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Taper Talk Impact on the Rupee: Preconditions for the Success of an Interest Rate Defence of the Exchange Rate

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The Reserve Bank of India (RBI) used exceptional monetary measures to address the taper tantrum-induced exchange market pressure on the rupee in the third quarter of 2013. This paper provides theoretical and empirical justifications for using the monetary policy to defend the exchange rate under exceptional circumstances, and also outlines certain preconditions which may determine the success of such a policy response. The empirical hypothesis on the effectiveness of an interest rate defence has been examined using four alternative approaches: first, the conventional monetary approach to exchange rate; second, uncovered interest rate parity (UIP) condition in the presence of time-varying risk premium; third, impact assessment in a vector auto regression (VAR) framework; and fourth, a comparative quantitative assessment of the costs associated with depreciation of the rupee relative to a higher interest rate for the Indian corporate sector in a panel regression framework. The scope for different policy inferences that could be derived from the results of alternative approaches highlight the need for a careful assessment of preconditions while designing and applying monetary measures to stabilise the exchange rate.

Keywords: Exchange Market Pressure, Interest Rate Defence, Spillovers, Monetary Approach, Uncovered Interest Rate Parity (UIP), Exchange Rate, Taper Tantrum.

JEL Classification: E43, E52, F41

Section I
Introduction

The Indian rupee came under intense pressure after the US Fed's taper talk in May and June 2013. The rupee depreciated by more than 19 per cent over a

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short time span of just about three months, from Rs. 55.34 per US dollar on May 21, 2013 to Rs. 68.64 per US dollar on September 3, 2013. The RBI responded with explicit and direct use of exceptional monetary policy measures – during mid-July to September 2013 – to contain the pace of depreciation of the rupee and arrest its unidirectional free fall. The exceptional monetary measures effectively aimed at raising money market interest rates by 300 basis points and also restricting access to liquidity from the RBI for the banking system.

The pre-crisis emerging consensus that a flexible exchange rate regime enhances the scope for an independent conduct of monetary policy faced the test of time, because addressing exchange market pressure emerged as the predominant near-term policy objective in the immediate aftermath of taper talk, in view of significant risks to other macro objectives – inflation, growth and financial stability in particular – from large and sudden depreciation of the rupee. Restoration of exchange rate stability became an explicit short-term intermediate objective of monetary policy in the pursuit of its ultimate goals.

This paper examines empirically the effectiveness of RBI's exceptional monetary policy measures in addressing exchange market pressure on the Rupee after the taper talk. Section II reviews related theoretical arguments to underscore the point that a text book version of monetary policy defence of the exchange rate still makes sense, and that it should be a rational policy choice for central banks, when circumstances so demand, particularly in the event of an intense exchange market pressure triggered by external spillovers. An assessment of necessary preconditions for the success of an interest rate defence of the exchange rate is set out in Section III, taking into account lessons from India's experience with managing the exchange market pressure in the post-taper talk period.

While the RBI used a combination of exceptional monetary measures, forex market interventions and capital controls (besides specific targeted policy measures to reduce gold imports, shift temporarily a part of the forex demand of oil marketing companies from the market, and attract large foreign capital under two innovative swap schemes for NRIs and banks), the focus of this paper is only on monetary policy measures, notwithstanding the fact that all the other measures would have worked together with monetary measures in stabilising the exchange rate, and that it may be difficult to disentangle the impact of monetary measures alone from the impact of other measures.

Section IV deals with an empirical assessment of the effectiveness of the RBI's exceptional monetary measures in stabilising the exchange rate. The first part examines the role of past accumulated monetary imbalances in contributing to the depreciation of the rupee following the monetary approach to exchange rate. The second part makes an assessment of the impact of a tighter interest rate policy on exchange rate of the rupee in a vector auto regression (VAR)

framework. The UIP puzzle is also examined taking into account the role of time-varying risk premium, which seems to have been highly sensitive to spillovers from unconventional monetary policies (UMPs) in advanced countries (AEs) and subsequent announcements relating to normalisation of UMPs.

The third part checks for the sensitivity of corporate profitability to interest rate and exchange rate shocks in a panel regression framework, in view of the policy trade-off confronting monetary policy amid intense exchange market pressure between allowing sustained depreciation of the exchange rate and resisting depreciation through an interest rate defence, both of which entail costs for the corporate and the economy. Concluding observations are presented in Section V.

Section II
Why Tight Monetary Policy is a Rational Policy Choice to Stabilise the Exchange Rate?

The role of monetary disequilibrium as a determinant of exchange rate in a flexible exchange rate regime could be traced to the monetary approach to balance of payments under a fixed exchange rate regime. As per the monetary approach to balance of payments, "... balance of payments deficit or surplus reflects stock disequilibrium between demand and supply in the market for money" (Johnson, 1976). According to the strong version of the monetary approach, balance of payments is a monetary phenomenon under a fixed exchange rate regime, and exchange rate is a monetary phenomenon under a flexible exchange rate regime. In a flexible exchange rate regime, the role of monetary disequilibrium in explaining movements in exchange rates could be ascribed to three key assumptions: *(a)* a stable money demand function; *(b)* purchasing power parity (PPP); and *(c)* uncovered interest rate parity.

Empirical research on exchange rate is replete with references to different measures of monetary disequilibrium to study the role of money in driving the path of an exchange rate. According to the "money view" of exchange rate, or the monetary approach to exchange rate, easy money – interpreted in the conventional sense in terms of money supply exceeding the demand for it, and in the contemporary sense in terms of the monetary policy interest rate stance being too expansionary or inflationary relative to an optimal rule-based interest rate path – is a prime factor behind exchange market pressure. Depending on the key assumptions – particularly the impact of monetary disequilibrium on domestic inflation and asset prices, degree of openness to cross-border capital flows, and the expectations formation process – the evolution of the exchange rate path in a flexible exchange rate regime may vary.

The real life outcome, which is often contrary to what the monetary approach suggests, could be due to the overwhelming shift from explicit monetary

targeting (under which money stock disequilibrium is the key determinant of inflation and exchange rate) to a monetary policy operating framework under which monetary policy stance is conducted by changing the policy interest rate, and liquidity conditions are calibrated appropriately to ensure that money market rates remain aligned to the policy rate, thereby making money supply an endogenous process. The demand for liquidity is fully accommodated to avoid overshooting of money market rates in both upward and downward directions.

Given the emphasis on use of interest rate as an instrument for indicating the stance of monetary policy, the impact of a money supply shock as opposed to an interest rate shock on the exchange rate needs to be examined carefully. For example, because of an increase in money supply (as the policy shock), if nominal interest rate declines, then depreciation of the exchange rate could be consistent with both higher money supply and lower nominal interest rate. In this case, expansion in money is the cause, and decline in interest rate and depreciation of the exchange rate are the effects. However, if interest rate is raised (as the policy shock), then it can depress the demand for money, leading to excess money in the system (with unchanged money supply), and therefore, depreciation of the exchange rate. Thus, depending on whether a change in the interest rate is the cause or the effect, the impact on exchange rate could reverse. In one case, lower interest rate (resulting from higher money supply) can lead to depreciation, whereas in another case, higher interest rate (as a policy decision) can lead to depreciation. The latter result is consistent with UIP.

