Stock market participation in the aftermath of an accounting scandal

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Abstract

In this paper we study the impact on investor behaviour of fraud revelation. We ask if investors with direct exposure to stock market fraud are more likely to decrease their participation in the stock market than investors with no direct exposure to fraud? We use daily holding data from the National Stock Depository Limited (NSDL), the largest depository in India, and a matching methodology to compare investors directly exposed to fraud with investors who were not directly affected. We find that treated investors cash out almost 10.6 percentage points of their overall portfolio relative to control investors post the crisis. The cashing out is largely restricted to the bad stock. If anything, treated investors make net purchases of related stocks during the same period. Over the period of a month, there is no difference in the trading behaviour of the treated and control investors.

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1 Introduction

Research on investor participation in financial markets has produced certain evidence on investor irrationality such as too much trading, over-confidence, trading on attention-grabbing stocks or a disposition effect (Odean, 1998; Barber and Odean, 2000; Barber and Odean, 2001; Barber and Odean, 2008). More recent work suggests that investors personal experiences play a disproportionate role in shaping their risk appetite and consequently their trading decisions (Malmendier and Nagel, 2011; Malmendier and Nagel, 2016; Anagol, Balasubramaniam, and Ramadorai, 2015).

A parallel stream of literature is emerging on how trust affects investor behaviour, both in terms of participation and trading. Guiso, Sapienza, and Zingales (2008) claim that low trust is a detriment to stock market participation. More recent work has estimated the precise impact of a decline in trust on investor participation and trading. This literature uses instances of fraud revelation as a channel that undermines trust in stock markets, and estimates the effect on household participation. Gurun, Stoffman, and Yonker (2015) exploit the collapse of the multi-billion dollar Ponzi scheme orchestrated by Bernard Madoff, and find that residents of communities that were more exposed to the fraud subsequently withdrew assets from investment advisers and increased deposits at banks. Similarly, Giannetti and Wang (2016) find evidence that a one-standard-deviation increase in fraud revelation intensity in a state during a year leads to a 0.4 percentage point decrease in the households equity holdings as a result of lowering of trust and that such withdrawals have huge implications for cost of capital.

In this paper we use a remarkable natural experiment to obtain new evidence about these questions. We ask, how do investors behave when revelation of fraud is likely to have lowered trust? As recent literature suggests, personally experienced outcomes are over-weighted compared to rational Bayesian learning (Kaustia and Knupfer, 2008; Malmendier and Nagel, 2016) We, therefore, ask if investors with direct exposure to stock market fraud are more likely to decrease their participation in the stock market than investors with no direct exposure to fraud? Is this behaviour restricted to the stock in question, or is their an effect on other stocks? More importantly, we ask if the reaction to fraud is an immediate response or continues to persist over long horizons?

We narrow our attention to a single event, the biggest, and most unexpected accounting fraud in the Indian stock market, also known as the "Enron of India". On 7 January 2009, the chairman of one of the most successful IT companies, Satyam, confessed that he had manipulated the accounts of the firm by US$1.47 billion. Investors in Satyam are

said to have lost almost Rs.136 billion (US$2 billion) over the next month. This news was a complete surprise, and had the market shaken.

Our data on daily holdings comes from the National Securities Depository Limited (NSDL), the largest depository in India in terms of total assets tracked (roughly 80%). We are thus able to capture trading behaviour immediately after the event, and on a daily basis for an extended period of time unlike other papers that base their analysis on household survey data, or observe investors at monthly or yearly frequency.

We focus on investors who held Satyam shares in their accounts one day prior to the event, and compare them to those who did not have such exposure. The selection on observables problem is overcome by using a matching framework. Matching procedures are preferable to randomly selecting investors with no exposure to Satyam as they are less likely to lead to estimation bias by picking investors with completely different characteristics.

We find that investors with direct exposure to Satyam trade more intensely immediately i.e. over seven days after the Satyam event relative to control investors, and that this trading was largely driven by *cashing out* of the portfolio. Treated investors cash out almost 10.6 percentage points of their overall portfolio relative to control investors post the crisis. The cashing out is largely restricted to the "bad stock". If anything, treated investors make *net purchases* of related stocks during the same period. Over the period of a month, there is no difference in the trading behaviour of the treated and control investors.

Our results are contrary to international evidence in two respects. First, our results show that the effect is restricted only to those investors and stocks that were the subject of the governance fraud, unlike results from the US which show that households withdraw from unrelated stocks as well as from the asset class itself. Second, our results show that the effect is attenuated over time. Results from the US indicate that effects of fraud are long-lasting (Gurun, Stoffman, and Yonker, 2015; Giannetti and Wang, 2016).

This paper is the first to focus on the impact of fraud in an emerging market, which is characterised by low participation, low financial literacy, and a larger trust deficit.[1] The literature on limited participation in emerging economies, especially India, has so far focused on supply side challenges i.e. the problems in the distribution of retail financial products (Anagol and Kim, 2012; Halan, Sane, and Thomas, 2014; Halan and Sane, 2016). According to the evidence so far, low trust is a consequence of sharp sales practices, and not of failure of regulation on corporate governance of financial market entities themselves.

[1]The World Values Survey evidence shows that low income countries have lower levels of trust capital.

The channel of trust is also suggestive, that is, there is no direct evidence that can help link fall in trust to investor decisions. This paper is able to contribute towards this question.

Our results raise questions on the importance of the cultural and institutional settings on investor behaviour. For example, household survey data from India indicates portfolios of Indian households, are dominated by real assets such as gold and real estate, and barely 2 percent of the country participates in the stock market (Badarinza, Balasubramaniam, and Ramadorai, 2016). Within the class of investors that do participate in the stock market, it is believed that retail participants are largely dominated by "day traders". As well, there is general skepticism about corporate governance standards.

It is in this context of limited stock market participation, and high mistrust of accounting standards that the Satyam fraud needs to be placed. In such a setting, it is possible that an accounting fraud, even as big as Satyam, does not affect trust perceptions of those already in the market relative to a setting where a larger fraction of the population participates in such markets, and expectations of corporate governance are higher. Of course, instances of fraud may deter participation on the extensive margin, and cause fewer people to enter the market, but data restrictions prohibit us from throwing light on this important question.

The paper proceeds as follows. In Section 2 we describe the data, and in Section 3 the research design including a discussion of the fraud, as well as the estimation methodology. In Section 4 we discuss the results, and heterogenous treatment effects in Section 5. Section 6 describes the robustness checks. Section 7 concludes.

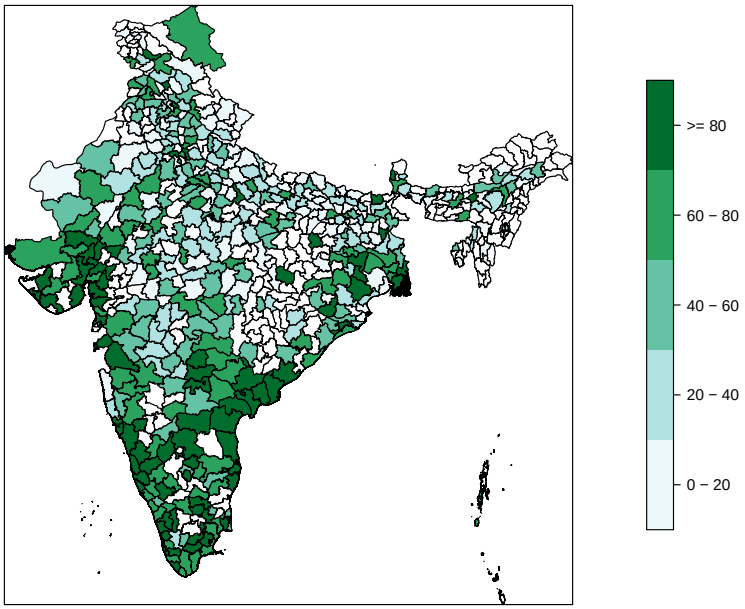
2 Data

Our data come from India's National Securities Depository Limited (NSDL), the largest depository in India in terms of total assets tracked (roughly 80%). Equity securities can be held in both dematerialised and physical form, most stock transactions take place in dematerialised form.

