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Exchange Rate Forecasting
Are FX Forwards a useful Indicator of Future Spot Rate?

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Abstract—*The volatility in the foreign exchange markets and its impact on economic decision making has always been an interesting subject for market participants and regulators. This paper examines the key drivers of exchange rate, relationship between spot and forward rate, how effective forward rate has been as a predictor of future spot rate, does forward rates reflect market expectations and finally concludes with certain risk management guidelines for Indian corporates. The study has been done in context to India and Indian Rupee (INR) against the US Dollar (USD).*

Understanding Macro-economic Variables

In free market economics, each asset or commodity is valued against the country's currency. Likewise, in the foreign exchange market, each currency is valued against another currency and in market terminology, known as "exchange rate". In the short to medium term, exchange rate movement takes into account a number of macro-economic variables that alters exchange rate expectations and market participant's behavior. The frequency at which information continues to flows in the market causes significant volatility in the exchange rate.

The key macro variables that influences the "exchange rate" are discussed below:

(1) Balance of Payment (BoP)

Balance of Payments represents the demand for, and supply of, foreign exchange which ultimately determine the value of the home currency. The basic demand and supply of foreign exchange emanates from a country's trade account. Exports - both visible (merchandise) and invisible (services), represent the supply side for foreign exchange while Imports - visible (merchandise) and invisible, create demand for foreign exchange. In other words, export from the country creates demand for its currency in the foreign exchange market as the exporters would offer the foreign currencies they have acquired and demand in exchange the local currency in the market. Conversely, imports into the country will increase the supply of its currency in the foreign exchange market. Besides trade flows, the capital account flows which primarily consists of foreign direct investments (FDI), foreign portfolio investments (FPI), commercial borrowings by banks and corporate and deposit from non-residents, also influences the value of home currency in the foreign exchange market.

Hence from a presentation perspective, the balance of payments (BoP) provides a means to account for all cash flows in foreign currency in a standardized and systematic manner. This statement is prepared for a specified period, say quarterly or annual. The net of all transactions included in the BoP is matched by a change in the country's international monetary reserves. In summary, the BoP provides guidance on the underlying demand-supply dynamics of foreign exchange in an economy and help in assessing the relative exchange rate movements.

When the balance of payments of a country is continuously in deficit, it implies that the supply of its currency is higher than its demand and therefore its value in the market declines. If the balance of payments is in surplus it shows that the demand for the currency in the exchange market is higher than its supply and therefore the currency gains in value.

The relationship between the BOP and exchange rates can be illustrated by use of a simplified equation that summarizes BOP data:

BOP = (X-M) + ((CI+FI) – (CO+FO)) +FXB

Where:

X is exports of goods and services,

M is imports of goods and services,

(X-M) is known as Current Account Balance

CI and **FI** is capital inflows and financial inflows,

CO and **FO** is capital outflows and financial outflows,

((CI+FI) – (CO+FO)) is known as Capital Account Balance

FXB is the change in official monetary reserves

How BoP influences the exchange rate expectations

The identity of the BoP sets the primary mechanism to determine the direction in which the exchange rate should move. For instance:

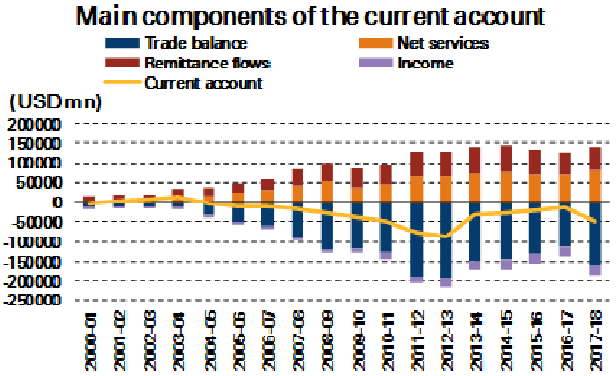
- **Appreciation bias:** A BoP surplus implies that there are more inflows over that period and thereby creates more demand for the home currency than the supply. The net result is currency strength or appreciation in the home currency.
- **Depreciation bias:** A BoP deficit implies that there are more outflows over that period implying less demand than supply for the home currency. The net result is currency weakness or depreciation in the home currency.
- **Neutral bias:** A balanced BoP value implies a state of equilibrium and stable exchange rate as demand for and supply of a home and foreign currency is almost matched.

To understand the movements in the INR from the point of view of BoP, a more comprehensive review of the two major sub-components within the BoP is warranted.

1) Why does the current account work as a depreciation driver?

There are four key components of the current account:

- **Trade balance:** The trade balance is equal to the sum of total merchandise exports minus sum of total merchandise imports. A positive balance results in a trade surplus whereas a negative balance results in a trade deficit.
- **Services balances:** The services balance consists of the difference between those services that are exported to the rest of the world such as software exports and those that are imported from the rest of the world. It also includes net balances on account of travel, medical tourism, education etc.
- **Remittance flows:** This is the net inflow of remittances into and outside the country. For instance, it captures the money transferred by Indian citizens working abroad or NRIs sending money home to their family members.
- **Income flows:** This is a summary of the difference between interest payments that are made by Indian corporations/government to foreigners and interest payments that are received by various domestic entities from foreigners.
    - The important point to keep in mind is that the Indian economy has a problem of a chronic trade deficit. There is a greater reliance on imports on a variety of goods such as crude oil, gold, consumer goods, electronic items and other capital goods. The upshot is that the importer demand exceeds exporter demand by a substantial amount. The persistence of the trade deficit offsets the positive balances seen in the services balances and remittance flows resulting in a problem of a 'chronic current account deficit' that has been in place for more than a decade now. Income flows have also turned substantially negative indicating an outflow of interest payments from local companies/government of India to overseas investors that works to complement the trade deficit. Hence, there is an inherent mismatch of demand and supply of USDs in the Indian markets.



Source: RBI

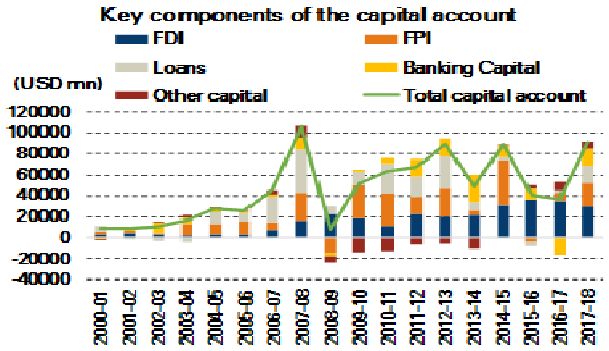
Figure 1: The current account deficit for India has remained in a deficit position

A current account deficit implies that the INR is positioned to undergo a structural depreciation over the medium-term given a greater demand for the USD relative to its supply in the local markets. Further in assessing the incremental pressures that build-up from the current account side and given that India is a net energy importer and crude is the largest import item, the movement in crude oil prices works as a substantial volatility factor in shaping up the overall BoP. The current account deficit is required to be funded through capital flows. However, it has been seen that capital flows are not always able to compensate for the current account deficit. The main components of the capital account include:

- **FDI flows:** This component is the value of cross-border transactions, both inflows and outflows, related to direct investments into an economy at a specified period of time. FDI inflows are a function of global investor's assessment of long-term growth potential and the government policy related to FDI flows.
- **FPI flows:** This component is a function of net foreign investor money into either Indian equity markets or debt markets. FPI flows tend to be very volatile reflecting investor's short-term expectations on the economy and global risk appetite.
- **External loans:** These components are a sum of loans taken from the foreign market by domestic corporations and the Government of India. They come in a variety of forms such as external commercial borrowings, trade credit and official external assistance taken by the government of India. The demand for external loans picks

up either if there is a substantial investment boom in the local economy that requires funding or if global rates move sharply lower that reduces net interest costs for domestic corporations.

- **Banking Capital:** These are the value of cross-border transactions undertaken by the local banking sector. For instance, NRI deposits that flow into the domestic banking sector get captured into this category. Similarly, if the Indian banking sector needs to raise capital from the overseas market then that results in a net inflow of capital into the domestic markets or conversely if an Indian bank wants to send money to an overseas branch then that gets captured as an outflow.
- **Other capital flows:** These are other capital flows that are not defined by the main categories and are typically relatively small in magnitude.

