

STOCHASTIC MODELLING OF BALANCE OF PAYMENTS IN THE POST-LIBERALISED INDIAN ECONOMY

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Abstract

This paper studies the determinants of Balance of payments (BOP) in post-liberalised Indian economy. The endogenous variables taken for the investigation are BOP, interest rate, gross fiscal deficit, foreign direct investment, crude oil price, exchange rate, external debt, growth rate and inflation from 1991 to 2022. VECM was applied for analysing these time series data. The findings of this study reveal that FDI and Growth rate have positive influence on BOP in the short-run. FDI, gross fiscal deficit, growth rate and inflation have positive impact on BOP in the long run whereas interest rate and crude oil price have negative influence on BOP in the long-run. Significant negative adjustment coefficients shows that Balance of Payments is mean reverting. The outcomes of this study will guide researchers and policymakers to formulate appropriate policies to manage India's Balance of Payments.

Keywords: Fiscal Deficit, Exchange Rate, Growth Rate, VECM, Cointegration

1. Introduction

Balance of Payments (BOP) is a systematic record of all economic transactions between the residents of a country and the rest of the world in a year. BOP comprises the current account balance (CUAB) and the capital account balance (CAB). In the early 1991, India had been facing severe BOP crisis. Current account deficit (CAD) reached to 3.6 % of GDP. High CAD led to high external debt and high interest payment on external debt. Furthermore, Inflation was too high due to monetisation of fiscal deficit.

To address this severe Balance of Payments crisis, India implemented key economic reforms. The reforms in the form of macroeconomic stabilisation programme was aimed to restore short-term economic stability by controlling inflation, reducing fiscal and current account deficits and correcting external imbalances. Key measures taken under stabilisation programme were fiscal consolidation through reduction in Government expenditure, contraction of monetary policy and reduction in the monetisation of fiscal deficit. Some other strategies under

stabilisation programme were devaluation of the rupee to increase exports and seeking financial help from the IMF and World Bank to increase the volume of foreign exchange reserves.

In contrast, the structural reforms were aimed to bring long term efficiency in the economy and these reforms were also designed to make India competitive at international level by removing the rigidities in the Indian economy. These reforms included liberalisation of industrial licensing, reduction of trade barriers and import tariffs, disinvestment in public sector enterprises and financial sector liberalisation, encouragement of foreign direct investment (FDI), rationalisation of taxes and adoption of flexible exchange rate system. These reforms shifted Indian economy from a controlled, inward-looking economy to open, market oriented and globally integrated economy. These reforms are also known as Liberalisation, Privatisation and Globalisation of India economy.

In the course of liberalisation, India adopted flexible exchange rate system and subsequently adopted current account convertibility. CAD indicates the use of growth supportive external resources in a country. It is financed by Capital inflows from abroad for long term development. A large CAD indicates a high dependence on foreign capital and associated with large amount of external liabilities (Reddy, 2001). Dua & Garg (2014) studied the macroeconomic determinants of FDI in Indian economy during the period 1997 to 2011. It was observed that depreciating exchange rate, higher domestic output and domestic interest rate had positive impact on FDI inflow in the long run. Depreciation of rupee improves trade balance in the short run, while rise in prices have negative impact on trade balance in both the short run and the long run (Parrray et al., 2022).

This research aims to study the determinants of Balance of Payments (BOP) in post-liberalised Indian economy. Some research works was done to analyse the influence of macroeconomic variables on CUAB and CAB in the Post-liberalised Indian economy. But none of the research works have been done to see the impact of macroeconomic variables on BOP in the post-liberalised Indian economy. The remaining of this research paper is organised as follows. Section 2 presents the Literature Review. Section 3 explains Data and Methodology. Section 4 presents analysis of empirical results and section 5 concludes.

2. Literature Review

Sahoo et al. (2020) studied the influence of import of crude oil and exchange rate on India's CUAB for the time period from 1980-81 to 2014-15 by applying VECM model. It was found that exchange rate adversely affected CUAB, while crude oil import positively affected CUAB in the long run and negatively affected it in the short run.

Mehta & Mallikarjun (2023) analysed the impact of fiscal deficit and exchange rate on India's current account deficit during the time period 1981-2021 by applying ARDL model. It was found that fiscal deficit, exchange rate and trade openness have positive influence on CAD in both the short run and the long run.

