5 OPEN ECONOMY FLEXIBLE INFLATION TARGETING

"… WHEREAS it is essential to have a modern monetary policy framework to meet the challenge of an increasingly complex economy."

[Excerpted from Preamble to the Reserve Bank of India (RBI) Act, 1934 (amended by the Finance Act, 2016)]

1. Introduction

V.1 As India's experience in the lead-up to the institution of flexible inflation targeting (FIT) vividly showed, persistently high inflation can carry the seeds of external vulnerabilities, which surged to a crescendo during the taper tantrum in the summer of 2013. High inflation morphed into a balance of payments crisis, posing a severe challenge to monetary policy credibility (Patra, 2017). For an open emerging market economy, surges, sudden stops and reversals in capital flows and related volatile exchange rate movements complicate the conduct of monetary policy in the short run. By influencing domestic liquidity and monetary conditions, they feed into domestic inflation, depending on the degree of exchange rate pass-through (ERPT) to domestic prices and the effectiveness of sterilisation operations. Over the longer run, persistently high levels of inflation tend to erode export competitiveness and along with imported inflation can worsen the terms of trade and the current account balance.

V.2 In an open economy setting, therefore, policy authorities are confronted with 'impossible' trade-offs, requiring them to sacrifice one of three policy choices: monetary policy independence; exchange rate stability; and an open capital account (Mundell, 1963; Fleming, 1962). The rapid globalisation of economies and the cross-border integration of domestic financial markets have amplified these challenges. In fact, irrespective of the exchange rate regime, financial openness has posed complications for independent conduct of monetary policy, morphing the trilemma into a dilemma, a choice between capital mobility and independent monetary policy (Rey, 2013). In the aftermath of the global financial crisis (GFC), global spillovers of unconventional monetary policies (UMPs) of systemically important central banks added a new dimension to the open economy policy trade-offs, *i.e.*, domestic financial conditions became heavily influenced by interest rate settings in advanced economies (AEs) and the slosh of global liquidity which impacted credit spreads, risk premia, credit flows and leverage, rendering the pursuit of domestic monetary policy objectives even more challenging. Countries with fixed/managed exchange rate regimes found that they are more likely to experience financial vulnerabilities – faster domestic credit and housing price growth, and increases in bank leverage – than those with relatively flexible regimes (Obstfeld *et al.*, 2017). In this complex international environment, emerging market economies (EMEs) have brought to bear several innovations in the conduct of open economy monetary policy. They have resisted depreciation with a combination of foreign exchange interventions and interest rate defences;

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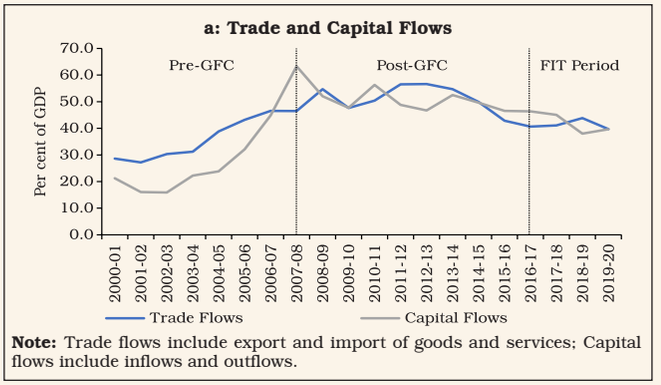
they have learnt over time to manage appreciation pressures better, using a combination of sterilised interventions, capital flow management measures (CFMs) and macro-prudential policies. As a result, EMEs have transformed the dilemma in practice to an asymmetric 2.5 lemma (Cheng and Rajan, 2019). The most important innovation brought in by EMEs has been the happy marriage between FIT and foreign exchange intervention. This can be characterised as an intermediate approach between the two 'impossible' corner solutions – fixed exchange rate *versus* fully open capital account – in the conduct of monetary policy. As a result, the practice of monetary policy in EMEs has moved ahead of theory (BIS, 2019). The global narrative today is all about developing a consensus on an integrated policy framework (IMF, 2019; Adrian and Gopinath, 2020).

V.3 Since the adoption of FIT in India in June 2016, India has also used its own intermediate approach to deal with global spillovers, absent any multilateral consensus on an ideal framework. This chapter covers India-specific issues relating to managing open economy challenges and trade-offs under FIT. Section 2 provides stylised facts on India's openness, comparing the FIT experience with that of the pre-FIT period. Section 3 drills down into underlying exchange rate dynamics, including the effectiveness of sterilised interventions in enhancing flexibility in the conduct of monetary policy in India, and nuances of exchange rate pass-through to domestic inflation. Section 4 summarises policy responses with the help of an open economy Taylor type rule to guide the setting of monetary policy amidst UMPs and global spillovers, taking into account implications for current account sustainability and competitiveness. Section 5 summarises the findings and ends with key takeaways and policy inferences.

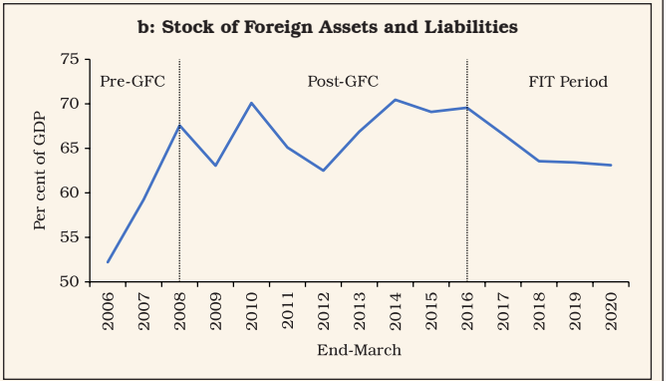
2. Openness: Some Stylised Facts

V.4 Despite various *de jure* policies that have sustained the progressive liberalisation of the capital account in India, cross-border capital flows as a ratio to GDP have moderated during the FIT period (Chart V.1). This reflects a global pattern among EMEs (Chart V.2). At the global level, growing trade protectionism and the retrenchment of banking sector flows largely explain the moderate levels of trade related and capital flows in the post-GFC period. In the case of India, deceleration in the rate of domestic capital formation has also constrained productive absorption of foreign capital.

Chart V.1: India's Openness Indicators

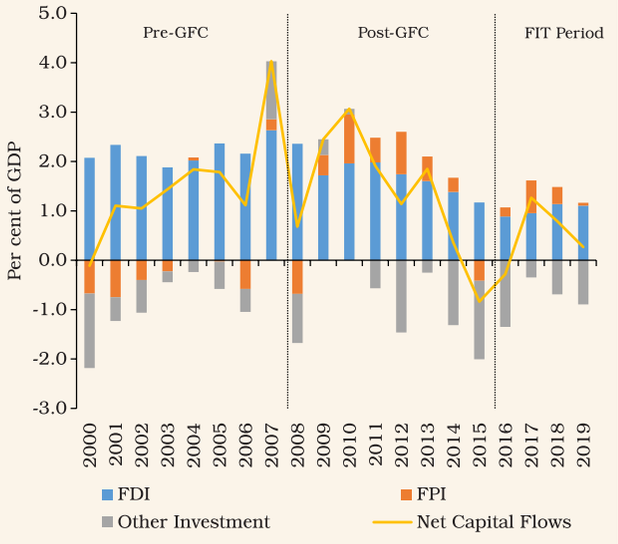


Note: Trade flows include export and import of goods and services; Capital flows include inflows and outflows.



Source: RBI.

Chart V.2: Net Capital Flows to EMEs



Source: IMF.

V.5 On the other hand, India's external vulnerability indicators have improved dramatically, allowing for greater independence of monetary policy from global developments (Table V.1). In particular, the current account balance, the bellwether indicator of India's external viability in view of the historical predominance of trade and remittances in the country's external interface, has strengthened, benefitting from low oil prices during the FIT period and net terms of trade (ToT) turning favourable in 2019-20 (Chart V.3).

