Research article

VaR as a mitigating risk tool in the maritime sector: An empirical approach on freight rates

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Supplementary

Table 1. Descriptive Statistics.

Full Sample	22/5/2007–21/09/2015					
In Sample	22/05/2007–13/08/2013					
Out of Sample	14/08/2013–21/09/2015					
Route	TC2 Spot	TC2 One month	TC2 Three months	TD3 Spot	TD3 One month	TD3 Three months
No of Obs	2085	2085	2085	2085	2085	2085
Mean	158.11	158.32	154.69	63.51	62.34	60.18
Median	146.67	146.50	141.50	52.28	54.00	51.59
Maximum	386.25	353.00	305.00	319.22	215.00	180.00
Minimum	9.55	80.00	91.00	25.36	30.00	30.50
Std. Dev	60.10	51.57	48.43	39.68	30.84	2630
Skewness	1.33	1.21	1.23	2.92	2.31	2.02
Kurtosis	4.99	4.03	3.57	12.85	9.04	7.67
J–B	960.70	602.42	522.88	11,394.58	5,028.34	3,312.13

Table 2. Value at Risk Statistics-TC2-Spot price returns.

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
GARCH (1,1)-N	–8.78%	–6.21%	–4.84%	–60.99%	–43.13%	–33.61%	–7.02%	–4.96%	–3.87%	1.14%	3.61%	7.79%	3.42%	5.51%	7.22%
GARCH (1,1)-T	–33.96%	–24%	–18.69%	–422.84%	–298.84%	–232.75%	–7.02%	–4.96%	–3.87%	0.19%	0.38%	0.38%	0.19%	0.38%	0.95%
GARCH (1,1)-GED	–6.72%	–6.17%	–5.48%	–79.11%	–72.62%	–64.55%	–3.49%	–3.20%	–2.85%	5.51%	6.08%	7.98%	6.08%	7.22%	7.41%
IGARCH (1,1)-N	–8.31%	–5.88%	–4.58%	–11.56%	–8.17%	–6.37%	–6.70%	–4.74%	–3.69%	1.14%	4.18%	6.84%	4.18%	6.84%	7.79%
IGARCH (1,1)-T	–9.00%	–6.36%	–4.95%	–36.09%	–25.50%	–19.86%	–2.11%	–1.49%	–1.16%	1.52%	4.94%	7.60%	3.61%	5.89%	8.37%
IGARCH (1,1)-GED	–5.93%	–5.44%	–4.84%	–7.57%	–6.94%	–6.17%	–5.15%	–4.72%	–4.19%	3.99%	5.32%	6.65%	6.84%	7.03%	7.41%
(GJR)TGARCH (1,1)-N	–8.72%	–6.17%	–4.81%	–42.59%	–30.12%	–23.47%	–6.50%	–4.60%	–3.58%	1.52%	5.32%	8.37%	2.85%	5.13%	7.03%
(GJR)TGARCH (1,1)-T	–31.40%	–22.19%	–17.29%	–373.05%	–263.65%	–205.35%	–14.74%	–10.42%	–8.12%	0.19%	0.38%	0.38%	0.19%	0.57%	1.14%
(GJR)TGARCH (1,1)-GED	–6.74%	–6.19%	–5.50%	–71.55%	–65.69%	–58.39%	–3.51%	–3.23%	–2.87%	5.70%	6.46%	8.17%	5.89%	6.84%	7.41%
EGARCH (1,1)-N	–8.74%	–6.18%	–4.82%	–77.38%	–54.72%	–42.65%	–6.69%	–4.73%	–3.69%	1.52%	5.51%	8.56%	2.09%	5.32%	6.65%
EGARCH (1,1)-T	–20.85%	–14.74%	–11.48%	–2144.37%	–1515.51%	–1180.37%	–8.45%	–5.97%	–4.65%	0.38%	0.57%	2.09%	0.95%	1.71%	2.66%
EGARCH (1,1)-GED	–7.21%	–6.62%	–5.88%	–432.87%	–397.38%	–353.23%	–3.50%	–3.21%	–2.86%	6.08%	7.22%	8.75%	5.70%	6.08%	7.22%
APARCH (1,1)-N	–8.47%	–5.99%	–4.67%	–18.35%	–12.97%	–10.11%	–2.50%	–1.77%	–1.38%	2.28%	6.65%	9.70%	2.47%	5.51%	7.60%
APARCH (1,1)-T	–14.59%	–10.31%	–8.03%	–96.04%	–67.88%	–52.87%	–5.04%	–3.56%	–2.77%	0.57%	1.33%	3.42%	1.14%	2.09%	3.42%
APARCH (1,1)-GED	–5.96%	–5.48%	–4.87%	–25.40%	–23.32%	–20.73%	–2.12%	–1.94%	–1.73%	5.70%	7.22%	8.56%	5.89%	6.46%	7.22%

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
TARCH (1,1)-X-N	−8.73%	−6.17%	−4.81%	−42.41%	−29.99%	−23.37%	−6.55%	−4.63%	−3.61%	1.52%	5.32%	8.17%	2.85%	5.13%	7.22%
TARCH (1,1)-X-T	−21.70%	−15.34%	−11.94%	−246.18%	−173.98%	−135.51%	−4.80%	−3.39%	−2.64%	0.19%	0.38%	0.76%	0.57%	1.33%	1.71%
TARCH (1,1)-X-GED	−6.67%	−6.12%	−5.44%	−67.51%	−61.98%	−55.09%	−1.74%	−1.60%	−1.42%	5.51%	6.27%	7.03%	6.08%	6.65%	7.41%
RISK METRICS	−16.45%	−11.63%	−9.07%	−211.23%	−149.39%	−116.42%	−3.19%	−2.25%	−1.76%	0.95%	4.37%	6.46%	3.42%	6.08%	7.41%
HS(100) Long position	−24.88%	−5.59%	−3.80%	−275.11%	−7.97%	−5.65%	−5.33%	−2.95%	−2.11%	1.52%	4.75%	11.03%			
HS(250) Long position	−8.81%	−5.04%	−3.33%	−12.70%	−6.70%	−4.65%	−7.03%	−3.83%	−2.68%	1.14%	5.32%	11.98%			
HS(FS) Long position	−7.92%	−4.35%	−2.99%	−8.39%	−4.60%	−3.12%	−7.32%	−4.20%	−2.92%	1.71%	8.17%	13.69%			
HS(100) Short position	29.64%	7.44%	4.13%	9.54%	2.79%	1.52%	257.18%	12.93%	7.37%				1.14%	4.56%	9.51%
HS(250) Short position	14.11%	7.02%	3.32%	10.33%	4.26%	2.18%	15.75%	8.47%	4.68%				1.33%	5.51%	10.65%
HS(FS) Short position	11.22%	5.44%	3.33%	10.26%	5.37%	3.24%	12.31%	5.56%	3.43%				2.28%	7.03%	10.65%

Note: Table 2 represents out of sample observations. The number of observations is 526. * denotes each confidence level at 1%, 5% or 10%.

Table 3. Backtesting-TC2-Spot price returns-long positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1)-N	0.101	2.351	3.052*		0.135	4.177**		2.486	7.229**	8.003	7.838	7.764
GARCH (1,1)-T	5.234**	39.457***	93.347***							101.585	56.868	38.078
GARCH (1,1)-GED	52.635***	1.220	2.532	0.288	0.626	0.744	52.923***	1.846	3.275	9.490	9.218	9.051
IGARCH (1,1)-N	0.101	0.782	6.473**		3.356*	6.858***		4.138	13.331***	7.143	7.343	7.444
IGARCH (1,1)-T	1.243	0.004	3.625*		4.277**	16.172***		4.281	19.798***	8.234	7.979	7.865
IGARCH (1,1)-GED	27.145***	0.113	7.331***	1.289	6.069**	4.885**	28.434***	6.182**	12.216***	7.555	7.312	7.461
(GJR) TGARCH (1,1)-N	1.243	0.113	1.645		1.352	4.766**		1.465	6.411**	8.081	7.880	7.800
(GJR)TGARCH (1,1)-T	5.234**	39.457***	93.347***							86.572	49.145	33.338
(GJR)TGARCH (1,1)-GED	56.178***	2.181	2.063	0.387	0.918	0.901	56.566***	3.099	2.964	9.554	9.282	9.105
EGARCH (1,1)-N	1.243	0.283	1.277		2.969*	6.369**		3.252	7.645**	8.684	8.186	7.988
EGARCH (1,1)-T	2.672	34.644***	52.327***							511.207	260.309	161.20
EGARCH (1,1)-GED	63.476***	4.845**	0.957	1.942	5.687**	8.101***	65.418***	10.533***	9.058**	29.399	26.135	22.456
APARCH (1,1)-N	6.402**	2.757*	0.055		7.496***	9.531***		10.253***	9.586***	7.561	7.594	7.620
APARCH (1,1)-T	1.161	20.805***	33.065***							13.912	11.302	9.976
APARCH (1,1)-GED	56.178***	4.845**	1.277	0.387	1.782	4.289**	56.566***	6.628**	5.566*	8.101	7.821	7.877
TARCH (1,1)-X-N	1.243	0.113	2.063		3.372*	5.273**		3.485	7.336**	8.072	7.875	7.796
TARCH (1,1)-X-T	5.234**	39.457***	81.415***							40.168	25.084	18.521
TARCH (1,1)-X-GED	52.635***	1.668	5.675**			0.176			5.852*	9.488	9.200	9.031
RISK METRICS	0.013	0.454	8.249***		2.942*	5.410**		3.396	13.659***	65.567	37.378	25.911
HS(100) Long position	1.243	0.069	0.598	8.418**	4.784**	14.129***	9.661***	4.853*	14.728***	227.759	7.336	7.446
HS(250) Long position	0.101	0.113	2.163	3.808*	13.145***	27.585***	3.908	13.258***	29.748***	7.134	7.302	7.410
HS(FS) Long position	2.215	9.445***	7.215***	2.215	13.256***	38.370***	4.430	22.701***	45.585***	7.147	7.353	7.462

