Understanding the ADR premium under market segmentation

Matthieu Stigler Ajay Shah Ila Patnaik*

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Abstract

Capital controls can induce large and persistent deviations from the Law of One Price for cross-listed stocks in international capital markets. A considerable literature has explored firm-specific factors which influence ADR pricing when LOP is violated. In this paper, we examine the interlinkages between Indian ADR premiums and macroeconomic time-series. We construct an ADR premium index, whereby diversification across firms diminishes idiosyncratic fluctuations associated with each security. We find that the S&P 500 index and the domestic Nifty index influence the ADR Premium Index. Positive shocks to the ADR premium index precede higher purchases by foreign investors on the domestic market, and precede positive returns on the domestic index.
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Keywords: capital market integration, depository receipts.

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Contents

1 Introduction

In ideal markets, the law of one price (LOP) holds. The empirical literature has identified LOP violations in many situations. As an example, commodities markets exhibit substantial LOP violations (Juvenal and Taylor, 2008). Transportation costs, nontariff barriers, nontraded components as labour costs and taxes and finally heterogeneity of commodities leads to LOP violations.

Financial securities can, in principle, achieve extremely efficient pricing given the absence of these physical frictions. American Depository Receipts (ADRs) and domestic shares are exactly the same asset; there is no nontraded component or transportation cost. Hence, one would expect that the price would be the same. A recent literature has examined the extent of LOP violations with stock prices in international markets (Akram *et al.*, 2009; Levy Yeyati *et al.*, 2008). In some situations, ADRs are indeed priced extremely efficiently, However, capital controls and other trading frictions can interfere with arbitrage, and result in a lack of efficient pricing.

This paper focuses on ADRs issued by Indian companies. India is a large emerging market with a highly liquid domestic market. There are two key impediments to ADR arbitrage for Indian underlyings. First, the structure of capital controls impedes arbitrage, but only *when the ADR premium is positive*. Second, the time difference between New York and Bombay implies that there is no time of day at which both markets are open. These problems have generated persistent LOP violations in the form of large and positive ADR premiums. The size and persistence of this pricing error is much unlike that seen with other countries.

The empirical literature on Indian ADRs has focused on explaining the cross-sectional and time-series dynamics of the ADR premium series for one stock at a time. This involves issues such as timing, liquidity, fungibility and transaction costs (Amary and Ottoni, 2005; Saxena, 2006; Levy Yeyati *et al.*, 2008).

In this paper, we examine macroeconomic influences upon the ADR premium. In order to do this, we shift away from idiosyncratic factors, at the level of each firm, by constructing an ADR Premium Index: the average of the ADR premium for Indian stocks with substantial ADR liquidity. This index induces diversification across stock-specific factors. We then interpret this index as a *macroeconomic* time-series: it represents the behaviour of Indian ADRs as a group, thus reflecting features about the macroeconomy and not the individual firm. We measure inter-linkages between the ADR Premium Index and a group of macroeconomic time-series: the exchange rate, domestic and foreign stock market indexes, and net purchases of foreign investors.

We find strong evidence of interlinkages between these macroeconomic series and the ADR Premium Index. This perspective yields new insights into macroeconomic influences upon ADR pricing in a segmented market. Positive shocks to the ADR Premium Index are associated with larger net foreign purchases of Indian equities in following days. This may suggest that when demand for Indian equities in the US goes up, the ADR market in New York shows increased demand first, and with a lag this demand percolates into the domestic market. Positive shocks to the ADR Premium also have a positive effect on the domestic Nifty index in following days, which may reflect the price pressure associated with these purchases by foreign investors.

We find that positive shocks to the S&P 500 yield elevated values of the ADR Premium: under market segmentation, Indian ADR prices in the US may be influenced by shocks to the S&P 500. Finally, positive shocks to the domestic Nifty index lead to a reduction of the ADR Premium. This suggests a mechanical change in the premium under segmented markets.

For some countries, such as Mexico and Brazil, the LOP broadly holds and ADRs are efficiently priced. However, for countries with large time differences and/or capital controls, where economically significant LOP violations are found, the analysis of this paper yields new insights into ADR premiums.

The remainder of this paper is organized as follows. In Section 3 we describe the dataset and broad empirical facts about the premium/discount for India, Brazil and Mexico. Section 4 discusses the multivariate analysis we conduct and the results. Section 5 concludes.

