DISSERTATION

On

INTERNATIONAL FISHER EFFECT ON CONTEMPORARY FOREIGN EXCHANGE MARKETS OF THE MAJOR WORLD ECONOMIES, viz. USA, CHINA, JAPAN, INDIA & SINGAPORE

Course – MBA 4th Semester

Submitted By - Arindam Chatterjee

University Roll No. –

University Registration No. -

Supervisor's Certificate

This is to certify that Mr. Arindam Chatterjee, a student of M.B.A. in Finance from the Indian Institute of Social Welfare and Business Management (IISWBM) under the University of Calcutta has worked under my supervision and guidance for his project work and prepared a Dissertation report with the title "***INTERNATIONAL FISHER EFFECT ON CONTEMPORARY FOREIGN EXCHANGE MARKETS OF MAJOR WORLD ECONOMIES,viz.USA, CHINA, JAPAN, INDIA & SINGAPORE***". This is his genuine and original work to the best of my knowledge.

Place: Kolkata

Date: 06.07.2021

SIGNATURE:

NAME: Prof. SOUMITRA KUMAR MALLICK

DESIGNATION: SIR ASHUTOSH MUKHERJEE CHAIR PROFESSOR

NAME OF THE COLLEGE: I.I.S.W.B.M.

STUDENT'S DECLARATION

I hereby declare that my Dissertation work, titled " *INTERNATIONAL FISHER EFFECT ON CONTEMPORARY FOREIGN EXCHANGE MARKETS OF MAJOR WORLD ECONOMIES, viz. USA, CHINA, JAPAN, INDIA & SINGAPORE* " is being submitted by me as the Dissertation for the partial fulfillment of the degree of M.B.A. in Finance from the Indian Institute of Social Welfare and Business Management, under the University of Calcutta is my original work and the same has not been submitted earlier to any other University/ Institution for the fulfillment of the requirement of any course/ study.

I also declare that no chapter of this manuscript in whole or in part has been incorporated here in this report from any earlier work. However extracts of any literature which has been used for this report has been duly acknowledged by providing the details of such literature in the references.

Place: Kolkata

Date: 06.07.2021

SIGNATURE:

NAME: ARINDAM CHATTERJEE

ADDRESS:

ROLL NO.-

REGISTRATION NO.-

NAME OF THE INSTITUTION: I.I.S.W.B.M.

ACKNOWLEDGEMENT

I am indebted to thank our respected Head of Department, Prof. (Dr.) Tanima Roy, Prof. (Dr.) Soumitra Kumar Mallick, Asst. Prof. (Dr.) Soubarna Pal, Prof. (Dr.) Mukul Mitra, Asst. Prof. (Dr.) Arijit Sen, Prof. (Dr.) Chinmoy Jana and Asst. Prof. Manjit Sircar for giving me support, encouragement and equipping me with all the necessary knowledge to carry out my research on this thesis paper.

Last but not the least, I extend my gratitude towards my mother and friends for their constant co-operation and support which has helped me in completion of this thesis/ dissertation.

_____

Arindam Chatterjee
Student of 4th Semester MBA 2019-'21
University Roll No. –
Indian Institute of Social Welfare and Business Management (I.I.S.W.B.M.)

Place: Kolkata

Date: 06.07.2021

CONTENTS

1. QUOTATIONS

"In The Long Run, We Are All Dead"

- John Meynard Keynes

" There is no escape from the vast imbalances in international trade and finance. They will be corrected, sooner or later, by the inexorable principles that govern human action. "

- Hans F. Sennholz

" The real price of everything, what everything really costs to the man who wants to acquire it, is the toil and trouble of acquiring it."

- Adam Smith

2. ABSTRACT

This paper aims to check the validity of the International Fisher Effect (IFE) between USA, China, Japan, India and Singapore. Nominal Interest Rate Differentials, obtained from the historical annual data for Real Interest Rates and Rate of Inflation, are used to explain why exchange rates change over time. Here Regression Analysis approach is considered to trace the relationship between nominal interest rate differentials and the foreign exchange rates of these countries. The estimated value of R- Squared, obtained by applying the Regression Analysis in the Minitab Statistical Software © from the data points collected and/ or calculated using the Microsoft Excel ©, is used to determine the relationship between nominal interest rates and foreign exchange rates for yearly data from 2001 to 2019, to check whether the exchange rates can be explained more by applying the International Fisher Effect as the world has now become a global village due to Globalization and the concept Free Market with lesser intervention of the Central Banks on the exchange rates is more valid now than three/ four decades earlier. The contribution of this paper is reflected in the resulted obtained therein. The co-efficient of determination, R^2 values are very low in all the Currency pairs, except for USD/ INR & INR/ USD. R^2 values are even less than 10% for India-Japan, India-Singapore, USA-China, USA-Japan, USA-Singapore & Japan-Singapore. Therefore, we can say that for these currency/ country pairs, the annual changes in the exchange rates depend on other factors, like the Purchasing Power Parity(PPP), Central Bank intervention in terms of managing the liquidity(money supply), Index of Industrial Production(IIP), i.e. strong economic performance and also on the terms of trade.

***Key Words*:-** Foreign Exchange, International Finance Forecasting and Simulation: Models and Applications, Mathematical and Quantitative Methods, Exchange Rate, Nominal Interest Rate, Inflation, Interest Rate Differential, Fisher Effect, International Fisher Effect (IFE)

***JEL Classification Codes*:-** C00, C58, D53, E31, E43, F31, F37

3. PREFACE

Foreign Trade is one of the most significant indicator of economic development of a country. The Foreign Trade of a country consists of Inward and Outward movement of goods and services, which result in outflow and inflow of foreign exchange from home country to foreign country, thereby affecting the foreign exchange reserves of the home country. International Trade is an effective instrument of economic growth, employment generation and poverty alleviation for a country.

The long-run behaviour of interest rates is normally analyzed using the so-called Fisher relationship/ Fisher Effect, linking nominal rates and expected inflation and requiring a one-to-one adjustment of the former to the latter, in the absence of which permanent shocks to either inflation or nominal rates have permanent effects on real rates themselves.

International Fisher Effect (IFE) is one of the oldest exchange-rate models. IFE is used in the financial sector to determine the future direction of financial markets. Here in this paper we shall examine the movement of foreign exchange rates of US Dollar, Chinese Yuan, Japanese Yen, Indian Rupee and Singapore Dollar interchangeably during the period 2001 to 2019 and we shall test the relevance of the International Fisher Effect with the help of Regression Analysis.

4. INTRODUCTION

Today the major economies have removed their controls on the movement of capital and at the same time the technological innovations have made it possible to transfer capital throughout the world more quickly. As a result the capital has become more mobile. Free International Capital Movements led to the breakdown of the Bretton Woods System in the 1970s. The Bretton Woods system with fixed and pegged exchanged rates proved to be insufficient to cope with the currency speculation.

The current international monetary system can be described as a hybrid system, where the basic market mechanism for establishing the exchange rates include the free float, managed float, target-zone arrangement and fixed rate system. The rose of the international capital mobility has made it difficult for many governments to defend their fixed or pegged exchange rates or even pursue independent macroeconomic policies. Governments trying to defend their currencies have been forced to maintain high interest rates to prevent capital outflows.

International Fisher Effect is one theory that links the exchange rates, interest rates and the inflation rates. It states that the future spot exchange rate can be determined from the nominal interest rate differential.

Background of the International Fisher Effect - The **International Fisher Effect**, also known as the **IFE**, is a popular and dominant hypothesis in the field of finance. It came into existence courtesy of Irving Fisher, an eminent economist of the 1900s. He created the theory in the early 1930s. Economist Irving Fisher also brought two other theories that relate to the IFE. These are the Fisher Index and the Quantity Theory of Money. These theories collectively state that the levels of prices in an economy are directly proportional to the rate of inflation and the money supply.

The two later theories have contributed to the working of International Fisher Effect. These theories help it in making future predictions by explaining how exchange rates between different countries with floating exchange rates are expected to change.

5. LITERATURE REVIEW

The long-run behavior of the ex-ante/ real rate of interest is linked directly to the long-run relationship between inflation and nominal interest rates. The Fisher identity (Fisher, 1930) defines the ex-ante real rate as the difference between the nominal rate and expected inflation. Thus, for the ex ante real interest rate to be affected only by transitory disturbances, any permanent shocks to the nominal interest rate and expected inflation must cancel out through the identity. Scholars such as Darby (1975) and Feldstein (1976) argue that the relationship is greater than one-to-one, while others such as Mundell (1963) and Tobin (1965) argue that the 3 true relationship is less than one to-one. This is an important observation because recent research has found that both realized inflation rate and nominal interest rate are affected by permanent shocks. The long-run relationship between inflation rate and nominal interest rate using recent time-series techniques had been examined by the Evans and Lewis (1995), where it shows that nominal rate move less than one-for-one with inflation rate so that it appears to move permanently in ex-post real interest rates. Early studies analyzed the Fisher effect without considering stationarity issues. These include Fama (1975), Nelson and Schwert (1977) and Garbade and Wachtel (1978). Gilbert and Yeoward (1994) argued that papers using short rates are not informative about the Fisher effect unless short and long rates are strongly correlated; examples are the papers by Summers (1983) and Barsky (1987). Coppock and Poitras (2000) examine on a larger sample (N=40) of countries, where they finds some support for a partial Fisher Effect rather than the support for full Fisher Effect.

Evidence from the study of Cloninger (2003) to measure the extent of the Fisher Effect across countries suggests the presence of the full Fisher Effect across a large number of countries. The other empirical support for the long-run Fisher effect has been mixed (e.g., Weber 1994, King and Watson 1997, Koustas and Serletis 1999, Rapach 2003). Empirical studies of the long-run Fisher effect have employed variations of the Fisher and Seater (1993) or by the FS approach. This approach argues that a permanent change in inflation has not taken place; instead, inflation is a mean-reverting, long-memory, fractionally integrated process. The study also stated that a reduced-form test of the long-run Fisher effect will be invalid and any inference as to whether the hypothesis holds or not will be unsupported.

Aliber and Stickney (1975) calculated the percentage deviation from the Fisher effect for thirteen countries, constituting both developed and developing countries for the period of 1966-71. They used the average annual deviation as a measure for long-term validity and maximum annual deviation as a measure for short-term validity. They concluded that the international Fisher effect holds in the long run because the average annual deviation tended to be zero. The current international monetary system can be described as a hybrid system, where the basic market mechanisms for establishing exchange rates include the free float, managed float, target-zone arrangement and fixed-rate system. This system has led to rapidly fluctuating exchange rates, creating both problems and opportunities for actors dealing with foreign currencies (Shapiro 1998, p 55-56). However, in this examination, all three countries' (Bangladesh, China and India) currencies are pegged exchange rate against dollar. Eichengreen (1996, p-188) stated that the rise of the international capital mobility has made it difficult for many governments to defend their fixed or pegged exchange rates or even pursue independent macroeconomic policies.

Robinson and Warburton (1980) disputed the validity of the international Fisher effect. They argued that according to the Fisher effect the possibility to earn a higher interest return would be eroded in the medium term by the appreciation of the currency with the lower interest rate relatively to the currency with the higher interest rate. They concluded that superior returns could be earned and therefore argued that the international Fisher effect does not hold empirically. The maximum annual deviation was however too large to support the theory in the short run. Another study indicating a long-run tendency for interest differentials to offset exchange rate changes were made by Giddy and Dufey (1975).

The following generation of studies took a co-integration approach (see, e.g., Wallace and Warner, 1993). Engsted (1995) looked at the spread between the long-term (multi-period) interest rate and the one-period inflation estimating a VAR model and found considerable cross-country differences. More recently, fractional integration and fractional co-integration techniques have been used to analyze the long memory properties of inflation and interest rates. For example, Shea (1991) investigated the consequences of long memory in interest rates for tests of the expectations hypothesis of the term structure. Phillips (1998) found stationarity but with a high degree of dependence in US interest rates. Tsay (2000) modeled interest rates as Auto Regressive Fractionally Integrated Moving Average (ARFIMA) processes and concluded that the ex-post real interest rate can be well described as a fractionally integrated process. Further evidence of long-memory behaviour in interest rates is provided by Barkoulas and Baum (1997), Meade and Maier (2003), Gil-Alana (2004a,b), Couchman et al. (2006), Gil-Alana and Moreno (2012), Haug (2014), Apergis et al. (2015), Abbritti et al. (2016), etc. As for inflation rates, evidence of long memory has been reported in many papers including Hassler (1993), Delgado and Robinson (1994), Hassler and Wolters (1995), Baillie et al. (1996), Baum et al. (1999), Hyung et al. (2006), Kumar and Okimoto (2007), etc. Lardic and Mignon (2003) found some evidence for the Fisher hypothesis in the G7 countries using semi-parametric I(d) techniques based on log-period gram regressions; by contrast, no evidence of co-integration between short-term interest rates and inflation was found by Ghazali and Ramlee (2003) by estimating fully parameterised AutoRegressive Fractionally Integrated Moving Average (ARFIMA) models for the same set of countries.

Kasman et al. (2006) examined the Fisher relationship with fractional co-integration techniques in 33 developed and developing countries. They found no evidence of co-integration when using classical methods (i.e., Johansen, 1996); however, they found fractional co-integration by using the Geweke and Porter-Hudak (GPH, 1983) log-period gram approach on the estimated errors from the co-integrating relationship. Similar conclusions were reached in the case of Turkey by Kiran (2013) and for Nigeria by Etuk et al. (2014). The present paper differs from the earlier studies using fractional integration/ co-integration methods to test the Fisher hypothesis since, instead of using semi-parametric or fully parametric methods, we adopt a testing procedure for the differencing parameter that relies on non-parametric disturbances.

Hatemi (2009) adapts a method which is based on the asset pricing to obtain the international version of Fisher effect. Namely, the international Fisher effect tests the difference between UK and U.S. in interest rate and inflation rate. He has applied the case of hetero-variance and non-normal, strong case, the case-wise bootstrap technique, which is usually the characteriztic of financial data. He also took into account the structural breakthroughs in October 1987. It turns out the international fisher effect is slightly less than unity. Namely, the nominal interest rate differentials are response to changes in the inflation rate differential value is less than point by point. İncekara, Demez, and Ustaoğlu (2012) use the quarterly series data between first quarter of 1989 and fourth quarter of 2011 to verify the validity of Fisher effect for Turkish economy via Johansen co-integration and vector auto-regression method. It can be summarized that, in the long run, the Fisher effect is valid for Turkish economy. At the same time, Shalishali (2012) draws on the history of the eight selected Asian countries exchange rate and carry the data. Each of these countries is interchangeably utilized as the home country, and foreign country to trace the trail of the effect. Although the theory of comparative advantage in the application and assessment must be cautious, but the international fisher effect model in daily currency trading may not be realistic, but its value is that it can clarify expectations of relationship between interest rates, inflation and currency. Ar (2013) investigates the Fisher effect's validity in Turkey from 1978-Q1 to 2010-Q3. For this purpose, He employs co-integration test with a structural break and time varying parameters approach that considers the system or policy changes on the influence of the relationship between interest rate and inflation rate. The empirical results indicate that the weak form of fisher's effect holds true in the Turkish economy. Benazić (2013) test the Fisher effect in Croatia using vector error correction model. The results suggest that the full Fisher effect in Croatia may de facto hold only in the long-run. El Khawaga, Esam, and Hammam (2013) examine the validity of the international Fisher effect theory for the Egyptian economy. Two case studies are investigated: Egypt vs. USA and Egypt

vs. Germany during the period (2003-2012). The long-run relationship between nominal changes in exchange rate and nominal interest rate differential for each of the two case studies, is examined using autoregressive distributed lag bounds test approach to co-integration and error correction model. The short-run relationship is examined through impulse response function and variance decomposition. Besides, the Granger causality test is employed to identify the direction of the relationship. The empirical findings reveal partial significance of international Fisher effect in the case of Egyptian pound vs. US dollars, while no sign of the international Fisher effect is detected in the case of Egyptian pound vs. Euro currency. The irrelevance of international Fisher effect can be attributed to the irrelevance of Purchasing Power Parity theory in Egypt. This is in addition to Egypt's limited financial integration with international financial markets. Everaert (2014) investigates the Fisher effect in a menu of twenty one OECD countries over the period from the year of 1983 to 2010. A standard panel test reveals the co-integration between inflation rate and nominal interest rates. The regression results are false. For non-stationary common factors, a possible explanation is that it reflects that the due time preference, risk aversion and technology change the steady-state growth rate of real interest rates of permanent change together. Next, he controls for an unobserved non-stationary common factor by using both the common correlated effects estimation methods and updated Yugang He/ International Journal of Industrial Distribution & Business 9-7 (2018) 33-42 35 bias correction estimators. The estimated slope coefficient on inflation is detected to be insignificantly different from one. Zainal, Nassir and Yahya (2014) try to study the effectiveness of fisher effect on Malaysian money market. The time series between 2000 to 2012 is elected as the study duration. Three variables are targeted in this paper, they are the inflation rate, 3-months treasury bills rate and interbank rate. In order to analyze this relationship, the autoregressive distributed lag boundary test is adopted in this paper, which can test the long-run relationship between variables, regardless of whether the time series is the process of I(0) or I(1). The estimation results show that there is long-run co-integration between variables. Overall, the study provides evidence that the fisher effect exists in Malaysia. Ucak, Ozturk, and Aslan (2014) test the Fisher effect for the selected four transition economies that are also new EU member states. The empirical analysis is conducted by allowing for a structural break that takes place in year 2004. In this study, a case-wise bootstrap approach empirical method which developed by Hatemi-J and Hacker (2005) is used and the results support a tax adjusted Fisher effect in the presence of a structural break. Edirisinghe, Sivarajasingham, and Nigel (2015) investigate the existence and the price confusion of the fisher effect in Sri Lanka. The results of co-integration technology and the error correction estimation show that, in the short term, there is a significant positive correlation between nominal interest rates and expected inflation, but there is no complete fisher effect. Puci and Mansaku (2016) analyze the international Fisher effect considering United State Dollar and Chinese Yuan Renminbi for the period 2002–2014. In order to reach this objective Augmented Dickey Fuller and Phillip Peron unit root tests are performed to check for stationary. Moreover, the Engle-Granger and the Johansen co-integration techniques are performed to identify long-run relationships. Even if the international Fisher effect might not be successful to apply in daily currency transaction, its usefulness consists in its capability to illustrate the expected relation among exchange rates, interest rates and inflation. Further, this information is beneficial in searching export possibilities for countries and in assessing the price of foreign imports. Uyaebo, Bello, Omotosho, Karu, Stephen, Ogbuka, and Mimiko (2016) test for the validity of the Fisher hypothesis in Nigeria during the period 1970–2014. The Gregory and Hansen's co-integration test ensures a long-run relationship between inflation rate and nominal interest rates, albeit with a structural break in October 2005. In addition, the obtained Fisher coefficient in the co-integrating relation is 0.08, implying a weak form of Fisher effect in the long-run. On the basis of these findings, they uphold a weak Fisher effect in the long run and non-existence of Fisher effect in the short run. This implies that the short-run nominal interest rate is a good characterization of monetary policy stance. Also, the obtained partial Fisher effect indicates that changes in monetary policy are capable of altering the long-term real interest rate and influencing economic growth through the interest rate channel. They therefore recommend a more forward looking monetary policy as a way of anchoring inflationary expectations and ensuring low and stable prices in Nigeria. Alam, Alam, and Shuvo (2017) try to find the empirical evidences of the international Fisher effect between Bangladesh and two other trading partners, China and India. The international Fisher effect applies the interest rate differentials to

interpret why exchange rates change over time. Considering a time series approach to tracking the relationship between nominal interest rates and exchange rates in these countries, the estimated value, by applying ordinary least squares, is used to determine the random relationship between interest rates and exchange rates in quarterly data from 1995-Q4 to 2008-Q2. The empirical results show that the exchange rate and interest rate differences between Bangladesh and China, Bangladesh and India are weak, and the relationship between variables is not worthy of Bangladesh's attention. Moreover, these trends argue that it is unrealistic for these countries to use the assumptions of the international fisher effect to predict exchange rates. Adam and Ofori (2017) investigate the validity of the international Fisher effect in the West African Monetary Zone. The conventional fractional co-integration tests are employed on nominal exchange differentials and exchange rates change of all the countries within the West African Monetary Zone except Liberia due to lack of data. They observe co-integrating relationship in fifteen out of the twenty country pairs; indicating evidence of common stochastic drift in nominal exchange differentials and exchange rates change. However, the assumptions necessary for the validity of very weak international Fisher effect are met for only between Ghana and Cape Verde and between Ghana and Sierra Leone at five percent significance level; An evidence of lack of macroeconomic coordination. It is important to note that macroeconomic coordination is necessary condition for currency union and seen as alternative to member countries meeting the convergence criterion. These findings are seen as a setback to the common currency agenda of West African Monetary Zone because the findings signify lack of macroeconomic coordination among will be currency union countries, which is a necessary condition for conduct of monetary policy.