Table V.1: India's External Vulnerability Indicators

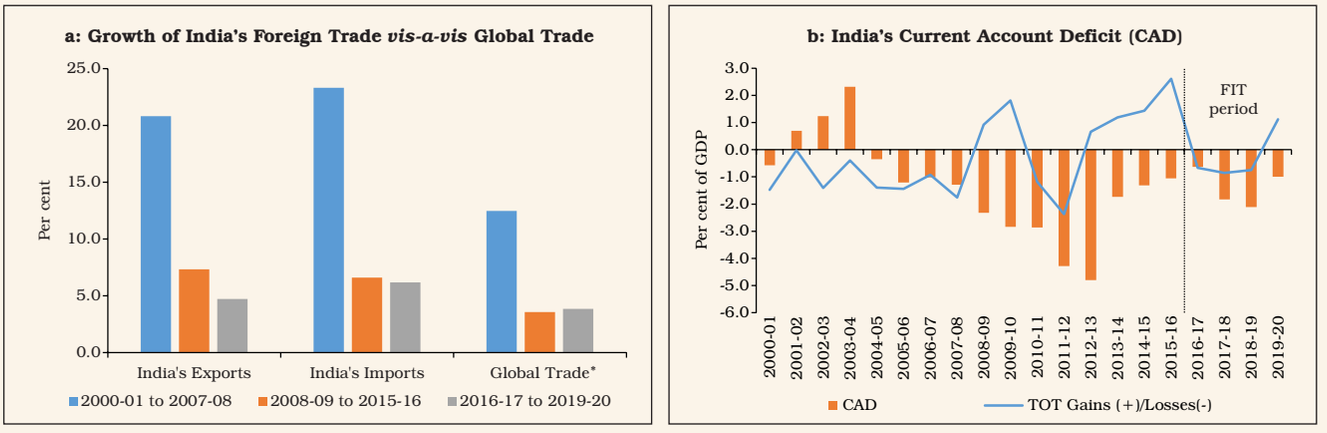
(Per cent, unless indicated otherwise)

Indicator	End-March 2013	End-September 2016	End-March 2020
1. Current Account Balance to GDP ratio*	-4.8	-0.5	-0.9
2. External Debt to GDP ratio	22.4	22.2	20.6
3. Short-term Debt (residual maturity) to Reserves ratio	59.0	54.7	49.6
4. Short-term Debt (original maturity) to Reserves ratio	33.1	21.9	22.4
5. Reserves to Total External Debt ratio	71.3	76.8	85.6
6. Reserve Cover of Imports (in months)	7.0	12.0	12.0
7. Debt Service ratio (debt service to current receipts)	5.9	8.2	6.5
8. Net International Investment Position to GDP ratio	-17.8	-16.9	-13.9

*Average of four quarters.
Source: RBI.

V.6 Net capital inflows exceeded CAD funding requirements during the FIT period. The Indian economy, thus, experienced the problem of poor absorption of saving from abroad that could have complemented domestic savings and worked as a lever for stepping up the pace of growth in a time of abundant global liquidity and ultra-low interest

Chart V.3: India's Foreign Trade during FIT



Note: *Excludes 2009-10 as the world trade declined sharply after the global financial crisis.
Source: RBI and IMF.

Table V.2: Episodes of Excess Capital Inflows

Period	Net Capital Flows		Excess Capital Flows (BoP Basis)	
	> CAD	< CAD		
	No. of Quarters		(US$ billion)	Per cent of GDP
Pre-GFC (2000-01 to 2007-08)	28	4	236.0	4.1
Post-GFC (2008-09 to 2015-16)	21	11	92.2	0.7
FIT period (2016-17 to 2019-20)	12	4	121.3	1.1

Source: RBI.

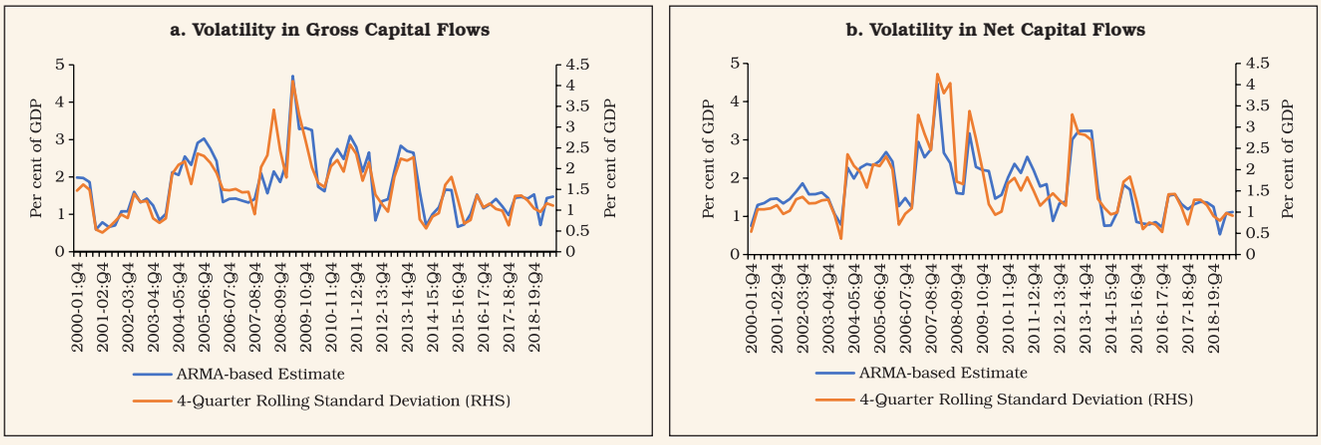
rates. The result was overall balance of payments surpluses and an unprecedented accumulation of India's official reserves (Table V.2). This assumes relevance in comparison with the pre-GFC period when capital inflows averaged about 4.1 per cent of GDP per annum during 2000-01 to 2007-08, coinciding with a phase of high domestic investment rates that peaked at 37.7 per cent of GDP in 2007-08.

V.7 Volatility in capital flows – both gross and net – declined during the FIT period in terms of both standard deviations over a rolling window of four quarters (Engle *et al.*, 2008; Broto *et al.*, 2011; Eichengreen *et al.*, 2017; and Pagliari and Hannan 2017) and standard deviations of residuals obtained from an auto-regressive moving average (ARMA (1, 2)) model to check for the presence of any ARCH effects[1] (Val and Libanio, 2009; Pagliari and Hannan, 2017) (Chart V.4).[2]

3. Exchange Rate Dynamics and FIT

V.8 EMEs have been late movers in the adoption of FIT in view of large exogenous effects of exchange rate volatility on inflation and price competitiveness, embodied in the 'fear of floating' (Calvo and Reinhart, 2002) and 'fear of appreciation' (Levy-Yeyati and Sturzenegger, 2007). This also reflected their large dependence on trade in goods and services and the existence of less developed financial markets (Cavoli, 2009). In practice, most of the EMEs and some AEs have resorted to frequent and large interventions

Chart V.4: Volatility in Capital Flows in India

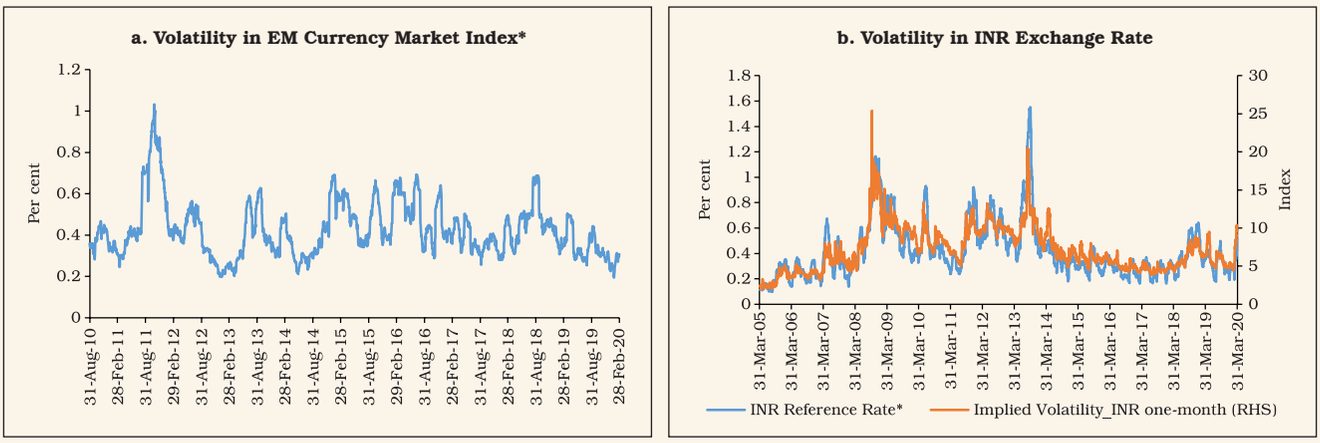


Source: RBI staff estimates.

1 ARCH effects refer to the phenomenon of volatility or variance clustering, where periods of high volatility are followed by periods of higher volatility and period of low volatility are followed by periods of lower volatility.