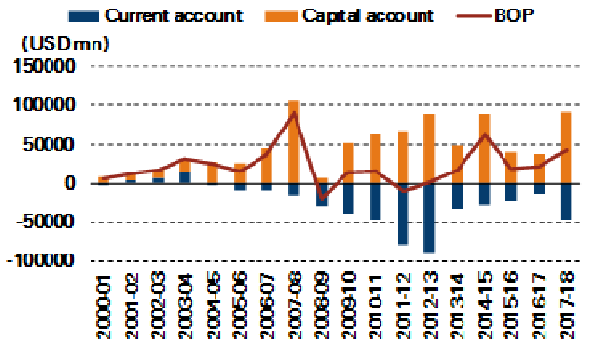


Source: RBI

Figure 2: Capital flows volatile-driven primarily by FPI flows

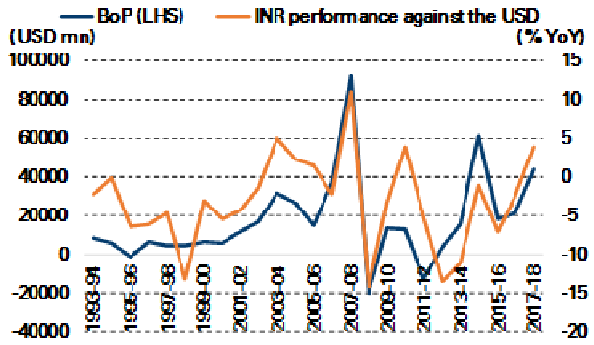
The drivers for capital flows in an economy vary over time and across different types of capital flows. Such drivers can be classified using the traditional distinction between 'push' and 'pull' drivers and continues to serve as a useful framework. Push factors like global risk aversion and external interest rates are found to matter most for foreign portfolio debt and equity flows, but somewhat less for banking capital. Pull factors includes domestic output and productivity growth, return on local asset, country specific risk etc.

In Indian context, it has been noted that the portfolio capital flows tend to be very volatile, and are increasingly driven by short term yield differential and asset market performance. FPI flows typically work as the primary push-factor from the capital account side that influences the USD/INR pair. However, an encouraging development has been the improvement in more stable category of flows such as in the FDI flows seen over the last three fiscal years. The step-up in FDI flows has come on the back of a greater liberalization, with the government allowing for increased inflows into a number of sectors and as markets responded to structural reforms undertaken by the government over the last five years. Even as FDI flows have proved to be stable, they are simply not adequate enough in terms of magnitude to shield the INR from the current account deficit and to offset other volatile components within the capital account. Hence, the study revealed that as capital flows ebbs or reverses, INR gets exposed to disorderly bouts of depreciation.



Source: RBI

Figure 3: BoP is a snapshot of net fund flows into the economy in a particular year



Source: RBI

Figure 4: The INR tracks the movements in the BoP

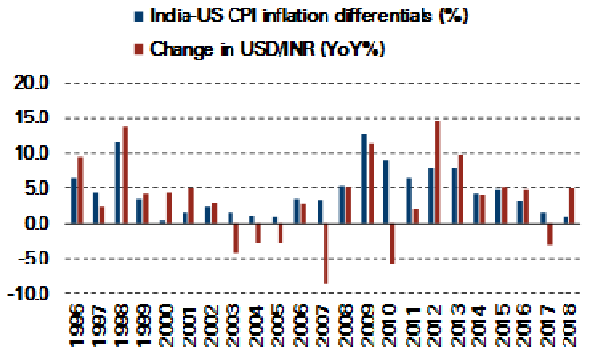
2) Inflation and Productivity Differential

The most basic theory of exchange rate determination is the theory of Purchasing Power Parity (PPP). This theory asserts that the exchange rate change between two currencies over a medium period is determined by the change in the two countries relative price levels. Because the theory singles out price level changes as the overriding determinants of exchange rate movements it has also been called "inflation theory of exchange rate".

For instance, the real Dollar-INR exchange rate compares the quantity of similar quality goods that one Dollar buys in the United States with the quantity of goods that the same dollar, converted into Rupees, buys in India. In other words, we could say that the real exchange rate allows us to compare the cost of a fixed basket of goods in the United States and India. Over longer run, PPP theory suggests that the exchange rate of Dollar-INR will reach its equilibrium where there should be no arbitrage opportunities among traded goods due to price differences.

How inflation feeds into BoP balance

A higher inflation in the country increases the domestic prices of tradable products. With increase in local prices, the export prices tend to get uncompetitive. As prices become uncompetitive, exports are likely to dwindle which means that the demand for the local currency will also decline; this in turn would result in the decline of the external value of the currency. It may be noted that unit is the relative rate of inflation in the two countries that cause changes in exchange rates. If, for instance, both India and the USA experience 7% inflation, the exchange rate between Rupee and US Dollar is likely to remain stable. If inflation in India is 8% and in the USA it is 2%, the relative price increase in India will be higher. Therefore, the rupee is likely to depreciate in value against the US Dollar. Empirical studies have shown that inflation differential has a definite influence on the exchange rates in the medium term. However, in the short term, the rates may fluctuate widely from the trend set by the inflation differential. These fluctuations are accounted for by causes other than inflation.

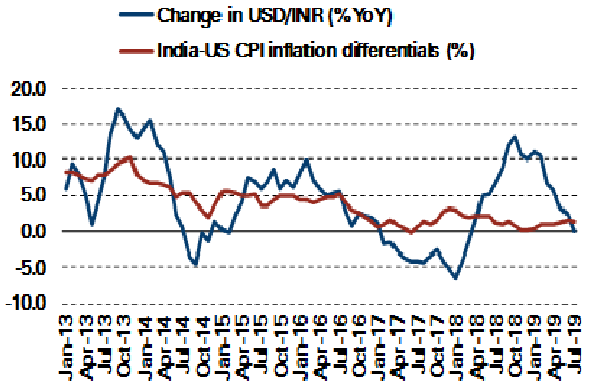


Source: RBI, IMF

Figure 5: USD/INR tracks the US-CPI inflation differentials in the long-term

In context of the Indian economy, inflation rates have remained much above the global and US average. We find that over the last two decades, the USD/INR pair has moved in the same direction as the inflation differentials that are observed between the Indian economy and the US economy respectively. In short, higher local prices work to depreciate the exchange rate over a period of time. The by-product of having structurally higher inflation rates is a reflection of demand exceeding supply resulting in a current account deficit because of a higher import bill.

While the BoP captures the net transactions that are taking place between India and the rest of the world, what must not be overlooked is that these transactions are driven by prevailing conditions in the macro economy. Global investors in particular pay very careful attention to the underlying macroeconomic landscape in making investment decisions. Hence, this section takes a deeper look into the effect of the developments in the domestic economy that in turn influences the USD/INR pair.



Source: RBI, IMF

Figure 6: USD/INR can deviate from the inflation differential path in the short-term

Productivity growth: Plays a critical role in influencing price trends

Productivity growth can be calculated in several ways but the basic definition is the total output/total input. This can be obtained by dividing total GDP growth (value added) by employment or number of hours worked. An improvement in productivity growth takes place if the output improves with the same level of input that can work as a positive shock for the economy. It also implies greater efficiency in producing output that in turn drives wages higher. However, productivity growth rates vary across sectors and are the divergence that needs to be examined while assessing the impact on the exchange rates. In this regard, the role that productivity growth plays in driving exchange rate depends on the gains seen in the traded and non-traded sectors of the economy respectively.

The traded sector includes all those industries that produce goods for exports of goods that compete with foreign goods. Industries in these sectors include agriculture, hunting, fishing, mining and quarrying and manufacturing.

The non-traded sector includes those industries that are primarily services that produced primarily to meet local demand. These sectors typically do not compete extensively with foreign markets. Industries in these sectors include electricity, gas and water, construction, wholesale, retail trade, restaurants, hotels, transport, storage, communications, finance, insurance, real estate, business services and other services that are provided by the government.

The upshot is that prices on ‘traded goods’ and ‘non-traded goods’ differ substantially. For instance, the price of goods in the traded goods sector that competes with the international market forces producers of these industries to keep prices for their products in sync with the international market. On the other hand, the price of goods in the non-traded sector are not subject to foreign competition are subsequently driven more by local demand and supply factors.

If the Indian economy witnesses a 'positive productivity gap' in the traded goods sector that means that more output is being produced relative to input, the price of trade goods may not increase substantially with respect to the levels seen in the international markets. However, wage growth might start to pick-up in the traded sectors as an improvement in productivity tends to drive profits higher. A similar increase in wage growth could also be seen in the non-traded sector as employers in these sectors might be forced to match increases seen in the traded sector. Since productivity increases are unlikely to be as large as that seen in the traded goods sector, companies in the non-traded goods sector will not be in a position to absorb the wage increases fully and will be compelled to raise prices. Hence, price levels on an aggregate in the economy will tend to rise that in turn implies an adjustment in the nominal exchange rate such as in the USD/INR pair to these higher prices.