Note: Table 3 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TC2 spot prices for long positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch. In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch. In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 4. Backtesting-TC2-Spot price returns-short positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1)-N	19.123***	0.283	4.936**		2.969*	5.687**		3.252	10.623***	5.124	4.965	5.385
GARCH (1,1)-T	5.234**	39.457***	76.301***							85.503	48.278	25.510
GARCH (1,1)-GED	63.476***	4.845**	4.253**	0.001	0.026	0.004	63.477***	4.871*	4.257	6.355	4.788	5.028
IGARCH (1,1)-N	30.024***	3.394*	3.052*	1.056	20.735***	22.635***	31.080***	24.128***	25.687***	6.987	6.376	6.557
IGARCH (1,1)-T	21.689***	0.838	1.645	4.835**	10.448***	22.763***	26.525***	11.287***	24.408***	6.615	6.104	6.282
IGARCH (1,1)-GED	78.855***	4.091**	4.253**	20.735***	23.717***	25.322***	99.590***	27.808***	29.575***	8.370	6.421	6.577
(GJR)TGARCH (1,1)-N	12.141***	0.019	5.675**		0.267	3.933**		0.286	9.608***	6.656	6.039	6.208
(GJR)TGARCH (1,1)-T	5.234**	34.644***	71.592***							71.428	40.648	22.136
(GJR)TGARCH (1,1)-GED	59.793***	3.394*	4.253**	0.500	0.109	0.004	60.293***	3.503	4.257	6.775	5.189	5.372
EGARCH (1,1)-N	4.814**	0.113	7.331***		0.175	4.885**		0.289	12.216***	6.958	6.118	6.219
EGARCH (1,1)-T	0.013	15.890***	43.203***							499.964	252.260	153.775
EGARCH (1,1)-GED	56.178***	1.220	4.936**	0.909	0.561	0.590	57.087***	1.781	5.526*	23.364	18.727	15.098
APARCH (1,1)-N	8.161***	0.283	3.625*		2.969*	6.982***		3.252	10.608***	7.020	6.318	6.464
APARCH (1,1)-T	0.101	11.887***	33.065***							7.161	6.906	6.591
APARCH (1,1)-GED	59.793***	2.181	4.936**	0.017	1.394	1.782	59.810***	3.575	6.718**	7.952	5.962	6.109
TARCH (1,1)-X-N	12.141***	0.019	4.936**		0.267	5.687**		0.286	10.623***	6.683	6.062	6.222
TARCH (1,1)-X-T	1.161	20.805***	59.319***							23.246	14.920	10.887
TARCH (1,1)-X-GED	63.476***	2.757*	4.253**	0.626	0.057	0.004	64.102***	2.814	4.257	6.922	5.303	5.473
RISK METRICS	19.123***	1.220	4.253**	5.419**	13.180***	17.236***	24.542***	14.399***	21.489***	54.856	30.603	20.773
HS(100) Short position	0.101	0.218	0.145	3.808*	8.806***	30.436***	3.908	9.024**	30.581***	187.279	6.776	6.817
HS(250) Short position	0.527	0.283	0.240		16.275***	29.473***		16.558***	29.713***	6.172	6.470	6.635
HS(FS) Short position	6.402**	4.091**	0.240	1.229	23.717***	25.783***	7.631**	27.808***	26.023***	6.138	6.461	6.657

Note: Table 4 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TC2 spot prices for short positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch. In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch. In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 5. Value at Risk Statistics-TC2-One month front FFA price returns.

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
GARCH (1,1)-N	–8.59%	–6.07%	–4.73%	–10.79%	–7.63%	–5.94%	–7.42%	–5.25%	–4.09%	2.47%	5.13%	8.94%	1.90%	4.75%	8.94%
GARCH (1,1)-T	–9.10%	–6.43%	–5.01%	–12.19%	–8.62%	–6.71%	–7.54%	–5.33%	–4.15%	1.71%	4.37%	7.22%	1.52%	3.99%	7.22%
GARCH (1,1)-GED	–6.07%	–5.58%	–4.96%	–9.91%	–9.10%	–8.09%	–4.96%	–4.55%	–4.05%	4.94%	6.46%	7.79%	5.13%	6.08%	7.98%
IGARCH (1,1)-N	–8.72%	–6.16%	–4.80%	–10.41%	–7.36%	–5.74%	–6.70%	–4.74%	–3.69%	2.09%	5.51%	8.17%	1.90%	4.37%	8.37%
IGARCH (1,1)-T	–8.83%	–6.24%	–4.86%	–10.87%	–7.68%	–5.98%	–6.63%	–4.69%	–3.65%	2.09%	5.32%	7.98%	1.90%	4.37%	7.79%
IGARCH (1,1)-GED	–5.89%	–5.40%	–4.80%	–6.56%	–6.02%	–5.35%	–5.07%	–4.65%	–4.14%	5.70%	6.46%	8.94%	4.37%	5.51%	8.17%
(GJR)TGARCH (1,1)-N	–8.66%	–6.13%	–4.78%	–10.15%	–7.18%	–5.59%	–7.63%	–5.40%	–4.20%	2.09%	4.94%	8.56%	1.71%	4.18%	8.37%
(GJR)TGARCH (1,1)-T	–9.15%	–6.47%	–5.04%	–22.74%	–16.07%	–12.52%	–7.93%	–5.60%	–4.36%	2.28%	4.94%	7.79%	1.71%	4.56%	7.98%
(GJR)TGARCH (1,1)-GED	–5.86%	–5.37%	–4.78%	–14.39%	–13.21%	–11.74%	–5.44%	–4.99%	–4.44%	5.70%	6.84%	8.94%	5.32%	5.89%	8.75%
EGARCH (1,1)-N	–8.96%	–6.33%	–4.94%	–10.37%	–7.33%	–5.71%	–7.31%	–5.17%	–4.03%	1.90%	4.56%	7.41%	1.71%	4.18%	7.98%
EGARCH (1,1)-T	–9.46%	–6.69%	–5.21%	–12.31%	–8.70%	–6.78%	–7.44%	–5.26%	–4.10%	1.33%	4.18%	7.03%	1.14%	3.99%	6.65%
EGARCH (1,1)-GED	–6.43%	–5.91%	–5.25%	–8.75%	–8.03%	–7.14%	–4.94%	–4.53%	–4.03%	4.75%	5.51%	6.84%	3.99%	5.13%	6.65%
APARCH (1,1)-N	–8.97%	–6.34%	–4.94%	–10.41%	–7.36%	–5.74%	–7.31%	–5.17%	–4.03%	1.90%	4.56%	7.41%	1.71%	4.18%	7.98%
APARCH (1,1)-T	–9.62%	–6.80%	–5.30%	–12.52%	–8.85%	–6.89%	–7.37%	–5.21%	–4.05%	1.52%	4.37%	6.84%	1.14%	3.80%	6.65%
APARCH (1,1)-GED	–6.54%	–6.00%	–5.34%	–8.62%	–7.91%	–7.04%	–5.35%	–4.91%	–4.36%	4.37%	5.13%	6.84%	3.80%	4.75%	6.65%
TARCH (1,1)-X-N	–8.61%	–6.09%	–4.74%	–10.69%	–7.56%	–5.89%	–7.42%	–5.25%	–4.09%	2.28%	5.13%	8.37%	1.90%	4.75%	8.56%
TARCH (1,1)-X-T	–9.15%	–6.46%	–5.03%	–22.90%	–16.19%	–12.61%	–7.91%	–5.59%	–4.36%	2.09%	4.94%	7.79%	1.71%	4.75%	7.98%
TARCH (1,1)-X-GED	–5.97%	–5.48%	–4.87%	–15.09%	–13.85%	–12.31%	–5.44%	–5.00%	–4.44%	5.70%	6.84%	8.37%	5.32%	5.70%	8.37%

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Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
RISK METRICS	−8.98%	−6.35%	−4.95%	−16.18%	−11.44%	−8.92%	−5.42%	−3.83%	−2.99%	2.28%	5.32%	8.37%	1.90%	4.56%	8.75%
HS(100) Long position	−12.90%	−6.33%	−4.28%	−21.65%	−9.02%	−5.56%	−8.09%	−4.21%	−2.96%	0.76%	5.70%	11.41%			
HS(250) Long position	−13.76%	−6.08%	−3.98%	−16.45%	−9.28%	−4.92%	−11.87%	−5.31%	−2.84%	0.38%	5.51%	12.55%			
HS(FS) Long position	−11.09%	−5.06%	−3.58%	−11.12%	−5.25%	−3.69%	−11.01%	−4.92%	−3.42%	1.14%	7.60%	14.26%			
HS(100) Short position	12.47%	6.14%	4.38%	5.44%	3.36%	2.96%	20.91%	8.80%	5.58%				1.90%	5.70%	10.27%
HS(250) Short position	10.09%	5.17%	4.09%	6.54%	3.92%	3.25%	12.85%	6.41%	5.02%				1.71%	7.03%	12.55%
HS(FS) Short position	9.36%	4.98%	3.65%	9.21%	4.83%	3.47%	9.48%	5.10%	3.84%				1.33%	7.79%	14.64%

Note: Table 5 represents out of sample observations. The number of observations is 526. * denotes each confidence level at 1%, 5% or 10%.