A paper written by Fredric Mishkin (1995) of Princeton University found that the Fisher Effect exists in the long term, but in the short term, the paper found there was no relationship between inflation and nominal interest rate. Another paper by the same author conducts an empirical analysis of the Fisher Effect in Australia and comes to the same conclusion.

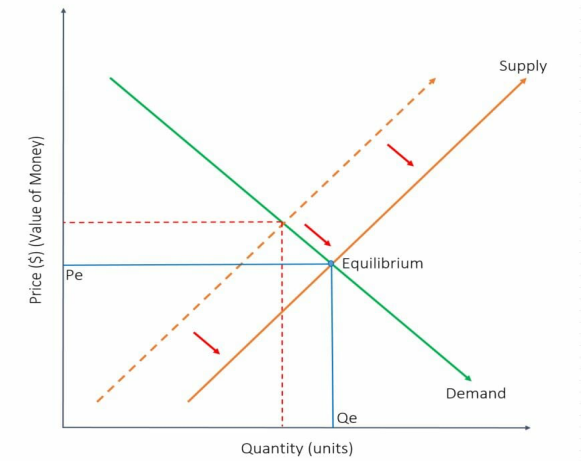
Jaffe and Mandelker studied the relationship between inflation and returns on risky assets. More specifically, they studied the relationship between stock market returns and inflation. Most studies of the Fisher Effect study the relationship between the risk-free rate (or nominal interest rate) and inflation.
Their study found no evidence for the existence of the Fisher Effect in stock market returns. In fact, it found that increased inflation expectation is negatively correlated with market returns. The finding runs counter the relationship described by the Fisher Effect.

One of the more recent investigations into the Fisher Effect finds that it holds true for temporary changes in the nominal interest rate, but in case of a permanent increase in the nominal interest rate, the opposite holds true, and an increase in the nominal rate leads to inflation.
Note that the above is the exact opposite of the mechanism described in the monetary policy section. The author calls the mechanism the neo-Fisher Effect. It is a new theoretical framework in response to the unconventional monetary policy being used since the Great Financial Crisis (GFC) of 2008.

6. DEFINITIONS

Rate of Inflation - Inflation is an economic concept that refers to increase in the price level of goods over a period of time. The rise in the price level signifies that the currency in a given economy loses purchasing power (i.e., less can be bought with the same amount of money). Decrease in unemployment and decrease in the real value of debt are the effects of inflation.

The causes for inflation in the short term and medium term remain a contested issue among economists all over the world. However, there is a consensus that, in the long term, inflation is caused by changes in the money supply. In the long run, money supply affects the purchasing power of a currency as per supply and demand rules. The diagram below illustrates how an increase in the money supply in an economy would affect inflation:



The money supply can increase in a variety of ways, namely if governments print more money or make credit more easily accessible. Lower interest rates may spur consumer borrowing and lead to an increase in the money supply. In the diagram above, we can see that an influx of money in an environment where demand remains the same will result in a devaluation of the currency in question. The opposite is also true; if governments restrict the money supply and all else remains constant, the currency will begin to appreciate in value.

Interest Rate - Interest is needed to entice individuals to give up liquidity or sacrifice their present consumption, that is, to let someone else use their money for a period of time. The following story told by economist Irving Fisher helps illustrate the idea of the " time value of money. " The irony is that is was Fisher who had earlier formalized this exact idea in his theory of interest.

> *In the process of a massage, a masseur informed Fisher that he was a socialist who believed that " interest is the basis of capitalism and is robbery. " Following the massage, Fisher asked, " How much do I owe you? "*
> *The masseur replied, " Thirty dollars. "*
> *" Very well, " said Fisher, " I will give you a note payable a hundred years hence. I suppose you have no objections to taking this note without any interest. At the end of that time, you or perhaps your grandchildren, can redeem it. "*
> *" But I can not afford to wait that long, " said the masseur.*
> *" I thought you said that interest was robbery. If interest is robbery, you ought to be willing to wait indefinitely for the money. If you are willing to wait ten years, how much would you require? "*
> *" Well, I would have to get more than thirty dollars. "*
> *His point now made, Fisher replied, " That is interest. "*

Real Interest Rate - A real interest rate is an interest rate that has been adjusted to remove the effects of inflation to reflect the real cost of funds to the borrower and the real yield to the lender or to an investor. The real interest rate reflects the rate of time-preference for current goods over future goods. The real interest rate of an investment is calculated as the difference between the nominal interest rate and the inflation rate:

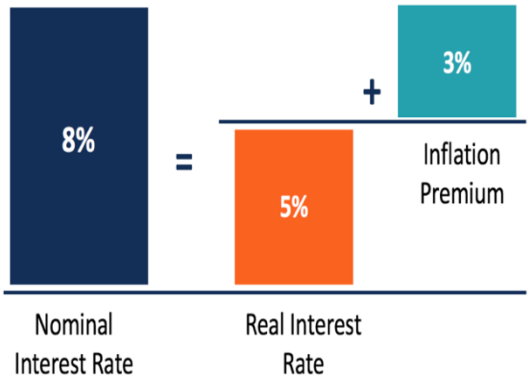
Real Interest Rate = Nominal Interest Rate – Rate of Inflation (Expected or Actual)

The real interest rate reflects the purchasing power value of the interest paid on an investment or loan and represents the rate of time-preference of the borrower and lender. Because inflation rates are not constant, prospective real interest rates must rely on estimates of expected future inflation over the time to maturity of a loan or investment.

While the nominal interest rate is the interest rate actually paid on a loan or investment, the real interest rate is a reflection of the change in purchasing power derived from an investment or given up by the borrower. According to the time-preference theory of interest, the real interest rate reflects the degree to which an individual prefers current goods over future goods. A borrower who is eager to enjoy the present use of funds shows a stronger time-preference for current goods over future goods and is willing to pay a higher interest rate for loaned funds. Similarly a lender who strongly prefers to put off consumption to the future shows a lower time-preference and will be willing to loan funds at a lower rate. Adjusting for inflation can help reveal the rate of time-preference among market participants.

Nominal Interest Rate - The nominal interest rate refers to the rate of interest before adjusting for inflation. It also refers to the rate specified in the loan contract without adjusting for compounding. The nominal interest rate is in contrast to the real interest rate regarding the inflation adjustment and effective interest rate regarding the compounding adjustment. Nominal interest rates can be impacted by different factors, including the demand and supply of money, the action of the federal government, the monetary policy of the central bank, and many others.

Central banks implement the short-term nominal interest rate as a tool of monetary policy. During an economic recession, the nominal rate is lowered to stimulate economic activities. During inflationary periods, the nominal rate is raised.



Interest Yield Differential - The relation between short-term and long-term interest yield differentials and exchange rate is complex. There are two views regarding the relationship between the interest rate and exchange rate. According to one view uncovered interest parity theory which implies that domestic interest rate is the sum of world interest rate and expected depreciation of home currency is the basis of exchange rate determination. In other words, the interest rate differential between domestic and world interest rate is equal to the expected change in the domestic exchange rate. Therefore, a higher interest differential would attract capital inflows and result in exchange rate appreciation. On the other hand, monetarists believe that higher interest rate reduces the demand for money which leads to depreciation of currency due to high inflation.

7. UNDERSTANDING INTERNATIONAL FISHER EFFECT

The **IFE** is defined as an economic concept which states that the anticipated disparity between the exchange rate of one currency and another is somehow equal to the difference between the nominal interest rates of those countries, i.e. the difference between the nominal interest rates of any two countries is equal and proportional to the changes in their exchange rates at any given time.

The theory is derived from the concept that real interest rates are independent of other monetary variables, such as changes in the monetary policy of a particular nation, and the real interest rates provide a better indication of the health of a particular currency within the global market. It implies that a country with lower interest rates, is likely to experience lower inflation levels. This effectively leads to an increase in value of the currency when compared to other economies with higher interest rates. In a nutshell, a country with high interest rates is likely to witness the depreciation of its currency.

The concept of IFE is unique because unlike other economic indicators, it analyzes both interest and inflation rates to predict the future movement of a currency. Present and future investments which are considered risk-free (eg. Treasuries) is also considered by IFE. The other theories are mostly based on inflation rates only.

The International Fisher's effect relates the nominal interest rate between two countries and the movement of exchange rate between the currencies of two countries. It indicates that the country with lower nominal (higher) interest rate will appreciate (depreciate) compared to the other currency. If the spot rate is INR40/USD and 1 year interest rate is 12% and 8% in India and US respectively, then INR is expected to depreciate or USD is expected to appreciate. The % appreciation and depreciation will be governed by Interest rate differential.

8. FISHER EFFECT AND INTERNATIONAL FISHER EFFECT

The Fisher Effect and the International Fisher Effect are related models but are not interchangeable. The Fisher effect describes the relationship between the interest rate and the rate of inflation. According to Fisher Effect the combination of anticipated rate of inflation and real rate of return are represented in the nominal rate of interest. It proposes that the nominal interest rate in a country is equal to the sum of real interest rate and inflation rate, i.e. real interest rate is equal to the difference between nominal interest rate and the rate of inflation. The IFE expands on the Fisher Effect, suggesting that nominal interest rates reflect anticipated inflation rates and currency exchange rate changes are driven by inflation rates. Therefore the changes in the value of the currency are proportional to the difference between the two nations' nominal interest rates.

Therefore, any increase in the rate of inflation will result in a proportional increase in the nominal interest rate, where the real interest rate is constant. Let us take an example. Let's assume that the real interest rate is 5.5% and the rate of inflation changes from 2.5% to 3.5%. The nominal interest rate is calculated as follows:

(1 + Nominal Interest Rate) = (1+Real Interest Rate) (1+Rate of Inflation)
Thus, Nominal Interest Rate = [**(1+Real Interest Rate) (1+Rate of Inflation)**]-1
= [(1+0.055) (1+0.025)] – 1
= [(1.055) (1.025)] – 1
= 0.081 or **8.1%**

Again, Nominal Interest Rate = [(1.055) (1.035)] – 1
= 0.092 or **9.2%**

Therefore, the nominal interest rate would've increased from 8.1% to 9.2%, when the inflation rate changed from 2.5% to 3.5%.

The International Fisher Effect (IFE) does expand on the Fisher Effect theory. IFE suggests that the estimated appreciation or depreciation of the currencies of two countries is proportional to the difference in the nominal interest rates of the two countries. For example, if the nominal interest rate of USA is greater than that of the United Kingdom, the value of USD should fall by the interest rate differential.

9. HOW TO CALCULATE THE INTERNATIONAL FISHER EFFECT

The formula for calculating the IFE is –
$E = [(I_1-I_2) / (1+ I_2)] * (I_1-i_2)$

Where:
E = Percentage (%) change in exchange rate of the country's currency
I_1 = Country's A's Interest rate
I_2 = Country's B's Interest rate

Now let us take an example.

Let us take the example of two currencies, the USD (the United States) and the CAD (the Canadian Dollar). The USD/CAD spot exchange rate is 1.30, and the interest rate of the United States is 5.0% while that of Canada is 6.0%.

Based on the IFE assumption, the country with a higher interest rate, Canada in this case, will see a higher inflation rate and that country will witness a depreciation in the value of its currency. The future spot rate is calculated by taking the spot rate and multiplying it by the ratio of the foreign interest rate to the domestic interest rate, as shown below:

$$1.3 \times [1+\{(0.06-0.05)/1.05\}] = 1.312$$

Given the future spot rate, the International Fisher Effect assumes that the CAD currency will depreciate against the USD. 1 USD will exchange into 1.312 CAD, up from the original rate of 1.30. Here the investors will receive a lower interest rate on the USD currency, but on the other hand, they will gain from an increase in the value of the US currency.

For the IFE to work, several assumptions have to be made. Some of the assumptions include free flow of capital between countries, capital market integration, and the lack of control on the currency for trade purposes.

Again, International Fisher Effect postulates that the estimated change in the current exchange rate between any two currencies is directly proportional to the difference between the two countries' nominal interest rates at a particular time. In other words, the percentage change in the spot exchange rate over time is governed by the difference between the nominal interest rate for the two currencies. For example, if the nominal interest rate in India is 12% per annum and it is 8% in USA, then INR is expected to depreciate vis-a vis USD. Plugging the interest rate in the right hand side of the International Fisher Effect equation, we get,

$$\frac{i_{USA} - i_{India}}{1+ i_{India}} = \frac{8\% - 12\%}{1+12\%} = -3.57\%$$, where INR is considered as the foreign currency

This indicates that the left hand side of the equation should also be equal to -3.57%. Hence, percentage difference between the spot rate prevailing today and spot rate to prevail after a year should be equal to -3.57%. Elaborating the example given above, suppose a Government of India issued a G-Sec on 1st January 2010 having a maturity of 1 year has a coupon rate of 12% per annum. Govt. of USA paper with a maturity of 1 year is available at 8%. The differential in the nominal interest rate prevailing in Indian and USA indicates that INR will depreciate by 3.57% by the end of one year i.e, 1st January 2011.

Intuitively, the International Fisher effect works like this: Suppose on 1st January 2010, the exchange rate is INR 40/USD. On this date an investor invest INR 1600 at his disposal. He invests INR 800 on a Govt. of India paper at 12% interest per annum. He converts the other INR 800 to USD (USD 20) and invests in Govt. of USA paper for 1 year. After a year, he has INR 896 and USD21.6 from INR and USD investment respectively. According to the International Fisher's effect, the spot exchange rate on 1st January 2011 will be decided by these two investment returns i.e USD 21.6 = INR 896. Hence the spot rate on 1st January 2011 will be USD 0.024107/ INR

$$\frac{\text{Spot}_{\text{after a year}} - \text{Spot}_{\text{today}}}{\text{Spot}_{\text{today}}} = \frac{0.024107-0.025}{0.025} = -3.57\%$$

Now let us find out what would be the % appreciation/depreciation of USD/ INR . The nominal interest rate in India is 12% per annum and it is 8% in USA, then USD is expected to appreciate. The USD appreciation amount is governed by

$$\frac{\text{Spot}_{\text{today}} - \text{Spot}_{\text{after a year}}}{\text{Spot}_{\text{after a year}}} = \frac{i_{\text{India}} - i_{\text{USA}}}{1 + i_{\text{USA}}} = \frac{12\% - 8\%}{1 + 8\%} = 3.7\%$$, where USD is considered as the foreign currency

In other words, USD is expected to appreciate by 3.7%. Suppose on 1st January 2010, the exchange rate is INR 40/USD. On this date an investor invest INR 1600 at his disposal. He invests INR 800 on a Govt. of India paper at 12% interest per annum. He converts the other INR 800 to USD (USD 20) and invests in Govt. of USA paper for 1 year. After a year, he has INR 896 and USD21.6 from INR and USD investment respectively. According to the international Fisher's effect, the spot exchange rate on 1st January 2010 will be INR 41.48/USD or USD0.024108/INR.

$$\frac{\text{Spot}_{\text{after a year}} - \text{Spot}_{\text{today}}}{\text{Spot}_{\text{today}}} = \frac{41.48-40}{40} = 3.7\%$$

Thus the % appreciation and depreciation of USD and INR respectively will be governed by the Nominal Interest Rate Differential.

10. COLLECTION OF DATA AND REGRESSION OUTPUT

According to Fisher Effect, the nominal interest rates in any country must compensate for the anticipated inflation and desired returns. If real rates of returns are equalized across world, then interest rates must keep pace with inflation rates.

Now to get the evidence regarding the explanation of the International Fisher Effect on major world economies (viz. the USA, China, Japan, India and also Singapore which is one of the most advanced Asain countries), I have considered the time period of 2001 to 2019.

A direct quote is an exchange rate quotation in the foreign exchange market. It quotes a fixed unit of a foreign currency against a variable amount of the domestic currency. In other words, a direct quote depicts the amount of foreign currency that can be bought for a certain unit of the domestic currency. The exact opposite of the direct quote is known as the indirect quote. Again an indirect quote is an exchange rate quotation in the foreign exchange market that quotes a variable amount of a foreign currency against a fixed unit of the domestic currency. The indirect quote is also popularly referred to as a "quantity quotation." It basically reflects the quantity of foreign currency needed to buy a certain unit of the domestic currency. For example, if the exchange rate between the US dollar and the Chinese yuan is 0.56 yuan per US dollar, it is a direct quote for China, as the domestic currency for China is represented per unit of the US dollar (foreign currency) and similarly, the exact currency quote above is an indirect quote for the USA, as a USD1.79 per yuan.

The data has been collected for all the major five economies and thus for 10 currency pairs, i.e ***USD/ INR & INR/ USD***, ***JPY/ INR & INR/ JPY***, ***CNY/ INR & INR/ CNY***, ***SGD/ INR & INR/ SGD, USD/ JPY & JPY/ USD, USD/ CNY & CNY/ USD, USD/ SGD & SGD/ USD, JPY/ CNY & CNY/ JPY, JPY/ SGD & SGD/ JPY, CNY/ SGD & SGD/ CNY*** for the years 2001 to 2019. For each instance Nominal Interest Rates have been worked out for the Home Country and the Foreign Country respectively by adopting the mathematical equation of the Fisher Effect. Then Nominal Interest Rate Differentials have been calculated for the Home Country and the Foreign Country alternatively.

The data in the form of Microsoft Excel © is fed to Minitab Statistical Software © in each instances to get the Regression output which has been explained in the ' Discussion ' section later.