Soo et al. (2023) conducted a study to investigate the determinants of CUAB in 48 Asian countries during the period 1990-2021. Panel cointegration method was used for the analysis. The study shows that fiscal balance has positive impact on CUAB and real GDP has negative influence on CUAB. Lin & Kueh (2019) examines the determinants of CUAB in six ASEAN

countries during the period 1990-2016, by applying panel vector error correction model and panel Granger causality method. Empirical result shows that public debt and real GDP are positively related to CUAB. Ariyani et al. (2018) studied the factors that affect CUAB in ASEAN six countries during the period 2001-2016. PVECM was applied to analyse CUAB. Result shows that FDI and exchange rate negatively affected CUAB. Calderón et al. (1999) analysed panel data of developing nations during the period 1966-95 and observed that an appreciation of real exchange rate widens CAD. Marimuthu et al. (2021) conducted empirical study for ASEAN-10 countries during the period 1990-2019 by applying panel data model. Empirical result shows that fiscal deficit and currency appreciation in domestic country have positive effect on CAD in long run.

Nugent (2018) analyses annual data of net foreign direct investment inflows from 1995 to 2015 for 100 countries by applying Arellano–Bond generalized method of moments. The result shows that restriction on inflows of short term capital cause a higher level of inflow of FDI. Ray (2012) studies the determinants of Balance on Trade (BOT) during 1972-73 to 2010-11 by applying OLS and VECM. OLS result shows that FDI positively affect BOT and appreciation of domestic currency worsens BOT. VECM result shows FDI is negatively related to BOT in short run. Velić & Cvečić (2024) examines the impact of accession to the Economic and Monetary Union (EMU) on inflow of foreign direct investment (FDI) in New Member States (NMS), during the period 2005-2018 by applying panel data model and the gravity model. The empirical study suggests that in the NMS, REER and interest rate are positively related to inflow of FDI in NMS. It was further found that Inflation in NMS countries are negatively related to FDI inflows in NMS countries.

Chotia & Rao (2015) analyzed the balance of payments for India using annual data from 1980 to 2013. It was found that bidirectional causality existed between FDI and BOT and between FDI and BOP. Eita & Gaomab (2012) investigates macroeconomic determinants of the balance of payments in Namibia for the period 1999 to 2009. VECM applied for the analysis. The result shows that fiscal balance, GDP growth and rate of interest positively affect BOP in the long run. Kandil (2009) analyses annual time-series data of developing countries during 1971-2000. It was found that appreciation of currency worsens CUAB. Lakshmanasamy (2022) This paper examines the relationship between budget deficit and trade deficit in India by using quarterly data for the time period from 1994 to 2016. The empirical result displays that fiscal deficit and exchange rate positively affect CAD. Nepal & Thapa (2021) explore the effect of inflation, exchange rate, GDP, FDI and GCE on trade balance of South Asian countries from 2001 to 2019 by applying panel ARDL/PMG. The result shows that inflation, exchange rate and GDP have positive effect on trade balance in long run while Government Consumption Expenditure has negative effect on trade balance. Ratha (2010) conducts empirical study to find out the existence of twin deficit in India during the period 1998-2009. Budget deficit and trade deficit, usually known as the twin-deficits. Empirical results suggest that budget deficit contributes to trade deficit in the short run.

3. Data and Methodology

3.1 Data

Table 1. Macroeconomic Variables and Sources of Data

Variables and its explanation	Mnemonic	Sources
Balance of Payments (BOP)	BOP	RBI

Exchange rate	ER	RBI
External Debt	ED	RBI
Foreign Direct Investment	FDI	World Bank
Gross Fiscal Deficit	GFD	RBI
Inflation	INF	World Bank
Spot Price of OPEC Reference Basket (ORB) crude oil (\$/b)	ORB	OPEC
Annual GDP Growth rate (Growth rate)	GR	RBI
Weighted average of Central Government Securities (Interest rate)	INT	RBI

BOP, External debt, FDI, GFD are taken as percentage of Gross Domestic Product (GDP)

3.2 Methodology

3.2.1 Augmented Dickey-Fuller (ADF) Test

ADF regression equation:

$$\Delta z_t = \alpha + \beta t + (\delta - 1) z_{t-1} + \sum_{i=1}^p \theta_i \Delta z_{t-i} + \varepsilon_t \quad (1)$$

Where,

θ_i = Coefficients of lagged first-differenced terms

ε_t = White noise error term

Null hypothesis:

$$H_0: \delta = 1$$

$$H_1: \delta < 1$$

3.2.2 Johansen's Vector Error Correction Model

A non-stationary Vector Autoregressive (VAR) model cointegrates.