The role of the asset market has increasingly become the key to understand movements in any exchange rate, contrary to the traditional view that emphasized the role of demand- supply mismatch in foreign exchange, primarily driven by equilibrium conditions linked to trade in goods. The asset market view is dominated either by the monetary disequilibrium view (with money seen as the key financial asset and relative supply-demand mismatch in money driving the exchange rate) or the portfolio balance view (with relative money market conditions, in terms of interest rate/return differentials and the associated portfolio shifts conditioning the movements in exchange rate). In recent decades, with central banks generally conducting their monetary policies by altering interest rates, the relationship between interest rate and exchange rate has received greater focus of empirical research, a very common feature of this being the emphasis given to test whether the "uncovered interest rate parity (UIP)" holds, and to explain the "UIP puzzle" in country/time specific context.

As per the UIP, if a country has higher interest rate relative to the rest of the world, its exchange rate should be expected to depreciate. What one often gets in real life, however, is that higher interest rates lead to currency appreciation, and hence the UIP puzzle. The UIP puzzle has several explanations, such as imperfect asset substitutability, non-rational expectations, time-varying risk

premium and the peso problem (i.e. when market prices reflect the low probability of a large change). It is a fact that UIP (as presented in Equation A) assumes perfect capital mobility and domestic and foreign bonds as perfect substitutes. As a result, risk premium is also assumed to be zero. In reality, however, risk premium is both non-zero and time varying; i.e. foreign investors in EMEs would expect a risk premium, and their "risk on-risk off" behaviour could make the risk premium time-varying, which in turn could be influenced by both domestic and external macro-financial developments, including monetary policies. The relevant UIP condition could therefore be as shown in Equation B.

$$\text{Risk neutrality: } r_t = r_t^* + \Delta e_{t+1} \text{ or, } r_t - r_t^* = \Delta e_{t+1} \quad \text{(A)}$$

For empirical testing, Equation A could be represented as:

$$\Delta e_{t+1} = \alpha + \beta (r_t - r_t^*) + \varepsilon_t \quad \text{(A1)}$$

If UIP holds, then $\alpha = 0$, $\beta = 1$, and ε_t is stationary. In empirical research, however, β is often wrongly signed with a value different from 1, posing the puzzle.

$$\text{Risk aversion: } (r_t - r_t^*) - RP = \Delta e_{t+1} \quad \text{(B)}$$

where r_t is domestic interest rate at time t, r_t^* is foreign interest rate, Δe_{t+1} is expected change in domestic exchange rate at time t+1, and RP is risk premium. When time-varying RP becomes a key determinant of Δe, the expected UIP relationship between $(r_t - r_t^*)$ and Δe may not hold. As a simple and straightforward interpretation of Equation B one could say that as long as RP is positive, but less than $(r_t - r_t^*)$, the exchange rate may still depreciate, but the depreciation would be less than $(r_t - r_t^*)$ in magnitude. The policy inference from this could be that: *(a)* if the exchange rate is under pressure to depreciate and exchange rate expectations point to a unidirectional free fall, then $(r_t - r_t^*)$ must be raised by increasing r_t; and *(b)* if RP demanded by foreign investors increases, that too when the exchange rate is expected to depreciate, it would also require further increase in $(r_t - r_t^*)$, through higher r_t.[1]

In the context of cyclical waves in capital flows, when surges in capital inflows exert appreciation pressure, foreign investors get adequately compensated for the risk premium they demand, through positive interest rate differential as well as appreciation of the exchange rate, which jointly yield higher returns in US dollar terms relative to $(r_t - r_t^*)$. During episodes of sudden stops/capital

1. According to Kraay (2000), "A classic example in support of the conventional wisdom is the response to the attack on the Swedish krona in the summer of 1992. Between July and August, speculative pressures against the krona resulted in a loss of nearly one-quarter of the reserves of the Swedish central bank. To stem the outflow, the central bank's marginal lending rate was raised to an incredible 500 per cent on September 17 and 18, and hovered in the vicinity of 50 per cent for the next week. Reserve losses were promptly halted, and the krona's peg was maintained."

flight, however, expected depreciation and increase in risk premium demanded by foreign investors can depress returns in US dollar terms significantly – often to negative territory – unless offset fully by large increase in $(r_t - r_t^*)$. Interest rate defence of the exchange rate, thus, has a robust theoretical underpinning.

For empirical testing, Equation B could be represented as:

$$\Delta e_{t+1} = \alpha + \beta(r_t - r_t^*) + \mu RP + \varepsilon_t \quad \text{(B1)}$$

According to Li, Ghoshray and Morely (2012), risk premium could be decomposed into a constant component and a time varying component, and Equation B1 could accordingly be represented as:

$$\Delta e_{t+1} = \alpha + \beta(r_t - r_t^*) + \mu\sigma_{t+1} + \varepsilon_t \quad \text{(B2)}$$

Where α is the constant component of risk premium, and μ is the coefficient of time-varying component of risk premium (proxied by conditional standard deviation[2]). When both α and μ are zero or close to zero, risk premium is zero. In turn, if α is non zero and μ is close to zero, then that indicates the presence of only the constant component of risk premium. If α is close to zero but μ is significantly non-zero, that points to the presence of time-varying risk premium. In emerging economies, RP may be generally positive and therefore, there may be a negative relationship between RP and Δe_{t+1}. For investing capital in emerging markets, investors would expect to get a rate of return higher than the interest rate differential, which will be possible only if the exchange rate appreciates. This generally happens during episodes of surges in capital inflows.

The relationship may reverse, however, during episodes of sudden stops, because expected depreciation (either because of weak fundamentals or adverse external spillovers) will invariably coincide with demand for higher risk premium (as a compensation for higher risk), leading to sustained actual depreciation and expectations of further depreciation. A virtuous cycle (of appreciation and low expected risk premium) can turn into a vicious one (of depreciation and rising expected risk premium), but in both phases assessing the relationship between interest rate differentials, exchange rate and time-varying risk premium would be important for designing and conducting timely policy interventions.

In the context of the taper tantrum, one may need to recognise that risk premium could be both endogenous and exogenous, and therefore, before using an interest rate defence policy, one needs to assess the role of endogenous risk premium properly. As outlined by Goldfajan and Baig (1998), when foreign investors invest in a country, their expected return [E(R)] would take into

2. Time-varying risk premium may remain hidden in the errors when UIP is specified as Equation A1, and the high correlation between risk premium hidden in errors and changes in exchange rate could yield biased estimates of β.

account the nominal interest rate (r), expected risk premium (RP) above the risk free rate (r) and also the probability of default, adjusted for the expected depreciation of the exchange rate:

$$E(R) = r + E(\Delta e) + RP \quad (C)$$

If a high interest rate policy leads to corporate defaults and dampens growth prospects of the economy (which in turn lowers corporate net worth and earnings outlook), expected return has to be adjusted down mirroring possible increase in corporate defaults. This would indicate that a part of the risk premium could as well be endogenous:

$$E(R) = r + E(\Delta e) + RP(\text{exogenous}) + RP(\text{endogenous}) \quad (C1)$$

One could view the increase the in risk premium resulting from taper tantrum induced spillovers as exogenous, and the increase in risk premium due to adverse implications of the RBI's exceptional monetary tightening for corporate profitability and default as endogenous.

It is not necessary that the endogenous risk premium must always increase with the use of exceptional monetary tightening, because exchange rate depreciation may be a greater risk to corporate profitability than higher interest rate. There may be a trade-off between depreciation and higher interest rate, and at times, gains from preventing a depreciation may outweigh costs associated with a higher interest rate for corporates. However, if a higher interest rate policy fails and the exchange rate continues to depreciate, then there would not be any trade-off. Both high interest rate and depreciation could amplify the probability of default, in which case use of exceptional monetary measures would not represent an appropriate policy option.