Year	Currency Value INR/ USD	Currency Value USD/ INR	%Change In USD/ INR over Previous Period	%Change In INR/ USD over Previous Period	Real Interest Rate, India (%)	Rate of Inflation, India (%)	Nominal Interest Rate, India (%) = [(1+Real Interest Rate)(1+ Inflation Rate)]-1	Real Interest Rate, USA (%)	Rate of Inflation, USA (%)	Nominal Interest Rate, USA (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, India - Nominal Intt. Foreign, USA)/ (1 + Nominal Interest Foreign, USA)	Nominal Interest Rate Differential = (Nominal Intt. Home, USA - Nominal Intt. Foreign, India)/ (1 + Nominal Interest Foreign, India)
2001	0.0216	46.39	0	0	8.591	3.779	0.127	4.627	2.826	0.076	0.048	-0.045
2002	0.0206	48.51	0.046	-0.044	7.907	4.297	0.125	3.045	1.586	0.047	0.075	-0.070
2003	0.0209	47.8	-0.015	0.015	7.308	3.806	0.114	2.224	2.27	0.045	0.065	-0.061
2004	0.0221	45.27	-0.053	0.056	4.91	3.767	0.089	1.605	2.677	0.043	0.043	-0.042
2005	0.0229	43.65	-0.036	0.037	4.855	4.246	0.093	2.981	3.393	0.065	0.027	-0.026
2006	0.0228	43.93	0.006	-0.006	2.571	5.797	0.085	4.786	3.226	0.082	0.003	-0.003
2007	0.0227	44.08	0.004	-0.004	5.682	6.373	0.124	5.223	2.853	0.082	0.039	-0.037
2008	0.0255	39.28	-0.109	0.122	3.772	8.349	0.124	3.082	3.839	0.070	0.050	-0.048
2009	0.0205	48.85	0.244	-0.196	4.809	10.882	0.162	2.469	-0.36	0.021	0.138	-0.121
2010	0.0217	46.13	-0.056	0.059	-1.98	11.989	0.098	2.061	1.64	0.037	0.058	-0.055
2011	0.0218	45.8	-0.007	0.007	1.318	8.858	0.103	1.137	3.157	0.043	0.057	-0.054
2012	0.0202	49.5	0.081	-0.075	2.474	9.312	0.120	1.307	2.069	0.034	0.083	-0.077
2013	0.0188	53.26	0.076	-0.071	3.866	10.908	0.152	1.469	1.465	0.030	0.119	-0.106
2014	0.0160	62.68	0.177	-0.150	6.695	6.353	0.135	1.375	1.622	0.030	0.101	-0.092
2015	0.0161	62.01	-0.011	0.011	7.556	5.872	0.139	2.196	0.119	0.023	0.113	-0.101
2016	0.0147	67.87	0.094	-0.086	6.233	4.941	0.115	2.451	1.262	0.037	0.075	-0.069
2017	0.0148	67.49	-0.006	0.006	5.522	2.491	0.082	2.172	2.13	0.043	0.036	-0.035
2018	0.0157	63.54	-0.059	0.062	4.685	4.861	0.098	2.409	2.443	0.049	0.046	-0.044
2019	0.0141	70.95	0.117	-0.104	6.369	7.66	0.145	3.277	1.812	0.051	0.089	-0.082

Regression Analysis: % Change In USD/ INR over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – India, Foreign Country – USA)

Regression Equation

%Change In USD/ INR over Previous Period = -0.0936 + 1.794 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.0936	0.0328	-2.86	0.011	
Nominal Interest Rate Different	1.794	0.439	4.08	0.001	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0639517	49.49%	46.52%	29.53%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.06813	0.068126	16.66	0.001
Nominal Interest Rate Different	1	0.06813	0.068126	16.66	0.001
Error	17	0.06953	0.004090		
Total	18	0.13765			

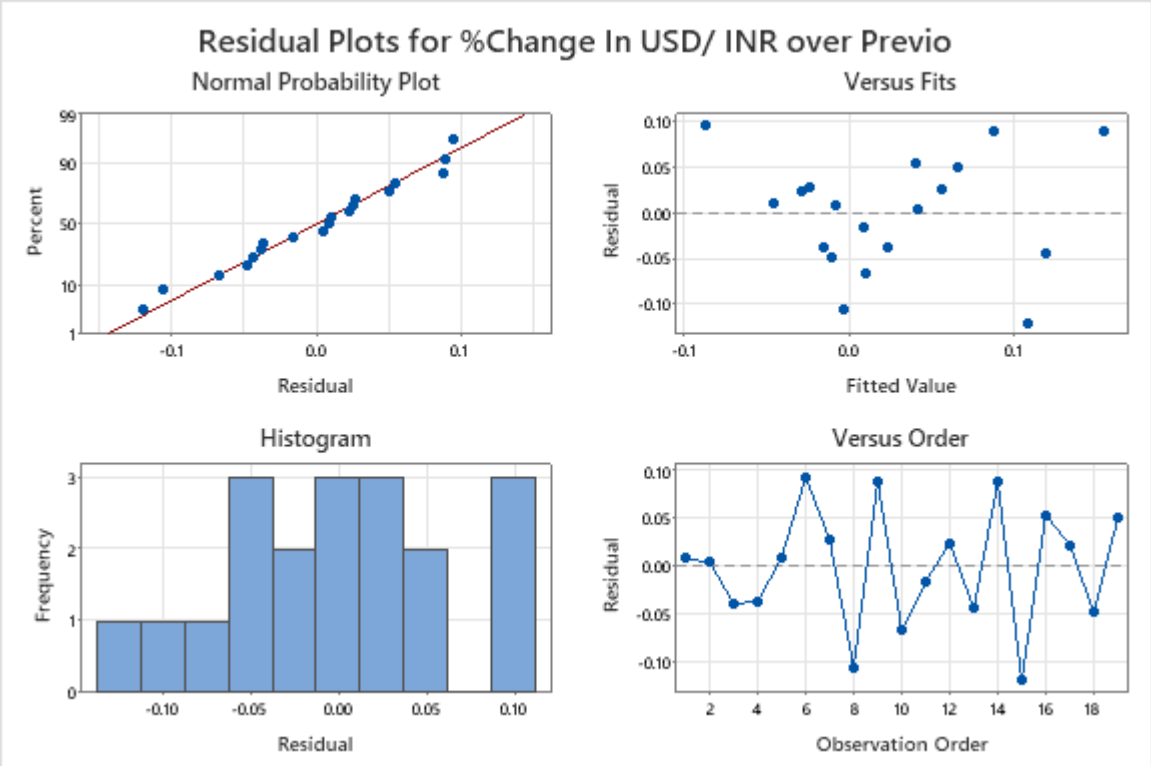
Fits and Diagnostics for Unusual Observations

Obs	%Change In USD/ INR over Previo	Fit	Resid	Std Resid	
15	-0.0107	0.1089	-0.1196	-2.03	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 3.04088



Regression Analysis: % Change In INR/ USD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – USA, Foreign Country – India)

Regression Equation

%Change In INR/ USD over Previous Period = 0.0907 + 1.780 Nominal Interest Rate Differential

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0907	0.0322	2.81	0.012	
Nominal Interest Rate Differe_1	1.780	0.473	3.76	0.002	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0600215	45.42%	42.21%	25.86%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.05097	0.050972	14.15	0.002
Nominal Interest Rate Differe_1	1	0.05097	0.050972	14.15	0.002
Error	17	0.06124	0.003603		
Total	18	0.11222			

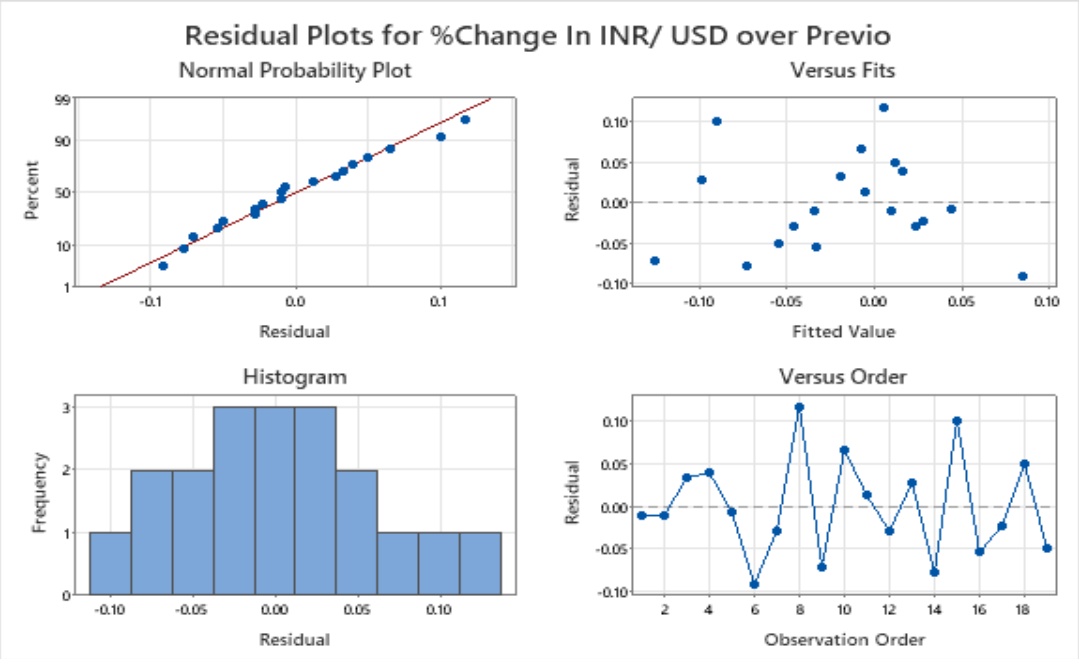
Fits and Diagnostics for Unusual Observations

Obs	%Change In INR/ USD over Previo	Fit	Resid	Std Resid	
8	0.1222	0.0052	0.1170	2.01	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic 2.94374
=



Year	Currency Value INR/ JPY	Currency Value JPY/ INR	%Change In JPY/ INR over Previous Period	%Change In INR/ JPY over Previous Period	Real Interest Rate, JAPAN (%)	Rate of Inflation, JAPAN (%)	Nominal Interest Rate, JAPAN (%) = [(1+Real Interest Rate)(1+ Inflation Rate)]-1	Real Interest Rate, India (%)	Rate of Inflation, India (%)	Nominal Interest Rate, India (%) = [(1+Real Interest Rate)(1+ Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, India - Nominal Intt. Foreign, Japan)/ (1 + Nominal Interest Foreign, Japan)	Nominal Interest Rate Differential = (Nominal Intt. Home, Japan - Nominal Intt. Foreign, India)/ (1 + Nominal Interest Foreign, India)
2001	2.5088	0.3986	0	0	3.108	-0.74	0.023	8.591	3.779	0.127	0.1011	-0.0918
2002	2.7732	0.3606	-0.095	0.105	3.372	-0.923	0.024	7.907	4.297	0.125	0.0989	-0.0900
2003	2.5082	0.3987	0.106	-0.096	3.496	-0.257	0.032	7.308	3.806	0.114	0.0791	-0.0733
2004	2.3359	0.4281	0.074	-0.069	2.899	-0.009	0.029	4.91	3.767	0.089	0.0580	-0.0549
2005	2.3753	0.421	-0.017	0.017	2.743	-0.283	0.025	4.855	4.246	0.093	0.0669	-0.0627
2006	2.6688	0.3747	-0.110	0.124	2.571	0.249	0.028	2.571	5.797	0.085	0.0553	-0.0524
2007	2.7375	0.3653	-0.025	0.026	2.632	0.06	0.027	5.682	6.373	0.124	0.0947	-0.0865
2008	2.7086	0.3692	0.011	-0.011	2.919	1.38	0.043	3.772	8.349	0.124	0.0776	-0.0720
2009	1.8423	0.5428	0.470	-0.320	2.349	-1.353	0.010	4.809	10.882	0.162	0.1510	-0.1312
2010	1.9577	0.5108	-0.059	0.063	3.561	-0.72	0.028	-1.984	11.989	0.098	0.0676	-0.0633
2011	1.7912	0.5583	0.093	-0.085	3.229	-0.268	0.030	1.318	8.858	0.103	0.0713	-0.0666
2012	1.5401	0.6493	0.163	-0.140	2.186	-0.052	0.021	2.474	9.312	0.120	0.0968	-0.0882
2013	1.7185	0.5819	-0.104	0.116	1.642	0.346	0.020	3.866	10.908	0.152	0.1294	-0.1146
2014	1.6276	0.6144	0.056	-0.053	-0.517	2.762	0.022	6.695	6.353	0.135	0.1100	-0.0991
2015	1.8936	0.5281	-0.140	0.163	-0.982	0.79	-0.002	7.556	5.872	0.139	0.1410	-0.1236
2016	1.7835	0.5607	0.062	-0.058	0.772	-0.117	0.007	6.233	4.941	0.115	0.1076	-0.0971
2017	1.6700	0.5988	0.068	-0.064	1.226	0.467	0.017	5.522	2.491	0.082	0.0634	-0.0597
2018	1.7185	0.5819	-0.028	0.029	-0.1	0.98	0.009	4.685	4.861	0.098	0.0882	-0.0810
2019	1.5340	0.6519	0.120	-0.107	-0.1	0.477	0.004	6.369	7.66	0.145	0.1409	-0.1235

Regression Analysis: % Change In JPY/ INR over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – India, Foreign Country – Japan)

Regression Equation

%Change In JPY/ INR over Previous Period = -0.095 + 1.36 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.095	0.106	-0.90	0.382	
Nominal Interest Rate Different	1.36	1.07	1.27	0.221	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.133972	8.67%	3.30%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.02898	0.02898	1.61	0.221
Nominal Interest Rate Different	1	0.02898	0.02898	1.61	0.221
Error	17	0.30512	0.01795		
Total	18	0.33410			

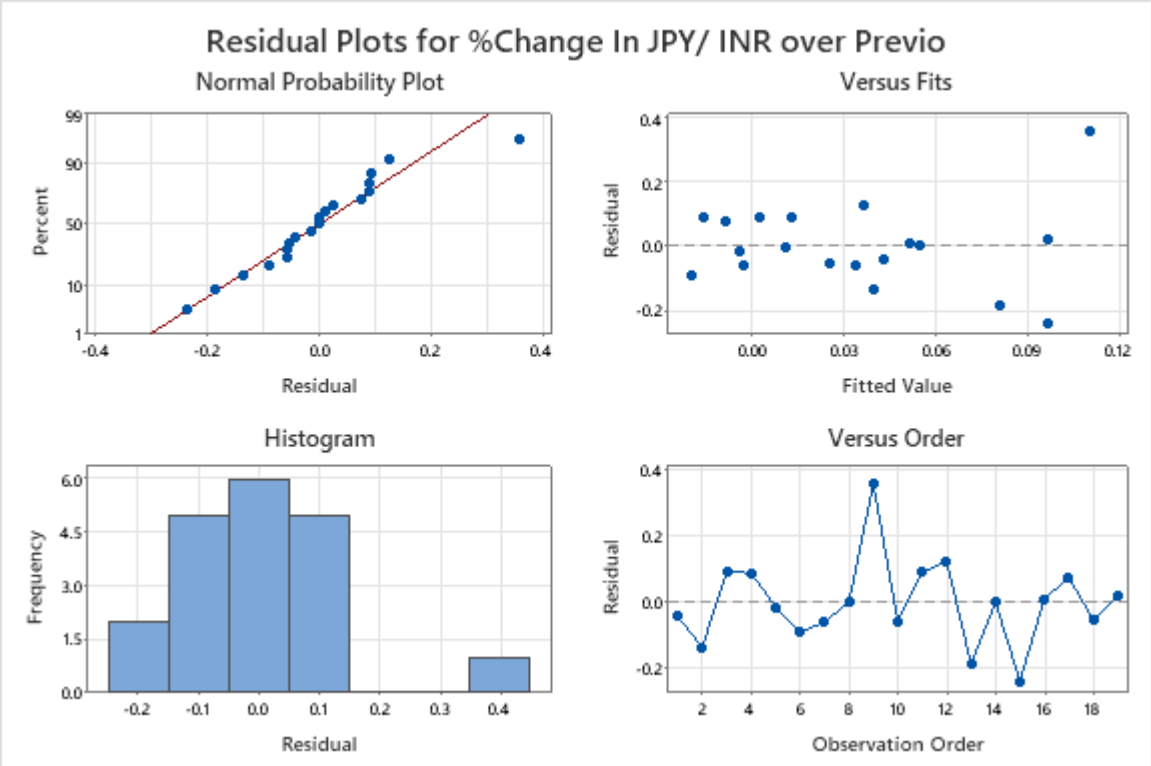
Fits and Diagnostics for Unusual Observations

Obs	%Change In JPY/ INR over Previo	Fit	Resid	Std Resid	
9	0.4702	0.1106	0.3596	3.11	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 2.23907



Regression Analysis: % Change In INR/ JPY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – Japan, Foreign Country – India)

Regression Equation

%Change In INR/ JPY over Previous Period = 0.0584
+ 0.90 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0584	0.0986	0.59	0.562	
Nominal Interest Rate Differe_1	0.90	1.11	0.81	0.428	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.114192	3.74%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.008617	0.008617	0.66	0.428
Nominal Interest Rate Differe_1	1	0.008617	0.008617	0.66	0.428
Error	17	0.221677	0.013040		
Total	18	0.230294			

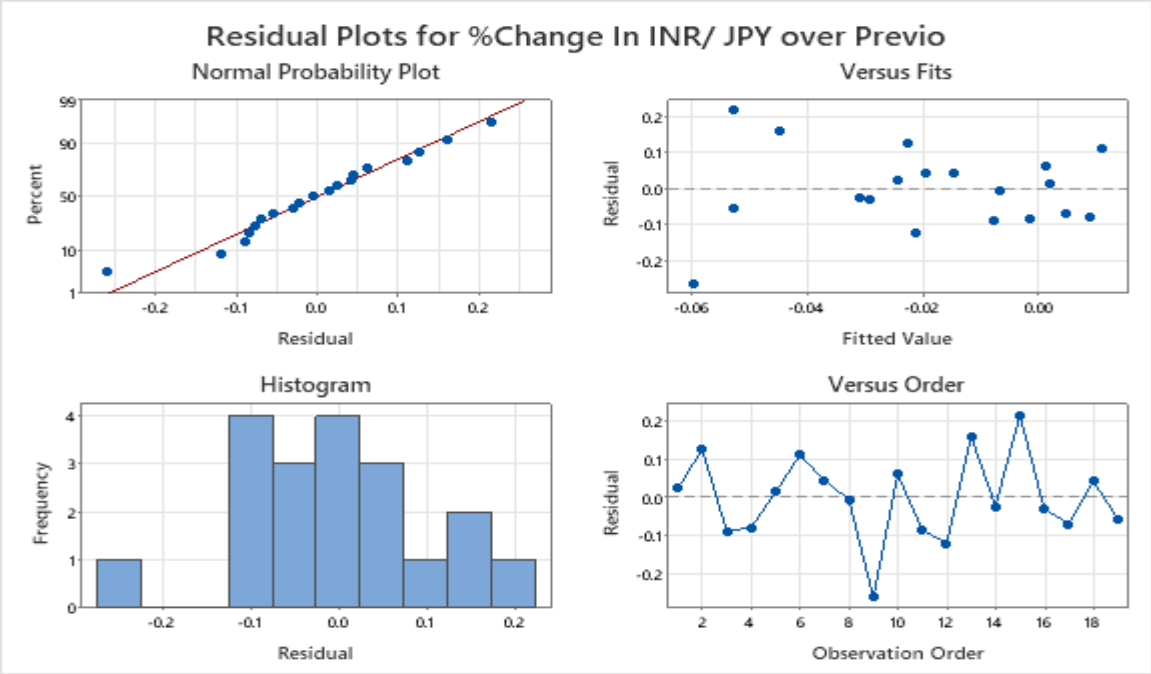
Fits and Diagnostics for Unusual Observations

Obs	%Change In INR/ JPY over Previo	Fit	Resid	Std Resid	
9	-0.3198	-0.0597	-0.2601	-2.62	R
15	0.1634	-0.0529	0.2163	2.10	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 2.37236



