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Does FX market in India integrated to exchange rate theories? a review amidst COVID-19

¿El mercado de divisas en la India se integra a las teorías del tipo de cambio? una revisión en medio de COVID-19

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Abstract

The exchange rate theories argue that the parity between two currencies is determined by various macro-economic factors prevailing across economies. It is quite interesting to examine what happened to currency exchange rates in a period of inactivity for the overall economies due to COVID-19 outbreak. In this context a study was carried out during the period of turbulence to empirically test whether foreign exchange market in India moves in accordance with the principles of exchange rate theories. The bound test of co-integration (Pesaran,et.al., 2001) was employed to examine the evidence of a long-run relationship between the macroeconomic variables with the exchange rate of hard currencies such as USD, EUR, GBP and JPY against INR. The cross sectional relationship was further validated by using auto regressive distributed lag (ARDL) model. The absolute version of purchasing power parity theory (PPP) is evident in the Indian foreign exchange market as the analysis established a strong integration of Wholesale Price Index (WPI) and Consumer Price Index (CPI) with leading hard currencies such as USD, EUR and JPY. The association of 364 days Treasury bill return (TBR) and government Bond Return (GBR) further confirmed the postulation of Interest Rate Parity (IRP) theory as any increase in interest rate can cause exchange rate depreciation to INR. Results of this study add to the existing literature by confirming the bondage between price levels across the economies and the exchange rates during COVID-

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19 crisis. The result urges active market intervention from the policymakers even if the economy is not fully functional.

JEL Code: C01, F31, G12, O24
Keywords: FX market; PPP theory; IRP theory; Fisher effect; ARDL model

Resumen

Las teorías del tipo de cambio argumentan que la paridad entre dos monedas está determinada por varios factores macroeconómicos que prevalecen a través de sus economías. Es bastante interesante examinar qué sucedió con los tipos de cambio en un período de inactividad para las economías en general debido al brote de COVID-19. En este contexto, se llevó a cabo un estudio durante el período de turbulencia para probar empíricamente si el mercado de divisas en la India se mueve de acuerdo con los principios de las teorías del tipo de cambio. Se empleó la prueba de cointegración ligada (Pesaran, et.al., 2001) para examinar la evidencia de una relación a largo plazo entre las variables macroeconómicas con el tipo de cambio de monedas duras como USD, EUR, GBP y JPY frente a INR. La relación de corte transversal se validó aún más mediante el uso del modelo de rezagos distribuidos autorregresivos (ARDL). La versión absoluta de la teoría de la paridad del poder adquisitivo (PPA) es evidente en el mercado de divisas de la India, ya que el análisis estableció una fuerte integración del Índice de Precios de Mayoreo (WPI) y el Índice de Precios al Consumidor (CPI) con las principales monedas duras como USD, EUR y JPY. La asociación del rendimiento de los Certificados de la Tesorería (TBR) a 364 días y el rendimiento de los bonos del gobierno (GBR) confirmó aún más la postulación de la teoría de la paridad de la tasa de interés (IRP), ya que cualquier aumento en la tasa de interés puede causar una depreciación del tipo de cambio a INR. Los resultados de este estudio se suman a la literatura existente al confirmar la vinculación entre los niveles de precios en las economías y los tipos de cambio durante la crisis de COVID-19. El resultado exige una intervención activa en el mercado por parte de los formuladores de políticas, incluso si la economía no está funcionando completamente.

Código JEL: C01, F31, G12, O24
Palabras clave: mercado de divisas; teoría de la PPA; teoría del IRP; efecto Fisher; modelo ARDL

Introduction

COVID-19 outbreak was first conveyed in December 2019 and the government of India urged for a nationwide lockdown on 24th March 2020. Till then the nation is going through several waves of COVID-19 though restoration to normalcy is still standing as a delusion. Since the international monetary flow was not normalized as it before of the corona virus outbreak and the exchange rate determined between currencies still oriented to the demand and supply factors. During 2020 it is reported that the Nominal Effective Exchange Rate (NEER) of Indian rupee (INR) with its trading partners depreciated to its lowest level since November 2018 (Misra and Iqbal; 2020). In case of the Real Effective Exchange Rate (REER) the value of Indian rupee (INR) had fallen down to the lowest mark since September 2019. The Nominal Effective Exchange Rate (NEER) is developed in terms of purchasing power of Indian currency with its

trading partners, whereas the Real Effective Exchange Rate (REER) is also includes the domestic inflation across economies. The reserve bank of India, indexed the trade weightage of Indian rupee (INR) with its thirty six major trading partners. This index reports that the trade weightage of NEER is dejected from 75 to 112 and that of REER fell down to 116 by the end of March 2020. The fall in NEER and REER during the initial phase of a COVID-19 outbreak could establish how this pandemic has affected the exchange rates and devalued the Indian currency. The above statistics really motivated to review how the Indian foreign exchange market is integrated with the conventional exchange rate theories. This study will also help to decide whether the market participants can obtain relevant inputs on exchange rates from conventional theoretical models and if so which factor should be emphasized more during the midst of a crisis.

The exchange rate of two currencies was determined on the basis of numerous macro-economic factors and still there exist a lot of arguments between various thinkers and philosophers in fixing the exchange rates. Till the beginning of the First World War in 1914 the currencies were issued with the backing of gold or of other precious metals and the exchange rate between currencies were determined on the basis of the possession of gold by the central bank of the countries. Determining exchange rate based on the weightage of gold backup in each currency is called as the mint parity theory. However the disorganized foreign exchange markets across the world made it difficult to determine the value currencies based on mint parity (Terborgh, 1926). The economic conditions post to the world wars and the less tranquility in international relations gradually obliterated the relevance of mint parity theory (McCloskey and Zecher, 1984).

One of the major theoretical inputs was proposed by Cassel (1918) as the purchasing power parity between two currencies will determine the exchange rates. The absolute version of the Purchasing Power Parity (PPP) theory states that the exchange rate is determined on the basis of the relative price level of the same commodities in two countries. Its relative version states that the variation in exchange is a result of inflation differential between two countries. The purchasing power of a currency can be numerically determined using various price indices like the Consumer Price Index (CPI), Wholesale Price Index (WPI) etc.

Another important theoretical contribution was made by J. M. Keynes (1923) by proposing the Interest Rate Parity (IRP) theory. According to IRP theory forward rate differential in the exchange of two currencies will be equal to the nominal interest rate differential between two countries. The nominal interest rate is the market interest rate charged for lending or borrowing. In India the nominal interest rate is determined by the Reserve Bank of India and calculated on the basis of inflation and other monetary policies. This proposition was further explained by the American economist Irving Fisher (1930) in two different notions. In the closed hypothesis the interest rate differential between two countries will be equal

to inflation rate differential between two countries. Thereby it is concluded that the variation in exchange rate between two currencies will be equal to the nominal interest rate differential in two countries.