A review of the above theoretical perspectives point to the need for revisiting the key policy question – *whether exchange rate is just a channel of monetary policy transmission or an objective of monetary policy*?. The exchange rate variable in the conduct of monetary policy may be viewed differently during abnormal times compared with normal times. In normal times, by stabilising the output around its potential and ensuring price stability, monetary policy would automatically contribute to exchange rate stability. In terms of the standard new Keynesian framework used to guide the conduct of monetary policy, in essence, exchange rate should neither appear in the Taylor type interest rate rule equation nor in the central bank's loss function.

In abnormal times, however, exchange rate volatility itself may become a risk to the goals of price stability, growth and financial stability. In such a situation, the exchange rate may have to be explicitly recognised as an objective – and possibly the predominant short-run objective – i.e. stabilise the exchange rate first to be able to stabilise the output gap and inflation in the medium-run. Thus, in normal times, low and stable inflation and zero output gap stability

objectives may be the means to stabilise the exchange rate. In exceptional periods, however, exchange rate stability may be the means to stabilise output and inflation, i.e. to avoid large output and employment loss associated with an exchange rate crisis and also contain the risk of getting embroiled in an inflation-depreciation vicious cycle.[3]

Section III
Preconditions for the Success of an Interest Rate Defence of the Exchange Rate – Lessons from the Indian Experience

The sudden and significant change in global monetary and financial conditions following the Fed's taper talk spilled over to the Indian markets, which was manifested in the form of sustained (almost) daily outflows of foreign capital and deteriorating confidence of foreign investors, on the back of an already vulnerable domestic macroeconomic environment. Portfolio outflows by foreign institutional investors (FIIs) from the debt segment of the capital market continued over successive days, and daily outflows on some of the days were in the range of USD 300 million to USD 600 million. Despite caps on maximum FII investment in sovereign debt and corporate debt[4] – aimed at limiting the country's exposure to the risk of sudden outflows – because of sustained outflows over successive days, the outstanding FII investment fell almost by half in both government securities and corporate debt.[5] Revision in the assessment of risk

3. According to the BIS Quarterly Review, March 2014, in 16 out of 20 emerging economies, the US monetary policy had a significant effect over and above domestic conditions (i.e. inflation and output gap) in setting their domestic monetary policy, with US interest rate as an explicit variable in their estimated Taylor rules coming statistically significant. On an average, domestic interest rates were about 150 basis points lower in these countries on account of quantitative easing in the US, which served the purpose of avoiding surges in QE-driven capital inflows. Taylor (2013) also documented evidence on the US interest rate coming statistically significant in the Taylor rules for both advanced and emerging economies, though he concluded that such monetary policy responses to the US monetary policy could only amplify global spillovers.

4. Around the time of the taper talk, the limit/cap for FII investment in government securities was USD 30 billion (USD 20 billion excluding sovereign wealth funds and others) and in corporate bonds it was USD 52 billion. Actual outstanding investment just before the taper talk in May 2013 was about USD 18 billion and USD 26 billion, respectively. Thus, sudden outflow of about USD 44 billion was possible in the absence of policy measures to stem outflows. These outflows were driven by two factors: *(a)* yield differential turning adverse for India after the taper talk, and *(b)* increase in expected risk premium for staying invested in India. An increase in domestic yield engineered through tighter monetary policy to compensate for both factors, thus, became necessary.

5. Hardening of domestic yields entailed significant mark-to-market (MtM) losses for FIIs. In an environment of sustained fall in the exchange rate of the rupee, early exit as a cut-loss strategy propelled and sustained the FII outflows. Recognising the risk of large MtM losses to banks on their investment portfolio, the RBI provided prudential relaxations for a limited period (details of which are set out in the RBI press release dated August 20, 2014). This highlights one major first round trade-off cost for financial stability stemming from an interest rate defence of the exchange rate, with the second round and more significant effects operating through the impact of a higher interest rate on corporate sector performance and the overall growth outlook, and therefore, on asset quality.

and risk-adjusted return prospects, on the back of a depreciating rupee, had also triggered FII outflows from the equity segment of the capital market, which amplified the impact of initial yield differential-induced capital outflows on the exchange rate.

The yield differential turned adverse for India with the hardening of long-term yields in the US by more than 100 bps (Chart 1). To offset the decline in yield differential (between 10-year G-sec yields in India and the US) from more than 6.2 per cent before May 2013 to less than 5 per cent in June and July 2013, temporary increase in domestic yields by a minimum of 120 bps became necessary (assuming unchanged risk premium). However, due to sudden increase in risk premium, the required magnitude of increase in domestic yield had to be more than 120 bps. The RBI, accordingly, aimed at raising the effective policy rate by 300 bps – from an effective policy repo rate of 7.25 per cent to an effective policy marginal standing facility (MSF) rate of 10.25 per cent – on July 15, 2013 (Please see Appendix Table 1 for details of specific exceptional monetary measures).

Chart 1
Yield Differential (10-year G-sec: India-US) and Exchange Rate Movement

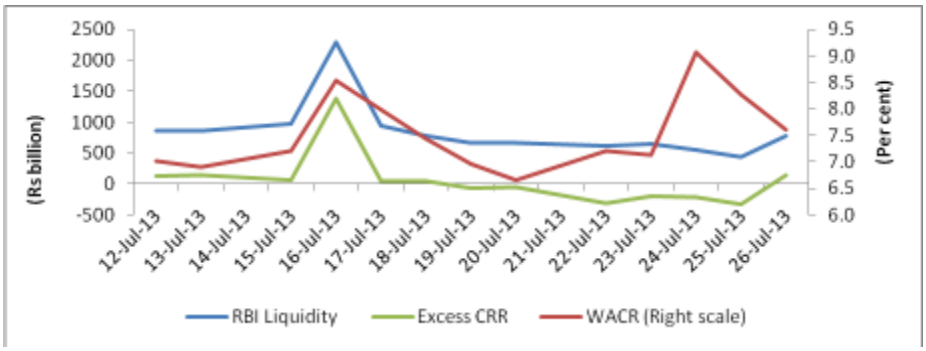
Source: Bloomberg

Several challenges had to be faced in making the MSF rate as the effective policy rate, and more importantly, in ensuring that 300 bps increase in interest rate quickly delivered the goal of stabilising the exchange rate. The first challenge had to be addressed through quantitative tightening of liquidity to ensure that money market rates gravitate quickly from around the repo rate to the MSF rate. The second challenge was to assess, as a policy strategy, whether 300 bps tightening could be sufficient.

As regards the first challenge, the July 15, 2013 liquidity tightening measures became largely ineffective because, while the policy was announced on July

15, it became effective from July 17, which allowed banks adequate time to borrow as much as necessary and possible on July 16 to meet the reserve requirement for the entire fortnight (Chart 2). Because of the fortnightly average reserve requirement norm, with a high reserve level maintained on one single day by borrowing maximum liquidity from the RBI on July 16, banks did not have to borrow enough from the money market on subsequent days of the fortnight to meet the reserve requirement, which kept the money market rates depressed, at much below the MSF rate throughout the fortnight. The key lesson from the July 15 experience is that monetary policy measures aimed at addressing exchange market pressure should become effective immediately, as and when the policy is announced, leaving no time for the markets to take advantage and dilute its impact.[6]

Chart 2
Impact of July 15 Liquidity Tightening Measures Diluted by Implementation Lag



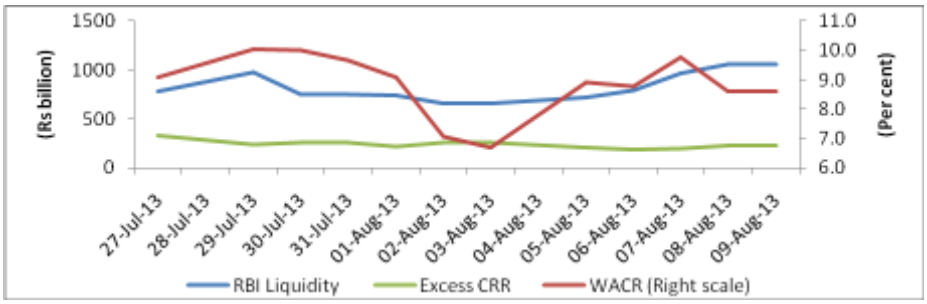
Source: Reserve Bank of India.

