Determinants of FII Inflows:India

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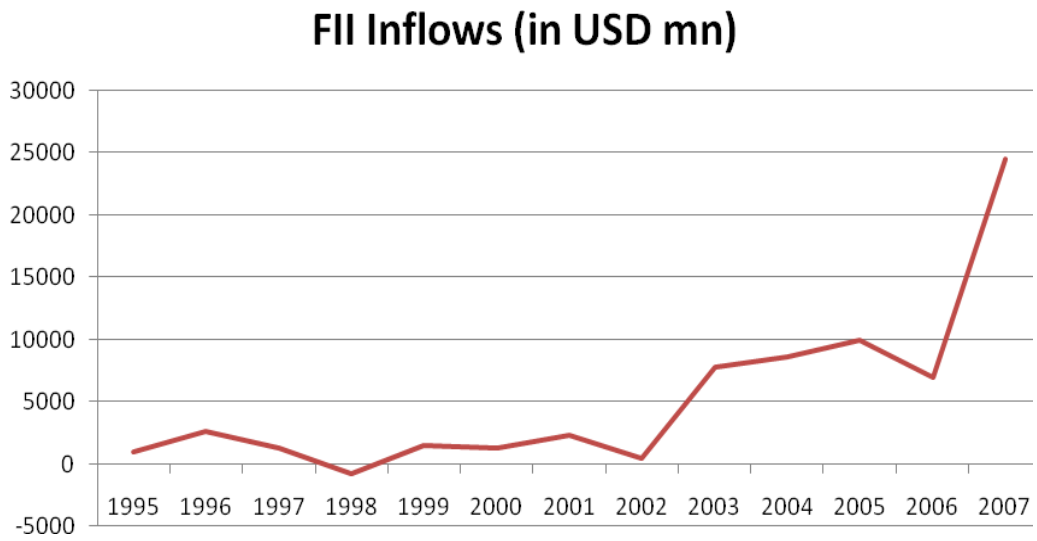
This paper attempts to identify the important determinants of foreign institutional investments (FII) into India. The issue is extremely important for contemporary policy making since managing the large foreign inflows into India in recent times has come to haunt both the RBI and the Government. It is hoped the insight offered by this paper will help us identify the important determinants of FII inflows into India, the knowledge of which can be used to construct suitable policies to manage the problem of large foreign inflows into our economy.

Objective

From the problem of scarcity in the early 1990s to the problem of plenty now, the management of large foreign inflows into our economy has assumed utmost importance in recent times. FII inflows into India have shown an increasing trend after the 1997 Asian Financial Crisis. Total FII inflows in 1997 stood at USD 1317 million. At present, for the year 2007, India received FII inflows to the tune of USD 24,448 million. It is in this context that the management of such inflows throws up new policy challenges as foreign inflows influences various domestic macroeconomic variables like inflation, money supply, foreign exchange reserves, exchange rate, etc.



In recent times, it has become important to identify the key triggers for such inflows into the economy as foreign inflows have assumed such gargantuan proportions in recent times that managing such inflows have become a challenge in itself. Traditionally, such inflows were absorbed by buying the dollars sloshing in the economy (resulting to an equal increase in the domestic money supply for unsterilized interventions) and adding them to our forex reserves. However, to prevent inflationary tendencies arising out of such interventions, the government issues bonds to mop up liquidity released on account of dollar purchases. This process is called sterilization.

Sterilization, however, has a fiscal cost attached to it. The interest that the government earns by investing its forex reserves in US government treasury bonds is much lower than what has to be paid on domestic bonds issued for sterilization purposes. Thus, there is a limit to sterilized intervention, and unsterilized intervention has a very romantic relationship with inflation, and hence politically

unacceptable in India. This leaves the RBI with no option but to stay away from massive interventions in the forex market as such interventions turn out to be inflationary in the absence of corresponding sterilization, and in the absence of such interventions, the domestic currency tends to appreciate. This is exactly what happened in April-May 2007 when the INR (Indian Rupee) appreciated by a whopping 11 per cent against the USD (US Dollar) in view of continued foreign inflows but no corresponding intervention by the RBI in the forex market. After appreciating by more than ten per cent in such a short period, letting the rupee appreciate further will kill our exports and hence even this door is shut for the RBI.

This leaves us with only option, i.e., imposition of capital controls to restrict foreign inflows. However, over the past several years, India has been on a path of capital account liberalization and imposition of capital controls will reverse this process towards full convertibility of the rupee.

Thus it seems there's a problem here in how to manage large foreign inflows. In this regard it becomes imperative that we understand what the determinants of foreign institutional investments (FII) in India are. This paper does exactly that. The issue of foreign inflows is extremely important for contemporary policy making since managing such inflows has come to haunt both the RBI and the Government in recent times. It is hoped the insight offered by this paper will help us identify the important determinants of FII inflows into India, the knowledge of which can be used to construct suitable policies to manage the problem of large inflows into our economy.

The Model

We have assumed a linear model between the dependent variable FII and the independent explanatory variables. A model for FII inflows in India would require certain macroeconomic and financial parameters for the Indian economy to be compared with the ROW to gauge which factors make India attract FII from abroad. However, it is not possible to do an analysis on all important foreign economies vis-à-vis the Indian economy and hence, we have used the US economy as a proxy for the ROW while comparing indicators such as return on equities, risk, inflation, interest rate differential, etc.