From the above conventional theories it is obvious that the exchange rate between currencies is determined on the basis of its purchasing power, gold reserves, nominal interest rates and inflation. The Indian rupee (INR) is frequently traded with four international currencies viz., US Dollar (USD), Euro (GUR), British Pound Sterling (GBP) and the Japanese Yen (JPY). The above currencies are often called as hard currencies. This paper intends to examine how the exchange rate between the INR and hard currencies were influenced by various macro-economic factors during the COVID-19 period and also this paper aims to check does the parameters in exchange rate theories can be straight away applied in an abnormal period for policy decisions.

Literature review

COVID-19 reported in China during the last week of 2019, till then the economies and industries across the globe trying hard to get out of the impact of this crisis (Aravind, 2020). A few studies were aimed to examine the impact of COVID-19 on currency exchange rates. It is observed that the COVID death reported in China and the USA has a negative impact on their currency exchange rates (Li, 2021). A similar line of relationship was observed in terms of COVID-19 death rate and BRICS currency returns (Phiri, 2021). The COVID-19 influence limited the predictive ability of exchange rates (EUR/USD) based on oil shocks (Devpura, 2021). The euro- dollar exchange rate volatility has doubled during COVID-19 period shows how this pandemic hits the exchange market (Konstantakis, 2021). In another context Aslam (2020) reported that the efficiency of foreign exchange market has declined due to COVID-19. Efficiency here refers to the ability of the market to adjust towards a new piece of information. It is conveyed that Canadian Dollar and Swiss Franc exhibit highest efficiency during COVID outbreak.

Hoshikawa (2021) opined that the increase in the COVID infection rate in South Korea results in withdrawal of foreign investment from stock market. Ultimately, this result in depreciating the South Korean won (SKW). During the period of disaster unconventional monetary policies and expansionary fiscal policies controlled the depreciation of currencies in advanced countries (Zhou, 2021). It is found that the traditional monetary policies on exchange rate have gained superiority in policy decisions. From the above literature, it is evident that studies pertaining to COVID impact on currency exchange rate are a recent topic of debate. Only a limited number of studies were carried out in this line with an economy like India as it is one of the emerging economies in the world. Above all the real motive behind this research was no one has examined the workability of exchange rate models in the context of COVID-19.

While examining the literature on exchange rate theories Bunting (1939) criticized the Purchasing Power Parity Theory of Cassel (1918) on the ground that the pre-ward gold standard measure was appropriate and the European nations may return to the gold standard after the turmoil. Officer (1976) suggests that purchasing power parity is still relevant if a unique standard country is used for exchange rate computation among a broad group of countries. Hakkio (1982) states that though there can persists some deviation the purchasing power parity (PPP) theory for short period, it can hold good in the long run. The studies pertaining to Purchasing Power Parity (PPP) using a large number of observations can generate spurious results (Kuo, 1999). After analyzing data over the past thirty years Taylor (2004) alarmed that the PPP theory will emerge again. While reexamining the PPP it is found that the unit root test and co-integration tests are dominating (Ong, 2003). In recent days a weak form of PPP existence was confirmed with USD and EUR in 33 African countries after the great recession (Nsiah, 2016). Bošnjak (2020) has conducted a study in Croatia to examine the PPP effect with their currency, Croatian cuna, the results turned down the relevance of PPP theory.

Mahdavi and Zhou (1994) have employed co-integration and error correction model to examine the presence of absolute or relative versions of PPP in Argentina, Brazil, Israel, Mexico, Peru, South Africa, Uruguay, and Yugoslavia. It is suggested that the PPP relative version may hold for long if the inflation rate is very high. Qiu, Pinfold and Rose (2011) confirmed that PPP have a significant influence in determining exchange rate for the short run. The exchange rate fluctuation for freely floating currencies tends to be very high in short run.

Coe and Seletis (2002) examined the exchange rate data of 21 OECD countries, it is reported that the absolute version of PPP is rejected when USD is used as a base currency, whereas the study provided supportive result for relative version of PPP hypothesis. Kalyoncu and Kalyoncu (2008) investigates the relative PPP hypotheses in OCED countries using panel unit root test and reported that real exchange rate in OECD countries supports long-run purchasing power parity. The purchasing power parity equilibrium in long run works if the productivity differential between traded goods and non-traded goods are adjusted fast (Vo and Vo, 2022). The inflation rate differential in developing countries are on average reflected the nominal exchange rate depreciation (Coakley et al., 2005). This result confirms the relative version of PPP hypothesis. Stronger evidence was produced in favor of PPP hypothesis with Turkey and its major trading partners such as USA, China, European Union and Russia. These results were arrived on the basis of battery unit root test and interestingly reported that PPP increases when nonlinearities are properly accommodated (Yildirim, 2017)

Wee and Lee (2022) examined the PPP hypotheses across 27 economies and the study extensively covers data from 1999 to 2021. The study revealed that weak-form PPP is robust, is evident across economies whereas inconclusive results were obtained for the relative version of PPP hypothesis.

Kargbo (2003) has reported that the relative version of PPP is evident in 22 African countries however the test results produced inconclusive result for the economies such as Algeria, Morocco and Togo. The validity of relative version of PPP theory was examined in Economic Community of West African States (ECOWAS) by Nathaniel (2019). The variables such as real exchange rates, domestic inflation rates, and foreign inflation rates were used as regressors. The panel co integration test rejects the validity of the PPP hypothesis in long run.

Hegwood and Nath (2014) examined the bilateral exchange rates between India and its 16 trading partners for a period of 50 years. They have used panel unit procedures with and without structural breaks, the result inveterate that the relative PPP hypothesis is evident in India. In another study the validity of PPP hypothesis in India was examined by using Breitung rank tests and it is reported that the relative PPP hypothesis hold only between the Indian Rupee and Japanese Yen. While considering the bilateral nominal exchange rate between INR/USD, INR/GBP and INR/EUR produced inconclusive results (Tiwari, Aruna and Dash, 2018).

