Chapter 5 Analysis

5.1 Results for Objective 1

5.1.1 Stationarity Test results

Model	HH		JCC		Critical value	Critical value
	Test Statistic					
	Level	1st Difference	Level	1st Difference	1%	5%
Augmented Dickey-Fuller	-2.283433	-11.75332**	-3.238324*	-5.809203**	-3.48655	-2.88607
Kwiatkowski-Phillips-Schmidt-Shin	0.995836**	0.039270	0.587279**	0.116851	0.739	0.463

Table 5.1 Stationarity results for objective 1

The estimated values of parameters of HH and JCC, reported by various test statistics are found stationary. At first difference, the ADF test statistics of HH and JCC exceed the critical values of 1% level of significance. KPSS test statistics of HH and JCC are not found significant. Hence, the null hypotheses of unit roots in the intercepts are rejected and all the variables are said to be stationary.

5.1.2 Descriptive statistics for Henry Hub prices

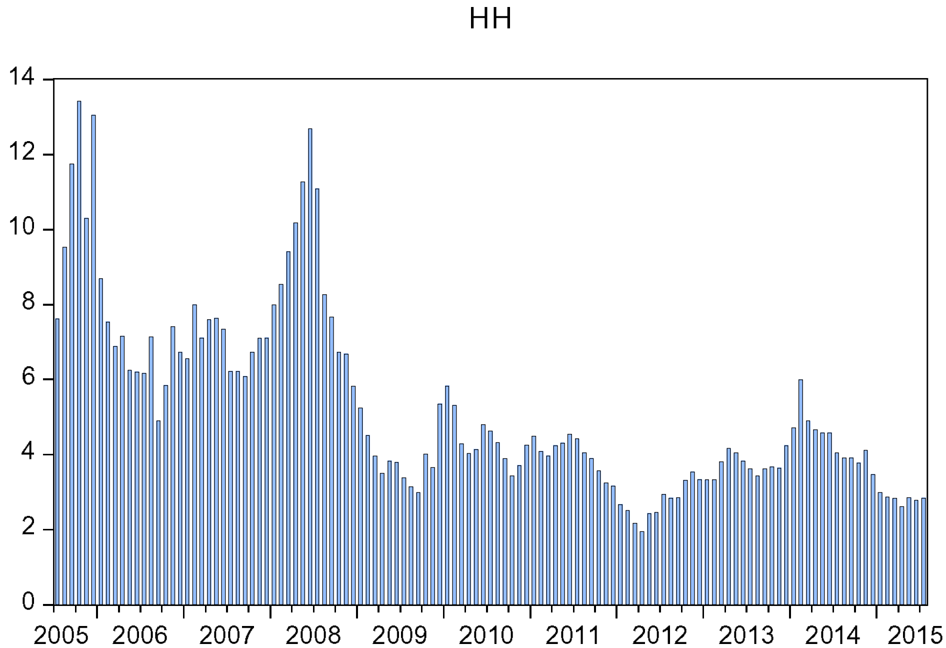

Figure 5.1 Descriptive statistics graph for Henry Hub prices (HH)

HH	
Mean	5.247438
Median	4.290000
Maximum	13.42000
Minimum	1.950000
Std. Dev.	2.457032
Skewness	1.324366
Kurtosis	4.429482
Jarque-Bera	45.67347
Probability	0.000000
Sum	634.9400
Sum Sq. Dev.	724.4407
Observations	120

Table 5.2 Descriptive statistics for Henry Hub prices (HH)

From the above value of skewness of 1.324366 it shows that the distribution of Henry Hub prices is asymmetric with a tail to the right implying positively skewed distribution. This is substantiated by the fact that value of skewness is greater than 1.

The value of Kurtosis which is positive shows that the distribution of Henry Hub prices is more peaked than a Gaussian distribution. The distribution is leptokurtic as it is excess of 1.43 than 3 and hence tails are longer and fatter. The central peak is higher and sharper than a normal distribution.

5.1.3 Henry Hub Price Volatility

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Mean Equation				
C	0.370154	0.127855	2.895101	0.0038**
P (-1)	0.900277	0.029237	30.79191	0.0000**
Variance Equation				
C	0.030034	0.015739	1.908259	0.0564
RESID (-1)^2	0.388105	0.160959	2.411199	0.0159*
GARCH (-1)	0.548804	0.109240	5.023822	0.0000**
R-squared	0.862568	Mean dependent var		5.247647
Adjusted R-squared	0.861393	S.D. dependent var		2.458069
S.E. of regression	0.915137	Akaike info criterion		1.930083
Sum squared resid	97.98475	Schwarz criterion		2.046852
Log likelihood	-109.8399	Hannan-Quinn criteria.		1.977499
Durbin-Watson stat	1.916150			

Table 5.3 GARCH (HH)- Henry Hub Volatility

From table 5.3, the Henry hub Volatility P_t is assumed to be a return. The first equation suggests that the mean return is dependent upon the risk. As the parameter, P_{t-1} is positive and significant at 1% level. Hence, it is concluded that the mean return increases when there is a greater risk.

The ARCH terms indicate the short-run persistence of shocks whereas the GARCH term represents the contribution of shocks to long run persistence. $\beta+\gamma$ is a measure of the persistence of volatility clustering. Where $\alpha < 0$, $\beta \geq 0$, $\gamma \geq 0$ are required to ensure that the conditional variance is never negative.

