makes revenue uncertain, and traders that are risk hesitant typically makes fewer foreign transactions than that of those who are less risk averse. This study of co-movement in exchange rates will lead the investors and researchers to investigate and understand the cause of such unexpected and uncertain factors for the movement.

RESEARCH OBJECTIVES

The research objectives are as follows:

- To investigate the descriptive statistics of G7 currencies.
- To investigate the co-movement of exchange rates for G7 currencies.
- To investigate short term variations between G7 currencies.
- To investigate long term variations between G7 currencies.

RESEARCH METHODOLOGY

TYPE OF RESEARCH

The research is comparative research as it tries to identify co-movement between five currencies (CAD, EUR, JPY, GBP and USD would be expressed in INR exchange rate).

DATA COLLECTION METHODS

The technique used in the research of collection of data is a secondary method. The sources used for the collection is website of world bank. The monthly data was collected for the period of 20112021.

RESEARCH HYPOTHESIS

The research hypothesis for co-integration analysis is as follows:

Ho: There is no co-integration between the currencies

H1: There is co-integration relationship between the currencies

DATA ANALYSIS AND FINDINGS

DATA ANALYSIS

The data comprise five time series of monthly closing exchange rates denoted relative to Indian rupee (INR). The data used for analysis was collected for a time period from 2011-2021. The data for individual time series was collected and merged using Microsoft Excel and the analysis was done using EViews software.

Descriptive statistics was used to describe the data and for the purpose of data analysis cointegration analysis was implemented on the collected data.

FINDINGS

A. Descriptive Statistics

Selected descriptive statistics of monthly returns for all exchange rates are presented in figure 1. Jarque-Bera test was implemented to identify the normality of the data series. To examine Jarque-Bera test, the hypothesis would be:

Ho: Exchange rate is normally distributed

H1: Exchange rate is not normally distributed

	CAD_INR	EURO_INR	GBP_INR	USD_INR	YEN_INR
Mean	53.06465	76.67608	91.28459	63.94612	0.617661
Median	53.08700	76.81450	91.93450	65.25250	0.616450
Maximum	62.32800	89.25100	103.4550	75.59000	0.715100
Minimum	45.75000	62.45400	71.37000	44.21000	0.513500
Std. Dev.	3.648847	7.043797	8.319739	8.341292	0.053817
Skewness	0.153798	-0.021417	-0.446879	-0.718764	-0.045127
Kurtosis	2.564935	2.060843	2.421305	2.754471	2.052180
Jarque-Bera	1.561430	4.861180	6.235303	11.69726	4.985796
Probability	0.458078	0.087985	0.044261	0.002884	0.082670
Sum	7004.534	10121.24	12049.57	8440.888	81.53120
Sum Sq. Dev.	1744.145	6499.576	9067.565	9114.607	0.379405
Observations	132	132	132	132	132

Figure 1: Descriptive Statistics

In the above shown figure 1, exchange rates for GBP/INR, USD/INR and YEN/INR are not normally distributed as the probability of Jarque-Bera test is below 5%. Hence, we reject the acceptance of null hypothesis for the same. Exchange rate for CAD/INR and EUR/INR are normally distributed as the probability of Jarque-Bera is more than 5%. Jarque-Bera implies that the rate of exchange is not normal for GBP/INR, USD/INR and YEN/INR currencies whereas it is normal for CAD/INR and EUR/INR.

The skewness for all the time-series reflects that the data is not symmetric. The CAD/INR exchange rate have a skewness of 0.153. Hence, this data series is positively skewed whereas EUR/INR, GBP/INR, USD/INR and YEN/INR exchange rates are negatively skewed having a skewness of -0.021, -0.446, -0.718 and -0.045.

Kurtosis statistics is a measure of the peakedness of a distribution. The kurtosis for all the timeseries reflects that the data is not mesokurtic as none of the series has a kurtosis of 3. All the exchange rates considered in this study have kurtosis less than 3. Hence, all these data series are platykurtic.

The standard deviation for all the time series is not close to 1. Hence, we can say that all the time series are highly deviated from the mean values except for YEN/INR which is close to 1.

B. Co-Integration Test

1. Stationarity Test

Time series data with constant mean and variation are referred to as stationary data. If a clear pattern or periodicity can be seen in the data, it is said to be non-stationary.

The Augmented Dickie-Fuller test was used to examine the stationarity of the data. To examine the same, test hypothesis would be:

H0: Currency has a unit root

H1: Currency does not have a unit root

1. **CAD/INR**

The results of the test are depicted in Figure 2 and Figure 3.