2 Quarterly data for the period 2000-01:Q1 to 2019-20:Q3 (as per cent of GDP) are used.

Chart V.5: Exchange Rate Volatility



*: 30-day Standard Deviation.
Source: Calculations based on JP Morgan EM Currency Market Index and INR Reference Rate.

in the foreign exchange market to deal with the challenges arising from excessive capital flows and the associated impact on exchange rate volatility (BIS, 2005; IMF, 2011; Berganza and Broto, 2012).

V.9 In India, exchange rate policy aims at containing excessive volatility, without any pre-specified target or band for the Indian rupee (INR). With the decline in volatility of capital inflows (as highlighted in the previous section and Chart V.4), the INR has also exhibited stability during the FIT period (Chart V.5). In India, changes in capital flows emerge as one of the key forces influencing INR volatility (Box V.1).

Box V.1
Drivers of INR Volatility

There is considerable variation across different instruments of capital flows in terms of observed volatility, with net portfolio flows being the most volatile (Table 1).

A six-variable vector autoregression (VAR) model, using quarterly data from 1996:Q2 to 2019:Q4, is estimated. Exchange rate volatility (ERV) is represented by ARMA based residuals (US dollar per INR). Other variables, *viz.*, the current account balance (CABGDP) and net capital flows (both FPI (FPIGDP) and non-FPI (NONFPI) flows) expressed as ratios to GDP, changes in foreign exchange reserves (D(RESERVES)) and GDP growth are also used in the VAR. All variables are found to be stationary. The impulse response paths suggest that INR volatility declines in response to an increase in net FPI flows *vis-à-vis* non-FPI flows (Chart 1).

Table 1: Component-wise Volatility in Net Capital Flows (Coefficient of Variation)

(Per cent)

Period	FDI	FPI	Other Investments	Net capital flows
2000-01 to 2007-08	106	118	95	75
2008-09 to 2015-16	48	153	155	63
2016-17 to 2019-20	43	222	138	46

Source: RBI staff calculations.

The forecast error variance decomposition suggests that change in reserves is the dominant factor in explaining variations in exchange rate volatility (15.1 per cent), followed by foreign portfolio investment flows (13.1 per cent), the current account balance (4.8 per cent), and non-FPI flows and GDP growth (less than 2 per cent each). These results reinforce the volatility smoothing role of the Reserve Bank's foreign exchange interventions and the degrees of freedom that interventions allow for conducting domestic monetary policy.

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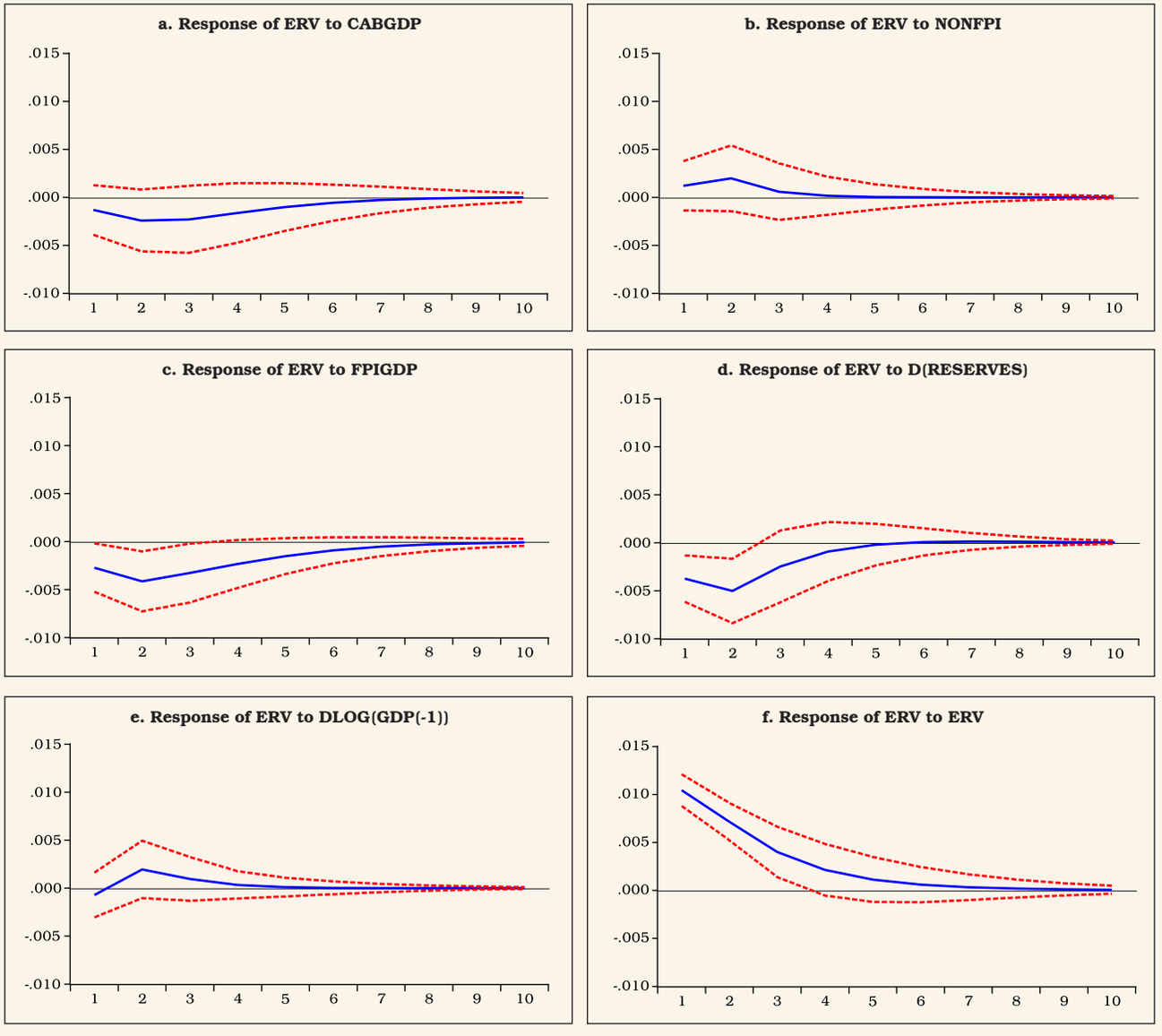
Chart 1: Response Paths of INR Exchange Rate Volatility

Response to Cholesky One S.D. Innovations ±2 S.E.



Source: RBI staff estimates.

References:

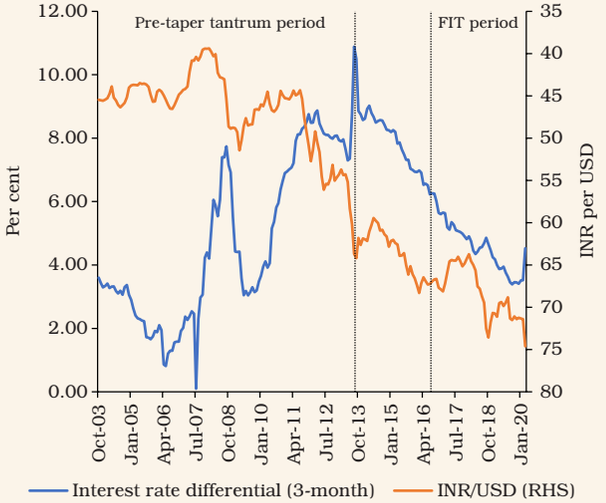
Dua, Pami and Partha Sen (2006), "Capital Flow Volatility and Exchange Rates: The Case of India", *CDE Working Paper No.144*.

Kohli, R (2015), "Capital Flows and Exchange Rate Volatility in India: How Crucial Are Reserves?", *Review of Development Economics,* Vol.19, No.3, pp.577–591.

Rafi, O. P. C. Muhammed and M. Ramachandran (2018), "Capital Flows and Exchange Rate Volatility: Experience of Emerging Economies", *Indian Economic Review*, Vol.53, pp.183-205.