Year	Currency Value INR/ CNY	Currency Value CNY/ INR	%Change In CNY/INR over Previous Period	%Change In INR/CNY over Previous Period	Real Interest Rate, India (%)	Inflation Rate, India (%)	Nominal Interest Rate, India (%) = [(1+Real Interest Rate)(1+ Inflation Rate)]-1	Real Interest Rate, CHINA (%)	Inflation Rate, CHINA (%)	Nominal Interest Rate, CHINA (%) = [(1+Real Interest Rate)(1+ Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, India - Nominal Intt. Foreign, China)/ (1 + Nominal Interest Foreign, China)	Nominal Interest Rate Differential = (Nominal Intt. Home, China - Nominal Intt. Foreign, India)/ (1 + Nominal Interest Foreign, India)
2001	0.1785	5.6027	0.0000	0.0000	8.591	3.779	0.127	3.727	0.719	0.045	0.079	-0.073
2002	0.1707	5.8587	0.046	-0.044	7.907	4.297	0.125	4.68	-0.732	0.039	0.083	-0.077
2003	0.1732	5.7729	-0.015	0.015	7.308	3.806	0.114	2.638	1.128	0.038	0.073	-0.068
2004	0.1829	5.4674	-0.053	0.056	4.91	3.767	0.089	-1.283	3.825	0.025	0.062	-0.059
2005	0.1794	5.5755	0.020	-0.019	4.855	4.246	0.093	1.613	1.776	0.034	0.057	-0.054
2006	0.1835	5.4482	-0.023	0.023	2.571	5.797	0.085	2.111	1.649	0.038	0.045	-0.044
2007	0.1764	5.6696	0.041	-0.039	5.682	6.373	0.124	-0.26	4.817	0.045	0.075	-0.070
2008	0.1828	5.4691	-0.035	0.037	3.772	8.349	0.124	-2.306	5.925	0.035	0.087	-0.080
2009	0.1399	7.147	0.307	-0.235	4.809	10.882	0.162	5.531	-0.728	0.048	0.109	-0.099
2010	0.1480	6.7564	-0.055	0.058	-1.984	11.989	0.098	-1.002	3.175	0.021	0.075	-0.069
2011	0.1443	6.9308	0.026	-0.025	1.318	8.858	0.103	-1.402	5.554	0.041	0.060	-0.056
2012	0.1275	7.8447	0.132	-0.116	2.474	9.312	0.120	3.585	2.62	0.063	0.054	-0.051
2013	0.1168	8.5641	0.092	-0.084	3.866	10.908	0.152	3.755	2.621	0.065	0.082	-0.076
2014	0.0967	10.34	0.207	-0.172	6.695	6.353	0.135	4.522	1.922	0.065	0.065	-0.061
2015	0.1008	9.9208	-0.041	0.042	7.556	5.872	0.139	4.353	1.437	0.059	0.076	-0.070
2016	0.0969	10.3191	0.040	-0.039	6.233	4.941	0.115	2.902	2	0.050	0.062	-0.059
2017	0.1020	9.8003	-0.050	0.053	5.522	2.491	0.082	0.113	1.593	0.017	0.063	-0.060
2018	0.0990	10.0961	0.030	-0.029	4.685	4.861	0.098	0.822	2.075	0.029	0.067	-0.062
2019	0.0945	10.5804	0.048	-0.046	6.369	7.66	0.145	3.024	2.899	0.060	0.080	-0.074

Regression Analysis: Change In CNY/ INR over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – India, Foreign Country – China)

Regression Equation

%Change In CNY/ INR over Previous Period = -0.148 + 2.60 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.148	0.105	-1.40	0.178	
Nominal Interest Rate Different	2.60	1.45	1.80	0.090	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0882294	15.95%	11.01%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.02512	0.025116	3.23	0.090
Nominal Interest Rate Different	1	0.02512	0.025116	3.23	0.090
Error	17	0.13234	0.007784		
Total	18	0.15745			

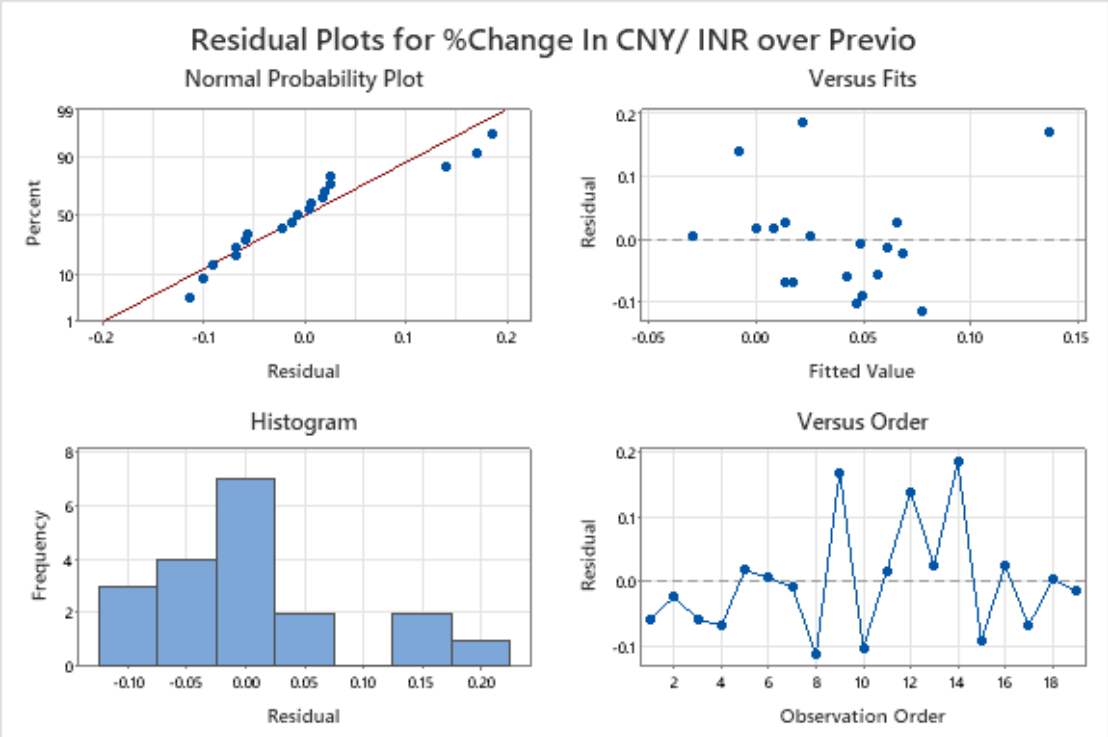
Fits and Diagnostics for Unusual Observations

Obs	%Change In CNY/ INR over Previo	Fit	Resid	Std Resid		
9	0.3068	0.1366	0.1702	2.58	R	X
14	0.2074	0.0219	0.1855	2.17	R	

R Large residual
X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 2.61261



Regression Analysis: Change In INR/ CNY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – China, Foreign Country – India)

Regression Equation

%Change In INR/ CNY over Previous Period = 0.1178
+ 2.22 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.1178	0.0966	1.22	0.239	
Nominal Interest Rate Differe_1	2.22	1.43	1.55	0.139	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0754644	12.42%	7.26%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.01373	0.013725	2.41	0.139
Nominal Interest Rate Differe_1	1	0.01373	0.013725	2.41	0.139
Error	17	0.09681	0.005695		
Total	18	0.11054			

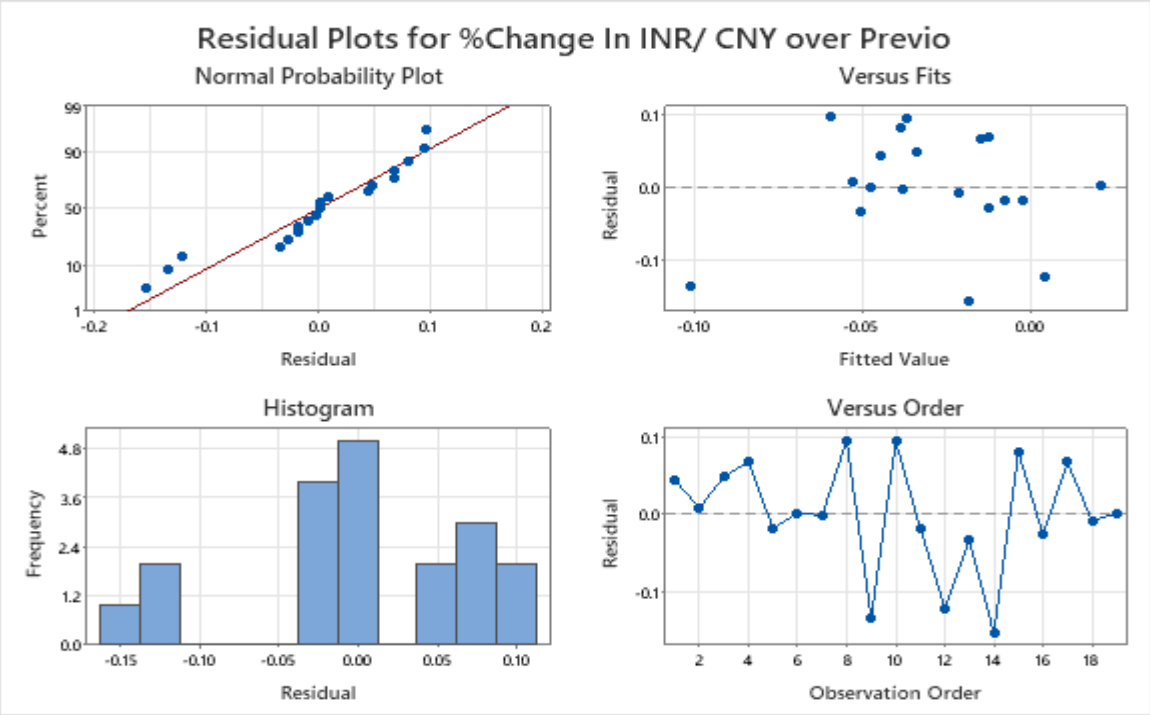
Fits and Diagnostics for Unusual Observations

Obs	%Change In INR/ CNY over Previo	Fit	Resid	Std Resid	
9	-0.2348	-0.1012	-0.1336	-2.33	R X
14	-0.1718	-0.0182	-0.1536	-2.10	R

R Large residual
X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic 2.59662
=



Year	Currency Value INR/ SGD	Currency Value SGD/ INR	%Change In SGD/ INR over Previous Period	%Change In INR/ SGD over Previous Period	Real Interest Rate, India (%)	Rate of Inflation, India (%)	Nominal Interest Rate, India (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Real Interest Rate, Singapore (%)	Rate of Inflation, Singapore (%)	Nominal Interest Rate, Singapore (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, India - Nominal Intt. Foreign, Singapore)/ (1 + Nominal Interest Foreign, Singapore)	Nominal Interest Rate Differential = (Nominal Intt. Home, Singapore - Nominal Intt. Foreign, India)/ (1 + Nominal Interest Foreign, India)
2001	0.0376	26.608	0.0000	0.0000	8.591	3.779	0.127	7.603	0.997	0.087	0.0370	-0.0357
2002	0.0379	26.360	-0.009	0.009	7.907	4.297	0.125	6.29	-0.392	0.059	0.0630	-0.0593
2003	0.0364	27.494	0.043	-0.041	7.308	3.806	0.114	7.223	0.508	0.078	0.0336	-0.0325
2004	0.0374	26.727	-0.028	0.029	4.91	3.767	0.089	1.178	1.663	0.029	0.0583	-0.0551
2005	0.0375	26.648	-0.003	0.003	4.855	4.246	0.093	3.329	0.425	0.038	0.0534	-0.0507
2006	0.0369	27.079	0.016	-0.016	2.571	5.797	0.085	3.404	0.963	0.044	0.0394	-0.0379
2007	0.0348	28.698	0.060	-0.056	5.682	6.373	0.124	-0.553	2.105	0.015	0.1071	-0.0968
2008	0.0361	27.726	-0.034	0.035	3.772	8.349	0.124	6.861	6.628	0.139	-0.0132	0.0134
2009	0.0309	32.367	0.167	-0.143	4.809	10.882	0.162	2.349	0.597	0.030	0.1287	-0.1141
2010	0.0305	32.800	0.013	-0.013	-1.984	11.989	0.098	4.231	2.824	0.072	0.0242	-0.0236
2011	0.0279	35.795	0.091	-0.084	1.318	8.858	0.103	4.281	5.248	0.098	0.0049	-0.0049
2012	0.0254	39.336	0.099	-0.090	2.474	9.312	0.120	4.887	4.576	0.097	0.0212	-0.0208

2013	0.0232	43.031	0.094	-0.086	3.866	10.908	0.152	5.856	2.359	0.084	0.0632	-0.0594
2014	0.0204	49.080	0.141	-0.123	6.695	6.353	0.135	5.635	1.025	0.067	0.0633	-0.0595
2015	0.0218	45.798	-0.067	0.072	7.556	5.872	0.139	2.222	-0.523	0.017	0.1198	-0.1070
2016	0.0210	47.643	0.040	-0.039	6.233	4.941	0.115	4.623	-0.532	0.041	0.0713	-0.0665
2017	0.0209	47.858	0.005	-0.004	5.522	2.491	0.082	2.432	0.576	0.030	0.0498	-0.0474
2018	0.0207	48.411	0.012	-0.011	4.685	4.861	0.098	2.174	0.439	0.026	0.0697	-0.0651
2019	0.0190	52.720	0.089	-0.082	6.369	7.66	0.145	5.15	0.565	0.057	0.0830	-0.0766

Regression Analysis: % Change In SGD/ INR over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – India, Foreign Country - Singapore)

Regression Equation

%Change In SGD/ INR over Previous Period = 0.0201 + 0.322 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0201	0.0270	0.75	0.466	
Nominal Interest Rate Different	0.322	0.403	0.80	0.435	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0624635	3.62%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.002490	0.002490	0.64	0.435
Nominal Interest Rate Different	1	0.002490	0.002490	0.64	0.435
Error	17	0.066329	0.003902		
Total	18	0.068819			

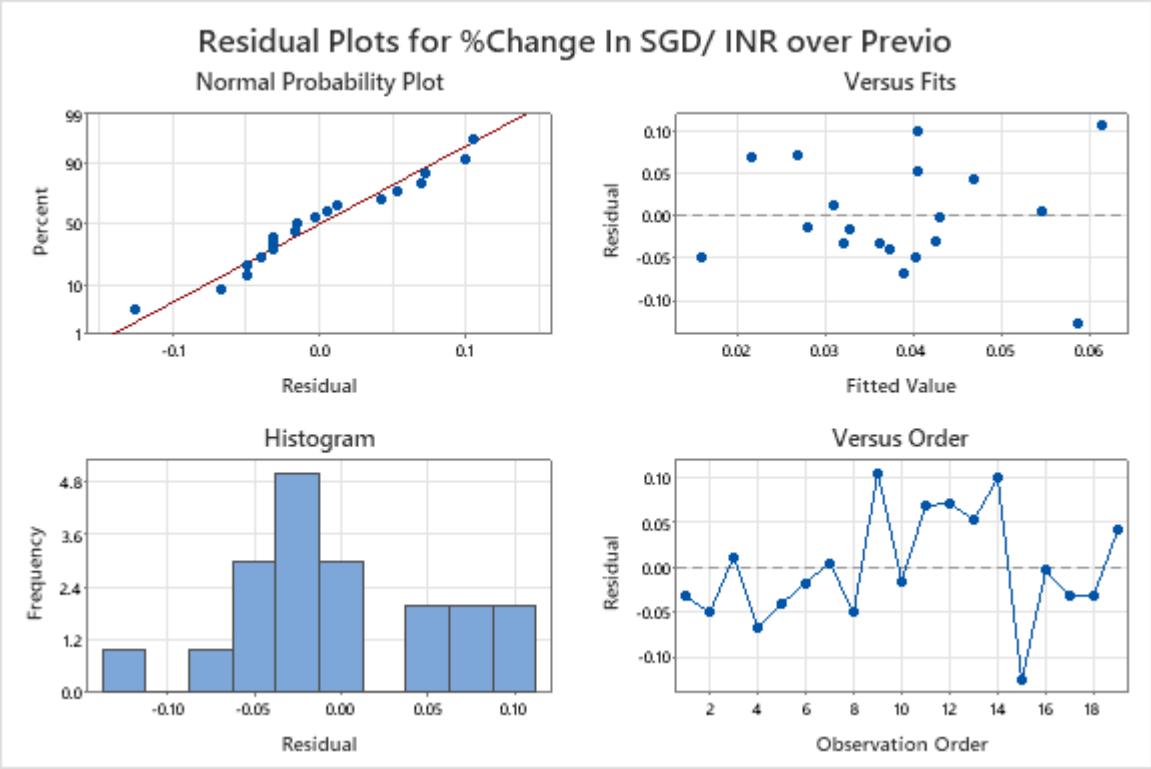
Fits and Diagnostics for Unusual Observations

Obs	%Change In SGD/ INR over Previo	Fit	Resid	Std Resid	
15	-0.0669	0.0587	-0.1255	-2.27	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic 2.04403
=



Regression Analysis: %Change In INR/ SGD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – Singapore, Foreign Country – India)

Regression Equation

%Change In INR/ SGD over Previous Period = -0.0191
+ 0.279 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.0191	0.0255	-0.75	0.463	
Nominal Interest Rate Differe_1	0.279	0.414	0.67	0.510	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0573957	2.59%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.001490	0.001490	0.45	0.510
Nominal Interest Rate Differe_1	1	0.001490	0.001490	0.45	0.510
Error	17	0.056002	0.003294		
Total	18	0.057492			

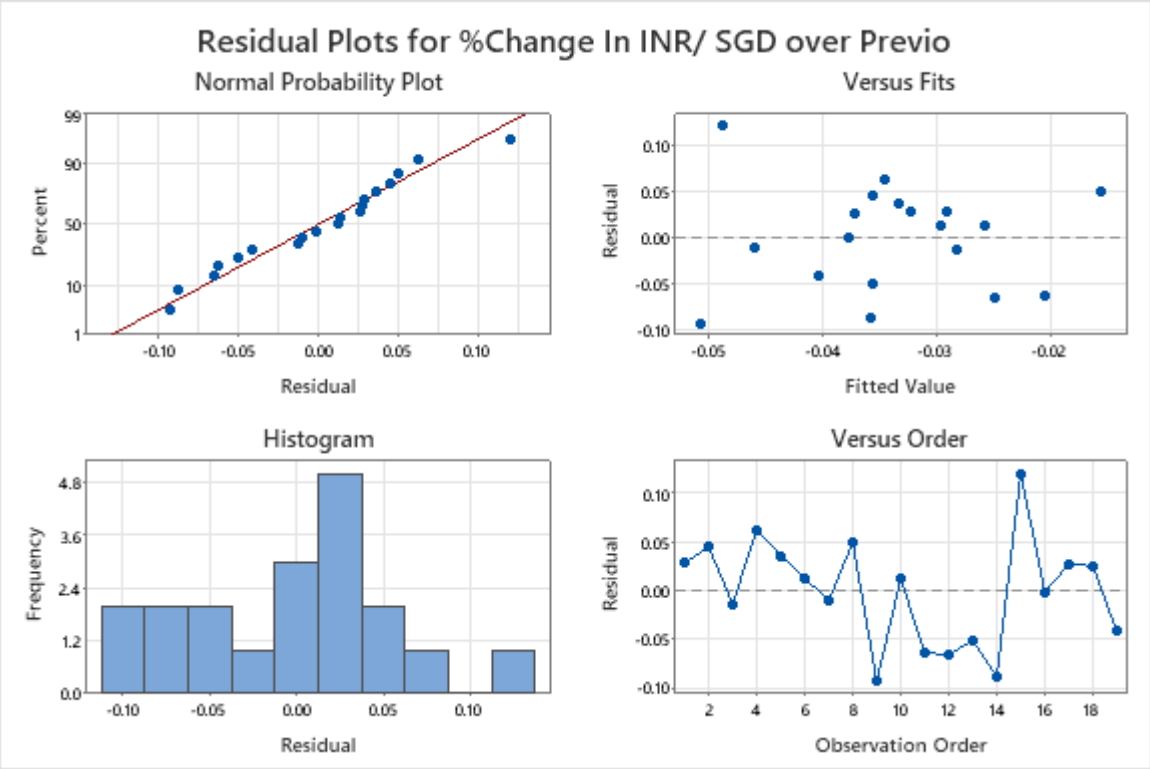
Fits and Diagnostics for Unusual Observations

Obs	%Change In INR/ SGD over Previo	Fit	Resid	Std Resid	
15	0.0717	-0.0489	0.1206	2.36	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic 2.09304
=