The July 23rd measures, which aimed at increasing reserve demand by tightening the cash reserve requirement (CRR) norm – from daily minimum of 70 per cent of the fortnightly average to daily minimum of 99 per cent – was also diluted by large increase in government expenditure (or decline in government's cash balances with the RBI), amounting to autonomous infusion of liquidity by the government when the RBI was using discretionary liquidity tightening measures to push up money market rates closer to the MSF rate. As may be seen from Chart 3, banks did maintain excess reserves throughout the

6. As announced on July 15, an open market sale auction of Rs 12,000 crore was announced to tighten liquidity conditions. But despite receiving bids of Rs 24,270 crore, only Rs 2,532 crore was accepted, possibly with a view to avoiding significant hardening of sovereign yields. As explained in the previous section, for an interest rate defence policy to work, given the particular importance of yield differential in driving capital outflows, along with money market rates even G-sec yields needed to harden adequately mirroring the 300 bps effective increase in the policy rate, which, however, did not materialise.

fortnight (above the required reserves to avoid default on any single day), but the weighted average call rate – the operating target of monetary policy – remained below the MSF (10.25 per cent) rate on most of the days. Lessons from the July 23rd measures suggest the need for better coordination between the RBI and the government while using monetary measures to address exchange market pressures, given the significant role of changing cash flows of the government for the domestic market daily liquidity conditions.

Chart 3
Impact of July 23rd Liquidity Tightening Measures Diluted by Improvement in Liquidity on Account of Increase in Government Expenditure



Source: RBI

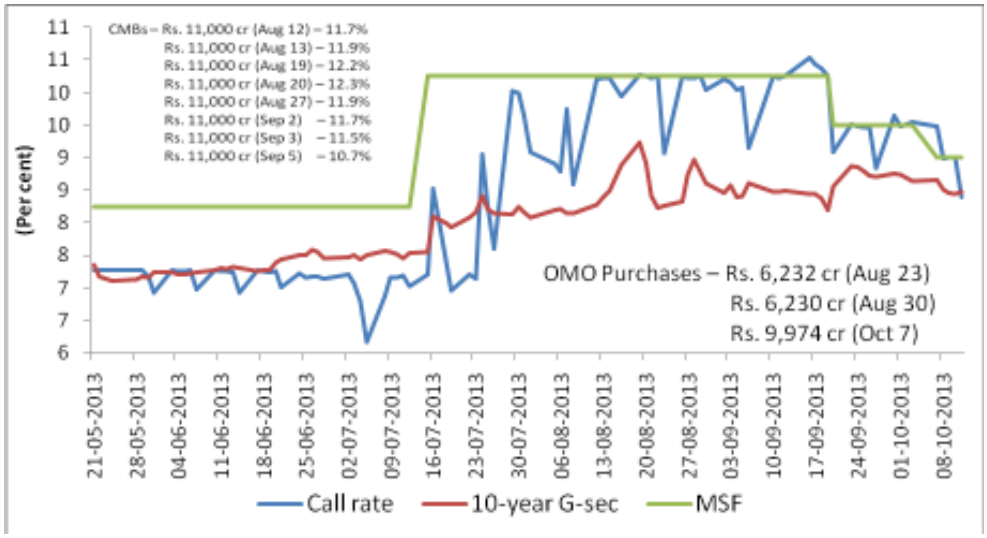
The coordinated approach to tightening liquidity conditions became visible only from the second week of August 2013 (i.e. almost after one month of the initial round of measures announced on July 15), in the form of large and sustained liquidity absorption through frequent issuances of cash management bills (CMBs), that too at a much higher cost for the government (Chart 4). As against the 91-day Treasury Bill yield of about 10.5 per cent prevailing in the first week of August, the government's short-term borrowing costs through CMBs (of 27-day to 48-day maturity) ranged between 12.3 per cent to 10.7 per cent for about one month, which nevertheless proved effective in pushing up the weighted average call rate closer to the MSF rate of 10.25 per cent.[7]

7. Large and continuous use of MSF over successive six fortnights ensured the intended tightening of money market rates, including the hardening of yields. Fortnightly averages of access to MSF (in rupees crore) are set out below:

Aug 10 to Aug 23	44,100
Aug 24 to Sep 06	52,800
Sep 07 to Sep 20	89,100
Sep 21 to Oct 04	64,600
Oct 05 to Oct 18	45,600
Oct 19 to Nov 01	26,700

With the weighted average call rate rising, as intended, the 10-year G-sec yield also hardened, from about 7.4 per cent before the taper talk to more than 9 per cent in the second half of August. This helped in achieving the goal of offsetting fully the impact of hardening long-term yields in the US, which was necessary to preserve the yield differential, besides compensating for the higher risk premium. The monetary policy thrust, which had turned fully focused on addressing exchange market pressure by mid-August, however, had to be diluted because of the growing concerns for growth, which was already sluggish over successive quarters. Around this time, the RBI conducted its own variant of operation twist, with issuance of CMBs on the one hand trying to keep money market interest rates tight so as to stem speculation in the forex market, while conducting open market purchase auctions on the other aimed at depressing yields so as to minimise risks to growth from a generalised hardening of medium and longer term interest rates.

Chart 4
Use of CMBs to Make MSF the Effective Policy Rate, but also Operation Twist to Depress Yield



Source: RBI

There was an apparent contradiction in this strategy, which became evident from the fact that there was limited scope for speculative position build up in India by borrowing cheap from money markets relative to expected return from depreciation of the rupee, whereas yield differential sensitive capital outflows clearly warranted hardening of domestic yields. Limits on open positions of banks is a more effective instrument to stem speculation in the forex market, and according to then prevailing guidelines of the RBI on open

positions, "NOP-INR (net open positions involving rupee as one of the currencies) may be prescribed to authorised dealers at the discretion of the RBI depending on the market conditions". Exchange market pressures could reflect the roles of both speculation by domestic market players who may have the regulatory flexibility to easily switch positions between the money market and the foreign exchange market, and that of interest rate sensitive capital outflows by foreign investors who would be driven by changes in yield differentials, risk premium and the magnitude of expected fall in the exchange rate.

While raising money market rates assumes importance to deal with the former, allowing domestic yields to harden may be necessary for the latter. Effective prudential regulations on net open positions can limit the need for an interest rate defence to stem speculation of the former type, whereas in the absence of such regulations allowing freedom to speculate, the order of increase in interest rate may have to be substantial, at least larger than the expected return from depreciation of the exchange rate.[8] In India, with appropriate regulations to stem speculation by residents in the forex market, the primary objective of exceptional monetary tightening should have been to allow longer term yields to rise, so as to more than offset the impact of hardening of yields in the US on yield differential, adjusted for the increase in risk premium and expected depreciation of the rupee, to be able to successfully discourage FII outflows from the G-sec and corporate bond markets. Because of concerns for domestic growth, such hardening of G-sec yields was not allowed, though it was necessary for an interest rate defence to succeed.