This is primarily what can be observed in the Indian economy. Service sector inflation such as in education, healthcare, household goods and furniture tend to be structurally higher reflecting a chronic demand-supply imbalance in the non-traded goods sector. Put differently, differential in the productivity growth rates between the traded goods sector and the non-traded goods sector works to keep Indian inflation higher than US inflation that works as an important exchange rate driver.

On the other hand, a 'negative sectoral productivity' gap that is slower productivity growth in the tradable goods sector has the converse effect on the exchange rate. However, if productivity growth is equally strong in the traded and non-traded sectors respectively the effect on the exchange rate is negligible.

3) Monetary policies channel: Money Supply and Interest Rate

Money Supply: An increase in money supply affects the exchange rate through inflation channel in the economy. It also affects the exchange rate directly.

An increase in money supply in the country relative to its demand will lead to large scale spending on foreign goods and services. Thus the supply of the currency in the foreign exchange markets is increased and its value declines. The downward pressure on the external value of the currency then increases the cost of imports and so adds to inflation.

The effect of money supply on exchange rate directly is more immediate than its effect through inflation. While in the long run inflation seems to correlate exchange rate variations in a better way, in the short run exchange rates move more in sympathy with changes in money supply.

One explanation of how changes in money supply vary the exchange rate is this; the total money supply in the country represents the value of total commodities and services in the country. Based on this the outside world determines the external value of the currency. If the money supply doubles, the currency will be valued at half the previous value so as to keep the external value of the total money stock of the country constant.

Another argument which is offered is that the excess money supply flows out of the country and directly exerts a pressure on the exchange rate. The excess money created, to the extent they are in excess of the domestic demand for money, will flow out of the country. This will increase the supply of the currency and pull down its exchange rate.

Interest rate: The interest rate generally has a great influence on the short – term movement of capital. When the interest rate in an economy rises, it tends to attract short term funds from overseas investors. This would increase the demand for the currency and hence its value. Rising of interest rate may be adopted by a country due to tight money conditions or as a deliberate attempt to attract foreign investment. Whatever be the intention, the effect of an increase in interest rate is to strengthen the currency of the country through larger inflow of investment and reduction in the outflow of investments by the residents of the country.

Understanding in the Indian context

Monetary policy is nothing but the policy adopted by India's central bank – the Reserve Bank of India (RBI), to meet its objectives of ensuring that inflation is stable and growth in the economy is around or above its trend level. The targets that are given to the RBI are stipulated in an act as determined by the government.

Since independence, the RBI has resorted to three different monetary regimes:

- It first employed a 'monetary targeting' regime from 1986-1998. During this regime, the RBI targeted broad money supply growth as it nominal anchor to influence price levels and growth in the economy.
- Post this regime, the RBI then resorted to a 'multiple indicator approach' from 1999-H12016. Under this framework, the RBI resorted to targeting a number of variables such as GDP growth, headline inflation rate (based on the WPI index), broad money supply growth, current account deficit, FX movements and bank credit growth.
- The RBI currently follows an 'inflation targeting regime'. As part of its regime, it is mandated to achieve an inflation target of 4% up to March-2021 with an upper tolerance of 6% and a lower limit of 2% with a focus on achieving macroeconomic stability to boost growth while keeping prices in check.

What does the RBI do?

The RBI, like any other global central bank, can either influence the price of money via making changes to domestic interest rates or influence the quantity of money by adjusting the quantum of domestic liquidity in the financial system. The

RBI primarily uses its policy rate such as the repo rate, which is the rate at which the domestic banking sector borrows money from the RBI, to influence interest rates in the local markets. For instance, the RBI can either cut or raise the repo rate that in turn works to influence the cost of money or funds in the banking system. The RBI looks to ensure that the liquidity in the financial system is in sync with its policy objectives—tighter liquidity is maintained when the RBI is hiking rates and vice-versa. Banks subsequently adjust their lending rates accordingly or put differently, changes in the RBI's policy rate tends to get transmitted to a wide spectrum of interest rates in the economy.

If one looks at the current juncture, the RBI has been cutting the repo rate primarily because of CPI inflation remaining well below its target level and as concerns about the growth outlook has intensified considerably. What must not be lost is that even as the RBI has a firm inflation target, it tends to look at forward looking indicators to predict the future path of inflation that might be. In this regard, weakening growth would suggest that price pressures could remain muted in the future that in turn opens up considerable space for the RBI to cut policy rates. The idea of reducing interest rates is to stimulate lending that could work to revive growth in the economy with a lag and ensure that the RBI does not undershoot its inflation target.

How are exchange rates influenced by monetary policy?

From an exchange rate perspective, the role of monetary policy is a direct extension of the PPP framework given that central banking decision making is influenced by price trends in the economy. However, historically interest rates have not played a substantial role in influencing the USD/INR pair as can be seen from the graph below. There are three reasons for this.

- The government has liberalized foreign investment into Indian debt markets very gradually over the last twenty-five years while the liberalization into Indian equity markets was a lot faster. This has meant that foreign investors have not been in a position to invest in local interest rate securities to a substantial degree. However, in recent times that have changed somewhat given that foreign investors are now allowed to invest a lot more than was the case about a decade back.
- Second, in deciding whether to invest in interest rate related securities investors typically do not just look at the level of prevailing interest rates alone. Instead, they look at a metrics that is referred to as 'real interest rates'. Real interest rates are nothing but the prevailing current interest rate minus the current inflation rates. The prevailing rate such as the repo rate or lending rate or yields on government bonds and corporate bonds are referred to as the nominal rate, the current level not adjusted for inflation. [Real interest rates = Nominal interest rates (prevailing interest rate like the repo rate) – inflation rate]. Investors typically look to invest in sectors that offer a substantial real return that is above the underlying inflation rate. If the real rates are negative that has been historically the case in India, then global investors tend not to have much appetite for such interest related securities.
- Lastly, global investors tend to have a lot of interest in investing in Indian equity markets because of the relative growth differentials that India offers to the rest of the world. Hence, RBI hiking rates because of concerns about inflation works to force investors to reduce their future expectations on growth that forces them to pull out money from Indian equity markets. RBI cutting rates tends to have the reverse effect as far as fund flows into the equity market are concerned. Hence, there have been several occasions in which the flows of funds have responded conversely to a rise in interest rates.

In short, the interest channel of exchange rate depreciation tends to be weak in the Indian context.

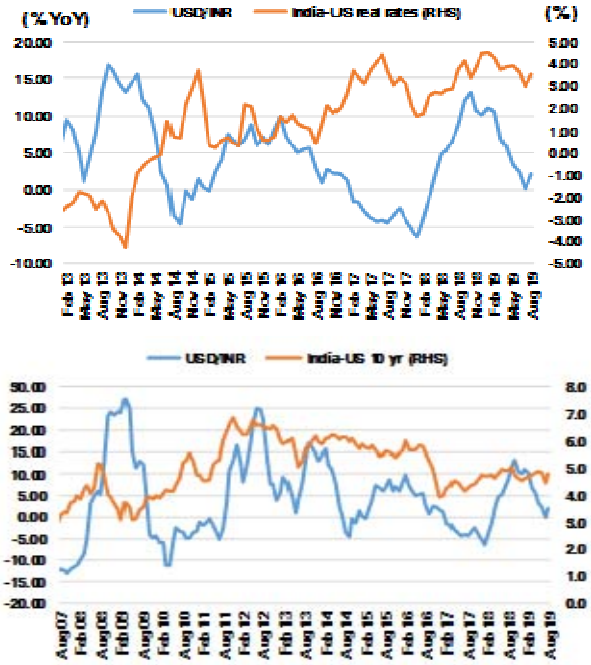


Figure 7: USD/INR and interest rate differentials: Not always a strong relation

4)The role of fiscal policy in influencing the exchange rate

Fiscal policy refers to policies and program that a government follows with respect to the government revenue and spending. Fiscal policies can affect the exchange rate in three different ways through income changes, price changes, and interest rates. Let's explore each now.

Income Changes

When the government lowers your taxes through fiscal policy, it puts more income in the hand of her citizens and thereby

increases their purchasing abilities. This usually results into an increased demand for goods and services and thereby likely to result into more imports of goods in the economy and inflationary pressure. Hence, a loose fiscal policy is likely to exert depreciation pressure on local currency and vice versa.

Price Changes

When the government wants to stimulate the economy through expansionary fiscal policies, either by reducing taxes or increased public spending, it leads to increased demand for goods and services and thereby pushes the overall price of goods and services higher.

As the prices of goods and services increases, it makes the exports of local goods to outside world more expensive and imports cheaper. This leads to higher demand for foreign currency to buy goods and lower demand for local currencies. The resultant impact is a lower exchange rate for local currency. On the other hand, a restrictive fiscal policy is characterized by a decrease in government spending or increases in taxes, and thereby leads to an opposite effect on the local currency.