The results of GARCH (1,1) Model in the table 5.3 reveal that ARCH term e_{t-1}^2 (i.e. RESID (-1)^2) and GARCH term h_{t-1} (ie. GARCH (-1)) are statistically significant at the 5% and 1% level respectively. The statistical significance of the coefficient α is very close to 5 % level. Hence, the volatility clustering in GARCH (1,1) model is almost a presence. Furthermore, the significance of both $\alpha$and β it indicates that, lagged conditional variance and lagged squared disturbance have an impact on the conditional variance, in other words, this means that news about volatility from the previous periods have an explanatory power on current volatility.

For HH, the sum of the ARCH and GARCH coefficients (0.936909) is very close to one, which is required to have a mean reverting variance process, indicating that volatility shocks are quite persistent.

5.1.4 Descriptive statistics for Japanese Crude cocktail prices (JCC)

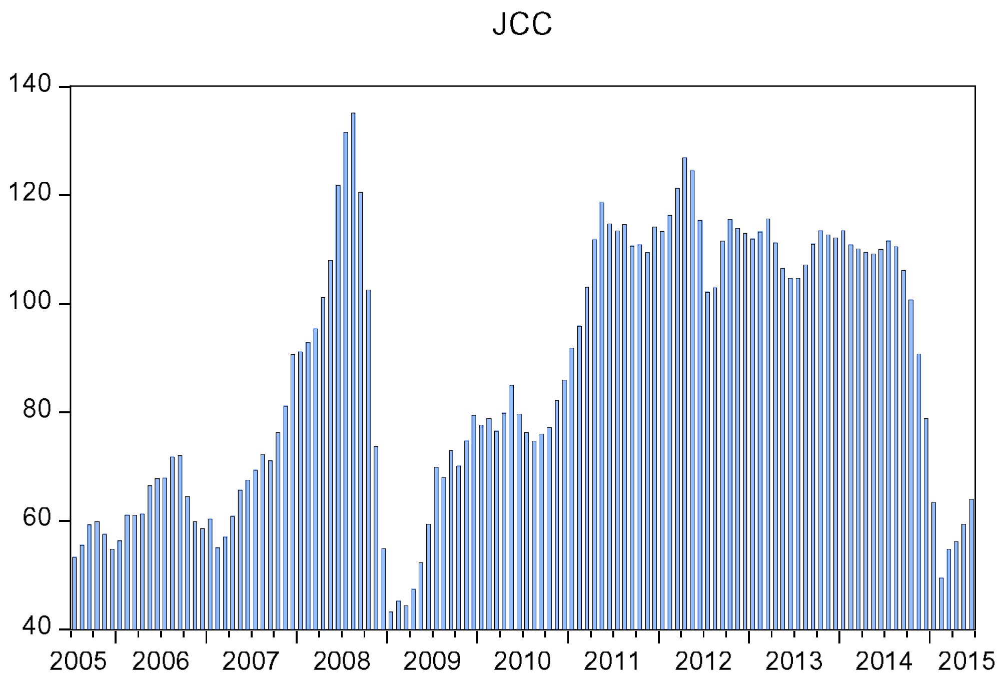

Figure 5.2 Descriptive statistics graph for Japanese Crude Cocktail prices (JCC)

JCC	
Mean	87.19125
Median	83.61876
Maximum	135.1454
Minimum	43.17232
Std. Dev.	24.39576
Skewness	-0.019746
Kurtosis	1.619085
Jarque-Bera	9.542434
Probability	0.008470
Sum	10462.95
Sum Sq. Dev.	70823.20
Observations	120

Table 5.4 Descriptive statistics for Japanese Crude Cocktail prices (JCC)

From the negative value of skewness which is -0.019746 means that the left of the tail is longer and the mass of the distribution concentrated to the right. The Japanese crude cocktail prices are symmetric in nature.

The value of Kurtosis is 1.619085 which is less than 3 which suggests that the distribution is platykurtic where there are flatter tails.

5.1.5 Japanese Crude Cocktail Price Volatility

Variable	Coefficient	Std. Error	z-statistic	Prob.
	Mean Equation			
C	4.870243	0.847113	5.749221	0.0000**
JCC (-1)	0.954779	0.010244	93.20425	0.0000**
	Variance Equation			
C	5.955400	2.001936	2.974820	0.0029*
RESID (-1)^2	0.799057	0.175965	4.540994	0.0000**
GARCH (-1)	0.119484	0.096588	1.237041	0.2161
R-squared	0.933266	Mean dependent var		87.47622
Adjusted R-squared	0.932696	S.D. dependent var		24.29751
S.E. of regression	6.303511	Akaike info criterion		5.921170
Sum squared resid	4648.907	Schwarz criterion		6.037940
Log likelihood	-347.3096	Hannan-Quinn criterion		5.968587
Durbin-Watson stat	0.682295			

Table 5.5 GARCH (JCC) Japanese Crude Cocktail Volatility

From the table 5.5 Input (JCC) is assumed to be a return. The first equation suggests that the mean return is dependent upon the risk. As the parameter InP_{t-1} is positive and significant at 1% level, it is concluded that the mean return increases when there is a greater risk.

The results of GARCH (1,1) model in above table reveal that the first two coefficients α (constant) and ARCH term e_{t-1}^2 are statistically significant at 1%. GARCH term h_{t-1} is found significant at 5% level. The statistical significance of the coefficient α is the presence of volatility clustering in GARCH (1,1) model.

Furthermore, the significance of α indicates that, lagged conditional variance has an impact on the conditional variance and β indicates that lagged squared disturbance did not have an impact on conditional variance, in other words; news about volatility from the previous periods had not an explanatory power on current volatility. And the results confirm the only persistence of short run *and* GARCH term h_{t-1} i.e. GARCH (-1)) confirms that there are no long-run shocks.

For HH, the sum of the ARCH and GARCH coefficients (0.918541) is very close to one, which is required to have a mean reverting variance process, indicating that volatility shocks are quite persistent.

