# Trade Misinvoicing and Macroeconomic Outcomes in India[1]

Raghbendra Jha and Duc Nguyen Truong

Australian National University

ABSTRACT

This paper has two main objectives. First, it computes capital flight (CF) through trade misinvoicing from India using data from UNCOMTRADE, MIT Observatory of Economic Complexity and IMF E-library. India's trade with 17 countries over the period 1988-2012 is considered. We find that CF has accelerated since 2004 and particularly sharply since 2007. It peaked at nearly $40 billion in 2008 with the total outflow between 1988-2012 exceeding $186 billion. Second, we model the mutual dependence of GDP growth, CF, and various risk factors in a VAR framework. We find that the VAR models chosen fit the data well. We conduct impulse response function analysis, forecast the key variables until 2020 and forecast error variance decomposition. Broadly we find that, if left undisturbed, CF through trade misinvoicing will continue to be high and play a significant macroeconomic role. Thus, CF needs to be checked urgently not only because it is a drain of the country's resources but also because it continues to have a significant and, by its very nature, uncontrollable effect on the economy. At least some of the failures of current macroeconomic policy in India could be attributed to CF.

Keywords: Trade Misinvocing, VAR, Impulse Response, Forecasting, India.

JEL Codes: E170, F32, F47, K42

Address all correspondence to:

Prof. Raghbendra Jha,
Arndt-Corden Department of Economics,
Crawford School of Public Policy,
College of Asia and the Pacific,
Coombs Building (09),
The Australian National University,
Canberra, ACT 0200, Australia.
Phone: +61 2 6125 2683, +61 2 6125 4482,
Fax:+ 61 2 6125 0443
Email: r.jha@anu.edu.au

[1] We wish to thank Hoa Nguyen for her help with the analysis in this paper. The usual caveat applies.

## I. Introduction

Illegal capital outflow, particularly from developing countries, has become an issue of major concern with attendant rapid growth in the literature. Thus, World Bank and Stolen Assets Recovery Initiative (StAR) report published in 2011 (World Bank and StAR2011) provides a useful summary of methods used by corrupt practitioners to convert potential public gains for the many to private gain for a few. Some of its deleterious consequences for developing countries are discussed in a number of publications, including Collier (2013).

One aspect of such corruption is illicit financial flows (IFF) from developing countries to tax havens and other destinations. IFF are intrinsically hard to measure particularly because many illicit transactions are settled in cash so that there is no paper trail to follow with the consequence that it is difficult to decipher the magnitude of IFF from published official data. Kar and LeBlanc (2013) at Global Financial Integrity have put together a methodology for estimating IFF for several developing countries.

The contribution of this paper is to compute data on trade misinvoicing for India for the period 1988-2012 and to relate it to key macroeconomic variables. Since no other components of IFF are being considered in this paper we will refer to the amounts involved in trade misinvoicing as capital flight (CF). This has long been recognized as one of the principal components of IFF. We then conduct time series analysis of the interaction between CF and key macroeconomic aggregates. This underscores the importance of CF in influencing and being influenced by other key macroeconomic variables. To that extent macroeconomic policy that ignores CF is likely to be less successful than anticipated.

The plan of this paper is as follows. In section II we discuss the data and methodology. Section III lays out key features of our estimates for CF for India for the period 1988-2004. Section IV presents our results for the VAR analysis and section V concludes.

## II. Estimating Trade Misinvoicing for India

In this paper, as in the literature, CF is assumed to take place through both exports and imports and can be computed through comparisons of bilateral trade flows. India's exports f.o.b. to country *j* ($E_{ij}$) are compared to country *j*'s recorded imports $M_{ji}$ from India after adjusting for insurance and freight. We take 1.1 to be the factor to convert c.i.f. values into f.o.b. values. On the import side we convert India's imports from country j ($M_{ij}$) to f.o.b. value and compare it with country *j* reports as having exported to India. For any year underinvoicing of exports and overinvoicing of imports are added to arrive at an estimate of outflow from India to that country. This magnitude is added across countries to arrive at an aggregate figure of outflow or inflow from India from CF for that year.

**Formula to Calculate Trade Misinvoicing:**

Following UNComtrade (2014), imports are recorded as a CIF price and exports are recorded as FOB price. CIF price = FOB price + insurance and freight. Therefore, when comparing the export and import values reported by a country and its trading partner, the CIF should be adjusted by a factor β. β is different among countries depending on the location of each country. However, an average β of 1.1 which include insurance and freight of 10% is acceptable (Kar and LeBlanc, 2013). Consider Export (E) and Import (M) values of Country *i* and its trading partner, Country *j*. CF through trade misinvoicing has two components – one comparing imports coming into country *i* with exports reported from country *j*. The second component compares exports from country *i* with imports reported by country *j*. The first component can be written as:

$$\text{Outflow from country } i = (M_i)/1.1 - E_j \quad (1)$$

Following this formula, if the reported (adjusted) value of country *i's* import from country *j* is higher than the value of exports (to country *i)* reported by country *j* there is a commensurate outflow from country *i*. If this difference is negative money flows in. For example, if India reports that it imports $ 2 billion worth of goods and services from Switzerland and sends $ 2 billion abroad, but Switzerland reports that its export to India is only $ 1 billion, there is an outflow of $ 1 billion from India.

Similarly, the second component of CF through Trade Misinvoicing can be written as:

$$\text{Inflow into country } i = E_i - (M_j)/1.1 \quad (2)$$

Following this formula, if country *i*'s reported export value is higher than country *j*'s (adjusted) import reported value, $Inflow_i > 0$, whereby flows into country *i*. If $Inflow_i < 0$, money flows out from country *i*. For example, India's export reported value to Switzerland is $ 2 billion, but Switzerland reports (an adjusted) value of only $ 1 billion then $1 billion flows into country India. Thus, total capital flight is:[2]

$$CF = Outflow_i – Inflow_i = [(M_i)/1.1 - E_j] – [E_i - (M_j)/1.1] \quad (3)$$

Data for the analysis in this paper was obtained from UN COMTRADE Standard International Classification (SITC) Rev.3. For the period 1988-2012 we tried to get data[3] for 20 most significant trade partners of India. However, we could obtain data only for 17 countries: United Arab Emirates (UAE), Brazil, Switzerland, China, Germany, France, United Kingdom, Hong Kong China, Indonesia, Italy, Japan, South Korea, Kuwait, the Netherlands, Singapore, United States and South Africa. Even so the COMTRADE data had to be supplemented with MIT Observatory of Economic Complexity data (MIT, 2014). Some macroeconomic data were obtained from IMF E-library. Table 1 provides details of data

[2] Capital flight if CF > 0, Capital flow in if CF < 0.

[3] Data of the period earlier than 1988 are difficult to compile on a consistent basis.

obtained from the latter source and also some interpolations that were done using EViews8 cubin spline to fill in some gaps. Most of these adjustments had to be done for the early part of this period, whence our estimates for recent years are likely to be robust.

**Table 1 here.**

## III. Key Features of CF Estimates

Aggregate estimates of outflows (inflows) from CF are presented in Table 2 and depicted in Figure 1.[4]

**Table 2 and Figure 1 here.**

Until about 1996 IFF through CF was subdued and even recorded the odd year of inflow. IFF accelerated from 1997, fell in 1999 and remained stabilized between 2000 and 2003. There was a sharp acceleration in 2004 and particularly since 2007. There was a sharp drop in 2009 followed by another acceleration the following year and a milder drop in 2011. At its peak in 2008 nearly $40 billion was illegally transferred out of India through CF. Perhaps this peak was influenced by the Global Financial Crisis of 2008. Total outflow through trade misinvoicing during the period 1988-2012 exceeds $186 billion. These are astounding figures indeed!

We next present information on the behaviour of key macroeconomic aggregates for the Indian economy. Since the CF figures are in US$ Figure 2 presents data on GDP growth in US $ terms (Figure 2a for real GDP growth and Figure 2b for nominal GDP growth). In the rest of the paper we will present analyses with respect to both.

**Figures 2a and 2b here.**

[4] Details for individual countries can be obtained from the corresponding author.

We now present some evidence on key macroeconomic aggregates with which we purport to relate and CF and GDP growth. Figure 3 plots the co-movement of Indian and US real interest rates (defined as lending rates minus inflation) whereas Figure 4 plots differences between Indian and US real interest rates. Except for short spells Indian real interest rates are always higher than US real interest rates. This points to the possibility that differences in the levels of real interest rates may not be influencing capital flight.

**Figures 3 and 4 here.**

We also include into the analysis interest rate risk (calculated as square root of (interest rate-trend interest rate)$^2$). Figure 5 reports interest rate risk for India whereas Figure 6 compares interest rate risks for India and the US. As indicated by Figure 7 except for short periods interest rate risk in India is higher than that in the US. This differential may be a factor influencing CF.

**Figures 5, 6 and 7 here.**

Figure 8 depicts inflation risk for India. This is calculated as follows as the square root of the square of the deviation between current deviation form trend inflation, the latter computed using a Hedrick-Prescott filter. High episodes of inflation are associated with aggravated inflation risk. Figure 9 charts out difference in inflation risk between India and the US.

**Figures 8 and 9 here.**

Figure 10 charts out exchange rate risk for India whereas figure 11 compares the interest rate risk differential with the inflation rate risk differential. From Figure 11 we find that interest rate risk differential and inflation risk differential nearly overlap. So, to avoid collinearity we include only interest rate differential in the VAR. Thus, we perceive CF, GDP growth, inflation risk differntial, interest rate differentials and exchange rate risks as being jointly determined. Unit root properties of these variables are noted in Table 3.

**Figures 10 and 11 and Table 3 here.**

## IV. VAR Analysis

We now wish to establish the mutual dependence between CF and key macroeconomic aggregates, like GDP growth and various risk factors. If such dependence can be established then a macroeconomic policy framework that ignores CF is likely to be less successful than anticipated.

VAR is a very simple and powerful tool for the analysis of multivariate time series. Besides the ability to describe the dynamic of time series, it provides excellent forecasts for economists as well as policy makers. Sims (1980) proposes to use a lower triangular matrix coming from the Cholesky decomposition. This implies a specific order of the variables. Changing the order will change the impulse response result. In this paper we assume that the order of the VAR is as follows: The first variable is India_exchange_rate_risk. Since India's financial markets are not big enough to influence world financial markets, hence India's market must follow world markets. Next, a change in the exchange rate will be followed by movement in domestic interest rates. Here, we use the interest_rate_different (interest rate differential) between India and the US and inflation risk. Movement in monetary policy will affect GDP. The change in GDP, through its effect on demand and supply, will affect inflation. Capital flight is at the end of the order. Two versions of the VAR are estimated. [5]

As detailed in Appendix 1a lag length of 2 is optimal for the model with real GDP growth and a lag length of 1 is adequate for the model with nominal GDP growth.

VAR results for the two models are presented in Tables 4 and 5.

**Tables 4 and 5 here.**

[5] Details of ADF tests on these variables can be found in Appendix 2.