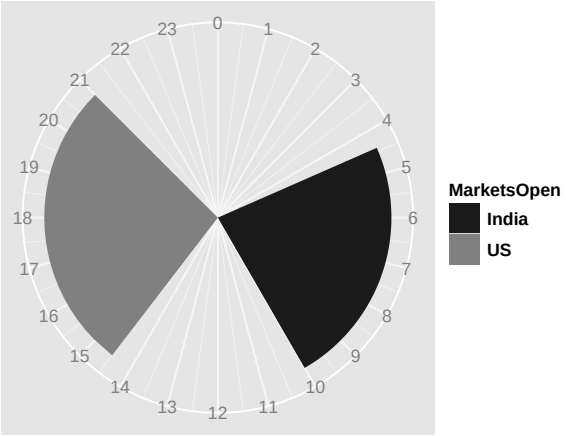
2 The puzzle of Indian ADR pricing

While foreign investors operating in the Indian market constitute the dominant channel through which Indian equities have entered global portfolios, many Indian firms have issued Global Depository Receipts (GDRs) in London and American Depository Receipts (ADRs) in New York. Almost all GDRs issued by Indian firms have failed to achieve significant liquidity. In contrast, some of the ADRs have become fairly liquid. In this sense, the ADR market constitutes a more important mechanism for dual listing by Indian firms.

There are two unique features of Indian ADRs, when compared with the ADRs of issueers from most other countries. The first issue is the non-overlapping trading hours.

In contrast to countries such as Mexico and Brazil, there is no simultaneous trading in the domestic markets and the ADR markets, due to the time zone differences. Specifically, the Indian market closes at 3:30 PM in

Figure 1: Time of trading (in GMT)



Indian Standard Time (ISR), and the New York market opens at 8 PM IST as shown in Figure 1. This lack of overlap in the operation of the Indian and the US market inhibits arbitrage. At the same time, while this can generate fluctuations of the ADR Premium Index about 1.0, it cannot generate a systematic bias in ADR pricing.

The second key factor at work is capital controls. When an ADR is priced below the domestic share price, the arbitrageur buys the ADR, converts it into underlying shares, and sells them on the Indian market. Through this, the number of ADRs outstanding goes down. When an ADR is priced *above* the domestic share price, an arbitrageur needs to buy shares in the domestic market and convert them into ADRs. Indian capital controls permit this reconversion into ADRs only when the number of ADRs outstanding is below the original issue size. Once the number of ADRs outstanding reaches the original issue size of the ADR, this reconversion is banned, thus removing the arbitrage mechanism. This creates the possibility of large positive ADR premiums which cannot be arbitraged away.

A small literature explored the unique features of dual listings by Indian firms. (Jithendranathan *et al.*, 2000) document that ADRs and GDRs are systematically priced above domestic shares. (Hansda and Ray, 2003) find

Table 1: Companies in the dataset

India	Mexico	Brazil
Satyam Computer Services	CEMEX	Companhia Vale
Infosys Technologies	Telefonos de Mexico	Banco Bradesco S.A
Dr. Reddy's Laboratories	Fomento Economico Mexicano	Banco Itau Holding Financeira S.A.
Tata Motors	Homex Development Corp.	Gerdau S.A.
Wipro	America Movil	Petroleo Brasileiro

bidirectional causality between the onshore and offshore price, for 10 Indian ADRs.