5.1.6 Heteroskedasticity

Heteroskedasticity Test for HH			
F-statistic	0.369898	Prob. F (1,116)	0.5442
Obs*R-squared	0.375079	Prob. Chi-Square (1)	0.5402

Table 5.6 Heteroskedasticity test for Henry Hub

Heteroskedasticity Test for JCC			
F-statistic	0.117178	Prob. F (1,116)	0.7327
Obs*R-squared	0.119078	Prob. Chi-Square (1)	0.73

Table 5.7 Heteroskedasticity test for Japanese Crude Cocktail (JCC)

From table 5.6 and table 5.7, the results of the residuals for evidence of heteroscedasticity are given in above tables ARCH LM (k) is the portmanteau test; statistics testing the null hypothesis of no ARCH effect in the estimated squared residuals for lags 1 to k. The test *p*-values do not reject the null hypothesis which confirms that *there is no ARCH effect.*

5.1.7 Autocorrelation

Autocorrelation Test for HH				
Lags	AC	PAC	Q-Stat	Prob*
1	0.097	0.097	1.1507	0.283
2	0.006	-0.004	1.1545	0.561
3	-0.094	-0.095	2.2491	0.522
4	-0.006	0.013	2.253	0.689
5	-0.001	-0.001	2.2532	0.813
6	0.102	0.095	3.5715	0.734
7	-0.062	-0.083	4.0681	0.772
8	-0.062	-0.051	4.5627	0.803
9	-0.194	-0.169	9.4677	0.395
10	-0.086	-0.067	10.449	0.402

Table 5.8 Autocorrelation test for Henry Hub

Autocorrelation Test for JCC				
Lags	AC	PAC	Q-Stat	Prob*
1	0.032	0.032	0.1229	0.726
2	0.081	0.08	0.931	0.628
3	-0.015	-0.02	0.9603	0.811
4	0.014	0.009	0.9854	0.912
5	0.07	0.073	1.603	0.901
6	0.011	0.005	1.6195	0.951
7	-0.081	-0.093	2.4548	0.93
8	0.04	0.047	2.6577	0.954
9	0.015	0.026	2.6866	0.975
10	0.031	0.013	2.8103	0.986

Table 5.9

Autocorrelation results for HH and JCC are given on the tables 5.8 and 5.9. The Q test statistics for the null hypothesis of 'no serial correlation' of up to the k-order lag in returns has not been rejected. This confirms that *there is no serial correlation* in HH and JCC.

5.1.8 EGARCH Results

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Mean Equation				
C	0.363711	0.122802	2.961773	0.0031**
HH (-1)	0.907486	0.028570	31.76327	0.0000**
Variance Equation				
C (3)	-0.620213	0.165118	-3.756173	0.0002**
C (4)	0.507633	0.167268	3.034842	0.0024**
C (5)	0.287720	0.102000	2.820783	0.0048**
C (6)	0.842287	0.058854	14.31149	0.0000**
R-squared	0.864021	Mean dependent var		5.247647
Adjusted R-squared	0.862858	S.D. dependent var		2.458069
S.E. of regression	0.910288	Akaike info criterion		1.893695
Sum squared resid	96.94899	Schwarz criterion		2.033819
Log likelihood	-106.6749	Hannan-Quinn criterion.		1.950595
Durbin-Watson stat	1.950924			

Table 5.10 EGARCH results for Henry Hub prices

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Mean equation				
C	5.098874	1.635023	3.118533	0.0018
JCC (-1)	0.952453	0.017321	54.98764	0.0000
Variance Equation				
C (3)	0.058086	0.321016	0.180944	0.8564
C (4)	1.124639	0.294749	3.815588	0.0001
C (5)	0.011493	0.165131	0.069600	0.9445
C (6)	0.685382	0.103696	6.609541	0.0000
R-squared	0.933152	Mean dependent var		87.47622
Adjusted R-squared	0.932580	S.D. dependent var		24.29751
S.E. of regression	6.308915	Akaike info criterion		5.936034
Sum squared resid	4656.882	Schwarz criterion		6.076158
Log likelihood	-347.1940	Hannan-Quinn criterion.		5.992934
Durbin-Watson stat	0.679696			

Table 5.11 EGARCH results for Japanese Crude Cocktail prices

The results of E-GARCH models used in table 5.10 & 5.11 whether negative shocks imply a higher next period conditional variance than positive shocks of the same sign and the existence of leverage effects in the returns of the HH and JCC prices during the study period.

The EGARCH (1,1) model estimated for the returns of HH in Table 5.10 shows that all the estimated coefficients for all periods are statistically significant at 1% confidence level. If the asymmetry term is negative, it implies that the negative shocks have a greater impact on volatility rather than the positive shocks of the same magnitude. The significance of negative shocks persistence or the volatility asymmetry indicates that investors are more likely to the negative news in comparison to the positive news. This implies that the volatility spillover mechanism is asymmetric. However, the asymmetric (leverage) effect captured by the parameter estimates C (5) is also a statistically significant positive sign, indicate the condition that volatility tends to have a positive shock with the same magnitude.

This may be due to the asymmetric (leverage) effect in JCC price mechanism captured by the parameter estimate C (5) is not statistically significant with a positive sign, indicate that the existence of leverage effect is not observed in returns of the JCC price mechanism during the sample period.

5.2 Results for Objective 2

5.2.1 Unit root test results

The Estimated values of parameters of Long Term Charter rates (LT) and Short Term Charter rates (ST) found by various test statistics are stationary.

At the first difference, Augmented Dicky Fuller test statistics of LT and ST exceed the critical values of 1% level of significance. Therefore, the null hypothesis of unit roots in the intercepts are rejected and all the variables are said to be stationary.