The equation for the Vector Error Correction Model (VECM) is:

$$\Delta \Pi_t = \alpha \beta' \Pi_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta \Pi_{t-i} + \varepsilon_t \quad (2)$$

Where,

Π_t = Vector of endogenous variables

Γ_i = Short-run coefficient matrix

ε_t = White noise error terms.

α = adjustment coefficients

β = cointegrating vectors

4. Analysis of Empirical Results

4.1 Test of Stationarity

ADF test suggest that BOP, GFD, inflation and Growth rate are stationary time series whereas ER, ED, FDI, interest rate and ORB are non-stationary time series.

4.2 Lag length of Vector Auto Regression (VAR)

Table 2. Lags of VAR

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-600.1811	NA	3510972.	40.61207	41.03243	40.74655
1	-362.7183	316.6171	131.4530	30.18122	34.38481	31.52598
2	-198.5007	120.4262*	3.119942*	24.63338*	32.62021*	27.18844*

Result in Table 2, demonstrates that VAR has two lags.

4.2.1 Testing the Stationarity of VAR

Figure 1. Unit Root Circle

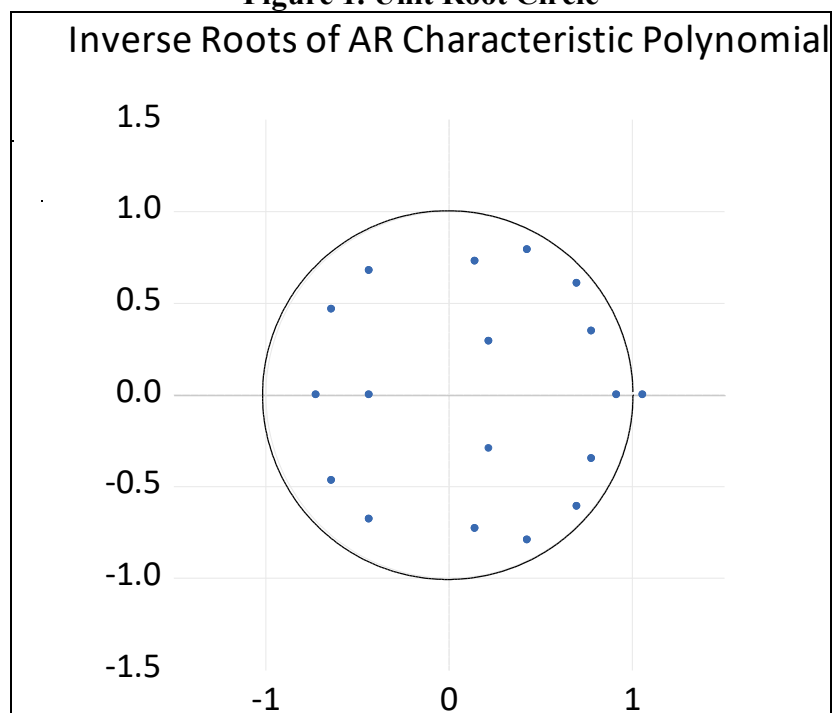


Figure 1, shows the non-stationarity of structural VAR.

4.3 Co-integration Test

Table 3. Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
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None *	0.990750	140.4924	58.43354	0.0000
At most 1 *	0.929899	79.73446	52.36261	0.0000
At most 2 *	0.846025	56.12888	46.23142	0.0033
At most 3	0.733562	39.67837	40.07757	0.0554

Result in Table 3, confirms the presence of 3 cointegrating equations.

