

Trade Misinvoicing and Macroeconomic Outcomes in India¹

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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 Misinvoicing, VAR, Impulse Response, Forecasting, India.

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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, $\text{Inflow}_i > 0$, whereby flows into country i . If $\text{Inflow}_i < 0$, 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

$$\text{CF} = \text{Outflow}_i - \text{Inflow}_i = [(M_i)/1.1 - E_j] - [E_i - (M_j)/1.1] \quad (3)$$

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 data³ 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 $\text{CF} > 0$, Capital flow in if $\text{CF} < 0$.

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 cubic 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 from 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 differential, 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 1 a 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 ± 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, \dots, Y_T) and follows a chain-rule. First, we forecast $Y_{T+1|T}$. After that, based on $(Y_1, Y_2, \dots, Y_t, Y_{T+1|T})$, we achieve $Y_{T+2|T}, \dots, Y_{T+h|T}$. 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.

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

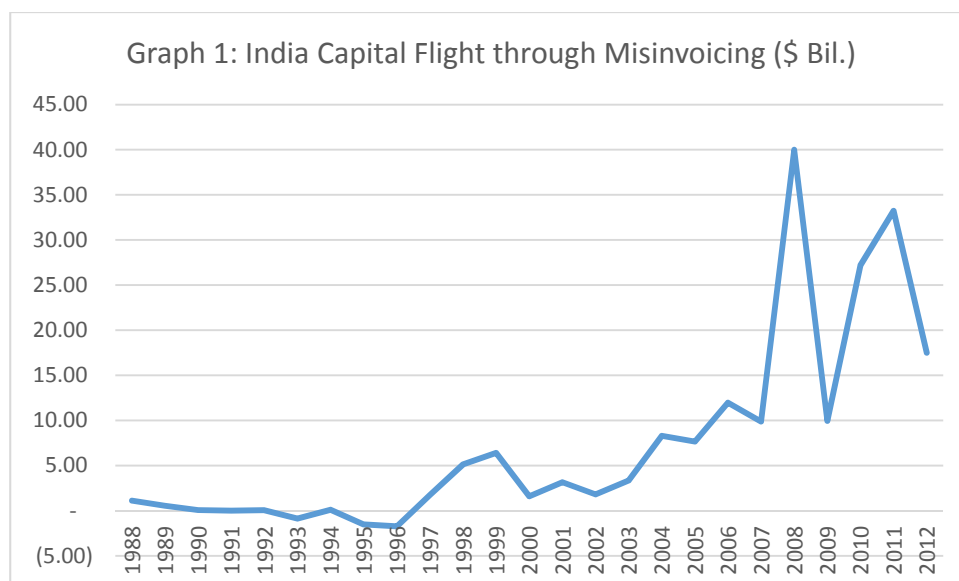
Sample (adjusted): 1989 2012

Included observations: 24 after adjustments

Standard errors in () and t-statistics in [].

Standard errors in () & t-statistics in []

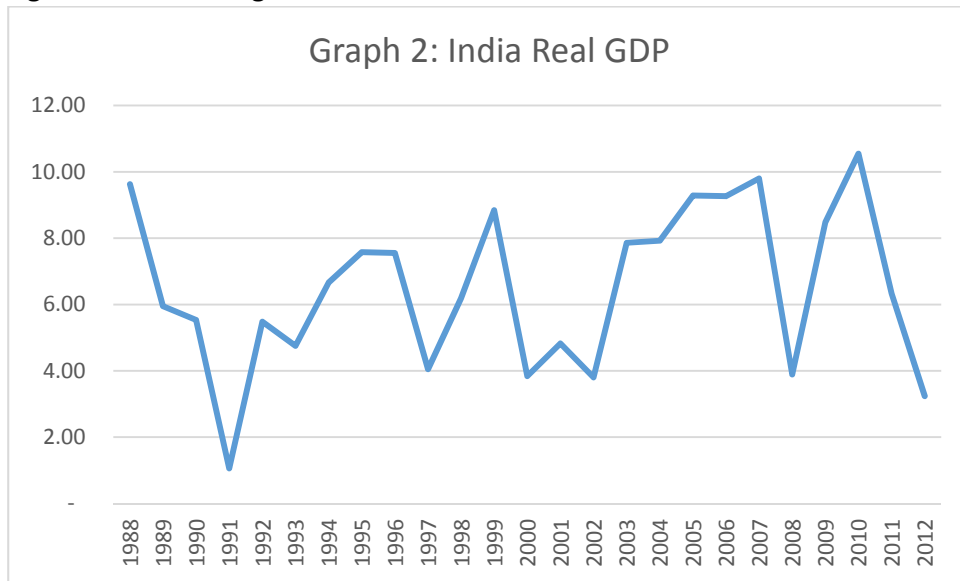
	EXRATERISK	INTRATEDIFF	NOMINALGDP	INFRISKDIFF	CF
EXRATERISK(-1)	0.294016 (0.51194) [0.57432]	-0.103380 (0.18917) [-0.54648]	0.047560 (0.62846) [0.07568]	-0.014408 (0.07812) [-0.18443]	0.531286 (0.40603) [1.30848]
INTRATEDIFF(-1)	-0.089488 (0.60955) [-0.14681]	0.310338 (0.22525) [1.37778]	0.155565 (0.74830) [0.20789]	-0.194750 (0.09302) [-2.09361]	-0.424917 (0.48345) [-0.87892]
NOMINALGDP(-1)	-0.174412 (0.42331) [-0.41202]	-0.000986 (0.15642) [-0.00630]	0.140680 (0.51966) [0.27071]	-0.084339 (0.06460) [-1.30558]	1.031805 (0.33574) [3.07325]
INFRISKDIFF(-1)	-1.606642 (1.32263) [-1.21473]	0.854575 (0.48874) [1.74851]	0.939201 (1.62367) [0.57844]	-0.576639 (0.20184) [-2.85692]	0.322397 (1.04901) [0.30733]
CF(-1)	0.004653 (0.19380) [0.02401]	-0.059254 (0.07161) [-0.82740]	0.127294 (0.23791) [0.53505]	-0.076453 (0.02957) [-2.58507]	0.521347 (0.15371) [3.39179]
C	8.070222 (7.74538) [1.04194]	1.152112 (2.86211) [0.40254]	4.392563 (9.50831) [0.46197]	3.736618 (1.18198) [3.16132]	-7.508482 (6.14306) [-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.