By September 2013, this apparent contradiction was fully recognised, with the realisation that persistent high inflation was the key fundamental driving factor behind exchange market pressure – notwithstanding the role of spillovers after the taper talk as the proximate trigger for pressure – and that monetary policy could best contribute to exchange rate stability through stronger commitment to price stability, matched by resolute anti-inflationary policy actions. After September, while the RBI's exceptional measures to address exchange market pressure were normalised quickly, the policy repo rate was raised thrice, and then left unchanged through 2014, consistent with the disinflation glide path which assumed prominence in the transition to a flexible inflation targeting regime. This reflected the realisation that durable price stability is necessary for addressing domestic macro-imbalance and for exchange market pressure.

It is indeed a fact that taper talk-induced spillovers contaminated all the emerging markets, irrespective of domestic fundamentals, and EME currencies generally faced depreciation pressure. But countries with weak fundamentals

8. According to Drazen (2003), "... an expected overnight devaluation of 0.5 per cent would require an annual interest rate of over 500 per cent [(1.005365 - 1) *100 =517] to make speculation unprofitable".

faced a greater challenge in terms of making their domestic policy response to exchange market pressure look credible and effective. India's macro fundamentals were deteriorating since 2012, and several analysts had started drawing comparisons with key macro trends prevailing prior to India's 1991 balance of payments crisis. High persistent inflation, elevated inflation expectations, larger than sustainable level of current account deficit and significant cumulative appreciation of the real exchange rate, all pointed to the need for an orderly adjustment of the exchange rate; taper talk-induced spillovers only worked as the trigger, but the adjustment tend to become disorderly.

Allowing disorderly adjustment of the exchange rate without any policy resistance could have only amplified the costs for the economy. Reversing adverse market sentiment, even with adequate countervailing policy response, may at times be difficult because of the role of adverse feedback loop. The non-deliverable forward (NDF) market for the Indian rupee, for example, generally hinted at larger fall in the exchange rate than in the on-shore market, which often became self-fulfilling. Moreover, before the taper talk, India's forex reserves level was generally seen as adequate, and some even had highlighted the high opportunity costs of large reserves to recommend its more effective use by funding infrastructure projects. However, once reserves started to decline over successive weeks – reflecting largely intervention operations to stabilise the exchange rate – markets increasingly perceived the reserve level as inadequate to manage the full impact of the unwinding of QE in AEs – from taper talk to actual taper to eventual lift-off from zero lower bound.

The Indian experience with the use of monetary policy measures to address exchange rate volatility, thus, points to the significance of certain preconditions that could enhance the effectiveness of an interest rate defence of the exchange rate (Table 2). It is important in this context to refer to the causes and consequences of an exchange rate crisis as documented in the literature on well-known currency crisis models. In a very broad sense, according to the first generation model (Krugman, 1979; Flood and Garber, 1984) excess money growth, unsustainable fiscal deficit/debt and misaligned exchange rate could be the key culprits. The second generation model (Obstfeld, 1996) emphasises multiple equlibria, for given fundamentals of an economy, where self-fulfilling expectations could take exchange rate from one equilibrium to another. Any noise/unanticipated news that can change market expectations and trigger a revision in market assessment of fundamentals of an economy (say, for example, the taper talk) could give rise to a chain of repeated self-fulfilling fall in the exchange rate. The third generation model (Kaminsky and Reinhart, 1999; Eichengreen and Hausmann, 1999) highlights the role of the financial sector as a causative factor, in particular balance-sheet effects on banks and financial institutions (who may borrow in foreign currency and lend in domestic currency, and also borrow short-term and lend long-term) and on corporates (who may borrow in foreign currency and leave a large part of it unhedged).

Unlike currency crisis models, the literature is scanty on what could be the optimal monetary policy response to an exchange rate crisis. According to Christiano, Braggion and Roldos (2006) "...it is optimal to raise interest rates during a currency crisis and to lower them immediately thereafter". The RBI's exceptional monetary measures were also employed swiftly and sustained over only a short span of less than three months, which were subsequently fully normalised in about three months. An assessment of the preconditions, however, would suggest that the first generation model-related risks relating to fundamentals were significant in India before the exchange market pressures started. The scope for second generation self-fulfilling unidirectional fall in the exchange rate was also evident, with the NDF market trends on the one hand and the falling foreign exchange reserves level on the other – on the back of overall deteriorating prospects for capital inflows – justifying every new low level of the exchange rate as a possible new equilibrium.

Empirical research on the balance-sheet impact of exchange rate shock on corporate balance sheet is limited, largely due to non-availability of data on unhedged exposures of corporates. According to Jaiswal (2013), Indian corporates do not hedge about 60 per cent of their external debt liabilities, and projected yearly debt service payments relating to external commercial borrowings (i.e. principal and interest) could be about USD 20 billion. A 10 per cent depreciation of the rupee, therefore, could increase repayment costs in Indian rupees by an amount equivalent to about USD 1.2 billion (depending on the prevailing exchange rate). The corporate sector performance – both profitability and sales growth – may also be impacted by depreciation, depending on total forex earnings and spending.

Available data for the Indian corporate sector (from the RBI's annual survey of companies) suggest that their expenditure in foreign exchange has been consistently higher than earnings in foreign exchange, and therefore, depreciation of the exchange rate can increase costs on a net basis. A 10 per cent depreciation of the rupee from the average exchange rate prevailing in 2012-13 is estimated to have increased costs for the corporate sector by Rs 119.8 billion in 2012-13 (assuming no hedging of forex expenditure and earnings). In turn, an increase in interest rate by one percentage point would have raised the net interest cost by about Rs 15 billion (assuming higher interest rate applicable to only the increment in leverage during the year). The gain from preventing 10 per cent depreciation could thus be justifiable from the corporate sector perspective only if the increase in interest rate to prevent the deprecation is less than 8 per cent (Table 3). Whether an increase in interest rate by less than 8 per cent can prevent 10 per cent depreciation is an empirical issue, which is attempted in the next session.

Static comparison of relative costs, however, would generally hide the enormous impact an increase in interest rate by 8 per cent could have on the economy, and accordingly on the corporate sector in terms of the demand impact (i.e.

lower demand) and the cost impact (i.e. the viability of new investment projects). Therefore, more than a mere direct comparison of costs, what may be important for designing an appropriate policy response is the realisation that there is a trade-off between exchange rate depreciation and higher interest rate.

Section IV
Empirical Assessment of Effectiveness of an Interest Rate Defence in Stabilising the Exchange Rate of the Rupee

To empirically test the relevance of the conventional monetary approach, quarterly data on money stock (MS), 10-year sovereign yields and real GDP (for India and the US) and the rupee/US dollar exchange rate have been used (Data Source: International Financial Statistics of the IMF and Handbook of Statistics (RBI) for the period 1999 Q1 to 2014 Q1). All variables are found to be first difference stationary, i.e. I(1) processes, according to ADF and Phillips-Perron tests (Table 4). As all variables are of the same order of integration, Johansen and Juselius (1990) test was employed to check for the presence of and number of cointegrating relationships among these variables. The trace and maximum Eigen value test statistics point to the presence of one cointegrating relationship (Table 5). Optimal lag length of order 1 was considered based on the Akaike Information Criteria (AIC) and Schwarz Criteria (SC) (Table 6). Further, LM tests suggest that errors are stationary, confirming the existence of a long-run relationship among variables. The estimated long-run cointegrating relationship presented below shows that only some of the coefficients are statistically significant, and more importantly only some of the statistically significant coefficients are consistent with the theoretical relationships presented in Table 1.

$$\begin{aligned} LOG(XRATE) = {} & 30.8 + 0.13*TREND + 0.60*LOG(USMS) - 3.31*LOG(USGDP) - \\ & \quad (6.21)^* \qquad\quad (0.90) \qquad\quad (-5.10)^* \\ & 0.03*US10YR - 2.85*LOG(I\text{-}MS) - 0.37*LOG(I\text{-}GDP) + 0.04*I\text{-}10YR \\ & \quad (-1.49) \qquad (-7.60)^* \qquad (-4.83)^* \qquad\quad (6.16)^* \end{aligned}$$

*: Significant at 5 per cent level. Figures in parentheses denote t-statistics.