Wu (1998) has investigated the CPI-based real interest rate parity and conclude that the interest rate parity doesn't exist in the exchange market. Frachot (1996) confirmed that the uncovered interest parity (UIP) hypothesis of exchange rates is the spot exchange rates are unbiased predictors of forward rates. In the above study this hypothesis was rejected in the short run. A study conducted to check the interest rate differential and nominal interest rate in China confirmed that covered interest parity (CIP) does not hold true (Su, 2019). In some other studies a non-linear relationship was observed in terms of interest rates and exchange market (Yung, 2017). The uncovered interest rate parity establishes a proportional relationship between exchange rate differential and the interest rate between two economies. This relationship holds true for high income economies, whereas this proposition has rejected for medium-income countries (Orellana and Pino, 2021). The UIRP theory will not work in the absence of efficient market hypothesis. This may create an opportunity for arbitrage (Lily, Kogid, Mulok and Asid, 2012).

Chernyshoff (2009) pointed the lack of inflexibility during the gold standard regime. Mollick (2016) claimed that efficient economies will adjust to the interest rates quickly for exchange rate determination provided the currency exchange is backed by gold standards.

The real exchange rate between INR and GBP reported to be stationary at level and mean reverting from 1860-1893 using battery unit root test. It supports the hypotheses of PPP theory in long run (Hasan, 2004). The exchange rate between USD-INR found to be stationary at level when the lag length for unit root tests is chosen by Schwarz Information Criteria (SIC). The study extensively covers daily exchange rates spanning for ten years from 2006-2015 (Jain and Biswal, 2016). It is reported that UDS, GBP, JPY and EUR against INR is stationary at 1(0) while observing the daily return data blowout for a time period of 1500 days from 17th December 2009 to 31st December 2015 (Aravind, 2017). The Inter-

linkage between USD–INR, EUR–INR, GBP–INR and JPY–INR and their integration at level was further confirmed by Dua and Suri (2019).

A study conducted across eight emerging market currencies of Brazil, Russia, India, China, Mexico, South Korea, Turkey, and Indonesia revealed that the structural addictions across the pairs of exchange rates are evident and the stationary test produced and integration order of 1(0) across the currencies (Rehman, Tiwari and Samontaray, 2022). While examining the currency exchange rates of SAARC countries with USD from 2005 to 2016, it is reported to be stationary at level for all countries except Afghanistan and Sri Lanka (Wawale et al. , 2022).

Methodology

This research intended to address a question like; do the exchange rate variation of Indian Rupees (INR) during COVID pandemic aligned to conventional theoretical models? Which exchange rate theory is more operational for exchange rate fixation during COVID-19 period? How these variables can be taken ahead for policy formation? This study can help the authorities to have a relook on the policy decisions pertaining to exchange rates when the black swan crashes the exchange market.

In this research we have used cross-sectional time series data spread across a period of 40 months from December 2018 to March 2022. This period was selected to observe the impact of COVID-19 shocks on the dependent variables. Sampling method can be classified as simple random sampling, because in a time series data time is assumed to have a random effect that produces only variance, not bias (Lavarkas, 2008). The monthly data of price indices, interest rates, gold reserve and FX reserve position were obtained from the time series data published and updated by the Reserve Bank of India (www.rbi.org.in). The monthly exchange rate of INR with other hard currencies was obtained from the web portal www.investing.com. The inflation rates based on WPI and CPI were manually computed by using the data from the RBI web portal. The period of study was fixed at 40 months for having adequate number of observations. For a binomial distribution the minimum sample size suggested was 30 (Agresti, 2002) and for ARDL model Narayan (2005) suggested that the number of observations must be greater than 30. This collection of the time series observations was spills beyond the COVID-19 period for want of adequate number of data.

The monthly data of Wholesale Price Index (WPI) and Consumer Price Index (CPI) was used to observe the impact of Purchasing Power Parity on exchange rates (Cassel, 1918). For checking the relative version of PPP theory monthly inflation rate was calculated based on WPI and CPI price indices. The effect of interest rate on exchange rate fluctuations was observed in the context of interest rate parity theory (Keynes, 1923) and International Fisher effect (Fisher, 1930). The monthly return data of 364 days

Treasury bills (TBR) and rate return offered by the government bonds (GBR) was used in this context. The monthly data of Gold reserve (GR) and foreign Exchange Reserve (FER) kept with the Reserve Bank of India was duly employed in examining the mint parity theory.

For testing co-integrations the experts have proposed several models such as The Engle Granger test (Engle and Granger, 1987), Johansen co-integration method (Johansen, 1990), and ARDL Bound Test (Pesaran, Shin, and Smith, 2001). The Engle Granger test is a single equation model and not productive for testing integration of multiple variables. The co-integration models such as Johansen co-integration test will not support for data with mixed order of integration (Shrestha and Bhatta, 2018). While comparing with other co-integration methods ARDL reduces the chances of serial correlation and endogeneity (Ghatak and Siddiki, 2001). The problems in econometric analysis such as autocorrelation, misspecification etc. can be easily dealt with ARDL approach (Ghouse, Khan, Rehman and Bhatti, 2021). It is suggested that the ARDL model can be applied if the variables are not integrated in the same order (Harris and Sollis, 2003). ARDL model works better with relatively small sample size. If the number of time points is 80 or less ARDL model will be weighed over other co-integration models (Jordan and Philips, 2018).

The data analysis was performed through the following steps. Initially Augmented Dickey Fuller test was performed to check the unit root of the data set. The data set reaching stationary either at level 1(0) or at first difference 1(1) was retained for further analysis. Here USD, EUR, GBP and JPY reached stationary at a level and all other variable touched stationary at first difference. Due to this co-integration vector is evident. Thereby Johansen's (Johansen and Juselius, 1990) co-integration procedure cannot be applied. Thus, long run ARDL models were formed. In this process Schwarz Bayesian Criterion (SBC) is used for lag selection. Then Bounds Test was performed to see if there is evidence of a long-run relationship between the variables (Pesaran,et.al., 2001). The models which are not integrated or produced inconclusive results were eliminated at this stage. Long-run coefficients of the ARDL models estimated to inspect how variables indicated in numerous theoretical models can impact the exchange rate between currencies. Finally the short-run dynamic effects of the estimated ARDL model are measured by using Error Correction Model (ECM).

Augmented Dickey Fuller (ADF) test

In this research a genuine effort was made to ensure that there is no unit root in the given time series data. In order to endorse this postulation the statistical model suggested by Dickey and Fuller (1979, 1981) and by Dickey, Bell and Miller (1986) were duly employed. The Augmented Dickey-Fuller (ADF) test

constructs a parametric correction for higher-order correlation by assuming that the y series follows an AR(p) process and adding ' p' lagged difference terms of the dependent variable 'y' to the right-hand side of the test regression;

$$\Delta Y_t = \alpha Y_{t-1} + X_t' \delta + \beta 1 \Delta Y_{t-1} + \beta 2 \Delta Y_{t-2} + \ldots + \beta p \Delta Y_{t-p} + \gamma_t \quad (1)$$

The basic assumption of ADF test is that there is a unit root in the time series data. Where Yt represents time series to be tested, α is an intercept constant called drift, β the coefficient on a time trend and p is the lag order difference of the autoregressive process and 'γt' is the white noise error term. The null hypothesis is rejected if the probability value of the test statistics is falling within the respective levels of significances of 1%, 5% and 10%.