The US economy can be used as an effective proxy as over 40 per cent of FII inflows into India originate from the US. Using the US economy as a proxy for the ROW in analyzing FII investments in India is not without precedent. It is assumed that the results thrown up by analyzing the US financial and

macroeconomic variables vis-à-vis the Indian variables in this study can be extended to other countries also. For measuring attractiveness of a destination to FII investments, we have primarily relied on the data for stock market returns as a substantial flow of FII investments is channeled into equities.

$$fii_t = \beta_1 + \beta_2 (sensex_t) + \beta_3 (sp500_t) + \beta_4 (stdev\_sensex_t) + \beta_5 (stdev\_sp500_t) + \beta_6 (wpi_t) + \beta_7 (er_t) + \beta_8 (fii_{t-1}) + \beta_9 (fii_{t-2})$$

The above model specifies that foreign institutional investments in India is a linear function of the value of the BSE Sensex, the value of S&P 500 stock index in the US, the riskiness of investing in Indian equities and US equities, as given by the standard deviation of the movements in Sensex and S&P 500 respectively, the inflation rate in India, the nominal exchange rate and FII inflows in the corresponding previous two time periods (in our case, previous 2 months).

β_1 = the intercept term

$\beta_{2.....9}$ = the partial regression slope coefficients

u_t = the random (stochastic) error term

The time series data for the analysis are **monthly estimates** ranging from Jan 2001 to Dec 2007, i.e., 7 year monthly estimates, and hence the number of observations is 7 X 12 = 84 observations. However because of introducing a first order and a second order lagged variable, the last two observations have been lost. Thus, the effective number of observations for estimation purposes is 84-2=82 observations.

The variables used in the model are given in the next page –

Type	Variable	Unit	Label	Obs
Dependent	fii_t	in USD mn	Foreign Institutional Investments	84
Independent	wpi_t	in per cent	Wholesale Price Index (for India)	84
Independent	$sp500_t$	points	S&P 500 Index	84
Independent	$sensex_t$	points	BSE Sensitive Index	84
Independent	int_diff_t	in per cent	Interest Rate Differential	84
Independent	$stdev\_sensex_t$	-	Standard Deviation (for Sensex)	84
Independent	$stdev\_sp500_t$	-	Standard Deviation (for S&P 500)	84
Independent	er_t	Rs. Per USD	Nominal Exchange Rate	84
Independent	fii_{t-1}	in USD mn	Lag variable, lag=1	84
Independent	fii_{t-2}	in USD mn	Lag variable, lag=2	84

A Note on the Variables

Foreign Institutional Investment:

FII is basically an investor or investment fund that is from or registered in a country outside of the one in which it is currently investing. Institutional investors include hedge funds, insurance companies, pension funds and mutual funds. The term is used most commonly in India to refer to outside companies investing in the financial markets of India. International institutional investors must register with the Securities and Exchange Board of India to participate in the market[1]. The monthly time series data for FII inflows into India were taken from the RBI's[2] Database on Indian Economy and is measured in USD millions.

Wholesale Price Index (for the Indian economy):

The monthly time series data for Wholesale Price Index (WPI) has been used as a measure for inflation in the Indian economy. The monthly data was collected from the RBI's[3] Database on Indian Economy.

Standard & Poor's 500 Stock Index:

The S&P 500 is an index containing the stocks of 500 Large-Cap corporations, most of which are American. The S&P 500 is one of the most widely watched index of large-cap US stocks. It is considered to be a bellwether for the US economy[4]. The monthly time series data for S&P 500 has been used as a proxy to gauge the returns one can expect by investing in equities outside of India as it is a world-renowned index including 500 leading companies in leading industries of the U.S. economy. The historical data for this variable was taken from Yahoo! Finance[5].

BSE Sensitive Index (Sensex):

Sensex is not only scientifically designed but also based on globally accepted construction and review methodology. First compiled in 1986, SENSEX is a basket of 30 constituent stocks representing a sample of large, liquid and representative companies in India. The base year of Sensex is 1978-79 and the base value is 100. The index is widely reported in both domestic and international markets through print as

[1] Definition from Investopedia: http://www.investopedia.com/terms/f/fii.asp
[2] https://59.160.162.25/businessobjects/enterprise115/desktoplaunch1/InfoView/main/main.do?objId=6169
[3] https://59.160.162.25/businessobjects/enterprise115/desktoplaunch1/InfoView/main/main.do?objId=6169
[4] From the Wikipedia: http://en.wikipedia.org/wiki/S&P_500
[5] http://finance.yahoo.com/q/hp?s=%5EGSPC

well as electronic media[6].The BSE Sensex has been used as an index to measure returns from investing in Indian equities. The historical data for this variable was also taken from Yahoo! Finance[7].

Standard Deviation for Sensex:

The standard deviation for sensex was calculated to measure the volatility (used as a proxy for risk associated with investing in Indian equities) of the index. The SD was calculated by taking the data on daily returns[8] for each month, and calculating the SD for the individual months.

Standard Deviation for S&P 500:

Here too, the standard deviation for S&P 500 was calculated to measure the volatility (to be used as a proxy for risk associated with investing in US equities) of the index. The procedure adopted is similar to

that for calculating standard deviation for the sensex (see above).

Exchange Rate:

The nominal exchange rate is defined in the model as the number of units of domestic currency obtained per foreign currency, i.e., the number of Indian Rupee that can be exchanged for one US Dollar. The exchange rate plays an important role in decision making process of an FII investment as a depreciation of the domestic currency results in losses when an FII investment is converted back into the foreign currency while an appreciation of the domestic currency would result in higher returns for the foreign investments.

Lag Variables

Two lag variables have been introduced in the model, fii_{t-1} and fii_{t-2}. This has been done to capture the lagged effect of FII investments in India as it is expected that FII investment in time period t is also a function of past FII investments.