We will comment on the results for GDP growth and CF. In the equation with real GDP growth CF accelerates after 1, and particularly 2 time periods, the inflation risk differential lowers CF after 2 time periods, the exchange rate risk two periods ago accelerates CF.

Real GDP growth falls with exchange rate risk two periods ago, and rises with interest rate differential two periods ago.

In the equation with nominal GDP growth CF rises with one period lagged exchange rate risk, falls with nominal GDP growth one period ago and accelerates with CF one period ago. There are no significant influences on nominal GDP growth.

**Impulse Response**

Figure 12 a outlines the impulse response to Cholesky one standard deviation innovation $\pm 2$ standard errors and Figure 12b does the same for the model with nominal GDP. One important conclusion from this figure is that convergence is much quicker in the nominal GDP growth case in contrast to the real GDP growth case. Further, in this latter instance, standard deviation bands are much wider. In the real GDP growth case as well as in the nominal GDP growth case past CF has a tendency to perpetuate current CF. If people see risk they accelerate CF. Hence, CF is uncontrollable on its own. Devaluation (higher exchange rate risk) brings in capital. This movement is stable in the nominal GDP growth case but unstable in the real GDP growth case. Also CF is significantly impacted by nominal GDP growth, but barely significantly in the model with real GDP growth. Higher GDP growth leads to higher CF.

**Figures 12 a and 12 b here.**

**Forecasting**

Following Zivot and Wang (2005), there are two forecasting methods used in VAR. The traditional method assumes that all endogenous variables follow a normal distribution, the model is linear, and errors are normal. In this case, the solution from the sample represents the deterministic solution to the model. Forecasting for the *T+h* period is based on the information we have up to the *T* period ($Y_1$, $Y_2$, …, $Y_t$) and follows a chain-rule. First, we forecast $Y_{T+1|T}$. After that, based on ($Y_1$, $Y_2$, …, $Y_t$, $Y_{T+1|T}$), we achieve $Y_{T+2|T}$, … $Y_{T+h|T}$. This method is used to forecast a single observation for each endogenous variable at a point of time in future.

However, the assumptions used in the traditional forecasting method may be too strict. We can introduce some uncertainty to our model and our forecasting value for each variable is now a distribution rather than a single observation at each point of time. To deal with this problem, Zivot and Wang (2005) describe the simulation-based forecasting method for VAR. First, this method includes obtaining the coefficients and residuals of VAR as usual. Then, Monte Carlo simulation or bootstrapping the fitted residual is carried out. The last step yields a new set of coefficient and forecasts of endogenous variables.

In this paper, assuming that our model is not linear, we make uses of the available tool in Eviews 8 to forecast the evolution of India capital flight through misinvoicing and its effects on India's economy growth to 2020 using the simulation-based methods. For the simulation-based forecasting, we prefer the method of bootstrapping the fitted residuals using the whole sample period from 1988 to 2012 to the Monte Carlo for more accurate result. Results of our forecasts are reported in Figure 13 a for the real GDP growth model and in Figure 13 b for the nominal GDP growth model. These are based on the simulation-based forecasting method using 1000 repetitions:

**Figures 13 and 13 b here.**

Following this forecast (from figure 13a), CF through misinvoicing should drop from 2015 and stabilize. Real GDP growth should be stable around 6 per cent. Exchange rate risk, interest rate differential and inflation risk differential should all stabilize after 2015, although there is a slight rise in the inflation risk differential. In the case of Figure 13b CF again stabilizes after 2015 at about $10 billion (with a slight downward trend) as does nominal GDP growth (the latter around 5 to 6 per cent). All other variables tend to stabilize after 2015. We also used the traditional method of forecasting and the results were not very different. This suggests that our VAR model is specified correctly.

**Forecast Error Variance Decomposition**

One important aspect of VAR analysis is to see how an innovation from one variable affects itself and other variables. This can be achieved by applying the Forecast Error Variance Decomposition (FEVD). The theory behind FEVD is straightforward. First, we forecast with our VAR model. Then, forecast error and variance of the forecast error at any h-step forecast are calculated. In this step, the variance of forecast error is the sum of all portions of all shocks. Finally, FEVD is calculated by dividing the portions of each shock to the compound variance. If the innovation of one variable accounts for a large part in the total variance of itself or of another variable at the h-step forecast, then, we can say the former variable has important effect to itself or to the latter variable. Zivot and Wang (2005) provide detailed formulae on how to calculate FEVD. Figures 14a and 14b provide Error Variance Decomposition for the model with real GDP growth and nominal GDP growth respectively. Impacted variables are real and nominal GDP growth and CF.

**Figures 14 a and 14 b here.**

It seems that CF through misinvoicing does not affect real GDP growth, but the standard error band widens. The effects of other variables, except inflation risk differential, are significantly higher. India real GDP is affected by exchange rate, interest rate, and its own inertia. Inflation risk and CF do not affect India's real GDP growth. CF is very strongly affected by exchange rate risk and this effect appears to be very significantly increasing over time. CF is also affected by interest rate differential (increasing over time), real GDP growth (declining over time), inflation risk differential (mildly declining over time), and its own inertia (declining over time).

Nominal GDP growth is also not significantly affected by CF, although the standard error band widens considerably over time. Nominal GDP growth is not much affected by interest rate differential or inflation risk differential but it is affected by its own inertia. Exchange rate risk has a strong effect on CF as does nominal GDP growth and CF's own inertia. Interest rate differential increases CF, but not by a large amount.

## V. Conclusions

This paper has had two main objectives. First, it computes CF through trade misinvoicing from India using reliable data sources. India's trade with 17 countries over the period 1988-2012 is considered. We find that CF has accelerated since 2004 and particularly sharply since 2007. At its peak in 2008 nearly $40 billion was illegally transferred out of India through trade misinvoicing.

Second, we model the mutual dependence of GDP growth, CF, and various risk factors in a VAR framework. We find that the VAR models chosen fit the data well. We conduct impulse response function analysis, forecast the key variables until 2020 and forecast error variance decomposition. Broadly we find that, if left undisturbed, CF through trade misinvoicing will continue to be high and play a significant macroeconomic role. Thus, CF needs to be checked urgently not only because it is a drain of the country's resources but also because it continues to have a significant and, by its very nature, uncontrollable effect on the economy. At least some of the failures of current macroeconomic policy in India could be attributed to CF.

This paper computes CF only through trade misinvoicing and that too only for India's trade with 17 countries. Total Illegal Financial Flows may be higher or lower than the amounts reported in this paper. There is an urgent need to make CF an integral part of the macroeconomic analysis of the Indian economy.

**References**

Collier, P. (2013) "How we can help African nations to extract fair value" *The Financial Times*, May 12, 2013, Available at

http://www.ft.com/cms/s/0/45065606-b8d9-11e2-869f-00144feabdc0.html#axzz2x1UjRzQw

(Accessed 26th March 2014)

IMF (2014) IMF E-Library Available at http://elibrary-data.imf.org/DataExplorer.aspx

Accessed on 26th March 2014.

Kar, D. and LeBlanc (2013) *Illicit Financial Flows from Developing Countries: 2002-2011*, Washington DC: Global Financial Integrity

Available at *iff.gfintegrity.org*

Accessed on 26th March 2014

Johansen, S. (1995) *Likelihood Based Inferences in Cointegrated Vector Autoregressive Models*, New York: Oxford University Press.

Lutkepohl, H. (1991) *Introduction to Multiple Time Series Analysis*, Berlin: Springer-Verlag.

Mackinnon, J. (1991) "Critical Values for Cointegration Tests" in Engle, R. and C. Granger *Long-run economic relationships: readings in cointegration"* New York: Oxford University Press, pp. 267-276.

MIT (2014) MIT's Observatory of Economic Complexity at http://atlas.media.mit.edu/

Accessed 3rd April 2014

Sims, C. (1980), "Macroeconomics and Reality", *Econometrica* vol. 48, no.1, pp. 1-48

UN Comtrade (2014) Commodity Trade Statistics Database, available at

*http://comtrade.un.org/* Accessed 31st March 2014.

World Bank and StAR (2011) *The Puppet Masters: How the Corrupt Use Legal Structures to Hide Stolen Assets and what to do about it*, World Bank, Washington DC

Zivot, E. and J. Wang (2005) *Modelling Financial Time Series with S-Plus,(2nd edition)*¸ New York, Berlin, Heidelberg: Springer Verlag.

**Table 1: Supplemental Data from MIT Observatory of Economic Complexity**

| Country | Years | No. of supplemented observations | Source |
|---|---|---|---|
| United Arab Emirates | 1994-1998 | 5 | SITC |
| Brazil | 1988 | 1 | SITC |
| China | 1988-1991 | 4 | SITC |
| United Kingdom | 2002 | 1 | SITC |
| Hong Kong | 1988-1991 | 4 | SITC |
| Indonesia | 1988 | 1 | SITC |
| Kuwait | 2005 | 1 | SITC |
| Singapore | 1988 | 1 | SITC |
| USA | 1988 | 1 | SITC |
| South Africa | 1988-1991 | 4 | SITC |
| Total | | 23 | |

Interpolated Data:

| Country | Years | No. of interpolated observations | Source |
|---|---|---|---|
| United Arab Emirates | 1988-1990, 2012 | 4 | Interpolated |
| Germany | 1988-1990 | 3 | Interpolated |
| Kuwait | 2009-2012 | 4 | Interpolated |
| Total | | 11 | |

**Table 2: Aggregate Estimates of Outflow (Inflow) into India due to TM**

| Year | Aggregate Outflow (Inflow) $1000s | Year | Aggregate Outflow (Inflow) $1000s |
|---|---|---|---|
| 1988 | 1,122,295 | 2001 | 3,160,409 |
| 1989 | 544,842 | 2002 | 1,816,716 |
| 1990 | 62,488 | 2003 | 3,352,468 |
| 1991 | (8,058) | 2004 | 8,297,652 |
| 1992 | 60,158 | 2005 | 7,655,285 |
| 1993 | (872,896) | 2006 | 11,974,473 |
| 1994 | 97,236 | 2007 | 9,871,083 |
| 1995 | (1,519,088) | 2008 | 39,992,772 |
| 1996 | (1,741,843) | 2009 | 9,948,471 |
| 1997 | 1,761,542 | 2010 | 27,202,975 |
| 1998 | 5,125,192 | 2011 | 33,230,333 |
| 1999 | 6,402,844 | 2012 | 17,508,109 |
| 2000 | 1,590,486 | Cumulative Total: 1988-2012 | 186,635,944 |

**Table 3: Summary Table for ADF Test**

| Variable | Critical Value (5%) | t-Stat | Stationary |
|---|---|---|---|
| **CF** | -3.632896 | -7.794196 | **I(0)** |
| **Real GDP Growth** | -2.991878 | -3.829278 | **I(0)** |
| **Nominal GDP Growth** | -2.991878 | -4.297744 | **I(0)** |
| **Inflation Risk Different** | -2.991878 | -5.991302 | **I(0)** |
| **Interest Rate Different** | -3.004861 | -6.619719 | **I(0)** |
| **India Exchange Rate Risk** | -2.991878 | -3.331564 | **I(0)** |