While our dataset is similar to that of (Campbell, Ramadorai, and Ranish, 2013), it differs in two important respects. First, we have daily holdings data for each investor, as opposed to monthly holdings data. This is an important difference, as it allows us to evaluate changes to account balances immediately after any event, which is difficult to do with a monthly aggregation. Second, our data extends beyond 2012, till 2016. For

Figure 1 Satyam holdings as of 6 January 2009

This figure shows the number of investors with Satyam holdings as a proportion of total number of investors in each district across the NSDL sample, as of 6 January, 2009. We then plot the distribution of the percentage of Satyam account holders in five buckets. Here the 20th percentile value corresponds to 0.66% i.e. districts which have less than equal to 1.35% of total accounts with Satyam stock. The 40th percentile value corresponds to 1.11% of total accounts, the 60th percentile value to 1.85% and the 80% percentile value - 3.15% of total accounts.



the rest, we have similar limitations on demographic information provided to us, namely, we are able to identify the state and district of the account's residence, but not able to identify actual age, gender, or any other household information.

In our data-set a single investor can hold multiple accounts. However, we are able to merge all accounts with a single Permanent Account Number (PAN) number[2], to arrive at an estimate of one account per investor.Permanent Account Number. We also focus on those accounts that have at least one equity ISIN listed in NSE in their portfolio. As of 6 January, 2009, the day before the Satyam crisis, there were 5.6 million individual accounts in NSDL.

Figure 1 shows the number of investors with Satyam holdings as a proportion of total number of investors in each state across the NSDL sample, as of 6 January, 2009. We then

[2]The PAN is a unique identifier issued to all taxpayers by the Income Tax Department of India, and is mandatory at the time of account opening at NSDL.

plot the distribution of the percentage of Satyam account holders in five buckets. Here the 20th percentile value corresponds to 0.66% i.e. districts which have less than equal to 1.35% of total accounts with Satyam stock. The 40th percentile value corresponds to 1.11% of total accounts, the 60th percentile value to 1.85% and the 80% percentile value - 3.15% of total accounts. The maximum value of a district is 14.28%. Thus, we find that the districts in states of Gujarat, Maharashtra, Karnataka, Andhra Pradesh (and now Telangana) and Tamil Nadu have about 3% or more accounts which held Satyam stocks as of the date of the crisis.[3]

2.1 Sample

We focus our attention on analysis of a stratified random sample of investors from the NSDL universe. The sample is created as follows. We have randomly selected drawing 20,000 individual accounts from each Indian state with more than 20,000 accounts, and all accounts from states with fewer than 20,000 accounts. We have additionally sampled 4000 Satyam holders from each state, and a total sample of 439,461 investors. The investors are retail participants with Indian domicile and not foreign and institutional participants.

We then remove observations whose portfolio value as of 6 January, 2009 is greater than a Rs.1 million. This gives us a sample of 423,362 investors. Of these, 10% or 40,461 investors held Satyam shares prior to the crisis date. Figure 2 plots the value of Satyam shares of the Satyam owners as a proportion of total portfolio value just prior to the crisis. The mode of the distribution was 0.28. The mean was 0.2, while the median was 0.07.

Table 1 shows the summary statistics of Satyam and non-Satyam holders. Satyam holders are a little older than non-Satyam holders – the average number of years they have been in the market is 4.5 as opposed to 3.7, statistically significant at the 1% level. Satyam holders also have higher portfolio values prior to the crisis than non Satyam holders, and also trade larger quantities. Satyam holders also had been making net purchases into the portfolio over the 30 day period prior to the crisis. The Satyam group has a lower portfolio beta, and lower portfolio returns than the other group - perhaps a result of trading higher quantities. These differences underscore the need for a matching framework.

[3]The districts with the largest proportion of Satyam holders include Rangareddi (3.08%), Dakshin Kannada (2.96%), Hyderabad (2.889%), Chennai (2.56%), Bangalore (2.55%),and Mangalore (2.52%). It is useful to note that all of these are districts in South India, in regions close to the head quarters of Satyam in Hyderabad

Figure 2 Satyam value as a proportion of portfolio value as of 6 January 2009

This figure shows the value of Satyam shares as a proportion of total portfolio value as of 6 January, 2009.

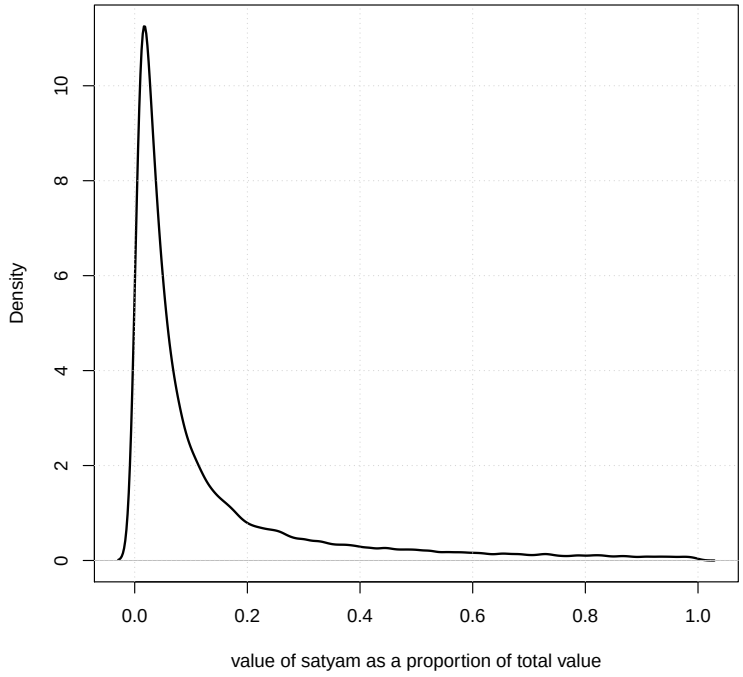


Table 1 Sample summary statistics as on January 6, 2009

The table presents the average values of account characteristics between investors who held Satyam shares and investors who did not. The numbers in the bracket indicate the standard deviation. For example, the average account age of non-Satyam owners was 3.7 years, while that of Satyam owners was 4.5 years. Total traded value is calculated as the total traded value over the last 30 days. Net traded value is calculated as the difference between buy and sell value over the last 30 days. Portfolio returns are calculated from the previous day i.e. 5 January 2009.

	Does not own Satyam	Owns Satyam	Overall
Account age	3.67	4.64***	3.75
	(2.86)	(2.54)	(2.59)
Total traded value (Rs.000) between $t-30$ and t	5.51	25.82***	7.45
	(77.64)	(94.67)	(79.65)
Net traded value (Rs.000) between $t-30$ and t	-1.05	2.57***	-7
	(75.14)	(68.33)	(74.5)
Portfolio value (Rs.000)	81.44	210.27***	93.75
	(145.48)	(227.09)	(159.71)
Portfolio returns between $t-1$ and t	-0.09	-0.29***	-0.11
	(0.04)	(0.37)	(0.13)
Portfolio Beta	0.88	0.85***	0.87
	(0.31)	(0.23)	(0.30)
Has other IT stocks	0.18	0.58***	0.22
	(0.49)	(0.38)	(0.41)
N	382,901	40,461	423,362

*** indicates statistically significant at 1% level

3 Research design

The central problem in identifying the causal impact of fraud on stock market participation is that fraud may occur at the beginning of a down-turn, and this may independently drive households to reduce their investments in equities (Wang, Winton, and Yu, 2010). We therefore require the unraveling of a fraud that was not unearthed because of a down-turn. Another problem in identification is that the outcomes are not an effect of fraud, but a result of unobserved preferences of investors. We begin by presenting the context of the occurrence of fraud and present a case that this was a complete surprise, and not driven by the 2008 downturn. We then turn our attention to the deriving a sample where we control for selection on observables.