Year	Currency Value CNY/ USD	Currency Value USD/CNY	%Change In USD/ CNY over Previous Period	%Change In CNY/ USD over Previous Period	Real Interest Rate, China (%)	Rate of Inflation, China (%)	Nominal Interest Rate, CHINA (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Real Interest Rate, USA (%)	Rate of Inflation, USA (%)	Nominal Interest Rate, USA (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, China - Nominal Intt. Foreign, USA)/ (1 + Nominal Interest Foreign, USA)	Nominal Interest Rate Differential = (Nominal Intt. Home, USA - Nominal Intt. Foreign, China)/ (1 + Nominal Interest Foreign, China)
2001	0.1208	8.28	0.000	0.000	3.727	0.719	0.045	4.627	2.826	0.076	-0.0289	0.0298
2002	0.1208	8.28	0.000	0.000	4.68	-0.732	0.039	3.045	1.586	0.047	-0.0073	0.0074
2003	0.1208	8.28	0.000	0.000	2.638	1.128	0.038	2.224	2.27	0.045	-0.0072	0.0072
2004	0.1208	8.28	0.000	0.000	-1.283	3.825	0.025	1.605	2.677	0.043	-0.0176	0.0179
2005	0.1208	8.28	0.000	0.000	1.613	1.776	0.034	2.981	3.393	0.065	-0.0287	0.0296
2006	0.1239	8.07	-0.025	0.026	2.111	1.649	0.038	4.786	3.226	0.082	-0.0404	0.0421
2007	0.1280	7.81	-0.032	0.033	-0.26	4.817	0.045	5.223	2.853	0.082	-0.0340	0.0352
2008	0.1372	7.29	-0.067	0.071	-2.306	5.925	0.035	3.082	3.839	0.070	-0.0332	0.0344
2009	0.1466	6.82	-0.064	0.069	5.531	-0.728	0.048	2.469	-0.356	0.021	0.0260	-0.0254
2010	0.1464	6.83	0.001	-0.001	-1.002	3.175	0.021	2.061	1.64	0.037	-0.0154	0.0156
2011	0.1517	6.59	-0.035	0.036	-1.402	5.554	0.041	1.137	3.157	0.043	-0.0025	0.0025
2012	0.1590	6.29	-0.046	0.048	3.585	2.62	0.063	1.307	2.069	0.034	0.0280	-0.0272
2013	0.1605	6.23	-0.010	0.010	3.755	2.621	0.065	1.469	1.465	0.030	0.0342	-0.0330
2014	0.1653	6.05	-0.029	0.030	4.522	1.922	0.065	1.375	1.622	0.030	0.0341	-0.0330
2015	0.1613	6.2	0.025	-0.024	4.353	1.437	0.059	2.196	0.119	0.023	0.0345	-0.0334
2016	0.1531	6.53	0.053	-0.051	2.902	2	0.050	2.451	1.262	0.037	0.0117	-0.0116

2017	0.1436	6.964	0.066	-0.062	0.113	1.593	0.017	2.172	2.13	0.043	-0.0253	0.0260
2018	0.1541	6.491	-0.068	0.073	0.822	2.075	0.029	2.409	2.443	0.049	-0.0190	0.0194
2019	0.1454	6.878	0.060	-0.056	3.024	2.899	0.060	3.277	1.812	0.051	0.0082	-0.0081

Regression Analysis: % Change In CNY/ USD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - USA, Foreign Country - China)

Regression Equation

%Change In CNY/ USD over Previous Period = 0.01014
+ 0.089 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.01014	0.00974	1.04	0.312	
Nominal Interest Rate Differe_1	0.089	0.379	0.24	0.816	1.00

Model Summary

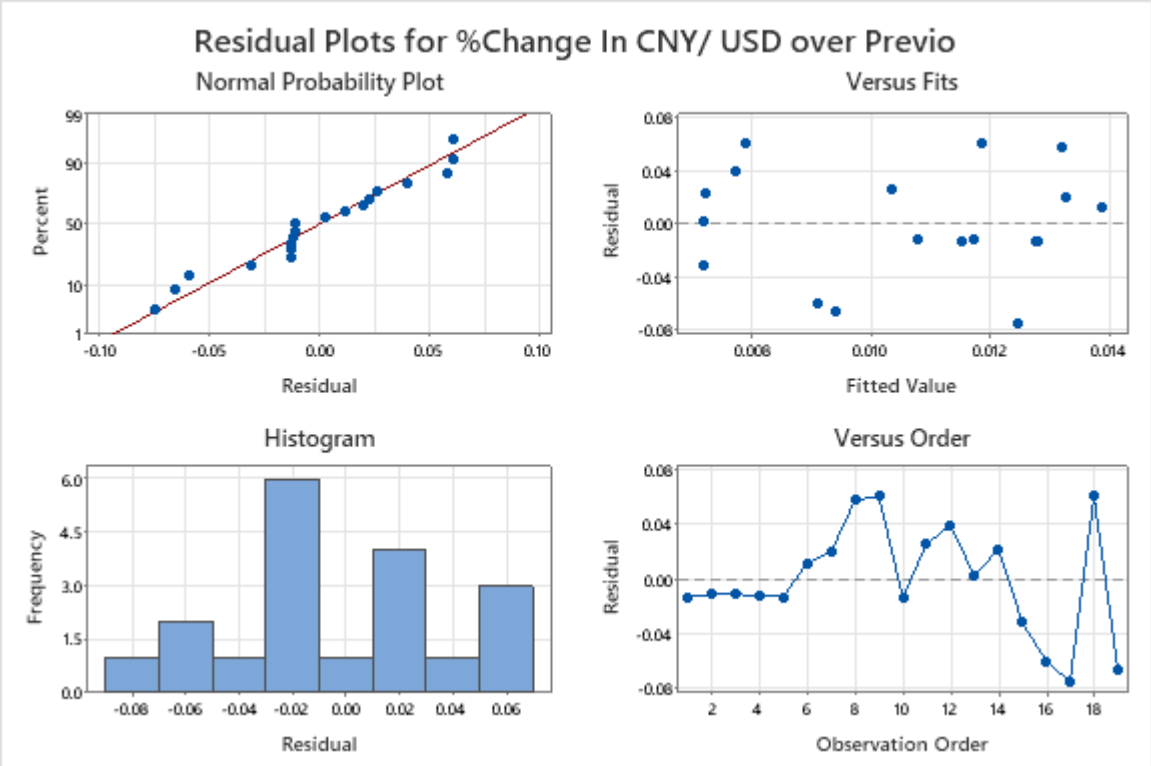
S	R-sq	R-sq(adj)	R-sq(pred)
0.0416408	0.33%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.000096	0.000096	0.06	0.816
Nominal Interest Rate Differe_1	1	0.000096	0.000096	0.06	0.816
Error	17	0.029477	0.001734		
Total	18	0.029574			

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.68206



Regression Analysis: % Change In USD/ CNY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - China, Foreign Country - USA)

Regression Equation

%Change In USD/ CNY over Previous Period = -0.00860 + 0.081 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.00860	0.00961	-0.90	0.383	
Nominal Interest Rate Different	0.081	0.376	0.21	0.832	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0412581	0.27%	0.00%	0.00%

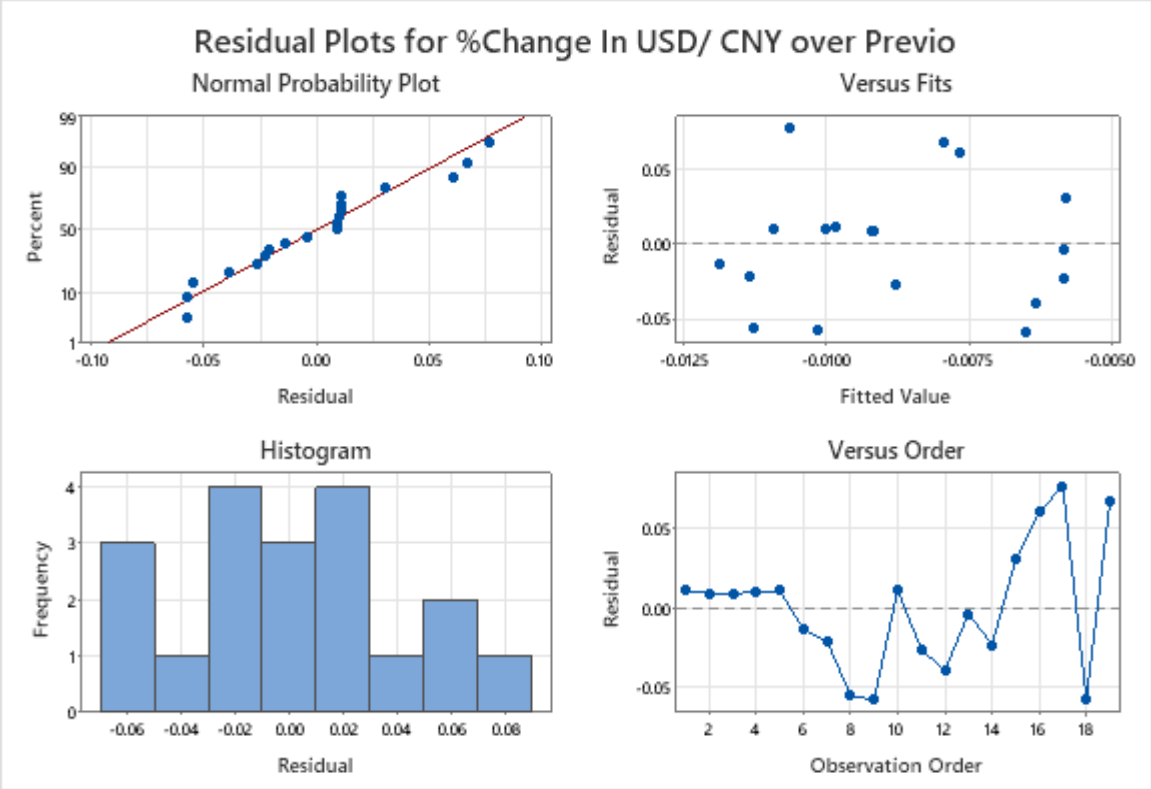
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.000079	0.000079	0.05	0.832
Nominal Interest Rate Different	1	0.000079	0.000079	0.05	0.832
Error	17	0.028938	0.001702		
Total	18	0.029016			

Durbin-Watson Statistic

Durbin-Watson Statistic 1.65276

=



Year	Currency Value JPY/ USD	Currency Value USD/ JPY	%Change In USD/ JPY over Previous Period	%Change In JPY/ USD over Previous Period	Real Interest Rate, JAPAN (%)	Rate of Inflation, JAPAN (%)	Nominal Interest Rate, JAPAN (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Real Interest Rate, USA (%)	Rate of Inflation, USA (%)	Nominal Interest Rate, USA (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, Japan - Nominal Intt. Foreign, USA)/ (1 + Nominal Interest Foreign, USA)	Nominal Interest Rate Differential = (Nominal Intt. Home, USA - Nominal Intt. Foreign, Japan)/ (1 + Nominal Interest Foreign, Japan)
2001	0.0086	116.59	0.0000	0.0000	3.108	-0.74	0.023	4.627	2.826	0.076	-0.0487	0.0512
2002	0.0074	134.72	0.156	-0.135	3.372	-0.923	0.024	3.045	1.586	0.047	-0.0216	0.0221
2003	0.0083	119.91	-0.110	0.124	3.496	-0.257	0.032	2.224	2.27	0.045	-0.0126	0.0127
2004	0.0095	105.71	-0.118	0.134	2.899	-0.009	0.029	1.605	2.677	0.043	-0.0138	0.0139
2005	0.0096	103.67	-0.019	0.020	2.743	-0.283	0.025	2.981	3.393	0.065	-0.0378	0.0393
2006	0.0085	117.25	0.131	-0.116	2.571	0.249	0.028	4.786	3.226	0.082	-0.0494	0.0519
2007	0.0083	120.67	0.029	-0.028	2.632	0.06	0.027	5.223	2.853	0.082	-0.0511	0.0539
2008	0.0094	106.36	-0.119	0.135	2.919	1.38	0.043	3.082	3.839	0.070	-0.0252	0.0259
2009	0.0111	89.99	-0.154	0.182	2.349	-1.353	0.010	2.469	-0.356	0.021	-0.0112	0.0113
2010	0.0111	90.31	0.004	-0.004	3.561	-0.72	0.028	2.061	1.64	0.037	-0.0089	0.0089

2011	0.0122	82.08	-0.091	0.100	3.229	-0.268	0.030	1.137	3.157	0.043	-0.0132	0.0134
2012	0.0131	76.23	-0.071	0.077	2.186	-0.052	0.021	1.307	2.069	0.034	-0.0123	0.0124
2013	0.0109	91.72	0.203	-0.169	1.642	0.346	0.020	1.469	1.465	0.030	-0.0093	0.0094
2014	0.0098	102.03	0.112	-0.101	-0.517	2.762	0.022	1.375	1.622	0.030	-0.0077	0.0077
2015	0.0085	117.45	0.151	-0.131	-0.982	0.79	-0.002	2.196	0.119	0.023	-0.0246	0.0252
2016	0.0083	121.06	0.031	-0.030	0.772	-0.117	0.007	2.451	1.262	0.037	-0.0298	0.0307
2017	0.0089	112.80	-0.068	0.073	1.226	0.467	0.017	2.172	2.13	0.043	-0.0254	0.0261
2018	0.0092	109.19	-0.032	0.033	-0.1	0.98	0.009	2.409	2.443	0.049	-0.0384	0.0400
2019	0.0092	108.88	-0.003	0.003	-0.1	0.477	0.004	3.277	1.812	0.051	-0.0454	0.0475

Regression Analysis: % Change In JPY/ USD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - USA, Foreign Country - Japan)

Regression Equation

%Change In JPY/ USD over Previous Period = 0.0432 - 1.30 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0432	0.0470	0.92	0.371	
Nominal Interest Rate Differe_1	-1.30	1.52	-0.85	0.406	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.104890	4.10%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.007990	0.007990	0.73	0.406
Nominal Interest Rate Differe_1	1	0.007990	0.007990	0.73	0.406
Error	17	0.187031	0.011002		
Total	18	0.195021			

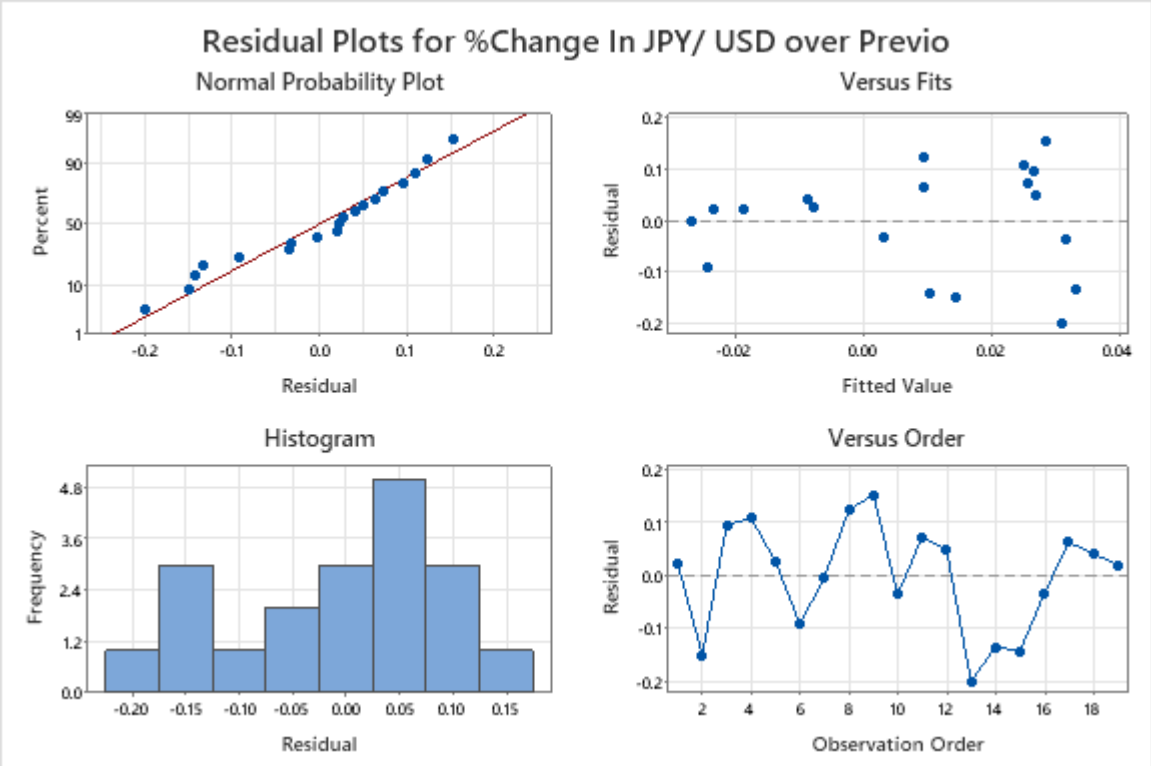
Fits and Diagnostics for Unusual Observations

Obs	%Change In JPY/ USD over Previo	Fit	Resid	Std Resid	
13	-0.1689	0.0310	-0.1998	-2.02	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.45971



Regression Analysis: % Change In USD/ JPY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - Japan, Foreign Country - USA)

Regression Equation

%Change In USD/ JPY over Previous Period = -0.0247 - 1.03 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.0247	0.0494	-0.50	0.623	
Nominal Interest Rate Different	-1.03	1.67	-0.62	0.545	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.108117	2.19%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.004451	0.004451	0.38	0.545
Nominal Interest Rate Different	1	0.004451	0.004451	0.38	0.545

Error	17	0.198718	0.011689	
Total	18	0.203169		

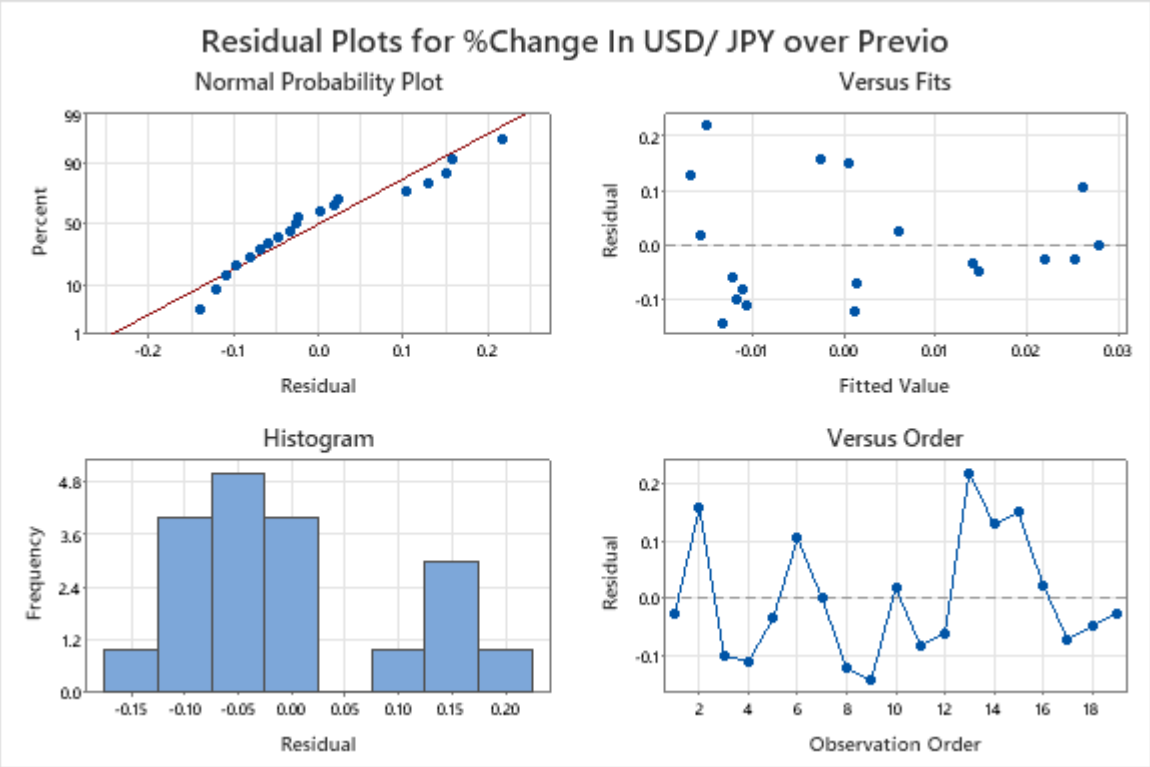
Fits and Diagnostics for Unusual Observations