**Table 4: Vector Autoregression Estimates Using real GDP growth**

Sample (adjusted): 1990:2012,
Included observations: 23 after adjustments
Standard errors in () &t-statistics in [ ]

| | INDIA_EXRATE_RISK | INTEREST_RATE_DIFFERENT | INDIA_GDP | INF_RISK_DIFF | CF |
|---|---|---|---|---|---|
| INDIA_EXRATE_RISK(-1) | 0.139766 | -0.134448 | 0.028427 | -0.032000 | -0.470658 |
| | (0.35095) | (0.14739) | (0.09364) | (0.05075) | (0.24570) |
| | [ 0.39825] | [-0.91220] | [ 0.30357] | [-0.63057] | [-1.91556] |
| INDIA_EXRATE_RISK(-2) | 0.457431 | -0.061551 | -0.131354 | 0.044519 | 0.572967 |
| | (0.31370) | (0.13175) | (0.08370) | (0.04536) | (0.21962) |
| | [ 1.45820] | [-0.46720] | [-1.56927] | [ 0.98143] | [ 2.60888] |
| INTEREST_RATE_DIFFERENT(-1) | -0.404802 | 0.346726 | -0.065010 | -0.182750 | -0.041898 |
| | (0.60096) | (0.25239) | (0.16035) | (0.08690) | (0.42074) |
| | [-0.67360] | [ 1.37378] | [-0.40541] | [-2.10297] | [-0.09958] |
| INTEREST_RATE_DIFFERENT(-2) | -0.072753 | -0.205332 | 0.351004 | 0.022292 | -0.154977 |
| | (0.65439) | (0.27483) | (0.17461) | (0.09463) | (0.45815) |
| | [-0.11118] | [-0.74712] | [ 2.01019] | [ 0.23558] | [-0.33827] |
| INDIA_GDP(-1) | -1.525849 | -0.093809 | 0.361456 | -0.406227 | 1.005151 |
| | (1.17197) | (0.49220) | (0.31272) | (0.16947) | (0.82051) |
| | [-1.30196] | [-0.19059] | [ 1.15585] | [-2.39703] | [ 1.22504] |
| INDIA_GDP(-2) | 1.163306 | -0.454873 | -0.383231 | -0.105796 | 0.696596 |
| | (1.01076) | (0.42450) | (0.26970) | (0.14616) | (0.70765) |
| | [ 1.15092] | [-1.07155] | [-1.42093] | [-0.72383] | [ 0.98438] |
| INF_RISK_DIFF(-1) | -0.883257 | 0.866625 | 0.327211 | -0.329514 | -0.192495 |
| | (1.62049) | (0.68057) | (0.43240) | (0.23433) | (1.13452) |
| | [-0.54506] | [ 1.27339] | [ 0.75674] | [-1.40621] | [-0.16967] |
| INF_RISK_DIFF(-2) | 1.264644 | 0.085337 | -0.198067 | 0.102389 | -3.660306 |
| | (1.55327) | (0.65234) | (0.41446) | (0.22461) | (1.08746) |
| | [ 0.81418] | [ 0.13082] | [-0.47789] | [ 0.45585] | [-3.36591] |
| CF(-1) | 0.162170 | -0.016631 | 0.056905 | -0.037821 | 0.176158 |
| | (0.23877) | (0.10028) | (0.06371) | (0.03453) | (0.16716) |
| | [ 0.67920] | [-0.16585] | [ 0.89318] | [-1.09543] | [ 1.05381] |
| CF(-2) | -0.126970 | -0.049492 | 0.005719 | 0.025234 | 0.489502 |
| | (0.26971) | (0.11327) | (0.07197) | (0.03900) | (0.18883) |
| | [-0.47077] | [-0.43693] | [ 0.07946] | [ 0.64701] | [ 2.59234] |
| C | 4.219440 | 5.230226 | 6.041439 | 5.121041 | -2.468421 |
| | (11.4972) | (4.82857) | (3.06782) | (1.66254) | (8.04933) |
| | [ 0.36700] | [ 1.08318] | [ 1.96929] | [ 3.08025] | [-0.30666] |
| R-squared | 0.529109 | 0.433172 | 0.593228 | 0.680827 | 0.868251 |
| Adj. R-squared | 0.136700 | -0.039185 | 0.254251 | 0.414850 | 0.758461 |
| Sum sq. resids | 761.5094 | 134.3159 | 54.21889 | 15.92337 | 373.2587 |
| S.E. equation | 7.966123 | 3.345593 | 2.125615 | 1.151932 | 5.577176 |

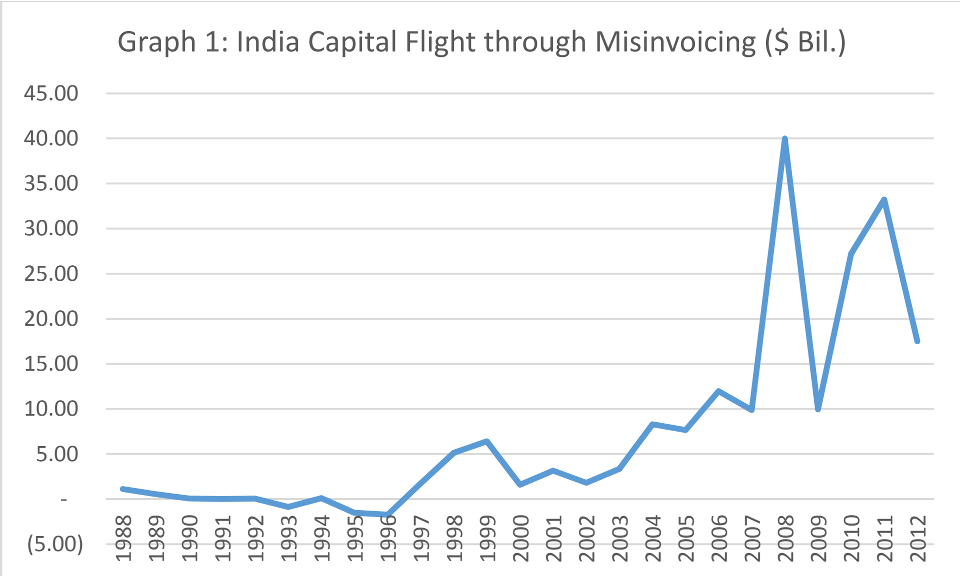
| | | | | | |
|---|---|---|---|---|---|
| F-statistic | 1.348360 | 0.917044 | 1.750053 | 2.559718 | 7.908258 |
| Log likelihood | -72.88338 | -52.92964 | -42.49724 | -28.40697 | -64.68353 |
| Akaike AIC | 7.294207 | 5.559099 | 4.651934 | 3.426693 | 6.581176 |
| Schwarz SC | 7.837270 | 6.102162 | 5.194996 | 3.969755 | 7.124239 |
| Mean dependent | 5.640000 | 1.559130 | 6.380435 | 1.139565 | 8.042174 |
| S.D. dependent | 8.573656 | 3.281910 | 2.461434 | 1.505890 | 11.34803 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 36303.03 |
| Determinant resid covariance | 1403.492 |
| Log likelihood | -246.5152 |
| Akaike information criterion | 26.21871 |
| Schwarz criterion | 28.93402 |

**Table 5: Vector Autoregression Estimates Using Nominal GDP growth**
Sample (adjusted): 1989 2012
Included observations: 24 after adjustments
Standard errors in ( ) and & t-statistics in [ ].
Standard errors in ( ) & t-statistics in [ ]

| | EXRATERISK | INTRATEDIFF | NOMINALGDP | INFRISKDIFF | CF |
|---|---|---|---|---|---|
| EXRATERISK(-1) | 0.294016 | -0.103380 | 0.047560 | -0.014408 | 0.531286 |
| | (0.51194) | (0.18917) | (0.62846) | (0.07812) | (0.40603) |
| | [ 0.57432] | [-0.54648] | [ 0.07568] | [-0.18443] | [ 1.30848] |
| INTRATEDIFF(-1) | -0.089488 | 0.310338 | 0.155565 | -0.194750 | -0.424917 |
| | (0.60955) | (0.22525) | (0.74830) | (0.09302) | (0.48345) |
| | [-0.14681] | [ 1.37778] | [ 0.20789] | [-2.09361] | [-0.87892] |
| NOMINALGDP(-1) | -0.174412 | -0.000986 | 0.140680 | -0.084339 | 1.031805 |
| | (0.42331) | (0.15642) | (0.51966) | (0.06460) | (0.33574) |
| | [-0.41202] | [-0.00630] | [ 0.27071] | [-1.30558] | [ 3.07325] |
| INFRISKDIFF(-1) | -1.606642 | 0.854575 | 0.939201 | -0.576639 | 0.322397 |
| | (1.32263) | (0.48874) | (1.62367) | (0.20184) | (1.04901) |
| | [-1.21473] | [ 1.74851] | [ 0.57844] | [-2.85692] | [ 0.30733] |
| CF(-1) | 0.004653 | -0.059254 | 0.127294 | -0.076453 | 0.521347 |
| | (0.19380) | (0.07161) | (0.23791) | (0.02957) | (0.15371) |
| | [ 0.02401] | [-0.82740] | [ 0.53505] | [-2.58507] | [ 3.39179] |
| C | 8.070222 | 1.152112 | 4.392563 | 3.736618 | -7.508482 |
| | (7.74538) | (2.86211) | (9.50831) | (1.18198) | (6.14306) |
| | [ 1.04194] | [ 0.40254] | [ 0.46197] | [ 3.16132] | [-1.22227] |
| R-squared | 0.176553 | 0.271524 | 0.032605 | 0.470504 | 0.689235 |
| Adj. R-squared | -0.052183 | 0.069169 | -0.236115 | 0.323421 | 0.602912 |
| Sum sq. resids | 1426.271 | 194.7553 | 2149.429 | 33.21531 | 897.1937 |
| S.E. equation | 8.901532 | 3.289337 | 10.92761 | 1.358416 | 7.060035 |
| F-statistic | 0.771865 | 1.341823 | 0.121336 | 3.198913 | 7.984325 |
| Log likelihood | -83.07170 | -59.17881 | -87.99337 | -37.95401 | -77.50914 |
| Akaike AIC | 7.422642 | 5.431567 | 7.832781 | 3.662834 | 6.959095 |
| Schwarz SC | 7.717155 | 5.726081 | 8.127294 | 3.957347 | 7.253608 |
| Mean dependent | 6.096250 | 1.793750 | 8.260417 | 1.292083 | 7.729583 |
| S.D. dependent | 8.677992 | 3.409362 | 9.828695 | 1.651481 | 11.20375 |
| Determinant resid covariance (dof adj.) | | 967911.3 | | | |
| Determinant resid covariance | | 229689.9 | | | |
| Log likelihood | | -318.4064 | | | |
| Akaike information criterion | | 29.03387 | | | |
| Schwarz criterion | | 30.50644 | | | |