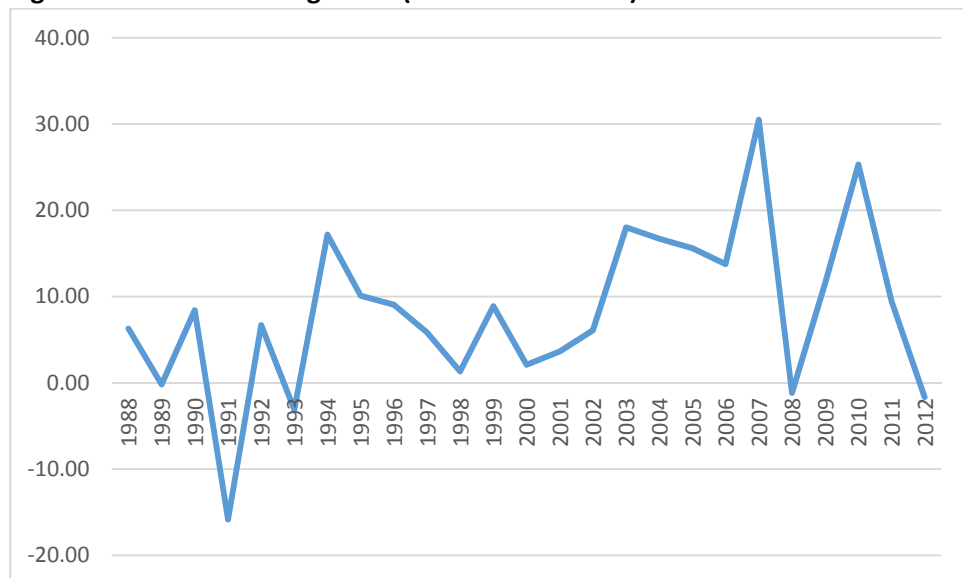
N.B. We intended to get CF data from India's 20 largest trading partners. However, due to the paucity of data, three countries were dropped. Therefore, the CF data is composed of 17 countries for 25 years (425 observations). In 17 remaining countries, there are still some missing data. Thus, the CF database 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

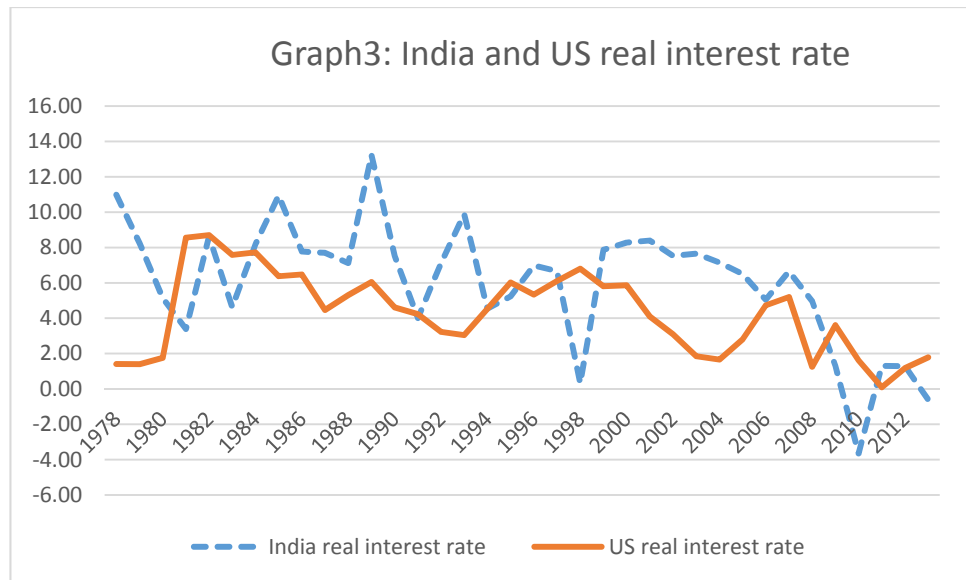


Data Source: World Bank's World Development Indicators (in USD, 2005 price)

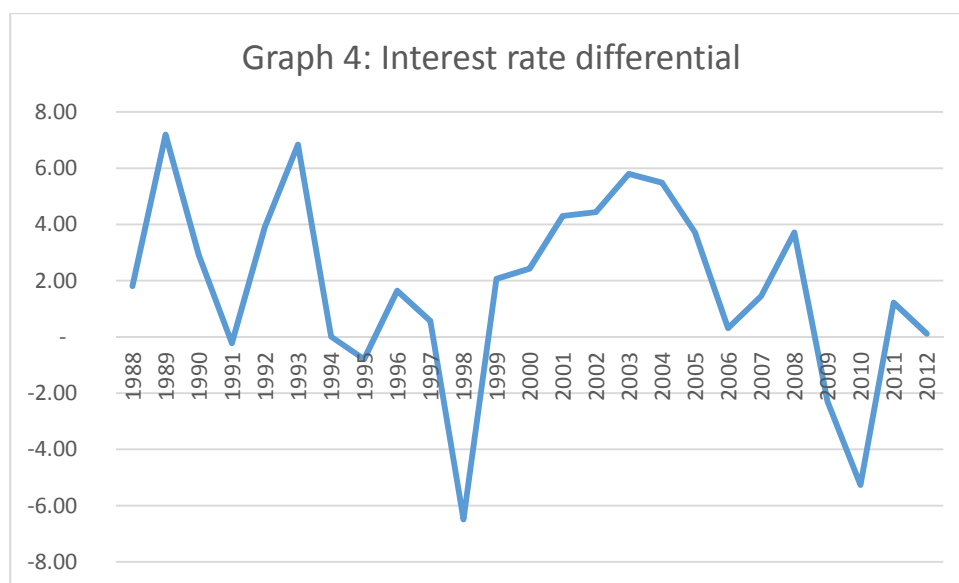
Figure 2b: Nominal GDP growth (current US dollars)



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/>.