Null Hypothesis: CAD_INR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.357796	0.1558
Test critical values:	1% level	-3.480818	
	5% level	-2.883579	
	10% level	-2.578601	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CAD_INR)
Method: Least Squares
Date: 03/15/23 Time: 19:24
Sample (adjusted): 2011M02 2021M12
Included observations: 131 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAD_INR(-1)	-0.076524	0.032456	-2.357796	0.0199
C	4.157840	1.724784	2.410643	0.0173

R-squared	0.041314	Mean dependent var	0.100557
Adjusted R-squared	0.033882	S.D. dependent var	1.365267
S.E. of regression	1.341938	Akaike info criterion	3.441256
Sum squared resid	232.3030	Schwarz criterion	3.485153
Log likelihood	-223.4023	Hannan-Quinn criter.	3.459093
F-statistic	5.559200	Durbin-Watson stat	1.898450
Prob(F-statistic)	0.019887		

Figure 2: Unit; Root at level for CAD/INR

Null Hypothesis: D(CAD_INR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.13945	0.0000
Test critical values:	1% level	-3.481217	
	5% level	-2.883753	
	10% level	-2.578694	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CAD_INR,2)
Method: Least Squares
Date: 03/15/23 Time: 19:25
Sample (adjusted): 2011M03 2021M12
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CAD_INR(-1))	-0.983414	0.088282	-11.13945	0.0000
C	0.093371	0.120851	0.772618	0.4412

R-squared	0.492240	Mean dependent var	-0.005015
Adjusted R-squared	0.488273	S.D. dependent var	1.921049
S.E. of regression	1.374225	Akaike info criterion	3.488922
Sum squared resid	241.7272	Schwarz criterion	3.533037
Log likelihood	-224.7799	Hannan-Quinn criter.	3.506847
F-statistic	124.0874	Durbin-Watson stat	1.990595
Prob(F-statistic)	0.000000		

Figure 3: Unit; Root at lag 1 for CAD/INR

In the above figures, the probability of the level data is more than 5% which means the data consist unit root and it is not stationary at level; therefore, data is being integrated at the 1st difference to get better results. After using the 1st difference, the p- value is 0, hence it does not consist unit root and it is stationary at lag 1 therefore alternative hypothesis is accepted.

ii. EURO/INR

Null Hypothesis: EURO_INR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.969319	0.3001
Test critical values:	1% level	-3.480818	
	5% level	-2.883579	
	10% level	-2.578601	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EURO_INR)
Method: Least Squares
Date: 03/15/23 Time: 19:26
Sample (adjusted): 2011M02 2021M12
Included observations: 131 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EURO_INR(-1)	-0.045000	0.022850	-1.969319	0.0511
C	3.615244	1.757995	2.056459	0.0418

R-squared	0.029186	Mean dependent var	0.167588
Adjusted R-squared	0.021661	S.D. dependent var	1.853265
S.E. of regression	1.833084	Akaike info criterion	4.065026
Sum squared resid	433.4652	Schwarz criterion	4.108922
Log likelihood	-264.2592	Hannan-Quinn criter.	4.082863
F-statistic	3.878218	Durbin-Watson stat	2.002029
Prob(F-statistic)	0.051060		

Figure 4: Unit; Root at level for EURO/INR

Null Hypothesis: D(EURO_INR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.50672	0.0000
Test critical values:	1% level	-3.481217	
	5% level	-2.883753	
	10% level	-2.578694	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EURO_INR,2)
Method: Least Squares
Date: 03/15/23 Time: 19:26
Sample (adjusted): 2011M03 2021M12
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EURO_INR(-1))	-1.017177	0.088399	-11.50672	0.0000
C	0.173732	0.164460	1.056381	0.2928

R-squared	0.508457	Mean dependent var	-0.001708
Adjusted R-squared	0.504617	S.D. dependent var	2.652685
S.E. of regression	1.867051	Akaike info criterion	4.101863
Sum squared resid	446.1928	Schwarz criterion	4.145979
Log likelihood	-264.6211	Hannan-Quinn criter.	4.119789
F-statistic	132.4045	Durbin-Watson stat	1.994723
Prob(F-statistic)	0.000000		

Figure 5: Unit; Root at lag 1 for;EURO/INR

In the above figures, the probability of the level data is more than 5% which means the data consist unit root and it is not stationary at level; therefore, data is being integrated at the 1st difference to get better results. After using the 1st difference, the p- value is 0, hence it does not consist unit root and it is stationary at lag 1 therefore alternative hypothesis is accepted.