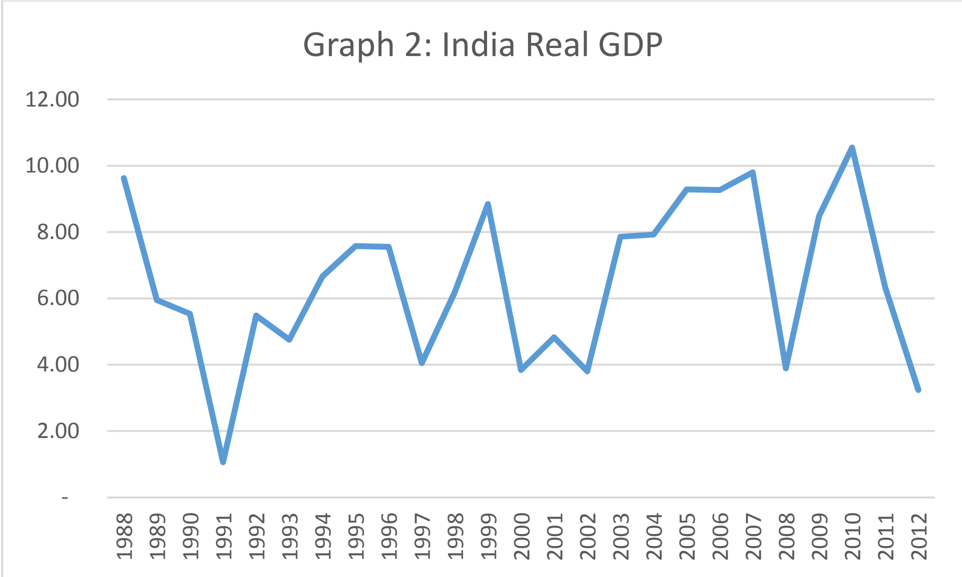
**Figure 1: Capital Flight from India through Trade Misinvoicing**




Source: UN Comtrade Standard International Trade Classification (SITC) Rev. 3.

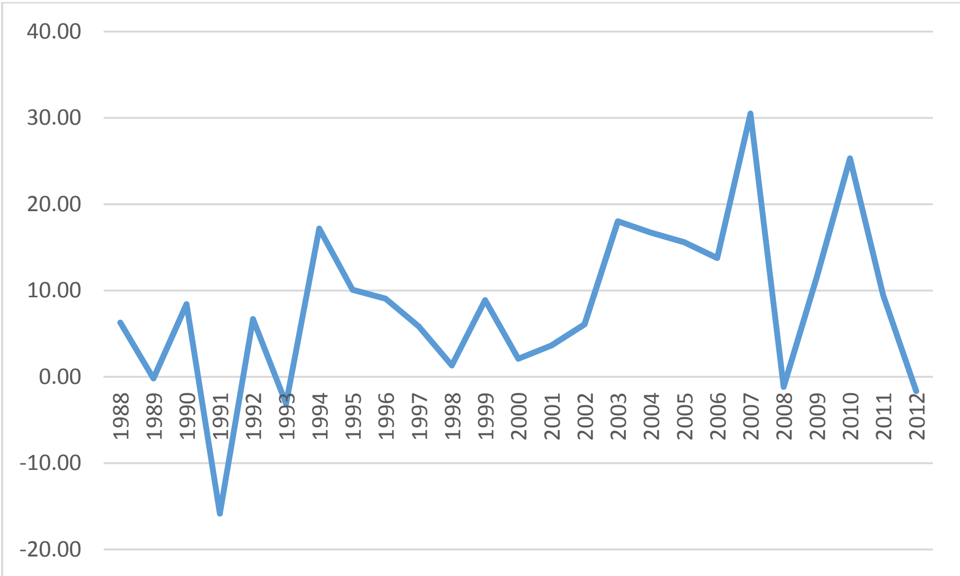
N.B. We intended to get CF data from India's 20 largest trading partners. However, due to the paucity of data, three countries were dropped. Therefore, the CF data is composed of 17 countries for 25 years (425 observations). In 17 remaining countries, there are still some missing data. Thus, the CF database from UN Comtrade is supplemented by MIT's Observatory of Economic Complexity at http://atlas.media.mit.edu/ or interpolated.

**Figure 2a: Real GDP growth**




Data Source: World Bank's World Development Indicators (in USD, 2005 price)

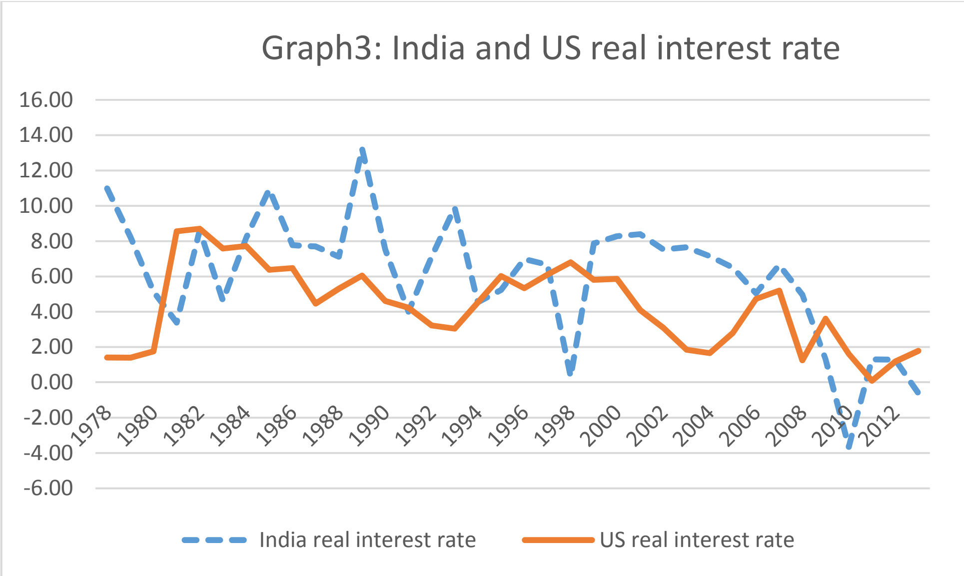
**Figure 2b: Nominal GDP growth (current US dollars)**




Data Source: World Bank's World Development Indicators (in current USD)

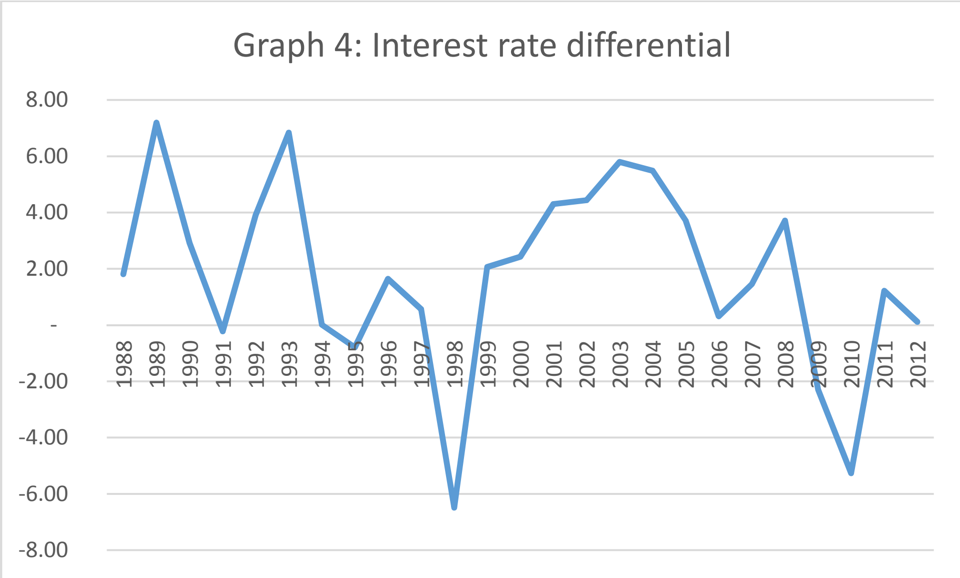
-

**Figure3: India and US real interest rates**




Data Source: IMF e-Library at http://elibrary-data.imf.org/.

**Figure 4: Interest Rate Differential (Indian interest rate-US interest rate)**

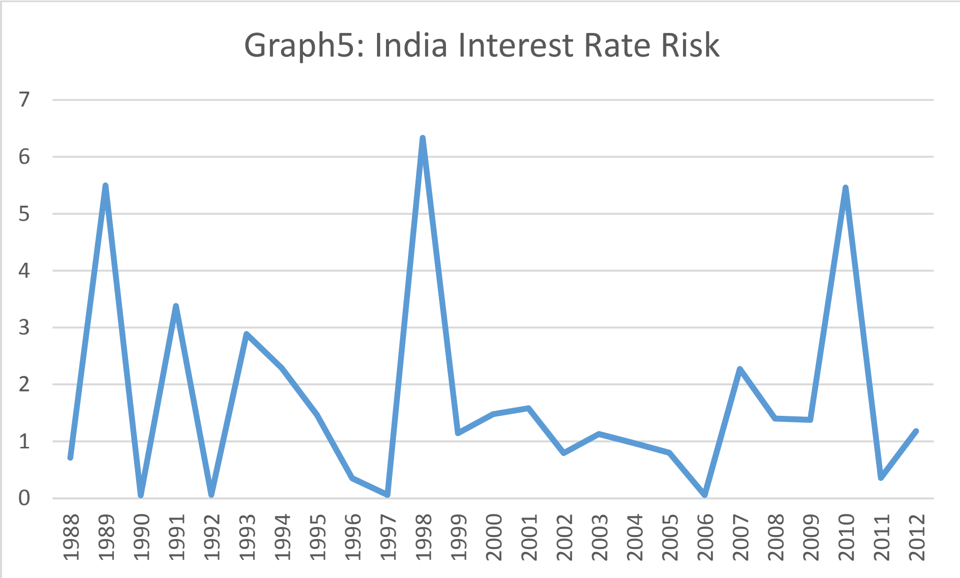



Data source: IMF E-Library at http://elibrary-data.imf.org/.

Data Source: Lending Rate from IMF E-library at http://elibrary-data.imf.org/

- Lending Rates are adjusted by inflation. Then Interest rate trend is calculated by using Hedrick-Prescott filter. Interest risk = Square root((Interest rate – interest trend)$^2$)
- The real interest rate level in India may not be a problem aggravating capital flight. In general, India's real interest rate is higher than that of the US.
  Interest rate differential = India real interest rate – US real interest rate.
- Most of the time, India's real interest rate is higher than US's real interest rate.
- Capital flight could also be caused by the interest risk (fluctuation). We should look at interest rate risk.