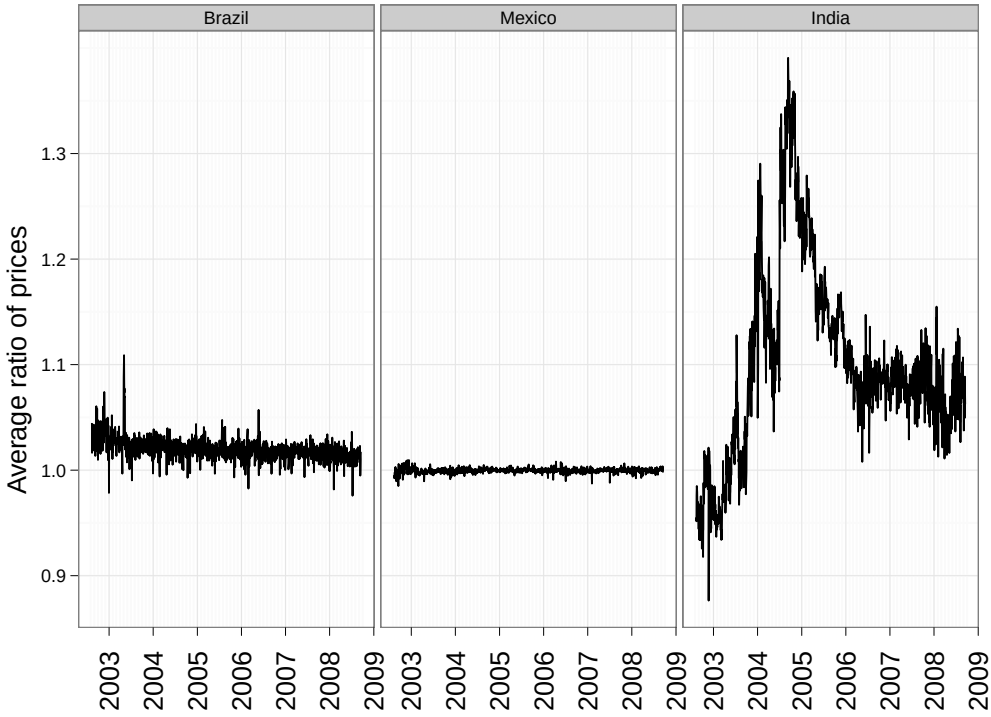
3 The ADR Premium Index

Many researchers have examined the characteristics of the LOP deviation at the level of one firm at a time. In this paper, we focus on a common factor across multiple ADRs from one country: the ADR Premium Index. The ADR Premium Index involves diversification across the ADR Premium of each of the component stocks. Through this, idiosyncratic factors about each stock would tend to get cancelled out. This enables the analysis of interrelationships between the ADR Premium and other macroeconomic series. In order to compare the Indian ADR Premium Index against that found from countries where capital controls do not hinder arbitrage, and where the time of day is well suited for arbitrage, we compute the ADR Premium Index for Brazil and Mexico also.

We construct an index of the ADR premium for Indian, Brazilian and Mexican ADRs, at a daily frequency, with information for the firms listed in Table 1. The ADR Premium Index is computed as the mean of the ADR Premium for the 5 most liquid ADRs in each country. This focus on the most liquid stocks avoids the interplay between the ADR premium and liquidity of the underlying (Levy Yeyati *et al.*, 2008).

The data starts on January 1, 2002 and ends on September 15, 2008. This period was chosen to avoid the unique issues associated with the financial crisis after the Lehman failure. The ADR Premium for each firm is constructed in the following way. Let $P_{i,t}^{\text{ADR}}$ be the price of one unit of the i'th ADR stock quoted in US Dollars. Let γ_i be the conversion ratio: one emerging market share can be converted into $1/\gamma_i$ ADR stocks for the same price. Let

Figure 2: Premium Index for Mexico, Brazil and India



S_t be the market exchange rate on day t and $P_{i,t}^{\text{LM}}$ be the price of one unit of the i'th stock in the domestic market quoted in local currency. Then the ADR Premium for the i'th stock is defined as:

$$\text{Prem}_{i,t} = \frac{P_{i,t}^{\text{ADR}} S_t}{P_{i,t}^{\text{LM}} \gamma_i}$$

This attains the value of 1 under LOP and positive values when ADRs are priced above the domestic share price.

Table 2: Descriptive statistics of the Premium Indexes

	Brazil	India	Mexico
Percentage of Premium Index < 1	2.680	11.847	57.432
Mean	1.022	1.102	1.000
Median	1.020	1.090	1.000
IQR	0.012	0.084	0.003

The three ADR Premium Index time-series are charted in Figure 2. With Mexico and Brazil, the ADR Premium Index is mostly near 1, reflecting effective arbitrage. India has a high and persistent ADR premium. Summary statistics for the three Premium Index time-series are shown in Table 2. The Brazil and Mexico premium have mean and median values at almost 1. The Indian index is largely asymmetric to the right and has a high mean.

4 Understanding the Premium Index

The Premium Index involves diversification across the ADR Premium of each of the component stocks. Idiosyncratic factors about each stock at a time would tend to get cancelled out. This may suggest relationships between the ADR Premium and *macroeconomic* time-series. Hence, we examine the inter-relationships between the ADR Premium Index and four critical macroeconomic series:

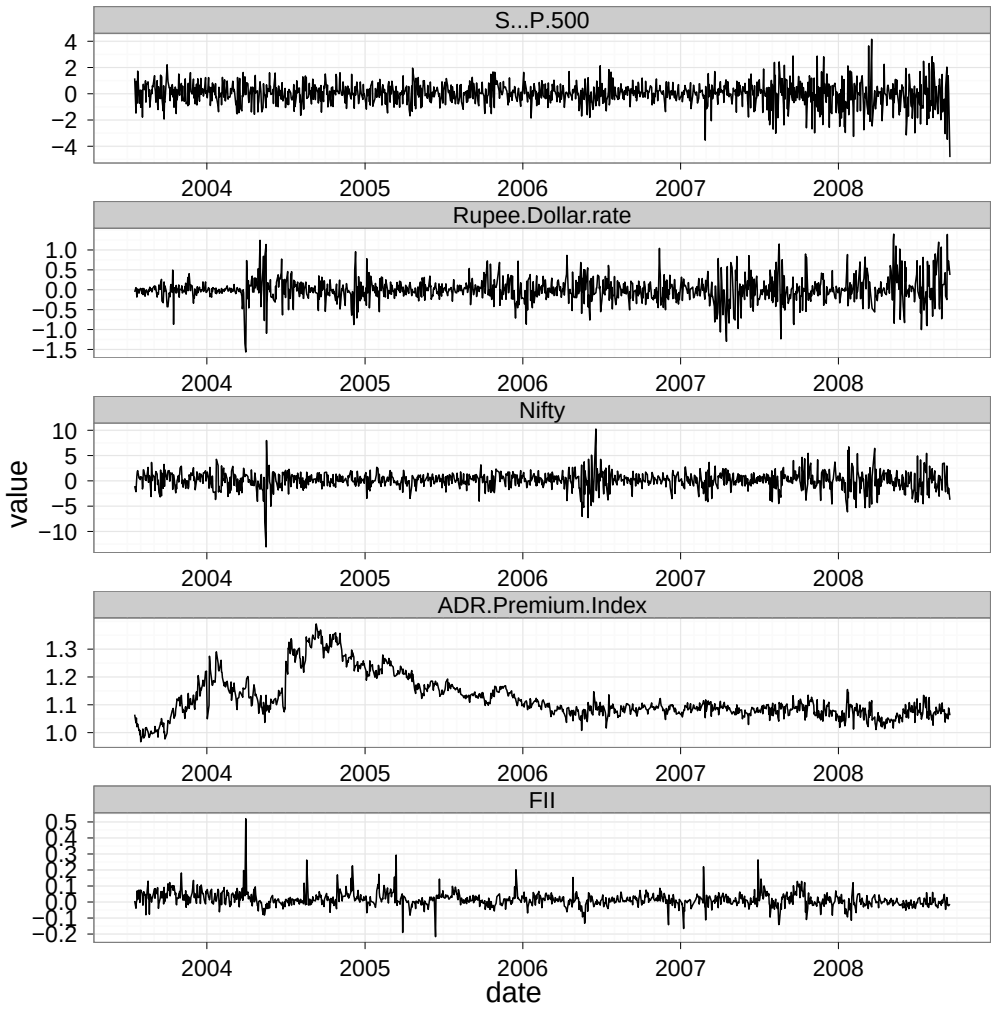
1. The domestic Nifty index (in log differences);
2. The S&P 500 index (in log differences);
3. The daily time-series for net purchases in India by foreign institutional investors ('FIIs'), expressed as a fraction of the overall Indian equity market capitalisation;
4. The rupee-dollar exchange rate (in log differences).

Figure 3 shows graphs of all the five macroeconomic time-series of interest.

4.1 Stationarity

To analyse the stationarity properties of the series, we use the ERS test (Elliott *et al.*, 1996), which offers several improvements over the classical ADF test, as well as the KPSS stationarity test (Kwiatkowski *et al.*, 1992) for a confirmatory analysis. Lag orders are selected depending on the Akaike Information Criterion (AIC). The null of a unit root using the ERS test is rejected at 1% for the exchange rate, the stock market indexes and the FII series. The confirmatory analysis using stationarity test is nevertheless rejected at 10% for the S&P500 and at 2.5% for the FII series, giving contradictory results. Unit root tests tend to have low power, and their rejection should be taken as strong evidence. The KPSS test has been shown to suffer from size distorsions. Hence, we conclude that the series are stationary.

Figure 3: Five macroeconomic series



The situation is less clear for the average premium, for which unit root tests are not rejected but stationary tests are rejected at high levels (1%). As this variable represents an arbitrage process with potential transactions costs, it may exhibit local non-stationary but be globally stationary, as has been argued by many authors in the case of LOP violations (Taylor, 2001; Obstfeld and Taylor, 1997). We hence use a unit root test consistent with this alternative hypothesis (Bec *et al.*, 2004), which indicates that the series is globally stationary. We hence conclude that the average premium is also stationary.

4.2 Multivariate analysis

With this stationarity analysis in hand, we explore the inter-relationships between the five stationary macroeconomic time-series of interest using a vector autoregression (VAR). The order of the lags is chosen based upon the AIC criterion, which indicates 4 lags. The more conservative BIC criterion prefers a model with 2 lags.

Model specification tests indicate problems due to the potential presence of conditional heteroscedasticity. While this could suggest analysis using a multivariate GARCH model, in this paper, the analysis focuses on a VAR since the economic questions concern relationships between the levels of the five series and not their volatility. The inference for this VAR would be affected by the presence of heteroscedasticity. We proceed in a nonparametric fashion, treating the precise form of the heteroskedasticity as unknown, and using heteroscedasticity-robust causality tests along with wild bootstrap inference procedures. Goncalves and Kilian (2004) establishes the validity of the wild bootstrap with heteroscedasticity of unknown form and Hafner and Herwartz (2009) show that causality tests based on robust covariance matrices have good size and power when a VAR model is specified instead of a multivariate GARCH.

To investigate the dynamics within the VAR, we perform two types of tests: a Granger Causality test and a contemporaneous correlation test. The latter test is based on the correlation of the residuals of the three equations, testing whether there is a contemporaneous link between the variables. The Granger Causality test focuses on lagged links.