Table 1
Impact on Exchange Rate as per the Monetary Approach

X % Increase In	MS_t	MS_t^*	Y_t	Y_t^*	i_t	i_t^*
Impact on Δe_t	(+) X%	(-) X%	(-)	(+)	(+)	(-)

Note: (+)/(-) imply depreciation/appreciation. MS, Y and i represent money stock, output and interest rate, respectively.
* indicates respective variables for the foreign economy (e.g. the US in this paper).

While the direction of the impact of changes in India's GDP and interest rate on the exchange rate of the rupee is consistent with the monetary approach, the impact of changes in India's money stock (M_3) is not so. Empirical literature for 1980s and thereafter is replete with findings across countries contrary to what the theoretical monetary approach suggests. Dornbusch (1980) noted in this context that " ...the econometric evidence ...leave little doubt that the monetary approach in the form of (above) equation is an unsatisfactory theory of exchange rate determination". The key problem in a specification like the above cointegrating relationship is that money supply is no more exogenously determined by central banks; instead, money supply responds automatically to money demand in an operating framework of monetary policy that aims at anchoring interest rates around the policy interest rate through efficient liquidity management. Money demand – that responds to changes in GDP and interest rate – therefore is fully accommodated under such operating frameworks, leading to an endogenous money supply process. In the above specification, therefore, MS itself is determined by GDP and interest rate, and accordingly it may not be appropriate to consider MS as an independent determinant of exchange rate in the same equation in which GDP and interest rate are also there on the right hand side.

With the gradual de-emphasis on monetary targeting (under which MS is expected to be exogenous), it is less common in empirical literature to explain inflation/exchange rate through changes in money supply. The theoretical proportional relationships between MS and inflation, and between MS and exchange rate (through PPP) often do not hold in the age of financial innovations, that pose challenges in terms of true measurement of money, and the stability of the relationship between money and inflation/exchange rate.

With monetary policy increasingly being conducted by changing the interest rate (rather than money supply), and liquidity often tightened to enhance the effectiveness of an interest rate defence, empirical relevance of the UIP, or rather the UIP puzzle, assumes greater importance than the monetary approach. Adopting the time-varying risk premium approach to UIP set out in Equation B2 in Section II, it may be observed from the estimates presented below that for the time period mid-July 2013 to December 2013 (i.e. the post-taper talk period of pressure on the rupee), the constant component of risk premium for India appears to be statistically insignificant, but the time-varying risk premium (proxied by conditional standard deviation, GARCH) is statistically significant, which also exhibits the expected negative relationship with the exchange rate.[9]

9. The LM test supports the need for representing errors through ARCH/GARCH. According to Lee (1991), LM test of the null hypothesis of white noise against an ARCH(1) process is equivalent to an LM test of white noise against the GARCH(1,1). The sum of the ARCH and GARCH coefficients is less than one, signifying the volatility process to be stationary. Both Δe_t and interest rate differential variables are stationary as per the ADF and PP tests. Positive ? et implies depreciation of the Indian rupee, and interest rate differential variable is the difference between overnight call money rate in India and the Fed fund rate.

$$e_{t+1} - e_t = \underset{(-1.6)}{-1.22} + \underset{(2.71)*}{0.24*}\ \text{Int. Diff.} - \underset{(-2.01)*}{0.95*}\text{GARCH}$$

$$\text{Error Variance} = \underset{(0.75)}{0.02} + \underset{(1.67)***}{0.11*}\ \text{ARCH (1)} + \underset{(13.95)*}{0.88*}\text{GARCH(1)}$$

Note: ARCH: Auto Regressive Conditional Heteroskedasticity
GARCH: Generalised Auto Regressive Conditional Heteroskedasticity
*,*** significant at 1 per cent and 10 per cent, respectively.

This validates the point that when risk premium increases, investors expect appreciation of the rupee to compensate them (with unchanged interest rate). An increase in interest rate, which can reverse adverse expectations about the rupee in the face of higher demand for risk premium from investors, should help in alleviating exchange market pressure. As a test of UIP, the interest rate coefficient can be less than one in the presence of time-varying risk premium, i.e. exchange rate depreciation would be less than the interest rate differential, because positive risk premium would require an appreciation of the exchange rate (or lower order of depreciation than what may be theoretically warranted as per the interest rate differential) for foreign investors to invest in the country.

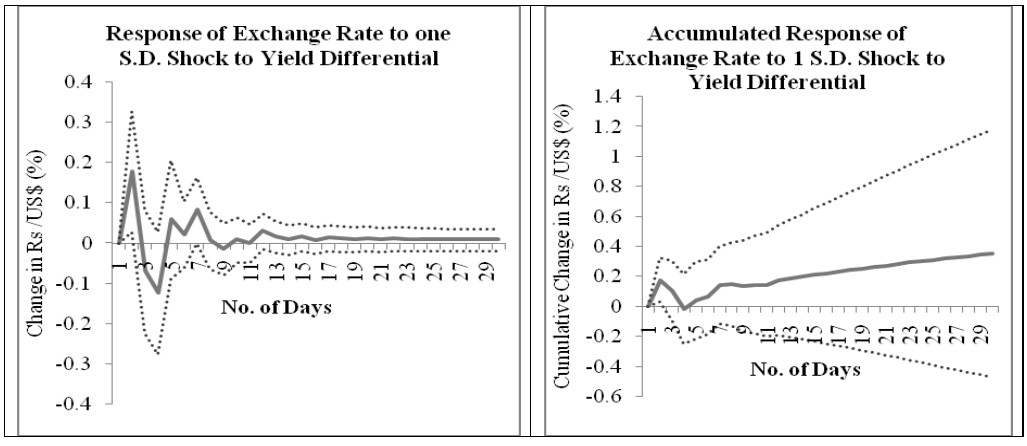
Higher interest rate and appreciation of the domestic currency can together make foreign investment in an emerging economy attractive enough, despite positive risk premium demanded by foreign investors to stay invested. However, when the domestic currency depreciates and risk premium rises (as experienced after the taper talk), domestic interest rate may have to be raised enough to compensate for both. This justification for using an interest rate defence is driven purely by the goal of stabilising the exchange rate through monetary policy actions, while in real life the opportunity costs of such an interest rate defence of the exchange rate for the economy also becomes important for policy decisions.

In response to the unidirectional slide of the rupee against the US dollar during the post-taper talk period, the RBI took several exceptional measures, including the increase in policy rate and tightening of liquidity conditions, to defend the exchange rate. Given the fact that several policy and non-policy factors constantly interact in a dynamic manner to influence the exchange rate, and that it is difficult to capture these dynamics in a predetermined structural model of the exchange rate (Glodfajn and Baig, 1998; Ohno *et al*, 1999), unrestricted vector auto regression (VAR) models have been commonly used to assess the impact of exceptional monetary measures on the exchange rate. As the exceptional measures were fully normalised by October 2013 and the exchange rate also stabilised by December 2013, it was considered appropriate to use high frequency (daily data) for the relevant period only to assess the impact of interest rate defence on the exchange rate in a VAR framework.