Table 6. Backtesting-TC2-One month front FFA price returns-Long positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1)-N	8.161***	0.019	0.685		1.612	0.930		1.631	1.615	0.390	0.107	0.145
GARCH (1,1)-T	2.215	0.454	4.936**			1.928			6.864**	0.293	0.153	0.178
GARCH (1,1)-GED	42.451***	2.181	3.052*	0.379	1.394	1.151	42.831***	3.575	4.203	1.359	0.101	0.181
IGARCH (1,1)-N	4.814**	0.283	2.063		0.244	1.913		0.527	3.976	0.378	0.124	0.157
IGARCH (1,1)-T	4.814**	0.113	2.532		0.166	2.220		0.279	4.752*	0.363	0.137	0.166
IGARCH (1,1)-GED	56.178***	2.181	0.685	0.909	3.331*	2.084	57.087***	5.512*	2.768	1.427	0.077	0.148
(GJR)TGARCH (1,1)-N	4.814**	0.004	1.277		0.379	1.374		0.383	2.651	0.362	0.109	0.148
(GJR)TGARCH (1,1)-T	6.402**	0.004	3.052*		1.899	2.553		1.903	5.605*	0.348	0.191	0.204
(GJR)TGARCH (1,1)-GED	56.178***	3.394*	0.685	0.909	4.393**	2.084	57.087***	7.787**	2.768	1.465	0.099	0.164
EGARCH (1,1)-N	3.412*	0.218	4.253**		0.010	3.300*		0.228	7.553**	0.296	0.128	0.164
EGARCH (1,1)-T	0.527	0.782	5.675**			2.238			7.913**	0.226	0.186	0.204
EGARCH (1,1)-GED	39.215***	0.283	6.473**	0.035	1.233	2.574	39.251***	1.515	9.047**	1.178	0.109	0.212
APARCH (1,1)-N	3.412*	0.218	4.253**		0.010	3.300*		0.228	7.553**	0.294	0.129	0.164
APARCH (1,1)-T	1.243	0.454	6.473**		0.000	2.574		0.454	9.047**	0.202	0.202	0.216
APARCH (1,1)-GED	32.998***	0.019	6.473**	0.000	1.612	2.574	32.998***	1.631	9.047**	1.123	0.106	0.217
TARCH (1,1)-X-N	6.402**	0.019	1.645		3.807*	1.632		3.827	3.277	0.392	0.115	0.151
TARCH (1,1)-X-T	4.814**	0.004	3.052*		1.899	2.553		1.903	5.605*	0.352	0.193	0.205
TARCH (1,1)-X-GED	56.178***	3.394*	1.645	0.909	4.393**	3.124*	57.087***	7.787**	4.769*	1.409	0.104	0.177
RISK METRICS	6.402**	0.113	1.645		0.166	0.050		0.279	1.695	0.518	0.247	0.237
HS(100) Long position	0.332	0.525	1.112		0.909	1.804		1.434	2.916	1.299	0.206	0.140
HS(250) Long position	2.672	0.283	3.539*		2.969*	0.508		3.252	4.047	0.583	0.109	0.120
HS(FS) Long position	0.101	6.524**	9.493***		4.898**	0.255		11.422***	9.747***	0.015	0.078	0.122

Note: Table 6 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TC2 One month front Forward Freight Agreements prices for long positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch. In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch. In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 7. Backtesting-TC2-One month front FFA price returns-Short positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1)-N	3.412*	0.069	0.685		2.216	0.930		2.284	1.615	0.100	0.119	0.130
GARCH (1,1)-T	1.243	1.204	4.936**		1.289	0.671		2.493	5.607*	0.091	0.168	0.159
GARCH (1,1)-GED	45.769***	1.220	2.532	0.267	0.561	0.176	46.035***	1.781	2.708	0.659	0.103	0.159
IGARCH (1,1)-N	3.412*	0.454	1.645		2.942*	1.632		3.396	3.277	0.110	0.142	0.146
IGARCH (1,1)-T	3.412*	0.454	3.052*		2.942*	1.151		3.396	4.203	0.115	0.155	0.153
IGARCH (1,1)-GED	32.998***	0.283	2.063	2.942*	1.118	0.751	35.940***	1.400	2.814	0.709	0.083	0.135
(GJR) TGARCH (1,1)-N	2.215	0.782	1.645		3.356*	1.632		4.138	3.277	0.080	0.120	0.132
(GJR) TGARCH (1,1)-T	2.215	0.218	2.532		0.670	0.029		0.888	2.561	0.159	0.209	0.186
(GJR) TGARCH (1,1)-GED	49.164***	0.838	0.957	0.175	0.017	1.141	49.339***	0.856	2.097	0.734	0.098	0.144
EGARCH (1,1)-N	2.215	0.782	2.532		3.356*	0.176		4.138	2.708	0.068	0.145	0.146
EGARCH (1,1)-T	0.101	1.204	7.331***		1.289	1.158		2.493	8.488**	0.085	0.203	0.181
EGARCH (1,1)-GED	27.145***	0.019	7.331***	1.289	1.612	1.158	28.434***	1.631	8.488**	0.543	0.117	0.189
APARCH (1,1)-N	2.215	0.782	2.532		3.356*	0.176		4.138	2.708	0.069	0.146	0.147
APARCH (1,1)-T	0.101	1.726	7.331***		1.550	1.158		3.276	8.488**	0.088	0.222	0.192
APARCH (1,1)-GED	24.365***	0.069	7.331***	1.550	2.216	1.158	25.915***	2.284	8.488**	0.500	0.114	0.191
TARCH (1,1)-X-N	3.412*	0.069	1.277		2.216	0.441		2.284	1.718	0.101	0.120	0.130
TARCH (1,1)-X-T	2.215	0.069	2.532		0.513	0.029		0.582	2.561	0.160	0.209	0.186
TARCH (1,1)-X-GED	49.164***	0.525	1.645	0.175	0.051	0.050	49.339***	0.576	1.695	0.697	0.104	0.156
RISK METRICS	3.412*	0.218	0.957		0.010	1.141		0.228	2.097	0.303	0.261	0.213
HS(100) Short position	3.412*	0.525	0.041		2.598	1.330		3.123	1.372	26.432	6.530	3.330
HS(250) Short position	2.215	4.091**	3.539*	2.215	0.757	3.310*	4.430	4.847*	6.849**	19.917	5.275	3.023
HS(FS) Short position	0.527	7.445***	11.168***		0.006	3.814*		7.451**	14.982***	18.402	5.010	2.634

Note: Table 7 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TC2 One month front Forward Freight Agreements prices for short positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 8. Value at Risk Statistics-TC2-three months front FFA price returns.

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
GARCH (1,1)-N	–5.45%	–3.85%	–3.00%	–18.73%	–13.25%	–10.33%	–4.42%	–3.13%	–2.44%	1.33%	3.80%	6.08%	1.90%	3.99%	5.89%
GARCH (1,1)-T	–7.20%	–5.09%	–3.97%	–10.96%	–7.75%	–6.03%	–5.85%	–4.13%	–3.22%	1.33%	1.90%	3.80%	0.95%	2.09%	2.85%
GARCH (1,1)-GED	–2.79%	–2.56%	–2.28%	–7.25%	–6.66%	–5.92%	–2.13%	–1.96%	–1.74%	7.03%	7.98%	8.37%	7.03%	7.22%	10.46%
IGARCH (1,1)-N	–5.09%	–3.60%	–2.81%	–7.58%	–5.36%	–4.18%	–3.02%	–2.13%	–1.66%	2.28%	4.56%	6.46%	2.28%	3.80%	6.46%
IGARCH (1,1)-T	–5.13%	–3.63%	–2.82%	–7.75%	–5.47%	–4.26%	–3.00%	–2.12%	–1.65%	2.28%	4.56%	6.46%	2.47%	3.80%	6.08%
IGARCH (1,1)-GED	–3.05%	–2.80%	–2.49%	–3.26%	–2.99%	–2.66%	–2.91%	–2.68%	–2.38%	5.51%	5.70%	7.60%	5.51%	6.27%	8.37%
(GJR)TGARCH (1,1)-N	–5.46%	–3.86%	–3.01%	–28.50%	–20.16%	–15.71%	–4.19%	–2.96%	–2.31%	2.28%	3.99%	6.46%	2.66%	4.37%	7.03%
(GJR)TGARCH (1,1)-T	–7.04%	–4.98%	–3.88%	–10.49%	–7.41%	–5.77%	–5.97%	–4.22%	–3.29%	1.33%	1.90%	3.80%	1.14%	1.90%	3.04%
(GJR)TGARCH (1,1)-GED	–3.72%	–3.42%	–3.04%	–9.02%	–8.28%	–7.36%	–2.14%	–1.97%	–1.75%	4.75%	5.13%	6.08%	4.94%	4.94%	5.70%
EGARCH (1,1)-N	–5.26%	–3.72%	–2.90%	–12.26%	–8.67%	–6.76%	–3.24%	–2.29%	–1.78%	1.90%	4.18%	7.22%	1.90%	4.94%	7.41%
EGARCH (1,1)-T	–6.89%	–4.87%	–3.79%	–12.42%	–8.78%	–6.83%	–4.95%	–3.50%	–2.73%	1.52%	2.09%	4.56%	1.33%	2.28%	3.80%
EGARCH (1,1) -GED	–2.77%	–2.54%	–2.26%	–7.91%	–7.27%	–6.46%	–2.56%	–2.35%	–2.09%	7.03%	7.60%	9.13%	6.27%	7.98%	9.51%
APARCH (1,1) - N	–5.03%	–3.56%	–2.77%	–10.68%	–7.55%	–5.89%	–2.90%	–2.05%	–1.60%	2.85%	4.37%	7.41%	1.90%	5.13%	8.37%

