

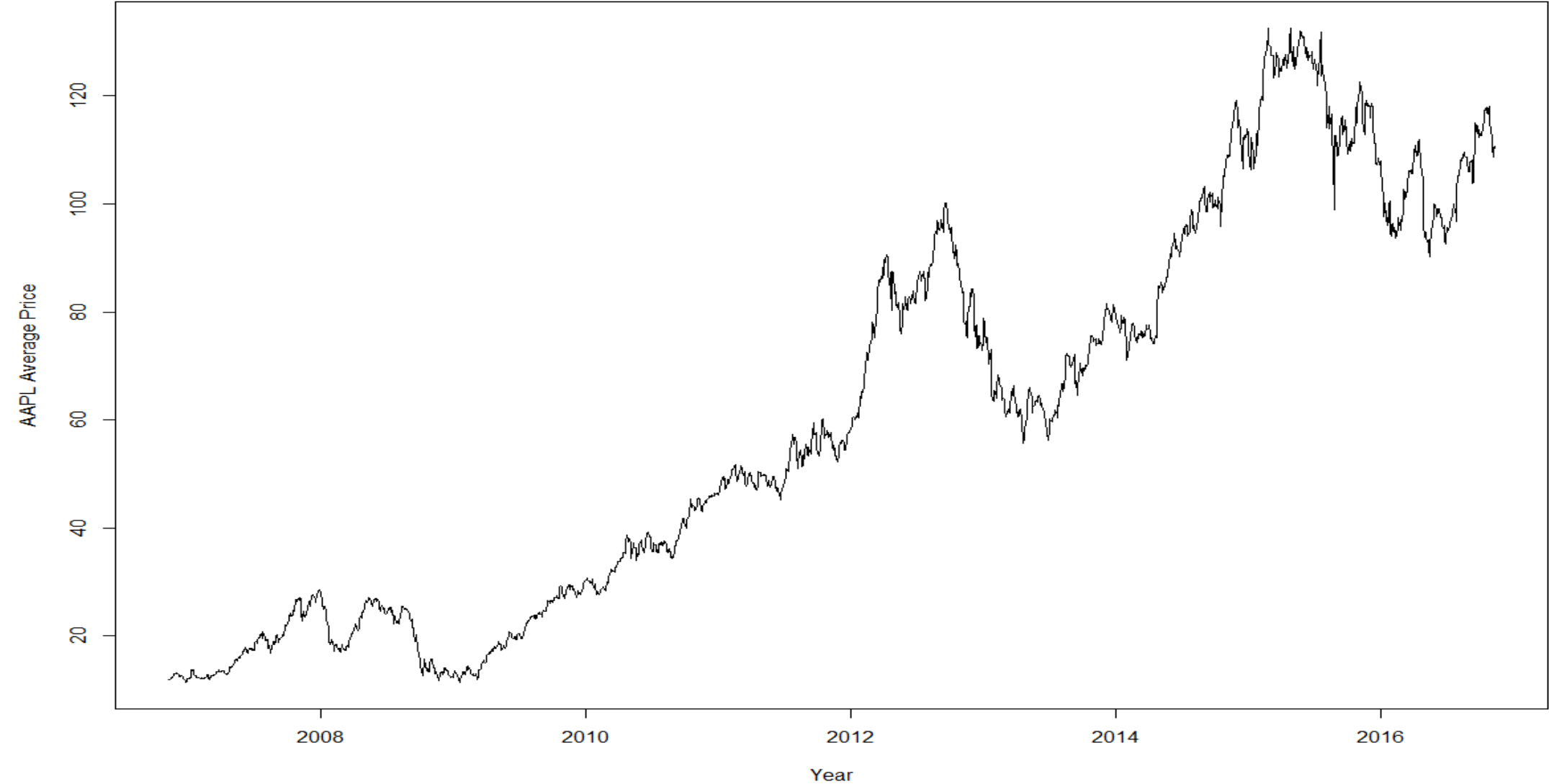
Time Series Exploration of Average Daily AAPL Price

Analysis conducted by: Joe Leong, Ryan Isherwood, Sam Whittaker

