A review of international Fisher's effect focusing on inflation in Indian context for corporate decisions

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Abstract. *Any economic phenomenon is an outcome an unidentified robust and complex model than researched ones till date. One among such phenomena is inflation. There are many economic theories for inflation by classical economists till modern economist. This study tries to ease out the corporate decision by finding the causal relationship between inflation and macroeconomic variables. The basis of selecting the predictor variables is on a renowned theory called International Fishers Effect. Theory believes that disparity in the interest rates of two countries is adjusted by exchange rate of the currencies. Thus study intendeds to find the causal relationship of selected variables with inflation to make corporate decisions.*

Keywords: corporate decision, causality, interest rate, exchange rate, inflation etc.

JEL Classification: E31, E32, E43, C32.

Introduction

Inflation is firmly identified with financing costs, which can impact trade rates. Nations endeavour to adjust debt rates and inflation, yet the interrelationship between the two is intricate and regularly hard to oversee. Low loan costs goad purchaser spending and monetary development, and by and large positive effects on money esteem. On the off chance that purchaser spending increments to the point where request surpasses supply, inflation may result, which isn't really an awful result. Yet, low financing costs don't regularly draw in outside speculation. Higher loan fees will in general draw in outside venture, which is probably going to build the interest for a nation's currency.

A definitive assurance of the value and exchange rate of a country's cash is the apparent attractive quality of holding that country's currency. That observation is impacted by a large group of financial components, for example, the dependability of a country's legislature and economy. Speculators' first thought concerning money, before whatever benefits they may understand, is the wellbeing of holding money resources in the cash. On the off chance that a nation is seen as politically or financially flimsy or if there is any noteworthy plausibility of an unexpected cheapening or other change in the estimation of the nation's currency, speculators will in general withdrawn far from the money and are hesitant to hold it for huge periods or in huge sums.

Exchange rates are relative, particularly in the cutting edge universe of fiat monetary forms where basically no monetary standards have any natural esteem, say, as characterized as far as gold, for which the money could be exchanged. The value of any nation's currency has is its apparent esteem in perceived value to the cash of different nations or its domestic purchasing power. This circumstance can influence the impact that information, for example, inflation has on a nation's exchange rate. For instance, a nation may have an inflation rate that is for the most part thought to be high by business analysts, yet in the event that it is still lower than that of another nation, the general estimation of its money can be higher than that of the other nation's currency.

Literature review

Perera et al. (2016), in their study about analyzed the connection between Interest rate and the Exchange rate and to discover the impact of changes in Interest rate on Exchange rate volatilities. After-effects of the examination are steady with Interest Rate Parity hypothesis that uncovers a solid positive connection between Interest rate and Exchange rate. This examination broadens the writing on universal financing and gives profitable data to chiefs in little open economies and to the scholarly world.

Asari et al. (2011), in their study have broken down the connection between interest rate, inflation rate and exchange rate unpredictability in Malaysia covering the period 1999-2009. The outcomes demonstrate that the exchange rate impacts the interest rate as shown by Granger-cause. In this way the financing cost impacts the swapping scale as appeared by the Granger cause test. Considering a long haul relationship, interest rate moves emphatically while exchange rate goes contrarily towards swapping scale instability in Malaysia.

Berument (1999), in his study have surveyed the impact of expected inflation and inflation hazard on interest rate inside the Fisher hypothesis framework. Autoregressive Conditional Heteroscedastic models are utilized to gauge the contingent fluctuation of inflation as an intermediary for risk. It is discovered that both the normal inflation and the conditional variability of inflation decidedly influence the UK three month Treasury charge rate.

Need for the study

Every businessman would have key macroeconomic indicators in his watchlist to take major business decisions at micro level. Among the major macroeconomic indicators, inflation is one such indicator. It is important to know the independent variables which have a significant impact on the inflation. Such predictor variables are domestic and foreign interest rates and exchange rates. Businesses which transact cross borders would be curious to know the relative strength of the home currency to take decisions like remitting money from foreign subsidiaries, investing in foreign subsidiaries for its factors of production, strategic alliances initiatives etc. Hence it is in need in deed to understand the causal factors that relates to inflationary trends.

Objective of the study

1. To verify the presence of long run between interest rates (domestic and foreign) and currency exchange rate on inflation.
2. To establish the causal relationship between interest rates (domestic and foreign), currency exchange rate and inflation.