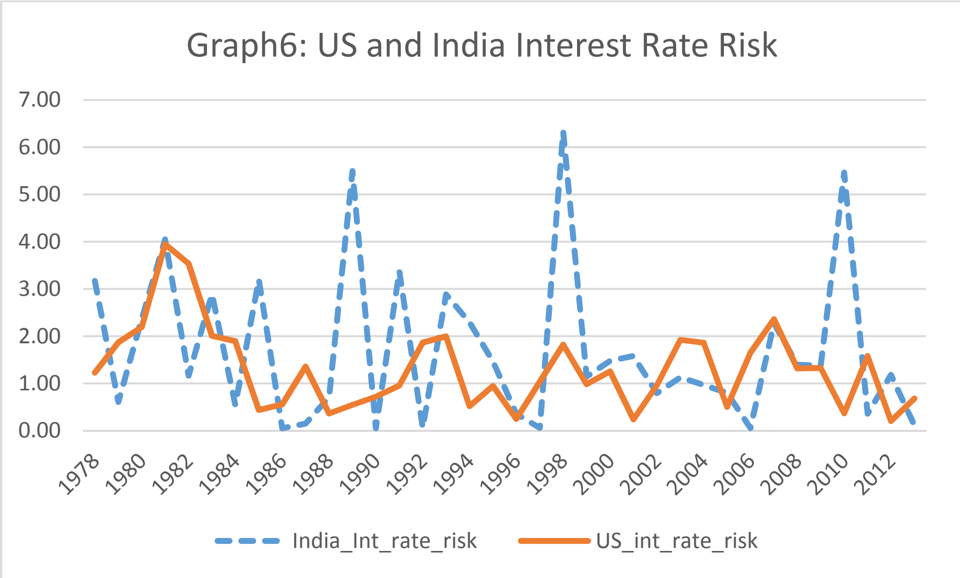
**Figure 5: India Interest Rate Risk**




N.B. Interest rate risk = square root of $(\text{interest rate} - \text{interest trend})^2$

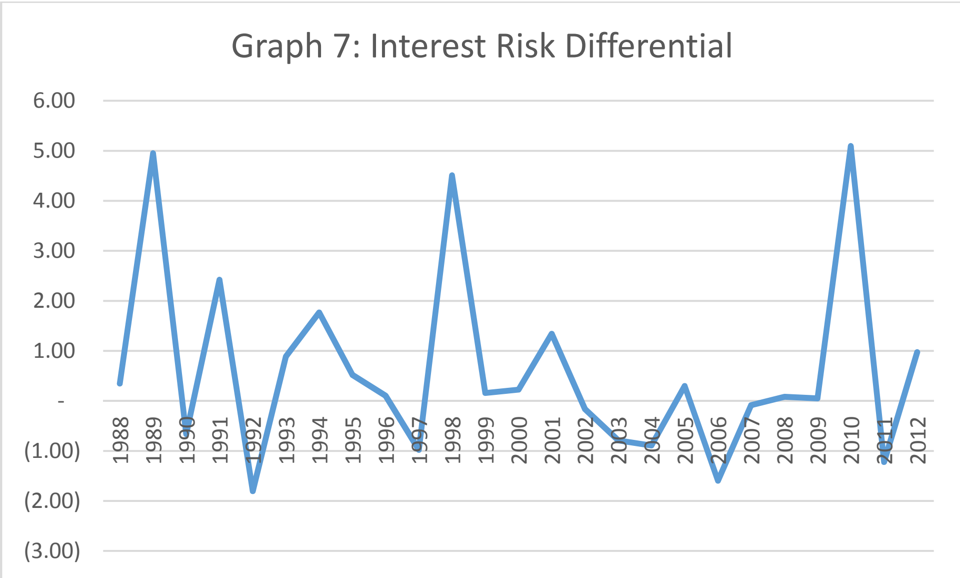
Data Source: IMF e-Library at http://elibrary-data.imf.org/.

**Figure 6: India and US Interest Rate Risk**




- India interest rate risk is almost always higher than US interest rate risk
- Data Source: IMF e-Library at http://elibrary-data.imf.org/.

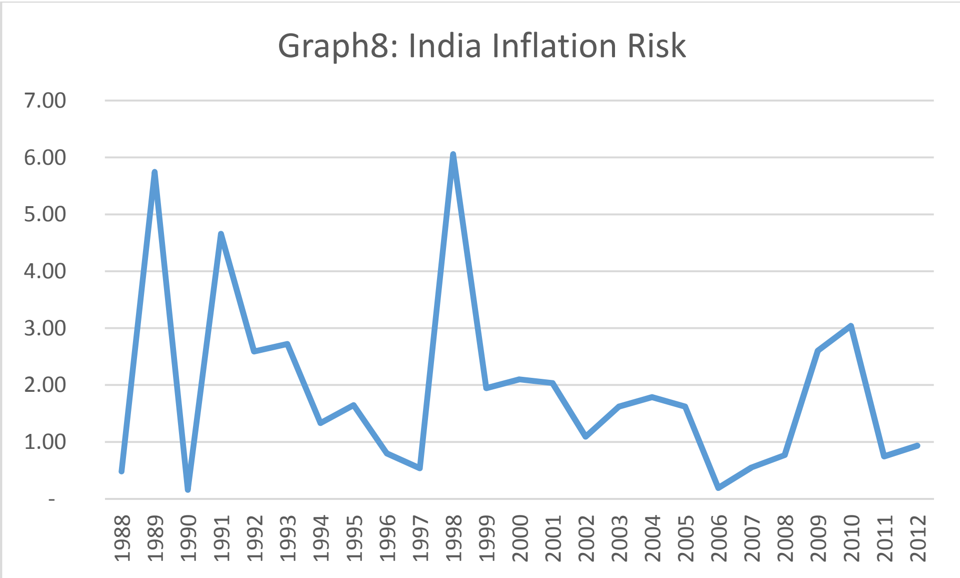
**Figure 7: Interest Risk Difference between US and India: (India Interest Risk – US Interest Risk)**




**India's Interest Risk is almost always higher than US interest risk**

Data Source: Authors'IMF e-Library at http://elibrary-data.imf.org/.

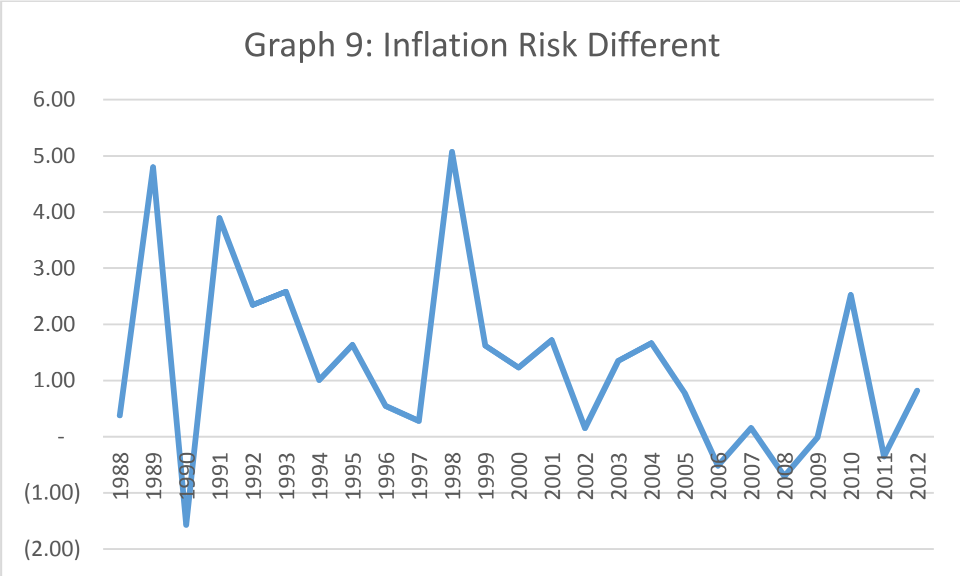
**Figure 8: Inflation Risk**




Data Source: CPI IMF E-library at http://elibrary-data.imf.org/.

- Inflation Trend calculated by HP filter
- Risk = Sqrt((inflation-inflation trend)$^2$)

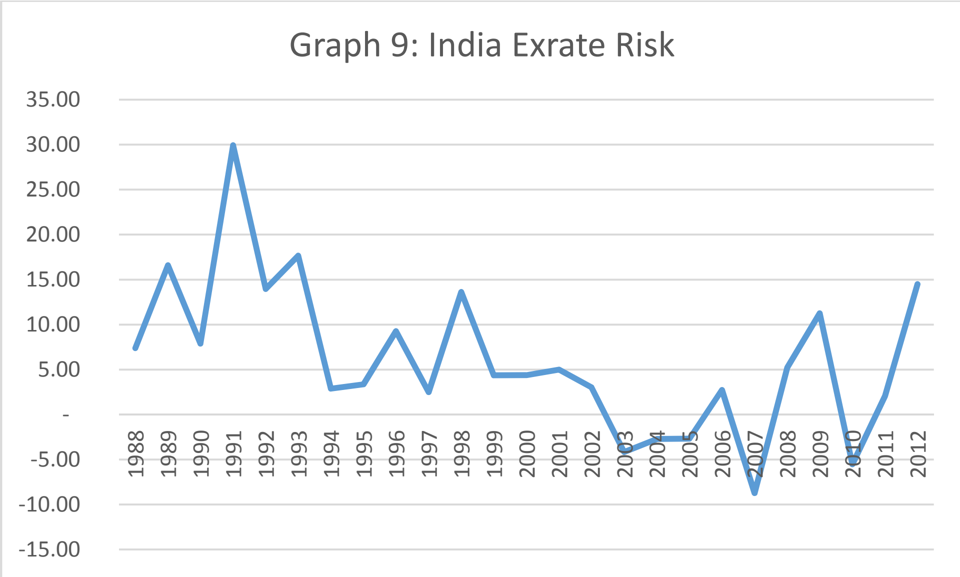
**Figure 9: Inflation Risk Difference between India and USUS: (India Inflation Risk- US Inflation Risk)**




Source: Author Calculation from IMF e-library

-

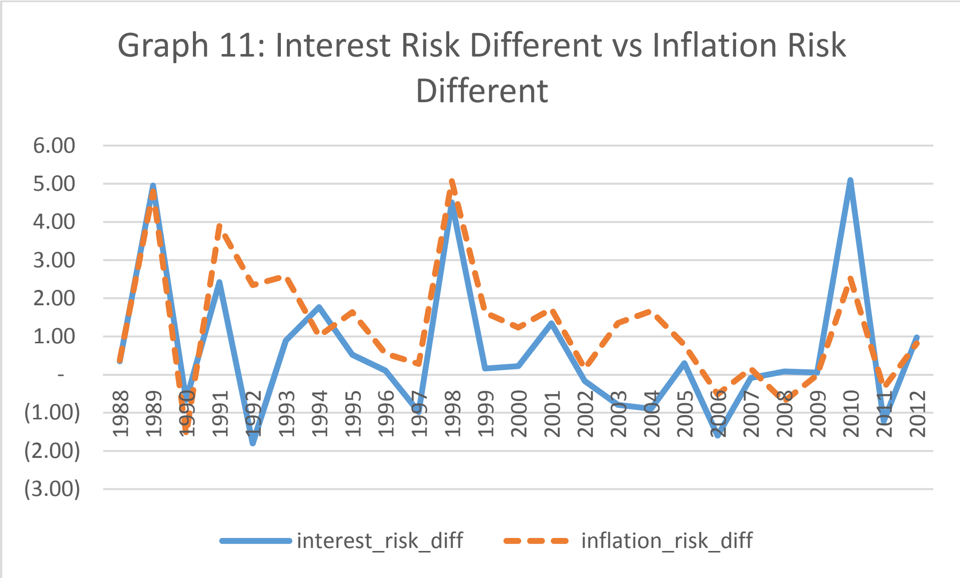
**Figure 9: India: Exchange Rate Risk**




Data Source: IMF E-library at http://elibrary-data.imf.org/

- Exchange rate risk is the percentage change of the nominal exchange rate with respect to the US dollar. This is also the risk of devaluation.