A Priori Expectation

Economic intuition would tell us that FII inflows into an economy should ideally depend on the returns that such funds can expect to make by investing in a foreign economy, expected returns in the home

[6] From the Bombay Stock Exchange official website: http://www.bseindia.com/about/abindices/bse30.asp
[7] http://finance.yahoo.com/q?s=%5EBSESN
[8] Daily Returns was calculated as: [(Today's Close – Previous Days Close) / (Previous Day Close)] * 100

economy, the risk associated with investing in a foreign economy, risk associated with investing in the domestic economy, the home inflation rates, the nominal exchange rate and interest rate differential among a host of other factors.

Even before running the regression analysis, we can form *a priori expectations* on the behavior of the above mentioned variables with regard to FII investments. The below mentioned *a priori expectations* follow normal text book definitions and analysis.

1) **Wholesale Price Index (wpi)** – wpi has been included in the model as a proxy for measuring inflation in the Indian economy. A high rate of inflation is a signal for macroeconomic instability and it lowers the purchasing power of investments, hence, we expect that ***FII investments in India should be a negative function of inflation or the wpi index.***

2) **S&P 500 stock index** – The Standard and Poor's 500 stock index has been included as a model to measure return on equities outside of India. It is expected that if the S&P 500 index shows a bullish trend, meaning that stock returns outside of India are higher, FII investments into India should decrease. The opposite would hold in case the S&P 500 turns bearish. The more bearish are stock returns abroad; greater will be FII inflows into the Indian stock markets. Hence, ***FII investments into India should be a negative function of the S&P 500 index.***

3) **BSE Sensex** – The Bombay Stock Exchange's Sensitive Index (Sensex) has been used as a proxy to measure the return on Indian equities. It is expected that when the Sensex rises, it signals a bullish trend, and hence attracts FII investments into India. The opposite would hold in case of a bearish trend. Therefore, ***there should be a positive relationship between the sensex and FII inflows into India.***

4) **Standard Deviation of the Sensex** - S.D. for the sensex has been computed to measure the volatility associated with equity investment in India. This measure for volatility has been used in the model as a proxy for riskiness of equity investment in India. ***We therefore expect a negative relationship between S.D. for sensex and FII inflows into India.***

5) **Standard Deviation of the S&P 500** - S.D. for S&P 500 has been computed to measure the volatility associated with equity investment outside of India. This measure for volatility has been used in the model as a proxy for riskiness of equity investment abroad. When the riskiness of equity investment abroad increases, we expect the attractiveness of the Indian market for

attracting FII inflows increases, and ***therefore expect a positive relationship between S.D. for S&P 500 and FII inflows into India.***

6) **Nominal Exchange Rate** – A depreciation in the nominal exchange rate (i.e. a depreciation of the INR against the USD) lowers the value of foreign investments in India while an appreciation of the Indian Rupee increases the value of foreign investments here. ***We therefore expect a negative relationship between the nominal exchange rate[9] and FII inflows.***

7) **Lagged Variables** – We expect a negative relationship between FII investment in time period t and time period t-1 and t-2 because if substantial FII inflows have already taken place, say for the past two months, then we can expect FII inflows in this month to cool down a bit, i.e., **there exists an inverse relationship between FII inflows in previous time periods and the present.**

Estimation

Output: (in Stata)

Source	SS	df	MS	Number of obs	82
Model	113934115.000	8	14241764.400	F(8, 73)	10.76
Residual	96621590.600	73	1323583.430	Prob > F	0
Total	210555706.00	81	2599453.160	R-squared	0.5411
				Adj R-squared	0.4908
				Root MSE	1150.5

fii_t	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
fii_{t-1}	-0.397	0.098	-4.070	0	-0.592	-0.203
fii_{t-2}	-0.415	0.099	-4.180	0	-0.614	-0.217
wpi_t	-128.548	24.732	-5.200	0	-177.838	-79.257
$sp500_t$	-4.532	1.824	-2.480	0.015	-8.168	-0.897
$sensex_t$	0.547	0.118	4.660	0	0.313	0.782
$stdev\_sensex_t$	-553.694	227.125	-2.440	0.017	-1006.354	-101.035
$stdev\_sp500_t$	-787.649	387.051	-2.040	0.045	-1559.040	-16.258
er_t	-695.725	121.288	-5.740	0	-937.451	-453.999
_cons	59556.220	9090.796	6.550	0	41438.290	77674.150

[9] Nominal exchange rate here has been defined as the number of units of Indian rupee (INR) that can be exchanged for one US Dollar (USD)

Hence the model can be specified as-

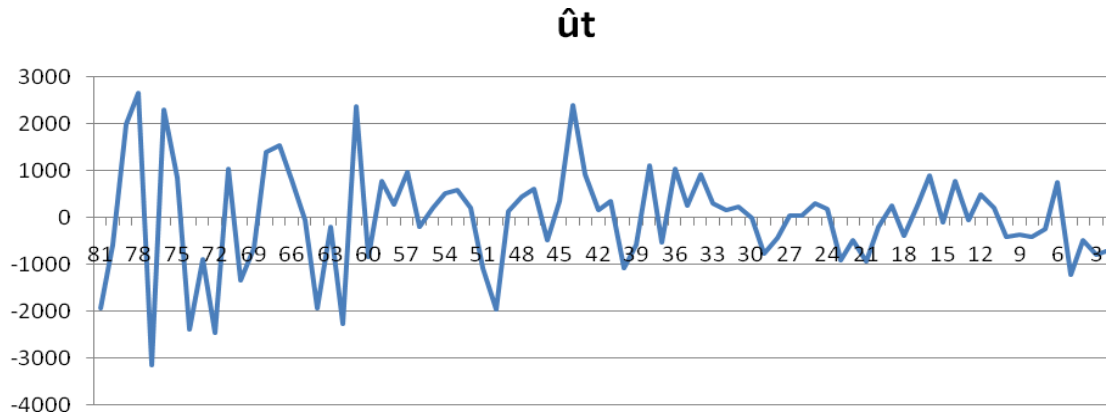
$$\mathbf{fii_t} = 59556.220 + 0.547\ \mathbf{(sensex_t)} - 4.532\ \mathbf{(sp500_t)} - 553.694\ \mathbf{(stdev\_sensex_t)} - 787.649\ \mathbf{(stdev\_sp500_t)} - 128.548\ \mathbf{(wpi_t)} - 695.725\ \mathbf{(er_t)} - 0.397\ \mathbf{(fii_{t-1})} - 0.415\ \mathbf{(fii_{t-2})} + \mathbf{U_t}$$