Scope of the study

The study confines understand the interrelationship between selected variables like interest rates (domestic and foreign) and currency exchange rate on inflation the basis of International Fisher's Effect theory. It considers only India as home country and US as foreign country. The data is compiled to analyse is from 2013 to 2018 on a monthly basis. Interest rates in the study mean 364 days T-Bill interest rate and one year T-Bill interest rate in US.

Data source

Monthly CPI from 2013-18 was extracted RBI website under time series publication. One year Fed T-bill rate from 2013-18 with monthly frequency is compiled from official website of Federal Reserve Bank of St. Louis. Monthly 364 days T-bill rate was extracted RBI website under time series publication. Monthly aggregated Exchange rate of Indian Rupee to US Dollars is extracted from a Global Financial Portal and Internet Brand Owned by Fusion Media Limited, registered in the British Virgin Islands.

Methodology

The methodology adopted to conduct this research is descriptive. The study tries to elaborate the interrelationship among the variables used in the International Fisher's Effect and validate the same. In the later part the study intends to find the empirical evidence for having causal relationship between inflation and predictor variables like,

interest rates(domestic and foreign) and currency exchange rate. The study is done in three stages. First stage is to bringing the data to stationary. Second, finding the existence of cointegration among the variables and lastly verifying the causal relationship.

Tools and techniques

Initially ensuring the stationary condition for all the four time series variables [i.e. N ~ (0,1)] before modelling. Stationarity is been confirmed using Augmented Dickey Fuller Test. Second stage being checking the cointegration between inflation and all other predictor variables like interest rate (India and US) and Exchange Rate individually. Cointegration assumptions are checked by Engle and Granger Cointegration hypothesis. Third Stage is verifying the causality between inflation and all other predictor variables like interest rate of India and US and Exchange Rate individually. Granger's Causality is used to confirm the causal relationship with the direction of causality. Eviews version 7 is used to run the above said procedure.

Data analysis & interpretation

Data collected from the authenticated sources are processed with the Eviews version 7 to run the laborious procedures of finding unit root issues, cointegration and causality. As a pre-requisite condition of eliminating the unit root in the time series data, initially, stationarity test is performed to test the presence of unit root at levels. The tests are run aging an integrated value of "1" [i.e. I(1)] to confirm stationarity.

Unit Root Tests

The results of stationarity test are given below;

Unit root condition for a stochastic trend is well explained with a following equation

$$\Delta Y_t = \alpha + \rho \Delta Y_{t-1} + u_t \qquad \{-1 \leq \rho \leq 1$$

Hypothesis to test unit root is as follows,

H_0: There exist unit root ($\rho = 0$)

H_1: There exists no unit root ($\rho \neq 0$)

The above hypothesis is tested for all the four variables Consumer Price Index Number, 364 days T-Bill rate, one year T-Bill rate of US and exchange rate. The test results of Augmented Dickey Fuller test is given below.

Table 1. *Table showing results of Augmented Dickey Fuller Test*

SL No	Variable	Order of Integration [I(x)]	t-statistic @ 5%	p-value	Result
1	CPI	0	-1.843529	0.3569	H_0 Accept
2	CPI	1	-5.907575	0.0000	H_0 Reject
3	EXUSD	0	-2.491857	0.1217	H_0 Accept
4	EXUSD	1	-8.324245	0.0000	H_0 Reject
5	ITB	0	-1.528160	0.5136	H_0 Accept
6	ITB	1	-7.467703	0.0000	H_0 Reject
7	LNUSTB	0	0.812600	0.9936	H_0 Accept
8	LNUSTB	1	-8.322385	0.0000	H_0 Reject

Source: Eviews output.

Where:

CPI – Consumer Price Index (a)

EXUSD – Exchange rate of US Dollars in Indian Rupee (x)

ITB – 364 days T-Bill rate in India (y)

LNUSTD – Natural Log of One year T-Bill rate in US (z)

The above table describes the behaviour exhibited by all the variables at different order of integration. It is observed that all the variables CPI, EXUSD, ITB are LNUSTB suffer with unit root problems (non-stationary) at levels i.e. me(0). Whereas all the variables are able to undergo the transformation of differencing at first level i.e. I(1). As stationarity is achieved first difference for all the variables, there stands a fair chance to check the cointegration among the variables.