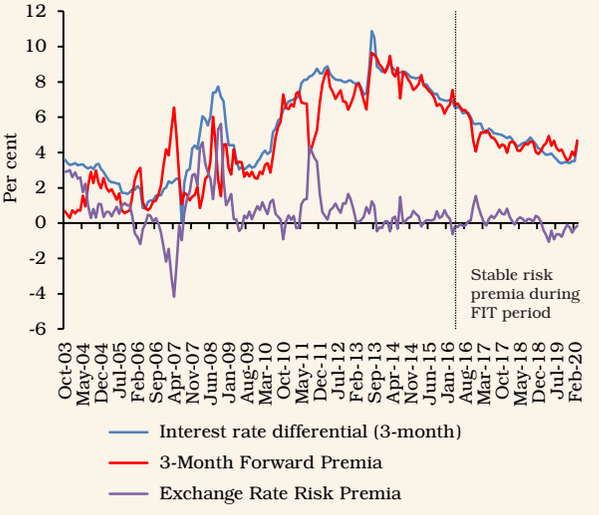
V.10 The sensitivity of INR to monetary policy changes – in India and abroad (in the US as a representative numeraire) – can be examined through the covered and uncovered interest rate parity conditions. The empirical literature on this subject, however, remains divided, with some views emphasizing the role of higher interest rates in attracting foreign capital which, in turn, leads to appreciation of the domestic currency (Dornbusch 1976, Frankel 1979 and Christiano *et al*. 1998), and others interpreting interest rate differential as an indicator of rising inflation, which must reflect in depreciation of the domestic currency in due course (Mussa 1979 and Bilson 1978, 1979). In India, the co-movement between interest rate differentials (based on three-month treasury bill rates in India and the US) and the INR (Chart V.6) does not provide empirical support for uncovered interest rate parity (UIP).[3] The covered interest rate parity is more directly verifiable and holds for the INR in the behaviour of forward premia (Chart V.7). Empirical estimates of determinants of the INR find weak evidence of any role for interest rate differentials; instead global VIX, an indicator of global risk aversion, emerges as a statistically significant determinant (Box V.2).

Chart V.6: Differential in Short-term Interest Rates (India-US) and INR Exchange Rate



Source: RBI and Bloomberg.

Chart V.7: Interest Rate Differentials and Forward Premia on USD/INR



Source: RBI, FBIL and Bloomberg.

V.11 Given the dominant role of capital flows in exchange rate volatility in India and the offset provided by reserve accumulation, it is inevitable that monetary policy design gets strongly influenced by the choice between non-sterilised interventions (and associated implications for domestic liquidity conditions) *versus* sterilised interventions (with associated implications for yields and forward premia). While unsterilised interventions can create surplus liquidity that can depress short-term interest rates to levels lower than the policy interest rate, sterilisation of surplus liquidity through open market operations (OMOs) can influence longer-term yields while the use of swaps to delay the liquidity impact of intervention

3 UIP theory states that the difference between interest rates between two economies should equal the expected change in exchange rate (rather than observed change in exchange rate) to nullify any opportunity for arbitrage gains.

Box V.2
Sensitivity of INR to Risk Premia

In order to analyse the role of interest rate differentials in influencing the risk premium embedded in movements of the INR, the following equation is estimated:

$$ERR_{t,t-3} = \beta 1_t + \beta 2_t * INTD3M_{t-3} + \beta 3 * ETDt + \beta 4 * LOG(CPIt) + \beta 5 * GVIX + \beta 6 * DUM * LOG(CPI) + \varepsilon_t$$

(Interest parity variable) (Risk premia variables)

where ERR is the change in the INR over a 3-month period; INTD3M represents the three-month interest rate differential between India and the US; and ETD is India's excess trade deficit (*i.e.*, trade deficit in excess of average deficit/surplus over past 12 months), CPI is India's consumer price index and the GVIX represents global VIX. An interaction term with a dummy for the CPI relating to the FIT period is used to examine any likely indirect effect on ERR due to change in inflation dynamics post FIT. The empirical results provide no strong evidence of interest rate differentials impacting movements in the INR while the impact of risk premia (GVIX) and excess trade deficit is found to be statistically significant (Table 1). It is possible that the US monetary policy influences the INR through the risk premia channel, but not directly through interest rate differentials.

Table 1: Dependent Variable - Change in Exchange Rate

N=195

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	1.87	4.99	0.38	0.71
INTD3M(-3)	-0.19	0.11	-1.64	0.10
GVIX	-0.07	0.02	-3.88	0.00
ETD(-1)	-0.10	0.05	-1.92	0.06
LOG(CPI)	0.04	1.08	0.03	0.97
DUM*LOG(CPI)	-0.05	0.13	-0.43	0.67
ERR(-1)	1.07	0.06	17.58	0.00
ERR(-2)	-0.52	0.06	-8.63	0.00
R-squared	0.72	F-statistic	68.67	
Adjusted R-squared	0.71	DW Statistic	1.93	

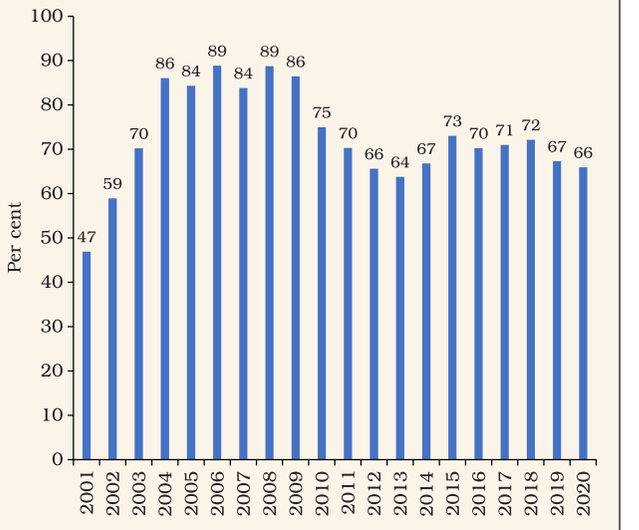
Reference:

Engle, Charles (2016), "Exchange Rates, Interest Rates and Risk Premium", *American Economic Review*, Vol. 106 (2), pp. 436-474.

could alter forward premia. Intervention operations to manage volatility in the exchange rate can thus pose challenges for monetary policy independence by influencing the term structure of interest rates.

V.12 Intervention operations alter the size and composition of the Reserve Bank's balance sheet. Sterilisation is conditioned by the size of domestic securities' holdings available with the Reserve Bank for conducting OMOs to absorb surplus liquidity. During the FIT period, the share of net foreign assets (NFA) has declined below 75 per cent of the Reserve Bank's balance sheet from around 85 per cent before the global financial crisis, creating space for sterilisation to manage the liquidity impact of interventions (Chart V.8). Besides, the high share of NFA induced the Reserve Bank to use multiple instruments such as market stabilisation scheme and cash reserve ratio in addition to open market sales operations for sterilisation purposes.

Chart V.8: Share of Foreign Currency Assets in Total Assets (End-June)



Source: RBI.

Table V.3: Reserve Money and Drivers of Durable Liquidity

(₹ crore)

Year	Change in Reserve Money	Net Forex Purchases by RBI	Net OMO Purchases
2013-14	2,17,856	58,619	52,324
2014-15	1,95,721	3,43,069	(-) 64,014
2015-16	2,52,277	63,087	53,285
2016-17	(-) 2,80,255	78,493	1,11,609
2017-18	5,18,295	2,22,827	(-)87,816
2018-19	3,51,702	(-) 1,11,945	2,99,232
2019-20	2,59,225	3,12,005	1,11,671

Source: RBI.

V.13 In some years, such as in 2017-18, net open market sales were undertaken to sterilise surplus liquidity (Table V.3). In 2018-19, however, a decline in NFA led to contraction in domestic liquidity and hence, the Reserve Bank conducted large open market purchase operations to counter the impact of lower NFA on liquidity and also to meet the normal incremental demand for primary liquidity in the economy. In 2019-20, open market purchases were undertaken to supplement the rupee liquidity generated from forex operations in order to first ensure easy financial conditions to counter the slowdown and in the context of the pandemic towards the close of the year.

V.14 Open market sales for sterilisation can harden yields which, in turn, can attract more yield-differential sensitive capital inflows and cause further addition to liquidity, eventually making sterilisation ineffective. Accordingly, updated estimates of the sterilisation coefficient and the offset coefficient become useful for policy purposes (Box V.3). The sterilisation coefficient indicates the extent of change in net domestic assets (NDA) in the balance sheet of the Reserve Bank that results in response to the change in the NFA. The offset coefficient indicates the change in NFA in response to the NDA-induced change in yields. Both the coefficients vary between 0 and -1. A sterilisation coefficient reaching close to -1 indicates a situation of full sterilisation of the liquidity generated from forex interventions, leaving the reserve money level unchanged. The

Box V.3
Sterilisation Effectiveness during FIT

Sterilisation and offset coefficients are estimated by using the standard model specification that captures the interactions between NFA and NDA in the balance sheet of a central bank (Gupta and Sen Gupta, 2013). In the sterilisation (NDA) equation, a change in NDA is regressed on change in NFA. Other control variables are used, depending on their expected influence on NDA. The estimation is carried out for two sub-periods, *i.e.*, January 2006 to June 2016 and for July 2016 to December 2019.