The above model is a preliminary estimation and hence needs to be checked if it satisfies the OLS properties before we begin interpreting the results. We have checked the above model for autocorrelation as it is likely that our time series model suffers from this model.

Relaxing the Assumptions of OLS

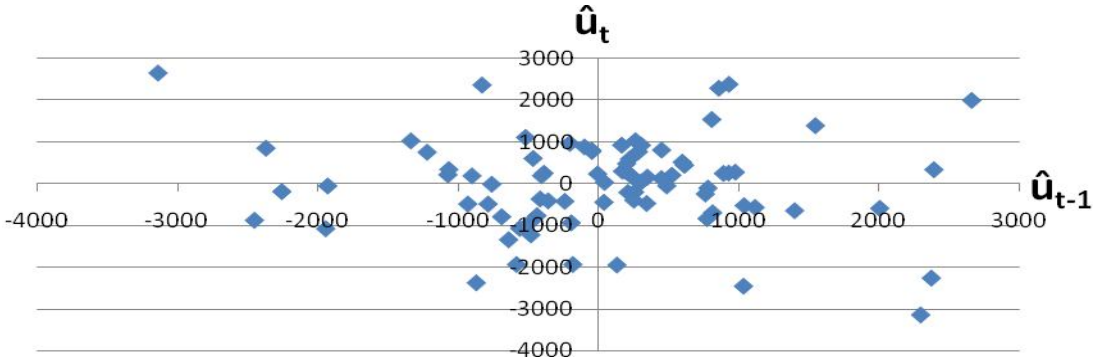
As mentioned previously, the estimation of the model was done without relaxing any of the assumptions of OLS estimation of the slope coefficients. However, in all probability, it is unlikely that any economic model completely satisfies all the properties of OLS estimation. Here, we analyze the data for autocorrelation.

Graphical Method-



In the above figure, we have plotted the residuals $\hat{u}_t$ on the y axis, and time (ranging from 1 to 84) on the x axis. The residual shows a strong negative correlation as we have successively increasingly $\hat{u}_t$ followed by successively decreasing $\hat{u}_t$ and so on.

In the next figure (given on the next page), we have plotted $\hat{u}_t$ against $\hat{u}_{t-1}$ to empirically verify the first order autoregressive model. The scatter plot in this case also shows a slight tendency of negative autocorrelation.



However, the Durbin Watson test statistic *d* for the model has been estimated at 2.1098. The table values for the same are $d_l = 1.425$ and $d_u = 1.861$ (for n=82 and k=8).

Testing for the hypothesis-

H_0 : No negative autocorrelation

H_1 : There is negative autocorrelation

We have $d_u < d < 4-d_u$

$= 1.861 < 2.1098 < 4-1.861$

$= 1.8616 < 2.1098 < 2.139$

Hence we accept H_o and H_1 that there is no autocorrelation. However, the above test can give us misleading results as our sample regression function includes lagged terms of the dependent variable.

Hence, the Durbin Watson test cannot be relied upon in our case. To test for autocorrelation, we ran **the Breusch Godfrey test**, the results of which are displayed-

Breusch-Godfrey LM Test for Autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.49	1	0.4839

Thus, the BG test reveals substantial autocorrelation in the data (the p value is very high at 48.39 per cent) and we reject the null hypothesis H_o : No Autocorrleation

Remedial Measure

We used the method of Generalized Least Squares to remedy the above problem of autocorrelation.

$$Y_t - pY_{t-1} = \beta_1^* (1-p) + \beta_2^* (X_{1t} - pX_{t-1}) + \ldots\ldots\ldots\ldots + \beta_k^* (X_{kt} - pX_{k-1}) + e_t$$

where, e_t is the error term that satisfies the usual OLS assumptions

$$\beta_1^* = \beta_1 (1+p)$$

and $\beta^*_{2\ldots k} = \beta_{2\ldots k}$

However, to estimate the above function, we need an estimate for p which was calculated from the residual approach by running the regression given below-

$$\hat{u}_t = p.\ \hat{u}_{t-1} + v_t$$

where $\hat{u}_t$ and its lag $\hat{u}_{t-1}$ are residuals obtained from running the first regression. The estimated p for our model was computed as = -0.078224. Using the above estimated value for p, OLS was applied on the transformed model which satisfies the CLRM properties with the given results-

Source	**SS**	**df**	**MS**	**Number of obs**	82
				F(8, 73)	9.42
Model	108377995	8	13547249.4	**Prob > F**	0
Residual	104966204	73	1437893.2	**R-squared**	0.508
				Adj R-squared	0.4541
Total	213344199	81	2633878.99	**Root MSE**	1199.1

fii_t	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf. Interval]**	
fii_{t-1}	-0.278	0.100	-2.790	0.007	-0.477	-0.080
fii_{t-2}	-0.336	0.101	-3.330	0.001	-0.536	-0.135
wpi_t	-96.983	22.450	-4.320	0.000	-141.726	-52.240
$sp500_t$	-3.654	1.784	-2.050	0.044	-7.210	-0.098
$sensex_t$	0.465	0.115	4.050	0.000	0.236	0.693
$stdev\_sensex_t$	-751.541	229.327	-3.280	0.002	-1208.588	-294.494
$stdev\_sp500_t$	-743.816	391.277	-1.900	0.061	-1523.630	35.999
er_t	-518.428	105.636	-4.910	0.000	-728.961	-307.895
_cons	48786.340	8385.494	5.820	0.000	32074.080	65498.610

Thus, under the GLS, all the explanatory variables remain significant at 5 per cent level of significance except stdev_sp500, i.e., risk of investing in S&P500, which becomes significant now only at 6.1 per cent level of significance.