Model	LT		ST		Critical value	Critical value
	Test Statistic					
	Level	1st Diff	Level	1st Diff	1%	5%
ADF	-1. 361773	-10. 28399**	-1.688	-11.02246**	-3.48655	-2.88607
KPSS	1.077322**	0.259014	0.323	0.129113	0.739	0.463

5.12 Stationarity test results for Long term and Short Term Charter rates

From the above table 5.12, the estimated values of parameters of LT and ST, reported by various test statistics are found stationary. At first difference, the Augmented Dickey Fuller, test statistics of LT and ST exceed the critical values of 1% level of significance. KPSS test statistics of LT and ST are not found significant. Hence, the null hypotheses of unit roots in the intercepts are rejected and all the variables are said to be stationary.

5.2.2 Descriptive statistics for Long Term Charter rates

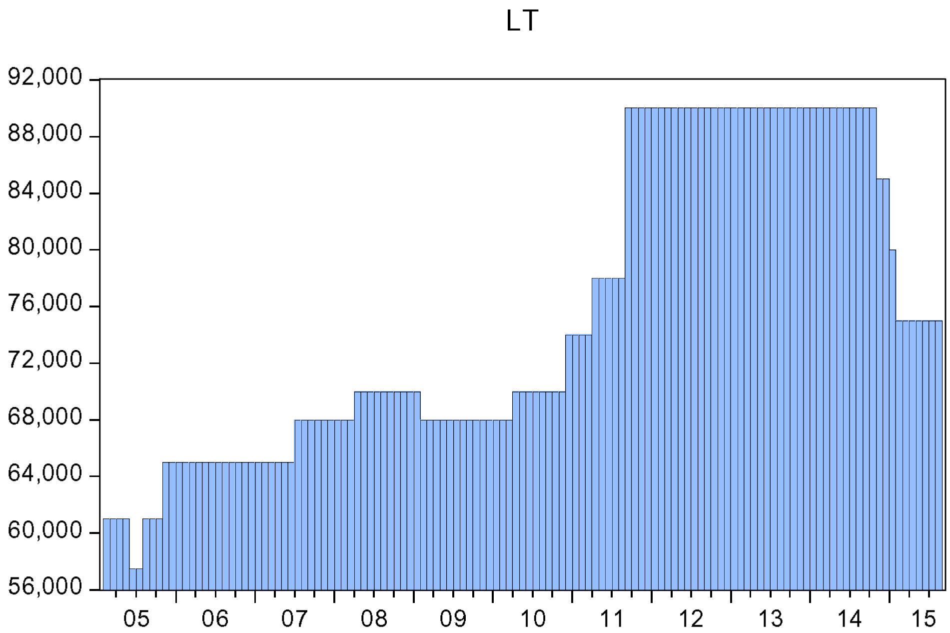

Figure 5.3 Descriptive statistics graph for Long Term Charter rates (LT)

LT	
Mean	75173.23
Median	70000.00
Maximum	90000.00
Minimum	57500.00
Std. Dev.	10683.65
Skewness	0.411425
Kurtosis	1.609676
Jarque-Bera	13.81169
Probability	0.001002
Sum	9547000.
Sum Sq. Dev.	1.44E+10
Observations	127

Table 5.13 Descriptive statistics for Long Term Charter Rates

The value of skewness for Long Term Charter rates is 0.411425 which is between -0.5 and +0.5 shows that the series has variation and is symmetric.

The value of Kurtosis is 1.609676 which is less than 3 indicates that the series is platykurtic where compared to normal distribution the central peak is lower and broader.

5.2.3 Descriptive Statistics for Short Term Charter Rates

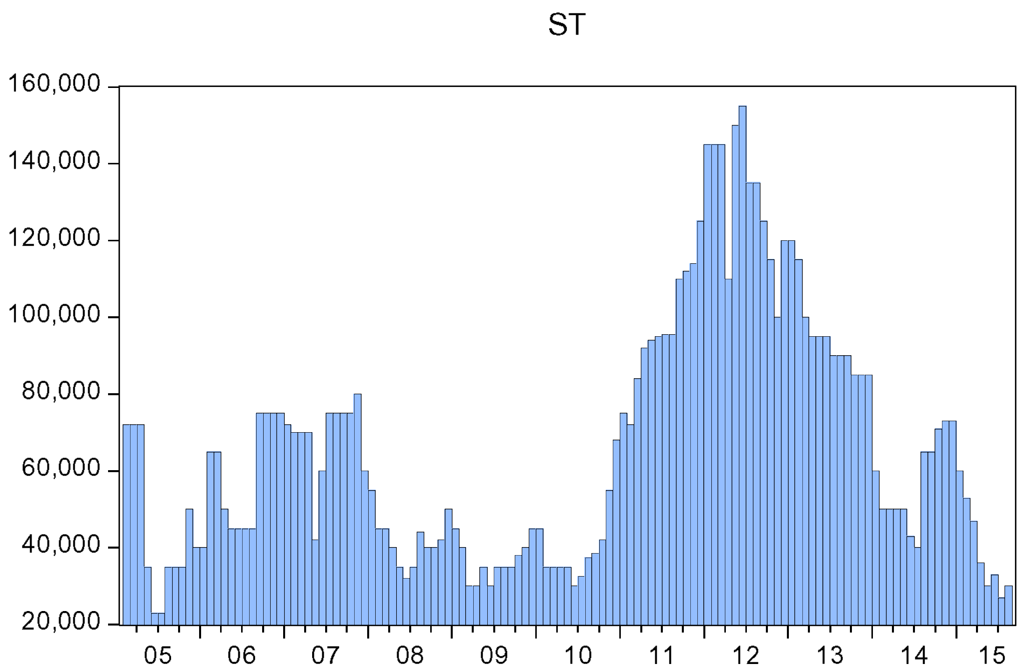

Figure 5.4 Descriptive statistics for Short term charter rates (ST)

ST	
Mean	65673.23
Median	60000.00
Maximum	155000.0
Minimum	23000.00
Std. Dev.	32156.20
Skewness	0.909789
Kurtosis	3.033842
Jarque-Bera	17.52606
Probability	0.000156
Sum	8340500.
Sum Sq. Dev.	1.30E+11
Observations	127

Table 5.14 Descriptive Statistics for Short Term Charter Rates

The data of Short term charter rates shows that the value of skewness is 0.909789 which indicates that the data is moderately skewed.