Auto Regressive Distributed Lag (ARDL) model

In this study the integration of various dependant variables on FX rates of hard currencies was examined by using ARDL models. ARDLs are standard least squares regressions that include lags of both the dependent variable and explanatory variables as regressors (Greene, 2008). This model was used to examine the long run integration between the observed variables. If the number of observations are not too large and the underlying regressors are reaching stationary at level [I (0)] or at first difference [I (1)] then it is widely recognised that Auto-Regressive Distributed Lag approach suggested by Pesaran(1997) and Pesaran(et al., 2000) is the best measure compared to the conventional co-integration methods. The Error Correction Model (ECM) was employed for checking the speed of adjustment of the observed variables towards the estimated model.

$$\Delta Y_t = \beta 0 + \Sigma \beta i \Delta Y_{t-i} + \Sigma \gamma j \Delta X1_{t-j} + \Sigma \delta k \Delta X2_{t-k} + \theta 0 Y_{t-1} + \theta 1 X1_{t-1} + \theta 2\, X2_{t-1} + \varepsilon_t \quad (2)$$

The above represents an error correction model for unrestricted coefficients. Where εt is a random "disturbance" term, 'β' is the long run multiplier, 'ΔY' represents the dependant variable and ΔX1, ΔX2 etc. Represents set of regressors used in the modelling. Here 'θ' we represent error-correction with the terms Yt-1, X1t-1, and X2t-1. If 'εt' is serially dependant then ARDL/ Bound testing methodology can be employed (Pesaran et al., 2001).

The initial postulation for bound testing is that the variables are not co-integrated [i.e. H0: θ0 = θ1 = θ2 = 0]. The essential precondition for ARDL/Bound test is that there should not be

any unit root in the time series data either at order [1(0)] or at first difference [1(1)]. Two asymptotic critical values (bounds) provide a test for co-integration when the independent variables are I(d) [(where $0 \leq d \leq 1$)]; a lower value assumed for regressors with I(0) and high value considered for regressors with I(1). If the values of F- statistics are lower than the asymptotic critical values (bounds) then it indicates that the variables are not co-integrated. Conversely, if the values of F- statistics are higher than the asymptotic critical values (bounds) then the null hypotheses is rejected by spotting the co-integration between variables. The result is inconclusive if the value of test statistics is in between the lower and upper bounds (Narayan, 2005).

If the variables are integrated then the ARDL long run model will be applied.

$$y_t = a_0 + \sum_{i=1}^{p} \beta 1 y_{t-1} + \sum_{i=0}^{q} \beta 2 X1_{t-1} + \sum_{i=0}^{r} \beta 3 X2_{t-1} + \varepsilon_t \quad (3)$$

In the above equation 'yt' denotes the dependant variable; ie., the exchange rate of the respective currencies. X1, X2 shows the independent variables. In the above equation 'p, q, r' indicates lag order selection of the ARDL model. Where εt is the error term, 'β' represents the long run multipliers.

The short term dynamics are assessed through the error correction model (ECM) related to the long-run estimates can be solved through the given equation;

$$\Delta y_t = a_0 + \sum_{i=1}^{p} \beta 1 \Delta y_{t-1} + \sum_{i=0}^{q} \beta 2 \Delta X1_{t-1} + \sum_{i=0}^{r} \beta 3 \Delta X2_{t-1} + \delta ECT_{t-1} + \varepsilon_t \quad (4)$$

In the above equation 'δ' the speed of adjustment towards the long run equilibrium path.

Results

Table 1
Descriptive Statistics

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis
US Dollar (USD)*	73.05	73.41	75.91	68.87	2.10	-0.52	2.12
Euro (EUR)*	83.59	84.31	89.25	76.25	4.07	-0.23	1.70
British Pound Sterling (GBP)*	96.16	97.21	103.3	83.71	5.26	-0.51	2.32
Japanese Yen (JPY)*	0.67	0.66	0.71	0.61	0.03	-0.01	2.14

Wholesale Price Index (WPI)	127.8	123.2	144.9	117.5	8.90	0.84	2.22
Consumer Price Index (CPI)	154.2	155.5	166.7	139.6	8.60	-0.13	1.83
Treasury Bill Rate (TBR)	4.60	4.20	6.82	3.39	1.09	0.60	1.93
Government Bond Rate (GBR)	6.51	6.51	7.44	5.78	0.45	0.31	2.48
Inflation based on Wholesale Price Index (INFWPI)	0.05	0.03	0.14	-0.03	0.05	0.62	1.83
Inflation based on Consumer Price Index (INFCPI)	0.05	0.05	0.08	0.02	0.02	-0.24	1.95
Gold Reserve with RBI(GR)**	242032	260445	319800	153000	50300	-0.40	1.91
Foreign Exchange Reserve (FER)**	3888298	3994274	4807657	2828380	693017	-0.20	1.55

Note:*exchange rate against INR, **Rupees in Crores ,
Source: Processed Data

The descriptive statistics of the variables used for this study were exhibited in Table 1. The dependent variables proposed for this research are exchange rate of Indian Rupees (INR) with hard currencies such as US Dollar (USD), Euro (EUR), British Pound (GBP) and Japanese Yen (JPY). USD reported to have a mean exchange value of INR 73.05 during the pandemic period. The standard deviation of the distribution is 2.10. The exchange rate of INR with USD has reached a maximum value of 75.91 while the lowest level touched was 68.87. The EUR has stated to have an average exchange rate of 83.59 with INR. During pandemic, it has attained a maximum exchange value of INR 89.25 and the standard deviation from the mean score was 4.07. GBP crossed INR 100 during the study period with a maximum exchange rate of INR 103.33. The mean exchange rate of GBP was 96.16 and the deviation for the distribution was 5.26. The average exchange rate of JPY during this period was 0.67 with a standard deviation of 0.03. The exchange value of JPY is much below INR, because Japan is an export oriented economy and the Japanese currency exchange rate is subject to frequent intervention from their government (Belke and Volz, 2020). The exchange rate of currencies during the study period skewed negatively with scores of -0.52,-0.23,-0.51, and -0.01 respectively for USD, EUR, GBP and JPY. It indicates that the tail of the distribution in the left side is longer. It can also be inferred that the mode is greater than median and mean score of these distributions and this results hints the policymakers to caution against black swan events during the period of pandemic.