Interest Rates

An expansionary fiscal policy or growing economy requires capital to fulfill its demand. This situation usually leads to rise in interest rates as demand for capital outgrows domestic savings. This higher domestic interest rate causes foreign savings to flow into the local economy as foreign investors get attracted to the higher interest rates for better return. Such foreign investment flows then lead to demand for local currency and hence supports the local currency value. On the contrary, restrictive fiscal policy leads to lower interest rates and likely to move capital out of the country which may push down the local exchange rate.

5) Relative growth differentials

Growth attracts capital and savings. A relative high local growth differential usually leads to appreciation in home currency as foreign investors chase domestic assets for better return, in all asset class, be it equity, fixed income or real estate. Also higher growth potential attracts long term money in form of foreign direct investment and thereby works as medium term appreciation factor for local currency.

6) Political and Policy stability

The stability in political leadership of an economy does influence the monetary and fiscal policies of the country. The stability on these counts induces confidence among both domestic and overseas investors on economic policy certainty leading to higher productivity and encourages capital inflows into the country. This has the effect of strengthening the currency of the country. On the other hand, where the political situation is unstable, it clouds the investor's horizon and may lead to withdrawal or curtailment of investments. Such situation usually leads to outflow of capital from the country and would weaken the currency.

A quick review of the INR's performance

The Rupee exchange rate market has witnessed sporadic bouts of volatility over the past decade or so. An analysis of the data shows that the exchange rate of USD/INR can be fairly volatile in the shorter-term than what the macro fundamental differentials framework alone would suggest. History indicates that the pace of structural depreciation of Rupee does not happen in an orderly and linear manner. We break-down the USD/INR pair's movement since prior to 2004-05 period by trying to identify key macroeconomic variables and BoP parameters that have played a role in driving price action in the pair.

Table 1: The INR is driven by multiple factors

	USD/INR Average for the period	Change in USD/INR YoY%	DXY	Current account % of GDP	Foreign investment % of GDP	Import cover (reserves /months)	Fiscal deficit % of GDP	CPI inflation (YoY%)	GDP growth (YoY%)	External debt to GDP ratio (%)	Short-term debt to total debt (%)
2004-05	44.9	-5.0	86.4	-0.3	2.1	14.3	-3.9	3.8	8.0	18.1	13.2
2005-06	44.3	-1.5	88.8	-1.2	2.6	11.6	-4.0	4.4	9.4	16.8	14
2006-07	45.3	2.2	85.2	-1.0	3.1	12.5	-3.3	6.7	9.2	17.5	16.3
2007-08	40.3	-11.0	78.5	-1.3	5.0	14.4	-2.5	6.2	9.8	18.0	20.4
2008-09	46.0	14.2	79.5	-2.3	2.3	9.8	-6.0	9.1	4.2	20.3	19.3
2009-10	47.4	3.2	79.1	-2.8	4.8	11.1	-6.5	12.3	8.4	18.2	20.1
2010-11	45.6	-4.0	80.7	-2.8	3.5	9.5	-4.8	10.5	10.3	18.2	20.4
2011-12	47.9	5.2	77.0	-4.2	2.8	7.1	-5.9	9.5	6.7	21.1	21.7
2012-13	54.4	13.5	80.9	-4.8	3.0	7.0	-4.9	10.0	5.5	22.4	23.6
2013-14	60.5	11.2	81.3	-1.7	1.9	7.8	-4.5	9.4	6.4	23.9	20.5
2014-15	61.1	1.1	86.2	-1.3	3.8	8.9	-4.1	5.8	7.4	23.9	18
2015-16	65.5	7.1	96.9	-1.1	2.0	10.9	-3.9	4.9	8.2	23.4	17.2
2016-17	67.1	2.4	97.8	-0.6	2.2	11.3	-3.5	4.5	7.1	20.0	18.7
2017-18	64.5	-3.9	93.9	-1.9	2.4	10.9	-3.5	3.6	6.5	20.5	19.3
2018-19	69.9	8.5	95.1	-2.1	1.1	9.3	-3.4	3.5	7.0	19.7	20.0

Source: RBI, IMF

We make the following observations:

- **Appreciation is rare:** Over the last fifteen years, there have only been five years in which there has been a downside bias in the USD/INR pairs or an annual appreciation trend in the INR. During these periods, a common theme has been: (a) The current account deficit not showing a sharp deterioration over the year, (b) The USD trades weak in the international markets reflecting funds moving from US markets into Indian markets and (c) foreign investment flows remain fairly strong. Besides, appreciation has almost always been followed by a sharp pace of depreciation the very next year itself.
- **Depreciation is the norm but the pace is not uniform:** Indeed, depreciation has been the norm for the majority of the period but the pace has not been uniform. The pace of depreciation intensified sharply over 2008-09, 2012-13 and 2013-14 that was driven not by a single factor but a multitude of factors reflecting a deterioration in the domestic macroeconomic landscape.
- **Important lessons from depreciation episodes:** We ignore the depreciation seen over 2008-09 that was primarily driven by one-off reaction to a global financial crisis as capital flows dwindled quite sharply. Instead, we focus on what when wrong over the 2011-14 period:

1. The current account deficit moved into unsustainable territory that started over 2011-12 and persisted over the

course of the period. However, the current account position improved over 2013-14 but that did not work to cap sharp depreciation pressures.

2. Local inflation rates moved sharply higher that started from 2008-09 and persisted up to 2013-14. The rise in local inflation rates was driven by both global factors such as a spurt seen in global crude oil prices over the period and local factors as fiscal policy turned more accommodative that drove food price inflation higher because the target of fiscal measures was on supporting the farm/rural sector.
3. Domestic growth was also much weaker as the economy faced several headwinds particularly from rising inflation rates and a sub-optimal policy environment.
4. Hence, the by-product of the adverse macroeconomic landscape—simultaneous rise in inflation, weakening growth, rising fiscal deficit and deterioration in the current account position—was the sharp disorderly weakness in the exchange rate.
5. Foreign investment flows exhibited some degree of inertia not falling sharply over 2010-2013 reflecting global monetary conditions that were fairly accommodative and easy. However, they fell quite sharply over 2013-14 driven by the 'taper tantrum' episode and as investors responded with a lag to the concerns about the domestic macro-economic landscape.

USD/INR: Building a forecasting model

We identify macroeconomic variables that drive the USD/INR exchange rate that is guided by economic theory. The idea is to build a model that best captures the trajectory of the pair. We subsequently employ an OLS model and test out different combinations to see which variables provide the best fit for the USD/INR pair. In the model the USD/INR pair is the dependent (y) variable. We use the following independent (x) variables:

1) Inflation = India CPI – US CPI. The β coefficient should have a positive sign indicating that a higher inflation differential works to push the pair higher.
2) OIS = India 1 year OIS – US 1 year OIS. The OIS curve has the advantage of reflecting policy rate differentials between the two different blocs. The β co-efficient should in theory be positive based on the CIP and the Uncovered Interest Parity (UIP, explained later in the report) implying that higher rate differentials should be adjusted for by exchange rate depreciation or a higher USD/INR pair.
3) Sovereign = India 1 year – US 1-year sovereign yield differentials. The sovereign yield differentials captures interest rate differentials as well as the difference in the credit profile of the two regions. The β co-efficient should have a positive sign.
4) Brent = Brent crude prices. Given that rising crude drives the import bill and trade deficit higher, there β co-efficient should have a positive sign because it implies an increase in local USD demand.
5) MSCI = MSCI EM equity market index. This is used as a proxy for risk sentiment given that EM equity markets tend to move in tandem. Improvement in global risk sentiment should drive EM equity markets higher on the back of an increase in fund flows. The Indian equity markets tend to have a strong correlation with EM equity indices and that is why we use this as an explanatory variable.
6) CNY = This is the USD/CNY pair. We use the USD/CNY pair given that it in recent times it has had a high degree of correlation with the USD/INR pair.

We use the sample period Jan-2012 to July-2019. One constraining factor is that the new Indian CPI index begins from 2012 onwards. The series prior to this was the CPI-IW but it is not considered as a robust indicator of price trends in the economy.