The value of Kurtosis is 3.033842 which is close to 3 suggests the distribution mesokurtic and has a normal distribution.

5.2.4 EGARCH analysis

Mean equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C (1)	0.002658	0.006375	0.417014	0.6767
C (2)	3.516148	0.219121	16.04663	0.0000
Variance Equation				
C (3)	-1.628862	0.239941	-6.788593	0.0000
C (4)	-1.144609	0.151818	-7.539346	0.0000
C (5)	-0.600834	0.150222	-3.999630	0.0001
C (6)	0.397008	0.063676	6.234799	0.0000
R-squared	0.077332	Mean dependent var		-0.006948
Adjusted R-squared	0.069892	S.D. dependent var		0.174884
S.E. of regression	0.168662	Akaike info criterion		-0.947213
Sum squared resid	3.527421	Schwarz criterion		-0.812151
Log likelihood	65.67439	Hannan-Quinn criter.		-0.892341
Durbin-Watson stat	1.978624			

Table 5.15 EGARCH results of Short Term Charter rate

Mean equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C (1)	-0.031343	0.003773	-8.307146	0.0000
C (2)	0.103462	0.000865	119.5600	0.0000
Variance Equation				
C (3)	-1.964220	0.046093	-42.61395	0.0000
C (4)	-0.864251	0.114287	-7.562097	0.0000
C (5)	-0.428848	0.021153	-20.27322	0.0000
C (6)	0.516623	0.004691	110.1221	0.0000
R-squared	-2.947963	Mean dependent var		0.001640
Adjusted R-squared	-2.979801	S.D. dependent var		0.020529
S.E. of regression	0.040954	Akaike info criterion		-3.408618
Sum squared resid	0.207978	Schwarz criterion		-3.273557
Log likelihood	220.7430	Hannan-Quinn criter.		-3.353747
Durbin-Watson stat	0.662800			

Table 5.16 EGARCH results of Long term charter rates

The first part of the table 5.15 & 5.16 shows the results of mean equation of EGARCH model which clearly prove that both the LT and ST charter rates have bidirectional positive impact at 1% level of significance. The second part of EGARCH (1,1) model estimated for the log returns of LT and ST charter rates in above Tables 2 and 3 shows that variance equation results in which all the estimated coefficients for all periods are statistically significant at 1% confidence level. If the asymmetry term, C (5) is negative, it implies that the negative shocks have a greater impact on volatility rather than the positive shocks of the same magnitude. The significance of negative shocks persistence or the volatility asymmetry indicates that vessel owners are more likely to the negative news in comparison to the positive news. This implies that the volatility spillover mechanism is asymmetric. The asymmetric (leverage) effect captured by the parameter estimates C (5) in both the rates are also a statistically significant with negative signs, indicate the condition that volatility tends to have a negative shock i.e. an unexpected drop in Long term and Short term charter rates tend to increase volatility more than an unexpected increase of the same magnitude.

5.2.5 Heteroskedasticity

	LT			ST		
	Lag 4	Lag 8	Lag 12	Lag 4	Lag 8	Lag 12
F-Statistic	2.265382	1.440444	0.865003	0.458843	0.655952	0.954673
Prob. F	0.0663	0.1879	0.5844	0.6331	0.7289	0.4968
Obs*R-squared	8.769579	11.28227	10.6242	0.933359	5.419969	11.61335
Prob. Chi-Squared	0.0671	0.1862	0.5614	0.6271	0.7119	0.4772

Table 5.17 Heteroskedasticity Test for Long Term and Short Term Charter rates

From the table 5.17, the results of residuals for the evidence of heteroscedasticity are given in the above tables. ARCH LM(k) is the portmanteau test, statistics testing the null hypothesis of no ARCH effect in the estimated squared residuals for lags 1 to k. The test p-values do not reject the null hypothesis which confirms that there is no ARCH effect.

5.2.6 Q test

	LT				ST			
	AC	PAC	Q-Stat	Prob*	AC	PAC	Q-Stat	Prob*
1	-0.007	0.01	16.848	0.112	0.03	0.03	0.1187	0.73
2	-0.005	0.001	16.852	0.155	-0.082	-0.08	0.9928	0.609
3	-0.03	-0.05	16.977	0.2	0.018	0.023	1.0335	0.793
4	-0.043	-0.029	17.239	0.244	0.031	0.023	1.1574	0.885
5	-0.028	0.006	17.357	0.298	-0.117	-0.12	2.9875	0.702
6	-0.029	-0.025	17.477	0.355	-0.128	-0.12	5.187	0.52
7	0.032	0.064	17.625	0.413	0.044	0.032	5.4436	0.606
8	0.025	-0.021	17.72	0.474	-0.237	-0.27	13.142	0.107
9	0.012	0.015	17.743	0.54	-0.11	-0.09	14.834	0.096
10	0.027	0.027	17.851	0.597	0.053	0.006	15.218	0.124
11	-0.3	-0.066	17.989	0.65	0.064	0.013	15.797	0.149
12	-0.057	-0.027	18.487	0.677	0.148	0.172	18.899	0.091
13	-0.005	0.041	18.491	0.73				
14	-0.017	-0.042	18.536	0.776				
15	-0.076	-0.053	19.457	0.775				
16	-0.066	-0.028	20.164	0.784				

Table 5.18 Q Test results of Long Term and Short Term charter rates

Autocorrelation results for LT and ST are given in above table 5. The Q test statistics for the null hypothesis of "no serial correlation" of up to the k-order lag in returns has not been rejected. This confirms that there is no serial correlation in LT and ST.