The results of the causality tests are shown in Table 3 and indicate a rich system with many interactions. Only the FII variable is seen to have no lagged influence on the VAR, and contemporaneous causality is found for every series.The p-values differ slightly whether one relies on asymptotic or bootstrap values, which show that, with the exception of Nifty which appear then to be insignificant, the results are rather robust.

Table 3: Causality tests

Granger causality		
Cause	P-value	
	Asymptotic	Bootstrap
ADR Premium	<0.001	0.016
S&P500	<0.001	0.004
Nifty	<0.001	0.046
Rupee-dollar	0.304	0.423
FII	0.192	0.452
Contemporaneous causality		
Cause	P-value	
ADR Premium	<0.001	
S&P500	<0.001	
Nifty	<0.001	
Rupee-dollar	<0.001	
FII	<0.001	

Table 4: Impulse response functions

	S&P 500	INR/USD	Nifty	ADR Premium	Net FII
Impact of:					
S&P 500		−	+	+	+
INR/USD			−	+	−
Nifty				−	+
Premium		−	+		+
Net FII					

The first group of results pertains to the null hypothesis H_0 where variable i does *not* Granger-cause the others. We find that this is not rejected for the rupee-dollar exchange rate, and the net purchases of foreign investors.

The second group of results pertains to contemporaneous causality. Here, H_0 : variable i does *not* contemporaneously cause the others. This is rejected for all the series.

As these causality tests indicate the presence of contemporaneous correlation, the VAR is not equivalent to a Structural VAR (SVAR) and hence some care needs to be taken with the impulse response functions (IRF). As there is no strong theoretical argument for simultaneous impact among the five variables, we adopt the classical Choleski decomposition. The order is specified as follows: the S&P500 is taken as the first variable, which is not affected by the four Indian variables, and which is allowed to impact all

others contemporaneously. The exchange rate follows, then Nifty, the ADR premium and finally FII.

All the impulse response functions are placed in the Appendix. Table 4 summarizes the key relations observed from the IRFs. The key features of the results are as follows:

Factors that influence the ADR Premium Index Positive shocks to the S&P 500 raise the ADR Premium. Indian ADR prices in the US are influenced by shocks to the S&P 500. In addition, positive shocks to the domestic Nifty index lead to a reduction of the ADR Premium.

Consequences of the ADR Premium Index The mainstream literature on ADR Premiums focuses on the *determinants* of the ADR Premium. In this analysis, however, we see the ADR Premium Index as a new source of information. The impulse response functions show that positive shocks to the ADR Premium have a positive effect on net foreign purchases of Indian equities in following days. This may suggest that when demand for Indian equities goes up, the ADR market in New York shows this first. After this, with a lag, this demand percolates into the domestic market through the actions of foreign investors. Shocks to the ADR Premium also precede increases in the domestic stock market index.

These results need to be understood in the context of the two constraints which impede the LOP: time zone differences and capital controls. The Indian domestic market closes four hours before trading starts in New York. News about the global economy, emerging markets or India that unfolds after the Indian market close would tend to be impounded into ADR prices. In addition, direct investment in Indian equities is only possible for registered FIIs. Economic agents who are optimistic about Indian equities, who do not have access to the Indian market, would execute trades in Indian ADRs in New York in the US daytime.

Consistent with the results of the Granger causality tests, the FII variable has no impact on the other variables. However, when the S&P 500 index, Nifty, or the ADR Premium do well, this leads to an increase in FII purchases. A positive value for the INR/USD returns corresponds to a rupee *depreciation*. Our results show that in the aftermath of a rupee appreciation, FII flows are bigger. FIIs appear to be momentum investors, buying Indian equities in the aftermath of positive returns on the Nifty and on the exchange rate. However, in the context of this VAR, fluctuations in net capital inflows into India have no effects on the other variables.

The fact that the S&P 500 has a positive impact both on the FII variable and on the Premium may reflect a common phenomenon where optimism and gains on the US market tend to be transmitted to other markets, through the FII channel or the ADR channel.

Other insights into the dynamics of VAR are obtained from the forecast error variance decomposition (FEVD). This indicates the contribution of variable i to the h-step forecast error variance of variable k.

Table 5 confirms that the S&P 500 is exogenous to the system. In the other four cases, a certain degree of explanatory power is visible. The ADR Premium Index has a small role in all the three important domestic Indian variables: the exchange rate, the FII flows and the Indian stock market index. By the standards of models predicting financial prices, the explanatory power seen in these models is significant. The ADR Premium index itself is shaped by the S&P 500, the exchange rate, and the domestic Nifty index.