3.1 The Satyam fraud

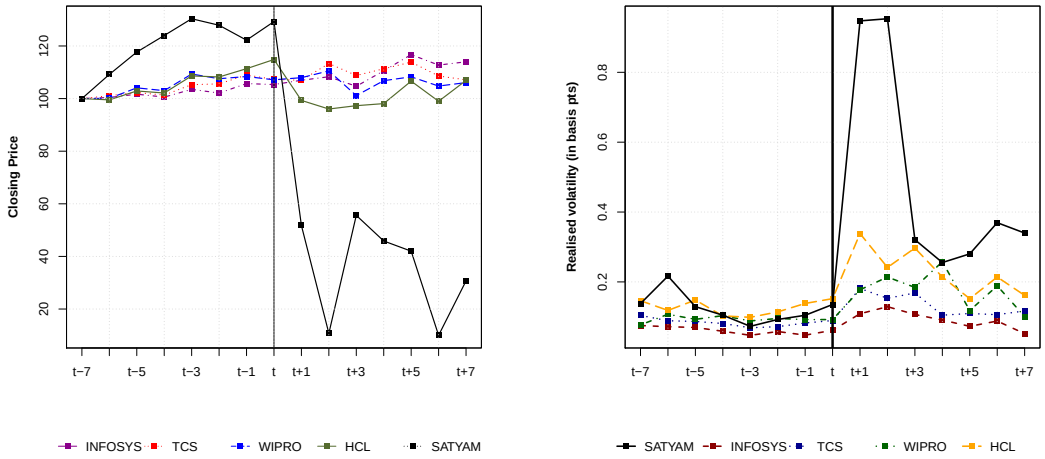
When India emerged out of its license raj, into a post-liberalised era in the early the 1990s, the software revolution played an important role in integrating India to globalisation. Satyam, based in Hyderabad, the capital of the then state of Andhra Pradesh[4] was an IT company of that time and offered software development, system maintenance, packaged software integration and engineering design services. By 1999, Satyam Infoway, a subsidiary of Satyam, had become the first Indian IT company to be listed on Nasdaq. Satyam had also expanded its footprint to 30 countries. In 2007, the promoter of Satyam, was named the Ernst & Young Entrepreneur of the Year. By 2008, Satyam's revenues had crossed almost $2 billion. Satyam's promoter was the poster boy of India's IT revolution.

On January 7, 2009, the chairman of Satyam publicly confessed that he had manipulated the accounts of the firm by US$1.47 billion (Joseph, Sukumar, and Raghu, 2009). Later investigations revealed that the top management had fudged the company's books by overstating its revenues, profit margins and profits for every single quarter over a period of five years, from 2003 to 2008. At the same time, both Satyam's internal as well as statutory auditors had not brought these discrepancy's to light (Krishnan, 2014). Thus, the announcement was a total surprise, and while Satyam had been in the news in the previous month over its acquisition of two real-estate companies (Maytas Properties and Maytas Infrastructure), the scale of the accounting fraud was entirely unexpected (Wharton, 2009).

We confirm this by Figure 3 which compares Satyam with its top competitors in the

[4]The state has recently split into Telangana and Andhra Pradesh

Figure 3 Close price and realised volatility of IT companies



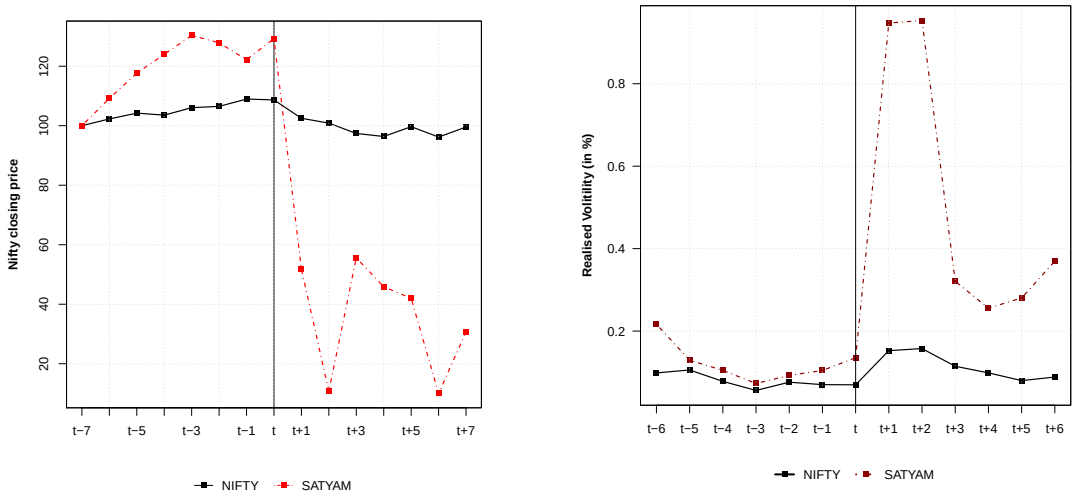
IT sector, and Figure 4 which shows a comparison of Satyam as against the NSE-Nifty market index. The left panel in each graph shows the daily close price, obtained from the NSE. The right hand panel shows the realised volatility. [5] The graphs suggest that there was nothing hugely different about the trading of Satyam stock. If anything for a few days before, the Satyam stock was trading at a higher price than its competitors. The stock was also not differentially affected by the global financial crisis either - in fact, the company was doing fairly well, and its stock price was stable.

Before the announcement, on the morning of the 7th September, 2009, there was no inkling that such a news was expected, either on the overall Nifty index, or on Satyam and its competitors. After the announcement, while Satyam did take a beating, similar falls were not experienced by any other stocks.

The disaster was mostly a result of an accounting fraud and is said to have had serious ramifications on investor confidence. It was believed that the promoters of Satyam had betrayed the trust of his employees, the IT industry and a whole nation that looked up to him (D'Monte, 2014). Both Satyam's internal as well as statutory auditors had not brought these discrepancy's to light, and Satyam was seen as a failure of the system - of auditors, or the board, of the regulator, leading to a loss of trust in the system itself (Krishnan, 2014).

[5]This is computed using intraday day returns of a stock at NSE aggregated at 12 second frequency. We split the entire day's trading time is split into 5 minute windows and compute the standard deviation of returns of the stock in all windows. The mean of all the standard deviation values is considered the daily realised volatility of the stock.

Figure 4 Close price and realised volatility of Nifty



Soon after the chairman's confession, the price fell to an all-time low of Rs 6.30. Investors in Satyam are said to have lost almost Rs.136 billion (US$2 billion) over the next month. This allows us to use the Satyam event to study the impact on investor participation of a revelation of a large-scale fraud.

The Serious Fraud Investigation Office (SFIO), multi-disciplinary investigating arm of the Ministry of Corporate Affairs, set up in 2003 with officials from various law enforcement agencies, was asked to investigate the fudging of accounts. It submitted its preliminary report on April 13, 2009. The Raju brothers were subsequently booked for criminal breach of trust, cheating, criminal conspiracy and forgery under the Indian Penal Code.

3.2 The matching framework

To test the hypothesis we require a counter factual of the investors' stock market participation in the absence of exposure to Satyam. This is best done using a matching framework where we match investors on observables that determine the choice of holding of Satyam prior to the crisis. Matching procedures are preferable to randomly selecting investors with no exposure to Satyam as they are less likely to lead to estimation bias by picking investors with completely different characteristics.

As the event was completely exogenous and unexpected, we use the he nearest neighbour matching with the Mahalonobis distance measure. In its simplest form, 1:1 nearest neighbor matching selects for each treated unit i the control unit with the smallest distance

from individual i. The Mahalanobis distance measure is calculated as follows:

$$D_{ij} = (X_i - X_j)'\Sigma^{-1}(X_i - X_j)$$

where D_{ij} is the distance between unit i and j and X_i and X_j are the characteristics of the control and treatment units. In our case, the treatment group consists of investors who held Satyam stock in their portfolio one day prior to the fraud announcement, while the control group consists of those who did not have prior direct exposure to Satyam.