4.4 Estimation and Analysis of Vector Error Correction Model

Table 4. VECM Estimates

Cointegrating Equation	Coint. Equ. 1	Coint. Equ. 2	Coint. Equ. 3
BOP(-1)	1.000000	0.000000	0.000000
ER(-1)	0.000000	1.000000	0.000000
ED(-1)	0.000000	0.000000	1.000000
FDI(-1)	-0.566740	7.644981	3.419795
	[-4.83847]	[2.54719]	[4.91560]
GFD(-1)	-0.540778	15.55315	-1.116464
	[-7.27713]	[8.16808]	[-2.52952]
GR(-1)	-0.366114	18.54783	-2.147628
	[-8.28359]	[16.3778]	[-8.18112]
INF(-1)	-0.301486	1.895549	0.725320
	[-10.1861]	[2.49940]	[4.12592]
INT(-1)	0.984782	-5.234216	-1.601789
	[23.1166]	[-4.79509]	[-6.33056]
ORB(-1)	0.060089	-0.401100	-0.097469
	[16.3032]	[-4.24709]	[-4.45241]
C	-5.956955	-196.2093	22.46872
Error Correction:	D(BOP)	D(EXCHANGE_RATE)	D(EXTERNAL_DEBT)
Coint. Equ. 1	-2.115232	-0.191155	0.138189
	[-7.99237]	[-0.52165]	[1.55506]
Coint. Equ. 2	-0.116689	-0.115090	0.009916
	[-4.89255]	[-3.48511]	[1.23826]
Coint. Equ. 3	-0.473119	-0.493415	-0.011786
	[-4.15299]	[-3.12806]	[-0.30811]
D [BOP(-1)]	0.826861	-0.412699	0.043526
	[4.75806]	[-1.71515]	[0.74593]
D [ER(-1)]	0.078534	-0.500376	0.013100
	[0.53294]	[-2.45239]	[0.26476]
D [ED(-1)]	-0.735209	1.446663	0.613731
	[-1.60542]	[2.28149]	[3.99128]
D [FDI(-1)]	4.723897	-1.397687	-0.422765
	[7.67712]	[-1.64051]	[-2.04622]
D [GFD(-1)]	-0.533926	1.536796	0.155916
	[-1.45326]	[3.02099]	[1.26388]
D [GR(-1)]	0.287324	0.767153	-0.048091
	[1.99753]	[3.85191]	[-0.99573]
D [INF(-1)]	0.085791	0.097174	0.029855
	[0.56965]	[0.46601]	[0.59040]
D [INT(-1)]	-0.328138	-0.060879	0.040451
	[-1.30119]	[-0.17435]	[0.47771]
D [ORB(-1)]	0.008628	-0.020716	0.004807
	[0.47290]	[-0.82002]	[0.78474]
C	-0.810648	3.101672	-0.144907
	[-2.41899]	[6.68450]	[-1.28779]
R ²	0.909490	0.849479	0.763220
Adjusted R ²	0.845601	0.743229	0.596082

F	14.23544	7.995104	4.566394
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t-statistics in []

VECM equation for Balance of Payments

$$D(BOP) = -2.115*(BOP(-1) - 0.566*FDI(-1) - 0.540*GFD(-1) - 0.366*GR(-1) - 0.301*INF(-1) + 0.984*INT(-1) + 0.060*ORB(-1) - 5.956) - 0.116*(ER(-1) + 7.644*FDI(-1) + 15.553*GFD(-1) + 18.547*GR(-1) + 1.895*INF(-1) - 5.234*INT(-1) - 0.401*ORB(-1) - 196.209) - 0.473*[ED(-1) + 3.419*FDI(-1) - 1.116*GFD(-1) - 2.147*GR(-1) + 0.725*INF(-1) - 1.601*INT(-1) - 0.097*ORB(-1) + 22.468] + .826*D[(BOP(-1))] + .078*D[ER(-1)] - 0.735*D[ED(-1)] + 4.723*D[FDI(-1)] - .533*D[GFD(-1)] + .287*D[GR(-1)] + .085*D[INF(-1)] - .328*D[INT(-1)] + .008*D[ORB(-1)] - 0.810 \quad (3)$$

Long run Equation of BOP:

$$BOP = 5.956 + 0.566*FDI + 0.540*GFD + 0.366*GR + 0.301*INF - 0.984*INT - 0.060*ORB \quad (4)$$

4.4.1 Test of Significance of VECM Coefficients

Table.5 Significance Test for Long-run parameters (Cointegration equation 1)

Variables	Coefficient	t-stat	P-value
FDI (-1)	-0.5667	-4.838	<0.0001**
GFD (-1)	-0.5408	-7.277	<0.0001**
Growth rate (-1)	-0.3661	-8.284	<0.0001**
Inflation (-1)	-0.3015	-10.186	<0.0001**
Interest rate (-1)	0.9848	23.117	<0.0001**
ORB (-1)	0.0601	16.303	<0.0001**

Table.6 Significance Test for Long-run Parameters (Cointegration equation 2)

Variables	Coefficient	t-stat	P-value
FDI (-1)	7.645	2.547	0.0109 *
GFD (-1)	15.553	8.168	<0.0001**
Growth rate (-1)	18.548	16.378	<0.0001**
Inflation (-1)	1.8955	2.499	0.0125*
Interest rate (-1)	-5.2342	-4.795	<0.0001**
ORB (-1)	-0.4011	-4.247	<0.0001**