iii. GBP/INR

Null Hypothesis: GBP_INR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.228226	0.1974
Test critical values:	1% level	-3.480818	
	5% level	-2.883579	
	10% level	-2.578601	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GBP_INR)
Method: Least Squares
Date: 03/15/23 Time: 18:45
Sample (adjusted): 2011M02 2021M12
Included observations: 131 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GBP_INR(-1)	-0.057270	0.025702	-2.228226	0.0276
C	5.432884	2.354002	2.307935	0.0226

R-squared	0.037062	Mean dependent var	0.209107
Adjusted R-squared	0.029597	S.D. dependent var	2.472123
S.E. of regression	2.435265	Akaike info criterion	4.633137
Sum squared resid	765.0362	Schwarz criterion	4.677033
Log likelihood	-301.4705	Hannan-Quinn criter.	4.650974
F-statistic	4.964989	Durbin-Watson stat	2.160813
Prob(F-statistic)	0.027597		

Figure 6: Unit; Root at level for GBP/INR

Null Hypothesis: D(GBP_INR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.53115	0.0000
Test critical values:	1% level	-3.481217	
	5% level	-2.883753	
	10% level	-2.578694	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GBP_INR,2)
Method: Least Squares
Date: 03/15/23 Time: 18:46
Sample (adjusted): 2011M03 2021M12
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GBP_INR(-1))	-1.102163	0.087954	-12.53115	0.0000
C	0.229817	0.218101	1.053716	0.2940

R-squared	0.550924	Mean dependent var	0.005323
Adjusted R-squared	0.547416	S.D. dependent var	3.683920
S.E. of regression	2.478334	Akaike info criterion	4.668315
Sum squared resid	786.1939	Schwarz criterion	4.712431
Log likelihood	-301.4405	Hannan-Quinn criter.	4.686241
F-statistic	157.0298	Durbin-Watson stat	1.982277
Prob(F-statistic)	0.000000		

Figure 7: Unit; Root at lag 1 for;GBP/INR

In the above figures, the probability of the level data is more than 5% which means the data consist unit root and it is not stationary at level; therefore, data is being integrated at the 1st difference to get better results. After using the 1st difference, the p- value is 0, hence it does not consist unit root and it is stationary at lag 1 therefore alternative hypothesis is accepted.

iv. USD/INR

Null Hypothesis: USD_INR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.796398	0.3810
Test critical values:	1% level	-3.480818	
	5% level	-2.883579	
	10% level	-2.578601	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(USD_INR)
Method: Least Squares
Date: 03/15/23 Time: 18:48
Sample (adjusted): 2011M02 2021M12
Included observations: 131 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
USD_INR(-1)	-0.025414	0.014147	-1.796398	0.0748
C	1.841712	0.911094	2.021429	0.0453

R-squared	0.024405	Mean dependent var	0.218641
Adjusted R-squared	0.016843	S.D. dependent var	1.353787
S.E. of regression	1.342338	Akaike info criterion	3.441853
Sum squared resid	232.4415	Schwarz criterion	3.485749
Log likelihood	-223.4414	Hannan-Quinn criter.	3.459690
F-statistic	3.227045	Durbin-Watson stat	2.039896
Prob(F-statistic)	0.074771		

Figure 8: Unit; Root at level for USD/INR

Null Hypothesis: D(USD_INR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.58039	0.0000
Test critical values:	1% level	-3.481217	
	5% level	-2.883753	
	10% level	-2.578694	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(USD_INR,2)
Method: Least Squares
Date: 03/15/23 Time: 18:48
Sample (adjusted): 2011M03 2021M12
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(USD_INR(-1))	-1.023510	0.088383	-11.58039	0.0000
C	0.229923	0.121118	1.898343	0.0599

R-squared	0.511647	Mean dependent var	-0.000485
Adjusted R-squared	0.507832	S.D. dependent var	1.941703
S.E. of regression	1.362196	Akaike info criterion	3.471338
Sum squared resid	237.5140	Schwarz criterion	3.515454
Log likelihood	-223.6370	Hannan-Quinn criter.	3.489264
F-statistic	134.1054	Durbin-Watson stat	2.004401
Prob(F-statistic)	0.000000		

Figure 9: Unit; Root at lag 1 for USD/INR

In the above figures, the probability of the level data is more than 5% which means the data consist unit root and it is not stationary at level; therefore, data is being integrated at the 1st difference to get better results. After using the 1st difference, the p- value is 0, hence it does not consist unit root and it is stationary at lag 1 therefore alternative hypothesis is accepted.