Structural innovations are generally recovered from the reduced form VAR for a meaningful impulse response and variance decomposition analysis. In transforming a VAR into an orthogonal form through Choleski Decomposition, however, one encounters the problem of ordering of the variables. To make sensible use of the model, some ordering based on casual relationships between variables is generally used. Since tighter liquidity conditions also influence the effectiveness of an interest rate defence, besides yield differential, daily stock market return (BSE Sensex), and daily change in exchange rate (rupee/ US dollar), liquidity accessed from the RBI as percentage of NDTL is also considered in the four variable VAR model. All variables used in the VAR model are found to be stationary. Optimal lag length of 5 has been selected as per the Schwarz criterion, but after taking into consideration LM tests also so as to ensure absence of auto-correlation for this lag length (Tables 6 and 7). The Jarque-Bera test points to normality of errors in this VAR specification.

To retain the focus of the analysis on the post-taper period till normalisation of the RBI's exceptional monetary measures, only daily data for the VAR model have been used. Over a longer time horizon, actual foreign exchange intervention data (available at monthly frequency and not daily) could have been used as an additional important variable in the VAR model, but that time horizon may not be relevant to the context of this paper. The impulse response path for daily data suggests that the exchange rate does appreciate in response to a tighter interest rate shock, and the appreciation also persists on a cumulative basis (Chart 5).

Chart 5
Response of Exchange Rate to Increase in Yield Differential*



Note: * For a 12 bps (equivalent to one standard deviation of yield differential) increase in yield differential, exchange rate appreciates by about 18 bps (or 18 paise) the very next day and by about 30 bps (or 30 paise) cumulatively over 25 days.

As indicated in Section III, the Indian corporate sector being a net importer, any depreciation of the rupee will impact their balance sheet adversely. However, at the same time, any increase in interest rate will also have adverse implications for corporate balance sheet. Therefore, an assessment of the costs of an interest rate defence would require a comparison with costs of allowing a free fall of the exchange rate. Using corporate data on leverage and unhedged exposures, one such comparative assessment is presented in Section III. To examine the same hypothesis empirically, a panel regression framework is used here to study the impact of interest rate and exchange rate on corporate profitability (proxied by net profit to sales ratio) using quarterly data. The results indicate that while the increase in weighted average call rate (WACR) and depreciation of the rupee both entail adverse impact on profitability, exchange rate depreciation has a higher impact than that of an interest rate increase (Table 8).[10] These estimates are validated using the dynamic generalised method of moment (GMM) and the results look comparable.

Section V
Concluding Observations

India faced the US Fed's taper talk-induced spillovers at a time when its monetary policy cycle was already on an easing mode and lingering domestic macro-imbalances had amplified vulnerability to adverse external shocks. The RBI raised the effective policy rate by 300 basis points on the back of measures to tighten liquidity conditions, and as a result it explicitly pursued an interest rate defence of the exchange rate. An assessment of the empirical relevance of the conventional monetary approach to explain the pressure on the rupee suggests the presence of a cointegrating long-run relationship between the exchange rate of the rupee, and money stock, real GDP and 10-year sovereign yields of India and the US.

Signs of the estimated coefficients for money stock, however, do not validate the monetary approach, as commonly observed in empirical research since 1980s. With monetary policy generally being conducted by changing the interest rate, instead of the monetary approach the uncovered interest rate parity (UIP) was empirically examined, recognising though the near universal failure of the UIP condition, particularly in context of the growing lure of international carry trade, and also the increasing role of time-varying risk premium to explain the relationship between interest rate differentials and exchange rate movements. Empirical estimates for the Indian data validate the presence of time varying risk premium, which explains why the rupee need not depreciate matching the

10. The panel regression has four variables – net profit to sales ratio, sales growth, weighted average call rate (WACR) and percentage change in the exchange rate. Use of Fixed Effect Model (FEM) is validated by the redundant fixed effect test. Generalised Least Square (GLS) estimation is preferred over Ordinary Least Square (OLS) to correct for heteroscedasticity. All variables in the panel regression are stationary.

interest rate differential, and why deviations from the UIP condition may often be the norm rather than an exception.

An interest rate defence becomes necessary when external spillovers increase risk premium demanded by foreign investors and the exchange rate also depreciates by more than the interest rate differential. The magnitude of increase in domestic interest rate must be sufficient to compensate for the higher risk premium and also to reverse the sustained fall in the exchange rate. The VAR impulse response analysis corroborates the effectiveness of an interest rate defence in contributing to the appreciation of the rupee. Since intervention in the foreign exchange market and other policy measures to contain gold import, shifting a part of the oil import-related foreign exchange demand out of the market, and attracting capital inflows under two innovative swap schemes also contributed to stabilise the exchange rate, it is difficult to establish clearly as to whether exceptional monetary policy measures alone could have succeeded in stabilising the rupee.

The corporate sector data for India suggest that their annual foreign exchange expenditure exceeds income in foreign exchange, and therefore, a depreciation of the exchange rate can increase their rupee cost of operations, impacting profitability adversely. Data on corporate leverage, on the other hand, indicates the likely impact an increase in interest rate could have on corporate profitability. Panel regression results point to corporate profitability coming under pressure on account of both deprecation of the rupee and higher interest rate. Clearly, therefore, there is a policy trade-off between allowing the exchange rate to depreciate and resisting a depreciation by deploying an interest rate defence.

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Appendix

Table 1
RBI's Exceptional Monetary Measures to Address Exchange Market Volatility (July 2013 to December 2013)

July 15, 2013	The MSF rate was recalibrated at 300 basis points above the policy repo rate under the LAF, as against the normal spread of 100 bps. The intention was to lift up overnight money market rates from around the repo rate to the MSF rate, imparting thereby an effective 300 bps tightening of interest rate. An effective increase in money market rates needed tighter liquidity conditions. Accordingly, the access to liquidity to banks at the fixed repo rate was restricted to 1 per cent of NDTL, from virtually unlimited (subject to availability of excess SLR securities). This tighter liquidity norm became effective from July 17, 2013. It was announced that OMO sales of Rs 12,000 crore will be conducted on July 18, 2013 (with the aim of tightening liquidity conditions). [While total bids received amounted to about Rs 24,000 crore, only about Rs 2,500 crore was accepted, possibly to avid hardening of yields, contrary to the objective behind July 15 measures.]
July 23, 2013	The norm for minimum daily CRR balances to be maintained by banks with the RBI was tightened from 70 per cent to 99 per cent of the requirement. (This decision curtailed the flexibility available with banks to dip up to 70 per cent of the requirement on any day during a fortnightly reserve requirement cycle and thereby avoid the need for borrowing at higher rates from the money market to meet the reserve requirement.) The access to overnight liquidity at the fixed repo rate was further curtailed from 1 per cent of NDTL for the system as a whole to 0.5 per cent of NDTL of each individual bank.
July 23, 2013	Primary dealers' access to LAF was restricted at 100 per cent of their individual net owned funds.
August 8, 2013	The RBI announced to auction cash management bills (CMBs) to drain out surplus liquidity (and thereby tighten liquidity conditions) and conducted nine auctions between August 12 and September 5, mopping up a cumulative amount of Rs 90,000 crore from the system. [During this period, it also conducted two OMO purchase auctions on August 23 and 30, which represented the Indian version of operation twist.]