Obs	%Change In USD/ JPY over Previo	Fit	Resid	Std Resid	
13	0.2032	-0.0151	0.2183	2.15	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic 1.49351
=



Year	Currency Value SGD/USD	Currency Value USD/SGD	%Change In USD/SGD over Previous Period	%Change In SGD/USD over Previous Period	Real Interest Rate, Singapore (%)	Rate of Inflation, Singapore (%)	Nominal Interest Rate, Singapore (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Real Interest Rate, USA (%)	Rate of Inflation, USA (%)	Nominal Interest Rate, USA (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, Singapore - Nominal Intt. Foreign, USA)/ (1 + Nominal Interest Foreign, USA)	Nominal Interest Rate Differential = (Nominal Intt. Home, USA - Nominal Intt. Foreign, Singapore)/ (1 + Nominal Interest Foreign, Singapore)
2001	0.5736	1.7435	0.0000	0.0000	7.603	0.997	0.087	4.627	2.826	0.076	0.0102	-0.0100
2002	0.5434	1.8403	0.056	-0.053	6.29	-0.392	0.059	3.045	1.586	0.047	0.0114	-0.0113
2003	0.5760	1.7361	-0.057	0.060	7.223	0.508	0.078	2.224	2.27	0.045	0.0308	-0.0299
2004	0.5904	1.6938	-0.024	0.025	1.178	1.663	0.029	1.605	2.677	0.043	-0.0140	0.0142
2005	0.6105	1.6379	-0.033	0.034	3.329	0.425	0.038	2.981	3.393	0.065	-0.0254	0.0261
2006	0.6165	1.6220	-0.010	0.010	3.404	0.963	0.044	4.786	3.226	0.082	-0.0348	0.0361
2007	0.6510	1.5360	-0.053	0.056	-0.553	2.105	0.015	5.223	2.853	0.082	-0.0618	0.0658

2008	0.7059	1.4167	-0.078	0.084	6.861	6.628	0.139	3.082	3.839	0.070	0.0645	-0.0606
2009	0.6627	1.5090	0.065	-0.061	2.349	0.597	0.030	2.469	-0.356	0.021	0.0084	-0.0083
2010	0.7111	1.4062	-0.068	0.073	4.231	2.824	0.072	2.061	1.64	0.037	0.0332	-0.0321
2011	0.7817	1.2792	-0.090	0.099	4.281	5.248	0.098	1.137	3.157	0.043	0.0520	-0.0494
2012	0.7947	1.2583	-0.016	0.017	4.887	4.576	0.097	1.307	2.069	0.034	0.0608	-0.0573
2013	0.8085	1.2369	-0.017	0.017	5.856	2.359	0.084	1.469	1.465	0.030	0.0524	-0.0498
2014	0.7833	1.2767	0.032	-0.031	5.635	1.025	0.067	1.375	1.622	0.030	0.0359	-0.0347
2015	0.7388	1.3535	0.060	-0.057	2.222	-0.523	0.017	2.196	0.119	0.023	-0.0062	0.0062
2016	0.7021	1.4242	0.052	-0.050	4.623	-0.532	0.041	2.451	1.262	0.037	0.0031	-0.0031
2017	0.7092	1.4100	-0.010	0.010	2.432	0.576	0.030	2.172	2.13	0.043	-0.0127	0.0129
2018	0.7621	1.3121	-0.069	0.075	2.174	0.439	0.026	2.409	2.443	0.049	-0.0218	0.0223
2019	0.7432	1.3455	-0.025	-0.025	5.15	0.565	0.057	3.277	1.812	0.051	0.0057	-0.0056

Regression Analysis: % Change In SGD/ USD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - USA, Foreign Country - Singapore)

Regression Equation

%Change In SGD/ USD over Previous Period = 0.0132 - 0.201 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0132	0.0123	1.07	0.301	
Nominal Interest Rate Differe_1	-0.201	0.358	-0.56	0.581	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0519275	1.83%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value

Regression	1	0.000854	0.000854	0.32	0.581
Nominal Interest Rate Differe_1	1	0.000854	0.000854	0.32	0.581
Error	17	0.045840	0.002696		
Total	18	0.046694			

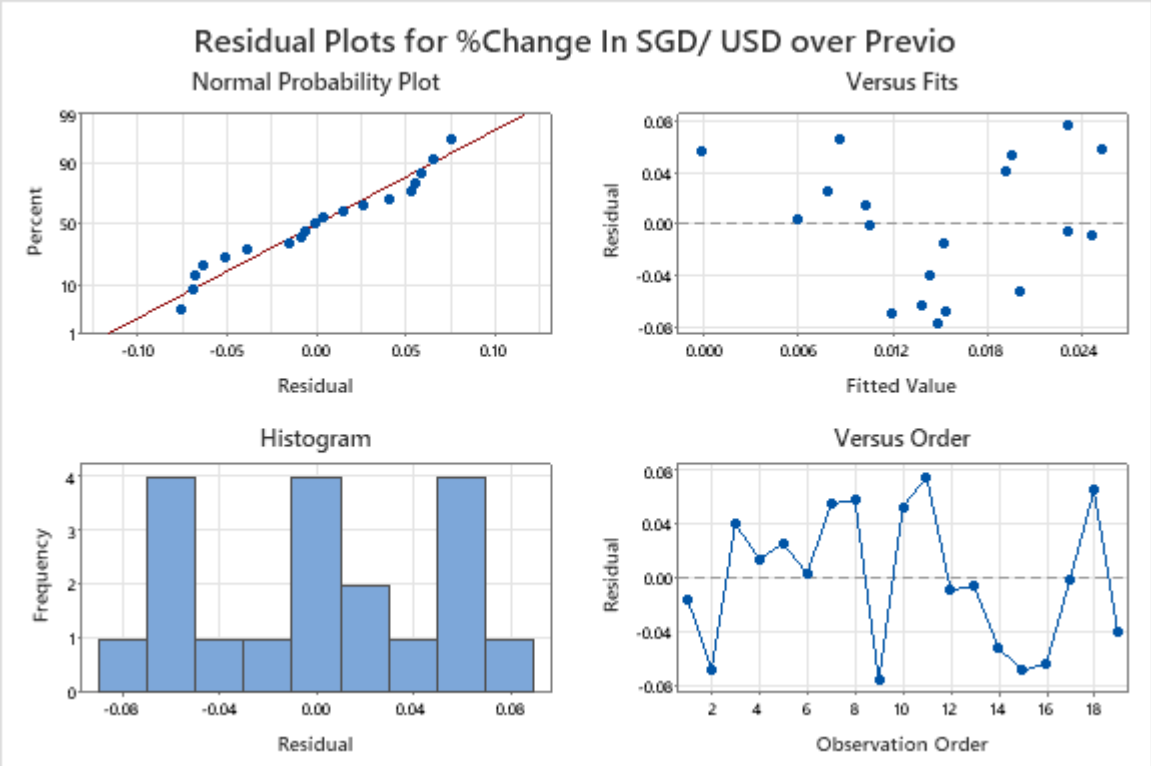
Fits and Diagnostics for Unusual Observations

Obs	%Change In SGD/ USD over Previo	Fit	Resid	Std Resid	
7	0.0560	-0.0001	0.0561	1.31	X

X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.81201



Regression Analysis: % Change In USD/ SGD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country – Singapore, Foreign Country - USA)

Regression Equation

%Change In USD/ SGD over Previous Period = -0.0130 - 0.199 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.0130	0.0119	-1.09	0.291	
Nominal Interest Rate Different	-0.199	0.339	-0.59	0.565	1.00

Model Summary

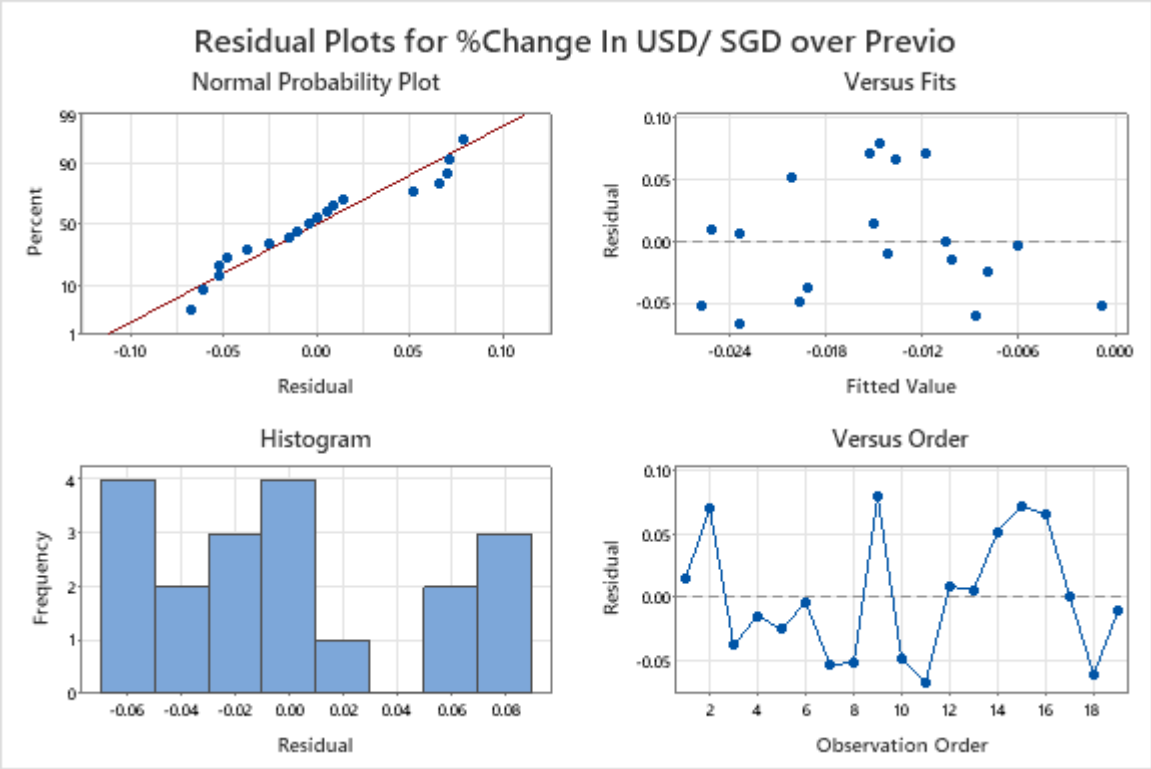
S	R-sq	R-sq(adj)	R-sq(pred)
0.0498774	1.98%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.000855	0.000855	0.34	0.565
Nominal Interest Rate Different	1	0.000855	0.000855	0.34	0.565
Error	17	0.042292	0.002488		
Total	18	0.043147			

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.68524



Year	Currency Value CNY/JPY	Currency Value JPY/CNY	%Change In JPY/CNY over Previous Period	%Change In CNY/JPY over Previous Period	Real Interest Rate, China (%)	Rate of Inflation, China (%)	Nominal Interest Rate, CHINA (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Real Interest Rate, JAPAN (%)	Rate of Inflation, JAPAN (%)	Nominal Interest Rate, JAPAN (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, China - Nominal Intt. Foreign, Japan)/ (1 + Nominal Interest Foreign, Japan)	Nominal Interest Rate Differential = (Nominal Intt. Home, Japan - Nominal Intt. Foreign, China)/ (1 + Nominal Interest Foreign, China)
2001	14.0587	0.0711	0.0000	0.0000	3.727	0.719	0.045	3.108	-0.74	0.023	0.0208	-0.0204
2002	16.2617	0.0615	-0.135	0.157	4.68	-0.732	0.039	3.372	-0.923	0.024	0.0146	-0.0144
2003	14.4845	0.0690	0.123	-0.109	2.638	1.128	0.038	3.496	-0.257	0.032	0.0055	-0.0055

2004	12.7767	0.0783	0.134	-0.118	-1.283	3.825	0.025	2.899	-0.009	0.029	-0.0039	0.0039
2005	12.5259	0.0798	0.020	-0.020	1.613	1.776	0.034	2.743	-0.283	0.025	0.0094	-0.0093
2006	14.545	0.0688	-0.139	0.161	2.111	1.649	0.038	2.571	0.249	0.028	0.0094	-0.0093
2007	15.5245	0.0644	-0.063	0.067	-0.26	4.817	0.045	2.632	0.06	0.027	0.0180	-0.0177
2008	14.8109	0.0675	0.048	-0.046	-2.306	5.925	0.035	2.919	1.38	0.043	-0.0082	0.0083
2009	13.1654	0.0760	0.125	-0.111	5.531	-0.728	0.048	2.349	-1.353	0.010	0.0376	-0.0363
2010	13.2228	0.0756	-0.004	0.004	-1.002	3.175	0.021	3.561	-0.72	0.028	-0.0066	0.0066
2011	12.4194	0.0805	0.065	-0.061	-1.402	5.554	0.041	3.229	-0.268	0.030	0.0109	-0.0108
2012	12.0792	0.0828	0.028	-0.027	3.585	2.62	0.063	2.186	-0.052	0.021	0.0408	-0.0392
2013	14.7194	0.0679	-0.179	0.219	3.755	2.621	0.065	1.642	0.346	0.020	0.0439	-0.0421
2014	16.8314	0.0594	-0.125	0.143	4.522	1.922	0.065	-0.517	2.762	0.022	0.0421	-0.0404
2015	18.7889	0.0532	-0.104	0.116	4.353	1.437	0.059	-0.982	0.79	-0.002	0.0606	-0.0572
2016	18.4023	0.0543	0.021	-0.021	2.902	2	0.050	0.772	-0.117	0.007	0.0428	-0.0410
2017	16.3784	0.0611	0.124	-0.110	0.113	1.593	0.017	1.226	0.467	0.017	0.0001	-0.0001
2018	17.3496	0.0576	-0.056	0.059	0.822	2.075	0.029	-0.1	0.98	0.009	0.0202	-0.0198
2019	16.2352	0.0616	0.069	-0.064	3.024	2.899	0.060	-0.1	0.477	0.004	0.0561	-0.0531

Regression Analysis: % Change In JPY/ CNY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - China, Foreign Country - Japan)

Regression Equation

%Change In JPY/ CNY over Previous Period = 0.0307 - 1.53 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0307	0.0323	0.95	0.355	
Nominal Interest Rate Different	-1.53	1.07	-1.43	0.171	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)

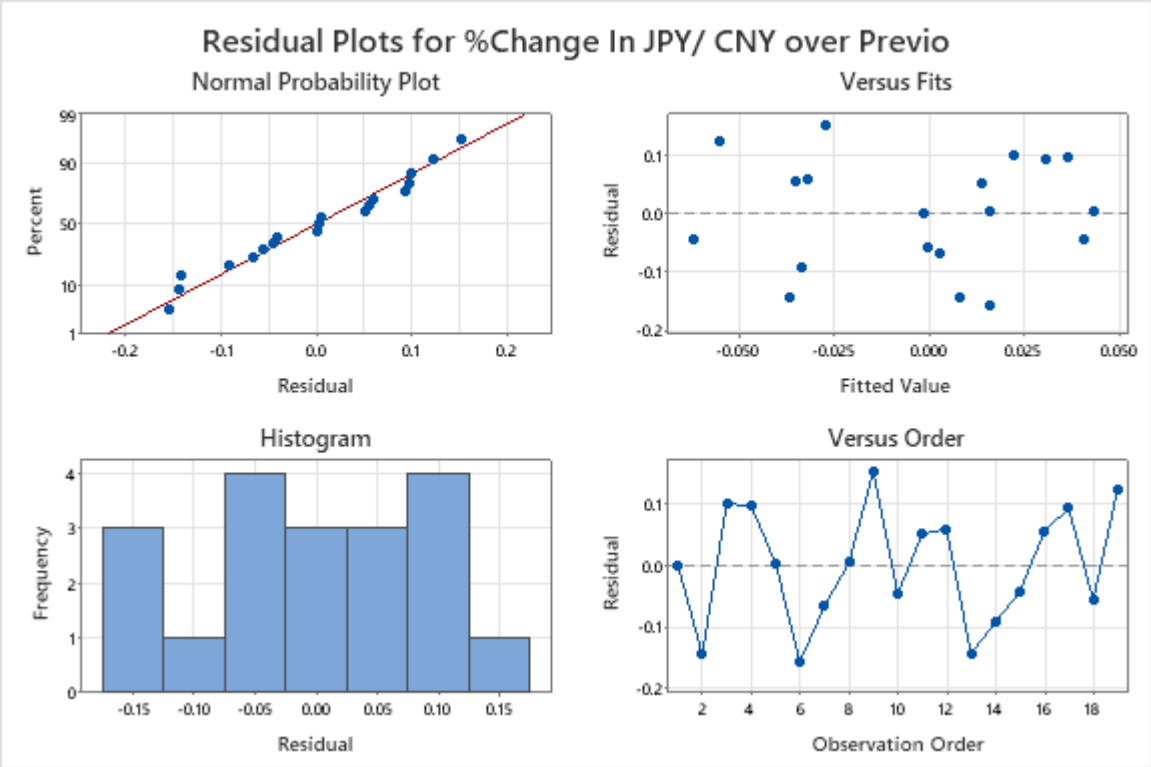
0.0972336 10.74% 5.49% 0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.01933	0.019332	2.04	0.171
Nominal Interest Rate Different	1	0.01933	0.019332	2.04	0.171
Error	17	0.16072	0.009454		
Total	18	0.18006			

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.92125



Regression Analysis: % Change In CNY/ JPY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - Japan, Foreign Country - China)

Regression Equation

%Change In CNY/ JPY over Previous Period = -0.0291 - 2.41 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.0291	0.0332	-0.88	0.393	
Nominal Interest Rate Differe_1	-2.41	1.24	-1.95	0.069	1.00