The Final Model: We tested out different combinations of the variables. **The monthly change in each variable was used to ensure that there were no problems of stationarity**[1]. We built the model in looking at the parameters that gave the lowest standard errors. We did not find Brent, sovereign and CNY to have a strong predictable power as all variables had relatively high standard errors. The final equation that we derived was as follows:

USD/INR = 0.288 + (0.255)*Inflation + (1.608)*OIS – (0.016)*MSCI

Table 2: Model results

		Constant	Inflation	OIS	MSCI	R-square
Final model	Coefficient	0.288	0.255	1.608	-0.016	0.481
	Standard error	0.084	0.114	0.363	0.002	

In other words, the monthly change in the USD/INR is a function of the respective monthly changes in inflation differentials, OIS spread and the MSCI index. The signs are compatible with theory. Rising inflation differentials works to drive upside bias in the USD/INR pair. A one unit change in the CPI inflation differential results in 0.255 change in the value of the USD/INR pair. A positive co-efficient for the OIS indicates that a rising interest rate differential leads to upward pressure on the spot prices. A one unit change in OIS results in 1.608 movement in the USD/INR pair. It also illustrates that rising local rates forces investors to lower their growth assessment for the region resulting in FPI outflows from equity markets. A negative MSCI is an indication of an improving global risk sentiment that works as a downside support for the USD/INR pair. A one unit change in the MSCI EM equity market index results in a -0.02 change in the USD/INR pair.

[1] The mean and variance of each term remains unchanged for the time period.

We have plotted the actual USD/INR movements with the fitted USD/INR and found that at least directionally it provides a good fit for the USD/INR pair.

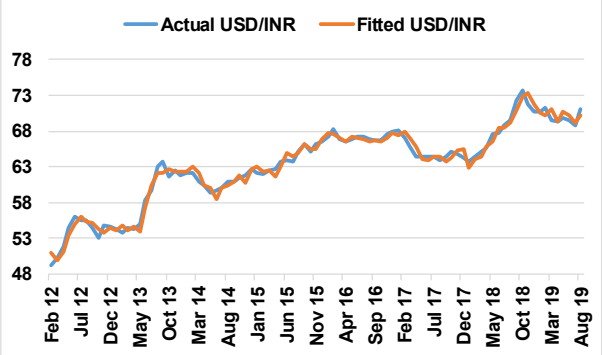


Figure 8: Fitted vs actual USDINR

Note: The fitted USD/INR is derived from the regression equation

What are FX forwards?

An FX forward is an agreement between two parties to purchase or sell foreign exchange at an agreed rate at a particular date in the future. The forward contract price is known as the forward rate. For instance, a three-month USD/INR forward currently at 4.5% p.a. implies that at the end of the period the parties can exchange the given amount of USDs for INR or vice-versa at the agreed differential rate irrespective of then prevailing market rate. Like the spot rate or other assets classes, forward rates are also driven by the prevailing market conditions of demand and supply via a market determined process.

The main premise behind forward rates is that exchange rate movements are driven by interest rate differentials. To understand the theoretical underpinning of how the forwards market works, two key conditions need to understood—**Covered Interest Parity (CIP)** and **Uncovered Interest Parity (UIP)**.

Covered Interest Parity: The CIP is considered a no-arbitrage condition in which the relationship between the interest rates and the spot and forward currency values of two countries are in equilibrium. In other words, a domestic investor should earn an equal return from investing in domestic assets or converting the currency at the spot exchange rate and investing in foreign currency assets subsequently exchanging the foreign currency for domestic currency at a market determined or negotiated forward rate. In theory, investors or corporations should be indifferent to the interest rates in these countries due to the equilibrium that arises via the forward rate. The CIP condition states that for no arbitrage opportunities the return on domestic interest rates $(i+i_d)$ should be equal to the return on US interest rates $\frac{F}{S}*(1+i_u)$. The differential interest rate adjustment normally happens through the movement in foreign exchange forward market.

The equation for CIP: $(i+i_d) = \frac{F}{S}*(1+i_u)$

Where: i_d = interest on domestic deposit rates, F = Forward rate, S = prevailing spot rate, i_u = interest on equivalent US deposit rate.

By re-arranging the equation the Forward rate $F= S*\frac{(i+i_d)}{(1+i_u)}$, where S is the prevailing spot rate. In simple terms, given the condition of covered interest rate parity the forward rate is simply a premium term that reflects the interest rate differentials between the Indian economy and the US economy.

Uncovered interest rate parity

The UIP is simply when the no-arbitrage condition is not satisfied. The difference in the interest rates between two countries works as the underlying driver in a manner such that the currency of the higher interest rate country will depreciate against the currency of the lower interest rate country to the extent that the interest rate differentials would suggest. However, there could be other variables that could be in play that influences the exchange rate. Hence, investors will be indifferent among the available interest rates in the two countries as the exchange rate adjusts with respect to the differential.

To test whether the forward exchange rate is an unbiased estimator of the future spot rate exchange, we use two approaches: (a) a formal regression analysis and (b) examining the trend of the actual spot rate versus the implied forward to calculate a forecasting error between the two variables and then making some important observations about the strength of forwards to predict the spot rate.

Two different equations are tested out:

A.) $S_{t+k}= \acute{\alpha}_i + \beta_i F_t + \mu$

This equation is defined as running a regression on the future spot exchange rate (S_{t+k}) on the current forward exchange rate F_t with an error term. If the forward exchange rate is a perfect predictor of the spot rate, then the β = 1 and ά = 0. We ran this regression for various tenors of the forwards curve—1 month, 3 month, 6 month and 1 year. Our observations on the results are as follows:

- We find that the β values for all the various regression to not be equal to 1 implying that forward rates do not act as an unbiased estimator for the spot rates. All the β values have a negative value.
- We find that the one and three-month forward tenors to not be statistically significant at the 5% level.
- However, the one year forward is statistically significant at the 5% level implying that the spot does over a longer period converge to levels that are consistent with interest differentials that the forwards curve is suggesting.

- This relationship can also be seen in the standard errors with it improving significantly for the one-year forward curve as compared to the one-month and three-month curves respectively.
- Also, each model has a very low R-square value indicating that it is a poor fit and the forwards are not a good forecaster for the spot rate.

Table 3: Results of the regression A

Results of the regression			
Forward tenor	α	β	R square
1 month	0.0005	-0.0315	0.001001
--Standard error	0.0044	0.0171	--
3 month	0.0005	-0.0205	0.000031
--Standard error	0.0044	0.0171	--
1 year	0.0008	-0.0053	0.000213
--Standard error	0.0044	0.0121	--

B.) S_{t+k}-S_t= $\acute{\alpha}_i$+ $\beta_i(F_t$-$S_t)$ + μ

This equation is defined as running a regression on the change in the spot rate (S_{t+k}-S_t) on the current forward-spot differential or forward premium (F_t-S_t) with an error term. If the forward premium is a good predictor of the change in the spot rate, then the β = 1 and ά = 0. The observations are as follows:

- These models are an extremely poor fit. None of the variables at the various tenors of 1 month, 3-month and 1 year are considered statistically significant and all of them have poor standard errors.
- None of the β values are equal to 1 that forces us to again reject the hypothesis that forwards are a perfect indicators of where the spot rate might move towards.

Table 4: Results of the regression B

Results of the regression			
Forward tenor	α	β	R square
1 month	0.2085	0.0027	0.000287
--Standard error	0.1912	0.0077	---
3 month	0.7795	-0.0119	0.000396
--Standard error	0.2126	0.0069	----
6 month	1.4956	-0.0027	0.000036
--Standard error	0.31	0.004	----
1 year	0.0031	-0.0011	0.000482
--Standard error	0.0131	0.0007	----

The following additional variables were plotted:

(a) The actual future spot rates and implied forward rate for the period were plotted from 2004-2018. The main insight from the graph shows that spot rate tends to follow the forward rate directionally over the medium-term. However, there can be sharp periods of variations that are fairly prominently visible.