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Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
APARCH (1,1) - T	−7.68%	−5.43%	−4.23%	−14.23%	−10.06%	−7.83%	−4.96%	−3.51%	−2.73%	0.95%	1.90%	3.23%	0.95%	1.90%	2.85%
APARCH (1,1)-GED	−3.12%	−2.87%	−2.55%	−7.15%	−6.56%	−5.83%	−2.49%	−2.29%	−2.03%	5.32%	6.46%	7.98%	5.51%	6.84%	7.60%
TARCH (1,1)-X-N	−5.45%	−3.86%	−3.01%	−27.23%	−19.26%	−15.01%	−4.14%	−2.93%	−2.28%	2.28%	3.99%	6.46%	2.28%	4.37%	7.03%
TARCH (1,1)-X-T	−7.03%	−4.97%	−3.87%	−10.44%	−7.38%	−5.75%	−5.91%	−4.17%	−3.25%	1.52%	1.90%	3.80%	1.14%	2.09%	3.23%
TARCH (1,1)-X-GED	−3.00%	−2.75%	−2.44%	−6.76%	−6.21%	−5.52%	−2.45%	−2.25%	−2.00%	6.27%	7.03%	7.98%	6.08%	7.03%	8.17%
RISK METRICS	−5.19%	−3.67%	−2.86%	−13.39%	−9.47%	−7.38%	−2.39%	−1.69%	−1.32%	2.85%	5.32%	7.03%	2.47%	4.56%	7.22%
HS(100) Long position	−9.32%	−3.49%	−2.15%	−14.81%	−6.80%	−4.07%	−3.11%	−1.53%	−1.35%	1.52%	5.13%	10.46%			
HS(250) Long position	−8.44%	−3.18%	−1.84%	−12.38%	−4.24%	−2.59%	−4.84%	−1.93%	−1.51%	1.33%	5.70%	11.41%			
HS(FS) Long position	−5.87%	−2.74%	−1.86%	−6.13%	−2.79%	−1.89%	−5.72%	−2.68%	−1.83%	1.71%	6.27%	10.84%			
HS(100) Short position	9.52%	3.37%	2.25%	2.59%	1.96%	1.49%	16.11%	5.32%	3.64%				1.33%	4.75%	9.70%
HS(250) Short position	6.36%	2.94%	1.91%	3.14%	2.45%	1.47%	8.94%	4.41%	2.69%				2.09%	6.84%	11.22%
HS(FS) Short position	5.05%	2.80%	1.94%	4.88%	2.71%	1.92%	5.32%	2.87%	1.98%				2.09%	6.65%	11.60%

Note: Table 8 represents out of sample observations. The number of observations is 526. * denotes each confidence level at 1%, 5% or 10%.

Table 9. Backtesting-TC2-three months front FFA price returns-Long positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1)-N	0.527	1.726	10.277***			0.001			10.278***	0.191	0.162	0.143
GARCH (1,1)-T	0.527	13.786***	28.716***		1.836	0.074		15.622***	28.789***	0.128	0.327	0.268
GARCH (1,1)-GED	82.853***	8.419***	1.645	2.238	2.220	1.632	85.091***	10.639***	3.277	0.614	0.074	0.081
IGARCH (1,1)-N	6.402**	0.218	8.249***	1.229	0.758	1.522	7.631**	0.976	9.772***	0.161	0.115	0.116
IGARCH (1,1)-T	6.402**	0.218	8.249***	1.229	0.758	1.522	7.631**	0.976	9.772***	0.161	0.119	0.119
IGARCH (1,1)-GED	52.635***	0.525	3.625*	0.104	0.051	1.265	52.738***	0.576	4.890*	0.518	0.052	0.075
(GJR)TGARCH (1,1)-N	6.402**	1.204	8.249***			0.918			9.167**	0.379	0.266	0.214
(GJR)TGARCH (1,1)-T	0.527	13.786***	28.716***		1.836	0.074		15.622***	28.789***	0.105	0.299	0.250
(GJR)TGARCH (1,1)-GED	39.215***	0.019	10.277***	0.513	1.612	4.209**	39.728***	1.631	14.486***	0.397	0.122	0.159
EGARCH (1,1)-N	3.412*	0.782	4.936**		0.007	1.928		0.789	6.864**	0.170	0.136	0.131
EGARCH (1,1)-T	1.243	11.887***	21.230***		1.510	0.670		13.397***	21.900***	0.128	0.292	0.242
EGARCH (1,1)-GED	82.853***	6.524**	0.459	0.757	1.265	3.223*	83.610***	7.788**	3.683	0.610	0.064	0.072
APARCH (1,1)-N	12.141***	0.454	4.253**	0.598	0.000	1.644	12.739***	0.454	5.897*	0.178	0.117	0.117
APARCH (1,1)-T	0.013	13.786***	35.409***		1.836	0.320		15.622***	35.729***	0.270	0.450	0.350
APARCH (1,1)-GED	49.164***	2.181	2.532	0.175	3.130*	2.220	49.339***	5.311*	4.752*	0.511	0.062	0.086
TARCH (1,1)-X-N	6.402**	1.204	8.249***			0.918			9.167**	0.362	0.258	0.210
TARCH (1,1)-X-T	1.243	13.786***	28.716***		1.836	0.074		15.622***	28.789***	0.105	0.297	0.248
TARCH (1,1)-X-GED	67.226***	4.091**	2.532	1.655	2.079	2.220	68.881***	6.169**	4.752*	0.544	0.062	0.080
RISK METRICS	12.141***	0.113	5.675**	0.598	6.375**	4.161**	12.739***	6.489**	9.836***	0.268	0.177	0.154
HS(100) Long position	1.243	0.019	0.120		4.040**	3.549*		4.060	3.669	1.271	0.168	0.092
HS(250) Long position	0.527	0.525	1.112		0.909	8.164***		1.434	9.276***	0.634	0.074	0.079
HS(FS) Long position	2.215	1.668	0.399	2.215	0.420	6.009**	4.430	2.089	6.408**	0.024	0.053	0.071

Note: Table 9 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TC2 Three months front Forward Freight Agreements prices for long positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 10. Backtesting-TC2-three months front FFA price returns-Short positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1) - N	3.412*	1.204	11.390***			0.500			11.890***	0.167	0.158	0.143
GARCH (1,1) - T	0.013	11.887***	40.470***							0.260	0.312	0.254
GARCH (1,1) - GED	82.853***	4.845**	0.120	0.176	0.259	0.012	83.030***	5.105*	0.132	0.383	0.078	0.079
IGARCH (1,1) - N	6.402**	1.726	8.249***			0.022			8.271**	0.115	0.112	0.110
IGARCH (1,1) - T	8.161***	1.726	10.277***			0.626			10.903***	0.119	0.116	0.112
IGARCH (1,1) - GED	52.635***	1.668	1.645	0.104	0.420	0.510	52.738***	2.089	2.155	0.303	0.051	0.068
(GJR)TGARCH (1,1) - N	10.077***	0.454	5.675**		0.000	0.176		0.454	5.852*	0.348	0.249	0.198
(GJR)TGARCH (1,1) - T	0.101	13.786***	37.875***							0.219	0.282	0.233
(GJR)TGARCH (1,1) - GED	42.451***	0.004	12.571***							0.242	0.125	0.156
EGARCH (1,1) - N	3.412*	0.004	4.253**		0.076	0.446		0.080	4.699*	0.127	0.123	0.118
EGARCH (1,1) - T	0.527	10.173***	28.716***							0.233	0.278	0.229
EGARCH (1,1) - GED	67.226***	8.419***	0.145	0.003	0.047	0.156	67.229***	8.466**	0.301	0.380	0.067	0.070
APARCH (1,1) - N	3.412*	0.019	1.645		0.267	0.031		0.286	1.676	0.121	0.107	0.106
APARCH (1,1) - T	0.013	13.786***	40.470***							0.444	0.435	0.334
APARCH (1,1) - GED	52.635***	3.394*	3.625*	0.288	0.109	0.001	52.923***	3.503	3.626	0.301	0.064	0.081
TARCH (1,1) - X - N	6.402**	0.454	5.675**		0.000	0.066		0.454	5.741*	0.328	0.237	0.191
TARCH (1,1) - X - T	0.101	11.887***	35.409***							0.219	0.281	0.232
TARCH (1,1) - X - GED	63.476***	4.091**	2.063	0.001	0.176	0.096	63.477***	4.267	2.159	0.327	0.065	0.077
RISK METRICS	8.161***	0.218	4.936**			0.259			5.195*	0.234	0.175	0.149
HS(100) Short position	0.527	0.069	0.055			0.257			0.312	2.009	0.106	0.081
HS(250) Short position	4.814**	3.394*	0.836		0.125	0.342		3.518	1.178	0.219	0.071	0.076
HS(FS) Short position	4.814**	2.757*	1.425		1.158	0.001		3.915	1.427	0.030	0.051	0.068

Note: Table 10 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TC2 Three months front Forward Freight Agreements prices for short positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 11. Value at Risk Statistics-TD3-Spot price returns.