In the offset (NFA) equation, the change in NFA is regressed on change in NDA. Additional control variables such as the index of industrial production (IIP), the money multiplier (MM), and the interest rate differential between the US federal funds rate and call money rate in India are used, besides a dummy variable for the global financial crisis (Table 1 and Table 2). In NFA and NDA equations, IIP captures the impact of economic activity on capital flows and NDA. The interest rate differential represents the attractiveness of domestic securities for foreign investors in search of yields while the money multiplier serves as a proxy to capture the overall impact of creating or withdrawing reserve money. In the NDA equation, the spread between repo rate and call rate captures the stance of monetary policy as reflected in liquidity conditions.

The estimated results show that both sterilisation and offset coefficients have increased during the FIT period. The sterilisation coefficient at -0.42 suggests that on an average about 42 per cent of the increase in liquidity resulting from increase in the RBI's NFA is sterilised. The

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Table 1: Offset Coefficients (Dependent Variable: NFA)

Variables	Jan. 2006 - Jun. 2016		Jul. 2016 - Dec. 2019	
	Coefficient	p-value	Coefficient	p-value
NDA	**-0.21**	**0.00**	**-0.31**	**0.00**
IIP (-1)	-9.8	0.47	-81.5	0.05
MM	-386	0.21	-1105	0.00
Spread (Call rate – Fed Funds rate)	-22	0.43	-278	0.07
GFC dummy	-183	0.50		
Constant	589	0.01	2183	0.00
NFA (-1)	0.81	0.00	0.76	0.00
Adjusted R^2	0.87		0.84	
DW Statistic	1.70		1.88	

Note: (i) All the variables are taken in first difference form (12-month variation). However, IIP has been used in growth form. Spread has been used without first-difference; (ii) Newey-West estimator-based regression has been used to overcome heteroscedasticity and autocorrelation in the error terms. (iii) Variables used are found to be stationary.

Source: RBI Staff estimates.

Table 2: Sterilisation Coefficients (Dependent Variable: NDA)

Variables	Jan. 2006 - Jun. 2016		Jul. 2016 - Dec. 2019	
	Coefficient	p-value	Coefficient	p-value
NFA	**-0.04**	**0.09**	**-0.42**	**0.00**
IIP (-1)	-15.8	0.02	-36.5	0.21
MM	-798	0.00	-2219	0.00
Spread (Repo rate - Call rate)	-39.9	0.07	-4485	0.05
GFC dummy	414	0.00		
Constant	212	0.01	1659	0.00
NDA (-1)	0.95	0.00	0.36	0.00
Adjusted R^2	0.92		0.94	
DW Statistic	1.87		1.25	

offset coefficient of -0.31 shows partial effectiveness of sterilisation operations. Monetary policy independence is largely preserved in India although the role of sterilisation in this regard is diminishing.

Reference:

Gupta, A. Sen and R. Sengupta (2013), "Management of Capital Flows in India", *ADB South Asia Working Paper Series*, No. 17, Asian Development Bank.

sterilisation coefficient, however, does not convey anything on the effectiveness of sterilisation. This is given by the offset coefficient – a value close to -1 indicates perfect capital mobility, making sterilisation operations completely ineffective. On the other hand, an offset coefficient closer to zero helps in preserving monetary policy independence through sterilised interventions. In India, the size of the estimated offset coefficient has increased during the FIT period to -0.3 from about -0.2 in the pre-FIT period, but remains well below -1, thereby establishing sterilised intervention as an effective instrument for preserving monetary policy independence.

Pass-Through of Exchange Rate Changes to Inflation

V.15 The sensitivity of inflation to exchange rate shocks has a more direct implication for the effectiveness of monetary policy. Since the exchange rate is neither an instrument of policy nor an intermediate target under FIT, a precise assessment of exchange rate pass-through to domestic inflation provides a forward-looking dimension to guide the implementation of monetary policy. In several IT practicing countries, experiences characterised by high volatility in the exchange rate and large pass-through effects may require explicit incorporation of exchange rate shocks as an additional determinant of flexibility within the FIT framework, whether in terms of the tolerance band or the time horizon over which the inflation target could be achieved.

V.16 Available estimates of ERPT for India mostly relate to WPI/CPI-IW inflation (Table V.4). Two estimates which relate to CPI-C inflation suggest an ERPT coefficient of 0.15 over five months (Patra *et al.*, 2018) and 0.10 over four

Table V.4: ERPT Estimates from Select Studies in the Indian Context

Study	Sample Period	Price Index	ERPT Coefficients
Khundrakpam (2007)	Aug 1991 - Mar 2005	WPI	10 per cent change in exchange rate increases final prices by 60 basis points (bps) in short-run and 90 bps in long-run.
Patra and Kapur (2010)	Q2:1996 - Q3:2009	WPI	10 per cent appreciation (depreciation) of the INR *vis-à-vis* the USD lowers (increases) inflation by 50 bps in the same quarter and by 150 bps after seven quarters.
Kapur (2012); Kapur and Behera (2012)	Q2:1996 - Q1:2011	WPI	10 per cent appreciation (depreciation) of INR *vis-à-vis* the USD decreases (increases) inflation by 60 bps in the same quarter, while the long-run ERPT is 120 bps.
Patra, *et al.* (2013-14)	Q2:1996 - Q1:2013	WPI	A 10 per cent change in the exchange rate results in 1.5 per cent change in prices prior to the global crisis and 1.0 per cent change including the post crisis period.
Ghosh and Rajan (2007)	Q1:1980 - Q4:2006	CPI-IW	ERPT elasticity of the INR-USD to CPI is between 45 per cent and 50 per cent and is stable over the sample period.
Bhattacharya, *et al.* (2008)	Sep1997 - Oct 2007	CPI-IW	1 per cent increase in exchange rate increases CPI by 0.10-0.11 per cent in the short-run and 0.04-0.17 per cent in the long-run.
Patra, *et al.* (2018)	Apr 2005 - Mar 2016	CPI-C	About 15 per cent of exchange rate changes are cumulatively passed through to CPI inflation over 5 months timeline, with time varying parameter increasing to above 15 per cent by 2013-14 and declining since then.
Kundu (2019)	Apr 2004 - Sep 2018	CPI-C	Around 10 per cent of exchange rate changes are cumulatively passed through to changes in CPI-C over 4 months.
Cross-Country Studies with India in the Sample			
Jiménez-Rodríguez and Morales-Zumaquero (2020)	Q1:1995 - Q2:2017	CPI-IW	The short-run ERPT is 13 per cent while long run ERPT is not statistically significant.
Choudhri and Hakura (2006)	1979-2000	CPI-IW	1 per cent increase in NEER causes 0.06-0.10 per cent increase in CPI in 1-4 quarters.

months (Kundu, 2019). Updated estimates of ERPT for India using alternative approaches suggest a range of 0.10 to 0.13, with a gradual decline in ERPT during the FIT period (Box V.4).

4. Open Economy Taylor Rule

V.17 Taking into account the stylised facts in Section 2 and the characteristics of underlying inflation dynamics in an open economy in Section 3, this section turns to the implementation of rule-based inflation targeting in an open economy drawing on seminal work (Svensson, 1997; Ball, 1997). In an open economy, monetary policy transmits through both the interest rate and the exchange rate. Accordingly, any monetary policy rule should take into account: (i) the role of real exchange rate changes in explaining output (through net exports) and inflation (through pass-through of import prices to domestic prices and inflation expectations) and (ii) the role of the interest rate in influencing movements in the exchange rate.

V.18 An open economy monetary policy rule, which has attracted intuitive practitioner appeal, can be defined in the form of a monetary conditions index (MCI) (Ball, 1999):

Box V.4
Exchange Rate Pass-Through during FIT

The transmission of exchange rate changes into domestic prices could happen in two stages. In the first stage, a unit change in the exchange rate leads to changes in import prices. In the second stage, import prices cause changes in domestic producer prices which, in turn, can trickle down to consumer prices (Bhattacharya *et al.*, 2008; Aron *et al.,* 2014). Exchange rate pass-through **(**ERPT) to CPI-C inflation is estimated by using a similar two stage approach covering data for 16 years from April 2004 to March 2020 (Table 1).