Outline

- **Objective**
 - Is data suitable for time series analysis
 - Use adequate models to predict prices over next 10 days
- **Methods**
 - Transformation of data
 - ACF/PACF plots
 - Fit to Arima Models
- **Analysis**
 - Checking to see if the model fit is adequate
 - Prediction
- **Conclusion**
 - Attempted GARCH
 - Benefit of analysis

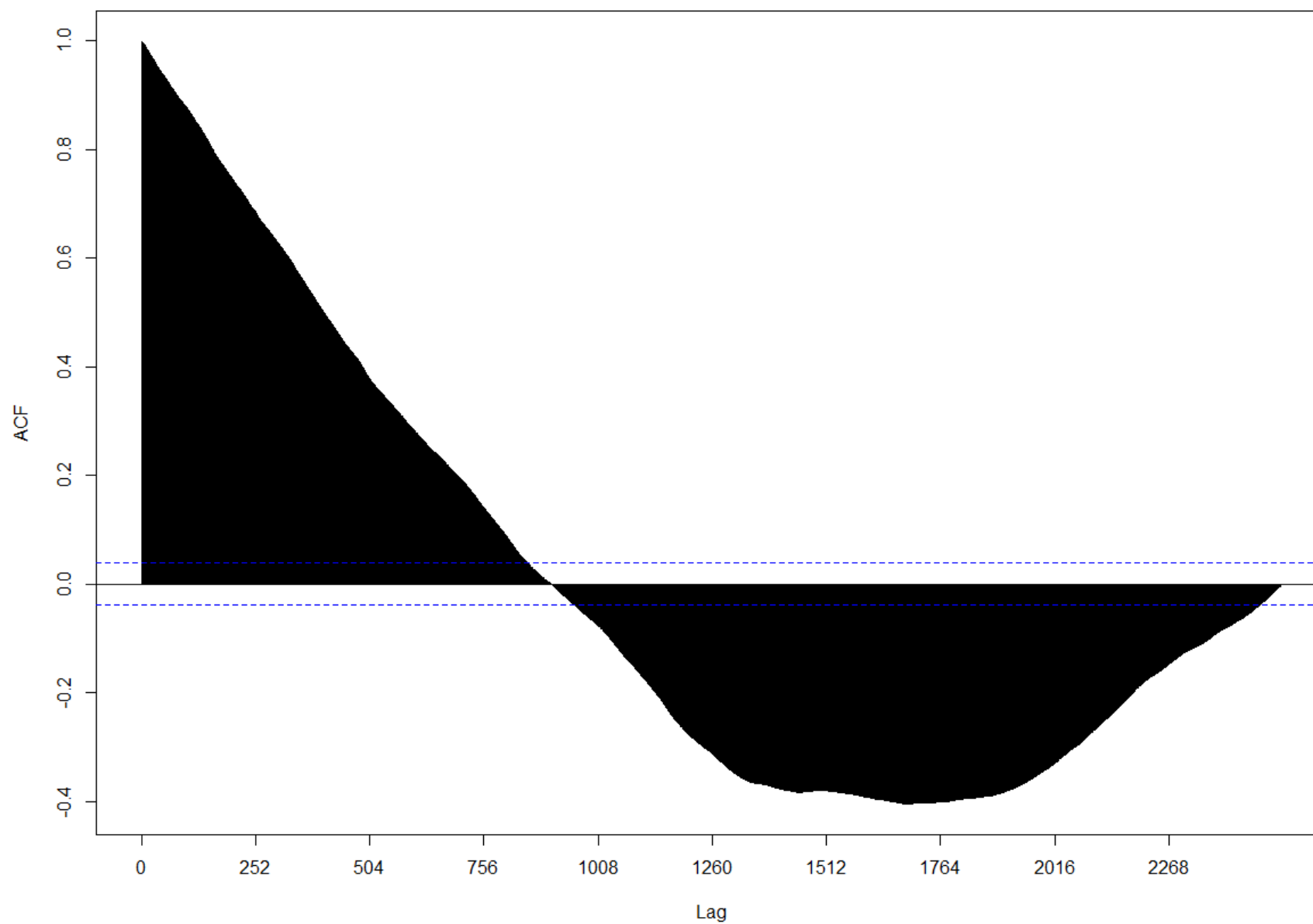
Performance of AAPL over a 10 year cycle