Our focus is the impact of fraud on investor behaviour. It is, therefore, important to control for similarities in investor characteristics. Since we do not have access to demographic details of the investors, we focus our attention on details related to investment behaviour, that is accessible using holding data of the accounts prior to the Satyam event. The observables for our matching exercise include:

Age of the investor : Experienced investors in India have a lower portfolio turnover, exhibit a smaller disposition effect, and invest more heavily in value stocks than novice investors (Campbell, Ramadorai, and Ranish, 2013). It is possible that older investors, measured in the number of years since first purchase in the stock market, are more resilient in the face of crisis, and have a better judgment about the overall status of the market.

Trading intensity : Research has shown that investors that engage in active trading earn lower returns (Barber and Odean, 2000; Barber et. al., 2009). It is possible that active investors also react to the "bad news" faster than "buy-and-hold" investors. We therefore measure the cash out or new money invested in a portfolio in the last 30 days prior to the Satyam event.

Portfolio beta : This captures the idiosyncratic share of portfolio variance and investors with a high beta portfolio are more likely to be under diversified. This is an important metric that captures investor behaviour. It is likely that investors with a high beta are more exposed to fewer stocks, and more likely to react to news of a fraud than investors with a low beta. We measure beta by a market model with the value-weighted universe of Indian stocks as the market portfolio (Campbell, Ramadorai, and Ranish, 2013) as of 6th September, 2009.

Log portfolio value : This captures the value of the investors portfolio. Investors with a larger portfolio value may feel less perturbed by the Satyam fraud, relative to smaller portfolios. We therefore match our investors on log of the portfolio value measured as of the 6th September, 2009.

Table 2 Match balance: t-stat, standardised difference and ks-stat

This table presents the match balance statistics between the treatment and control group. t-stat and p-val are generated from the t-test, SDIFF reflects the standardized difference.

	(1) Means Treated	(2) Means Control	(3) SD Control	(4) Mean Diff	(5) t-stat	(6) p-val	(7) SDIFF	(8) ks-stat	(9) p-val
Portfolio beta	0.85	0.89	0.29	-0.05	-0.23	0.82	-0.16	0.002	0.00***
Log (portfolio value)	11.46	10.06	17.55	13.98	-0.05	0.96	0.04	0.005	0.59
Net turnover (Rs.)	2576.62	-1052.26	76431.76	3628.87	1.45	0.14	1.02	0.08	0.00***
Account age	4.46	3.67	2.53	0.79	0.0004	0.99	0.0003	0.007	0.34

The matching methodology described so far provides us with 40,461 control observations (i.e. those who did not hold Satyam in their portfolio) for an equal number of treated observations (i.e. those who held Satyam stock prior to the crisis).

A fundamental assumption of the matching approach is that conditional on the covariates, the potential outcomes are independent of the treatment. The pre-treatment variables should be balanced between the treated and control investors. Lack of balance points to a possible mis-specification of the matching estimation (Rosenbaum and Rubin, 1983). We therefore need to verify that this balancing condition is satisfied by the data.

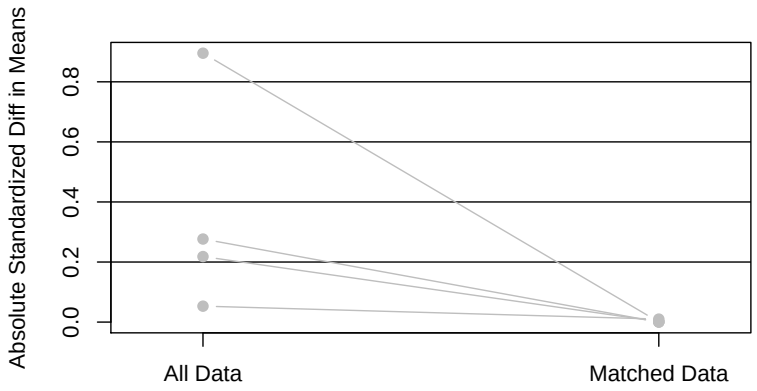
We present results on balance statistics in Table 2. These include the coefficients out of a paired t-test (Columns 5 and 6) and standardised bias (Column 7) for each variable entering the matching model. The standardised bias for the portfolio value variable, for example is defined as the difference in means between treated investors and the appropriately control investors by the average variances of the portfolio value variable in the two groups. We also report the Kolmogorov-Smirnov (KS) test statistic (Columns 8 and 9) which compares two empirical distributions (on the basis of the cumulative distribution function).

The t-stats confirm that there is no significant difference in means between the two groups, while the KS-statistic shows that there is no significant difference in the distributions between the two groups, except for the portfolio beta and net turnover variables. As the t-test does not show a significant difference for all variables, including those for whom the KS-statistic is statistically significant leading us to believe that the balancing conditions are reasonably satisfied for each variable.

The lower the standardised difference, the more balanced the treatment and control groups are for the variable in question. While there is no formal criterion for appropriate value of standardized difference, a value of upto 20 is considered acceptable (Rosenbaum and Rubin, 1985). The standardised difference is well below the limit of 20 for all our match variables. We also present the change in the standardised bias for all the covariates

Figure 5 Difference in the standardised bias

This figure shows the change in standardized bias after matching. The left hand dots show the standardized bias for the entire data-set, while the right hand shows that for the matched data-set.



after matching in Figure 5. The standardised bias has fallen dramatically after matching, and we take this as evidence for the existence of a reasonable matched control sample.

3.3 Main outcome of interest

In the event of a large accounting scandal such as the Satyam fraud, we expect that investors are likely to revise (upwards) their mistrust of accounting data, and of the equity market as well. Such increase in mistrust may lead investors to become "once burned twice shy", and lower their inclination to participate in the equity market. We expect that these effects are likely to be pronounced for investors with direct exposure to the fraud. There are three kinds of withdrawals that are likely:

1. Withdrawal from existing holdings in the market i.e. cashing out of the portfolio
2. Withdrawal from particular sectors, especially those that are likely to be related to the accounting fraud.
3. Complete withdrawal from the market. This could either be in the form of account closure by existing investors, or lack of entry by new investors.

In this paper we do not focus on the third measure, that is on account opening and closing by investors.[6] Participation on the intensive margin can be measured using the difference

[6]There is no household survey data spanning the years of the crisis to measure effects on portfolio

in the daily holdings data of each investor. Several papers that look at investor behaviour have to make inferences using data at intervals such as a month or a year. As a result, they are not able to distinguish between portfolio rebalancing and cashing-in/cashing-out from the portfolio. As we have daily holdings data for each investor, we are able to measure not only the changes in portfolio value, but also changes in the holdings of individual stock. This allows us to focus exclusively on cashing-in and out of the portfolio.

For a two stock portfolio, comprising of stocks A and stock B at any given time t, Cash-in and Cash-out (denoted by Δ_{At} and Δ_{Bt}) is calculated by:-

$$\Delta_{At} = P_{At-1}xQ_{At} - P_{At-1}xQ_{At-1} \tag{1}$$

$$\Delta_{Bt} = P_{Bt-1}xQ_{Bt} - P_{Bt-1}xQ_{Bt-1} \tag{2}$$

P_{it} is the price of the stock "i" in time t and Q_{it} is the weights or the quantity of the stock "i" at time t in the portfolio. The gross traded value or grossΔ is given by:-

$$gross\Delta_t = \sum_{A}^{B} |\Delta_{it}| \tag{3}$$

The net traded value or netΔ is given by:-

$$net\Delta_t = \sum_{A}^{B} \Delta_{it} \tag{4}$$

The net traded value is thus the difference between the total buy trades made using *new money* and total sell trades *that were not re-invested in another stock* between $t+1$ and t. This captures the *net purchase* element of investor trades, and is a more appropriate measure of the cashing-in (or cashing-out) of the investors portfolio. A positive value indicates that there were net purchases i.e. the investor purchased more securities, while a negative value indicates that there were net sales i.e. the investor sold more securities.