Table.7 Significance Test for Long-run Parameters (Cointegration equation 3)

Variable	Coefficient	t-stat	P-value
FDI (-1)	3.4198	4.916	<0.0001**
GFD (-1)	-1.1165	-2.53	0.0114*
Growth rate (-1)	-2.1476	-8.181	<0.0001**
Inflation (-1)	0.7253	4.126	<0.0001**
Interest rate (-1)	-1.6018	-6.331	<0.0001**

ORB (-1)	-0.0975	-4.452	<0.0001**
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**significant at 1% & *significant at 5%

Table.8 Significance Test of Error Correction Terms

Error Correction Term	Coefficient	t-stat	P-value
Cointegration Equation 1	-2.115	-7.992	<0.0001**
Cointegration Equation 2	-0.1167	-4.893	<0.0001**
Cointegration Equation 3	-0.4731	-4.153	<0.0001**

Table.9 Test of Significance of Short-run Dynamics

Variables	Coefficient	t-stat	P-value
D [BOP {-1}]	.8269	4.758	<.0001 **
D [ER {-1}]	.0785	.533	.594
D [ED {-1}]	-0.7352	-1.605	0.108
D [FDI (-1)]	4.7239	7.677	<0.0001 **
D [GFD (-1)]	-0.5339	-1.453	0.146
D [GR (-1)]	0.2873	1.998	0.046 *
D [INF (-1)]	0.0858	0.57	0.568
D [INT (-1)]	-0.3281	-1.301	0.193
D [ORB (-1)]	0.0086	0.473	0.636
Constant	-0.8106	-2.419	0.016

**significant at 1% & *significant at 5% .

Interpretation of VECM results

Long run impact: The coefficients of FDI, GFD, Growth rate and inflation are positive and significant. This empirical result shows that a rise in FDI will improve Balance of Payments in the long run. A rise in GFD will improve BOP in the long run. It implies that a rise in public expenditure will improve BOP in the long run. A higher GDP growth rate will lead to improvement in BOP. A high level of domestic output will reduce import and improve BOP. This study also shows that a higher price level will improve BOP.

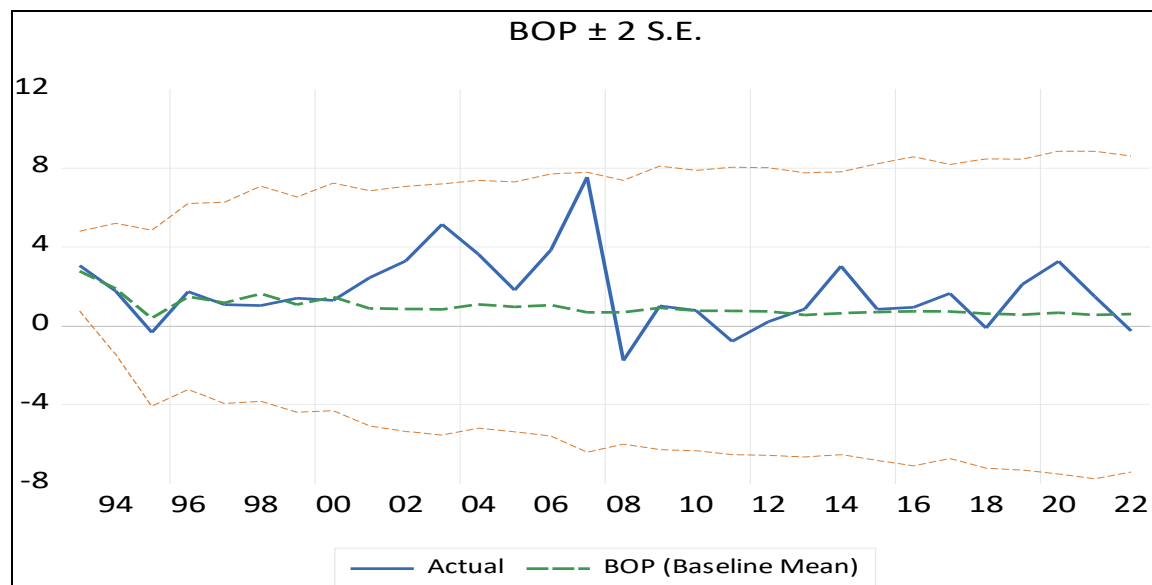
The coefficients of domestic interest rate and crude oil price are negative. This result shows that a rise in domestic rate of interest will improve BOP in the long run. A rise in crude oil price will reduce BOP.