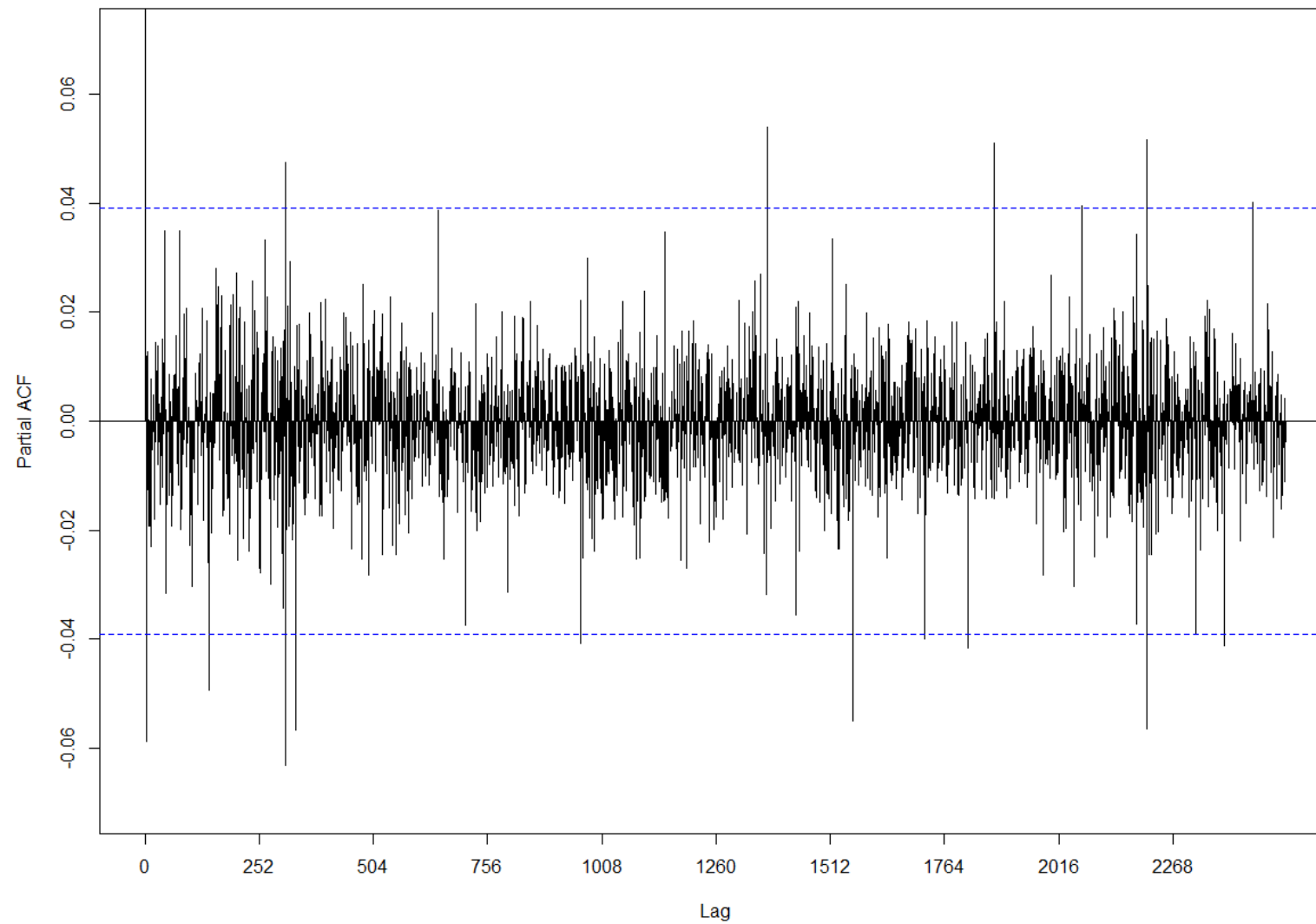
Performance of AAPL over a 10 year cycle



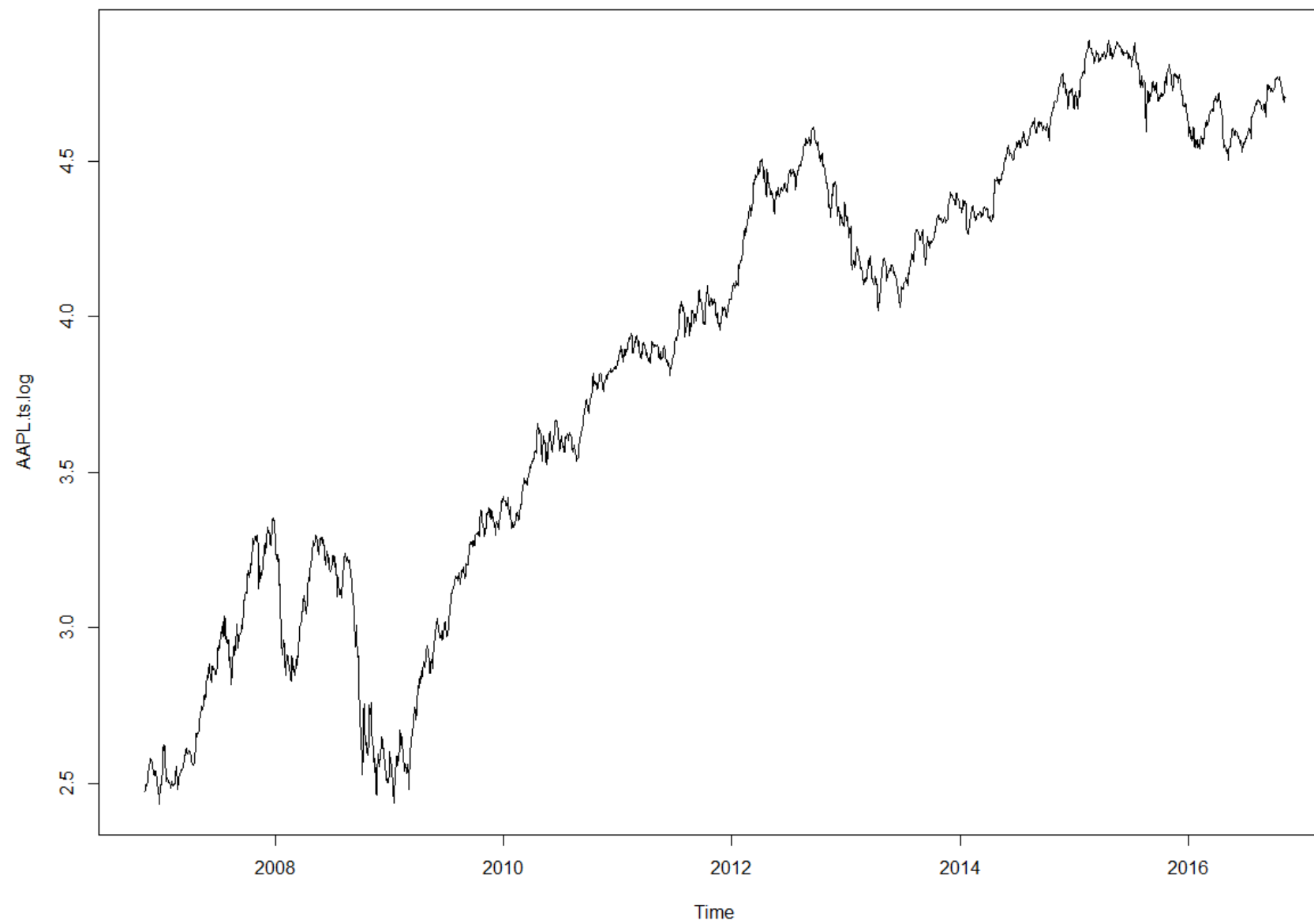
ACF of Untransformed AAPL Data