For example, if an investor has 10 shares of Company A of Rs.10 each in his portfolio on day t. The portfolio value of this investor is Rs.100. For simplicity, lets assume that the price remains at Rs.10 on $t+1$. Suppose the investor sells the 10 shares of Company A,

allocation of households.

and buys 10 shares of Company B. The gross traded value here is Rs.200. However, the net traded value is 0, as there would be no new money coming in, or money being taken out. If the investor sold the 10 shares of Company A, and made no other purchase, then the net traded value would be -Rs.100, that is there would be a cashing out of Rs.100 from the portfolio. Similarly if the investor did not sell these 10 shares, and instead bought 10 shares of Company B at Rs.10 each, then the net traded value would be Rs.100, that is there would be a cashing-in into the portfolio.

3.4 Difference-in-difference

The following DID model on the matched sample estimates the causal impact of the Satyam event:

$$y_{i,t} = \beta_0 + \beta_1 \text{SATYAM}_{i,t} + \beta_2 \text{POST-SATYAM}_{i,t} + \beta_3 (\text{SATYAM}_{i,t} \times \text{POST-SATYAM}_{i,t}) + s_i + \epsilon_{i,t}$$

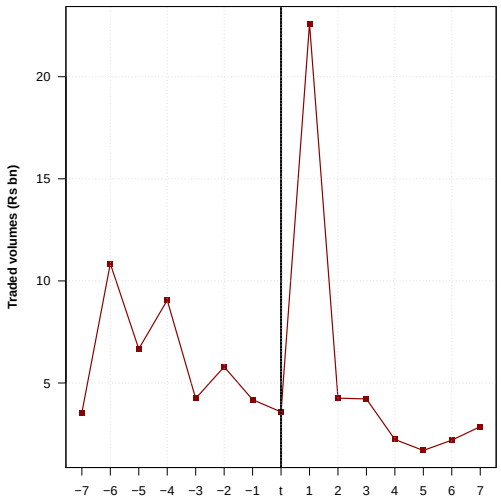
where $Y_{i,t}$ is the net traded value (in Rs.) or the net traded vale as a proportion of portfolio value. SATYAM is a dummy which takes value "1" if investor i held Satyam stock (the treated investor) and "0" otherwise (the control investor). POST-SATYAM captures whether the observation is from the period before the Satyam event (post-crisis = "0") or after (post-crisis = "1").

$\hat{\beta}_3$ will be positive and statistically significant if there is greater trading (and negative an statistically significant) if there is greater cash-out by the the treated investors after the event compared to the matched control investors. The matching DID estimator considerably improves on standard matching estimators (Blundell and Dias, 2000) by eliminating unobserved, time-invariant differences between the treatment and control groups (Smith and Todd, 2005). It is also an improvement on a simple DID where the treatment and control units may not have match balance.

We use a state fixed effect s_i to control for state-level conditions, which may affect households equity holdings or be correlated with the timing of fraud revelation. We cluster standard errors at the investor level because an investors decision to hold stocks is likely to be correlated over time.

Figure 6 Total traded volumes (Rs.billion)

The graph shows the total traded volumes on the NSE around the Satyam scandal date.



4 Results

4.1 Effect on cashing out Satyam

We begin by evaluating the impact on the Satyam trading activity of the news of fraud. Figure 6, which presents the total traded volumes of Satyam on the NSE, shows a sharp rise one day after the scandal, which subsides after. This suggests that the news of fraud led to a huge reaction on the trading of the Satyam stock.

The Satyam trades of the treated group in our sample traded were almost Rs.1.4 billion, while the control group were at Rs.36 million. The net traded value on Satyam i.e. the amount of Satyam stock cashed out by treated investors over the 7 days was Rs.1.1 billion. The control investors actually had a positive net traded value i.e. they "bought" Satyam shares after the scandal worth Rs.17 million. The effect of Satyam was large and negative on the trading behaviour of the treated group. The control group, on the contrary, seems to have seen this as an opportunity to buy some of the depressed stock.

Table 3 presents results from a DID regression on net traded value (in Rs. and and as a proportion of portfolio value) of Satyam shares on 10 days data pre and post the event. We find that treated investors, cashed out of their Satyam holdings post the scandal. The β_3 coefficient shows that the differential between the average amount cashed-out by the treated and control investors was about Rs.6,030. This is almost 10 times the pre-treatment average of Rs.583 of *net purchases*. When estimated as a proportion of

Table 3 Satyam traded value

The table presents results from a DID regression on net traded value (in Rs. and and as a proportion of portfolio value) on Satyam shares on 10 days data pre and post the event. Standard errors are clustered at the investor level.

	STV (Rs.)	STV/Val (%)
	(1)	(2)
Treat	1,306.203***	0.2
	(27.177)	(0.4)
Post	111.582***	−0.2***
	(5.795)	(0.1)
Treat*Post	−6,030.434***	−9.7***
	(110.596)	(0.8)
Constant	−197.793***	−1.9
	(65.362)	(1.3)
State FE	YES	YES
Observations	1,048,090	1,048,090
Note:	*p<0.1; **p<0.05; ***p<0.01	

portfolio value, treated investors cashed out Satyam shares worth 9.7 percentage points of the portfolio value more relative to control investors. The results indicate that news of a fraud has a significant negative effect on participation on the firm that commits the fraud. When investors heard bad news, their immediate response was to sell shares on the market.

4.2 Effect on cashing out of portfolio

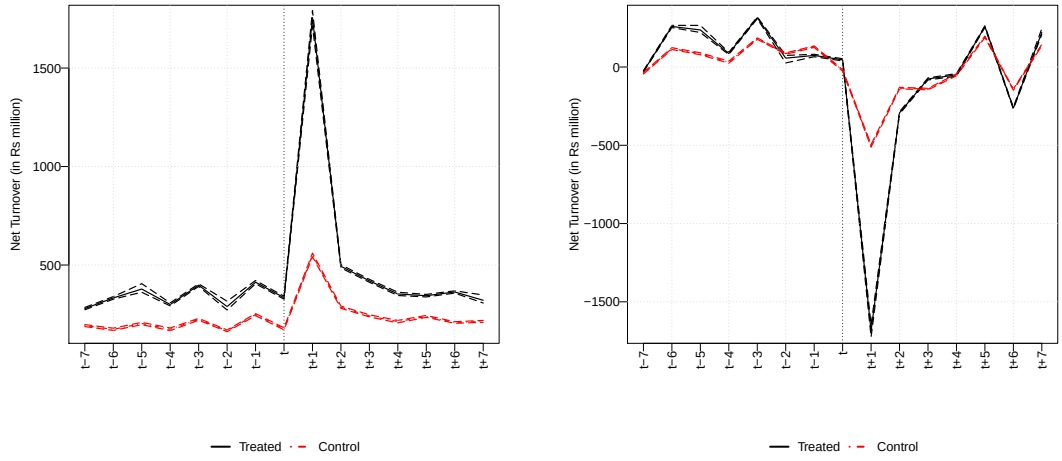
We now move to testing whether the news of fraud has an impact on trading activity beyond the narrow sphere of the stock in question. This is a more interesting analysis because it allows us to study the effect of experience of fraud on overall participation in the market.

Figure 7 plots the total traded volumes by the treated and control investors seven days before and after the Satyam announcement. The left panel plots the total value traded, while the right panel plots the net value traded i.e. the amount investors withdrew from the market. The confidence bands in the graph are created by bootstrapping the values of net and gross traded values separately.[7]

[7]We bootstrap the daily distribution of the net and gross traded value 1000 times and calculate the sample statistic. The 95% confidence interval bands are obtained by taking the 2.5th percentile and 97.5th percentile values of the resulting distribution of the sample statistic. The process is repeated for all the days i.e +- 7 days to get the 2.5th and 97.5th percentile values of the sample statistic.