5.3 Results for Objective 3

5.3.1 Unit Root Test results

ADF Test Statistic	-11.1455
Critical Value (99%)	-2.575829
Critical Value (95%)	-1.959964
Z – Lag 1 Coefficient	-1.00494
Standard Error	0.09017
t value	-11.15
Pr(>|t|)	<2e-16
Residual standard error	0.01798 on 123 degrees of freedom
Multiple R-squared	0.5025
Adjusted R-squared	0.4984
KPSS Test Statistic	
Value of test-statistic	0.1375
Critical Value (99%)	0.739
Critical Value (95%)	0.463

Table 5.19 Unit Root test results of New Ship Building Prices

5.3.1.1 Augmented Dicky Fuller Test results

ADF test goes with a null hypothesis that $|\varphi| = 1$ and the time series is not stationary. If the value of the statistic < 99% critical value, then the series is stationary. If the value of the statistics exceeds those critical values, then the series is not stationary. In this case, the ADF test statistic value is < Critical value at 99% indicating that all the is stationary. The same is confirmed through p-value (<2e-16).

5.3.1.2 Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test

Null hypothesis is Stationarity. If the value of the test statistic < Critical value, the series is stationary. In this case, the value of the test statistic < Critical value for 99% as well as 95% indicating that all the series is stationary

Hence it can be quite comfortably concluded that the time series data is stationary.

5.3.2 Descriptive Statistics for New Ship Building Prices

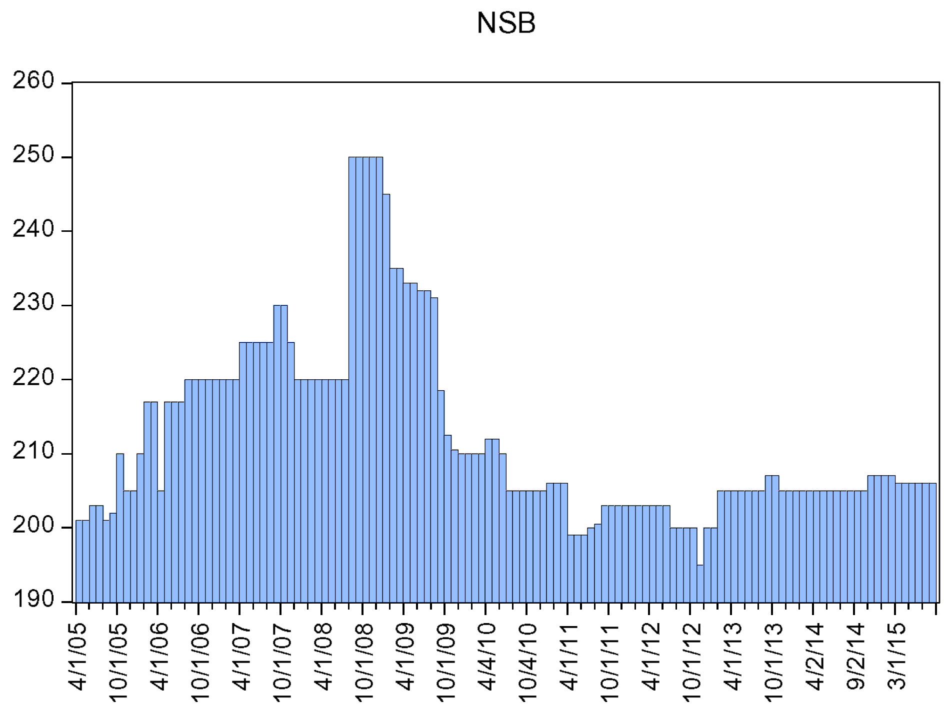

Figure 5.5 Descriptive statistics graph for New Ship Building prices for LNG

NSB	
Mean	212.3095
Median	206.0000
Maximum	250.0000
Minimum	195.0000
Std. Dev.	12.50534
Skewness	1.397364
Kurtosis	4.477682
Jarque-Bera	52.46874
Probability	0.000000
Sum	26751.00
Sum Sq. Dev.	19547.93
Observations	127

Figure 5.20 Descriptive Statistics for New Ship Building prices of LNG

From the above value of skewness of 1.397364 it shows that the distribution of New Ship building prices is asymmetric with a tail to the right implying positively skewed distribution. This is substantiated by the fact that value of skewness is greater than 1.

The value of Kurtosis which is positive shows that the distribution of New Ship building prices is more peaked than a Gaussian distribution. The distribution is leptokurtic as it is excess of 1.47 than 3 and hence tails are longer and fatter. The central peak is higher and sharper than a normal distribution

5.3.3 Volatility clustering, Autocorrelation, Persistence

Volatility clustering is a phenomenon where there are relative calm periods and periods of high volatility. This situation is very much a universal attribute of market data. GARCH (Generalized Auto Regressive Conditional Heteroscedasticity) is used to model volatility clustering. The GARCH view is that volatility spikes upwards and then falls until there is another spike. The estimation of a GARCH model is mostly about estimating how fast the downturn is. If you have fewer than 1000 daily observations, then the estimation is unlikely to give you much real information about the parameters. Hence, we are using with it because it is the most commonly available GARCH model which is estimated via maximum likelihood.