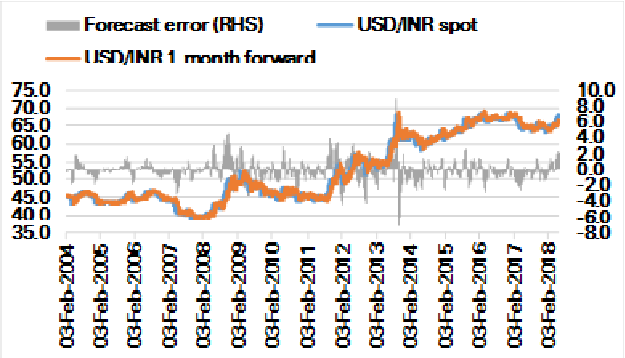


Figure 9: USD/INR vs USDINR 1m forward

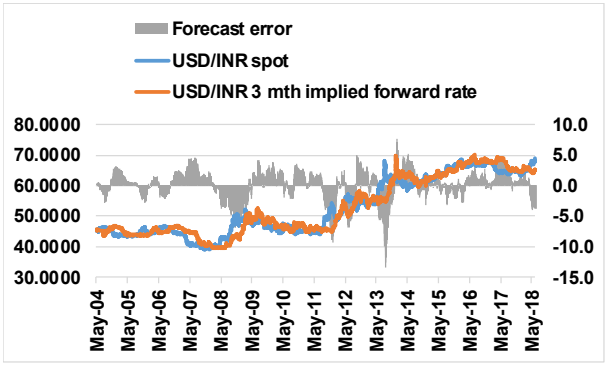


Figure 10: USD/INR vs USD/INR 3m implied forward rate

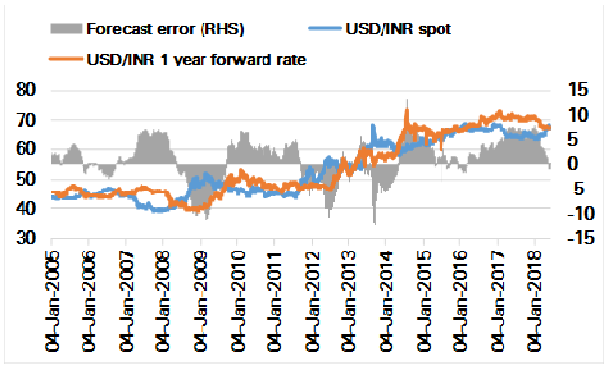


Figure 11: USD/INR vs USD/INR 1Y forward rate

(b) The forecast error that is equal to the spot rate minus the forward INR rate were also plotted. The forecast error does not follow a systematic pattern but is fairly random indicating that there have been several periods in which forwards have understated as well as several number of periods in which forwards have overstated the spot rate. The erratic nature of the forecast error is yet another indication of the poor forecasting accuracy of forward rates with respect to spot rates.

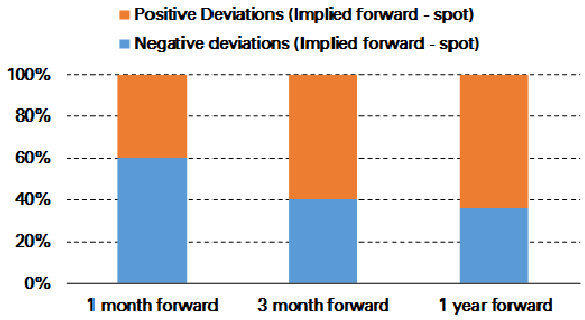


Figure 12: Deviations of spot from implied forward

c) An analysis that looks at the number of positive deviations versus the number of negative deviations there have been for the different tenors for the sample period of 2004-2018. We find that at shorter tenors the number of positive versus the number of negatives is almost equal to each other. However, as we can see from the longer tenors of the forwards market, we find that on average there have been more positive than negative deviations.

A further detailed analysis of the USD/INR spot performance against its forward curve was done over the last decade. The data revealed that the spot price movement over the longer period has moved in the direction of its forward curve, albeit at a lesser pace. However, in a shorter time frame, the actual spot movement has grossly deviated from its forward curve and necessitates the importance of hedging due to its two-way volatility.

Table 5: Details of market data

	Market Data (USD/INR)								
Year	Year Begin	Year Close	Avg Spot	Year High	Year Low	Year Range %	Avg Fwd (p.a)	Actual % move	Delta vs Fwd (agst Avg spot)
	(i)	(ii)	(iii)	(iv)	(v)	(vi) = {(iv)-(v)/(iii)}	(i)	(iii)/(i)	
2018-2019	68.04	69.17	69.89	74.39	64.93	13.53%	4.20%	8.44%	4.16%
2017-2018	64.84	65.04	64.45	65.76	63.35	3.74%	4.59%	-3.94%	-8.53%
2016-2017	66.33	64.84	67.09	68.72	64.84	5.79%	5.65%	2.49%	-3.16%
2015-2016	62.59	66.33	65.46	68.78	62.16	10.11%	6.97%	7.06%	0.09%
2014-2015	60.10	62.59	61.15	63.75	58.43	8.71%	8.17%	1.08%	-7.09%
2013-2014	54.39	60.10	60.49	68.36	53.74	24.18%	8.37%	11.10%	2.73%
2012-2013	51.16	54.39	54.43	57.22	50.36	12.22%	7.14%	13.57%	6.43%
2011-2012	44.65	51.16	47.95	54.24	43.96	21.46%	6.32%	5.20%	-1.12%
2010-2011	46.14	44.66	46.59	47.67	44.02	7.77%	6.40%	2.00%	0.20%
Time series average						11.94%	6.32%	4.57%	-1.75%

Key Observations

1. Out of 9 annual observations, spot Rupee has appreciated only on 2 occasions. In other words, in 3/4th observation, spot USD/INR has moved in the direction of its forward curve. This validates the "Purchasing Power Parity" theory of exchange rate modeling. Given that Indian inflation has always been higher than US, Rupee will have the tendency of depreciation against Dollar.
2. The above data analysis shows that USD/INR exchange rate has broadly followed the glide path of its forward curve over medium term. However, it has also been observed that over long period forward curve has often overpriced the Rupee deprecation. There can be possible reasons which we can be ascribed to this; (i) the short term forward curve doesn't necessarily factor the long term improvement in productivity differential (ii) there is a higher credit spread of Rupee assets against the US Dollar.
3. On an average, the delta gains of staying short Dollar against forward curve is relatively lower as compared to the annual volatility or yearly range.

Table 6: Observations on hedge ratio

No. of Monthly Observation	108
Observation deviated from implied Forward Rate	108

Risk Tolerance (v/s forward rate)	0.50%	1.00%
No. of observation - Breached	83	56
No. of observation - Not Breached	25	52
Total Observation	108	108
Recommendatory Hedge Ratio	76.85%	51.85%

Corporate Risk Management

The imperfect relationship between spot and forward exchange rates in the short term raises the question of efficacy of forward contracts. However, given that exchange rate risk is a by-product of corporate commercial decisions and such risk is asymmetric, forward contracts provide hedge effectiveness and brings certainty to the cash flows. The forecasting errors due to the imperfect relationship between spot and forward exchange rates in the short term can be addressed through appropriate usage of option contracts in the overall hedging arsenal.

The appropriate hedge ratio for an Indian corporates is always a function of its management philosophy and risk tolerance level. A higher tolerance level is always a function of business margin and shock absorption capacity and vice versa. The back tested data as shown in Appendix tables 1 and 2 over a long period shows that corporates with lesser risk tolerance level (assumed at 0.5% deviation from its forward price) should ideally maintain a very high hedge ratio (75%) at all times for their trade exposures. In case of higher risk tolerance level (deviation of 1% or above against forward rate), the corporate can work around with 50% hedge ratio for current account exposures. In case of balance sheet liability exposure having elongated maturity profile, given that spot depreciation of Rupee has largely underperformed the forward curve, the corporate can keep the exposures open till it turns into a current account exposure (having maturity of less than 1 year), wherein the proactive management of the risk can be undertaken based on the above matrix.

Key conclusions

1. There are multiple macro variables which determine the exchange rate movements. The divergence and collective ability of the market participants in interpretation of such macro variables influences the short term demand supply

in the foreign exchange market. This hypothesis suggests that realized spot is often different from the forward rate in the short term.

2. The determination of interest rates and exchange rates is a simultaneous process. Because interest rates are directly observable and exchange rate expectations are not, forward rate is often thought of as a hypothesis about exchange rate expectations. Though the covered interest rate hypothesis suggest that exchange rate change between two currencies would be reflective of corresponding interest rate differential between those two countries, observable data shows it doesn't happen in the short term. Over the medium term, the directional indicator of forward rate does hold to some extent.
3. In practice also, we often found that surveyed market expectation of spot rates generally differs from forward exchange rates. It leads us to conclude that exchange rate expectations are not necessarily reflected in short-term interest rate differentials/ forward rates.
4. The relationship between spot rates and forward exchange rates has been widely studied in the past also to test how efficient financial markets are. Typical tests have been whether forward rates have, on an average over time, equaled the spot rates at such future dates– that is, whether forward rates provided unbiased predictions of future spot rates. Despite many formal studies the unbiasedness hypothesis of forward rates has remained largely unresolved. Given how volatile financial market prices can be, it is often difficult to determine the answers to this question using formal statistical techniques.
5. A less stringent hypothesis that can be tested is to see how well forward rates indicated whether spot rates would go up or down, rather than picking the direction as well as the extent. The analysis shows that actual changes in spot rates are caused by information not embodied in forward market prices at the time the forward rates were determined. This raises the question as to what extent was this information 'not known', as distinct from being 'not reflected' in forward rates. In other words, did forward rates get it wrong because the market failed to take into account relevant information at the time, or because events unfolded in a way in which it genuinely could not have predicted?
6. To put everything into perspective, the spot rate changes varies from forward rate by a wide margin in short term is not surprising given that we deal with a reasonably short horizon. Numerous studies have documented the fact that economic fundamentals exert themselves more strongly over the longer-term. That is, what should happen according to fundamental theories does tend to happen, but it takes time. The short-term movement in prices generally characterized by a lot of 'noise' and hence volatility. In summary, taking the forward rate as an indicator of near term spot expectation is fraught with error. Over a longer time horizon however, the forward rate can be taken as a good directional indicator as fundamental reasons behind forward differential tends to get reflected in spot prices.
7. The very fact that future spot rates are difficult to predict explains the value and popularity of forward contracts – they offer certainty in an uncertain world. The paradox is that if forward rates were good at predicting future spot rates – so that markets knew where spot rates would be in the future – there would be little demand for forward products.