The results indicate that ERPT accumulated over a duration of 4 months comes to about 0.10-0.11, *i.e.*, about 10-11 per cent of the changes in the exchange rate are cumulatively passed on to the CPI-C in 4 months.[4] The results based on equation 2 indicate that ERPT is higher in the case of depreciation as the coefficient on the quadratic term is positive. Furthermore, the coefficient on the cubic term is also positive, which indicates that ERPT associated with large changes in the exchange rate is lower than with small changes.

A major drawback of the single equation linear ERPT estimates is that the model specification does not take into account the dynamic adjustment of the variables. Therefore, a four-variable structural vector autoregression (SVAR) model with the ordering of variables as Δy_d^t , Δe_t , Δp_d^t, $wacmr_t$ was carried out to validate the already obtained ERPT estimates. The ordering assumes that domestic output growth does not respond immediately to changes in the exchange rate and consumer prices, but output growth and exchange rate movements impact prices contemporaneously. Further, a monetary policy variable, proxied by the weighted average call money rate (WACR), was incorporated with the assumption that monetary policy responds to output growth, consumer prices and exchange rate movements. Global crude oil prices were considered as exogenous variable in the model.

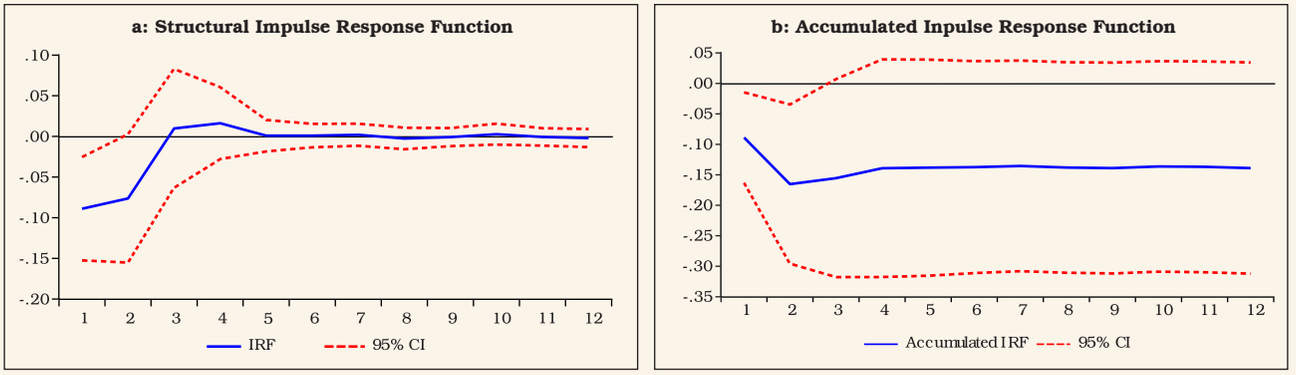
Table 1: Average ERPT Estimates - Dependent Variable Δ(logCPI-C)

Variables	Equation 1	Equation 2
Constant	0.001***	0.001**
	(2.75)	(2.37)
$\sum_{i=0}^{-4} \Delta NEER_{t-i}$	-0.10***	-0.11***
	(-4.28)	(-4.65)
$\sum_{i=0}^{-1} C_i^f$	0.21	0.21
	(1.10)	(1.11)
$\sum_{i=0}^{-2} \Delta IIPOECD_{t-i}$	0.08***	0.09***
	(2.97)	(3.20)
$\Delta Foodprice_t$	0.39***	0.39***
	(18.81)	(19.14)
$\Delta Foodprice_{t-1}$	0.08***	0.08***
	(2.84)	(2.83)
$\Delta Crudeoilprice_{t-1}$	0.004**	0.004**
	(2.07)	(2.16)
ΔGDP_{t-2}	0.01*	0.01*
	(1.65)	(1.66)
$Dummy\_IIPOECD_t$	0.001**	0.001**
	(2.38)	(2.35)
$Dummy\_GDP_t$	0.02***	0.02***
	(10.05)	(10.45)
$\Delta e^2{}_{t-i}$		1.30***
	-	(2.65)
$\Delta e^3{}_{t-i}$	-	34.60***
		(2.46)
Adj. R^2	0.77	0.77
DW Statistic	2.03	2.03
F Statistic	679.22***	572.08***
	[0.000]	[0.000]
Breusch Godfrey LM Test	Prob	Prob
	[chi²(2)]=0.35	[chi²(2)]=0.30
Breusch Pagan Godfrey Test	Prob	Prob
	[chi²(9)]=0.00	[chi²(11)]=0.00
No. of observations	190	190

(Contd.)

4 The study uses p^d as measured by the CPI-C published by the CSO under the MoSPI, GoI. *e* is represented by NEER (based on trade-based weights) published by the RBI. The indicator of foreign price/cost conditions is constructed as: c^f = NEER*CPI-C/REER. y^d is proxied by the CSO's quarterly real GDP series. Using the Denton method on the seasonally adjusted index of industrial production (IIP) of the CSO (taking average IIP as the indicator), the quarterly real GDP series at market prices was converted to a monthly series. IIP of the OECD countries available from the OECD statistics is used to incorporate y^f. p^c is proxied by the global average crude oil prices available from the World Bank Commodity Price Data (The Pink Sheet). Average crude oil prices are also treated as a proxy for domestic cost conditions. CPI-IW food is used for food prices. Variables were converted into their natural logarithms and were seasonally adjusted by the US Census Bureau X-13 ARIMA programme. The lag selection was done through the Schwarz Criterion (SC), Akaike Information Criterion (AIC), and the Hannan-Quinn Criterion (HQC). All variables were stationary at first differences. Dummy variables for IIPOECD and GDP were used to take into account the impact of the global financial crisis (2008-09 to 2010-11).

Chart 1: IRF of Δ(logCPI-C) from a ± 2 Standard Error Shock on Δ(log NEER)

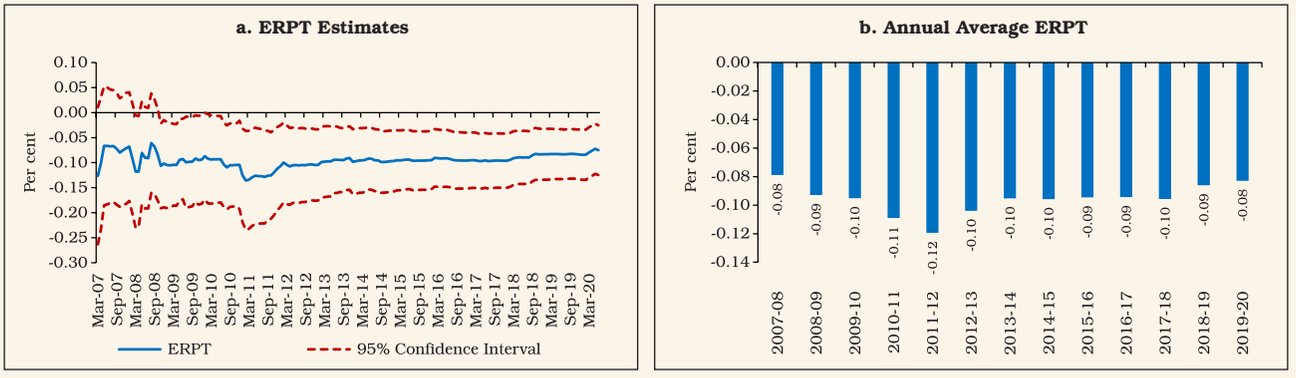


Source: RBI staff estimates.

The results indicate that a change in the exchange rate moves inflation by 16 per cent of the variation in the exchange rate during the first 2 months (Chart 1), which gradually reduces to 13 per cent at the end of a 12-month horizon.

Additionally, a rolling regression over a recursive window of 36 months is used to examine the time-varying nature of ERPT. The control variables remain the same as in the SVAR model, while autoregressive terms of the CPI-C with four lags are incorporated to take into account the intrinsic persistence of inflation (Patra *et al.,* 2014). The results suggest that ERPT has declined from 12 per cent in 2011-12 to 8 per cent in 2019-20 (Chart 2).

Chart 2: Time-varying Nature of ERPT in a Rolling Regression Framework - Dependent Variable Δ(log(CPI-C))



Source: RBI staff estimates.

Reference:

Patra, M. D.; J. K. Khundrakpam and A. T. George (2014), "Post-Global Crisis Inflation Dynamics in India: What has Changed," *India Policy Forum*, Vol. 10, pp.117-191.

