

# Does the type of settlement matter?

Evidence from Indian Derivatives Market

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- 3 High-frequency intra-day data is used to estimate multiple proxies gauging the spot market volatility, hedging efficiency and price-discovery efficiency of futures contracts.
- 4 A difference in difference analysis reveals a significant decline in volatility but, no significant deviation in hedging efficiency or price-discovery efficiency of futures contracts upon the adoption of physical mode of delivery.

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  - ② little scope for market manipulation tricks such as cornering, or squeezing.

Hence, it is interesting to evaluate the contribution of alternate settlement mechanisms in market-welfare.

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## Cash to physical settlement

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In all the three cases, the exchange claimed that the change would be beneficial for the markets. The shifts have been discussed in literature but the evidence has largely been contradictory and limited to the context of developed economies.

# Literature Review

- 1 [Chaherli and Hauser \(1995\)](#) found that a cash settlement system served as a better device for hedging by allowing up to 6 percent risk-reduction than physical delivery of corn or soybean. ([Elam, 1988](#); [Schroeder et al., 1988](#))
- 2 However, [Kenyon et al. \(1991\)](#) suggested that there was no statistically significant difference in the standard deviations of feeder steer basis in Oklahoma City and South-West Virginia auction markets upon a switch to cash-settlement mode.

# Literature Review

- ③ **Garbade and Silber (2000)** highlighted the importance of physical delivery as it enhances the convergence of futures and spot markets and thereby promotes risk-transfer and price-discovery functions of the futures market. At the same time, a cash settlement system is free of the costs and uncertainties of physical delivery.
- ④ **Pirrong (2001)** suggested that while the probability of manipulation by short-traders is higher in a physical settlement contract, in case of a cash settled contract, the manipulation is more likely from the long-traders end.
- ⑤ **Chan and Lien (2001)** establish that price discovery function of feeder cattle futures traded in CME improves upon introduction of a cash settlement system in August, 1986, but impairs for the live hog futures contracts.



# Literature Review

- ⑥ [Chan and Lien \(2002\)](#) find that the cash-settlement certainly improved the hedging effectiveness of the feeder-cattle futures contract and made markets not only more integrated but also more stable, however, the findings were drastically different for live hog futures. Additionally, [Chan and Lien \(2003\)](#) found a reduction in volatility of future prices upon the adoption of cash-settlement.
- ⑦ [Lien and Yang \(2004\)](#) found a significant rise in volatility, but higher hedging efficiency as 10 Australian stock futures switched to physical settlement in 2000.

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- ② The sample size in previous studies ([Lien and Yang, 2004](#)) appears small to allow for generalisation.
- ③ Extant studies overlook the emerging market context.

## Opportunity for exploration

A latest switch in settlement mechanism occurred recently in Indian markets upon the issuance of a mandate, where SEBI imposed a phased shift of all stock futures and options contracts from a cash settlement to a physical delivery system.

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A phased transition was prescribed as follows-

- 1 Stocks which were being cash settled shall be ranked in order based on daily market capitalization averaged for the month of December 2018;
- 2 Based on the ranking arrived above, the bottom 50 stocks shall move to physical settlement from April 2019 expiry, the next 50 stocks from July 2019 expiry, and the remaining stocks from October 2019 expiry.



## Development of Hypotheses: Volatility

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This leads us to our first hypothesis:

**$H_1$  : Spot-market volatility declines upon adoption of Physical mode of delivery of futures contracts.**

## Development of Hypotheses: Hedging Efficiency

With physical delivery of futures upon expiry, a call option writer is redeemed from purchasing the contracts in spot market to deliver them to the buyer. Instead, he would transfer the shares he received at an agreed price to the respective option buyers, hence mitigating his hedging risk exposure ([Lien and Yang, 2004](#)).

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Physical deliveries may reduce short-selling as short-sellers would now be required to borrow stocks under the SLB mechanism which remains a shallow space in India. With higher cost of borrowing under the SLB mechanism, cost of hedging is also raised.