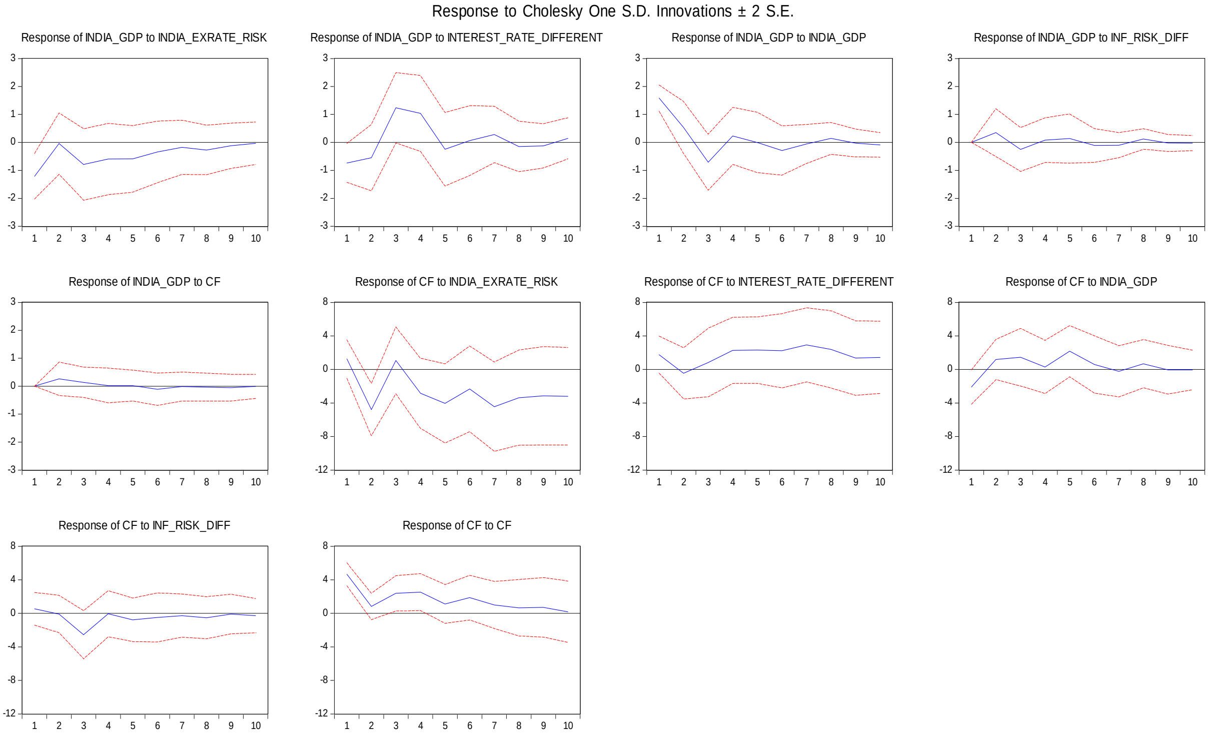
**Figure 11: Interest rate risk vs. Inflation Risk in India**




**Colinearity, Should drop one. We will include interest_rate_different (level) to VAR, thus we should drop Interest_rate_Risk_Different.**