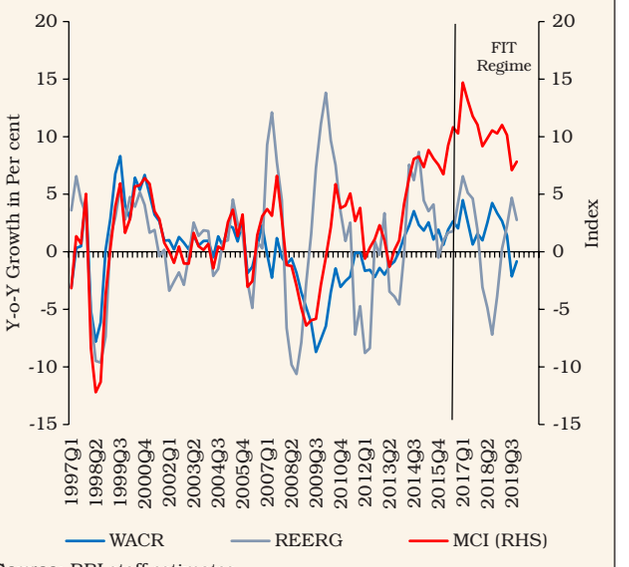
$$wr + (1 - w)e = ay + b\,\pi^{*}$$ [5]

The MCI is measured as a weighted sum of changes (per cent) in the short-term real interest rate relative to a base period and changes in the real effective exchange rate index relative to a base period. The MCI has been used by some inflation targeting central banks such as the Bank of Canada and the Reserve Bank of New Zealand

5 According to Ball (1999), π^{*} stands for $(\pi + \gamma e_{-1})$ where π is inflation, e is log of real exchange rate, y is log of real output and r is real interest rate.

as a short-term operational reference variable. The Bank of Canada generates short-term quarterly paths for desired MCI values, consistent with the quarterly inflation path. In some other countries like Sweden, Norway, Finland and Iceland, the MCI was used as one of several indicators for forming the policy stance (Gerlach and Smets 2000). The estimated MCI for India indicates that monetary conditions remained tighter during the FIT period than in the pre-FIT period (Chart V.9).[6]

Chart V.9: Movement in MCI



Source: RBI staff estimates.

V.19 The MCI is a statistical construct and is unobservable. Moreover, it is confined to monetary conditions as narrowly defined by the joint movements in the interest rate and the exchange rate. In order to set monetary policy, however, a broader array of macroeconomic and financial conditions need to be evaluated to determine the path of the policy instruments. For India, an open economy Taylor rule has been estimated with a global spillover index (GSI) that is constructed on

Box V.5
Open Economy Taylor Rule Estimates for India

An augmented open economy Taylor rule provides a convenient way to check whether domestic monetary policy responds only to domestic goal variables or it responds directly to global spillovers to mitigate proactively their impact on domestic goal variables. When monetary policy responds directly to resist exchange rate pressure, or follows the Fed's actions with policy changes in the same direction, or counters adverse global spillovers directly, it could be viewed as evidence of loss of monetary policy independence.

The model proposed by the Smets and Wouters (2007) is used here to estimate the Taylor-type interest rate rule for India:

$$r_t = \rho r_{t-1} + (1-\rho)\left[\phi_\pi \pi_t + \phi_y \tilde{y}_t\right] + \psi \Delta \tilde{y}_t + \epsilon_t$$

where r_t is the policy rate, π_t is the inflation rate, $\tilde{y}_t$ is the output gap at time period t. This formulation captures persistence in the policy rate or interest rate smoothing. Macroeconomic uncertainties are incorporated by taking the first difference of the output gap. Econometrically,

$$r_t = \theta_1 r_{t-1} + \theta_2 \pi_t + \theta_3 \tilde{y}_t + \theta_4 \tilde{y}_{t-1} + \epsilon_t$$

where

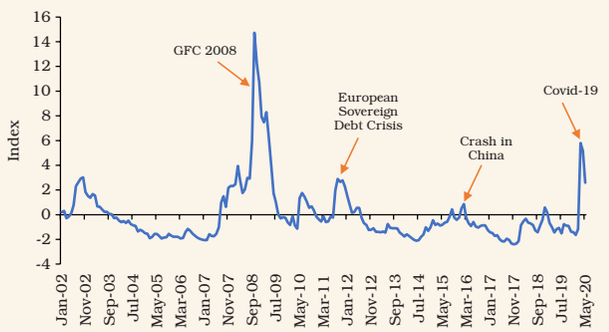
$$\theta_1 = \rho,\ \theta_2 = (1-\rho)\phi_\pi,\ \theta_3 = (1-\rho)\phi_y + \psi, \theta_4 = -\psi$$

A non-linear Taylor rule is estimated (Koustas and Lamarche, 2012). There is an interval of inflation in which monetary policy is accommodative, and the policy rate remains unchanged. Outside the interval, the standard Taylor rule works with different coefficients for above and below the pause interval. An instrument variable method is used to correct for endogeneity arising from aggregate demand and the Phillips curve equation.

(Contd.)

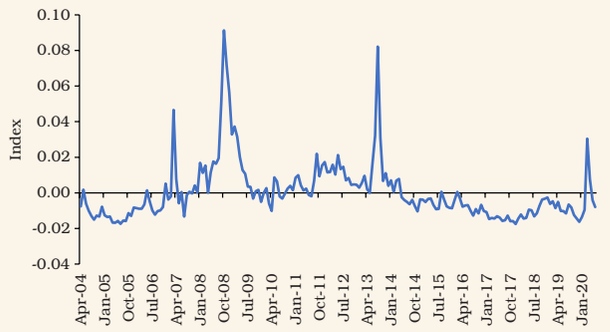
6 The weights w and 1-w for weighted average call rate and real effective exchange rate in MCI are estimated to be 0.65 and 0.35, respectively, and the overall MCI ratio works out to 1.83. A 1 percentage point change in the real interest rate has about the same effects over time on real aggregate demand as a 1.83 percentage point change in the real effective exchange rate.

Chart 1: Global Spillover Index



Source: Bloomberg and RBI staff estimates.

Chart 2: Financial Stress Index



Source: RBI staff estimates.

Quarterly data from 2004:Q2 to 2019:Q4 and an instrument variable GMM methodology have been used, with lags working as instruments to control for endogeneity. Along with inflation and real GDP gap, the standard Taylor rule equation has been augmented with the nominal effective exchange rate, the federal funds rate, the global spillover index (GSI) (Chart 1), and India's financial stress index (FSI) (Chart 2) in alternative specifications.[7]

It is found that monetary policy in India reacts mainly to inflation and the output gap. Domestic monetary policy does not seem to react to global monetary policy and INR exchange rate movements directly, as the relevant coefficients are found to be statistically insignificant. Global spillovers and domestic financial stress do seem to play an important role, however, in influencing domestic monetary policy responses (Table 1).

Table 1: Taylor-type Rule with Global and Financial Stress Variables

Variables	Policy Rate	Policy Rate	Policy Rate	Policy Rate
CPI Inflation Gap	0.175***	0.206***	0.118***	0.0753***
	(0.0397)	(0.0559)	(0.0212)	(0.0192)
Output Gap	0.225**	0.158	0.226***	0.188***
	(0.0928)	(0.106)	(0.0457)	(0.0473)
L. Policy Rate	0.915***	0.910***	0.887***	0.906***
	(0.0589)	(0.0632)	(0.0348)	(0.0400)
L. NEER	0.00214	-0.00149	-0.00566	0.00483
	(0.00565)	(0.00985)	(0.00365)	(0.00684)
L.FSI	-31.26***	-33.10***		
	(6.150)	(7.034)		
L. Federal Funds Rate		0.0360		-0.0476
		(0.0720)		(0.0299)
L.GSI			-0.112***	-0.132***
			(0.0260)	(0.0339)
Constant	-0.00830	-0.0680	0.218	0.414
	(0.359)	(0.411)	(0.206)	(0.350)
Observations	61	61	55	53
Adjusted R^2	0.840	0.835	0.826	0.837
Long-run Coefficient				
Inflation Gap	2.25	2.33	1.09	0.89
Output Gap	2.75	1.78	2.09	2.11

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7 In order to identify global spillovers, a composite global spillover index (GSI) is constructed following Patra *et al.* (2016) with the following five global spillover variables in standardised form (i) VIX, an indicator of risk aversion of the foreign investors; (ii) LIBOR-OIS spread, an indicator of liquidity stress in the overseas market and risk of default in short-term lending; (iii) DXY- the dollar index, capturing the exchange rate channel of global spillovers; (iv)Term-spread, or the difference between 10-year US treasury bill yield and 3-month US treasury bill yield; and (v) Risk-spread, which is the 10-year US treasury bill yield subtracted from 10-year US corporate bond yield. A dynamic factor model (DFM) is used to estimate the GSI for India (Stock and Watson, 2016). The constructed GSI for India captures reasonably well the various phases of stress in global financial markets and their spillover to Indian markets (Chart 1). A high value of GSI indicates turbulence in the global financial markets. The financial stress index (FSI), which is also used in the Taylor rule, reflects a composite measure of stress in various domestic financial market segments at any point in time (Chart 2). The FSI is constructed capturing both source of stress, *i.e.*, external *versus* domestic.

the basis of the sensitivity of domestic financial markets to global financial stress/spillovers (Box V.5), nominal/real effective exchange rates, the federal funds rate and a composite indicator of domestic financial stress that combines pressures in four markets – equity, bond, forex and money – by using a dynamic factor model. Empirical estimates show that while both the inflation gap and output gap play statistically significant roles in determining the path of the policy interest rate, neither the exchange rate nor the federal funds rate seems to have any statistically significant influence on monetary policy rate decisions in India. Monetary policy is, however, found to be sensitive to both global spillovers and domestic financial stress.