If the volatility clustering is properly explained by the model, then there will be no autocorrelation in the squared standardized residuals. It is common to do a Ljung-Box test (Ljung & Box, 1978) to test for this autocorrelation.

The persistence of a GARCH model should do with how fast large volatilities decay after a shock. For the GARCH (1,1) model the key statistic is the sum of the two main parameters (α_1 and β_1). The sum of α_1 and β_1 should be less than 1. If the sum is greater than 1, then the predictions of volatility are explosive which we are unlikely to believe that. If the sum is equal to 1, then we have an exponential decay model.

5.3.4 GARCH results

	Estimate	Std. Error	t Value	Pr(>|t|)
μ	-0.000174	-2.575829	-0.099993	0.92035
ω	0.000000	-1.959964	0.000000	1.00000
α_1	0.000057	-1.00494	0.061001	0.95136
β_1	0.990211	0.09017	448.890967	0.00000

Table 5.21 GARCH (NSB) New Ship Building Prices Volatility

The general process for a GARCH model involves three steps. The first is to estimate a best-fitting autoregressive model; secondly, to compute autocorrelations of the error term and lastly, to test for significance

α_1 measures the extent to which a volatility shock of the current period feeds through into next period's volatility and $\alpha_1+\beta_1$ measures the rate at which this effect perishes over time.

From the results, the sum of α_1 and β_1 is 0.990268 < 1 indicating there is a mean reversion in the process. Since the sum is very close to 1, the reversion process is slow. This also indicates that the weightage for Long term volatility based on long term rates is 0.97%, so the variance prediction model gives 0.0057% weightage to the latest squared error term (deviance of returns from the mean), 99.02% weightage to the variance based on the squares of previous time periods' and 0.97% for long term average volatility. Based on the omega, the mean reverting value of the variance is 0.000000/0.009732 = 0.0 and a monthly standard deviation of 0%. However, the p-values of $\beta_1$only are less than 0.05 indicating the inconsistency in the values of α_1 and ω being significantly different from 0. Other versions of GARCH can be evaluated for the same.

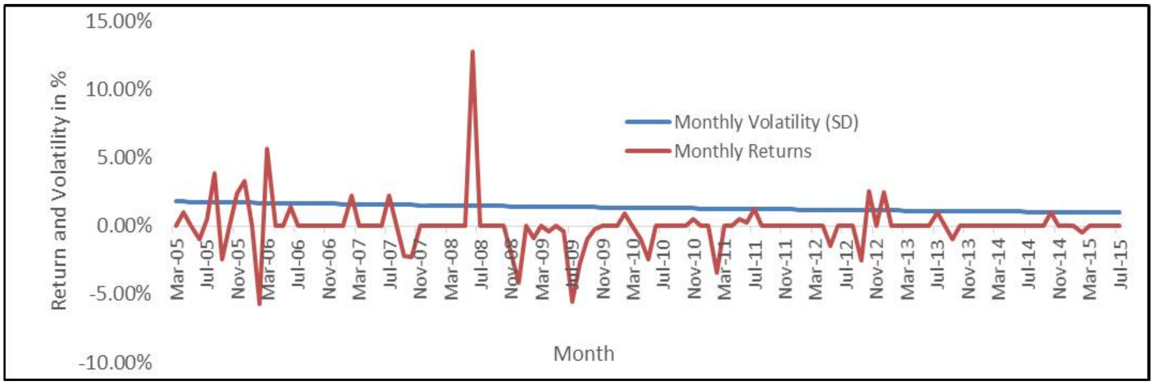

Figure 5.6 Monthly Returns vs. GARCH (1,1) volatility of New Ship Building Prices

Weighted ARCH LM	Statistic	Shape	Scale	P-Value
	0.0733	0.5	2	0.7866
ARCH Lag [5]	0.2089	1.44	1.667	0.9634
ARCH Lag [7]	0.5874	2.315	1.543	0.9698

5.22 Weighted Arch LM test results

This is used for testing the null hypothesis of adequately fitted ARCH process. This test can be performed after fitting an ARCH process to a time series. The p-values for each of the lags are above 0.05 indicating that for this data, the ARCH process is an adequate fit.

Weighted Ljung Box Test on Standardized Residuals		
	statistic	p-value
Lag [1]	0.02182	0.8826
Lag[2*(p+q) +(p+q)-1] [2]	0.03623	0.9672
Lag[4*(p+q) +(p+q)-1] [5]	0.31755	0.9819
Weighted Ljung Box Test on Standardized Squared Residuals		
	statistic	p-value
Lag [1]	0.0004628	0.9828
Lag[2*(p+q) +(p+q)-1] [5]	0.2076487	0.9920
Lag[4*(p+q) +(p+q)-1] [9]	0.5888449	0.9974

Table 5.23 Weighted Ljung Box Test on Standardized Residuals and Standardized Squared Residuals

The p-values of >0.05 clearly indicate that there is no auto correlation among the standardized residuals as well as standardized square residuals for different lags. This volatility clustering is aptly explained by the model.

Loglikelihood	334.2808
Akaike	-5.2845
Bayes	-5.1940
Shibata	-5.2865
Hannan-Quinn	-5.2477

Table 5.24 Likelihoods and Information Criteria

GARCH model assume that only the magnitude of unanticipated excess returns helps in determining the result. Not only the magnitude but also the direction of the returns affects volatility. Negative shocks (events/news, etc.) tend to impact volatility more than positive shocks. Using this model, we can expect a better estimate for the volatility of asset returns due to how the EGARCH counteracts the limitations based on the classic GARCH model.