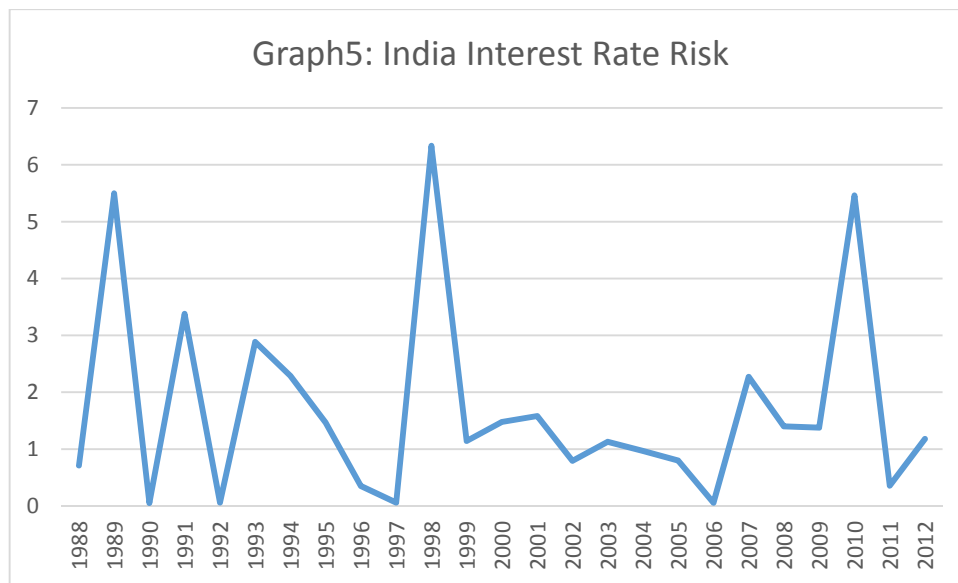
Figure 4: Interest Rate Differential (Indian interest rate-US interest rate)

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 $((\text{Interest rate} - \text{interest trend})^2)$
- 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.

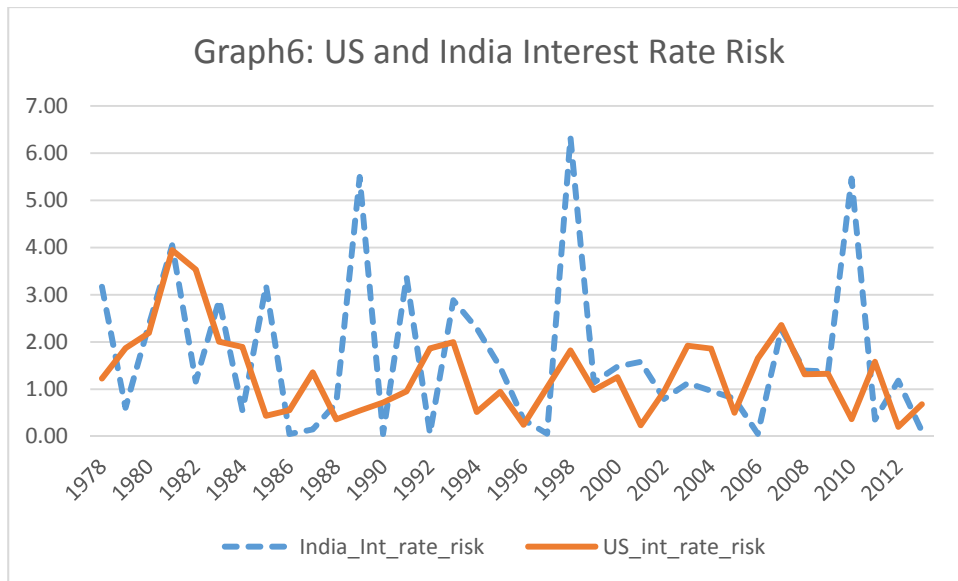
Figure 5: India Interest Rate Risk



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

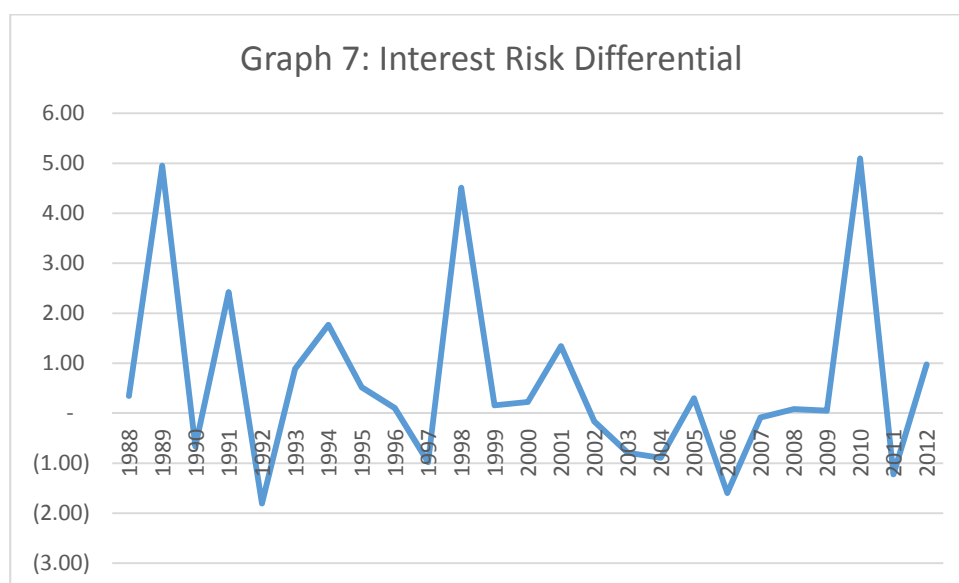
Data Source: IMF e-Library at <http://elibrary-data.imf.org/>.