Note: *It is observed that USTD is not stationary at levels and first difference but it is stationary at second difference i.e. I(2). As is it inconvenient to cointegrate the variable with other variable at first difference, USTD is transformed with natural log and named LNUSTD. LNUSTD is non stationary at levels and stationary at first difference.*

Cointegration Tests

Cointegration is defined between two variable when the variables are having linear relationship between them at first difference and residuals are stationary at levels i.e. I(0). Cointegration is tested for all the predictor variables with dependent variable at an integrated order of "1" as stationarity of the variables is achieved at first difference.

General form of OLS models at levels are given below;

OLS Regression between CPI(a) and EXUSD (x) i.e. $a = \alpha_1 + \beta_1 x + \varepsilon_1 t$

OLS Regression between CPI(a) and ITB (y) i.e. $a = \alpha_2 + \beta_2 x + \varepsilon_2 t$

OLS Regression between CPI(a) and LNUSTD (z) i.e. $a = \alpha_3 + \beta_3 x + \varepsilon_3 t$

Modelling the variables at levels is given below.

Table 2. *Table showing results of OLS models at levels*

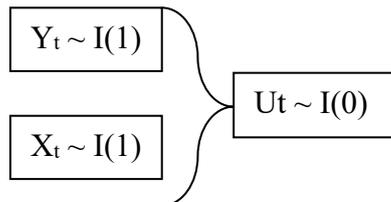| Dependent Variable	a	a	a
Independent Variable	x	y	z
R Square	0.6916	0.5290	0.8999
DW Stat	0.2515	0.1355	0.1680
Intercept	-38.8508	199.6529	138.1514
p-value	0.0052	0.0000	0.0000
Slope	2.6228	-9.4134	10.8011
p-value	0.0000	0.0000	0.0000

Source: Eviews output.

The above table describes the parameters, r-square, Durbin Watson statistic and p-value of different sets of OLS regression. It is observed that when models at level exhibits spurious relationship in all the sets i.e. a = f (x), a = f(y) and a = f(z). The models are said to be exhibiting a non-sense regression even though there is significance and adequate explanatory power because Durbin Watson's Statistic is less than R^2 in all the models. On the basis of this criterion the regression models at levels are confirmed to be spurious and long term equilibrium cannot be established between the variables. This phenomenon is

seen due to non stationarity behaviour of the variables. To test the presence of long term equilibrium, the variables are brought to stationarity by differencing method.

Engle and Granger Cointegration test is performed to check to establish long term relationship exist between the variables in the models.

General form of cointegration is explained below;

$$Y_t \sim I(1)$$

$$X_t \sim I(1)$$

$$U_t \sim I(0)$$

Cointegration between CPI(a) and EXUSD (x)   i.e. $\Delta a = \alpha_1 + \beta_1 \Delta x + \varepsilon_1 t$

Cointegration between CPI(a) and ITB (y)   i.e. $\Delta a = \alpha_2 + \beta_2 \Delta x + \varepsilon_2 t$

Cointegration between CPI(a) and LNUSTD (z)   i.e. $\Delta a = \alpha_3 + \beta_3 \Delta x + \varepsilon_3 t$

Cointegration is tested for all the three combination with dependent variable (CPI = a) and independent variables (EXUSD = x, ITB = y, LNUSTD = z) at its first difference and tested respective residuals to verify the long run equilibrium between the variables for all the three sets. Cointegration results of the variables with three sets are given below;

Table 3. *Table showing results of OLS models and ADF test of residuals*

Dependent Variable	a	a	a
Independent Variable	x	y	z
R Square	0.0050	0.0254	0.0139
DW Stat	1.4134	1.4312	1.3923
Intercept	0.6492	0.6576	0.6713
p-value	0.0000	0.0000	0.0000
Slope	0.0250	0.2352	-0.4041
p-value	0.5582	0.1844	0.3279
ADF t-stat	-6.0913	-6.1576	-6.0223
Granger Critical Value	3.6700	3.6700	3.6700
p-value	0.0000	0.0000	0.0000
Residual I(0)	N ~ (0,1)	N ~ (0,1)	N ~ (0,1)

Source: Eviews output.