The years 2007 to 2009 saw high number of new LNG vessel deliveries to the LNG shipping market. However, the same period experienced a record low in number of orders for new LNG vessels. The year 2008 also saw a global financial meltdown. The news resulted in negative price volatility in the months of July and August 2008. This was also followed by more negative shocks of a smaller magnitude.

5.3.5 E-GARCH Results

EGARCH models attempt to address volatility clustering in an innovative process. Volatility clustering occurs when such process does not exhibit significant autocorrelation, but the variance of the process changes with time. EGARCH models are appropriate when positive and negative shocks of equal magnitude may not contribute equally to volatility. Model posits that the current conditional variance is the sum of these linear processes:

- Past logged conditional variances (the GARCH component or polynomial β_1)
- Magnitudes of past standardized innovations (the ARCH component or polynomial α_1)
- Past standardized innovations (the leverage component or polynomial γ_1)

	Estimate	Std. Error	t Value	Pr(>|t|)
μ	0.004407	0.001286	3.4283	0.000607
ω	-0.237648	0.054331	-4.3741	0.000012
α_1	0.101338	0.043703	2.3188	0.020406
β_1	0.971452	0.140552	6.9117	0.000000
γ_1	0.18590	0.066240	-2.7942	0.005202

Figure 5.25 EGARCH results for New Ship Building Prices Returns

For the data given above, the α_1 value is 10.13% indicating that a positive weightage is given to the recent observations, a value of 97.14% to β_1 indicates a very high weightage being given to the volatility contributed to by the past few periods and a negative 18.51% to γ_1 indicates a weightage given towards leverage (Negative shocks contributing more to the volatility corresponding to the positive shocks). The p-values corresponding to all the coefficients are <0.05, indicating that all the coefficients are significant at 5%. The volatility is increasing drastically when there is a big reduction in the prices compared to an equal increase in the price.

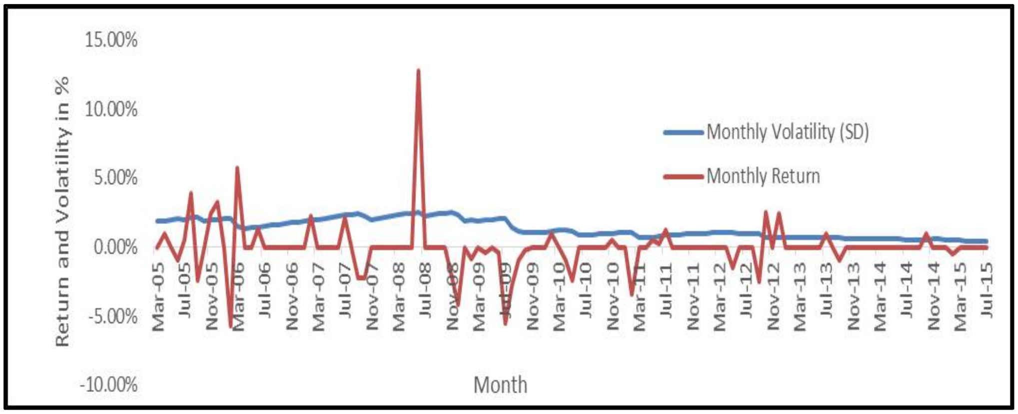

Figure 5.7 Monthly Returns vs. E-GARCH volatility of New Ship Building Prices

	EGARCH	GARCH
Loglikelihood	361.7645	334.2808
Akaike	-5.7082	-5.2845
Bayes	-5.5951	-5.1940
Shibata	-5.7113	-5.2865
Hannan-Quinn	-5.6623	-5.2477

Table 5.26 Likelihood and Information Criteria for GARCH and EGARCH

The log-likelihood value is higher for EGARCH compared to GARCH. The higher the Log Likelihood, the better the model is for comparison purposes. Hence EGARCH is a better model compared to GARCH. The other 4 information criteria specified (Akaike, Bayes, Shibata, Hannan Quinn) are lower for EGARCH compared to GARCH which also stress the same point that EGARCH is the better of the two models for modelling volatility for this data set.

Weighted Ljung-Box Test on Standardized Residuals		
	Statistic	p-value
Lag [1]	0.0302	0.8620
Lag[2*(p+q) +(p+q)-1] [2]	0.6164	0.6414
Lag[4*(p+q) +(p+q)-1] [5]	1.4734	0.7465

Table 5.27 Weighted Ljung-Box Test results on Standardized Residuals

Weighted Ljung-Box Test on Standardized Squared Residuals		
	Statistic	p-value
Lag [1]	0.907	0.3409
Lag[2*(p+q) +(p+q)-1] [5]	1.635	0.7068
Lag[4*(p+q) +(p+q)-1] [9]	2.398	0.8526

Table 5.28 Weighted Ljung-Box Test results on Standardized Squared Residuals

The p-values of >0.05 clearly indicate that there is no auto correlation among the standardized residuals as well as standardized square residuals for different lags. This volatility clustering is aptly explained by the model.

Weighted ARCH LM Tests				
	Statistic	Shape	Scale	P-Value
ARCH Lag [3]	0.09513	0.500	2.000	0.7578
ARCH Lag [5]	1.25970	1.440	1.667	0.6577
ARCH Lag [7]	1.52290	2.315	1.543	0.8168

Table 5.29 Weighted ARCH LM Tests

This is used for testing the null hypothesis of the adequate ARCH process. These tests can be performed after fitting an ARCH process to a time series. The p-values for each of the lags are above 0.05 indicating that for this data, ARCH process is a tolerable fit.