4.3 Sensitivity analysis

In order to assess the robustness of the previous results, the following seven different model specifications have been used:

- Model 1 : Using the premium in difference rather than in levels, as it can be locally non-stationary;
- Model 2 : Using all the 10 Indian ADRs instead of the five most liquid;
- Model 3 : Changing the number of lags to 2 based on BIC;
- Model 4 & Model 5 : Using the VAR on subsamples, with separated estimation before and after July 2006 respectively
- Model 6 : Permuting Nifty and Exchange Rate in the ordering for Cholesky Decomposition for VAR
- Model 7 : Permuting Adr premium and Nifty in the ordering for Cholesky Decomposition for VAR

Table 10 gives a summary of results of all the sensitivity tests. It shows how ADR premium reacts given a shock from other variables and how other variables respond given a shock in the ADR premium.

These calculations suggest that the basic results of the paper are robust to an array of alternative specifications.

5 Conclusion

When the Law of One Price holds, the ADR price is non-informative. In an environment with market segmentation, a significant literature has examined the issues which influence ADRs pricing. Indian ADRs have had large positive and persistent premiums, which are rooted in capital controls.

The main focus of the existing literature has been on identifying the factors which influence the ADR premium based on firm-specific information. The contribution of this paper lies in shifting focus from the idiosyncratic factors that influence one stock at a time to the macroeconomic forces that shape the ADR Premium Index. This gives us new insights on information and capital flows under market segmentation.

We find macroeconomic influences upon the ADR Premium Index (a positive impact of the S&P 500 index and a negative impact of the Nifty). The ADR Premium Index also contains interesting information in its own right: Positive innovations in the ADR Premium Index precede positive innovations for the domestic stock market index and for FII investment. This can have certain interesting applications in research and in the financial industry.

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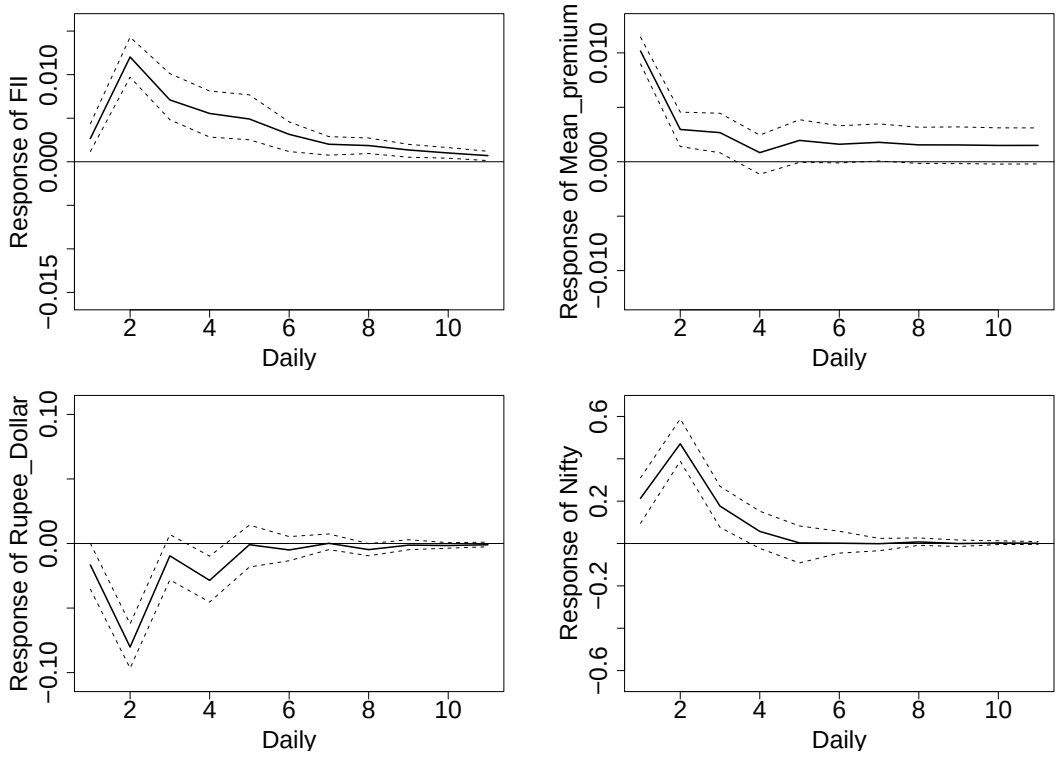
Figure 4: Orthogonal Response from S&P 500