In summary, the exchange rate forecasting and determination is too complex a subject to be fitted in a single model. This is amplified by the fact that despite being the most liquid amongst all asset classes in the world, the volatility in foreign exchange is the highest. These aspects underline the importance of proper risk management strategies for corporates who use the currency derivative markets as a hedge.

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Appendix

Table 1: Model variables and risk tolerance levels

		Market Data (USD/INR)										Risk Tolerance Level	
Year		Period Start	Period End	Avg Spot	Period High	Period Low	Period Range %	Avg Fwd (p.m)	Actual Spot % move	Delta vs Fwd (agst Avg spot)	Actual Deviation (v/s Fwd)	Deviation > 0.5%	Deviation > 1.0%
		(i)	(ii)	(iii)	(iv)	(v)	= {(iv)-(v)/(	(i)	(iii)/(i)				
2018-2019	Apr	65.04	66.78	65.64	66.83	64.93	2.90%	0.35%	0.95%	-0.59%	0.95%	Yes	No
	May	66.78	67.45	67.54	68.39	66.61	2.63%	0.35%	2.90%	-2.55%	2.90%	Yes	Yes
	Jun	67.45	68.58	67.79	68.94	67.02	2.83%	0.35%	0.38%	-0.03%	0.38%	No	No
	Jul	68.58	68.61	68.69	69.05	68.30	1.10%	0.37%	1.33%	-0.96%	1.33%	Yes	Yes
	Aug	68.61	70.93	69.55	70.93	68.36	3.69%	0.38%	1.24%	-0.87%	1.24%	Yes	Yes
	Sep	70.93	72.55	72.22	72.81	70.77	2.83%	0.40%	3.84%	-3.44%	3.84%	Yes	Yes
	Oct	72.55	73.99	73.63	74.39	72.80	2.15%	0.40%	1.96%	-1.56%	1.96%	Yes	Yes
	Nov	73.99	69.66	71.85	73.83	69.66	5.81%	0.36%	-2.41%	2.77%	2.41%	Yes	Yes
	Dec	69.66	69.79	70.73	72.04	69.79	3.18%	0.36%	-1.56%	1.92%	1.56%	Yes	Yes
	Jan	69.79	71.03	70.73	71.38	69.48	2.68%	0.34%	0.00%	0.34%	0.00%	No	No
	Feb	71.03	71.20	71.22	71.75	70.55	1.67%	0.33%	0.69%	-0.36%	0.69%	Yes	No
	Mar	71.20	69.17	69.48	70.97	68.58	3.43%	0.44%	-2.45%	2.88%	2.45%	Yes	Yes
2017-2018	Apr	64.84	64.22	64.51	65.04	64.00	1.62%	0.45%	-2.08%	2.53%	2.08%	Yes	Yes
	May	64.22	64.55	64.42	64.99	64.02	1.50%	0.42%	-0.13%	0.55%	0.13%	No	No
	Jun	64.55	64.74	64.44	64.74	64.26	0.74%	0.40%	0.03%	0.38%	0.03%	No	No
	Jul	64.74	64.08	64.46	64.82	64.08	1.15%	0.41%	0.02%	0.39%	0.02%	No	No
	Aug	64.08	64.02	63.97	64.24	63.63	0.96%	0.40%	-0.76%	1.15%	0.76%	Yes	No
	Sep	64.02	65.36	64.44	65.76	63.87	2.94%	0.38%	0.74%	-0.36%	0.74%	Yes	No
	Oct	65.36	64.77	65.08	65.55	64.76	1.22%	0.39%	0.99%	-0.61%	0.99%	Yes	No
	Nov	64.77	64.43	64.86	65.52	64.41	1.71%	0.37%	-0.34%	0.70%	0.34%	No	No
	Dec	64.43	63.93	64.24	64.54	63.93	0.95%	0.33%	-0.96%	1.29%	0.96%	Yes	No
	Jan	63.93	63.69	63.64	63.98	63.35	0.99%	0.35%	-0.94%	1.30%	0.94%	Yes	No
	Feb	63.69	65.10	64.37	65.10	63.61	2.32%	0.36%	1.16%	-0.79%	1.16%	Yes	Yes
	Mar	65.10	65.04	65.02	65.23	64.80	0.66%	0.42%	1.01%	-0.58%	1.01%	Yes	Yes
2016-2017	Apr	66.33	66.52	66.47	66.73	66.24	0.74%	0.59%	-0.82%	1.41%	0.82%	Yes	No
	May	66.52	67.20	66.91	67.71	66.27	2.15%	0.55%	0.66%	-0.11%	0.66%	Yes	No
	Jun	67.20	67.62	67.30	68.01	66.63	2.06%	0.53%	0.58%	-0.06%	0.58%	Yes	No
	Jul	67.62	67.03	67.21	67.50	66.91	0.87%	0.53%	-0.13%	0.67%	0.13%	No	No
	Aug	67.03	66.98	66.94	67.19	66.74	0.68%	0.54%	-0.40%	0.94%	0.40%	No	No
	Sep	66.98	66.66	66.74	67.06	66.36	1.05%	0.54%	-0.30%	0.84%	0.30%	No	No
	Oct	66.66	66.86	66.75	66.89	66.53	0.54%	0.50%	0.01%	0.49%	0.01%	No	No
	Nov	66.86	68.53	67.63	68.72	66.43	3.40%	0.36%	1.32%	-0.96%	1.32%	Yes	Yes
	Dec	68.53	67.95	67.90	68.37	67.43	1.39%	0.35%	0.41%	-0.06%	0.41%	No	No
	Jan	67.95	67.81	68.08	68.23	67.79	0.65%	0.41%	0.26%	0.14%	0.26%	No	No
	Feb	67.81	66.74	67.08	67.65	66.72	1.37%	0.39%	-1.48%	1.87%	1.48%	Yes	Yes
	Mar	66.74	64.84	65.88	66.85	64.84	3.05%	0.45%	-1.79%	2.23%	1.79%	Yes	Yes
2015-2016	Apr	62.59	63.58	62.75	63.61	62.16	2.32%	0.65%	0.49%	0.17%	0.49%	No	No
	May	63.58	63.76	63.80	64.20	63.52	1.07%	0.66%	1.67%	-1.01%	1.67%	Yes	Yes
	Jun	63.76	63.75	63.86	64.18	63.51	1.05%	0.61%	0.09%	0.51%	0.09%	No	No
	Jul	63.75	64.01	63.63	64.03	63.37	1.02%	0.61%	-0.35%	0.96%	0.35%	No	No
	Aug	64.01	66.31	65.07	66.71	63.76	4.53%	0.61%	2.26%	-1.65%	2.26%	Yes	Yes
	Sep	66.31	65.74	66.22	66.74	65.63	1.69%	0.56%	1.76%	-1.20%	1.76%	Yes	Yes
	Oct	65.74	65.22	65.06	65.55	64.73	1.27%	0.56%	-1.75%	2.31%	1.75%	Yes	Yes
	Nov	65.22	66.81	66.12	66.81	65.45	2.06%	0.57%	1.63%	-1.06%	1.63%	Yes	Yes
	Dec	66.81	66.33	66.60	67.04	66.14	1.36%	0.53%	0.72%	-0.19%	0.72%	Yes	No
	Jan	66.33	67.88	67.25	68.09	66.18	2.84%	0.54%	0.99%	-0.45%	0.99%	Yes	No
	Feb	67.88	68.62	68.24	68.78	67.64	1.67%	0.56%	1.47%	-0.90%	1.47%	Yes	Yes
	Mar	68.62	66.33	67.02	68.16	66.33	2.72%	0.76%	-1.78%	2.54%	1.78%	Yes	Yes
2014-2015	Apr	60.10	60.34	60.36	61.12	59.65	2.44%	0.70%	-1.08%	1.78%	1.08%	Yes	Yes
	May	60.34	59.03	59.31	60.23	58.43	3.03%	0.69%	-1.74%	2.44%	1.74%	Yes	Yes
	Jun	59.03	60.09	59.73	60.37	59.06	2.19%	0.71%	0.72%	0.00%	0.72%	Yes	No
	Jul	60.09	60.25	60.06	60.33	59.72	1.01%	0.74%	0.55%	0.19%	0.55%	Yes	No
	Aug	60.25	60.47	60.90	61.56	60.43	1.86%	0.76%	1.39%	-0.64%	1.39%	Yes	Yes
	Sep	60.47	61.61	60.86	61.61	60.26	2.22%	0.72%	-0.05%	0.77%	0.05%	No	No
	Oct	61.61	61.41	61.34	61.75	61.04	1.16%	0.68%	0.78%	-0.10%	0.78%	Yes	No
	Nov	61.41	61.97	61.70	62.10	61.39	1.16%	0.65%	0.59%	0.06%	0.59%	Yes	No
	Dec	61.97	63.33	62.75	63.75	61.85	3.02%	0.67%	1.70%	-1.03%	1.70%	Yes	Yes
	Jan	63.33	61.76	62.23	63.45	61.41	3.28%	0.64%	-0.84%	1.48%	0.84%	Yes	No
	Feb	61.76	61.79	62.04	62.43	61.68	1.21%	0.65%	-0.30%	0.95%	0.30%	No	No
	Mar	61.79	62.59	62.45	62.82	61.82	1.60%	0.75%	0.66%	0.09%	0.66%	Yes	No