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/>.

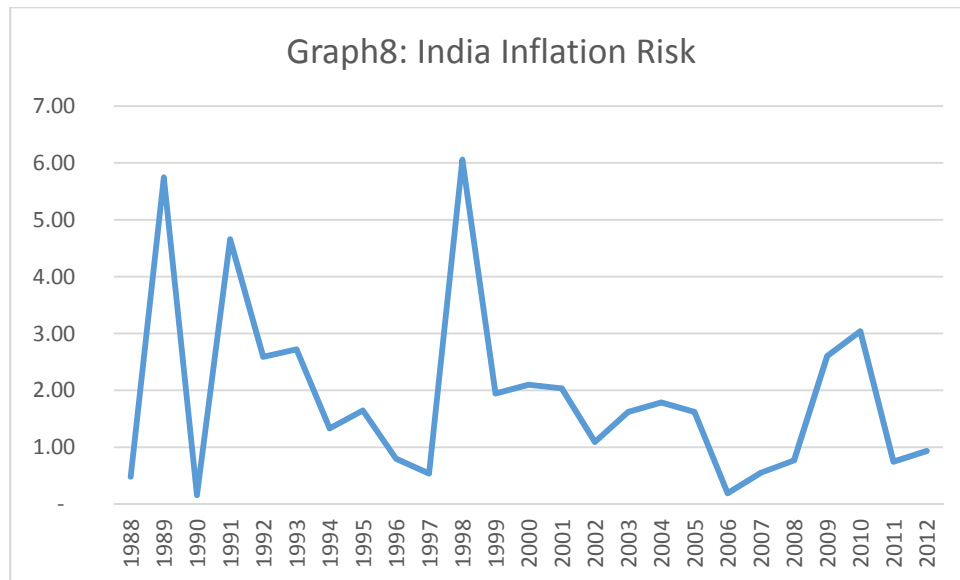
Figure 7: Interest Risk Difference between US and India: (India Interest Risk – US Interest Risk)



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

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

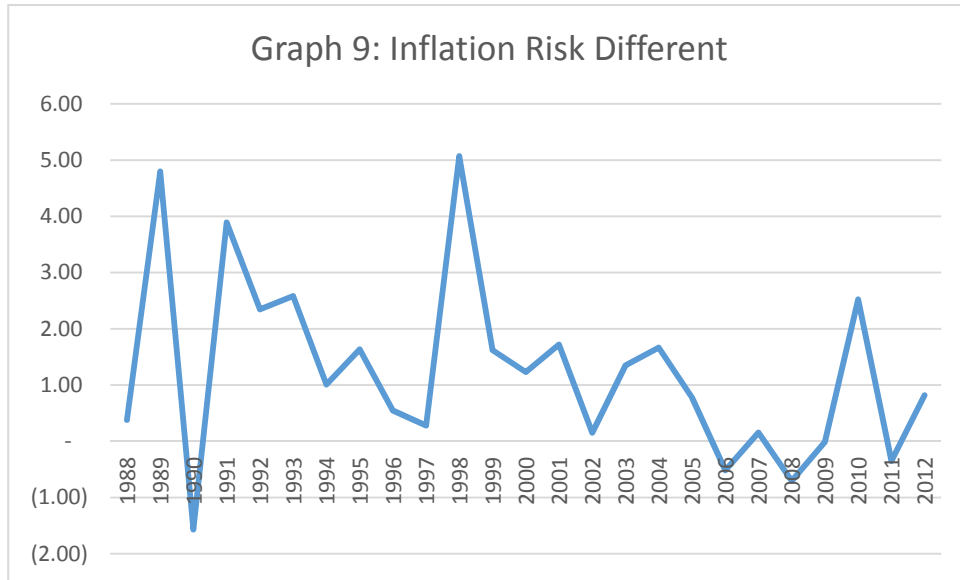
Figure 8: Inflation Risk



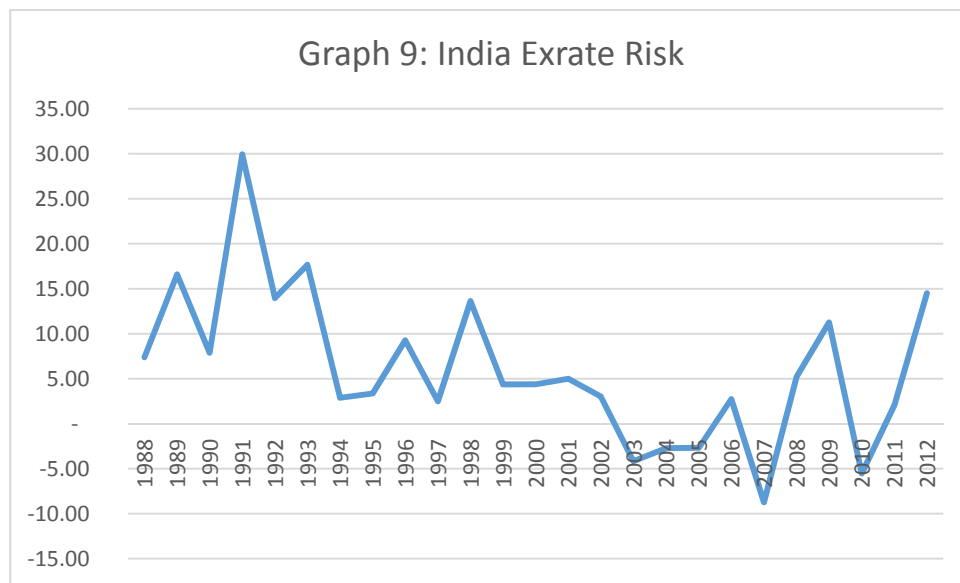
Data Source: CPI IMF E-library at <http://elibrary-data.imf.org/>.