Model Summary

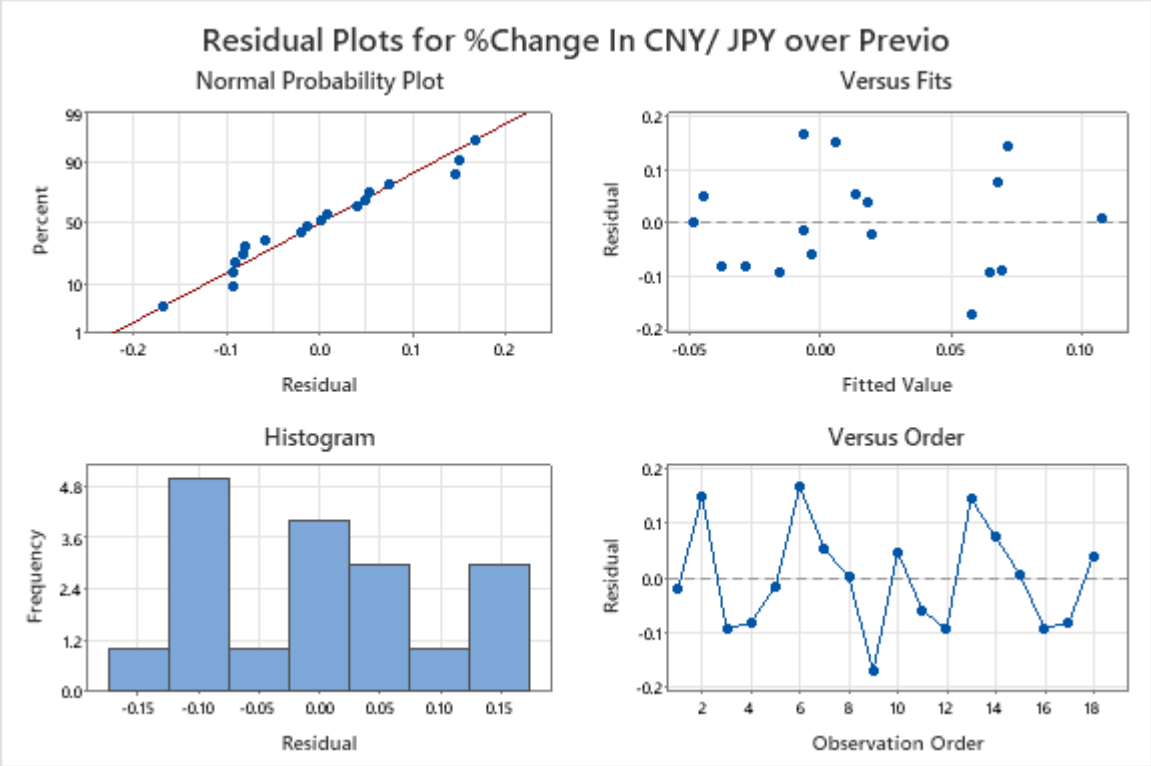
S	R-sq	R-sq(adj)	R-sq(pred)
0.0987603	19.14%	14.08%	0.30%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.03693	0.036931	3.79	0.069
Nominal Interest Rate Differe_1	1	0.03693	0.036931	3.79	0.069
Error	16	0.15606	0.009754		
Total	17	0.19299			

Durbin-Watson Statistic

Durbin-Watson Statistic = 2.07182



Year	Currency Value CNY/SGD	Currency Value SGD/CNY	%Change In SGD/CNY over Previous Period	%Change In CNY/SGD over Previous Period	Real Interest Rate, CHINA (%)	Rate of Inflation, CHINA (%)	Nominal Interest Rate, CHINA (%) = [(1+Real Interest Rate)(1+ Inflation Rate)]-1	Real Interest Rate, Singapore (%)	Rate of Inflation, Singapore (%)	Nominal Interest Rate, Singapore (%) = [(1+Real Interest Rate)(1+I nflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, China - Nominal Intt. Foreign, Singapore)/ (1 + Nominal Interest Foreign, Singapore)	Nominal Interest Rate Differential = (Nominal Intt. Home, Singapore - Nominal Intt. Foreign, China)/ (1 + Nominal Interest Foreign, China)

2001	0.2106	4.7479	0.0000	0.0000	3.727	0.719	0.045	7.603	0.997	0.087	-0.0387	0.0402
2002	0.2224	4.4973	-0.053	0.056	4.68	-0.732	0.039	6.29	-0.392	0.059	-0.0185	0.0189
2003	0.2098	4.7673	0.060	-0.057	2.638	1.128	0.038	7.223	0.508	0.078	-0.0369	0.0383
2004	0.2046	4.8867	0.025	-0.024	-1.283	3.825	0.025	1.178	1.663	0.029	-0.0036	0.0036
2005	0.1979	5.0533	0.034	-0.033	1.613	1.776	0.034	3.329	0.425	0.038	-0.0034	0.0034
2006	0.2012	4.9703	-0.016	0.017	2.111	1.649	0.038	3.404	0.963	0.044	-0.0058	0.0058
2007	0.1976	5.0617	0.018	-0.018	-0.26	4.817	0.045	-0.553	2.105	0.015	0.0296	-0.0287
2008	0.1973	5.0695	0.002	-0.002	-2.306	5.925	0.035	6.861	6.628	0.139	-0.0918	0.1011
2009	0.2208	4.5295	-0.107	0.119	5.531	-0.728	0.048	2.349	0.597	0.030	0.0175	-0.0172
2010	0.2061	4.8528	0.071	-0.067	-1.002	3.175	0.021	4.231	2.824	0.072	-0.0470	0.0493
2011	0.1938	5.1596	0.063	-0.059	-1.402	5.554	0.041	4.281	5.248	0.098	-0.0517	0.0546
2012	0.1995	5.0127	-0.028	0.029	3.585	2.62	0.063	4.887	4.576	0.097	-0.0309	0.0319
2013	0.1990	5.0243	0.002	-0.002	3.755	2.621	0.065	5.856	2.359	0.084	-0.0173	0.0176
2014	0.2107	4.7451	-0.056	0.059	4.522	1.922	0.065	5.635	1.025	0.067	-0.0018	0.0018
2015	0.2167	4.6156	-0.027	0.028	4.353	1.437	0.059	2.222	-0.523	0.017	0.0410	-0.0393
2016	0.2166	4.6158	0.000	0.000	2.902	2	0.050	4.623	-0.532	0.041	0.0086	-0.0085
2017	0.2051	4.8765	0.056	-0.053	0.113	1.593	0.017	2.432	0.576	0.030	-0.0128	0.0129
2018	0.2089	4.7879	-0.018	0.019	0.822	2.075	0.029	2.174	0.439	0.026	0.0028	-0.0028
2019	0.2010	4.9753	0.039	-0.038	3.024	2.899	0.060	5.15	0.565	0.057	0.0025	-0.0025

Regression Analysis: % Change In SGD/ CNY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - China, Foreign Country - Singapore)

Regression Equation

%Change In SGD/ CNY over Previous Period = -0.0038 - 0.538 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.0038	0.0112	-0.34	0.737	
Nominal Interest Rate Different	-0.538	0.337	-1.60	0.129	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0444874	13.05%	7.94%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.005051	0.005051	2.55	0.129
Nominal Interest Rate Different	1	0.005051	0.005051	2.55	0.129
Error	17	0.033645	0.001979		
Total	18	0.038696			

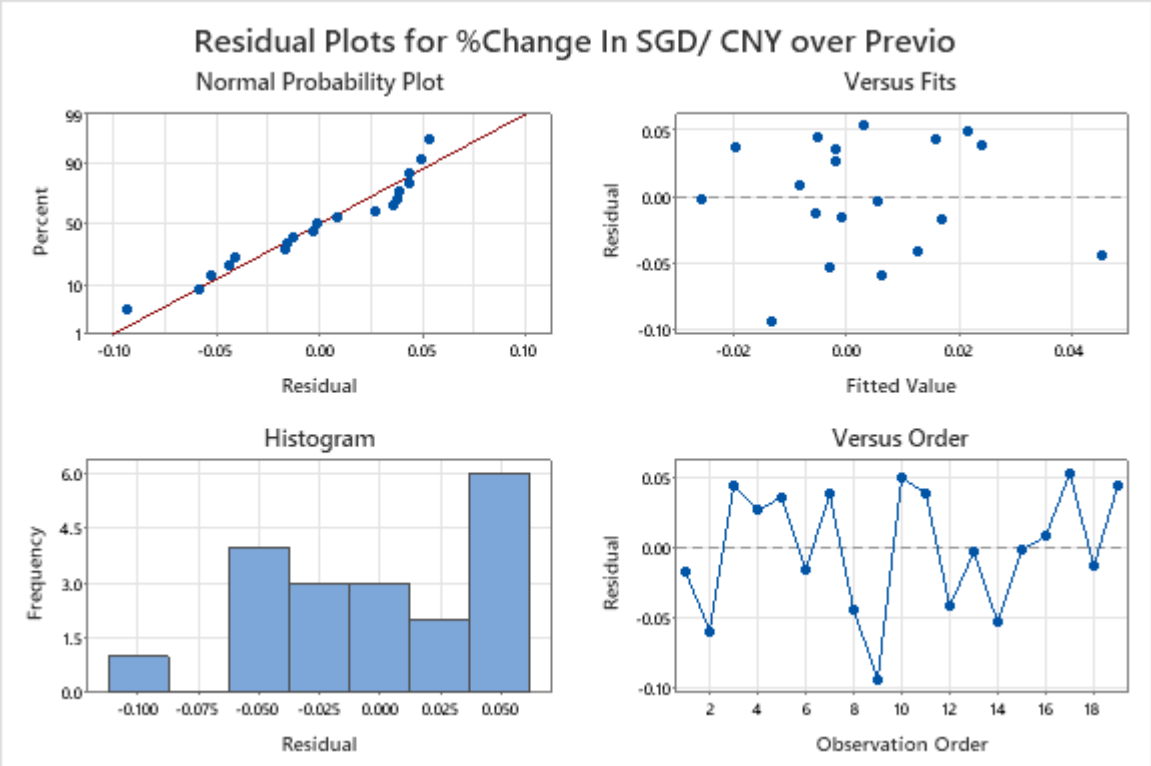
Fits and Diagnostics for Unusual Observations

Obs	%Change In SGD/ CNY over Previo	Fit	Resid	Std Resid	
8	0.0015	0.0456	-0.0441	-1.28	X
9	-0.1065	-0.0132	-0.0933	-2.22	R

R Large residual
X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 2.10690



Regression Analysis: % Change In CNY/ SGD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - Singapore, Foreign Country - China)

Regression Equation

%Change In CNY/ SGD over Previous Period = 0.0061 - 0.509 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0061	0.0116	0.53	0.605	

Nominal Interest Rate Differe_1	-0.509	0.329	-1.54	0.141	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0456981	12.31%	7.15%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.004984	0.004984	2.39	0.141
Nominal Interest Rate Differe_1	1	0.004984	0.004984	2.39	0.141
Error	17	0.035501	0.002088		
Total	18	0.040486			

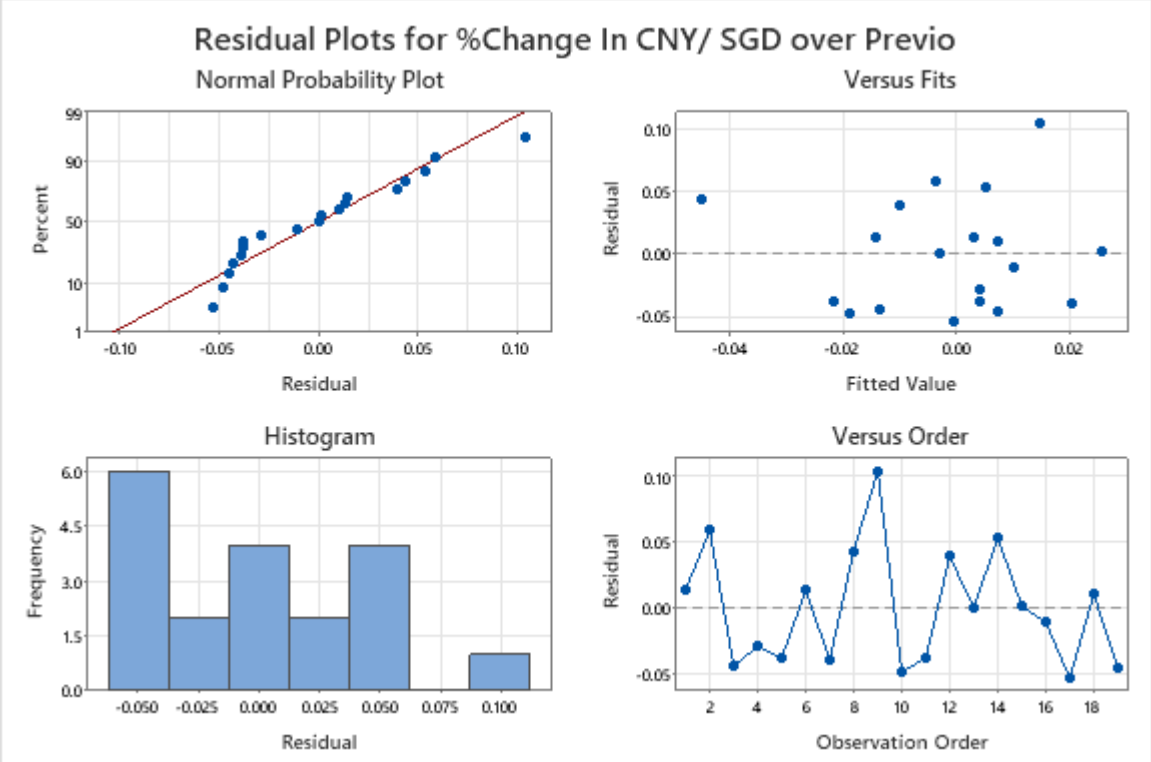
Fits and Diagnostics for Unusual Observations

Obs	%Change In CNY/ SGD over Previo	Fit	Resid	Std Resid	
8	-0.0015	-0.0454	0.0438	1.28	X
9	0.1192	0.0148	0.1044	2.42	R

R Large residual
X Unusual X

Durbin-Watson Statistic

Durbin-Watson Statistic = 2.08357



Year	Currency Value JPY/SGD	Currency Value SGD/JPY	%Change In SGD/JPY over Previous Period	%Change In JPY/SGD over Previous Period	Real Interest Rate, Singapore (%)	Rate of Inflation, Singapore (%)	Nominal Interest Rate, Singapore (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Real Interest Rate, JAPAN (%)	Rate of Inflation, JAPAN (%)	Nominal Interest Rate, JAPAN (%) = [(1+Real Interest Rate)(1+Inflation Rate)]-1	Nominal Interest Rate Differential = (Nominal Intt. Home, Japan - Nominal Intt. Foreign, Singapore)/ (1 + Nominal Interest Foreign, Singapore)	Nominal Interest Rate Differential = (Nominal Intt. Home, Singapore - Nominal Intt. Foreign, Japan)/ (1 + Nominal Interest Foreign, Japan)
2001	0.0150	66.75	0.0000	0.0000	7.603	0.997	0.087	3.108	-0.74	0.023	-0.0583	0.0619
2002	0.0137	73.10	0.095	-0.087	6.29	-0.392	0.059	3.372	-0.923	0.024	-0.0326	0.0337
2003	0.0145	69.05	-0.055	0.059	7.223	0.508	0.078	3.496	-0.257	0.032	-0.0421	0.0440
2004	0.0160	62.43	-0.096	0.106	1.178	1.663	0.029	2.899	-0.009	0.029	0.0003	-0.0003
2005	0.0158	63.30	0.014	-0.014	3.329	0.425	0.038	2.743	-0.283	0.025	-0.0127	0.0128
2006	0.0138	72.29	0.142	-0.124	3.404	0.963	0.044	2.571	0.249	0.028	-0.0151	0.0153
2007	0.0127	78.56	0.087	-0.080	-0.553	2.105	0.015	2.632	0.06	0.027	0.0114	-0.0112
2008	0.0133	75.09	-0.044	0.046	6.861	6.628	0.139	2.919	1.38	0.043	-0.0843	0.0921
2009	0.0168	59.63	-0.206	0.259	2.349	0.597	0.030	2.349	-1.353	0.010	-0.0194	0.0198
2010	0.0156	64.17	0.076	-0.071	4.231	2.824	0.072	3.561	-0.72	0.028	-0.0407	0.0424
2011	0.0156	64.16	0.000	0.000	4.281	5.248	0.098	3.229	-0.268	0.030	-0.0620	0.0661
2012	0.0165	60.60	-0.055	0.059	4.887	4.576	0.097	2.186	-0.052	0.021	-0.0689	0.0740
2013	0.0135	73.97	0.221	-0.181	5.856	2.359	0.084	1.642	0.346	0.020	-0.0587	0.0624
2014	0.0125	79.92	0.080	-0.074	5.635	1.025	0.067	-0.517	2.762	0.022	-0.0420	0.0439
2015	0.0115	86.78	0.086	-0.079	2.222	-0.523	0.017	-0.982	0.79	-0.002	-0.0186	0.0189
2016	0.0118	85.00	-0.021	0.021	4.623	-0.532	0.041	0.772	-0.117	0.007	-0.0328	0.0339
2017	0.0125	80.01	-0.059	0.062	2.432	0.576	0.030	1.226	0.467	0.017	-0.0128	0.0130
2018	0.0120	83.23	0.040	-0.039	2.174	0.439	0.026	-0.1	0.98	0.009	-0.0170	0.0173
2019	0.0124	80.92	-0.028	0.029	5.15	0.565	0.057	-0.1	0.477	0.004	-0.0508	0.0535

Regression Analysis: % Change In SGD/ JPY over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - Japan, Foreign Country - Singapore)

Regression Equation

%Change In SGD/ JPY over Previous Period = 0.0150
+ 0.011 Nominal Interest Rate Different

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.0150	0.0393	0.38	0.708	
Nominal Interest Rate Different	0.011	0.928	0.01	0.990	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0991555	0.00%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.000001	0.000001	0.00	0.990
Nominal Interest Rate Different	1	0.000001	0.000001	0.00	0.990
Error	17	0.167141	0.009832		
Total	18	0.167142			

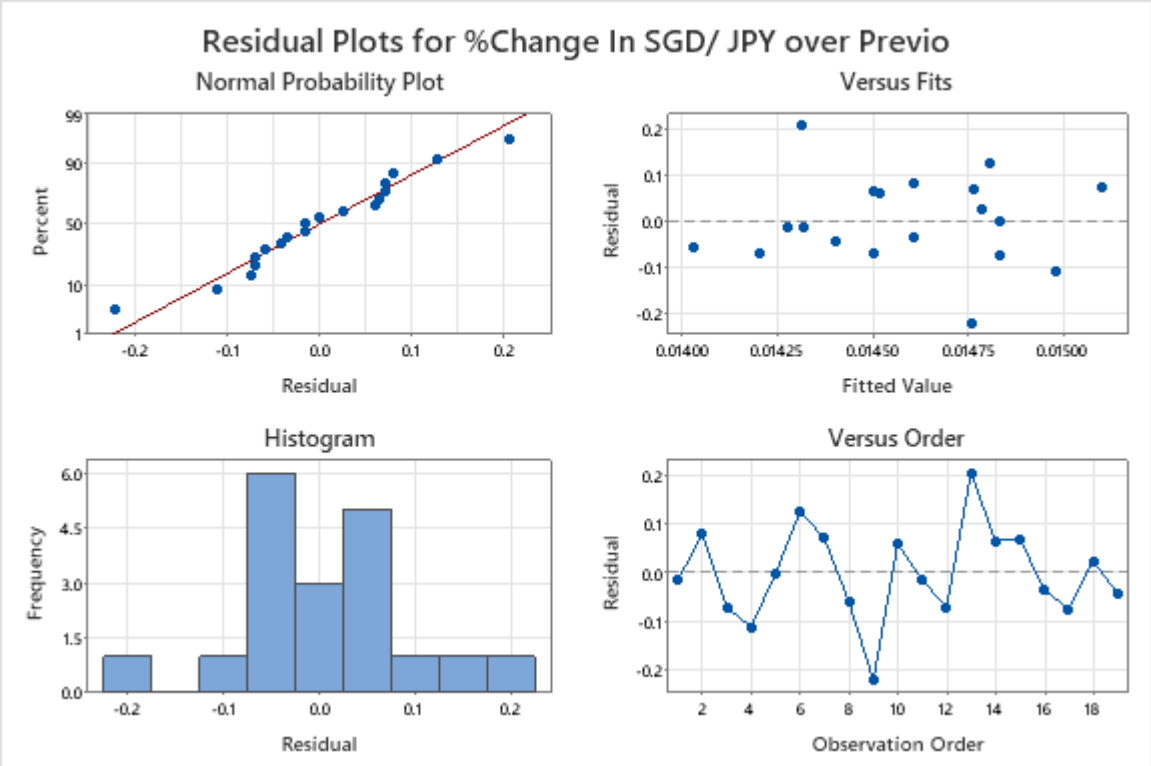
Fits and Diagnostics for Unusual Observations

Obs	%Change In SGD/ JPY over Previo	Fit	Resid	Std Resid	
9	-0.2059	0.0148	-0.2206	-2.31	R
13	0.2206	0.0143	0.2063	2.20	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic = 1.91262