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
GARCH (1,1) - N	−8.96%	−6.34%	−4.94%	−41.18%	−29.12%	−22.70%	−4.88%	-3.45%	−2.69%	1.14%	3.80%	6.27%	1.33%	4.37%	7.03%
GARCH (1,1) - T	−338.98%	−239.57%	−186.59%	−2535.35%	−1791.84%	−1395.59%	−131.88%	−93.21%	−72.59%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
GARCH (1,1) - GED	−6.90%	−6.30%	−5.60%	−45.09%	−41.21%	−36.63%	−2.87%	−2.62%	−2.33%	3.42%	3.99%	5.89%	3.61%	3.99%	5.51%
IGARCH (1,1) - N	−8.02%	−5.67%	−4.42%	−15.53%	−10.98%	−8.56%	−3.72%	−2.63%	−2.05%	2.09%	3.99%	6.84%	2.66%	5.89%	8.75%
IGARCH (1,1) - T	−7.60%	−5.37%	−4.18%	−22.54%	−15.93%	−12.41%	−2.08%	−1.47%	−1.14%	2.28%	5.32%	7.41%	3.42%	7.41%	10.27%
IGARCH (1,1) - GED	−5.67%	−5.18%	−4.61%	−14.93%	−13.62%	−12.10%	−1.95%	−1.78%	−1.58%	4.18%	5.13%	6.27%	6.08%	7.79%	9.70%
(GJR)TGARCH (1,1) - N	−8.99%	−6.36%	−4.95%	−42.44%	−30.02%	−23.39%	−4.86%	−3.43%	−2.68%	1.14%	4.18%	6.46%	1.33%	4.18%	7.03%
(GJR)TGARCH (1,1) - T	−324.49%	−229.33%	−178.62%	−2376.37%	−1679.48%	−1308.07%	−126.09%	−89.11%	−69.41%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
(GJR)TGARCH (1,1) - GED	−6.88%	−6.29%	−5.59%	−44.25%	−40.44%	−35.95%	−2.88%	−2.63%	−2.34%	3.42%	3.99%	5.70%	3.61%	4.18%	5.70%
EGARCH (1,1) - N	−8.93%	−6.31%	−4.92%	−59.01%	−41.73%	−32.52%	−4.04%	−2.86%	−2.23%	0.95%	3.99%	6.27%	1.90%	3.99%	6.84%
EGARCH (1,1) - T	−21.57%	−15.24%	−11.87%	−332.53%	−235.01%	−183.04%	−8.61%	−6.08%	−4.74%	0.00%	0.00%	0.19%	0.19%	0.57%	0.95%
EGARCH (1,1) - GED	−6.46%	−5.90%	−5.24%	−76.98%	−70.36%	−62.54%	−2.72%	−2.47%	−2.20%	3.61%	4.37%	6.08%	3.99%	5.32%	6.08%
APARCH (1,1) - N	−8.95%	−6.33%	−4.93%	−37.13%	−26.26%	−20.46%	−4.51%	−3.19%	−2.49%	0.76%	3.80%	6.27%	1.52%	3.99%	7.41%
APARCH (1,1) - T	−48.87%	−34.54%	−26.90%	−264.53%	−186.95%	−145.61%	−14.77%	−10.44%	−8.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
APARCH (1,1) - GED	−6.69%	−6.11%	−5.43%	−32.82%	−29.97%	−26.64%	−2.28%	−2.09%	−1.85%	3.23%	3.80%	5.51%	4.37%	4.94%	5.13%

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
TARCH (1,1) - X - N	–9.21%	–6.52%	–5.08%	–47.23%	–33.40%	–26.03%	–4.15%	–2.93%	–2.29%	0.95%	3.99%	6.46%	1.33%	3.80%	6.84%
TARCH (1,1) - X - T	–301.49%	–213.08%	–165.96%	–2210.88%	–1562.52%	–1216.98%	–103.54%	–73.18%	–56.99%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TARCH (1,1) - X - GED	–6.90%	–6.30%	–5.60%	–44.59%	–40.75%	–36.22%	–2.58%	–2.35%	–2.09%	3.42%	4.56%	5.32%	3.23%	4.18%	5.89%
RISK METRICS	–7.87%	–5.57%	–4.34%	–18.33%	–12.97%	–10.11%	–2.81%	–1.99%	–1.55%	2.28%	4.18%	7.22%	3.04%	6.84%	9.89%
HS(100) Long position	–9.74%	–5.51%	–3.48%	–17.17%	–8.55%	–5.42%	–2.98%	–1.03%	–0.77%	1.90%	5.89%	11.22%			
HS(250) Long position	–9.53%	–5.05%	–3.31%	–10.00%	–6.53%	–4.11%	–7.48%	–3.51%	–2.42%	1.33%	5.51%	10.84%			
HS(FS) Long position	–11.02%	–6.01%	–3.68%	–11.16%	–6.16%	–3.82%	–10.84%	–5.90%	–3.59%	0.19%	4.37%	9.32%			
HS(100) Short position	15.24%	6.42%	3.88%	7.58%	2.90%	1.82%	23.92%	11.09%	6.29%				1.33%	5.13%	10.46%
HS(250) Short position	11.14%	5.63%	3.31%	8.52%	3.84%	2.17%	12.98%	6.95%	4.72%				1.71%	5.13%	11.60%
HS(FS) Short position	13.88%	6.77%	3.86%	13.48%	6.56%	3.78%	14.02%	7.01%	3.99%				0.57%	3.80%	10.27%

Note: Table 11 represents out of sample observations. The number of observations is 526. * denotes each confidence level at 1%, 5% or 10%.

Table 12. Backtesting-TD3-Spot price returns-Long positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1) - N	0.101	1.726	9.231***			1.655			10.886***	6.733	3.819	2.653
GARCH (1,1) - T										10632.244	5315.220	3227.091
GARCH (1,1) - GED	19.123***	1.204	11.390***							5.194	4.466	3.716
IGARCH (1,1) - N	4.814**	1.204	6.473**	11.439***	11.402***	25.106***	16.253***	12.606***	31.579***	4.530	2.634	1.885
IGARCH (1,1) - T	6.402**	0.113	4.253**	10.295***	6.069**	5.152**	16.697***	6.182**	9.405***	4.908	2.850	2.021
IGARCH (1,1) - GED	30.024***	0.019	9.231***	10.477***	10.154***	8.889***	40.501***	10.174***	18.120***	2.985	2.570	2.184
(GJR)TGARCH (1,1) - N	0.101	0.782	8.249***			3.130*			11.379***	6.865	3.894	2.704
(GJR)TGARCH (1,1) - T										9674.296	4836.135	2936.113
(GJR)TGARCH (1,1)- GED	19.123***	1.204	12.571***			0.387			12.958***	5.116	4.400	3.662
EGARCH (1,1) - N	0.013	1.204	9.231***			8.889***			18.120***	6.511	3.713	2.592
EGARCH (1,1) - T			100.705***							44.741	22.997	14.407
EGARCH (1,1) - GED	21.689***	0.454	10.277***			0.001			10.278***	4.476	3.857	3.236
APARCH (1,1) - N	0.332	1.726	9.231***			3.537*			12.768***	6.512	3.710	2.587
APARCH (1,1) - T										191.026	96.193	58.885
APARCH (1,1) - GED	16.671***	1.726	13.823***			0.288			14.112***	4.358	3.758	3.149
TARCH (1,1) - X - N	0.013	1.204	8.249***			3.130*			11.379***	7.369	4.163	2.876
TARCH (1,1) - X - T										8251.111	4125.059	2504.631
TARCH (1,1) - X - GED	19.123***	0.218	15.148***		0.010	0.175		0.228	15.323***	5.108	4.396	3.658
RISK METRICS	6.402**	0.782	4.936**	10.295***	6.551**	22.389***	16.697***	7.332**	27.325***	4.656	2.700	1.933
HS(100) Long position	3.412*	0.838	0.836	12.727***	38.817***	54.499***	16.140***	39.655***	55.335***	6.749	2.581	1.446
HS(250) Long position	0.527	0.283	0.399	9.618***	20.802***	44.456***	10.145***	21.084***	44.856***	5.685	2.163	1.310
HS(FS) Long position	5.234**	0.454	0.280		24.277***	45.787***		24.731***	46.067***	7.298	2.716	1.455