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

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



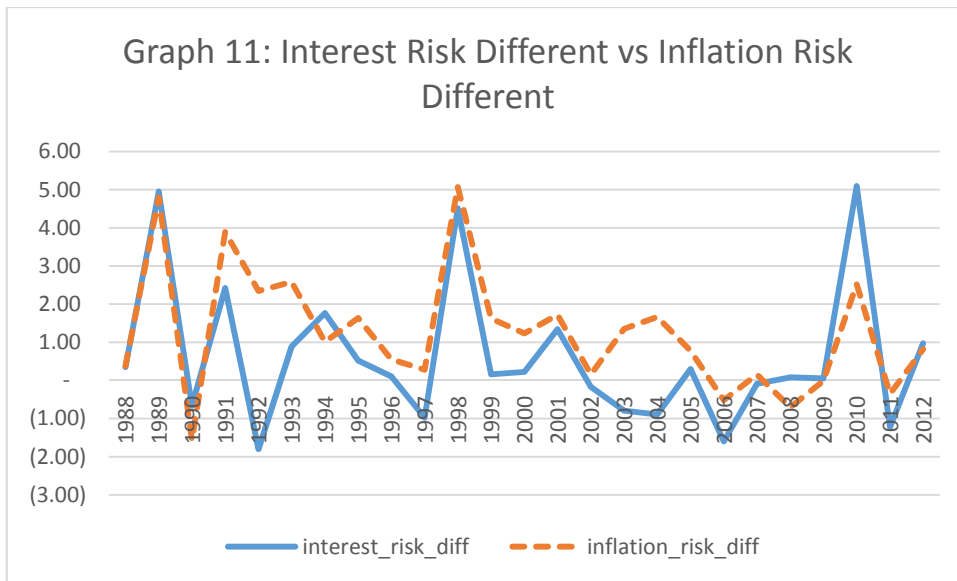
Source: Author Calculation from IMF e-library