Source: Author Calculation from IMF e-library

## Figure 12a: Impulse response of VAR Model with Real GDP Growth




## Figure 12b: Impulse Response of VAR Model with Nominal GDP growth

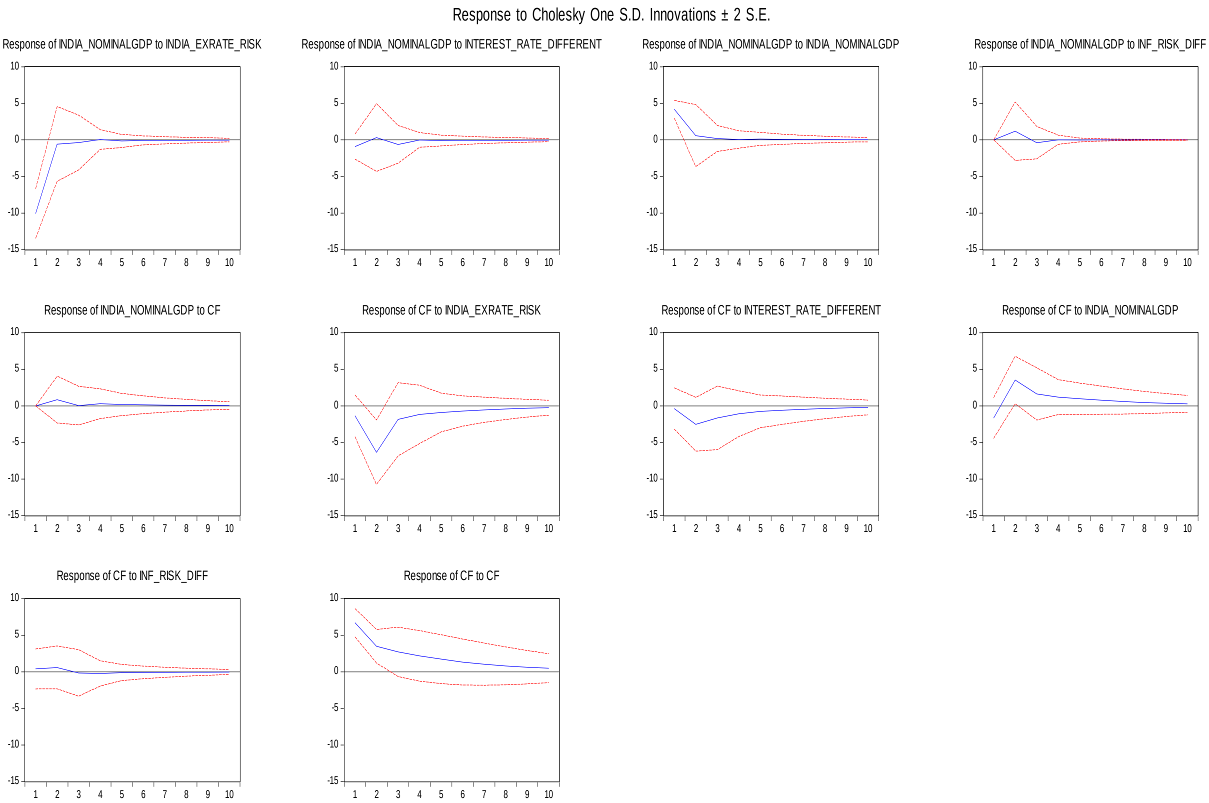


**Figure 13a: Forecasting to 2020 with real GDP growth model**

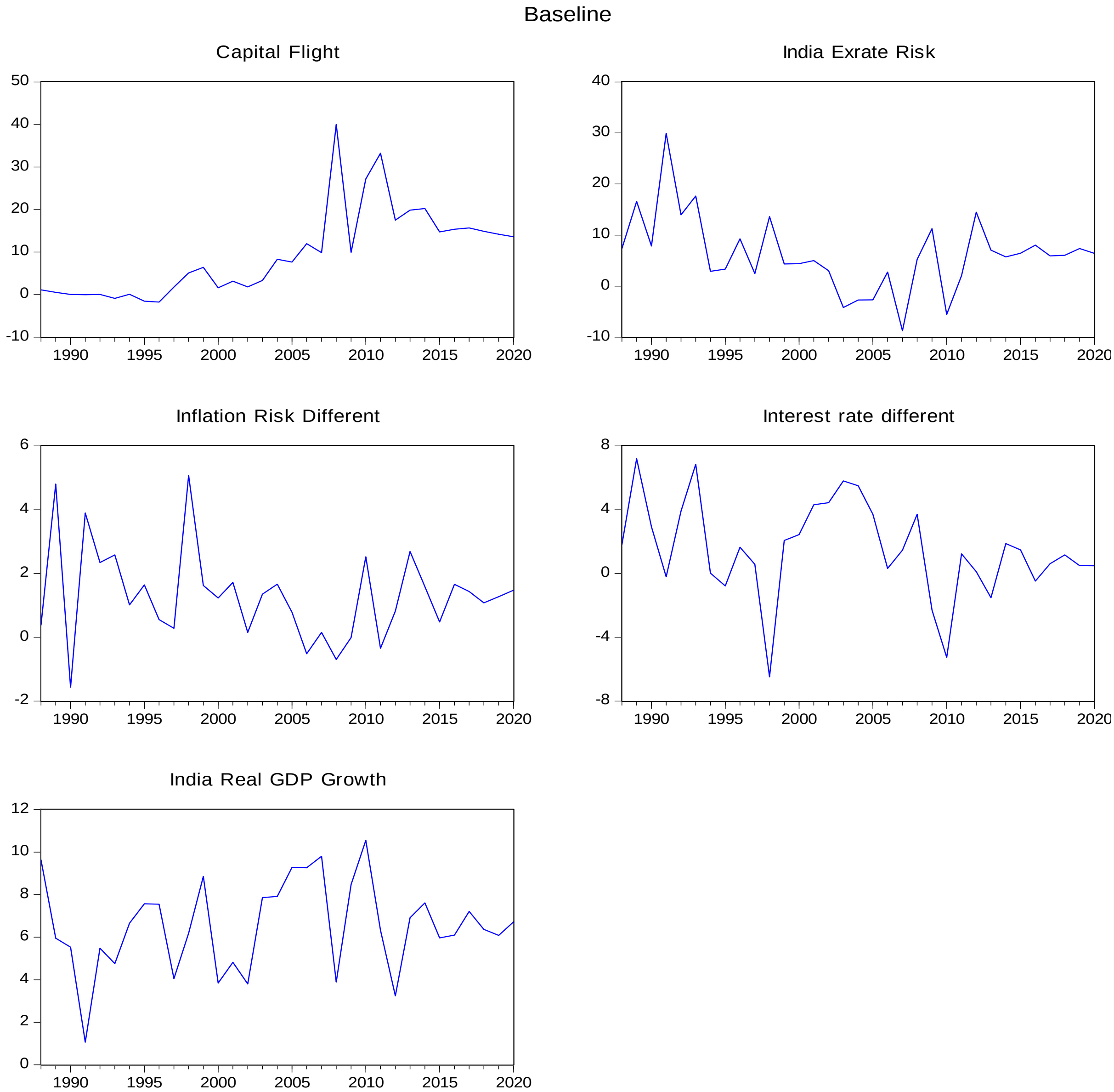


**Figure 13b: Forecasting to 2020 with nominal GDP growth**

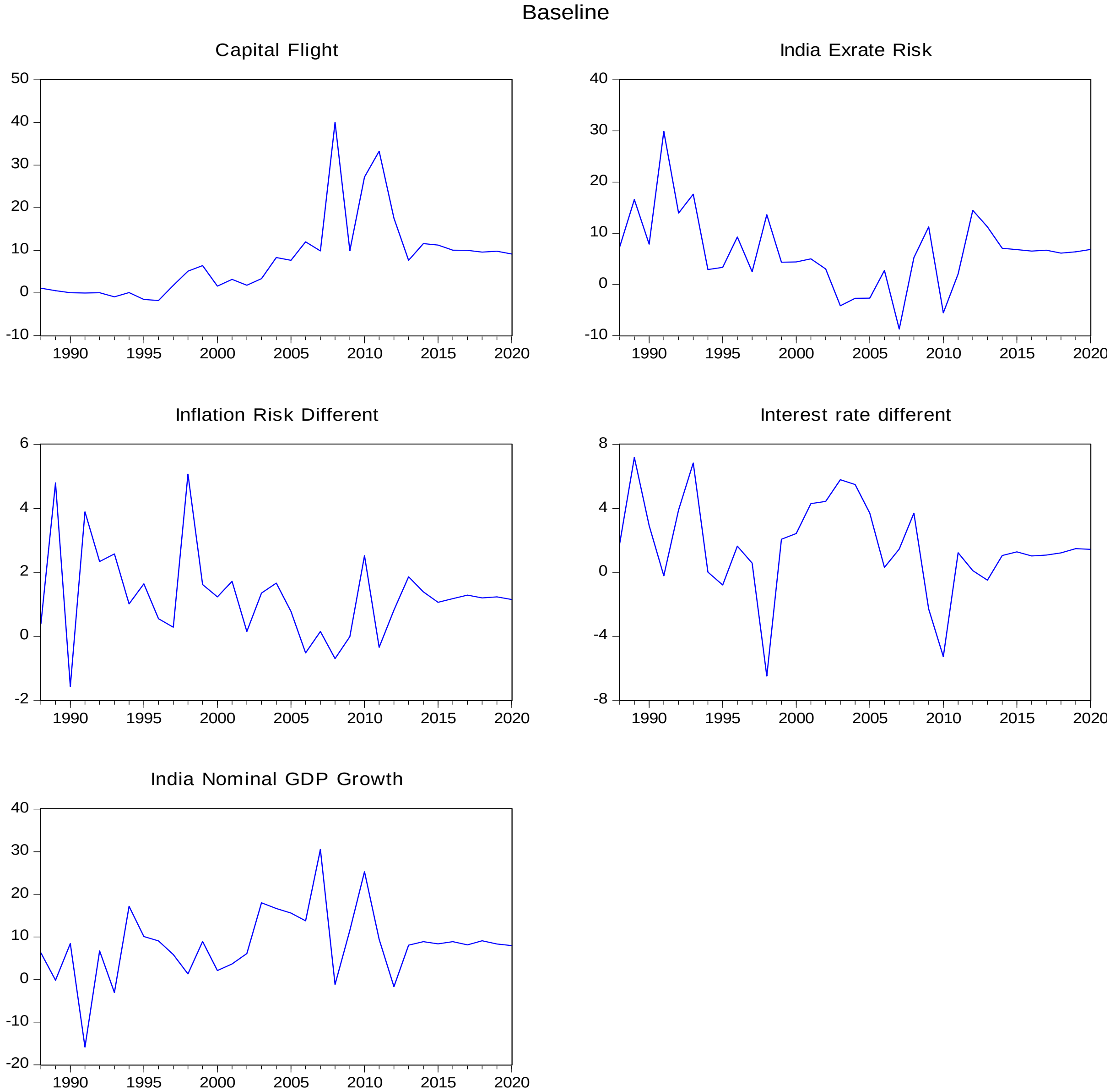


**Figure 14a:**

## Variance Decomposition of VAR Model with real GDP

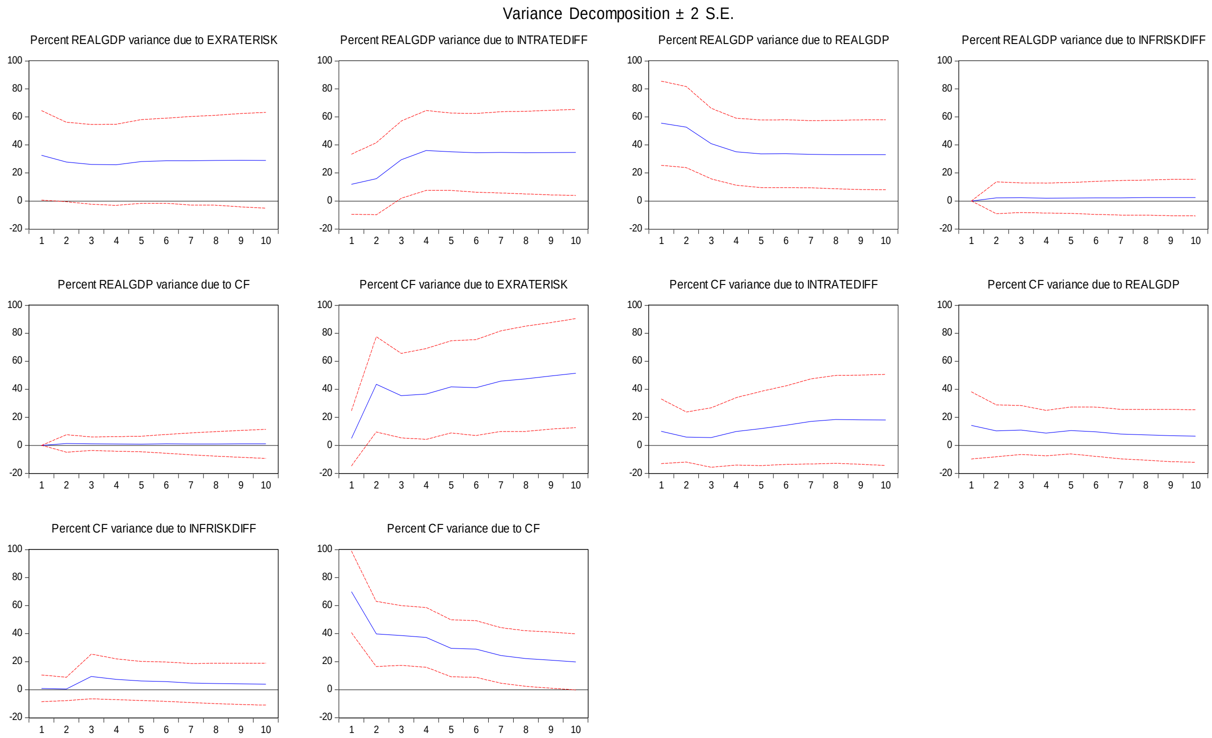
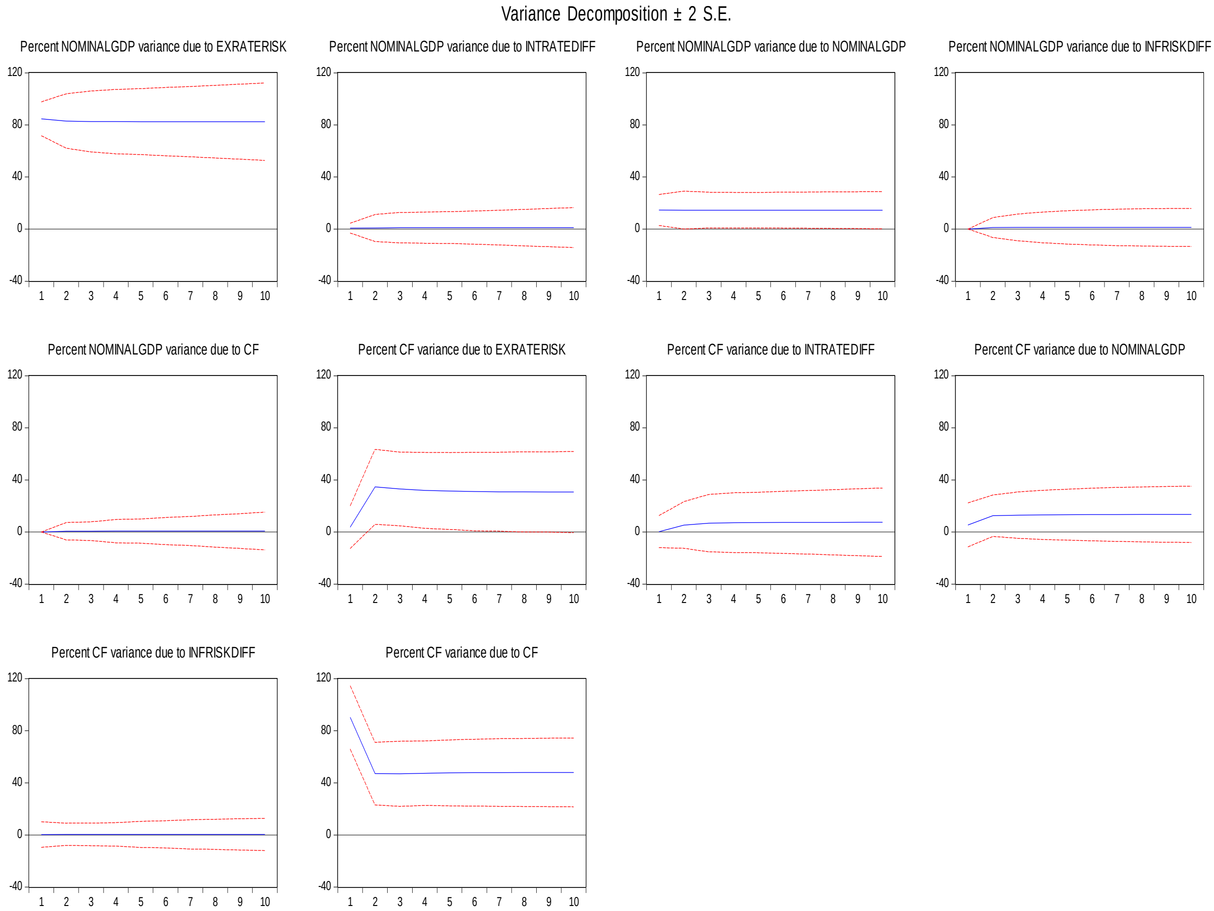


**Figure 14b: Variance Decomposition of VAR Model with nominal GDP**



**Appendix 1**

## Table A1.1 VAR Residual Serial Correlation LM Test (real GDP)

**Johansen (1995) suggests the Lagrange Multiplier LM test for auto correlation residual**

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 03/27/14 Time: 13:47
Sample: 1988 2012
Included observations: 24

| Lags | LM-Stat | Prob |
|---|---|---|
| 1 | 38.93618 | 0.0374 |
| 2 | 27.70772 | 0.3215 |

Probs from chi-square with 25 df.