Instead of using the GLS procedure, we can also still use OLS but correct the standard error for autocorrelation by computing the Newey West autocorrelation consistent standard error. The result for the same are given (for maximum lag 1)–

Regression with Newey West Standard Errors **Number of obs =** 82

Maximum lag: 1 **F(8, 73) =** 4.46

Prob > F = 0.0002

		Newey West				
fii_t	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf. Interval]**	
fii_{t-1}	-0.397	0.169	-2.350	0.021	-0.734	-0.060
fii_{t-2}	-0.415	0.161	-2.580	0.012	-0.736	-0.095
wpi_t	-128.548	38.642	-3.330	0.001	-205.561	-51.535
$sp500_t$	-4.532	2.052	-2.210	0.030	-8.622	-0.443
$sensex_t$	0.547	0.184	2.980	0.004	0.182	0.913
$stdev\_sensex_t$	-553.694	247.395	-2.240	0.028	-1046.751	-60.638
$stdev\_sp500_t$	-787.649	377.434	-2.090	0.040	-1539.875	-35.423
er_t	-695.725	182.878	-3.800	0.000	-1060.200	-331.251
_cons	59556.220	15384.720	3.870	0.000	28894.520	90217.910

Under the Newey West estimation, the standard errors are higher and hence the t values lower. However, though the t values fall as compared to our first regression, they still remain significant for all the independent variables at 5 per cent level of significance.

Conclusion

For our final analysis, we will stick with the GLS model of correction for autocorrelation. The results for the same are displayed again for the convenience of the reader on the next page.

Source	SS	df	MS	Number of obs	82
				F(8, 73)	9.42
Model	108377995	8	13547249.4	Prob > F	0
Residual	104966204	73	1437893.2	R-squared	0.508
				Adj R-squared	0.4541
Total	213344199	81	2633878.99	Root MSE	1199.1

fii_t	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
fii_{t-1}	-0.278	0.100	-2.790	0.007	-0.477	-0.080
fii_{t-2}	-0.336	0.101	-3.330	0.001	-0.536	-0.135
wpi_t	-96.983	22.450	-4.320	0.000	-141.726	-52.240
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$sensex_t$	0.465	0.115	4.050	0.000	0.236	0.693
$stdev\_sensex_t$	-751.541	229.327	-3.280	0.002	-1208.588	-294.494
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er_t	-518.428	105.636	-4.910	0.000	-728.961	-307.895
_cons	48786.340	8385.494	5.820	0.000	32074.080	65498.610

The **F value** is significant, therefore we can reject the null hypothesis $H_o: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = 0$. **$R^2$ = 50.8 per cent** and **Adj R^2 = 45.41 per cent**, therefore, nearly 50 per cent of the variation in the dependent variable is explained by the explanatory variables. All the explanatory variables (including the intercept) is coming out to be significant at the 5 per cent level of significance, except $stdev\_sp500_t$ which is significant only at 6.1 per cent level of significance.

Since, $\beta_1^* = \beta_1 (1+p)$, we compute β_1 as: $\beta_1 = (\beta_1^*) / (1+p) = 52913.60$

Our final sample regression function stands as-

$$fii_t = 52913.60 + 0.465\ (sensex_t) - 3.654\ (sp500_t) - 751.541\ (stdev\_sensex_t) - 743.816$$

$$(stdev\_sp500_t) - 96.983\ (wpi_t) - 518.428\ (er_t) - 0.278\ (fii_{t-1}) - 0.336\ (fii_{t-2})$$

Interpretation-

1) When the average monthly increase in sensex (computed as a 30 day average of the daily closing values) is one unit, monthly FII investments into India increases by (0.465 X 10,00,000) or USD 4,65,000.
2) When the average monthly increase in S&P 500 (computed as a 30 day average of the daily closing values) is one unit, monthly FII investments into India decreases by (3.654 X 10,00,000) or USD 36,54,000.
3) When the risk of investing in Indian equities (as measured by the monthly standard deviation of daily sensex returns) increases by one unit in a month, monthly FII investments into India falls by (751.541 X 10,00,000) or USD 7.51541 billion.
4) When the risk of investing in foreign equities (as measured by the monthly standard deviation of daily S&P 500 returns) increases by one unit in a month, monthly FII investments into India falls by (743.816 X 10,00,000) or USD 7.43816 billion.
5) When monthly inflation in India (as measured by the WPI) increases by one unit, monthly FII investments into India falls by (96.983 X 10,00,000) or USD 96.983 million.
6) When the nominal exchange rate depreciates by one unit, i.e., when the nominal exchange rate increases[10] by one unit in a month, monthly FII investments into India falls by (518.428 X 10,00,000) or USD 5.18428 billion.
7) A literal interpretation of the lag variables will be that when monthly FII investments in the previous time period, i.e., t-1 increases by 1 million USD, FII investments in the succeeding month, i.e., in time period t, falls by (0.278 X 10,00,000) or USD 2,78,000. Similarly, when monthly FII investments in time period t-2 increases by 1 million USD, FII investments in the the present time period t falls by (0.336 X 10,00,000) or USD 3,36,000. This is to say that FII investments in the present time period also depend on the inflows that have already taken place in the previous two months.