5. Conclusion

V.20 India's observed pattern in capital flows to GDP ratio during the FIT period reflects the generalised moderation in capital flows to EMEs. Compared with interest rate differentials, time varying risk premium – which is a function of global as well as domestic factors – appears to be a major driver of INR volatility. The monetary policy rate is not found to respond directly to exchange rate movements or the federal funds rate, although the conduct of monetary policy is sensitive to financial shocks, both global and domestic. Estimates of ERPT suggest some moderation during the FIT period, but inflation can still alter by 10-13 per cent of the change in exchange rate, warranting that the exchange rate be closely monitored as a key information variable for the conduct of monetary policy.

V.21 Sterilised intervention is an effective solution to manage the trilemma in India. Enhancement of sterilisation capacity may be necessary to deal with possible surges in capital flows in future. Activation of the standing deposit facility (SDF) can address the security availability constraint of RBI for undertaking sterilisation operations, but market-based sterilisation instruments are required to avoid misalignment of the operating target relative to the policy repo rate. Adequate provisions for market stabilisation scheme (MSS) securities in the Union Budget every year may be necessary to strengthen monetary operations of the RBI, consistent with the level of international reserves that is considered conducive for managing exchange rate volatility. The precautionary requirements for building adequate buffers against global spillovers is a public policy objective, and not confined to the realm of monetary policy alone.

V.22 In the absence of budgetary allocations of marketable securities for the conduct of monetary policy in an open economy context, lessons can be drawn from the practice of several central banks that issue their own securities to effectively pursue goals set for monetary policy in the face of large autonomous increase in surplus liquidity due to capital flows. Globally, many advanced country central banks, such as Switzerland, Japan and Sweden issued their own securities to absorb surplus liquidity in the aftermath of GFC. Among the EMEs which have adopted an inflation targeting framework, the Bank of Indonesia pioneered the use of central bank securities even before the Asian financial crisis of 1997. Other inflation targeting central banks which issue their own securities include Thailand, Mexico, Israel, Peru and Chile. For a majority of central banks, their respective legislations allow them to issue their own securities. The option of issuance of its own securities by the RBI, currently prohibited under section 19(5) of the RBI Act 1934, may be explored by amending the Act suitably.

V.23 Sustained accretion to foreign exchange reserves in recent years has improved reserve

adequacy in terms of conventional metrics such as cover for imports and short-term debt. Reserve cover for imports is still lower, however, than other major reserve holding economies. Moreover, in an extremely stressed environment in which external obligations become callable, about half of the reserves can be potentially encumbered for repayment of short-term debt by residual maturity (*i.e.*, falling due over the next twelve months) (Annex V.1). Going by the post-taper tantrum experience, *i.e.*, sudden shifts in market assessment of adequacy and self-fulfilling multiple equilibria in the exchange market, the foreign exchange reserve buffer needs to be strengthened further.

V.24 Looking ahead, the emergence of INR as an international currency appears inevitable. While greater internationalisation of the INR can lower transaction costs of cross-border trade and investment operations by mitigating exchange rate risk, it can also complicate the conduct of monetary policy. Internationalisation of a currency makes the simultaneous pursuit of exchange rate stability and a domestically oriented monetary policy more challenging, unless supported by large and deep domestic financial markets that could effectively absorb external shocks. By broadening the scope for both residents and non-residents to buy and sell domestic currency denominated financial instruments, internationalisation can potentially limit the ability of the central bank to control domestic money supply and influence interest rates as per domestic macroeconomic conditions.

V.25 Besides deep and sophisticated financial markets, the most important pre-requisite for internationalisation of a currency is price stability. Inflation, higher than the world average, undermines the use of a currency as an international medium of exchange and a store of value and can restrict the role of such an economy in global value chains. While high inflation disincentivises cross-border trade and investment by enhancing the cost of acquiring information for pricing, stable prices build confidence of international investors in the domestic currency. In India, the primary focus of FIT on price stability augurs well for further liberalisation of the capital account and internationalisation of the INR.

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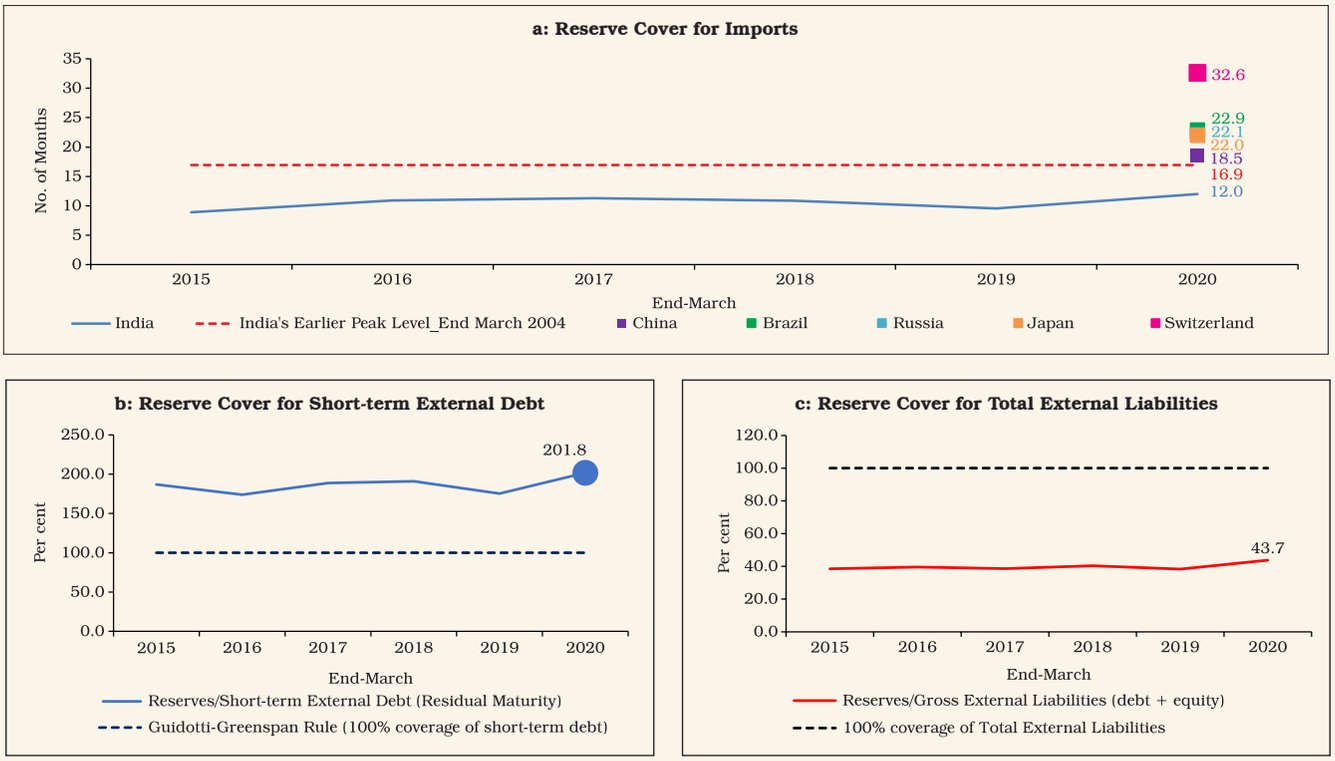
Annex V.1: India's Reserve Adequacy Indicators – A Comparison with Benchmarks



Source: RBI and CEIC.