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This leads us to our second hypothesis:

**$H_2$  : Hedging Efficiency of Futures Contracts improves upon adoption of Physical mode of delivery of futures contracts.**

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**$H_3$  : Efficiency of price-discovery function of Futures Contracts improves upon adoption of Physical mode of delivery of futures contracts.**

## Other plausible conjectures

- 1 With most of the positions squared off before expiry, physical settlement would be applicable to a small percentage of positions left to expiry.
- 2 Besides, high minimum-lot-size requirements build unnecessary pressure and volatility, including rollovers which are reflected through bogus increase in volumes.

# Data and Variables Estimation Method

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The sample starts on January 28, 2019 and ends on May 27, 2019 that is 2 months before and after the switch on March 28, 2019.

The data is sourced from NSE, and includes spot price, futures price of the nearby contracts, and spot market trading volumes for each security at 5-minute frequency.

## Difference between treatment and control group stocks

Particulars	Treatment Group	Control Group	t-stat (treat-control)
Average market Value (Rs million) for the month December 2018	1,24,573	3,55,670	-13.60***
Daily average of number of shares traded during the sample period (Thousands).	6,126	5,901	0.11

# Proxies for Volatility I

## Garman-Klass Volatility

$$\sigma_{GK} = \sqrt{(1/N) \sum_{i=1}^N \frac{1}{2} \log\left(\frac{H_i}{L_i}\right)^2 - \frac{1}{N} \sum_{i=1}^N (2\log(2) - 1) \log\left(\frac{C_i}{C_i - 1}\right)^2} \quad (1)$$

where ,  $N$  = Number of 5-minute trading intervals

$O_i$  = Open price in interval  $i$

$H_i$  = High price in interval  $i$

$L_i$  = Low price in interval  $i$

$C_i$  = Close price in interval  $i$



# Proxies for Volatility II

## Parkinson Volatility

$$\sigma_p = \sqrt{\frac{1}{4N \log 2} \sum_{i=1}^N \log\left(\frac{H_i}{L_i}\right)^2} \quad (2)$$

where,  $N$  = Number of 5-minute trading intervals

$H_i$  = High price in interval  $i$

$L_i$  = Low price in interval  $i$

# Proxies for Volatility III

## GARCH based Volatility

GARCH mean equation

$$r_t = \alpha_0 + \sum_{i=1}^l \beta_i r_{t-i} + \sum_{j=1}^m \gamma_j \xi_{t-j} + \epsilon_t \quad (3)$$

GARCH variance equation

$$\sigma_{garch}^2 = \theta_0 + \phi \xi_{t-1}^2 + \mu \sigma_{t-1}^2 \quad (4)$$

# Proxies for Hedging efficiency I

## Ederington's OLS Hedge Effectiveness

$$R_{s,t} = \alpha_0 + \beta_1 R_{f,t} + \epsilon_t \quad (5)$$

, where, the coefficient of determination,  $R^2$  is interpreted as hedging efficiency.

## DCC-GARCH Hedge Ratio

$$H_t = D_t \Gamma_t D_t \quad (6)$$

$$D_t = \text{diag}(h_{11,t}^{\frac{1}{2}}, h_{22,t}^{\frac{1}{2}}) \quad (7)$$

$$h_{ii,t} = \omega_i + \beta_i h_{ii,t-1} + \gamma_i \epsilon_{i,t-1}^2, \quad i = 1, 2 \quad (8)$$

$$\Gamma_t = \text{diag}(Q_t)^{-\frac{1}{2}} Q_t \text{diag}(Q_t)^{-\frac{1}{2}} \quad (9)$$

$$Q_t = (1 - \delta_1 - \delta_2) \bar{Q} + \delta_1 \mu_{t-1} \mu_{t-1} + \delta_2 Q_{t-1} \quad (10)$$

## Proxies for Hedging efficiency II

Given the model of the spot and futures price changes, the time-varying hedge ratio can be expressed with the variance-covariance estimates for the DCC models, respectively, as:

$$\hat{\beta}_{t-1} = \frac{\hat{h}_{sf,t}}{\hat{h}_{f,t}} \quad (11)$$

, such that higher hedge ratio  $\hat{\beta}_{t-1}$  implies lower hedging efficiency.