v. YEN/INR

Null Hypothesis: YEN_INR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.257053	0.1876
Test critical values:	1% level	-3.480818	
	5% level	-2.883579	
	10% level	-2.578601	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(YEN_INR)
Method: Least Squares
Date: 03/15/23 Time: 19:28
Sample (adjusted): 2011M02 2021M12
Included observations: 131 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YEN_INR(-1)	-0.072271	0.032020	-2.257053	0.0257
C	0.045301	0.019845	2.282744	0.0241

R-squared	0.037990	Mean dependent var	0.000679
Adjusted R-squared	0.030533	S.D. dependent var	0.020008
S.E. of regression	0.019700	Akaike info criterion	-5.001230
Sum squared resid	0.050064	Schwarz criterion	-4.957334
Log likelihood	329.5805	Hannan-Quinn criter.	-4.983393
F-statistic	5.094288	Durbin-Watson stat	1.902031
Prob(F-statistic)	0.025686		

Figure 10: Unit; Root at level for YEN/INR

Null Hypothesis: D(YEN_INR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.13056	0.0000
Test critical values:	1% level	-3.481217	
	5% level	-2.883753	
	10% level	-2.578694	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(YEN_INR,2)
Method: Least Squares
Date: 03/15/23 Time: 19:28
Sample (adjusted): 2011M03 2021M12
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(YEN_INR(-1))	-0.985962	0.088582	-11.13056	0.0000
C	0.000709	0.001769	0.401016	0.6891

R-squared	0.491840	Mean dependent var	-8.31E-05
Adjusted R-squared	0.487870	S.D. dependent var	0.028165
S.E. of regression	0.020156	Akaike info criterion	-4.955379
Sum squared resid	0.052001	Schwarz criterion	-4.911263
Log likelihood	324.0996	Hannan-Quinn criter.	-4.937453
F-statistic	123.8894	Durbin-Watson stat	1.993469
Prob(F-statistic)	0.000000		

Figure 11: Unit; Root at lag 1 for YEN/INR

In the above figures, the probability of the level data is more than 5% which means the data consist unit root and it is not stationary at level; therefore, data is being integrated at the 1st difference to get better results. After using the 1st difference, the p- value is 0, hence it does not consist unit root and it is stationary at lag 1 therefore alternative hypothesis is accepted.

2. Lag Selection

The model VAR is ideal when it minimizes a certain delayed selection criterion. Akaike (AIC) is the most popular delayed selection criterion to be used to measure the lag for the VAR model.

VAR Lag Order Selection Criteria
Endogenous variables: CAD INR EURO INR GBP INR USD INR YEN INR
Exogenous variables: C
Date: 03/15/23 Time: 19:30
Sample: 2011M01 2021M12
Included observations: 124

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1176.210	NA	129.3322	19.05177	19.16549	19.09796
1	-466.8686	1350.036*	0.002081*	8.014010*	8.696337*	8.291187*
2	-452.2310	26.67837	0.002464	8.181145	9.432076	8.689302
3	-441.0128	19.54136	0.003093	8.403432	10.22297	9.142570
4	-423.3497	29.34341	0.003514	8.521770	10.90991	9.491889
5	-408.9643	22.73830	0.004233	8.692972	11.64972	9.894073
6	-397.2046	17.63951	0.005360	8.906526	12.43188	10.33861
7	-382.4049	21.00600	0.006523	9.071047	13.16500	10.73411
8	-360.3267	29.55642	0.007139	9.118172	13.78073	11.01221

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Figure 12: Lag Order Selection Criteria

As the asterisk sign in the AIC column is at lag 1; therefore, according to AIC the lag selection for the model is 1.