Adjustment coefficients are negative and statistically significant. It indicates that Balance of Payments is mean reverting in the long run.

Short run Impact: The coefficients of FDI and GDP growth rate are positive and significant. This result shows that a rise in FDI will improve BOP situation in the short run. A rise in domestic output will improve BOP situation in the short run.

4.5 Stochastic Forecasting of Balance of Payments (BOP)

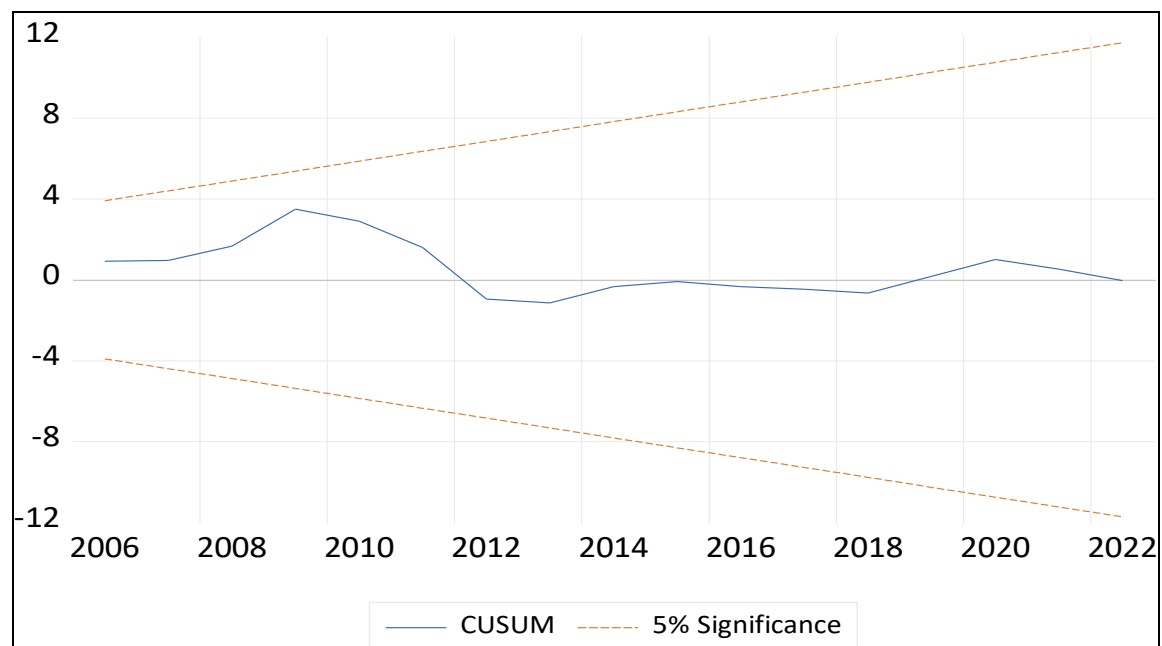
Fig. 2 Stochastic Forecasting with dynamic parameters



In Fig.2, stochastic forecasting with dynamic parameters captures the uncertainty in predicted mean and parameters. The actual BOP line is within ± 2 S.E. confidence interval; it shows that VECM model's dynamic parameters capture unforeseen shocks of Indian economy.

4.6 Stability Diagnostic

Figure. 3 CUSUM Test



In Fig 3, the plot of CUSUM of recursive residuals is between the critical bounds, it indicates that the estimated parameters of VECM are stable and VECM model is dynamically stable.

5. Conclusion

This paper studies the factors of BOP in post-liberalized Indian economy. The endogenous variables taken for the investigation are BOP, interest rate, gross fiscal deficit, foreign direct investment, crude oil price, exchange rate, external debt, GDP growth rate and inflation from 1991 to 2022. The time series Data of BOP, external debt, GFD and GDP growth rate has been taken from RBI whereas time series data of FDI and Inflation has been taken from W.D.I., World Bank. The time series data of crude oil price has been taken from Annual Statistical Bulletin, OPEC. The VECM model was applied for analysing these time series data. The findings of this study show that FDI and Growth rate have positive influence on BOP in the short-run. FDI, gross fiscal deficit, growth rate and inflation have positive influence on BOP in the long run whereas interest rate and crude oil price have negative impact on BOP in the long-run. Significant negative adjustment coefficients show that Balance of Payments is mean reverting. The findings of this study will help to researchers and policymakers to formulate appropriate policies to manage India's BOP in both the short run and the long run.

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