# Proxies for measuring efficiency of Price-Discovery I

## Hasbrouk's Information Share

$$IS_j = \frac{[(\Psi(F))_j]^2}{\Psi\Omega\Psi'}, j = 1, 2 \quad (12)$$

where  $F$  is the Cholesky factorization of the estimated VECM variance-covariance matrix  $\Omega$  and  $\Psi$  represents the long-run impact matrix of dimension  $(1 \times 2)$ .

## Gonzalo and Granger's Component Share

$$\theta_f = \frac{|\alpha_s|}{|\alpha_s| + |\alpha_f|}, \quad \theta_s = \frac{|\alpha_f|}{|\alpha_s| + |\alpha_f|} \quad (13)$$

Since the denominator represents the total adjustment of both markets to any difference between spot and futures prices, the common factor weights measure the relative portion of total adjustment. The values of the common factor weights are restricted to the interval between zero and one.

# Proxies for measuring efficiency of Price-Discovery II

## Time-varying Common Factor Weights

$$y_t = Z_t \xi_t + \epsilon_t, \epsilon_t \sim N(0, R) \quad (14)$$

$$\xi_t = F \xi_{t-1} + \eta_t, \eta_t \sim N(0, Q) \quad (16)$$

Time-varying parameters are assumed to evolve according to a random walk and are represented by the vector  $\xi_t$ .  $F$  is an identity matrix. The multivariate normally distributed error terms  $\epsilon_t$  and  $\eta_t$  are serially uncorrelated with zero mean and diagonal co-variance matrices  $R$  and  $Q$ , respectively.

Thereon, time-varying common factor weights are calculated as:

$$\theta_{f,t} = \frac{|\alpha_{s,t}|}{|\alpha_{s,t}| + |\alpha_{f,t}|}, \quad \theta_{s,t} = \frac{|\alpha_{f,t}|}{|\alpha_{s,t}| + |\alpha_{f,t}|} \quad (15)$$

# Empirical Strategy

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$$Y_{it} = \alpha + \beta_1 time + \beta_2 treat + \beta_3 treat * time + \beta_4 * volume + \epsilon_t \quad (16)$$

where,  $Y_{it}$  is the outcome variable of interest,  $time$  is the dummy variable that takes the value 1 for the period post the intervention and 0 otherwise, and  $treat$  is a dummy variable that takes the value 1 for stocks that shifted to physical-delivery mode of settlement from April, 2019 and 0 otherwise, and  $volume$  is log value of volume of contracts traded.

## Results and Discussion: t-test

Firstly, a simple t-test indicates a significant decline in all the three proxies of volatility for treatment stocks.

### Comparison of volatility prior to and post the adoption of physical settlement system.

Panel A : Volatility Outcome Variables	Treatment stocks			Control Stocks		
	Pre-period	Post-period	t-stat(post-pre)	Pre-period	Post-period	t-stat(post-pre)
Graman Klass Volatility	0.0179	0.0165	-8.22*	0.0142	0.0144	1.27
Parkinson Volatility	0.0226	0.0210	-8.23*	0.0181	0.0180	-0.06
Garch-based Volatility	0.2895	0.2625	-7.82*	0.2408	0.2346	-4.26*

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In contrast, the deviations in pre versus post intervention averages of Garman-Klass and Parkinson volatility estimates are insignificant for the control group stocks. A significant drop in GARCH-based volatility is witnessed for control group.

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## Results and Discussion: t-test

Time-invariant Ederington's hedge efficiency does not record any significant change in the pre versus post hedge efficiency for either of the two groups.