A Impulse response functions

Figure 5: Orthogonal Response from Exchange Rate

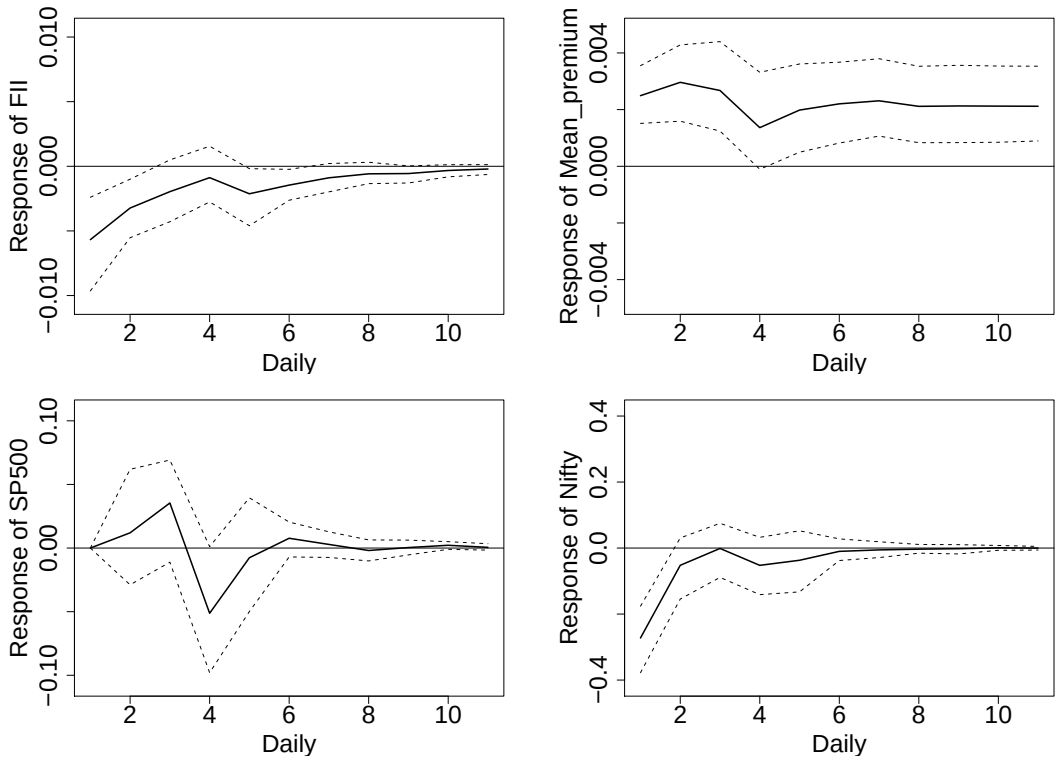


Figure 6: Orthogonal Response from Nifty

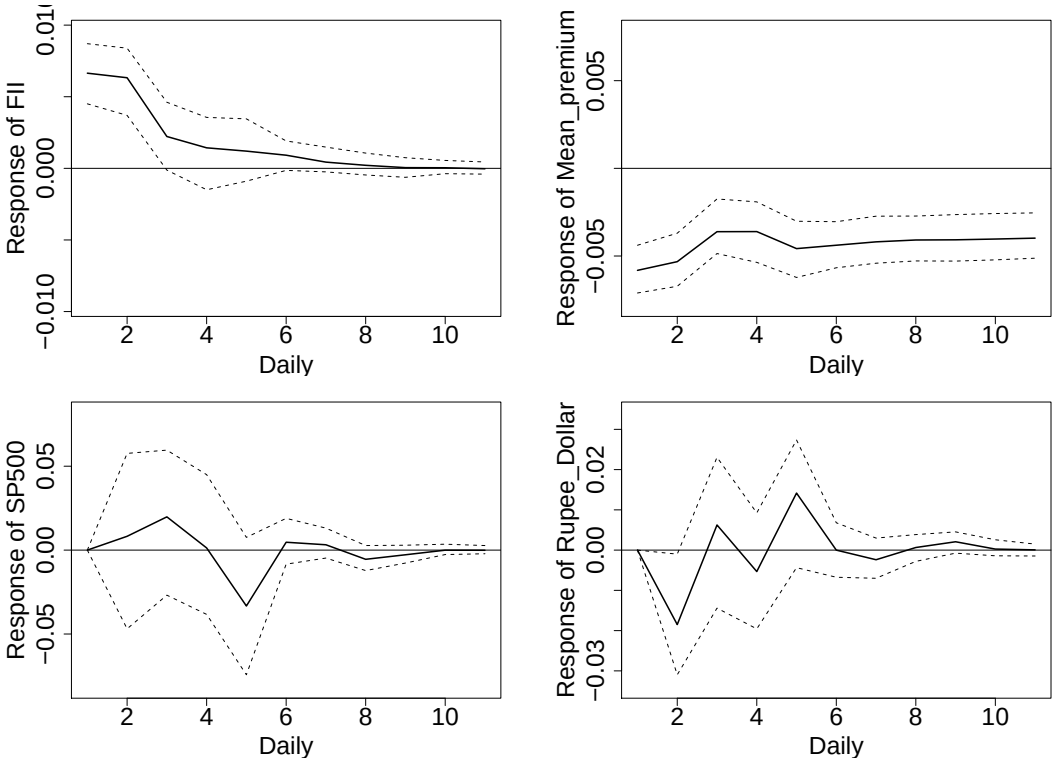


Table 5: FEVD for SP500

horizon	SP500	Rupee_Dollar	Nifty	Mean_premium	FII
1	100	0	0	0	0
5	98.51	0.52	0.2	0.64	0.14
10	98.47	0.53	0.21	0.65	0.15