Figure 7 Total traded value and net traded value

The graph shows the total traded value and net traded value by treated investors (i.e. those who held Satyam shares) and control investors (matched) five days before and after the Satyam crisis announcement. The vertical bar marks the date prior to the fraud revelation date.



Overall, the treated group had a gross traded value of Rs.3.7 billion, while the control group had Rs.1.7 billion over the seven day period. In contrast, in the seven days prior to the scandal, the treated investors' total traded value was Rs.2.4 billion, while that of the control investors was Rs.1.4 billion. Thus, while the treated investors always traded more than the control investors, this differential increased after the Satyam scandal.

The right panel of the figure indicates that the sale of stocks constituted a large part of the trading volumes. The overall net traded value of treated investors over this period was -Rs.2.1 billion, while that of control investors was -Rs.0.8 billion. In contrast, prior to the scandal, both the treated and control investors were "cashing-in". In the context of the cashing out of Satyam stock described earlier, we find that Satyam cashing out was 57% of the net traded value, suggesting that a large proportion of the exit by Satyam investors was of the Satyam stock itself.

We now ask, what is the average amount of cashing out by such investors? How has this changed after the scandal? The DID regression estimates on the rupee value of net trades (NTV), and NTV a percent of portfolio value are shown in Table 4 in Column (1) and (2) respectively. The treated group is those with Satyam shares a day prior to the event, while the control group is those without Satyam shares. We are interested in the coefficient (β_3) on the Treat*Post interaction term. This gives us the difference between the amount cashed out by treated and control group before and after the event.

Table 4 Net traded value

The table presents results from a DID regression on net traded value (NTV) and NTV a proportion of portfolio value on 10 days data pre and post the event. The regression reports clustered standard errors at the investor level.

	NTV (Rs.)	NTV/Val (%)
	(1)	(2)
Treat	918.994***	0.5
	(51.821)	(0.7)
Post	−7,380.171***	−3.0***
	(64.490)	(0.9)
Treat*Post	−5,136.610***	−10.7***
	(137.904)	(1.6)
Constant	2,816.367***	−1.9
	(84.548)	(1.5)
State FE	YES	YES
Observations	1,048,090	1,048,090
Note:	*p<0.1; **p<0.05; ***p<0.01	

Consistent with Figure 7, we find that the average amount traded by treated investors was larger than control investors, even though this was not statistically significantly different when measured as a proportion of portfolio value. We also find that investors, cashed out of their portfolios post the scandal, also consistent with earlier results. The β_3 coefficient shows that the average amount cashed-out by the treated investors was about Rs.5,137 relative to control investors. This is almost 1.5 times the pre-treatment average of *net purchases* of Rs.3,445. When estimated as a proportion of portfolio value we find that treated investors cashed out 11 percentage points of the portfolio value relative to control investors.[8] The results indicate that the Satyam crisis had a statistically significant impact on cashing-out behaviour of those who held Satyam stock.

4.3 Effects on related stocks

An interesting finding of the behavioural finance literature is that investors often extrapolate past events far into the future (Barberis and Thaler, 2003). This is based on the theory proposed by Griffin and Tversky (1992) that one-time strong news events should generate an overreaction as people pay too much attention to the strength of the evidence they are presented with and too little attention to its statistical weight. We, therefore, evaluate the trading behaviour of investors on various groups of stocks that could be

[8]There is no statistically significant difference in portfolio reallocations between the two investors. The results are available on request.

related to the Satyam event.

In the eyes of several people, Satyam was a failure of the institutional framework, especially of auditors, and of independent boards to bring accounting discrepency's to light (Krishnan, 2014). If this indeed led to a loss of trust in the entire system, we shoud see retail investors exiting out of firms that had the same auditor as Satyam (PriceWaterhouse Coopers), and that shared the same independent directors as Satyam. We find all the companies audited by PriceWaterHouse Coopers India in the year 2007-08 (one financial year prior to the scandal) as per CMIE Prowess.[9] We then subset all such companies listed at NSE for our analysis. We pull out the list of independent directors on Satyam's board on the date of the scandal.

Since the Satyam scandal broke out soon after the knowledge of Satyam's investments into real estate companies (Maytas), other real estate companies Firms in the same location and industry as a fraudulent firm may often be considered likely to have committed fraud (Gleason, Jenkins, and Johnson, 2008; Goldman, Peyer, and Stefanescu, 2012). We therefore focus on the set of firms headquartered in Hyderabad, as well as Andhra Pradesh, and other firms in the IT industry. These are also pulled out of CMIE Prowess, and the subset of these listed on NSE is used for the analysis.

Table 5 Net traded value on other groups of stocks

This table presents the results of a DID regression on various groups of stocks. Column (1) presents the net traded value of PWC stocks, Column (2) of stocks with other Satyam directors, Column (3) of companies headquartered in Hyderabad, Column (4) of companies headquartered in Andhra Pradesh, Column (5) of companies with real estate investments, and Column (6) of other IT companies. Standard errors are clustered at the investor level

	PWC	Directors	HQ HYD	HQ AP	Real Estate	IT
	(1)	(2)	(3)	(4)	(5)	(6)
NTV/Val (%)						
Treat*Post	0.3***	0.4***	0.7***	0.7***	−0.2**	0.3***
	(0.1)	(0.04)	(0.2)	(0.2)	(0.1)	(0.04)
Observations	850,848	549,243	646,553	665,817	246,979	703,266
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Note:						*p<0.1; **p<0.05; ***p<0.01

The results are presented in Table 5. Column (1) presents the net traded value of PWC stocks, Column (2) of stocks with other Satyam directors, Column (3) of companies headquartered in Hyderabad, Column (4) of companies headquartered in Andhra Pradesh, Column (5) of companies with real estate investments, and Column (6) of other IT com-

[9]Prowess is a database of the financial performance of over 27,000 companies. It includes all companies traded on the National Stock Exchange and the Bombay Stock Exchange, as well as unlisted public and private companies.

panies.

We find that, contrary to expectations, treated investors actually *cash-in* into stocks of related firms. Even though the coefficients are small, they are statistically significant. For example, treated investors cash-in to the tune of 0.3 percentage points more of portfolio value into other stocks who had PWC auditors relative to the control group. The only group of companies that seem to have seen exits are companies with real estate investments (Column 5), where treated investors are seen to cash-out to the tune of 0.2 percentage points more of the portfolio value relative to control investors. Our results indicate that fraud revelation does not affect all firms, certainly in the short-run, including those that may be seen to have shared characteristics with those that did commit fraud.[10]

4.4 Effects over time

The results so far have focused on the reaction of investors immediately after the crisis. A related question is if such cashing-out persisted after several days of the event. In Table 6, we present the results of a DID regression, but on 1 month of data pre and post the Satyam event. The period of analysis here is from 2008-11-20 to 2009-02-19. Column (1) presents the results on the net traded value (in Rs.), while Column (2) presents the results on net traded value as a percent of portfolio value.

Table 6 Net traded value (60 days)

	NTV (Rs.)	NTV/portval (%)
	(1)	(2)
Treat	−224.853***	0.6
	(20.754)	(0.6)
Post	−2,089.931***	−2.2*
	(21.048)	(1.2)
Treat*Post	−388.116***	−1.8
	(32.178)	(1.5)
Constant	1,205.814***	−0.7
	(30.802)	(0.6)
State FE	Yes	Yes
Observations	4,884,355	4,884,355
Note:	*p<0.1; **p<0.05; ***p<0.01	

[10]In the analysis on the Arthur Andersen shock, Giannetti and Wang (2016) also do not find significant drop in household equity-wealth ratio across specifications, possibly suggesting that while the shock caused some households to exit the stock market, other households were unaffected.