### Comparison of hedging efficiency prior to and post the adoption of physical settlement system.

Panel B : Hedging Efficiency Outcome Variables	Treatment stocks			Control Stocks		
	Pre-period	Post-period	t-stat(post-pre)	Pre-period	Post-period	t-stat(post-pre)
Ederington's Hedging efficiency	0.8720	0.8963	1.60	0.8931	0.9061	0.95
DCC-GARCH Based Hedge ratio	0.8840	0.8880	2.95*	0.9608	0.9073	-13.56*

<sup>1</sup>(Ku et al., 2007; Kumar and Bose, 2019)

## Results and Discussion: t-test

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In contrast, a DCC-GARCH based hedge ratio indicates a significant decline in hedge ratio for the treatment whereas the control group stocks witness a highly significant increase in hedging efficiency.<sup>1</sup>

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### Comparison of Price discovery efficiency prior to and post the adoption of physical settlement system.

Panel C : Price-Discovery Measure Outcome Variables	Treatment stocks			Control Stocks		
	Pre-period	Post-period	t-stat(post-pre)	Pre-period	Post-period	t-stat(post-pre)
Hasbrouk's Information Share	0.4813	0.5188	1.74*	0.4737	0.5063	1.64
Gonzalo and Granger's Component Share	0.4820	0.5393	1.04	0.4616	0.5316	1.30
Time-Varying Common Factor Weights	0.4996	0.5003	1.99*	0.4997	0.5003	2.31*

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## Results and Discussion: t-test

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Component share indicates no significant deviations for treatment or control group across the sub-periods.

Time-varying common factor weights on the other hand suggest a significant rise for both treatment as well as control group stock with a higher magnitude of increment in the control group stocks.<sup>2</sup>

### Comparison of Price discovery efficiency prior to and post the adoption of physical settlement system.

Panel C : Price-Discovery Measure Outcome Variables	Treatment stocks			Control Stocks		
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## Results and Discussion: DID regression

The treated group witnesses a significant decline in volatility estimates determined by Garman-Klass and Parkinson estimators, but no change in the conditional volatility deduced by a GARCH model.

However, since the range-based estimators are more efficient estimators of volatility ([Li and Weinbaum, 2001](#); [Pandey, 2005](#)), we rely on Garman Klass and Parkinson estimates to derive our conclusions.

## DID results to examine the impact of settlement change.

**Panel A : Garman-Klass Volatility**

Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	-0.04690	0.00625	-7.50	0.00
Volume	0.00390	0.00039	9.82	0.00
treat	0.00536	0.00113	4.74	0.00
time	0.00018	0.00034	0.52	0.60
treat*time	<b>-0.00112</b>	<b>0.00039</b>	<b>-2.80</b>	<b>0.00</b>
Number of observations	518471			
Adjusted R-square	0.17448			
F-statistic	25.36			

**Panel B : Parkinson Volatility**

Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	-0.05635	0.00778	-7.24	0.00
Volume	0.004752	0.00049	9.92	0.00
treat	0.00680	0.00140	4.84	0.00
time	-0.00028	0.00042	-0.06	0.
treat*time	<b>-0.00137</b>	<b>0.00049</b>	<b>-2.75</b>	<b>0.00</b>
Number of observations	518471			
Adjusted R-square	0.10702			
F-statistic	10.42			

**Panel C : Garch-Based Volatility**

Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	-0.3243	0.09010	-3.59	0.00
Volume	0.03474	0.00570	6.09	0.00
treat	0.06170	0.01514	4.07	0.00
time	-0.00698	0.00679	-1.03	0.30
treat*time	-0.0039	0.0087	-0.44	0.65
Number of observations	520415			
Adjusted R-square	0.10702			
F-statistic	10.42			

## Results and Discussion: DID regression

Both Ederington's hedging efficiency and the hedge ratio determined from DCC-GARCH model demonstrate no significant deviation in the hedging-efficiency of the futures contracts.