Table 2
Factors Driving Policy Choice on Use of an Interest Rate Defence of the Exchange Rate

When to Avoid Monetary Tightening	*When Monetary Tightening May be Necessary*
Large corporate leverage at floating interest rate relative to unhedged exchange rate exposures (i.e. if the costs associated with an interest rate shock is higher for corporates than an adverse exchange rate shock).	High CAD driven by the impact of past inflation (differentials) on external competitiveness – monetary tightening may be necessary to restore the policy focus on price stability, as the key means for ensuring a stable exchange rate in the medium-run.
Risk of a higher interest rate dampening growth outlook and triggering capital (equity) outflows.	Scope for speculation high (i.e. borrow from money market to build positions in forex).
Significant increase in risk premiums, which may require a large increase in interest rate that will be seen quickly as unsustainable.	Strong adverse external spillovers that could potentially leave behind a more damaging impact on the economy, if not resisted.
Limited scope for speculation in terms of flexibility to borrow from the money market to build positions in the forex market (because of limits placed on open positions).	Only after allowing some deprecation to adjust for perceived misalignment – so as to make the interest rate defence credible. Easing of monetary conditions after some depreciation – could also help later to justify a higher interest rate.
Misaligned exchange rate (requiring some adjustment, and only disorderly fall may have to be resisted).	When other available measures to defend the exchange rate – such as self insurance in the form of forex reserves and use of administrative/ capital/prudential control measures – are viewed as inadequate/ineffective or costlier compared with an interest rate defence.
Inability to resist pressure groups that may often demand monetary easing – rather than tightening – as the best response to an adverse external shock to protect domestic activity and employment level.	Growing market perception about policy vacuum contributing to the free fall in exchange rate – need for restoring faith on relevance of policy.

Table 3
Relative Sensitivity to Exchange Rate and Interest Rate Shock

(Rs Crore)

	Foreign Currency Expenditure	*Foreign Currency Income*	*Net Forex Outgo*	*Interest Pay-ments*	*Interest Recei-ved*	*Net Interest Payment*	*Outstanding Borrowings*	*Increment in Leverage*
	1	*2*	*3(1-2)*	*4*	*5*	*6(4-5)*	*7*	*8 (Change in 7)*
2000-01	69,025	57,369	11,656	20,181	3,018	17,163	1,70,094	
2002	74,606	64,238	10,368	18,744	2,902	15,842	1,68,959	–1135.0
2003	84,005	78,351	5,654	16,639	3,233	13,406	1,71,231	2272.0
2004	98,911	92,208	6,703	14,724	3,155	11,569	1,81,910	10679.0
2005	2,04,803	1,86,553	18,250	21,286	4,541	16,745	2,94,466	112556.0
2006	2,62,131	2,17,391	44,740	21,652	6,006	15,646	3,56,259	61793.0
2007	3,47,244	3,03,388	43,856	27,050	8,147	18,903	4,68,004	111745.0
2008	4,97,432	4,42,594	54,838	43,182	13,821	29,361	7,46,341	278337.0
2009	6,18,707	5,25,027	93,680	62,914	20,639	42,275	9,77,124	230783.0
2010	6,63,746	5,26,440	1,37,306	71,029	21,773	49,256	10,47,267	70143.0
2011	6,41,960	5,34,569	1,07,391	62,285	23,096	39,190	8,97,716	–149551.5
2012	8,12,763	6,89,770	1,22,993	81,293	31,108	50,185	10,31,617	133901.3
2013	9,07,161	7,87,393	1,19,768	99,240	36,862	62,378	11,83,731	152114.4

Table 4
Unit Root Tests

	ADF Test		*Phillips-Perron Test*		*ADF Test*		*Phillips-Perron Test*	
	t-statistics	*p-value*	*t-statistics*	*p-value*	*t-statistics*	*p-value*	*t-statistics*	*p-value*
	Level				*First Difference*			
Ind-10yr	–1.37	0.16	–1.27	0.19	–5.75	0.00	–5.79	0.00
Ind-MS	3.57	1.00	21.09	1.00	–4.64	0.00	–4.56	0.00
Ind-GDP	4.01	1.00	3.96	1.00	–6.17	0.00	–6.46	0.00
US-10yr	–1.07	0.25	–1.05	0.26	–6.42	0.00	–6.75	0.00
US-MS	4.84	1.00	12.88	1.00	–5.28	0.00	–5.28	0.00
US-GDP	2.56	1.00	3.73	1.00	–3.49	0.00	–3.36	0.00
Rupee/$ Exchange Rate	1.57	0.97	1.31	0.95	–5.98	0.00	–6.01	0.00

Note: GDP and money supply (MS) data are seasonally adjusted and converted to index form. All variables are used in log form, other than nominal interest rate.

Table 5
Cointegration Test Statistics – Johansen and Juselius

H_o	H_1	*Statistics*	*Critical Value (5%)*	*P-value*
Maximum Eigen Value Statistics				
r=0	r = 1	53.6	50.6	0.02
r ≤ 1	r = 2	31.6	44.5	0.60
r ≤ 2	r = 3	26.8	38.3	0.50
Trace Statistics				
r=0	r = 1	169.1	150.6	0.003
r ≤ 1	r = 2	115.4	117.7	0.07
r ≤ 2	r = 3	83.9	88.8	0.10

Table 6
Unit Root Tests for Daily Data (July 15, 2013 to March 31, 2014)

	ADF Test		*Phillips-Perron Test*	
	t-stat	*p-value*	*t-stat*	*p-value*
RBI Liquidity	-2.72	0.07	-2.57	0.10
Yield Difference	-4.98	0.00	-4.58	0.00
Exchange Rate (Dep/App)	-14.47	0.00	-14.50	0.00
Equity Daily Return (BSE) Sensex)	-11.67	0.00	-11.58	0.00

Note: Exchange rate in taken as log difference and RBI liquidity is taken as per cent of NDTL.

Table 7
VAR Lag Order Selection Criteria

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	267.1	NA	2.57 e-13	–9.1	–8.9	–9.0
1	822.9	955.6	4.92 e-21*	–26.9*	–24.9*	–26.1*
2	860.0	54.6	8.06 e-21	–26.5	–22.7	–25.0
3	916.7	69.7*	7.56 e-21	–26.8	–21.2	–24.6
4	964.9	47.4	1.20 e-20	–26.7	–19.5	–23.9

Note: * indicates lag order selected by the criterion.

Table 8
Panel Regression – Impact of Changes in Exchange Rate and Interest Rate on Corporate Profitability (Dependent Variable: Net Profit to Sales Ratio)

	FEM-GLS		*Dynamic-GMM*	
	Coeff.	*T-Stat*	*Coeff.*	*T-Stat*
Net Profit to Sales Ratio (-1)			0.51*	19.8
Sales Growth	0.05*	9.70	0.02*	4.76
WACR (-1)	–0.07**	–2.19	–0.08**	–2.48
Exchange Rate (Q-on-Q change, + Indicate Appreciation)	0.12 *	6.48	0.11*	6.48
Long-Run Impact				
WACR			-0.16	
Exchange Rate			0.22	
$\bar{R}^2$	0.67			
DW	1.02			
J-Statistics			955.2 (0.29)	
Number of Observations	1426		1364	

Note: Figure in parenthesis is p-value for J-stat. Instrument variables are lagged values of variables used in the equation for GMM. White standard errors and covariance (d.f. corrected)

*,**: Significant at 1 per cent and 5 per cent level respectively.

Quarterly data for the period 2002 Q2 to 2013 Q4.