Note: Table 12 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TD3 spot prices for long positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 13. Backtesting-TD3-Spot price returns-Short positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1) - N	0.527	0.454	5.675**		9.613***	6.255**		10.067***	11.931***	6.431	3.019	1.834
										10632.244	5315.220	3227.091
GARCH (1,1) - GED	21.689***	1.204	13.823***		0.031	8.586***		1.235	22.409***	4.827	3.936	2.923
IGARCH (1,1) - N	10.077***	0.838	0.957	13.875***	10.448***	24.070***	23.952***	11.287***	25.027***	3.992	1.830	1.098
IGARCH (1,1) - T	19.123***	5.657**	0.041	14.618***	10.470***	15.072***	33.741***	16.127***	15.113***	4.279	2.143	1.213
IGARCH (1,1) - GED	63.476***	7.445***	0.055	13.180***	11.890***	14.998***	76.655***	19.335***	15.052***	2.375	1.740	1.343
(GJR)TGARCH (1,1) - N	0.527	0.782	5.675**		10.477***	6.255**		11.258***	11.931***	6.561	3.117	1.878
(GJR)TGARCH (1,1) - T	6.561**	3.117*	1.878							9674.296	4836.135	2936.113
(GJR)TGARCH (1,1)-GED	21.689***	0.782	12.571***		0.007	7.871***		0.789	20.442***	4.753	3.863	2.860
EGARCH (1,1) - N	3.412*	1.204	6.473**	6.506**	11.402***	6.858***	9.918***	12.606***	13.331***	5.800	2.966	1.776
EGARCH (1,1) - T	5.234**	34.644***	76.301***							44.548	22.774	14.135
EGARCH (1,1) - GED	27.145***	0.113	10.277***	11.402***	9.346***	6.565**	38.547***	9.460***	16.842***	3.697	3.037	2.457
APARCH (1,1) - N	1.243	1.204	4.253**	2.658	11.402***	7.619***	3.901	12.606***	11.872***	6.037	2.955	1.706
APARCH (1,1) - T										191.026	96.193	58.885
APARCH (1,1) - GED	32.998***	0.004	16.549***	9.613***	11.013***	10.154***	42.611***	11.017***	26.703***	3.547	2.960	2.416
TARCH (1,1) - X - N	0.527	1.726	6.473**		12.396***	4.393**		14.122***	10.867***	7.069	3.381	2.081
TARCH (1,1) - X - T										8251.111	4125.059	2504.631
TARCH (1,1) - X - GED	16.671***	0.782	11.390***		0.007	7.198***		0.789	18.587***	4.747	3.868	2.849
RISK METRICS	14.342***	3.394*	0.008	17.218***	13.043***	20.312***	31.559***	16.437***	20.320***	4.076	1.928	1.105
HS(100) Short position	0.527	0.019	0.120	9.618***	18.640***	39.224***	10.145***	18.659***	39.344***	6.226	1.865	0.763
HS(250) Short position	2.215	0.019	1.425	7.394***	18.640***	50.305***	9.608***	18.659***	51.730***	5.121	1.498	0.612
HS(FS) Short position	1.161	1.726	0.041		12.396***	50.423***		14.122***	50.464***	6.970	2.057	0.729

Note: Table 13 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TD3 spot prices for short positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 14. Value at Risk Statistics-TD3-One month price returns.

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
GARCH (1,1) - N	–11.28%	–7.97%	–6.21%	–67.15%	–47.49%	–37.01%	–6.52%	–4.61%	–3.60%	1.33%	3.04%	5.70%	1.90%	4.56%	6.08%
GARCH (1,1) - T	–16.93%	–11.97%	–9.32%	–74.67%	–52.77%	–41.10%	–9.47%	–6.70%	–5.21%	0.57%	0.95%	1.71%	0.76%	1.90%	2.28%
GARCH (1,1) - GED	–7.21%	–6.59%	–5.85%	–53.63%	–49.07%	–43.62%	–5.13%	–4.68%	–4.15%	3.80%	4.37%	5.70%	4.37%	5.51%	6.65%
IGARCH (1,1) - N	–10.14%	–7.17%	–5.59%	–51.07%	–36.12%	–28.15%	–4.13%	–2.92%	–2.28%	1.71%	4.56%	7.98%	2.66%	5.51%	8.17%
IGARCH (1,1) - T	–10.84%	–7.66%	–5.97%	–34.89%	–24.66%	–19.21%	–5.13%	–3.62%	–2.82%	1.52%	3.42%	6.08%	2.28%	4.37%	7.03%
IGARCH (1,1)-GED	–8.08%	–7.38%	–6.56%	–22.07%	–20.19%	–17.95%	–3.98%	–3.63%	–3.23%	2.85%	3.61%	4.94%	3.42%	4.37%	5.70%
(GJR)TGARCH (1,1) - N	–11.20%	–7.92%	–6.18%	–69.11%	–48.87%	–38.09%	–6.46%	–4.57%	–3.56%	1.14%	3.04%	5.70%	1.71%	4.18%	6.27%
(GJR)TGARCH (1,1) - T	–17.00%	–12.01%	–9.36%	–71.83%	–50.76%	–39.54%	–9.37%	–6.62%	–5.16%	0.57%	1.14%	2.09%	0.76%	1.90%	2.66%
(GJR)TGARCH (1,1) - GED	–7.34%	–6.71%	–5.96%	–54.15%	–49.54%	–44.04%	–4.54%	–4.14%	–3.68%	3.99%	4.18%	6.27%	4.75%	5.70%	6.46%
EGARCH (1,1) - N	–10.68%	–7.56%	–5.89%	–57.05%	–40.34%	–31.44%	–5.84%	–4.13%	–3.22%	1.14%	3.04%	5.32%	1.71%	4.37%	6.08%
EGARCH (1,1) - T	–13.74%	–9.71%	–7.56%	–41.16%	–29.09%	–22.66%	–7.25%	–5.12%	–3.99%	0.57%	1.52%	3.80%	1.33%	2.47%	3.61%
EGARCH (1,1)-GED	–7.01%	–6.40%	–5.69%	–8.17%	–7.48%	–6.65%	–4.28%	–3.92%	–3.48%	2.85%	3.42%	4.94%	3.23%	3.42%	5.13%
APARCH (1,1) - N	–10.90%	–7.71%	–6.01%	–61.20%	–43.28%	–33.73%	–6.28%	–4.44%	–3.46%	0.95%	3.23%	5.70%	1.90%	4.56%	6.46%

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Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
APARCH (1,1) - T	–13.23%	–9.35%	–7.28%	–28.55%	–20.18%	–15.72%	–7.10%	–5.02%	–3.91%	0.57%	1.90%	3.61%	1.33%	2.66%	3.99%
APARCH (1,1)-GED	–6.63%	–6.05%	–5.38%	–21.50%	–19.68%	–17.49%	–3.37%	–3.07%	–2.72%	4.56%	4.94%	6.65%	5.32%	6.27%	7.22%
TARCH (1,1) - X - N	–11.30%	–7.99%	–6.23%	–71.31%	–50.43%	–39.30%	–5.99%	–4.23%	–3.30%	1.14%	3.04%	5.70%	1.71%	3.42%	6.08%
TARCH (1,1) - X - T	–17.14%	–12.11%	–9.43%	–69.88%	–49.39%	–38.46%	–9.79%	–6.92%	–5.39%	0.57%	1.14%	2.28%	0.76%	1.71%	2.66%
TARCH (1,1)-X-GED	–6.92%	–6.32%	–5.62%	–44.84%	–41.03%	–36.47%	–5.31%	–4.83%	–4.30%	3.23%	4.18%	5.70%	3.80%	4.37%	7.03%
RISK METRICS	–10.20%	–7.22%	–5.62%	–49.24%	–34.82%	–27.14%	–4.22%	–2.98%	–2.33%	1.71%	4.37%	7.79%	2.66%	5.51%	7.79%
HS(100) Long position	–22.36%	–5.78%	–3.91%	–61.12%	–9.53%	–5.30%	–4.76%	–2.84%	–2.07%	1.14%	6.46%	9.89%			
HS(250) Long position	–14.60%	–5.22%	–3.43%	–25.24%	–6.22%	–4.55%	–8.66%	–3.92%	–2.25%	0.95%	5.51%	12.17%			
HS(FS) Long position	–17.69%	–7.03%	–4.56%	–18.10%	–7.41%	–4.68%	–17.17%	–6.78%	–4.47%	0.38%	3.04%	7.41%			
HS(100) Short position	22.07%	6.07%	4.03%	7.23%	4.94%	2.47%	61.12%	8.89%	5.51%				1.33%	5.32%	11.03%
HS(250) Short position	11.71%	5.37%	3.92%	8.11%	4.32%	2.60%	15.59%	6.06%	4.80%				1.71%	6.08%	11.41%
HS(FS) Short position	14.41%	7.27%	5.06%	14.02%	7.08%	4.98%	14.54%	7.41%	5.24%				0.95%	3.23%	7.22%

Note: Table 14 represents out of sample observations. The number of observations is 526. * denotes each confidence level at 1%, 5% or 10%.