The Wholesale Price Index (WPI) is a representative basket over 240 commodities includes primary articles, fuel and power and other manufactured products. In India WPI is prepared and published by the Ministry of Commerce and Industry. It is argued that the Purchasing Power Parity (PPP) can be computed better with WPI (Keynes, 1932 & Officer, 1976). The average WPI during found in this study is 127.83 with a standard deviation of 8.90. The distribution is positively skewed with a skewness score of 0.84. Consumer Price Index (CPI) measures the change in price levels of consumer goods bought by Indian household and the same is prepared and updated by National Statistical Office of Ministry of

Statistics and Programme Implementation. CPI values are reported to have a central position of 154.23 and a standard deviation of 8.60. The distribution is negatively skewed with a value of -0.13 alarms the price irregularity of consumer goods. Several researches have already established the inherent relationship between CPI of a country and the Purchasing Power of its currency (Officer, 1976 & Chen, 2018).

For examining the effect of interest rates the average annualized yield of 364 days treasury bills (TBR) and government bonds (GBR) were taken. The mean annualized return on TBR stated to be 4.60 with a standard deviation of 1.09. With respect to the government bond the average annualized return is 6.51. A spread of 1.91% observed in between these two instruments. It indicates that the government bonds providing nominal interest after adjusting the effects of inflation, whereas TBR is offering market regulated real interest.

In India the change in CPI and WPI is used as a measure for computing inflation. The inflation rate for household commodities is computed by earmarking percentage of change in CPI in the current month compared to that of in the same month during the previous year. The inflation at wholesale level is measured through WPI. The mean Inflation on CPI (INFCPI) as well as that on the WPI (INFWPI) recounted to be 5% for the study period. However the deviation computed on the INFWPI and INFCPI were 5% and 2% respectively. The average gold reserve (GR) kept with the Reserve Bank of India during the pandemic period is valued to be INR 242032 crores. The foreign exchange reserve (FER) for the study period was reported to be INR 3888298 crores. The GR and FER distributions were testified to be skewed negatively signals the oscillation effect in reserve positions.

It is ensured that the collected data reached stationary either at level or at first difference. In this context Augmented Dickey Fuller Test (Dickey and Fuller, 1979, 1981) is used in this research (Refer equation 1). The data set exhibited a trend thereby trend and intercept is used in the equation. The test was conducted with a null hypothesis of "there exists a unit root in the time series data". The results of ADF test is presented in Table 2.

Table 2
Augmented Dickey Fuller (ADF) Test

	At Level		At Difference	
Variable	T- Statistics	p.value	T- Statistics	p.value
USD	-7.10	0.00***	***	***
EUR	-0.8.16	0.00***	***	***
GBP	-7.22	0.00***	***	***
JPY	-8.08	0.00***	***	***
WPI	-1.47	0.82	-3.77	0.00***
CPI	-3.24	0.091*	-4.73	0.00***
TBR	-1.03	0.93	-6.76	0.00***

GBR	-1.50	0.82	-7.09	0.00***
INFWPI	-0.83	0.80	-3.76	0.00***
INFCPI	-2.36	0.16	-5.05	0.00***
GR	-1.99	0.58	-6.43	0.00***
FER	-0.54	0.97	5.91	0.00***

Note:***significant at 1%,5% and 10% levels, *Significant 10% level
Source: Processed Data

The null hypothesis can be rejected if the probability value of the test statistics is below the critical level of 0.05 (at 5% level of significance). For performing bound test the variables should reach stationary either at level [1(0)] or at first difference [1(1)]. From Table 2 it can be observed that USD, EUR, GBP and JPY satisfied the unit root condition at level [1(0)] and other variables such as WPI, CPI, INFWPI, INFCPI, TBR, GBR, GR and FER reached stationary at first difference [1(1)]. Thus it is ensured that there is no unit root exists in the collected time series data. In other words it can be inferred that the exchange rate of INR with other foreign currencies are reaching stationary at level [1(0)]. This result would support the early literatures of Hasan (2004), Jain (2016), Aravind (2017), Dua (2019), Rehman (2022) and Wawale (2022).

For examining how the FX market is integrated in the context of exchange rate theories bound test of co-integration was employed. The result of bound test is displayed in Table 3. The null hypotheses (H0) assume that there is no integration between the foreign exchange rates and regressors.

Table 3
Bound Test for Co-integration

Dependent Variables	Concept	Regressors	Model	F-Statistics	p. value	Results
USD	Purchasing Power Parity (PPP) Theory-absolute version	WPI, CPI	ARDL (1,3,0)	5.23*	0.00*	H0 rejected
EUR			ARDL (2,0,0)	4.85*	0.00*	H0 rejected
GBP			ARDL (1,0,0)	2.73	0.13	H0 accepted

JPY			ARDL (1,0,0)	7.01*	0.00 *	H0 rejected
USD			ARDL (1,0,0)	3.66	0.05	Inconclusive
EUR			ARDL (2,0,0)	3.53	0.05	Inconclusive
GBP	Purchasing Power Parity (PPP) Theory- relative version	INFWPI, INFCPI	ARDL (1,0,0)	0.73	0.18	H0 accepted
JPY			ARDL (1,0,0)	3.87	0.05	Inconclusive
USD			ARDL (1,0,0)	0.79	0.16	H0 accepted
EUR			ARDL (1,1,2)	3.21	0.05	Inconclusive
GBP	Fisher Effect (FE) & Interest Rate Parity (IRP) Theory	TBR, GBR	ARDL (1,1,0)	4.80*	0.00 *	H0 rejected
JPY			ARDL (1,0,0)	2.49	0.11	H0 accepted
USD			ARDL (1,0,1)	2.96	0.11	H0 accepted
EUR			ARDL (2,0,2)	4.10	0.05	Inconclusive
GBP			ARDL (1,0,1)	2.32	0.12	H0 accepted
JPY	Mint Parity Theory	GB, FER	ARDL (1,0,1)	3.99	0.05	Inconclusive

Pesaran Critical Values

Level of Significance	Upper Bound 1(1)	Lower Bound 1(0)
1%	5.86	4.77
5%	4.26	3.44
10%	3.59	2.84

k=2. Source: Processed Data
* 5%level of significance

While performing bound test automatic lag selection under Schwarz Criterion (SC) has preferred. We have used observations for 40 months thereby a maximum lag order of 4 suggested to be ideal for the ARDL model (Sen-Liew, 2004) In ARDL (p,q,r) model "p" denotes the lag order of dependent variable and "q,r" indicates the lag order of the regressors (equation 3). Prior to validating the ARDL equation bound test was performed with the assumption that the variables are not co-integrated [i.e. H0: $\theta 0 = \theta 1 = \theta 2 = 0$]. If the value of F- statistics numerically greater than the critical levels of bound limits (4.26& 3.44 respectively) at 5% significance level then the null hypothesis (H0) is rejected.