Table 2: Model variables and risk tolerance limits

		Market Data (USD/INR)										Risk Tolerance Level	
Year		Period Start	Period End	Avg Spot	Period High	Period Low	Period Range %	Avg Fwd (p.m)	Actual Spot % move	Delta vs Fwd (agst Avg spot)	Actual Deviation (v/s Fwd)	Deviation >0.5%	Deviation >1.0%
		(i)	(ii)	(iii)	(iv)	(v)	= {(iv)-(v)/	(i)	(iii)/(i)				
2013-2014	Apr	54.39	54.22	54.38	54.88	53.94	1.73%	0.63%	-0.05%	0.68%	0.05%	No	No
	May	54.22	56.50	55.01	56.50	53.74	5.02%	0.59%	1.17%	-0.57%	1.17%	Yes	Yes
	Jun	56.50	59.70	58.46	60.59	56.42	7.12%	0.56%	6.27%	-5.71%	6.27%	Yes	Yes
	Jul	59.70	61.12	59.79	61.12	58.91	3.68%	0.68%	2.27%	-1.60%	2.27%	Yes	Yes
	Aug	61.12	66.57	63.21	68.36	60.74	12.05%	0.84%	5.72%	-4.88%	5.72%	Yes	Yes
	Sep	66.57	62.78	63.75	67.03	61.75	8.28%	0.86%	0.86%	0.00%	0.86%	Yes	No
	Oct	62.78	61.41	61.62	62.36	61.16	1.95%	0.80%	-3.35%	4.15%	3.35%	Yes	Yes
	Nov	61.41	62.39	62.63	63.65	61.79	2.98%	0.74%	1.65%	-0.91%	1.65%	Yes	Yes
	Dec	62.39	61.90	61.91	62.38	61.18	1.94%	0.76%	-1.15%	1.92%	1.15%	Yes	Yes
	Jan	61.90	62.48	62.08	62.99	61.35	2.64%	0.72%	0.27%	0.45%	0.27%	No	No
	Feb	62.48	62.07	62.25	62.69	61.94	1.21%	0.71%	0.29%	0.42%	0.29%	No	No
	Mar	62.07	60.10	61.01	61.90	60.10	2.96%	0.87%	-1.99%	2.86%	1.99%	Yes	Yes
2012-2013	Apr	51.16	52.52	51.80	52.79	50.56	4.30%	0.71%	2.94%	-2.23%	2.94%	Yes	Yes
	May	52.52	56.42	54.47	56.42	52.86	6.55%	0.65%	5.16%	-4.51%	5.16%	Yes	Yes
	Jun	56.42	56.31	56.03	57.22	55.15	3.70%	0.61%	2.86%	-2.25%	2.86%	Yes	Yes
	Jul	56.31	55.81	55.49	56.38	54.55	3.28%	0.64%	-0.96%	1.59%	0.96%	Yes	No
	Aug	55.81	55.72	55.56	56.08	55.15	1.69%	0.65%	0.12%	0.54%	0.12%	No	No
	Sep	55.72	52.70	54.61	55.97	52.70	6.00%	0.60%	-1.72%	2.32%	1.72%	Yes	Yes
	Oct	52.70	54.12	53.02	54.17	51.62	4.80%	0.61%	-2.90%	3.50%	2.90%	Yes	Yes
	Nov	54.12	54.53	54.78	55.70	53.66	3.72%	0.59%	3.30%	-2.72%	3.30%	Yes	Yes
	Dec	54.53	54.78	54.65	55.09	54.20	1.62%	0.63%	-0.23%	0.86%	0.23%	No	No
	Jan	54.78	53.29	54.32	55.33	53.29	3.75%	0.61%	-0.61%	1.21%	0.61%	Yes	No
	Feb	53.29	53.77	53.77	54.48	52.97	2.80%	0.59%	-1.00%	1.59%	1.00%	Yes	No
	Mar	53.77	54.39	54.40	55.05	54.10	1.75%	0.73%	1.17%	-0.44%	1.17%	Yes	Yes
2011-2012	Apr	44.65	44.38	44.37	44.68	44.04	1.44%	0.59%	-1.38%	1.97%	1.38%	Yes	Yes
	May	44.38	45.03	44.90	45.38	44.30	2.41%	0.53%	1.21%	-0.68%	1.21%	Yes	Yes
	Jun	45.03	44.72	44.85	45.10	44.61	1.09%	0.54%	-0.12%	0.65%	0.12%	No	No
	Jul	44.72	44.16	44.42	44.69	43.95	1.66%	0.53%	-0.97%	1.50%	0.97%	Yes	No
	Aug	44.16	46.02	45.28	46.13	44.05	4.59%	0.24%	1.94%	-1.70%	1.94%	Yes	Yes
	Sep	46.02	48.93	47.64	49.67	45.90	7.93%	0.38%	5.21%	-4.83%	5.21%	Yes	Yes
	Oct	48.93	48.87	49.26	50.07	48.82	2.53%	0.47%	3.40%	-2.93%	3.40%	Yes	Yes
	Nov	48.87	52.17	50.84	52.70	49.08	7.13%	0.52%	3.22%	-2.70%	3.22%	Yes	Yes
	Dec	52.17	53.27	52.67	54.24	51.35	5.47%	0.65%	3.59%	-2.94%	3.59%	Yes	Yes
	Jan	53.27	49.68	51.35	53.30	49.50	7.39%	0.73%	-2.51%	3.24%	2.51%	Yes	Yes
	Feb	49.68	48.94	49.16	49.64	48.68	1.96%	0.71%	-4.25%	4.96%	4.25%	Yes	Yes
	Mar	48.94	51.16	50.32	51.31	49.15	4.28%	0.82%	2.36%	-1.54%	2.36%	Yes	Yes
2010-2011	Apr	45.14	44.44	44.50	44.73	44.33	0.90%	0.27%	-2.20%	2.47%	2.20%	Yes	Yes
	May	44.44	46.45	45.80	47.57	44.56	6.57%	0.25%	2.93%	-2.69%	2.93%	Yes	Yes
	Jun	46.45	46.60	46.56	47.28	45.64	3.52%	0.34%	1.66%	-1.32%	1.66%	Yes	Yes
	Jul	46.60	46.46	46.84	47.33	46.46	1.86%	0.40%	0.58%	-0.18%	0.58%	Yes	No
	Aug	46.46	47.08	46.57	47.08	46.02	2.28%	0.43%	-0.57%	1.00%	0.57%	Yes	No
	Sep	47.08	44.92	46.06	46.87	44.92	4.23%	0.47%	-1.09%	1.56%	1.09%	Yes	Yes
	Oct	44.92	44.54	44.41	44.74	44.03	1.60%	0.59%	-3.58%	4.17%	3.58%	Yes	Yes
	Nov	44.54	46.04	45.02	46.04	44.25	3.98%	0.56%	1.36%	-0.80%	1.36%	Yes	Yes
	Dec	46.04	44.81	45.16	45.70	44.81	1.97%	0.54%	0.32%	0.22%	0.32%	No	No
	Jan	44.81	45.95	45.39	45.95	44.67	2.82%	0.53%	0.52%	0.01%	0.52%	Yes	No
	Feb	45.95	45.18	45.44	45.81	45.11	1.54%	0.53%	0.09%	0.43%	0.09%	No	No
	Mar	45.18	44.65	44.99	45.27	44.65	1.38%	0.63%	-0.98%	1.61%	0.98%	Yes	No