All our a priori expectations are being met expect for the variable stdev_sp500. We expected a positive relationship between this variable and FII inflows into India. This is because when the volatility of the S&P 500 index increases, more inflows can be expected into Indian equities as ROW investments

[10] Remember, we have defined nominal exchange rate as the no. of units of domestic currency that can be exchanged per foreign currency.

becomes more risky. However, our analysis tells us that there exists an inverse relationship between the volatility (risk) of investing in S&P 500 and FII inflows into India.

An immediate reason for the same might be that in today's globalized world, when financial markets have become more integrated, when the mood of investments becomes negative in the ROW because of excessive volatility in equity markets abroad, it becomes negative for India, i.e., volatility abroad results in bearishness for FII inflows into India.

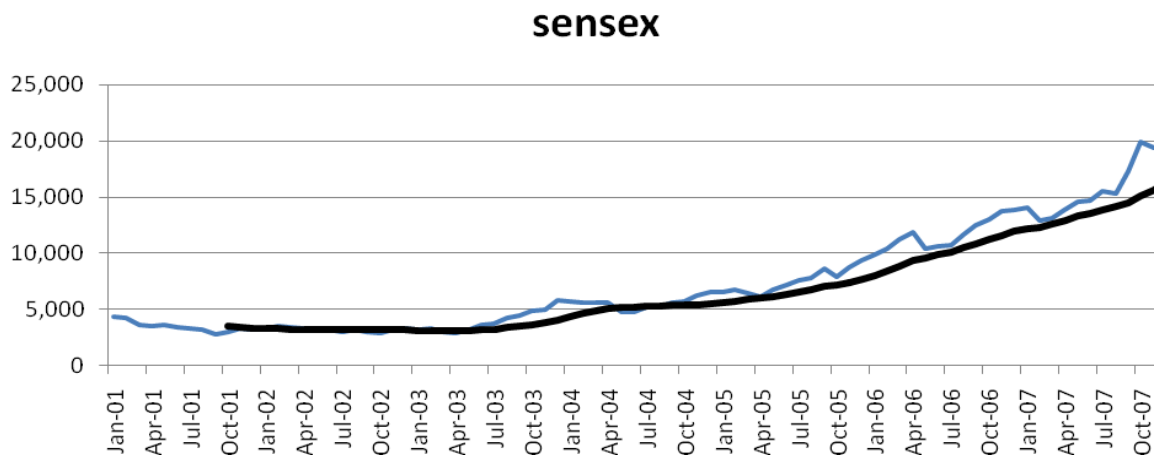
Some Policy Implications

It would appear from the analysis that to control FII inflows into India, the best policy would be to curb foreign inflows into Indian equity markets. We are basically talking about capital controls here. Since our domestic equity markets are booming, it is but natural that substantial FII inflows will take place to take advantage of the bull run. However, this approach may be difficult to adopt since India is currently pursuing a policy of gradual capital account liberalization. Thus, an effective solution would be to impose *selective capital controls*.

Appendix A:

Piecewise Linear Regression

An interesting analysis can be done whether there was any statistically significant bullish trend in the sensex after April 2003, when the bull run in the sensex is supposed to have begun. In the graph below,



the blue line traces out the movements in the sensex while the thick black line is a fitted 10 month moving average trend line. As can be seen, the graph does confirm that there was in fact an uptrend in the sensex post April 2003. However, was this break out statistically significant? To answer the question, we undertake the dummy variable piece wise liner regression analysis by fitting the model given below on the sensex data-

$$\mathbf{sensex}_t = \beta_1 + \beta_2 (\mathbf{X}_t) + \beta_3 (\mathbf{X}_t - \mathbf{X}^*) (\mathbf{dummy}) + u_t$$

The benchmark has been taken as April 2003 which is 28 months after Jan 2001, hence $X^* = 28$. Thus for months before April 2003, the dummy takes the value 0 and post April 2003, the dummy takes the value 1. The X_t variable has been defined as the no. of months after Jan 2001. Thus for Jan 2001, the X_t variable takes the value 1, for Feb 2001, it takes the value 2 and so on. The estimated results are as follows-

Source	SS	df	MS		Number of obs =	84
					F(2, 81) =	653.92
Model	1.6784e+09	2	839207555		Prob > F =	0.0000
Residual	103951064	81	1283346.47		R-squared =	0.9417
					Adj R-squared =	0.9402
Total	1.7824e+09	83	21474291.3		Root MSE =	1132.8

sensex	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
time	-66.10268	19.15514	-3.45	0.001	-104.2154	-27.98996
timedummy	318.3108	24.66227	12.91	0.000	269.2407	367.381
_cons	4086.207	402.7016	10.15	0.000	3284.957	4887.457

As the above results show, the coefficient of the variable timedummy (β_3) is coming out to be highly significant. Hence we can conclude that yes there was a statistically significant uptrend in the sensex post April 2003.