It is observed in that OLS regression models in all the three sets, R-square is less than Durbin Watson's statistic and respective residuals are stationary at levels. This confirms there exist cointegration between the predictor variables and dependent variable in all the three sets of simple regression models. Thus it is confirmed that there exist long run equilibrium with the help of Engle and Granger hypothesis. Hence it is understood that CPI is cointegrated with Exchange Rate of Indian and US currencies, 364 days T-Bill rate and one year T-Bills of US.

Cointegrations allow finding the causality of variables on each other. Granger's causality test is used to find the causality direction on both the sides. General Granger's Causality model for all the possibilities of the variables in the study is expressed below.

Table 4. *Table showing possible causal relationship among variables*

dCPI→dEXUSD	dEXUSD→dCPI
$da_t = \alpha_1 + \sum_{i=1}^{n} \beta_1\, da_{t-i} + \sum_{j=1}^{n} \delta_1 dx_{t-j} + \varepsilon_{1t}$	$dx_t = \alpha_2 + \sum_{i=1}^{n} \beta_2\, da_{t-i} + \sum_{j=1}^{n} \delta_2 da_{t-j} + \varepsilon_{2t}$
dCPI→dITB	dITB→dCPI
$da_t = \alpha_3 + \sum_{i=1}^{n} \beta_3\, da_{t-i} + \sum_{j=1}^{n} \delta_3 dy_{t-j} + \varepsilon_{3t}$	$dx_t = \alpha_4 + \sum_{i=1}^{n} \beta_4\, da_{t-i} + \sum_{j=1}^{n} \delta_4 da_{t-j} + \varepsilon_{4t}$
dCPI→dLNUSTD	dLNUSTD→dCPI
$da_t = \alpha_5 + \sum_{i=1}^{n} \beta_5\, da_{t-i} + \sum_{j=1}^{n} \delta_5 dx_{t-j} + \varepsilon_{5t}$	$dx_t = \alpha_6 + \sum_{i=1}^{n} \beta_6\, da_{t-i} + \sum_{j=1}^{n} \delta_6 da_{t-j} + \varepsilon_{6t}$

Causality tests are presented in the following table.

Table 5. *Table showing results of Granger's Causality*

Hypothesis	D(EXUSD) does not Granger Cause D(CPI)	D(CPI) does not Granger Cause D(EXUSD)	D(ITB) does not Granger Cause D(CPI)	D(CPI) does not Granger Cause D(ITB)	D(LNUSTD) does not Granger Cause D(CPI)	D(CPI) does not Granger Cause D(LNUSTD)	Lags	Observation
t-stat	2.7276	2.5757	1.3408	2.8905	0.5565	0.8888	2	69
p-value	0.073	0.084	0.2689	0.0628	0.576	0.4162		
t-stat	1.5643	2.0863	0.7083	2.9294	1.3523	1.4045	3	68
p-value	0.2072	0.1113	0.5508	0.0406	0.2659	0.2501		
t-stat	1.228	2.0118	0.7516	3.8424	1.2464	1.2853	4	67
p-value	0.309	0.1047	0.561	0.0077	0.3015	0.2863		
t-stat	1.1229	1.5827	1.0377	3.1615	1.3867	0.9907	5	66
p-value	0.3591	0.1803	0.4049	0.014	0.2436	0.432		
t-stat	1.3409	1.4295	0.3459	0.931	1.3275	1.2489	6	65
p-value	0.2561	0.2213	0.9091	0.4808	0.2618	0.2972		
t-stat	1.0425	0.2318	0.7932	2.0027	1.6705	0.9681	7	64
p-value	0.4144	0.9756	0.5966	0.0737	0.1384	0.4648		
t-stat	0.8954	0.3747	0.9396	2.6235	2.2282	0.8375	8	63
p-value	0.5282	0.9287	0.4939	0.0187	0.0423	0.5747		
t-stat	1.2118	0.2253	0.6437	1.7732	1.7829	1.0192	9	62
p-value	0.313	0.9891	0.7535	0.1017	0.0997	0.4403		
t-stat	1.1772	0.2101	0.5833	1.549	1.4993	1.8062	10	61
p-value	0.3343	0.9941	0.8177	0.1582	0.1756	0.0909		

Source: Eviews Output.