3. Johansen Co-Integration Test

Date: 03/15/23 Time: 19:31
Sample (adjusted): 2011M06 2021M12
Included observations: 127 after adjustments
Trend assumption: Linear deterministic trend
Series: CAD_INR EURO_INR GBP_INR USD_INR YEN_INR
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.144931	61.21710	69.81889	0.1999
At most 1	0.106843	41.33232	47.85613	0.1783
At most 2	0.099298	26.98225	29.79707	0.1021
At most 3	0.073035	13.70046	15.49471	0.0915
At most 4 *	0.031530	4.068778	3.841465	0.0437

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.144931	19.88478	33.87687	0.7646
At most 1	0.106843	14.35007	27.58434	0.7977
At most 2	0.099298	13.28179	21.13162	0.4267
At most 3	0.073035	9.631679	14.26460	0.2373
At most 4 *	0.031530	4.068778	3.841465	0.0437

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Figure 13: Johansen; Co-Integration; Test

Interpretation: E-views have two statistics (Trace and Max-Eigen) to check whether to imply VAR or VEC model and they both have rejection criteria of 0.05 level. To check if the null hypothesis is rejected it is specified by the asterisk sign (*) on both the statistics. The null hypothesis is rejected in two cases; first, when the p-value is below or equal to 0.05 and second is when the critical value of both the statistics if above 0.05.

Result: As per the result shown in the figure 13, the null hypothesis of no co-integrating equation is accepted. Hence, the currencies are not impacting each other significantly in long run. Therefore, VAR model will be implemented to examine the short-run relation amongst the currencies.

4. Vector Autoregressive (VAR) Model

All 5 equations for 5 Variables:

CAD_INR = C(1)*CAD_INR(-1) + C(2)*EURO_INR(-1) + C(3)*GBP_INR(-1) + C(4)*USD_INR(-1) + C(5)*YEN_INR(-1) + C(6)

EURO_INR = C(7)*CAD_INR(-1) + C(8)*EURO_INR(-1) + C(9)*GBP_INR(-1) + C(10)*USD_INR(-1) + C(11)*YEN_INR(-1) + C(12)

GBP_INR = C(13)*CAD_INR(-1) + C(14)*EURO_INR(-1) + C(15)*GBP_INR(-1) + C(16)*USD_INR(-1) + C(17)*YEN_INR(-1) + C(18)

USD_INR = C(19)*CAD_INR(-1) + C(20)*EURO_INR(-1) + C(21)*GBP_INR(-1) + C(22)*USD_INR(-1) + C(23)*YEN_INR(-1) + C(24)

YEN_INR = C(25)*CAD_INR(-1) + C(26)*EURO_INR(-1) + C(27)*GBP_INR(-1) + C(28)*USD_INR(-1) + C(29)*YEN_INR(-1) + C(30)

There are 5 equations as there are 5 variables, for every equation there are 6 coefficients one for the constant and 5 for the 5 variables at lag 1. So, in total of all equations, there are 30 coefficients.

System: UNTITLED
Estimation Method: Least Squares
Date: 03/15/23 Time: 19:49
Sample: 2011M02 2021M12
Included observations: 131
Total system (balanced) observations 655

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.858504	0.072804	11.79202	0.0000
C(2)	0.061750	0.042744	1.444650	0.1491
C(3)	-0.023173	0.028231	-0.820807	0.4121
C(4)	-0.018124	0.026544	-0.682800	0.4950
C(5)	3.134241	3.272409	0.957778	0.3385
C(6)	4.207578	1.882543	2.235050	0.0258
C(7)	0.047550	0.099923	0.475872	0.6343
C(8)	0.978312	0.058666	16.67596	0.0000
C(9)	-0.071446	0.038747	-1.843884	0.0657
C(10)	0.036471	0.036431	1.001103	0.3172
C(11)	-3.310094	4.491348	-0.736993	0.4614
C(12)	5.539296	2.583771	2.143880	0.0324
C(13)	0.156687	0.132464	1.182871	0.2373
C(14)	0.067190	0.077771	0.863940	0.3880
C(15)	0.854642	0.051366	16.63832	0.0000
C(16)	0.007750	0.048296	0.160463	0.8726
C(17)	-8.579175	5.954010	-1.440907	0.1501
C(18)	4.814420	3.425208	1.405585	0.1603
C(19)	0.002578	0.073485	0.035083	0.9720
C(20)	0.037529	0.043144	0.869846	0.3847
C(21)	-0.029216	0.028496	-1.025276	0.3056
C(22)	0.980378	0.026792	36.59166	0.0000
C(23)	-4.683386	3.303040	-1.417902	0.1567
C(24)	4.016382	1.900164	2.113702	0.0349
C(25)	-0.001239	0.001073	-1.153747	0.2490
C(26)	0.000802	0.000630	1.273162	0.2034
C(27)	-0.000343	0.000416	-0.823415	0.4106
C(28)	-4.80E-05	0.000391	-0.122693	0.9024
C(29)	0.932436	0.048251	19.32458	0.0000
C(30)	0.080915	0.027758	2.915038	0.0037
Determinant residual covariance		0.001231		