Table 15: Backtesting-TD3-One month price returns-Long positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1) - N	0.527	4.907**	12.571***		0.446	0.051		5.354*	12.622***	4.569	1.522	1.126
GARCH (1,1) - T	1.161	26.894***	59.319***							5.251	4.052	2.899
GARCH (1,1) - GED	24.365***	0.454	12.571***	0.074	0.000	0.051	24.439***	0.454	12.622***	5.979	0.804	0.777
IGARCH (1,1) - N	2.215	0.218	2.532		0.670	0.047		0.888	2.579	5.378	1.536	1.120
IGARCH (1,1) - T	1.243	3.086*	10.277***		0.217	0.561		3.303	10.838***	4.093	1.204	0.950
IGARCH (1,1) - GED	12.141***	2.351	18.027***	0.598	0.135	0.379	12.739***	2.486	18.406***	5.276	0.975	1.037
(GJR)TGARCH (1,1) - N	0.101	4.907**	12.571***		0.446	0.387		5.354*	12.958***	4.721	1.586	1.174
(GJR)TGARCH (1,1) - T	1.161	23.680***	52.327***			1.510			53.837***	5.097	3.988	2.849
(GJR)TGARCH (1,1) - GED	27.145***	0.782	9.231***	0.031	0.007	1.655	27.176***	0.789	10.886***	6.116	1.026	0.962
EGARCH (1,1) - N	0.101	4.907**	15.148***		0.446	0.203		5.354*	15.352***	3.571	0.805	0.690
EGARCH (1,1) - T			28.716***		2.658	0.074		20.878***	28.789***	2.268	1.369	1.150
EGARCH (1,1) - GED			18.027***	0.598	0.217	0.076	12.739***	3.303	18.104***	5.668	0.412	0.488
APARCH (1,1) - N			12.571***		0.320	0.387		4.256	12.958***	4.083	1.157	0.919
APARCH (1,1) - T			30.836***		1.836	0.135		15.622***	30.971***	1.770	0.951	0.908
APARCH (1,1) - GED			7.331***	0.010	0.076	1.083	36.073***	0.080	8.414**	6.144	0.551	0.537
TARCH (1,1) - X - N			12.571***		0.446	0.051		5.354*	12.622***	4.586	1.538	1.155
TARCH (1,1) - X - T			49.119***			1.229			50.348***	5.207	4.107	2.933
TARCH (1,1) - X - GED	16.671***	0.782	12.571***	0.320	0.007	0.909	16.992***	0.789	13.480***	5.665	0.265	0.311
RISK METRICS	2.215	0.454	3.052*		0.850	0.015		1.305	3.067	5.262	1.507	1.107
HS (100) Long position	0.101	2.181	0.008		1.394	3.033*		3.575	3.040	22.368	0.649	0.527
HS (250) Long position	0.013	0.283	2.586	4.578**	1.118	1.558	4.592	1.400	4.144	1.117	0.553	0.551
HS (FS) Long position	2.672	4.907**	4.253**		0.446	1.511		5.354*	5.764*	0.218	0.362	0.432

Table 15 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TD3 One month front Forward Freight Agreements prices for long positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 16. Backtesting-TD3-One month price returns-Short positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1) - N	3.412*	0.218	10.277***	1.836	2.563	1.942	5.249*	2.780	12.219***	3.639	1.772	1.303
GARCH (1,1) - T	0.332	13.786***	49.119***		1.836	1.229		15.622***	50.348***	5.893	4.201	2.915
GARCH (1,1) - GED	32.998***	0.283	7.331***	0.850	1.118	1.158	33.848***	1.400	8.488**	3.947	1.119	1.008
IGARCH (1,1) - N	10.077***	0.283	2.063	3.871**	2.969*	3.319*	13.948***	3.252	5.382*	4.044	1.751	1.270
IGARCH (1,1) - T	6.402**	0.454	5.675**	1.229	5.917**	6.255**	7.631**	6.372**	11.931***	2.864	1.327	1.036
IGARCH (1,1) - GED	19.123***	0.454	12.571***	5.419**	5.917**	11.296***	24.542***	6.372**	23.868***	3.259	1.076	1.081
(GJR)TGARCH (1,1) - N	2.215	0.782	9.231***	2.085	1.159	11.908***	4.299	1.940	21.139***	3.695	1.785	1.302
(GJR)TGARCH (1,1) - T	0.332	13.786***	43.203***		1.836	3.871**		15.622***	47.073***	5.798	4.175	2.892
(GJR)TGARCH (1,1) - GED	39.215***	0.525	8.249***	0.513	2.598	1.394	39.728***	3.123	9.643***	4.153	1.403	1.241
EGARCH (1,1) - N	2.215	0.454	10.277***	2.215	2.942*	0.561	4.430	3.396	10.838***	2.408	1.021	0.830
EGARCH (1,1) - T	0.527	8.631***	30.836***		4.421**	4.835**		13.052***	35.671***	1.846	1.448	1.167
EGARCH (1,1) - GED	16.671***	3.086*	16.549***	2.529	2.167	0.267	19.201***	5.254*	16.815***	3.256	0.406	0.426
APARCH (1,1) - N	3.412*	0.218	8.249***	1.836	2.563	1.394	5.249*	2.780	9.643***	2.928	1.330	1.019
APARCH (1,1) - T	0.527	7.246***	26.700***		3.871**	3.808*		11.116***	30.508***	1.104	0.951	0.844
APARCH (1,1) - GED	49.164***	1.668	4.936**	1.352	1.655	3.503*	50.516***	3.323	8.438**	3.722	0.644	0.580
TARCH (1,1) - X - N	2.215	3.086*	10.277***	2.215	2.167	1.942	4.430	5.254*	12.219***	3.584	1.755	1.285
TARCH (1,1) - X - T	0.332	15.890***	43.203***		2.215	3.871**		18.105***	47.073***	5.932	4.274	2.957
TARCH (1,1) - X - GED	24.365***	0.454	5.675**	1.550	0.850	0.757	25.915***	1.305	6.432**	3.601	0.653	0.612
RISK METRICS	10.077***	0.283	3.052*	3.871**	2.969*	4.177**	13.948***	3.252	7.229**	3.935	1.712	1.249
HS(100) Short position	0.527	0.113	0.598	9.618***	1.352	1.212	10.145***	1.465	1.810	22.717	0.522	0.546
HS(250) Short position	2.215	1.220	1.112	7.394***	0.001	2.817*	9.608***	1.221	3.928	0.855	0.571	0.543
HS(FS) Short position	0.013	3.936**	4.936**		2.529	0.026		6.465**	4.961*	0.234	0.362	0.427

Note: Table 16 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TD3 One month front Forward Freight Agreements prices for short positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 17. Value at Risk Statistics-TD3-three months price returns.

Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
GARCH (1,1) - N	–5.48%	–3.87%	–3.02%	–15.74%	–11.13%	–8.67%	–3.11%	–2.20%	–1.72%	2.28%	3.23%	6.46%	1.90%	4.56%	6.65%
GARCH (1,1) - T	–5.84%	–4.12%	–3.21%	–15.19%	–10.74%	–8.36%	–2.61%	–1.85%	–1.44%	1.90%	3.04%	5.32%	1.90%	3.99%	6.08%
GARCH (1,1) - GED	–4.02%	–3.68%	–3.27%	–13.45%	–12.32%	–10.95%	–3.04%	–2.77%	–2.46%	3.42%	4.56%	5.70%	3.80%	4.56%	5.70%
IGARCH (1,1) - N	–4.60%	–3.25%	–2.53%	–8.14%	–5.76%	–4.49%	–2.86%	–2.02%	–1.58%	2.85%	3.99%	7.41%	2.66%	6.46%	8.94%
IGARCH (1,1) - T	–4.65%	–3.29%	–2.56%	–8.83%	–6.24%	–4.86%	–2.71%	–1.92%	–1.49%	2.85%	3.80%	7.79%	2.66%	6.65%	8.94%
IGARCH (1,1)-GED	–3.33%	–3.04%	–2.71%	–5.54%	–5.08%	–4.51%	–2.18%	–1.99%	–1.77%	3.99%	4.94%	6.84%	6.08%	7.79%	8.56%
(GJR)TGARCH (1,1)-N	–5.44%	–3.85%	–3.00%	–14.73%	–10.42%	–8.12%	–3.04%	–2.15%	–1.68%	2.09%	3.42%	6.65%	1.90%	4.56%	6.84%
(GJR)TGARCH (1,1)-T	–17.59%	–12.43%	–9.68%	–41.75%	–29.51%	–22.98%	–7.61%	–5.38%	–4.19%	0.00%	0.19%	0.19%	0.00%	0.19%	0.57%
(GJR)TGARCH (1,1) - GED	–4.05%	–3.70%	–3.29%	–13.64%	–12.49%	–11.11%	–3.02%	–2.76%	–2.45%	3.42%	4.56%	5.70%	3.99%	4.75%	5.70%
EGARCH (1,1) - N	–5.37%	–3.79%	–2.96%	–11.68%	–8.26%	–6.44%	–2.55%	–1.80%	–1.40%	2.28%	3.23%	6.08%	1.90%	4.18%	7.03%
EGARCH (1,1) - T	–14.68%	–10.37%	–8.08%	–37.53%	–26.52%	–20.66%	–5.98%	–4.22%	–3.29%	0.00%	0.19%	0.19%	0.00%	0.38%	0.95%
EGARCH (1,1)-GED	–4.17%	–3.81%	–3.39%	–12.53%	–11.48%	–10.20%	–3.18%	–2.90%	–2.58%	3.04%	3.80%	4.94%	3.42%	4.37%	5.51%
APARCH (1,1) - N	–5.36%	–3.79%	–2.95%	–11.84%	–8.37%	–6.53%	–2.65%	–1.87%	–1.46%	2.28%	3.23%	6.46%	1.90%	4.37%	7.03%