Table 6: FEVD for Exchange Rate

horizon	SP500	Rupee_Dollar	Nifty	Mean_premium	FII
1	0.31	99.69	0	0	0
5	7.54	89.19	0.6	1.76	0.91
10	7.58	89.05	0.61	1.79	0.97

Table 7: FEVD for FII

horizon	SP500	Rupee_Dollar	Nifty	Mean_premium	FII
1	0.46	2.07	2.83	0.09	94.55
5	12.5	2.52	4.5	1.96	78.52
10	13.16	2.63	4.45	2.27	77.49

Table 8: FEVD for Mean Premium

horizon	SP500	Rupee_Dollar	Nifty	Mean_premium	FII
1	23.81	1.43	7.79	66.97	0
5	12.29	2.77	10.83	74.04	0.07
10	8.52	3.22	12.18	75.98	0.1

Table 9: FEVD for Nifty

horizon	SP500	Rupee_Dollar	Nifty	Mean_premium	FII
1	1.76	2.87	95.38	0	0
5	10.2	2.74	84.23	2.69	0.13
10	10.2	2.74	84.21	2.72	0.13

	Model1	Model2	Model3	Model4	Model5	Model6	Model7
Impulse from							
S&P 500	+	+	+	+	+	+	+
Exchange Rate	+	+	+	+	+	+	+
Nifty	−	−	−	−	−	−	−
FII							
Response of							
S&P 500							
Exchange Rate	−	−	−	−	−	−	−
Nifty	+	+	+	+	+	+	+
FII	+	+	+	+	+	+	+

Table 10: Sensitivity analysis

Figure 7: Orthogonal Response from ADR premium

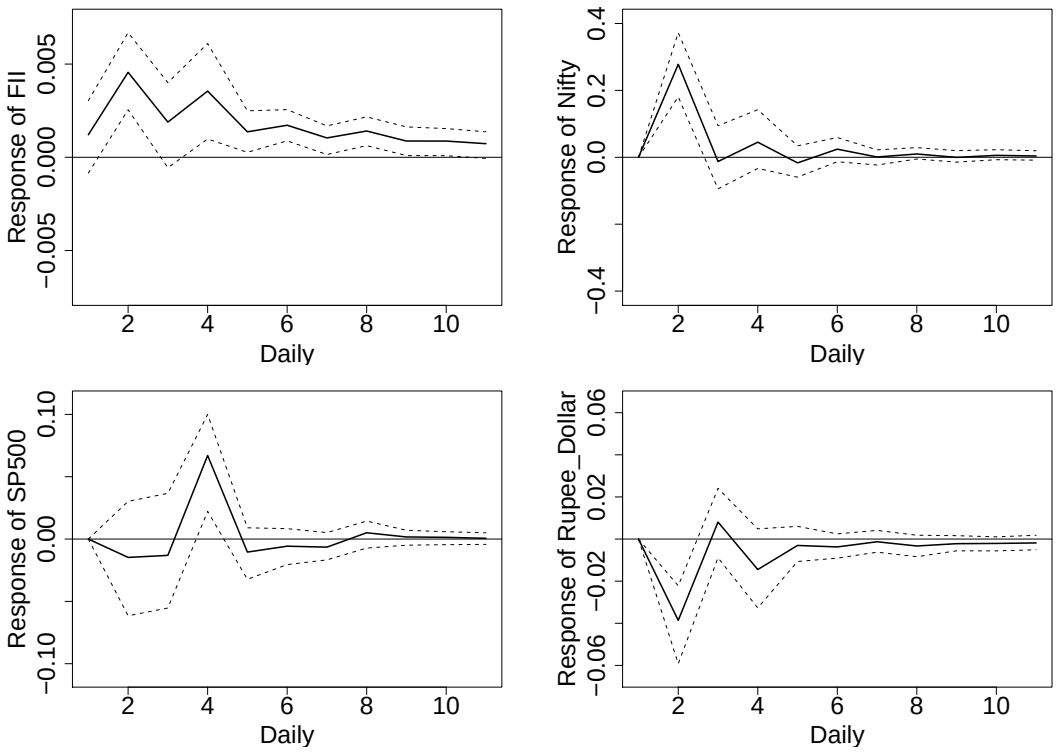


Figure 8: Orthogonal Response from FII