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

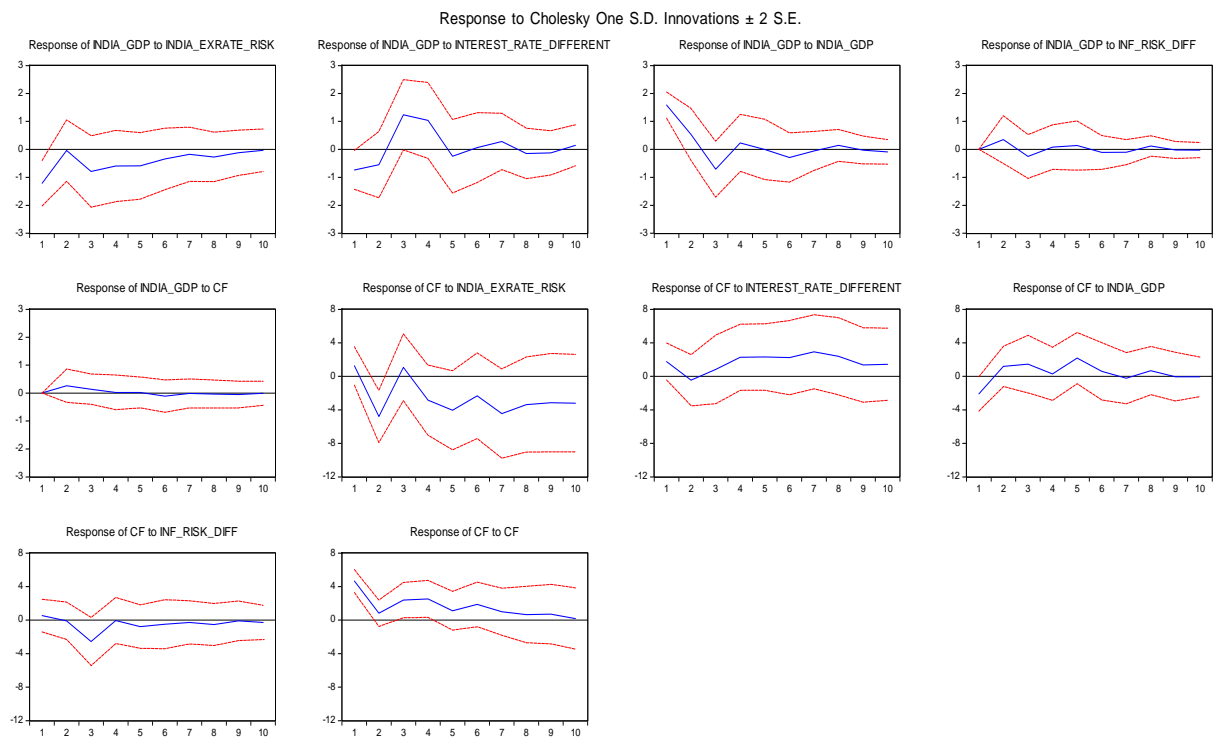


Figure 12b: Impulse Response of VAR Model with Nominal GDP growth

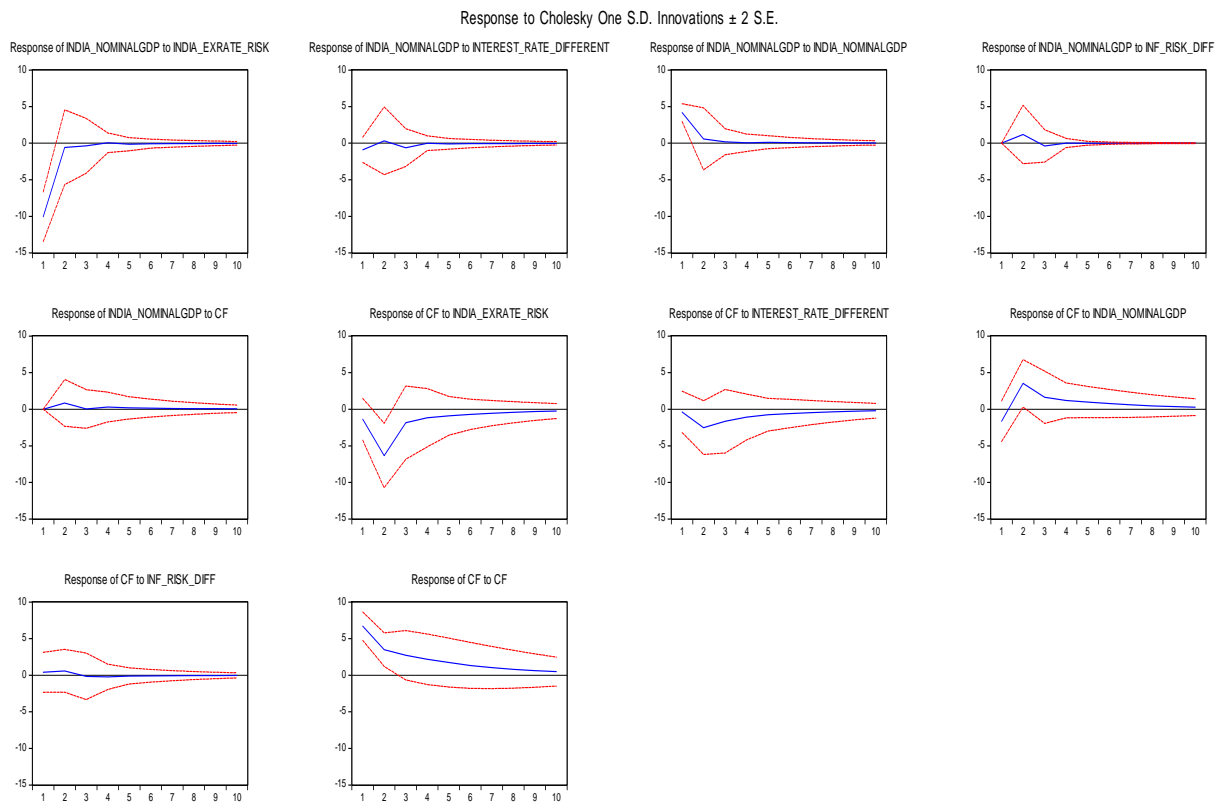