**Conclusion: The VAR(1) does not satisfy the VAR Residual Serial Correlation LM Test. The VAR(2) satisfies the VAR Residual Serial Correlation LM Test. Model with 2 lags is more appropriate.**

## Table A1.2 VAR Stability Condition Test

For a VAR to be stable, it must satisfy the VAR stability Condition Test suggested in Lükepohl (1991). Following Lükepohl (1991), the eigenvalues of the VAR's companion matrix have modulus smaller than one, then VAR is stable.

Roots of Characteristic Polynomial
Endogenous variables: INDIA_EXRATE_RISK INTEREST_RATE_DIFFERENT INDIA_GDP INF_RISK_DIFF CF
Exogenous variables: C
Lag specification: 1 2
Date: 03/27/14 Time: 13:52

| Root | Modulus |
|---|---|
| 0.831221 - 0.125683i | 0.840670 |
| 0.831221 + 0.125683i | 0.840670 |
| -0.214394 - 0.746450i | 0.776629 |
| -0.214394 + 0.746450i | 0.776629 |
| -0.547337 - 0.515147i | 0.751635 |
| -0.547337 + 0.515147i | 0.751635 |
| 0.450660 - 0.474032i | 0.654065 |
| 0.450660 + 0.474032i | 0.654065 |
| -0.622691 | 0.622691 |
| 0.276983 | 0.276983 |

No root lies outside the unit circle.
VAR satisfies the stability condition.

**Conclusion: VAR(2) satisfies the stability condition**

## Table A1.3 VAR Residual Serial Correlation LM Test (nominal GDP)

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 03/27/14 Time: 13:35
Sample: 1988 2012
Included observations: 24

| Lags | LM-Stat | Prob |
|---|---|---|
| 1 | 30.29772 | 0.2133 |

Probs from chi-square with 25 df.

**With P_value of 0.21, we cannot reject the Null Hypothesis of no serial correlation at lag order 1. Therefore, one lag is included in the model with nominal GDP**

## Table A1.4 VAR Stability Condition Test

Roots of Characteristic Polynomial
Endogenous variables: INDIA_EXRATE_RISK INTEREST_RATE_DIFFERENT INDIA_NOMINALGDP INF_RISK_DIFF CF
Exogenous variables: C
Lag specification: 1 1
Date: 03/27/14 Time: 13:43

| Root | Modulus |
|---|---|
| 0.777393 | 0.777393 |
| -0.263952 | 0.263952 |
| 0.243120 | 0.243120 |
| -0.033410 - 0.227131i | 0.229576 |
| -0.033410 + 0.227131i | 0.229576 |

No root lies outside the unit circle.
VAR satisfies the stability condition.

**Appendix 2**

## Unit Root Test ADF Test

**ADF Test for Capital Flight (allow for both trend and intercept: Capital Flight has increasing trend recently, thus I add trend to the test):**

Null Hypothesis: D(CF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -7.794196 | 0.0000 |
| Test critical values: | 1% level | -4.440739 | |
| | 5% level | -3.632896 | |
| | 10% level | -3.254671 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CF,2)
Method: Least Squares
Date: 03/21/14 Time: 14:08
Sample (adjusted): 1991 2012
Included observations: 22 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(CF(-1)) | -2.912964 | 0.373735 | -7.794196 | 0.0000 |
| D(CF(-1),2) | 0.713734 | 0.203398 | 3.509052 | 0.0025 |
| C | -2.933163 | 3.482575 | -0.842240 | 0.4107 |
| @TREND("1988") | 0.470696 | 0.244937 | 1.921705 | 0.0706 |

| | | | |
|---|---|---|---|
| R-squared | 0.891570 | Mean dependent var | -0.692727 |
| Adjusted R-squared | 0.873498 | S.D. dependent var | 19.16934 |
| S.E. of regression | 6.817972 | Akaike info criterion | 6.839967 |
| Sum squared resid | 836.7254 | Schwarz criterion | 7.038338 |
| Log likelihood | -71.23964 | Hannan-Quinn criter. | 6.886697 |
| F-statistic | 49.33524 | Durbin-Watson stat | 1.990131 |
| Prob(F-statistic) | 0.000000 | | |

**Conclusion: CF is I(0)**

**ADF Test for Real_GDP**

Null Hypothesis: INDIA_GDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.829278 | 0.0081 |
| Test critical values: | 1% level | -3.737853 | |
| | 5% level | -2.991878 | |

| | | | |
|---|---|---|---|
| | 10% level | -2.635542 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INDIA_GDP)
Method: Least Squares
Date: 03/21/14 Time: 13:56
Sample (adjusted): 1989 2012
Included observations: 24 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| INDIA_GDP(-1) | -0.802801 | 0.209648 | -3.829278 | 0.0009 |
| C | 5.055317 | 1.474547 | 3.428388 | 0.0024 |

| | | | |
|---|---|---|---|
| R-squared | 0.399946 | Mean dependent var | -0.266250 |
| Adjusted R-squared | 0.372671 | S.D. dependent var | 3.049072 |
| S.E. of regression | 2.414991 | Akaike info criterion | 4.680923 |
| Sum squared resid | 128.3079 | Schwarz criterion | 4.779094 |
| Log likelihood | -54.17108 | Hannan-Quinn criter. | 4.706968 |
| F-statistic | 14.66337 | Durbin-Watson stat | 1.822891 |
| Prob(F-statistic) | 0.000914 | | |

**Conclusion: Real GDP is I(0)**

### ADF Test for EXRATERISK with intercept:

Null Hypothesis: EXRATERISK has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.331564 | 0.0246 |
| Test critical values: | 1% level | -3.737853 | |
| | 5% level | -2.991878 | |
| | 10% level | -2.635542 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXRATERISK)
Method: Least Squares
Date: 04/07/14 Time: 14:25
Sample (adjusted): 1989 2012
Included observations: 24 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| EXRATERISK(-1) | -0.691434 | 0.207540 | -3.331564 | 0.0030 |
| C | 4.306821 | 2.104634 | 2.046352 | 0.0529 |

| | | | |
|---|---|---|---|
| R-squared | 0.335334 | Mean dependent var | 0.297083 |
| Adjusted R-squared | 0.305122 | S.D. dependent var | 10.14675 |
| S.E. of regression | 8.458262 | Akaike info criterion | 7.187820 |
| Sum squared resid | 1573.928 | Schwarz criterion | 7.285991 |

| | | | |
|---|---|---|---|
| Log likelihood | -84.25384 | Hannan-Quinn criter. | 7.213865 |
| F-statistic | 11.09932 | Durbin-Watson stat | 2.068722 |
| Prob(F-statistic) | 0.003027 | | |

**ADF Test for Inflation Risk Difference**

Null Hypothesis: INF_RISK_DIFF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -5.991302 | 0.0001 |
| Test critical values: | 1% level | -3.737853 | |
| | 5% level | -2.991878 | |
| | 10% level | -2.635542 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INF_RISK_DIFF)
Method: Least Squares
Date: 03/21/14 Time: 13:59
Sample (adjusted): 1989 2012
Included observations: 24 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| INF_RISK_DIFF(-1) | -1.235250 | 0.206174 | -5.991302 | 0.0000 |
| C | 1.591733 | 0.425599 | 3.739979 | 0.0011 |

| | | | |
|---|---|---|---|
| R-squared | 0.620006 | Mean dependent var | 0.018333 |
| Adjusted R-squared | 0.602734 | S.D. dependent var | 2.603160 |
| S.E. of regression | 1.640747 | Akaike info criterion | 3.907835 |
| Sum squared resid | 59.22511 | Schwarz criterion | 4.006007 |
| Log likelihood | -44.89403 | Hannan-Quinn criter. | 3.933880 |
| F-statistic | 35.89570 | Durbin-Watson stat | 1.631945 |
| Prob(F-statistic) | 0.000005 | | |

**Conclusion: Inflation Risk Different is I(0)**

**Interest Rate Different**

Null Hypothesis: D(INTEREST_RATE_DIFFERENT) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -6.619719 | 0.0000 |
| Test critical values: | 1% level | -3.769597 | |
| | 5% level | -3.004861 | |
| | 10% level | -2.642242 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(INTEREST_RATE_DIFFERENT,2)
Method: Least Squares
Date: 03/21/14 Time: 14:06
Sample (adjusted): 1991 2012
Included observations: 22 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(INTEREST_RATE_DIFFERENT(-1)) | -1.960328 | 0.296135 | -6.619719 | 0.0000 |
| D(INTEREST_RATE_DIFFERENT(-1),2) | 0.591374 | 0.187843 | 3.148239 | 0.0053 |
| C | -0.418163 | 0.705860 | -0.592416 | 0.5606 |

| | | | |
|---|---|---|---|
| R-squared | 0.749249 | Mean dependent var | 0.143636 |
| Adjusted R-squared | 0.722854 | S.D. dependent var | 6.239694 |
| S.E. of regression | 3.284866 | Akaike info criterion | 5.342653 |
| Sum squared resid | 205.0166 | Schwarz criterion | 5.491431 |
| Log likelihood | -55.76918 | Hannan-Quinn criter. | 5.377700 |
| F-statistic | 28.38616 | Durbin-Watson stat | 2.116129 |
| Prob(F-statistic) | 0.000002 | | |

**ADF Test for Indi_Nominal_GDP**

Null Hypothesis: INDIA_NOMINALGDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.297744 | 0.0028 |
| Test critical values: | 1% level | -3.737853 | |
| | 5% level | -2.991878 | |
| | 10% level | -2.635542 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INDIA_NOMINALGDP)
Method: Least Squares
Date: 03/27/14 Time: 10:07
Sample (adjusted): 1989 2012
Included observations: 24 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| INDIA_NOMINALGDP(-1) | -0.935111 | 0.217582 | -4.297744 | 0.0003 |
| C | 7.702911 | 2.772323 | 2.778505 | 0.0110 |

| | | | |
|---|---|---|---|
| R-squared | 0.456396 | Mean dependent var | -0.331250 |
| Adjusted R-squared | 0.431686 | S.D. dependent var | 13.30388 |
| S.E. of regression | 10.02934 | Akaike info criterion | 7.528562 |
| Sum squared resid | 2212.928 | Schwarz criterion | 7.626733 |
| Log likelihood | -88.34274 | Hannan-Quinn criter. | 7.554607 |
| F-statistic | 18.47060 | Durbin-Watson stat | 1.961687 |
| Prob(F-statistic) | 0.000292 | | |