Contrariwise if the calculated value F-statistic numerically falling within the critical levels leading to inconclusive results (Narayan, 2005).

The exchange rates of USD, EUR and JPY established a strong integration with the PPP regressors WPI and CPI with F-statistics of 5.23, 4.84 and 7.01 respectively. It is above the bound limits of suggested by Pesaran (2001). Thereby the null hypotheses will be rejected by confirming a strong integration of WPI and CPI with the exchange rates of USD, EUR and JPY. In this study WPI and CPI is used to examine the purchasing power parity of currencies (Officer, 1976 & Chen, 2018). This result confirms the theoretical proposition of Cassel (1918). The absolute version of Purchasing Power Parity Theory (PPP) established that the exchange rate between currencies is depending on the price level of commodities in two countries. Interestingly the GBP does not established a long run integration with WPI and CPI during the pandemic period (F statistics is 2.73). It indicates that the general price level of Britain does not integrate with the price level in India during the period of COVID-19. This deviation was observed on account of the violation of law of one currency. Recently trade with the Europe is dominated in terms of EUR and GBP. However this analysis is thronging a light on the relevance of PPP principles during COVID-19 period.

This result supports the findings of Officer (1976), Taylor (2004) and Nsiah (2016) as these studies support the absolute version of PPP hypothesis by confirming that exchange rate is greatly influenced by price level changes. However the test outcome questions the results of Coe (2002) as it is reported that absolute version of PPP is rejected when USD is used as a base currency. Further the result contradicts with the argument put forth by Hakkio (1982) as the absolute version of PPP theory hold true only in long run.

The integration of INFWPI and INFCPI with USD, EUR and JPY produced inconclusive results as the F-Statistics values falling within the bound limits of 4.26 and 3.44 at 5% significance level. The obtained test values are 3.66, 3.53 and 3.87. We cannot confirm the relative version of PPP theory with full confidence during COVID-19 period as the theory states that variation in exchange is a result of inflation differential between two countries (Cassel, 1918). However relying on literature it is evident that INFWPI and INFCPI can influence exchange rates in long run.

Several international literatures have long-established the relative version of PPP theory. Studies such as Mahdavi (1994), Coe (2002), Coakley (2005), Kalyoncu (2008), Qiu (2011) and Yildrim (2017) have confirmed that the inflation rate differential in long run can have a positive impact on exchange rate. In this study the integration result of INR/USD and INR/EUR with INFWPI and INFCPI produced inconclusive results. The inflation rate differential across economies during the period of turmoil did not adjust quickly with the exchange rates, because the financial activities among countries were stagnated during the study period due to COVID-19. This can be the cause of inconclusive test results for relative

PPP hypothesis. On the other side the study results are very much consistent with what is reported by Kargbo (2003), Nathaniel (2019), Bošnjak (2020) and Wee (2022).

In Indian context the relative PPP hypotheses was reported in long run by Hegwood (2014). Conversely in India there are studies which support these results by reporting inconclusive integration results on INR/USD, INR/GBP and INR/EUR exchange rates (Tiwari, 2018).

The time series monthly data of TBR and GBR are considered respectively for checking the impacts of real interest rate and nominal interest rates on exchange rate variation. Only GBP reported to be integrated with the interest rate variables during the study period (F value is 4.80). It indicates that the INR/GBP exchange rate was determined by interest rate factors than purchasing power parity. International fisher effect postulates the effect of inflation on nominal interest rates (Fisher, 1930) and the interest rate parity (IRP) explicate that the forward rate differential is depending on the nominal interest rate variation in two countries (Keynes, 1923). The insinuation of above theories is confirmed in INR/GBP relations during COVID period.

The interest rate variable failed to integrate with the exchange rates of INR/USD, INR/EUR and INR/JPY. This result agrees with the arguments of Wu (1998), Lily (2012), Yung (2017), Su (2019) and Orellana (2021). The COVID-19 related turbulence foil the efficiency of capital markets across the globe. The flow of capital across economies was not as usual, and a delay was observed in accommodating interest related information into the exchange rates. Interestingly INR/GBP seems to be integrated with exchange rate variables by supporting the findings of Frachot (1996). We can use the spot exchange rates of INR/GBP as unbiased predictors of forward rates.

The volume of Gold Reserve (GR) and Forex Reserve (FER) with the Reserve Bank of India are duly examined to check the impact of mint parity in exchange rate. The test results indicate that there is no mint parity seizes to exist in the exchange price of USD and GBP with INR as the obtained test values were 2.96 and 2.32 respectively; whereas inconclusive results attributed to the exchange rates of EUR and JPY (F statistics of 4.10 and 3.99). This reconfirms that applicability of mint parity for determining exchange rate is irrelevant in a liberalized regime. This result maintain a parity with the observations of Chernyshoff (2009) by reconfirming that the gold standard is highly inflexible and inappropriate for fixing the exchange rate.

The bound test result was straightaway carried forward for fixing new ARDL model for pandemic period. The long run ARDL Model is presented in Table 4.

Table 4
ARDL Model

Dependent Variable	USD				Dependent Variable	EUR			
Model	ARDL (1,3,0)				Model	ARDL (2,0,0)			
Regressors (Restricted)	Coefficient	Std. Error	T-Stat.	p. value	Regressors (Restricted)	Coefficient	Std. Error	T-Stat.	p. value
WPI	-0.075	0.06	-1.28	0.21	WPI	-0.90	0.26	-3.45	0.00*
CPI	0.344	0.06	5.45	0.00*	CPI	1.16	0.245	4.74	0.00*
Intercept	30.62	5.41	5.67	0.00*	Intercept	19.49	14.50	1.34	0.19
R Squared	0.858				R Squared	0.914			
Adjusted R squared	0.829				Adjusted R squared	0.904			
Durbin Watson Stat	2.21				Durbin Watson Stat	2.073			
Log Likelihood	-41.804				Log Likelihood	-60.651			
Dependent Variable	JPY				Dependent Variable	GBP			
Model	ARDL (1,0,0)				Model	ARDL (1,0,0)			
Regressors (Restricted)	Coefficient	Std. Error	T-Stat.	p. value	Regressors (Restricted)	Coefficient	Std. Error	T-Stat.	p. value
WPI	-0.006	0.01	-10.7	0.00*	TBR	-8.953	1.23	-7.304	0.00*
CPI	0.001	0	10.2	0.00*	GBR	12.93	2.99	4.324	0.00*
Intercept	0.529	0.04	11.8	0.00*	Intercept	53.41	14.6	3.651	0.00*
R Squared	0.845				R Squared	0.901			
Adjusted R squared	0.831				Adjusted R squared	0.889			
Durbin Watson Stat	2.11				Durbin Watson Stat	2.35			
Log Likelihood	121.49				Log Likelihood	-74.76			