## DID results to examine the impact of settlement change (contd.)

<b>Panel D : Ederington's hedging efficiency</b>				
Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	-0.10079	0.10945	-0.92100	0.36
Volume	0.06150	0.00666	9.22780	0.00
treat	0.01227	0.01217	1.00770	0.32
time	-0.01430	0.01200	-1.19090	0.24
treat*time	-0.00338	0.01690	-0.19970	0.84
Number of observations	182			
Adjusted R-square	0.33176			
F-statistic	23.46			

<b>Panel E : DCC-GARCH based Hedge Ratio</b>				
Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	0.59654	0.10826	5.5102	0.00
Volume	0.02093	0.00637	3.2815	0.00
treat	-0.03546	0.03049	-1.1632	0.24
time	-0.02123	0.04082	-0.5271	0.59
treat*time	0.02707	0.05057	0.5353	0.59
Number of observations	520323			
Adjusted R-square	0.01456			
F-statistic	3.90			

## Results and Discussion: DID regression

Proxies for efficiency of price-discovery by the futures contracts show no significant deviation in informativeness of futures contracts upon adoption of physical settlement system.

# DID results to examine the impact of settlement change (contd.)

**Panel F : Hasbrouk's Information Share**

Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	0.40403	0.19212	2.10300	0.04
Volume	0.00590	0.01170	0.50500	0.61
treat	0.01755	0.02137	0.82100	0.41
time	-0.03225	0.02107	-1.53000	0.13
treat*time	0.00046	0.02967	0.01600	0.99
Number of observations	170			
Adjusted R-square	0.01128			
F-statistic	1.52			

**Panel G : Gonzalo and Granger's Component Share**

Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	0.09415	0.47379	0.19900	0.84
Volume	0.02620	0.02885	0.90800	0.37
treat	0.02302	0.05270	0.43700	0.66
time	-0.06628	0.05196	-1.27500	0.20
treat*time	0.02504	0.07318	0.34200	0.73
Number of observations	170			
Adjusted R-square	-0.00216			
F-statistic	0.90			

**Panel H : Time-Varying Common Factor Weights**

Variables	Estimate	Std. Error	t-statistic	p-value
Intercept	0.5024	0.00174	288.92	0.00
Volume	-0.00017	0.00011	-1.65	0.09
treat	-0.00008	0.00044	-0.19	0.84
time	0.00058	0.00044	1.30	0.19
treat*time	0.00011	0.00048	0.24	0.80
Number of observations	520493			
Adjusted R-square	0.00077			
F-statistic	3.75			

## Summary and conclusion

- 1 The study investigates if the mode of settlement of futures contract - cash or physical-delivery has any significant influence on the volatility in the spot market, the hedging efficiency of futures, and the price-discovery function of futures contracts.

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# Summary and conclusion

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- 2 A treatment sample of 46 sample stocks is compared against a control group of 45 stocks under a DID framework.

## Summary of Findings

	<b>Outcome variables</b>	<b>DID Results</b>
3	Volatility	<b>Significant decline</b>
	Hedging efficiency	Insignificant change
	Price discovery efficiency	Insignificant change

## Contribution of the study

The study not only brings back to surface an important policy questions, but also investigates it in an emerging market context of India.

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The study not only brings back to surface an important policy questions, but also investigates it in an emerging market context of India. The analysis puts under the scanner a promising sample of 46 treatment stocks, and uses intra-day historical data to empirically prove the relative impact of physical delivery system when compared with cash-settlement system, making it an important contribution to the literature.

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The analysis puts under the scanner a promising sample of 46 treatment stocks, and uses intra-day historical data to empirically prove the relative impact of physical delivery system when compared with cash-settlement system, making it an important contribution to the literature.

Moreover, it serves as an imminent guiding tool for market-regulators, and policy-makers by illustrating the role played by a futures-settlement system in determination of important market constructs such as volatility, hedging efficiency and price-discovery.