Appendix B: Data

Period	Foreign Institutional Investments	Lag Variable 1	Lag Variable 2	Wholesale Price Index (India)	S&P 500 Stock Index (US)	BSE Sensitive Index (India)	S.D. (Sensex)	S.D. (S&P 500)	Nominal Exchange Rate
Variable Name :	fii	fii_{t-1}	fii_{t-2}	wpi	sp500	sensex	stdev_sensex	stdev_sp500	er
Units :	(in USD million)	(in USD million)	(in USD million)	(points)	(points)	(points)	-	-	Rs. per USD
2007:12(DEC)	2396.00	-265.00	6833.00	216.18	1468.36	20286.99	1.48	1.11	39.47
2007:11(NOV)	-265.00	6833.00	7057.00	215.88	1481.14	19363.19	1.74	1.65	39.47
2007:10(OCT)	6833.00	7057.00	-3323.00	215.18	1549.38	19837.99	2.36	0.85	39.53
2007:09(SEP)	7057.00	-3323.00	4685.00	215.06	1526.75	17291.1	1.08	1.00	40.31
2007:08(AUG)	-3323.00	4685.00	3279.00	213.78	1473.99	15318.6	1.99	1.56	40.83
2007:07(JUL)	4685.00	3279.00	1847.00	213.63	1455.27	15550.99	1.06	1.06	40.43
2007:06(JUN)	3279.00	1847.00	1963.00	212.28	1503.35	14650.51	0.82	0.83	40.81
2007:05(MAY)	1847.00	1963.00	-2433.00	212.28	1530.62	14544.46	0.81	0.56	40.84
2007:04(APR)	1963.00	-2433.00	2385.00	211.5	1482.37	13872.37	1.21	0.51	42.13
2007:03(MAR)	-2433.00	2385.00	24.00	209.76	1420.86	13072.1	1.95	0.87	43.93
2007:02(FEB)	2385.00	24.00	-507.00	208.88	1406.82	12938.09	1.53	0.90	44.13
2007:01(JAN)	24.00	-507.00	2159.00	208.83	1438.24	14090.92	1.17	0.48	44.30
2006:12(DEC)	-507.00	2159.00	1703.00	208.44	1418.3	13786.91	1.49	0.43	44.58
2006:11(NOV)	2159.00	1703.00	1064.00	209.08	1400.63	13696.31	0.59	0.52	44.86
2006:10(OCT)	1703.00	1064.00	1212.00	208.65	1377.94	12961.9	0.96	0.44	45.45
2006:09(SEP)	1064.00	1212.00	-595.00	207.76	1335.85	12454.42	1.05	0.51	46.19
2006:08(AUG)	1212.00	-595.00	-1157.00	205.28	1303.82	11699.05	0.67	0.44	46.57
2006:07(JUL)	-595.00	-1157.00	-3906.00	204.02	1276.66	10743.88	1.97	0.95	46.47
2006:06(JUN)	-1157.00	-3906.00	3276.00	203.1	1270.2	10609.25	3.34	1.00	46.03
2006:05(MAY)	-3906.00	3276.00	684.00	201.3	1270.09	10398.61	2.6	0.79	45.44
2006:04(APR)	3276.00	684.00	1692.00	199.02	1310.61	11851.93	1.67	0.57	44.94
2006:03(MAR)	684.00	1692.00	1386.00	196.75	1294.87	11279.96	0.88	0.49	44.46
2006:02(FEB)	1692.00	1386.00	2122.00	196.43	1280.66	10370.24	0.91	0.60	44.34
2006:01(JAN)	1386.00	2122.00	-17.00	196.3	1280.08	9919.89	1.04	0.70	44.39
2005:12(DEC)	2122.00	-17.00	-469.00	197.24	1248.29	9397.93	1.09	0.47	45.66
2005:11(NOV)	-17.00	-469.00	1035.00	198.2	1249.48	8788.81	1.03	0.49	45.76
2005:10(OCT)	-469.00	1035.00	1204.00	197.82	1207.01	7892.32	1.43	0.93	44.87
2005:09(SEP)	1035.00	1204.00	1746.00	197.15	1228.81	8634.48	1.1	0.60	43.94
2005:08(AUG)	1204.00	1746.00	1313.00	195.25	1220.33	7805.43	0.95	0.57	43.66