We find no statistically significant difference in the cashing out behaviour (as a proportion of portfolio value) of treated and control investors over a one month horizon. This means that while immediately after the crisis, those exposed to Satyam sold a lot of shares, this behaviour had ceased within one month the event. This is contrary to the results of (Giannetti and Wang, 2016) who find large withdrawals by households in equity participation over several years. Our results, however, are consistent with (Hoffmann, Post, and Pennings, 2013) who find that variables quickly recover, and investors continue to trade after the crisis is over.

5 Heterogenous treatment effects

The results so far tell us that there are implications for short-term trading activity, in particular on cashing-out of stock markets, owing to fraud revelation. Exposure to the stock in question has a large, statistically significant effect on cashing out of the market, largely driven by cashing out of the "fraduluent" stock. We now move to understanding treatment heterogeneity. This is important as it helps us tease out whether cashing-out behaviour is driven by wealth shocks or by a fall in overall trust in the market.[11]

5.1 By portfolio value

Table 7 considers how treatment effects vary by portfolio value prior to the crisis. We consider five quintiles of portfolio value corresponding to value less than Rs.34,000 for the first quintile. Portfolio values at 40%, 60% and 80% and 100% are Rs.91,488, Rs.187,032 and Rs.375,739 and Rs.3,685,288 respectively. Column (1) shows the results for the first quintile. Columns (2) - (5) show the results for the second to the fifth quintile respectively.

We find that at the lowest wealth quintile, treated investors cashed out almost 28 percentage points more of their portfolio relative to control investors at the same quintile. At low levels of portfolio wealth, the news of fraud seems to have had a large impact on stock market trading activity. As the portfolio value increases, the effect attenuates. There may be two reasons for this. At high levels of wealth, the loss from the scandal may be negligible, leading to no reaction. Or, it is also possible that investor portfolio value is correlated with actual wealth, and hence investor sophistication. More sophisticated

[11] Giannetti and Wang (2016) find that decrease in household stock market participation is not driven by financial losses associated with holdings in fraudulent stocks.

Table 7 Net traded value by portfolio value

This tables presents the DID regression results for each quintile of portfolio value. The quintiles are determined on the basis of portfolio value one day prior to the crisis. The first quintile which includes investors with portfolio value less than Rs.34,000. Porfolio values at 40%, 60% and 80% and 100% are Rs.91,488, Rs.187,032 and Rs.375,739 and Rs.3,685,288 respectively. All standard errors are clustered at the individual level

	Portfolio value as on 6 Jan, 2009 (Rs.)				
	Q1	Q2	Q3	Q4	Q5
	(1)	(2)	(3)	(4)	(5)
Net turnover / port val (%)					
Treat*Post	-28.0***	-11.0***	-0.3	-0.7	-7.5
	(0.03)	(0.04)	(0.023)	(0.017)	(0.063)
State FE	Yes	Yes	Yes	Yes	Yes
Observations	203334	186620	182786	175253	157728
Note:					*p<0.1; **p<0.05; ***p<0.01

investors do not react to news of one scandal and are able to withhold from making a panic sale.

5.2 By Satyam exposure

One way of testing if cashing-out behaviour is a wealth effect is to study how the treatment effect varies with Satyam exposure. In the class of investors that held Satyam, it is also likely that investors with larger exposure to Satyam would have been more affected. We would expect that cashing out of the stock market, and out of Satyam, would increase with portfolio exposure.

We divide the treated investors into quintiles based on their Satyam exposure one day prior to the scandal. The first quintile's exposure is upto 2% of the portfolio value, the second quintile's is between 2-5%, the third quintile is between 5-10%, the fourth quintile is between 10-32% and the fifth quintile is between 32-100%. We then interact the exposure quintile with the "post" dummy. This allows us to study the relative differences in the trading behaviour of different quantiles after the event. Table 8 presents the results on trading over 10 days of pre and post data.

The coefficient on "post" shows the traded value of the first quintile post the Satyam event. Relative to the period prior to the scandal, those with the lowest exposure to Satyam (upto 2%) cashed out an average of Rs.3,942 from their portfolio. This is almost 2.66 times of the net traded value pre-event average of "cashing-in" of Rs.1,479. The same investors cashed out an average of Rs.79 of Satyam shares post the event. This is 3.43 times the pre-treatment average of -23. As a proportion of portfolio value, those with

Table 8 Trading by exposure to Satyam

The table presents results from a DID regression on net traded value (NTV) in Column (1) Satyam stocks (STV) in Column (2), net traded value as a proportion of portfolio value (NTV/val) in Column (3) and Satyam traded value as a proportion of portfolio value (STV/val) in Column (4). Post refers to the period after the Satyam scandal. B2, B3, B4, B5 refer to the second, third, fourth and fifth quintile of Satyam exposure. Standard errors are clustered at the investor level.

	NTV (Rs.)	STV (Rs.)	NTV/Val (%)	STV/Val (%)
	(1)	(2)	(3)	(4)
Post	−3,941.911***	−79.522**	−9.1*	−2.0
	(88.668)	(37.563)	(5.1)	(1.8)
Post*B2	−2,288.990***	−464.079***	1.0	−2.0
	(128.232)	(38.546)	(5.1)	(1.9)
Post*B3	−4,107.557***	−990.240***	−0.7	−4.1**
	(162.174)	(38.526)	(5.1)	(1.9)
Post*B4	−6,351.781***	−2,190.812***	−2.0	−5.2***
	(132.454)	(40.037)	(5.1)	(1.8)
Post*B5	−29,044.280***	−24,986.150***	−21.2***	−25.6***
	(519.158)	(498.061)	(6.3)	(4.0)
Constant	1,523.182***	−56.246	−4.4	−4.1
	(98.178)	(83.754)	(3.4)	(3.3)
Observations	524,616	524,616	524,616	524,616
State FE	Yes	Yes	Yes	Yes
Note:	*p<0.1; **p<0.05; ***p<0.01			

the least exposure cashed out 9.1 percentage points more after the Satyam crisis. While we find that investors cashed out larger amounts from their portfolios with increase in exposure, the results are not statistically significant when measured as a proportion of portfolio value.

Relative to the first quintile, those in the fifth quintile of Satyam exposure, cashed out an average amount of Rs.29,000 from the portfolio and an average amount of Rs.25,000 of Satyam. This is 3.5 times the pre-treatment average of Rs.8,277 and 4.8 times the pre-treatment average of Rs.5,152 for the net traded value and Satyam traded value respectively. This is also a little over than 20 percentage points when measured as a proportion of portfolio value. The results indicate that the greater the exposure to the fraud, the greater is the withdrawal from the market in general, but mostly the greater is the withdrawal from the "bad stock". The results are consistent with (Odean, 1998) who finds that retail investors tend to sell entire positions than rebalance part of the position into another security, and point to the trading behaviour largely driven by a "wealth effect".

5.3 By proximity to crisis location

It is often argued that proximity to the event matters in determining the response to an event. For example, Giannetti and Wang (2016) find that households located in the state in which a corporate governance scandal broke out, had a more negative response to stock market participation. Similarly Gurun, Stoffman, and Yonker (2015) find that residents of communities that were more exposed to the Madoff fraud in the US subsequently withdrew assets from investment advisers.

In India, Satyam was the pride of the state of Andhra Pradesh (AP), both because the promoter ethnically belonged to the state of Andhra Pradesh, and because Satyam was headquartered in the state. In India, the top management of firms is often ethnically similar to that of the promoter. Investors in AP, even if they had not invested in Satyam themselves, may have been more aware of the fraud and felt its effects more directly than those outside of AP.