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Model Type	Average Value at Risk			Minimum Value at Risk			Maximum Value at Risk			Hit Sequence Long Position			Hit Sequence Short Position		
	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*	1%*	5%*	10%*
APARCH (1,1) - T	–13.85%	–9.79%	–7.62%	–34.77%	–24.57%	–19.14%	–5.69%	–4.02%	–3.13%	0.00%	0.19%	0.76%	0.19%	0.38%	0.95%
APARCH (1,1)-GED	–3.77%	–3.44%	–3.06%	–13.84%	–12.68%	–11.27%	–2.59%	–2.36%	–2.10%	4.18%	5.13%	6.65%	4.75%	5.13%	6.84%
TARCH (1,1) - X - N	–5.45%	–3.86%	–3.01%	–14.72%	–10.41%	–8.11%	–3.01%	–2.13%	–1.66%	2.09%	3.42%	6.65%	1.90%	4.56%	6.84%
TARCH (1,1)-X-GED	–3.87%	–3.54%	–3.15%	–9.91%	–9.08%	–8.07%	–2.55%	–2.33%	–2.07%	3.42%	4.37%	5.70%	4.18%	5.13%	6.27%
RISK METRICS	–4.72%	–3.33%	–2.60%	–13.05%	–9.23%	–7.20%	–1.71%	–1.21%	–0.94%	2.85%	4.75%	7.79%	3.04%	5.70%	8.75%
HS(100) Long position	–6.45%	–3.26%	–2.16%	–9.91%	–5.65%	–3.08%	–3.08%	–1.36%	–1.22%	1.33%	6.08%	10.27%			
HS(250) Long position	–6.47%	–2.96%	–1.93%	–7.67%	–4.08%	–2.82%	–4.88%	–2.53%	–1.32%	1.14%	6.27%	12.17%			
HS(FS) Long position	–9.03%	–4.51%	–2.92%	–9.36%	–4.88%	–3.06%	–8.43%	–4.31%	–2.82%	0.19%	2.66%	6.65%			
HS(100) Short position	7.96%	3.47%	2.38%	3.67%	2.38%	1.32%	16.99%	7.20%	3.45%				1.33%	5.70%	10.27%
HS(250) Short position	5.94%	3.17%	2.07%	4.83%	2.47%	1.36%	8.62%	3.67%	2.74%				1.33%	6.27%	11.41%
HS(FS) Short position	9.02%	4.50%	2.83%	8.59%	4.34%	2.72%	9.18%	4.65%	2.93%				0.57%	3.04%	7.98%

Note: Table 17 represents out of sample observations. The number of observations is 526. * denotes each confidence level at 1%, 5% or 10%.

Table 18. Backtesting-TD3-three months price returns-Long positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1) - N	6.402**	3.936**	8.249***		0.320	0.022		4.256	8.271**	0.722	0.114	0.074
GARCH (1,1) - T	3.412*	4.907**	15.148***		0.446	0.175		5.354*	15.323***	0.642	0.119	0.087
GARCH (1,1) - GED	19.123***	0.218	12.571***	0.217	0.010	0.387	19.340***	0.228	12.958***	1.188	0.094	0.070
IGARCH (1,1) - N	12.141***	1.204	4.253**	0.598	1.289	0.004	12.739***	2.493	4.257	0.910	0.102	0.043
IGARCH (1,1) - T	12.141***	1.726	3.052*	0.598	0.074	0.015	12.739***	1.799	3.067	0.901	0.104	0.046
IGARCH (1,1) - GED	27.145***	0.004	6.473**	1.289	0.379	0.125	28.434***	0.383	6.598**	1.488	0.122	0.036
(GJR)TGARCH (1,1) - N	4.814**	3.086*	7.331***		0.217	0.057		3.303	7.388**	0.724	0.109	0.070
(GJR)TGARCH (1,1) - N		45.321***	100.705***							6.000	4.340	3.012
(GJR)TGARCH (1,1) - T	19.123***	0.218	12.571***	0.217	0.010	0.387	19.340***	0.228	12.958***	1.180	0.095	0.074
(GJR)TGARCH (1,1) - GED	6.402**	3.936**	10.277***		0.320	0.001		4.256	10.278***	0.697	0.088	0.055
EGARCH (1,1) - N		45.321***	100.705***							3.337	2.625	1.879
EGARCH (1,1) - GED	14.342***	1.726	18.027***		0.074	0.076		1.799	18.104***	1.092	0.058	0.054
APARCH (1,1) - N	6.402**	3.936**	8.249***		0.320	0.022		4.256	8.271**	0.702	0.088	0.055
APARCH (1,1) - T		45.321***	81.415***							2.675	2.185	1.583
APARCH (1,1) - GED	30.024***	0.019	7.331***	0.007	0.133	0.057	30.031***	0.152	7.388**	1.316	0.126	0.076
TARCH (1,1) - X - N	4.814**	3.086*	7.331***		0.217	0.057		3.303	7.388**	0.721	0.109	0.070
TARCH (1,1) - X - T										2.857	0.801	0.404
TARCH (1,1) - X - GED	19.123***	0.454	12.571***	0.217	0.000	0.051	19.340***	0.454	12.622***	1.254	0.099	0.062
RISK METRICS	12.141***	0.069	3.052*	0.598	0.513	0.600	12.739***	0.582	3.652	0.985	0.152	0.076
HS(100) Long position	0.527	1.220	0.041		0.561	0.044		1.781	0.085	0.417	0.123	0.071
HS(250) Long position	0.101	1.668	2.586		0.003	0.110		1.671	2.696	0.310	0.121	0.081
HS(FS) Long position	5.234**	7.246***	7.331***			0.057			7.388**	0.010	0.010	0.020

Note: Table 18 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TD3 Three months front Forward Freight Agreements prices for long positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.

Table 19. Backtesting-TD3-three months price returns-Short positions.

Model Type	KUC			Ch.In.			J.T.			Q.L.F.		
	1%	5%	10%	1%	5%	10%	1%	5%	10%	1%	5%	10%
GARCH (1,1) - N	3.412*	0.218	7.331***		0.010	0.203		0.228	7.534**	0.822	0.130	0.092
GARCH (1,1) - T	3.412*	1.204	10.277***		0.031	0.561		1.235	10.838***	0.729	0.134	0.106
GARCH (1,1) - GED	24.365***	0.218	12.571***	0.074	0.010	0.387	24.439***	0.228	12.958***	1.328	0.115	0.089
IGARCH (1,1) - N	10.077***	2.181	0.685	0.777	0.301	0.172	10.854***	2.482	0.856	1.044	0.131	0.069
IGARCH (1,1) - T	10.077***	2.757*	0.685	0.777	1.158	0.172	10.854***	3.915	0.856	1.033	0.132	0.071
IGARCH (1,1) - GED	63.476***	7.445***	1.277	0.561	1.042	0.376	64.037***	8.487**	1.653	1.621	0.153	0.061
(GJR)TGARCH (1,1) - N	3.412*	0.218	6.473**		0.670	0.125		0.888	6.598**	0.821	0.125	0.087
(GJR)TGARCH (1,1) - T		45.321***	87.040***							5.760	4.269	3.016
(GJR)TGARCH (1,1) - GED	27.145***	0.069	12.571***	0.031	0.035	0.387	27.176***	0.104	12.958***	1.316	0.116	0.092
EGARCH (1,1) - N	3.412*	0.782	5.675**		0.007	0.757		0.789	6.432**	0.803	0.108	0.076
EGARCH (1,1) - T		39.457***	76.301***					39.457***	76.301***	3.177	2.574	1.883
EGARCH (1,1) - GED	19.123***	0.454	13.823***	0.217	0.000	0.104	19.340***	0.454	13.927***	1.230	0.082	0.076
APARCH (1,1) - N	3.412*	0.454	5.675**		0.000	0.757		0.454	6.432**	0.807	0.109	0.077
APARCH (1,1) - T	5.234**	39.457***	76.301***				5.234*	39.457***	76.301***	2.536	2.140	1.592
APARCH (1,1) - GED	39.215***	0.019	6.473**	0.035	0.133	1.261	39.251***	0.152	7.735**	1.459	0.150	0.094
TARCH (1,1) - X - N	3.412*	0.218	6.473**		0.670	0.125		0.888	6.598**	0.818	0.125	0.088
TARCH (1,1) - X - T										1.473	0.486	0.293
TARCH (1,1) - X - GED	30.024***	0.019	9.231***	0.007	0.267	0.420	30.031***	0.286	9.651***	1.392	0.121	0.081
RISK METRICS	14.342***	0.525	0.957		0.051	0.342		0.576	1.299	1.101	0.176	0.096
HS(100) Short position	0.527	0.525	0.041		2.598	1.212		3.123	1.253	0.572	0.108	0.077
HS(250) Short position	0.527	1.668	1.112		1.655	0.795		3.323	1.907	0.579	0.131	0.097
HS(FS) Short position	1.161	4.907**	2.532		2.930*	0.842		7.838**	3.374	0.009	0.031	0.051

Note: Table 19 represents out of sample observations. The number of observations is 526. The table represents statistical tests of unconditional, independent and conditional coverage of the interval forecasts under each approach and Loss Function scores for the TD3 Three months front Forward Freight Agreements prices for short positions. Where, KUC (Kupiec Unconditional Coverage Test), Ch.In. (Christoffersen Independence Test), J.T. (Joint Test for conditional coverage), Q.L.F. (Quintile Loss Function). *, ** and *** denote significance level at 10%, 5% and 1%. Critical values for Ch.In. are 9.21, 5.99 and 4.6 for 1%, 5%, 10% significance level respectively. Critical values for J.T. are 6.63, 3.84 and 2.7 for 1%, 5%, 10% significance level respectively. If value of the likelihood ratio is larger than the critical value, the VaR model is rejected at the significance level.