Figure 13a: Forecasting to 2020 with real GDP growth model

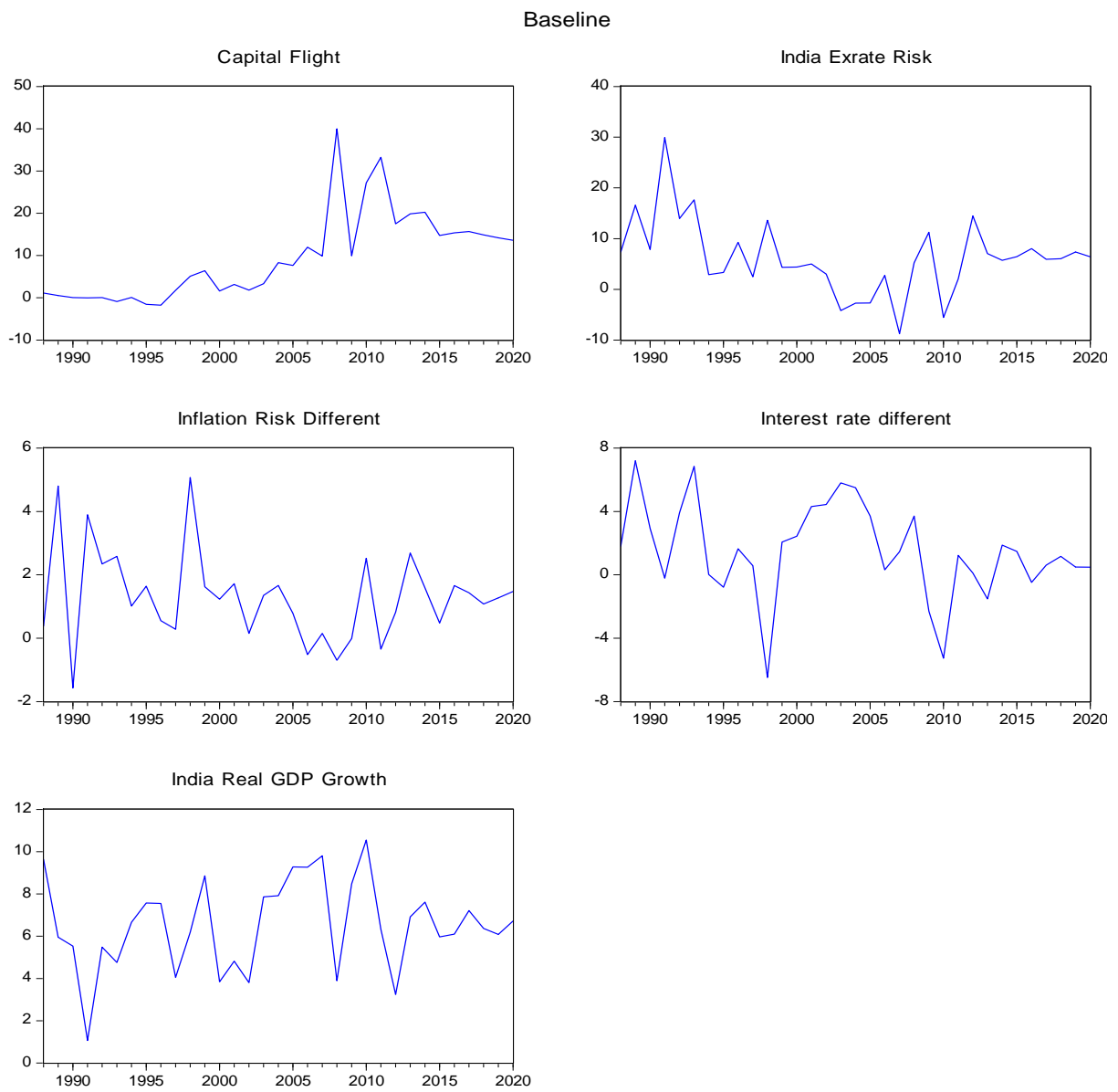


Figure 13b: Forecasting to 2020 with nominal GDP growth

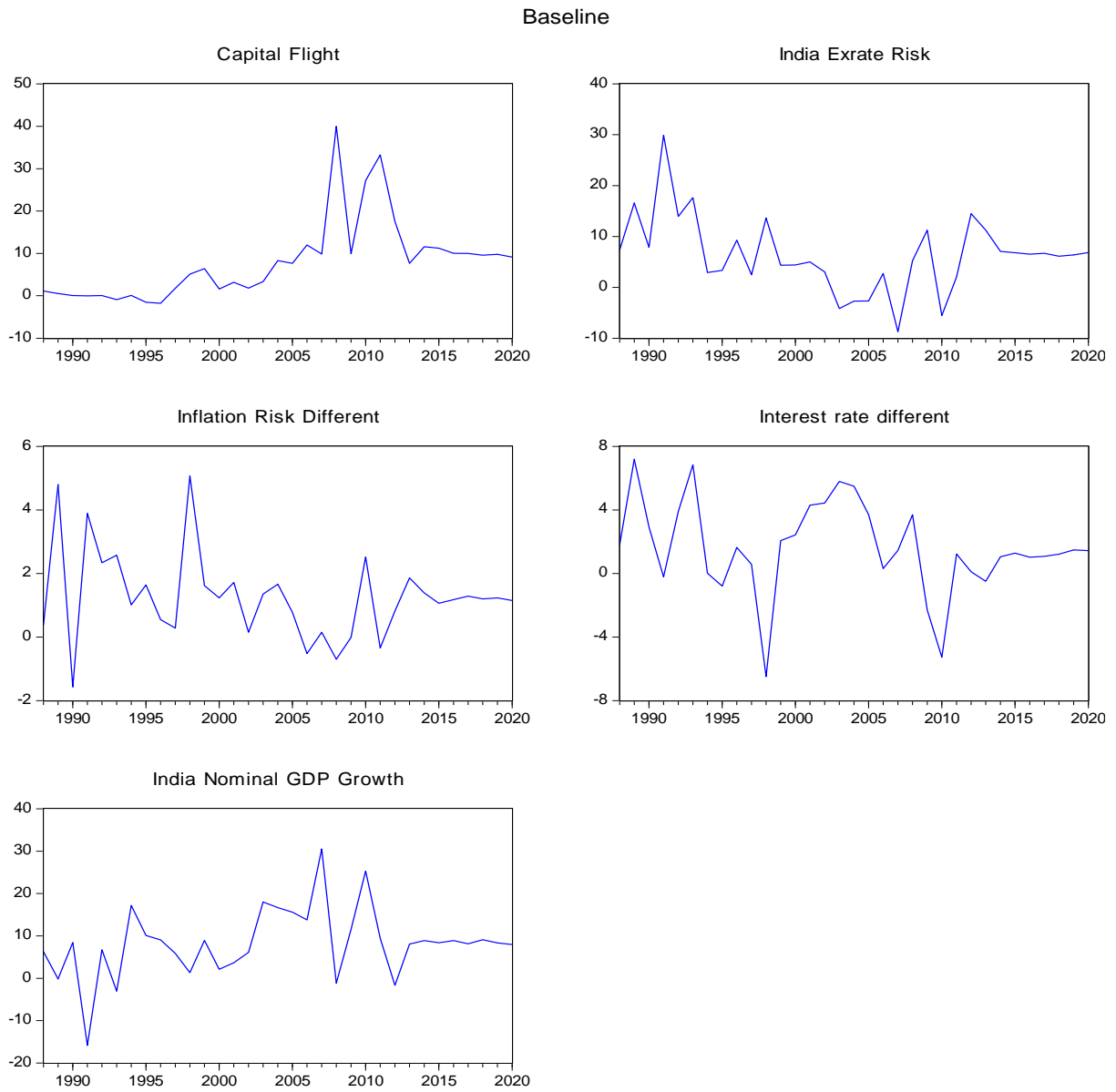


Figure 14a:

Variance Decomposition of VAR Model with real GDP

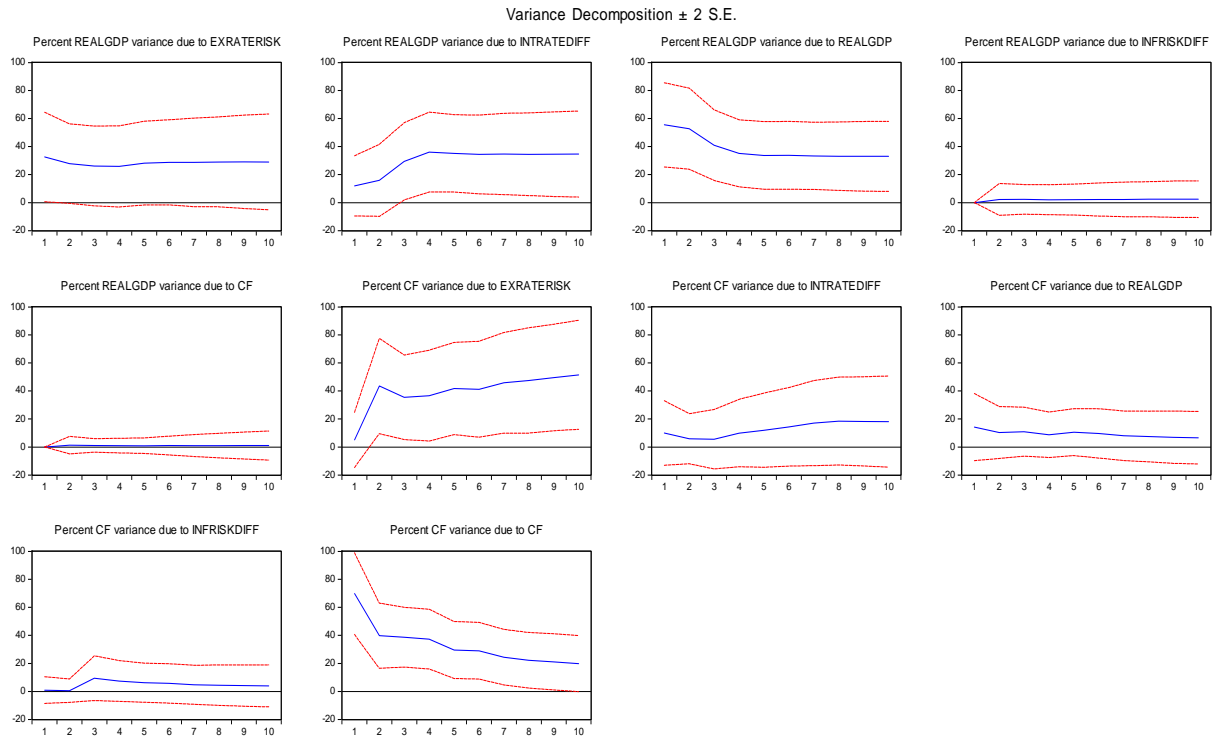
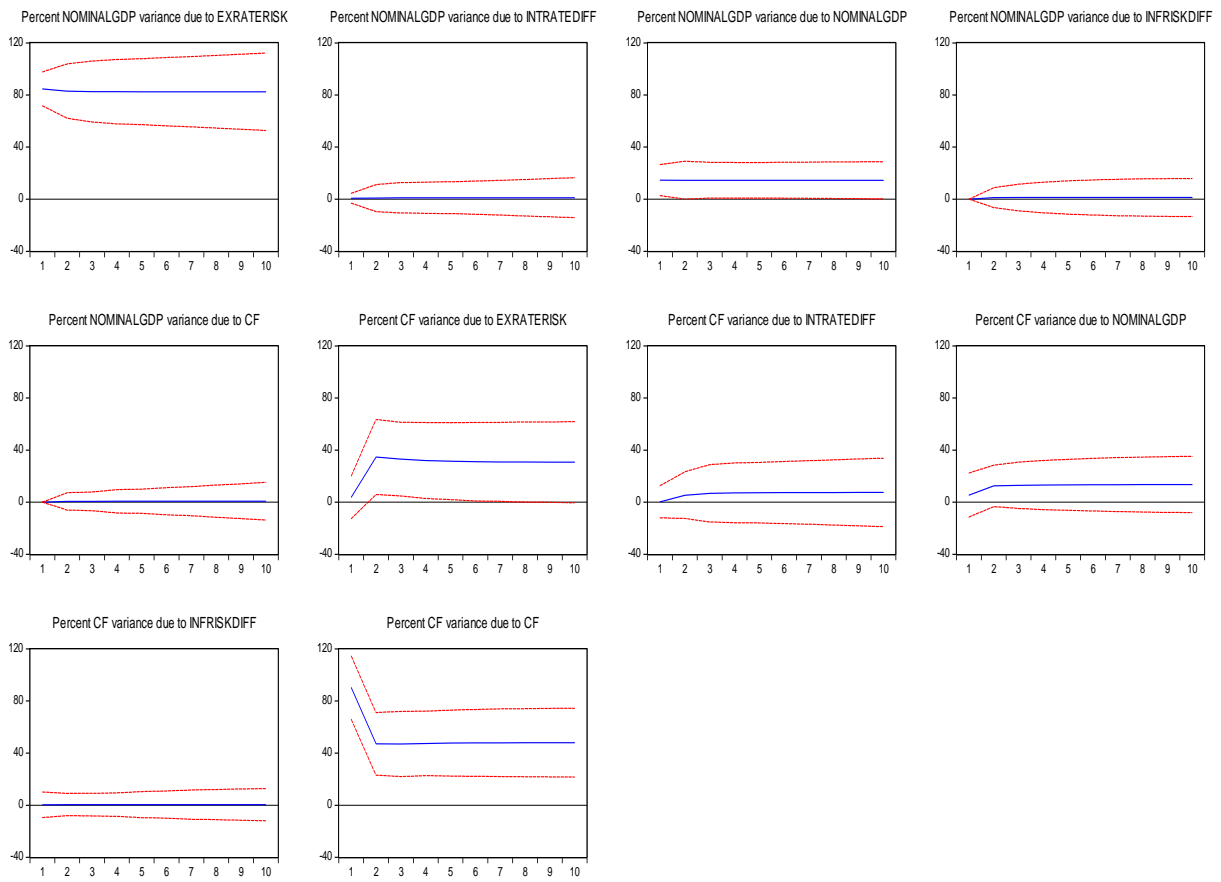


Figure 14b: Variance Decomposition of VAR Model with nominal GDP

Variance Decomposition ± 2 S.E.



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 Lütkepohl (1991). Following Lütkepohl (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			