We narrow our attention to only the control investors, that is those, who did not own any Satyam stock one day prior to the crisis. We then conduct a DID on residents in AP vis-a-vis residents outside of AP. This also allows us to understand if the cashing-out behaviour was a result of loss of trust, or a wealth effect, as the investors in this estimation do not own Satyam and could not have seen a loss in portfolio value owing to

Table 9 Trading by non Satyam investors in AP

	NTV (Rs.)	NTV/Val (%)
	(1)	(2)
AP	−617.262***	0.5
	(137.89)	(1.6)
Post	−7,429.318***	−2.8***
	(66.21)	(1.0)
AP*Post	1,141.522***	−4.4
	(284.89)	(4.2)
Constant	2983.950***	−0.8
	(38.99)	(0.9)
Observations	524,477	524,477
Note:	*p<0.1; **p<0.05; ***p<0.01	

Satyam.

Column (1) in Table 9 presents the results on net traded value, while Column (2) presents the results on Satyam traded value. We find that, contrary to international literature, investors in AP *increase* their participation in the market. The coefficient on net traded value is Rs.1,142, which is 0.38 times the pre-treatment average of Rs.2,957. When estimated as a proportion of portfolio value there is no difference between the trading of investors inside and outside AP. Thus, we find no difference in the trading behaviour of those not exposed to Satyam in and outside of AP, and if anything, there was actually *cashing-in* of a small amount. This also points to the channel of financial losses due to fraud revelation driving trading behaviour.

5.4 By investor experience

Prior experience of fraud as this is likely to have a high influence on risk preferences and expectations (Malmendier and Nagel, 2016). In India, the last scandal that matched the Satyam scandal was the Ketan Parekh scam. This scam hit the stock market on March 1, 2001 led a 176 point crash on the BSE Sensex.[12] The stock had an especially high impact on the ten stocks, known as the K10 stocks held by Ketan Parekh.[13] The value of these stocks began to surge between January and July 1999, that led brokers and investors to also buy these stocks. The fraud unraveled after the crash in NASDAQ began to have an effect on the liquidity of these stocks in the Indian market, and it became difficult for

[12]The Budget was released the prior day, and had led to a 177 point surge in the Sensex.

[13]These include Aftek Infosys, Silverline, SSI, DSQ Software, Satyam, Mukta Arts, HFCL, Global Telesystems (Global), Zee Telefilms, PentaMedia Graphics and Padmini T.

him to make payments on many stocks, which led to a crisis.[14]

We would have liked to isolate those investors who had held one of these ten stocks in 2001 and study their response to the Satyam scandal. However, we only have detailed holdings data from 2003 onward. We, therefore, use the age of the investor, measured by the account opening date, as a proxy for prior experience of fraud. We divide investors into three groups: those with less than five years in the market (26,370 investors), those between 5-10 years in the market (13,688 investors), and those greater than 10 years in the market (403 investors). The latter group will have been through the KP scandal. Each treated investor in the three groups is paired with its control investor from the matching estimation. This ensures that we continue to compare investors that are alike in terms of their broad trading and portfolio characteristics.

Table 10 Trading by investor age

	Age of the investor		
	Q1	Q2	Q3
	(1)	(2)	(3)
Net traded value/ portfolio value			
Treat*Post	−13.2***	−6.5***	−3.2***
	(2.4)	(1.1)	(0.6)
State FE	Yes	Yes	Yes
Observations	577,143	320,779	9,123
Note:		*p<0.1; **p<0.05; ***p<0.01	

Table 10 presents the results of the DID regressions. Column (1) presents the results of the less than five years in the market group, Column (2) of those between 5-10 years in the market, and Column (3) of those greater than 10 years in the market. We find that all the treated groups cashed out relative to the control group within seven days of the event. As a proportion of portfolio value, the magnitude of β_3 here is the largest for the youngest group (Column (1)). This is not surprising as if experience matters, then those relatively new to the markets are more likely to react by cashing out than those who have been in the market for longer.

5.5 By institutions

We have data on 1,026 institutions who held Satyam shares as of 6 January, 2009, one day before the crisis. We match these institutions on the same characteristics as described in the matching of individuals (Section 3.2). This gives us a matched set of "control" institutions.

[14]Ketan Parekh was arrested on 30th March, 2001. This led to another Sensex fall of 147 points.

We find that the treated institutions had a gross traded value of Rs.231 million over the seven days post the crisis, relative to a traded value of Rs.155 million by the control group. Thus, overall trading by the treated institutions was higher than control institutions, similar to the story on retail investors. In terms of size, a large part of the trading was driven by retail investors.

The average net traded value by the treated institutions was -Rs.59 million, relative to a pre-crisis traded value of 16.8 million. Similarly, average net traded value by the control institutions was -Rs.20 million post crisis relative to Rs.2 million pre-crisis. Treated institutions reacted more sharply than control institutions.

Table 11 Trading by institutions

	NTV (Rs.)	NTV/portval (%)
	(1)	(2)
Treat	−5,741.101	1.3***
	(6,107.539)	(0.004)
Post	−16,712.660***	0.1
	(2,231.116)	(0.035)
Treat*Post	−13,361.530	−5.7
	(8,158.044)	(0.102)
Constant	6,549.826***	1.8***
	(539.053)	(0.002)
Observations		
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 11 presents the results of the DID regression. The coefficient of β_3 on net traded value, the cashing out differential between treated and control institutions before and after the crisis, is Rs.−13,361. As a proportion of portfolio value, this is a "cashing-out" of 5.7 percentage points relative to the control group. Importantly neither of the two coefficients are statistically significant. This suggests that there was no differential response between the treated and control institutions after the Satyam crisis.

6 Threats to validity

A possible criticism of the analysis could be that there are unobservable differences between the treated and control group that are driving the behaviour, and not the Satyam event. While the matching strategy controls for differences on observables, it does not account for differences such as risk aversion that are not captured by the variables available for analysis.

One way of testing the importance of unobservables is to observe the difference between those who owned Satyam on the day of the event, and those who did not own Satyam on the event but had owned it earlier. These are investors in the "control" group in the regression, but given that they had once held Satyam, could be considered to be more similar to the treated group than those who had never held Satyam. In the class of investors who once held Satyam, there can be investors who had given up Satyam before the Maytas scandal, as well as investors who got spooked during the Maytas scandal.

Table 12 Restricting estimation to different control groups

	Full sample	Strict Control	Gave up before Maytas
	(1)	(2)	(3)
NTV/portfolio value Treat*Post	−10.7***	−9.5***	−13.8***
	(1.6)	(1.4)	(3.7)
Observations	1,049,093	1,012,500	539,623
State FE	Yes	Yes	Yes
Note:		*p<0.1; **p<0.05; ***p<0.01	

Table 12 presents the results. Column(1) is the main regression result (from Table 4). Column (2) uses only those observations as controls who have never had Satyam. Column (3) uses those observations who gave up Satyam before the Maytas scandal, that is they once had purchases Satyam but sold out before even the Maytas scandal broke out. Here too, we see that Satyam investors cashed-out more than non-Satyam investors. This suggests that it is not just unobservables that are driving the result.

7 Conclusion

In this paper we study the impact on investor behaviour of fraud revelation. We ask if investors with direct exposure to stock market fraud are more likely to decrease their participation in the stock market than investors with no direct exposure to fraud, over both the short and long run? We use daily holding data from the National Stock Depository Limited (NSDL), the largest depository in India, and a matching methodology to compare investors directly exposed to fraud with investors who were not directly affected.

We find that investors with direct exposure to Satyam trade more intensely immediately i.e. over seven days after the Satyam event relative to control investors, and that this trading was largely driven by *cashing out* of the portfolio. Treated investors cash out almost 10.6 percentage points more of their overall portfolio relative to control investors

post the crisis. The cashing out is largely restricted to the "bad stock". If anything, treated investors make *net purchases* of related stocks during the same period. Over the period of a month, there is no difference in the trading behaviour of the treated and control investors.

This paper is the first to focus on the impact of fraud in an emerging market, which is characterised by low participation, low financial literacy, and a larger trust deficit.[15] It finds results that are contrary to those found in more mature economics. The results raise questions on the importance of the cultural and institutional settings on investor behaviour.

[15]The World Values Survey evidence shows that low income countries have lower levels of trust capital.

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