Regression Analysis: % Change In JPY/ SGD over Previous Period (From 2001 To 2019) versus Nominal Interest Rate Differential (Home Country - Singapore, Foreign Country - Japan)

Regression Equation

%Change In JPY/ SGD over Previous Period = -0.0041 - 0.042 Nominal Interest Rate Differe_1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.0041	0.0394	-0.10	0.918	
Nominal Interest Rate Differe_1	-0.042	0.874	-0.05	0.962	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.100743	0.01%	0.00%	0.00%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	0.000024	0.000024	0.00	0.962
Nominal Interest Rate Differe_1	1	0.000024	0.000024	0.00	0.962
Error	17	0.172535	0.010149		
Total	18	0.172558			

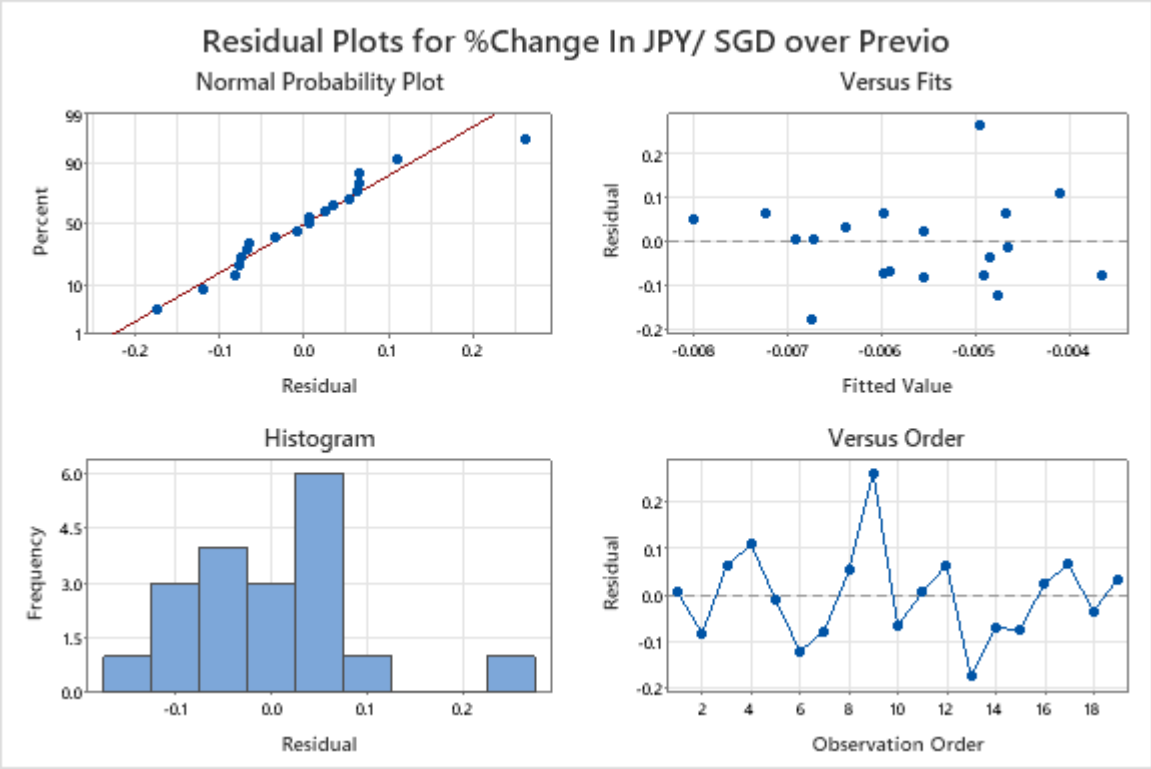
Fits and Diagnostics for Unusual Observations

Obs	%Change In JPY/ SGD over Previo	Fit	Resid	Std Resid	
9	0.2593	-0.0050	0.2642	2.73	R

R Large residual

Durbin-Watson Statistic

Durbin-Watson Statistic 1.92945
=



11. RESULTS AND DISCUSSIONS

In statistical modeling, **regression analysis** is a defined as a statistical process for estimating the relationship between a dependent/ outcome variable and one or more independent/ predictor variables. Linear Regression is the most common form of regression analysis. Here we find the line (or a more complex linear combination) that most closely fits the data according to a specific mathematical criterion.

After the construction of the regression model, it is important to confirm the goodness of fit of the model and to find the statistical significance of the estimated parameters. Commonly used checks of goodness of fit include the R-squared which has been used along with the p-value to check whether the regression model is significant.

Again R-squared is a statistical measure of how closely the data is fitted to the regression line. The measure, R-squared is also known as the coefficient of determination. R-Squared is defined as the percentage of the response variable variation that is explained by a linear model, i.e. R-squared = (**Explained variation/ Total variation**). R-squared is always between 0 and 100%, where 0% indicates that the model explains none of the variability of the response data around its mean. And 100% indicates that the model explains all the variability of the response data around its mean. Thus the higher the value of R-squared, the better the model of regression.

The respective percentage values of R-Squared are written below in the following table when the currencies of the major economies/ countries (USA, China, Japan, India and Singapore) have been used interchangeably as the domestic currency and the foreign currency respectively for the considered time period of 2001 to 2019.

Years Considered - 2001-2019					
Value of R-Squared					
Domestic Currency(Country)	**Foreign Currency(Country)**				
	INR (India)	**USD (USA)**	**Yuan (China)**	**Yen (Japan)**	**SGD (Singapore)**
INR(India)	***	49.49%	15.95%	8.67%	3.62%
USD(USA)	45.42%	***	0.33%	4.10%	1.83%
Yuan(China)	12.42%	0.27%	***	10.74%	13.05%
Yen(Japan)	3.74%	2.19%	19.14%	***	0.00%
SGD(Singapore)	2.59%	1.98%	12.31%	0.01%	***

Tabel -I

Here for all the tests during all time periods, the Null Hypothesis and the Alternate Hypothesis are –

$\mathbf{H_0 : a} = x$

AND

$\mathbf{H_a : a} \neq x;$

Where a = Percentage change in Foreign Currency w.r.t. Domestic Currency and

x = Nominal Interest Rate Differential

Thus if the Null Hypothesis is accepted, International Fisher Effect holds. Again if the Null Hypothesis is rejected and Alternative Hypothesis if accepted, International Fisher Effect does not hold.

During the time period (2001-2019) in consideration, the percentage R-squared values for India with USA (interchangeably used as the domestic and foreign currency) turns out to be 49.49%, 45.42% respectively which are greater than all of the other currency pairs. Again **at 95% level of significance, the p-values being lesser than 0.05 during both the time periods considered (2001-2019)**, explains the fact that the nominal interest differentials has significant impacts on the USD/ INR and INR/ USD exchange rate changes. Thus the Null Hypothesis is accepted for the India and the USA country/ currency pair and the International Fisher Effect theory holds here.

Again though the percentage values of R-Squared is in the 10%+ bracket for China-India(15.95% and 12.42%), China-Japan(19.14% and 10.74%) and China-Singapore(12.31% and 13.05%) when these countries were used interchangeably as the domestic and the foreign country/ currency, apart from India and the USA which is already mentioned above. All other R-Squared values are very less. Now if we look at the **p-values (being larger than 0.05 at 95% level of significance**), these also fail to explain the significance of the respective nominal interest rate differentials on the movement of exchange rates for all the country/ currency pairs and therefore the International Fisher Effect theory does not hold here except only for India & the USA. Therefore we reject the Null Hypothesis and accept the Alternative Hypothesis for all other country/ currency pairs.

One astonishing result that may be discussed here is very low (less than 1%) percentage R-Squared value between (USA and China). This scenario can be explained by the fact that China has been more of a closed economy and is still considered the same by the Economic/ Financial experts, with the Chinese Central Bank intentionally keeping the foreign exchange rate at lower value to benefit the exporters, without going for the market determined rates, as we see in the United States of America (USA) and other developed countries. Though it is said that China has become more open to foreign direct investment (FDI) than any other country in East Asia and indeed, it is one of the most open emerging market economies in the world as of the last decade, if we see the amount of FDIs that China has received, China's trade system still has important protectionist elements. China has largely focused on promoting its exports only, while remaining closed to foreign goods.

From the obtained results for Japan, we observe that the results might reflect the well-known liquidity trap characterizing this country, since its monetary policy was based on a very low interest rate as far back as 1995, which was followed by a zero interest rate since 1999, and Quantitative Easing (QE) since 2001, well before all the other countries where QE was introduced in response to the global financial crisis of 2007-'08. It should be noted that the period analyzed includes Quantitative Easing (QE); this increases inflation, but its impact on real rates is not clear since risk premia might decrease and therefore real rates could fall as well as rise. It also includes frequent shifts in inflation which might produce spurious evidence against the Fisher relationship. And therefore these results for Japan should be taken with caution.

India also took the path of Globalization during the early 1990's, when it's Forex Reserves came to a bare minimum. Since then India has completely accepted the path of ***Liberalization and Globalization***, by adopting the International Financial Standards and freeing it's Foreign Exchange Market to the market forces, without very less intervention by the Reserve Bank of India. It is evident from the fact that the percentage R-Squared values are greater in all considered cases during 2001-2019 than for other countries. To explain the results for India, if we look at the list of trading partner countries (volume wise), we shall see that the percentage R-Squared values have followed the total trade volumes with the countries in discussion here.
In case of Singapore, we know that China is their largest trading partner for both the export as well as the import category. Thus we observe highest percentage R-Squared value only with China (Singapore Dollar and Chinese Yuan pair).

12. VALUE OF THE HYPOTHESIS

So far so good. But does International Fisher Effect holds true? Many empirical studies have been undertaken to test the validity of international Fisher effect. One of research finding details are given below. Here in this paper of Dissertation, I have conducted a study to test the International Fisher effect empirically. The purpose of this research is to describe the theory of the International Fisher Effect and to test its empirical validity in the long run. The question asked in this research is if there is a tendency for nominal interest rate differentials to offset exchange rate changes? The International Fisher effect states that the future spot rate of exchange can be determined from the nominal interest rate differential. A regression analysis has been applied to quarterly nominal interest differentials and exchange rate changes for five country pairs between the years 2001-2019. The investigated country pairs are USA-China, USA-India, USA-Japan, USA-Singapore, China-India, China-Japan, China-Singapore, India-Japan, India-Singapore, Japan-Singapore. The regression tests whether nominal interest differentials are a good forecast for changes in the future spot rates of exchange for the tested time frame and respective country pair. The result shows that only for USA-India are the exchange rate changes can be explained/ determined by the nominal interest differentials on average. This means that the exchange rate movements react to other factors in addition to nominal interest differentials for the other country pairs.

13. APPLICATION OF INTERNATIONAL FISHER EFFECT

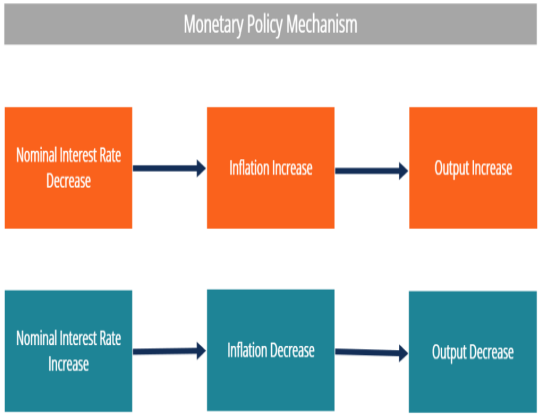
- ## *Monetary Policy*

The central bank in an economy is often tasked with keeping inflation in a tight range. The practice is to prevent the economy from overheating and inflation spiraling upwards in times of expansion. It is also important to have a small amount of inflation to prevent a deflation spiral, which pushes an economy into a depression in times of recession.

The main tool available to most central banks is their ability to set the nominal interest rate. They achieve this through many mechanisms like open market operations, changing reserve ratios, etc.

Given a fixed interest rate, we can see that an increase in the nominal interest rate will bring down inflation expectations and prevent overheating. Similarly, a decrease in the nominal interest rate can increase inflation expectations, and spur more investment, thereby avoiding a deflation spiral.

The following figure illustrates how monetary policy acts through the Fisher Effect:



Monetary Policy Mechanism using Fisher Effect

Measuring Portfolio Returns

One of the major objectives of investing is to generate enough returns to outpace inflation. It is necessary because if the returns are lower than inflation, the purchasing power of the total wealth of the investor will be lower than when they started investing.

For example, an investment in the sovereign debt of a country is considered risk-free and offers a yield of 2% over one year. Assume that the inflation in that country is 3% per year, and a business needs to purchase goods that are worth $100 today. They invest their cash in government debt, which means they get $102 in a year.

Since the inflation rate was 3%, the goods are now worth $103. Hence, there is a shortfall of $1 when the business needs to make the purchase.

The example above illustrates an important point that ignoring the impact of inflation can create liquidity issues in the future. The Fisher Effect is important because it helps the investor calculate the real rate of return on their investment.

The Fisher equation can also be used to determine the required nominal rate of return that will help the investor achieve their goals.

Currency Markets

In currency markets, the Fisher Effect is called the International Fisher Effect (IFE). It describes the relationship between the nominal interest rates in two countries and the spot exchange rate for their currencies.

Hence, given the nominal interest rates in the two countries and the spot exchange rate today, we can calculate the future spot rate. Use the following formula to calculate the future spot rate:

$$\text{Futures Price} = \text{Spot Price} * (1 + r_D) / (1 + r_F)$$

Where:
r_D = Nominal Interest Rate in the Domestic Currency
r_F = Nominal Interest Rate in the Foreign Currency

It is evident from the equation that if the domestic rate is lower than the foreign rate, the domestic currency is expected to depreciate relative to the foreign currency. It is the International Fisher Effect.

14. LIMITATIONS OF INTERNATIONAL FISHER EFFECT

While the IFE concept appears like a perfect leading indicator of future economic changes, it has certain limitations. This is because it is based on several assumptions. These assumptions, in turn, give rise to several limitations of the concept.

The limitations of the International Fisher Effect are mentioned below:

1. IFE makes long–term Predictions only

One of the major limitations of the IFE is that it can only make long term forecasts. Thus IFE cannot be used in analyzing the financial performances for periods of less than one year. It has been proved from the very low/ insignificant R-Squared values, obtained from the weekly data for the period Jan.,'18 to Dec.,'19. Whereas the R-Squared values were considerably larger for the other two periods of observations (1981-2019 & 2001-2019).

2. Uncovered Interest Parity

The second limitation of IFE is the uncovered interest parity. IFE can make almost-accurate currency movement predictions. But IFE can not tell when the effects will start. As such, while it might make true conclusions about the future currency movements, the users cannot have a specific time to watch. Therefore IFE is said to be unreliable in providing specific timelines.

3. Uncontrolled Exchange Rates

When International Fisher Effect theory was being developed, most nations controlled their exchange rates because of trade and economic purposes. Today most of the currencies are free-floating. This has brought on many questions over the effectiveness of IFE in today's economic environments.

4. Interest Rates used to Determine Inflation

The other limitation of the IFE is that in today's economic scenarios, most central banks are turning to inflation targeting for determining their interest rates, as against the interest rate targets which they have been following previously, i.e. they are now using inflation rates to make their predictions and conclusions. Where this new development is used, the IFE becomes useless.

5. Other Factors affecting Exchange Rates

Studies have confirmed that there are multiple other factors that affect the exchange rate movements beside inflation. These factors are government controls, exchange rate risks and income levels. Therefore, though the expected appreciation or depreciation of a currency's movement might be accurate, but depending solely on it to make forecasts is subject to significant errors.

15. CONCLUSION

In this paper, I have explored the evidence of International Fisher Effect (IFE) by applying regression analysis interchangeably between the major economies of the world, i.e. the USA, China, Japan, India and Singapore. USA, China, Japan and India are among the world's Top5 countries according to Nominal GDP and again China, Japan and India are among the world' Top4 countries according to their holdings of Foreign Exchange Reserves. With the help of historical annual data for exchange rates, real interest rate and rate of inflation between these countries, I have tested the IFE using regression analysis. Like a home country and foreign country, each of these countries were considered interchangeably and the trail of the effect were tracked and explored. Data have been collected from the Reserve Bank of India, World Bank and two website on the Financial Markets (investing.com and mitrade.com).

The International Fisher effect (IFE) holds somewhat strongly between India & USA (with significant p-values) and also in its weak form between India & China, China & Japan and China & Singapore during the investigated time period. The insignificant coefficient values show that the exchange rate movements react to other factors in addition to nominal interest differentials, for India & Japan, India & Singapore, USA & China, USA & Japan, USA & Singapore and Japan & Singapore. Here in case of USA-India, this would mean that investors investing purely in 3-month US certificate of deposits or India's 3-month interbank rate would have approximately the same returns on their deposits because the short term interest differentials would have been offset by the exchange rate changes.

However it has been seen that the Fisher relationship is often not supported by the empirical evidence. Many studies, going find that the slope coefficient in a regression of inflation against nominal rates is significantly different from one, and the real rates exhibit a unit root. This "paradox" might be due to various reasons, such as not measuring accurately inflationary expectations, overlooking taxation, using short rather than long rates, not distinguishing between short-run and long-run Fisher effect, and finally differences in estimation procedures. There are many restrictions that prevent free flow of capital across borders to directly match nominal interest rate differentials. Those restraining factors are political risk, currency risk, transaction costs, taxes and psychological barriers. The exchange rate changes can also come through some sort of activity between the goods market and the money market, some real cross-border investment activity or change in trade patterns in the goods market, that all in all, still indirectly ensure the nominal interest rate differentials are still, on average, offset by the exchange rate changes. And also if the domestic Fisher Effect and the PPP do not hold, the International Fisher Effect will not hold. This means that the interest differentials need to offset exchange rate changes and the nominal interest rate differentials would approximately equal the expected inflation rate differentials. If not, the International Fisher Effect can't be expected to hold. The appended observations (from Microsoft Excel ©) also show that the exchange rate sometimes has changed in the opposite direction than predicted by the theory, indicating a reaction to real interest differentials rather than relative inflationary expectations.

Again, the International Fisher Effect theorem holds that the real interest rates must be same across borders and the capital markets must be integrated. This certainly means that there must be free flow of capital across borders. However, with different central banks acting differently to support their domestic currency/ economy, the free flow of capital does not take place in most aspects and it can also be observed that the currency restrictions and other regulation, limit that integration.

16. CONFLICT OF INTEREST AND ETHICAL STATEMENT

i. **Conflict of Interest -** This is to state that there is no Conflict of Interest.

ii. **Funding -** This is to state that no funding has been received from any organization/ departments.

iii. **Ethical Approval and Informed Consent -** This is to state that the research was done under the guidance of Prof. Dr. Soumitra Kumar Mallick, Sir Ashutosh Mukherjee Chair Professor at I.I.S.W.B.M., Kolkata. Informed consent was obtained from Prof. Dr. Mallick for the same.

17. REFERENCES

<i> Stanley L. Brue, Campbell R. Mcconnell, " Essentials of Economics "

<ii> Rajiv Srivastava(2018), " International Finance " Pg. 171-172

<iii> https://en.wikipedia.org

<iv> https://data.worldbank.org

<v> https://www.rbi.org.in

<vi> https://in.investing.com

<vii> https://corporatefinanceinstitute.com

<viii> https://www.mitrade.com/forex/learn-to-trade/financial-dictionary/international-fisher-effect

<ix> Marijana Joksimović, Dušan Joksimović, Biljana Grujić Vučkovski for their article on "A TEST OF INTERNATIONAL FISHER EFFECT: RESEARCHING FROM SERBIA AND THE EUROPEAN UNION ", published in Ekonomika Vol. 66, april-june 2020, № 2 ISSN 0350-137X, EISSN 2334-9190, UDK 338 (497,1)

THANK YOU