The above table denotes the causality between two variables at various lags with its t-stat and p-values. The null hypothesis pronounces that there is no Granger Causality between variables. Causality can be tested only after the variables are cointegrated. As it is observed in the above cointegration models all the models observe the cointegration between the variables. Observing the above tables is understood that there is not causal relationship between CPI and EXUSD in both the direction as there is no significance observed in the test statistic. That means CPI doesn't cause Exchange Rate and vis-a-vis.

Whereas between ITB and CPI, ITB doesn't cause CPI but CPI cause ITB as it is significant with test statistic. That means causality between CPI and 364 days T-Bills rate

have a unidirectional causality i.e. only CPI cause domestic interest rate of 364 days T-Bills and vis-a-vis in not true as it is not significant with the test statistic. It is also important to note that CPI is Cause ITB only at 3rd, 4th, 5th and 8th lags.

With respect to causality between CPI and LNUSTD, it is experiential that only log of one year T-Bill rate cause CPI and vis-a-vis is not true. It is also noted that LNUSTD Granger Causes CPI only at 8th lag.

Study outcomes

1. The obtained data for all the 4 variables, Inflation, Dollar Exchange Rate, and Indian Interest Rate are US Interest Rate suffer with unit root problems (non-stationary) at levels i.e. I(0). This means the data of all the variables are non-stationary at level.
2. All the variables except one year T-Bill rate are stationary at first difference i.e. I(1). Hence one year T-Bill is transformed into natural log and found stationary at first difference.
3. CPI is regressed with Dollar Exchange Rate, Indian Interest Rate and US Interest Rate individually at the first order i.e. I(1) with their respective residuals being stationary at levels i.e. I(0). Hence all the predictor variables are said to be cointegrated with CPI individually.
4. It is observed that CPI is Cause ITB only at 3rd, 4th, 5th and 8th lags. This means monetary transmission is initiated for every 3rd, 4th, 5th and 8th month after inflation is observed in the economy to regulate it. It is also found that US Interest Rate Granger Causes CPI only at 8th lag. Which means, after changes in US Interest Rate, 8th month post changes cause inflation in India.
5. It is found that a chain movement in the causality among Inflation, Indian Interest Rate and US Interest Rate at exactly in the 8th lag.

Conclusions

The study intended to validate if any long run equilibrium existed among the variables Inflation, Dollar Exchange Rate, Indian Interest Rate and US Interest Rate and to find their causal relationship among them. As it is difficult to model the non-stationary time series data, first difference data are modelled to find the long run relationship among the study variables. It is found that all the predictor variables, namely exchange rate of USD, 364days T-Bills and one year T-Bill in US are individually cointegrated with Consumer Price Index of India. This shows there is a long run relationship between Inflation and US Interest Rate, Indian Interest Rate are US Interest Rate as their first difference regression model finds linear relationship and respective residuals are stationary at levels. It is also seen that Indian Interest Rate cause inflation at 3rd, 4th, 5th and 8th lag. That means Changes made RBI to 364days T-Bill finds its impact on Inflation only after 3rd, 4th, 5th and 8th. It is also seen a causal relationship between Inflation and US Interest Rate, where changes in US Interest Rate triggers inflation in India after 8 months.

The chain causality among Inflation, Indian Interest Rate and US Interest Rate is found at exactly in the 8th lag. This explains Changes in one month US
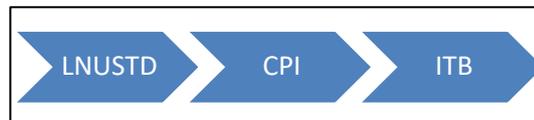
T-Bills rate triggers inflation in India after 8 months, this caused inflation is addressed by RBI only after 8 months. The representation of the chain model is shown in the above figure. Hence it is significant to consider these inter-relationships of macroeconomic variables to take strategic decisions like remitting money from foreign subsidiaries, investing in foreign subsidiaries for its factors of production, strategic alliances initiatives etc.

Changes in US interest would trigger inflation, hence better to take decisions following decision procurement, plan for forward contracts for raw materials, take up more orders to have a competitive edge over compotators and pile up stocks for the next cycle. Inflation triggering Indian interest rate is due to monetary transmission, hence the firms shall plan for invest in financial products to get maximum return. These mentioned global strategies would have a better financial control among the firms transacting cross border. Thus any manager will be in a position to take a tactical decision against risk of inflation using the inter-relationships with exchange rate, Indian interest rate and US interest rate established in the study.

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