## Limitation of the study

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The analysis further ignites the need to look at the changes in the markets near to and on the expiry days.

The study also offers the potential to corroborate the findings by comparing stocks that were shifted to physical settlement from July, 2019 to those that were shifted from October, 2019 onwards.

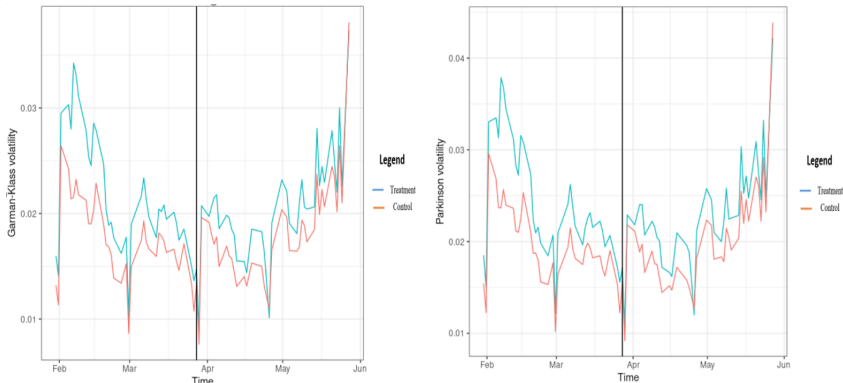
*Thank you!*



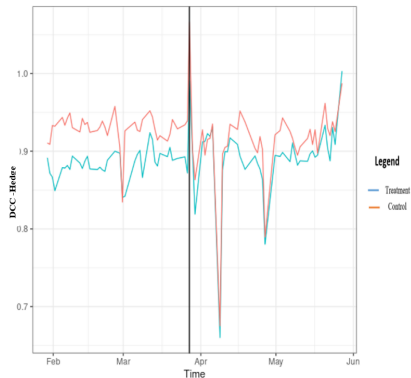
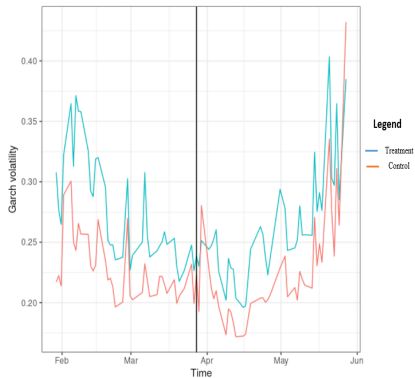
# Parallel Trends Assumption I

We find that the movements of the outcome variables for both the groups are mostly parallel during the period prior to the shift mandated by SEBI, indicated by the black vertical line.

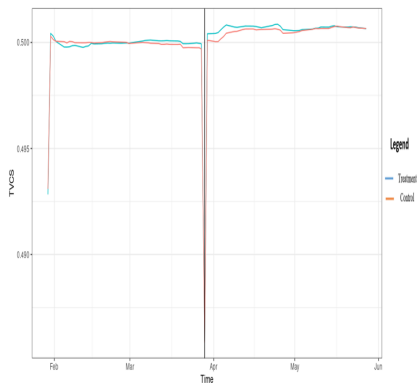
Figure: Movement of outcome variables across the sample period



# Parallel Trends Assumption II



# Parallel Trends Assumption III



The figures indicate a parallel movement between the outcome variables for the treatment and control variable prior to the intervention by SEBI. The green lines represent the movements in treatment groups, the red line indicates the movements in the control group, and the black vertical line marks the time of intervention in the markets.

# Comparison of Spot liquidity before and after the adoption of physical settlement.

## Comparison of hedging efficiency prior to and post the adoption of physical settlement system.

Spot Liquidity		Treatment stocks			Control Stocks		
Outcome Variables		Pre-period	Post-period	t-stat(post-pre)	Pre-period	Post-period	t-stat(post-pre)
Spot-market Volume	Trading	11813164.36	10335424.72	-8.77*	14652991.27	16282537.41	6.15*

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