Source: Processed Data, * Significant at 5% level

In ARDL (1, 3, 0) model WPI and CPI is considered as independent variables and its impact on exchange rate of USD is examined. It is found that CPI possesses a positive and significant relation with USD with a long run co-efficient of 0.344. Further probability value of the test statistics signifies the above relation at five percent level of significance (T-value is 5.45 & p.value is 0.00). From this result it can be inferred that exchange rate depreciation of INR/USD can cause increase in CPI. This linkage was reported by Usupbeylia and Ucak (2020) as any depreciation of the national currency may lead to increase in CPI.

The ARDL (2, 0, 0) model explicates the association of WPI and CPI with EUR. The co-efficient of -0.90 indicates that WPI is negatively associated with the INR/EUR exchange rate. It implies that decrease in WPI index may enhance the exchange rate INR/EUR (T-value is -3.45, p.value is 0.00 at 95% confidence). It is obvious that decrease in the price of wholesale goods shows a fragile demand for indigenous product in turn it wanes the domestic market and boost up imports. Increase in import will enhance the trade deficit of the country and weaken the domestic currency (Kang, 2018 & Thuy, 2019). CPI has a positive co-efficient of 1.16 with EUR signals the depreciation of INR lead to increase in CPI (T-value is 4.74 and p.value is 0.00 at 5% significance level). A similar direction of relation was observed for INR with JPY. The ARDL (1, 0, 0) model confirms that exchange rate depreciation of INR/JPY can cause fall in WPI (co-efficient=-0.006, T.value=-10.73, p.value=0.00). The CPI is positively linked with the exchange rate of JPY (coefficient=0.001, T- value =10.22, p. value =0.00) at 5% level of significance.

The impact of TBR and GBR on GBP was confirmed by ARDL (1,0,0) model. The exchange rate depreciation of INR/GBP can root decrease in TBR (co-efficient -8.95, T- value=-7.30, p.value=0.00). A unidirectional relation was observed with GBR impact on GBP exchange (co-efficient= 12.93, T-Value=4.32, pvalue=0.00) at 5% level of significance. In other words it confirms that GBR increases when INR weakens against GBP. It is argued that raising the interest rate can attract more foreign inflows into the capital market and the domestic currency will get strengthened with monetary inflows (Sarac and Karagoz, 2015). However raising interest rates can lower the risk adjusted returns, and may induce capital fight and may result in economic decline (Stiglitz, 1999).

The goodness of fit of the above ARDL models were assessed by using R- squared values. It is evident that the obtained R-squared values are closer to 1. It confirms the goodness of fit in the regression analysis. The autocorrelation was assessed by using d Durbin Watson statistics ((Durbin and Watson, 1950). The Durbin Watson values for ARDL models are within the threshold limit of 1.5 and 2.5 signals that there is no autocorrelation in the samples.

The speed of adjustment of ARDL models towards long run equilibrium was further validated by using Error Correction Model (ECM). ECM obtained for the ARDL models are negative and significant then the disequilibrium created in short run would easily get adjusted over a period. Table 5 represents the results of Error Correction Model (ECM).

Table 5
Error Correction representation of ARDL Models

Dependent Variable	Regressors	Model	Coefficient	Std Error	T-Statistics	p. value
USD	WPI,CPI	ARDL (1,3,0)	-0.606	0.126	-4.798	0.000*

EUR	WPI,CPI	ARDL (2,0,0)	-0.286	0.062	-4.599	0.000*
JPY	WPI,CPI	ARDL (1,0,0)	-0.797	0.145	-5.519	0.000*
GBP	TBR,GBR	ARDL (1,1,0)	-0.528	0.116	-4.573	0.000*

Source: Processed Data, * Significant at 5% level

The ECM confirms the validity of ARDL Models. It further explains that the change in WPI and CPI adjusted with the exchange rates of USD, EUR and JPY with a speed of 60.6%, 28.6% and 79.7% respectively. The change in TBR and GBR adjusted with the exchange rate of GBP at a speed of 52.8%.

Various diagnostic measures like serial correlation test, normality test, heteroskedasticity test etc. were performed to check the authenticity of the ARDL models.

Breusch-Godfrey (1978) serial correlation LM test was conducted to check the presence of serial correlation in the ARDL models. The test was performed with the null hypothesis of "there does not exists any serial correlation". The test results were duly presented in Table 6.

Table 6
Breusch-Godfrey Serial Correlation LM Test

Dependent Variable	Regressors	Model	F-Stat	p.value	Result
USD	WPI,CPI	ARDL (1,3,0)	0.799	0.45	H0 Accepted
EUR	WPI,CPI	ARDL (2,0,0)	4.24	0.20	H0 Accepted
JPY	WPI,CPI	ARDL (1,0,0)	1.301	0.28	H0 Accepted
GBP	TBR,GBR	ARDL (1,1,0)	1.03	0.36	H0 Accepted

Source: Data Analysis

From Table 6 it can be inferred that the probability value of the test statistics are numerically above the value of 0.05 at 5% significance level. In this context the null hypotheses can be accepted by confirming that serial correlation is not evident in the ARDL models. For performing this test we have followed automatic lag selection criterion suggested by the EVIEWS software and the software has suggested two lag intervals.

Further Jarque Bera test was conducted to identify whether the residuals are normality distributed. Initially it is assumed that the residuals are normally distributed. The test results are presented in Table 7.

Table 7
Normality Test

Dependent Variable	Regressors	Model	Jarque Bera	p.value	Result

USD	WPI,CPI	ARDL (1,3,0)	2.15	0.34	H0 Accepted
EUR	WPI,CPI	ARDL (2,0,0)	0.682	0.71	H0 Accepted
JPY	WPI,CPI	ARDL (1,0,0)	1.17	0.55	H0 Accepted
GBP	TBR,GBR	ARDL (1,1,0)	0.673	0.71	H0 Accepted

Source: Data Analysis

Based on the test result we can accept the null hypotheses by assuming that the residuals are normally distributed. Because the probability value of the test statistics is numerically above the critical value of 0.05 at 95 per cent confidence level. This result indicates that data set is well-modeled by a normal distribution.