Period	Foreign Institutional Investments	Lag Variable 1	Lag Variable 2	Wholesale Price Index (India)	S&P 500 Stock Index (US)	BSE Sensitive Index (India)	S.D. (Sensex)	S.D. (S&P 500)	Nominal Exchange Rate
Variable Name :	fii	fii_{t-1}	fii_{t-2}	wpi	sp500	sensex	stdev_sensex	stdev_sp500	er
Units :	(in USD million)	(in USD million)	(in USD million)	(points)	(points)	(points)	-	-	Rs. per USD
2005:07(JUL)	1746.00	1313.00	-470.00	194.64	1234.18	7635.42	0.94	0.56	43.56
2005:06(JUN)	1313.00	-470.00	-299.00	193.2	1191.33	7193.85	0.78	0.51	43.62
2005:05(MAY)	-470.00	-299.00	1475.00	192.15	1191.5	6715.11	0.63	0.66	43.54
2005:04(APR)	-299.00	1475.00	2467.00	191.64	1156.85	6154.44	1.24	0.93	43.76
2005:03(MAR)	1475.00	2467.00	-178.00	189.45	1180.59	6492.82	1.02	0.63	43.71
2005:02(FEB)	2467.00	-178.00	799.00	188.83	1203.6	6713.86	0.82	0.67	43.70
2005:01(JAN)	-178.00	799.00	2827.00	188.58	1181.27	6555.94	1.54	0.64	43.71
2004:12(DEC)	799.00	2827.00	848.00	188.75	1211.92	6602.69	0.77	0.57	43.99
2004:11(NOV)	2827.00	848.00	421.00	190.18	1173.82	6234.29	0.71	0.61	45.10
2004:10(OCT)	848.00	421.00	450.00	188.94	1130.2	5672.27	0.94	0.76	45.79
2004:09(SEP)	421.00	450.00	-410.00	189.45	1114.58	5583.61	0.73	0.58	46.11
2004:08(AUG)	450.00	-410.00	-467.00	188.43	1104.24	5192.08	0.92	0.83	46.37
2004:07(JUL)	-410.00	-467.00	-449.00	186.6	1101.72	5170.32	1.06	0.60	46.08
2004:06(JUN)	-467.00	-449.00	903.00	185.2	1140.84	4795.46	1.36	0.60	45.54
2004:05(MAY)	-449.00	903.00	1834.00	182.1	1120.68	4759.62	3.81	0.71	45.20
2004:04(APR)	903.00	1834.00	696.00	180.93	1107.3	5655.09	1.34	0.76	43.97
2004:03(MAR)	1834.00	696.00	1147.00	179.83	1126.21	5590.6	1.45	0.94	44.99
2004:02(FEB)	696.00	1147.00	1549.00	179.83	1144.94	5667.51	1.5	0.58	45.32
2004:01(JAN)	1147.00	1549.00	883.00	178.74	1131.13	5695.67	2.08	0.71	45.50
2003:12(DEC)	1549.00	883.00	1622.00	176.85	1111.92	5838.96	0.91	0.61	45.60
2003:11(NOV)	883.00	1622.00	904.00	176.88	1058.2	5044.82	1.37	0.71	45.61
2003:10(OCT)	1622.00	904.00	492.00	176.13	1050.71	4906.87	1.4	0.64	45.44
2003:09(SEP)	904.00	492.00	408.00	175.63	995.97	4453.24	1.69	0.95	45.91
2003:08(AUG)	492.00	408.00	629.00	173.68	1008.01	4244.73	1.4	0.67	46.00
2003:07(JUL)	408.00	629.00	469.00	173.4	990.31	3792.61	1.04	0.98	46.30
2003:06(JUN)	629.00	469.00	285.00	173.55	974.5	3607.13	1.02	1.02	46.77
2003:05(MAY)	469.00	285.00	182.00	173.44	963.59	3180.75	0.72	1.00	47.19
2003:04(APR)	285.00	182.00	77.00	173.1	916.92	2959.79	1.21	1.24	47.48
2003:03(MAR)	182.00	77.00	269.00	171.6	848.18	3048.72	1.08	1.75	47.74
2003:02(FEB)	77.00	269.00	53.00	169.43	841.15	3283.66	0.79	1.19	47.83
2003:01(JAN)	269.00	53.00	184.00	167.8	855.7	3250.38	0.71	1.56	48.03
2002:12(DEC)	53.00	184.00	-9.00	167.18	879.82	3377.28	0.84	1.08	48.23

Period	Foreign Institutional Investments	Lag Variable 1	Lag Variable 2	Wholesale Price Index (India)	S&P 500 Stock Index (US)	BSE Sensitive Index (India)	S.D. (Sensex)	S.D. (S&P 500)	Nominal Exchange Rate
Variable Name :	fii	fii_{t-1}	$.fii_{t-2}$	wpi	sp500	sensex	stdev_sensex	stdev_sp500	er
Units :	(in USD million)	(in USD million)	(in USD million)	(points)	(points)	(points)	-	-	Rs. per USD
2002:11(NOV)	184.00	-9.00	-131.00	167.78	936.31	3228.82	0.68	1.50	48.34
2002:10(OCT)	-9.00	-131.00	-33.00	167.5	885.76	2949.32	0.97	2.17	48.45
2002:09(SEP)	-131.00	-33.00	43.00	167.43	815.28	2991.36	0.83	1.88	48.54
2002:08(AUG)	-33.00	43.00	-272.00	167.12	916.07	3181.23	0.91	2.12	48.68
2002:07(JUL)	43.00	-272.00	87.00	165.65	911.62	2987.65	1.07	2.68	48.84
2002:06(JUN)	-272.00	87.00	-73.00	164.68	989.82	3244.7	1.18	1.35	49.05
2002:05(MAY)	87.00	-73.00	276.00	162.75	1067.14	3125.73	1.55	1.40	49.09
2002:04(APR)	-73.00	276.00	271.00	162.35	1076.92	3338.16	0.99	1.01	49.00
2002:03(MAR)	276.00	271.00	131.00	161.88	1147.39	3469.35	1.32	1.01	48.82
2002:02(FEB)	271.00	131.00	28.00	160.78	1106.73	3562.31	1.54	1.19	48.72
2002:01(JAN)	131.00	28.00	70.00	161.03	1130.2	3311.03	0.92	1.04	48.35
2001:12(DEC)	28.00	70.00	35.00	161.84	1148.08	3262.33	1.33	0.97	48.01
2001:11(NOV)	70.00	35.00	-179.00	162.28	1139.45	3287.56	1.27	0.96	48.07
2001:10(OCT)	35.00	-179.00	116.00	162.5	1059.78	2989.35	1.44	1.24	48.11
2001:09(SEP)	-179.00	116.00	125.00	161.68	1040.94	2811.6	2.8	2.19	47.66
2001:08(AUG)	116.00	125.00	138.00	161.65	1133.58	3244.95	0.71	0.97	47.16
2001:07(JUL)	125.00	138.00	265.00	161.15	1211.23	3329.28	1.18	1.17	47.18
2001:06(JUN)	138.00	265.00	229.00	160.82	1224.38	3456.78	1.28	0.85	47.03
2001:05(MAY)	265.00	229.00	354.00	160.35	1255.82	3631.91	0.94	1.10	46.94
2001:04(APR)	229.00	354.00	668.00	159.95	1249.46	3519.16	2.41	1.94	46.80
2001:03(MAR)	354.00	668.00	444.00	159.14	1160.33	3604.38	2.83	1.82	46.65
2001:02(FEB)	668.00	444.00	-	158.63	1239.94	4247.04	1.68	1.07	46.54
2001:01(JAN)	444.00	-	-	158.6	1366.01	4326.72	1.37	1.55	46.58