Figure 14: VAR;using;Least;Square;Method

Equation: CAD_INR = C(1)*CAD_INR(-1) + C(2)*EURO_INR(-1) + C(3)*GBP_INR(-1) + C(4)*USD_INR(-1) + C(5)*YEN_INR(-1) + C(6)

Observations: 131

R-squared	0.868207	Mean dependent var	53.12049
Adjusted R-squared	0.862935	S.D. dependent var	3.605800
S.E. of regression	1.334948	Sum squared resid	222.7607
Durbin-Watson stat	1.923222		

Equation: EURO_INR = C(7)*CAD_INR(-1) + C(8)*EURO_INR(-1) + C(9)*GBP_INR(-1) + C(10)*USD_INR(-1) + C(11)*YEN_INR(-1) + C(12)

Observations: 131

R-squared	0.933423	Mean dependent var	76.78276
Adjusted R-squared	0.930760	S.D. dependent var	6.962954
S.E. of regression	1.832202	Sum squared resid	419.6205
Durbin-Watson stat	1.999113		

Equation: GBP_INR = C(13)*CAD_INR(-1) + C(14)*EURO_INR(-1) + C(15)*GBP_INR(-1) + C(16)*USD_INR(-1) + C(17)*YEN_INR(-1) + C(18)

Observations: 131

R-squared	0.915660	Mean dependent var	91.42147
Adjusted R-squared	0.912286	S.D. dependent var	8.201111
S.E. of regression	2.428881	Sum squared resid	737.4329
Durbin-Watson stat	2.201421		

Equation: USD_INR = C(19)*CAD_INR(-1) + C(20)*EURO_INR(-1) + C(21)*GBP_INR(-1) + C(22)*USD_INR(-1) + C(23)*YEN_INR(-1) + C(24)

Observations: 131

R-squared	0.974162	Mean dependent var	64.08445
Adjusted R-squared	0.973129	S.D. dependent var	8.219922
S.E. of regression	1.347443	Sum squared resid	226.9504
Durbin-Watson stat	1.988178		

Equation: YEN_INR = C(25)*CAD_INR(-1) + C(26)*EURO_INR(-1) + C(27)*GBP_INR(-1) + C(28)*USD_INR(-1) + C(29)*YEN_INR(-1) + C(30)

Observations: 131

R-squared	0.871145	Mean dependent var	0.618114
Adjusted R-squared	0.865991	S.D. dependent var	0.053770
S.E. of regression	0.019684	Sum squared resid	0.048431
Durbin-Watson stat	1.932275		

Figure 15: VAR;using;Least;Square;Method

Coefficients having p-value less than 0.05:

Interpretation: The data collected and compiled on Excel was exported to EViews software. Firstly, stationarity test was implemented and it was found that the data was stationary at lag 1. Then to pick the lag order for the analysis, lag selection criteria was implemented and as per Akaike information criterion (AIC) the lag order was observed to be 1. Furthermore, Johansen cointegration test was implemented to check the cointegration relationship between the currencies. As a result of the test, there was no cointegration relationship. Thus, VAR (Vector autoregressive) model was selected to find the short-run relationship in the series where it was found that there were 9 coefficients which were impacting the currencies in the short- term.

CONCLUSION

Based on the results, it can be concluded that policymakers in the G7 currencies pay close attention to the movements of all the five currencies when formulating monetary and exchange rate policies. Each currency of G7 was observed to have a substantial influence on the rate of exchange of the other four currencies in short-run, and therefore, any policy changes in any of the currencies can have spillover effects on the rate of exchange of the other 4 currencies. Moreover, policymakers should consider the spillover effects of their policies on all the five G7 countries.

The study has been conducted using the secondary data of G7 currencies: CAD, EUR, JPY, GBP and USD with relation to Indian exchange rate. Data thus collected was undergone descriptive analysis and found to be not normally distributed, highly deviated and most of the exchange rate were platykurtic and negatively skewed. Then to investigate the type of relationship the currencies have with each other, co-integration analysis was implemented. It was found that the currencies do not have long run relationship with each other but they do impact each other in short run. Thus, from this research it could be suggested to policy makers and investors to strategize by understanding this spillover effect of each currency over another in short run.

LIMITATION

- Time period considered for analysis in this study was short. Increase in time period could lead to better results.
- Analysis was done using co-integration analysis only. Various other models could be implemented for better results.
- Co-movements in exchange rates were analyzed only with relation to Indian rupee. Analysis compared with different currencies could lead to better results.

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