In linear regression models it is assumed that heteroskedsticity is not evident. Table 8 indicates the results of heteroskedasticity test.

Table 8
Heteroskedasticity Test

Dependent Variable	Regressors	Model	F-Stat	p.value	Result
USD	WPI,CPI	ARDL (1,3,0)	0.425	0.86	H0 Accepted
EUR	WPI,CPI	ARDL (2,0,0)	1.17	0.34	H0 Accepted
JPY	WPI,CPI	ARDL (1,0,0)	1.98	0.14	H0 Accepted
GBP	TBR,GBR	ARDL (1,1,0)	1.11	0.36	H0 Accepted

Source: Data Analysis

From table 8 it is evident that heteroskedaticity is not evident for the existing models as the p. values are numerically above the critical level of 0.05. For performing heteroskedasticity test the model proposed by Breusch and Pagan (1979) was duly employed.

Discussion

It is empirically established that the exchange rates of INR/USD, INR/EUR, and INR/JPY during COVID crisis is aligned to the absolute version of purchasing power parity (PPP) theory of Cassel (1918). In the study it is observed that WPI possessing a negative and significant relationship with the established models; whereas CPI is found to have a positive impact on the exchange rates. Any increase in CPI is an indication of inflation in the economy. During the initial phase of COVID restrictions the economies across the globe shuts instantly. These effects somehow made consumer price indices as the key indicators among economies and the players began to evaluate the strengths and weaknesses of currencies in terms

of simple price levels. The variation of CPI in India caused not only because of food price but the increasing the cost of health care, raise in the cost of communication requirements, increasing requirement of the crude oil on account of heavy reliance on private vehicles etc. too add the a viable reason for change in the CPI (Nayar, 2020). The Indian economy is importing oil and health care aids that increased the requirement of foreign currencies. Thus the CPI increased and the INR exchange rate with major currencies weakened. Usupbeylia and Ucak (2020) have already confirmed that currency depreciation may lead to increase in CPI. In this context the established ARDL Model are valid during the period of pandemic. This result add to the existing literatures of Officer (1976), Taylor (2004) and Nsiah (2016) as price level changes can exert direct pressure on exchange rates.

The study confirmed that any decline in the exchange rates of INR/GBP, INR/ EUR and INR/ JPY can have a negative and significant impact on WPI. COVID-19 restrictions have not only affected the demand side but also supply side in Indian economy. Thus the normal functioning of the economy stagnated (Sahoo, 2020). This will affect the contribution of manufacturing, Trade and MSME sector to the GDP. As a result the GDP declines in turn upshot the depreciation of local currency based on PPP principles. Secondly the Indian export market was shrunken by 60.28 percent as an impact of COVID-19 lockdown. This brought a trade deficit of $6.28 billion (The Economic Times, 2020). The trade deficit can weaken the purchasing power of domestic currency (Kang, 2018 & Thuy, 2019).

GBP has established parity with TBR and GBR during the study period. The results shows that decline in real interest rate will devalue INR/GBP exchange rates. However the interest parity with other currencies like USD, EUR and JPY were not found to be significant. This can be examined in the context of the reports from Bhat (2021) that the Reserve Bank of India has kept the interest rates at low aiming recovery from the economic disorder created by pandemic. RBI has slashed the repo rate by 115 points since March 2020. The decline in policy rates will result in declining nominal interest rate on lending and borrowing. As a result this measure may locally stabilize the inflation. It is against the theoretically established belief that raising interest rates may attract more foreign capital to the economy (Sarac and Karagoz, 2015). The move of RBI to lowering the interest rates can be supported as it would help to ensure free flow of domestic capital in the economy (Stiglitz, 1999).

Theoretically it is argued that variation in interest rates can cause capital movement across the economies by identifying an arbitrage opportunity (Fisher, 1930). However the lack of co-integration between major currencies reported in this study indicates that the flow of capital across economies was limited by uncertainties mounted in COVID situations. And the decline in interest rate does not affect the capital flow into Indian economy. A report released by UNCTAD (2020) conveyed that global FDI falls by 49% in the first half of 2020 but a rise of 13% reported in Indian economy. This report shows that demand for INR was not declined by fall in interest rates. This study also examined whether mint parity

was brought back during the period of economic chaos. The test results failed to establish mint parity between with INR and other hard currencies.

Conclusion

The purpose of this research was to examine how the traditional exchange rate theories are integrated to the Indian foreign exchange market amidst the COVID-19 turmoil. The conventional exchange rate hypotheses such as Mint Parity Theory, Purchasing Power Parity theory (Cassel, 1918), Interest Rate Parity Theory (Keynes, 1923) and the Fisher effect (1930) were examined by observing the integration of various macroeconomic variables with the exchange rate of frequently traded currencies like USD, EUR, GBP and JPY. Pesaran's (2001) bound test was performed to examine the long-run relationship between the currency exchange rates and other macro-economic variables. Finally long-run coefficients of the ARDL models estimated to inspect the theoretical models can impact the exchange rate between currencies. The speeds of adjustment of ARDL models were measured by using Error Correction Model (ECM).

This study concludes that the absolute version of PPP theory (Cassel, 1918) was evident in the context of COVID-19. This reconfirms that the PPP theory can be applied in a context where the economic activities are limited. This would add to the literatures of Officer (1976), Taylor (2004) and Nsiah (2016) by confirming the direct impact price level changes on exchange rates. The relative version of the PPP theory produced inconclusive results as the period of study was short to adjust the impact of inflation in long run. A similar line of conclusion was reported by Nathaniel (2019) as the inflation rate differentials will not get adjusted to the exchange rates for a shorter period. The interest rate parity (Keynes, 1923) and the Fisher effect (1930) were not evident with major hard currencies other than GBP. This is in line with the findings of Wu (1998), Lily (2012), Yung (2017), Su (2019) and Orellana (2021).

Confirmation of PPP hypothesis (Cassel, 1918) demands active policy formation from the authorities to control the price levels during the period of turbulence. For controlling food price inflation, the government should strengthen the food supply chains through active market intrusion. The price variations in manufactured products can be leveled by enhancing indigenous production. Price level variation of imported products like crude oil should be addressed by offering subsidies and rebates on import, such direct economic intervention from the policymakers can control price inflation and prevent devaluation of the home currency. The government can look for geo-economic collaborations to boost up production and consumption through special trade agreement. Such agreements are considered to be a viable measure to keep the momentum of economic activities during crisis period. The monetary measures such as offering better interest rates would attract more foreign capital flow into the economy. This would

help to reduce the Balance of Payment (BOP) deficit of the country and the economy will flourish and in turn the domestic currency will get strengthened.

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