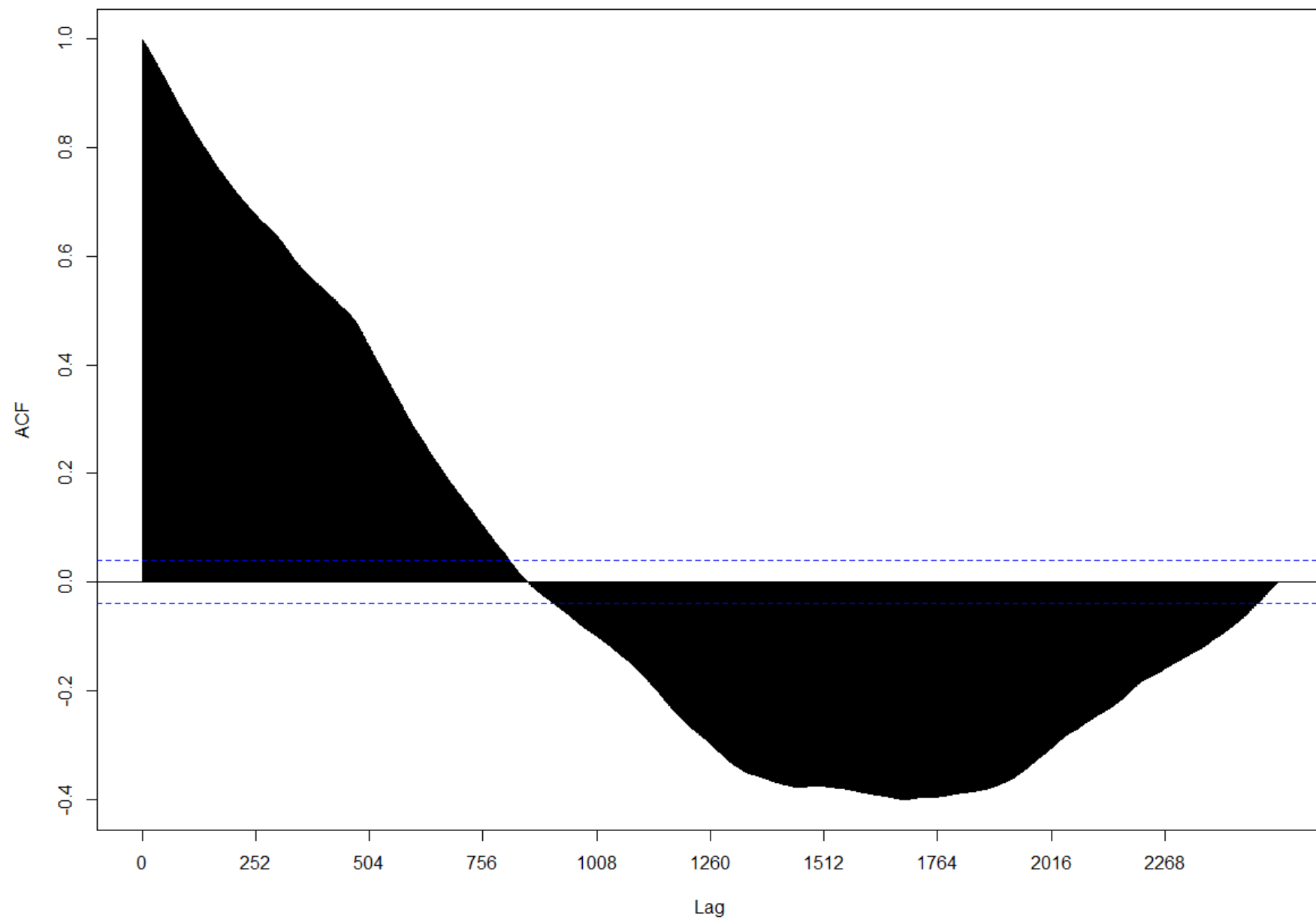
PACF of Untransformed AAPL Data



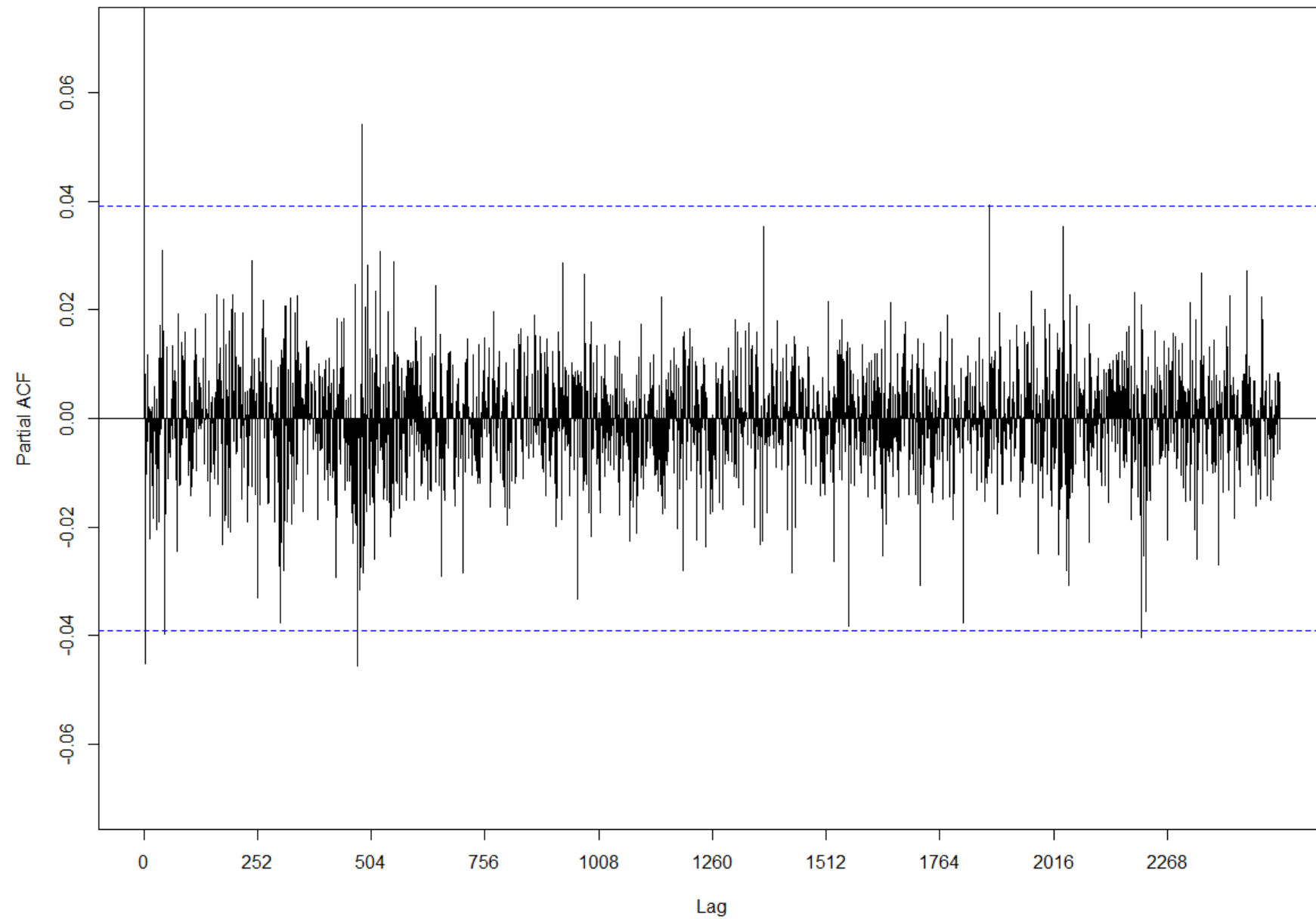
Log of Daily Average AAPL Price over 10 Years



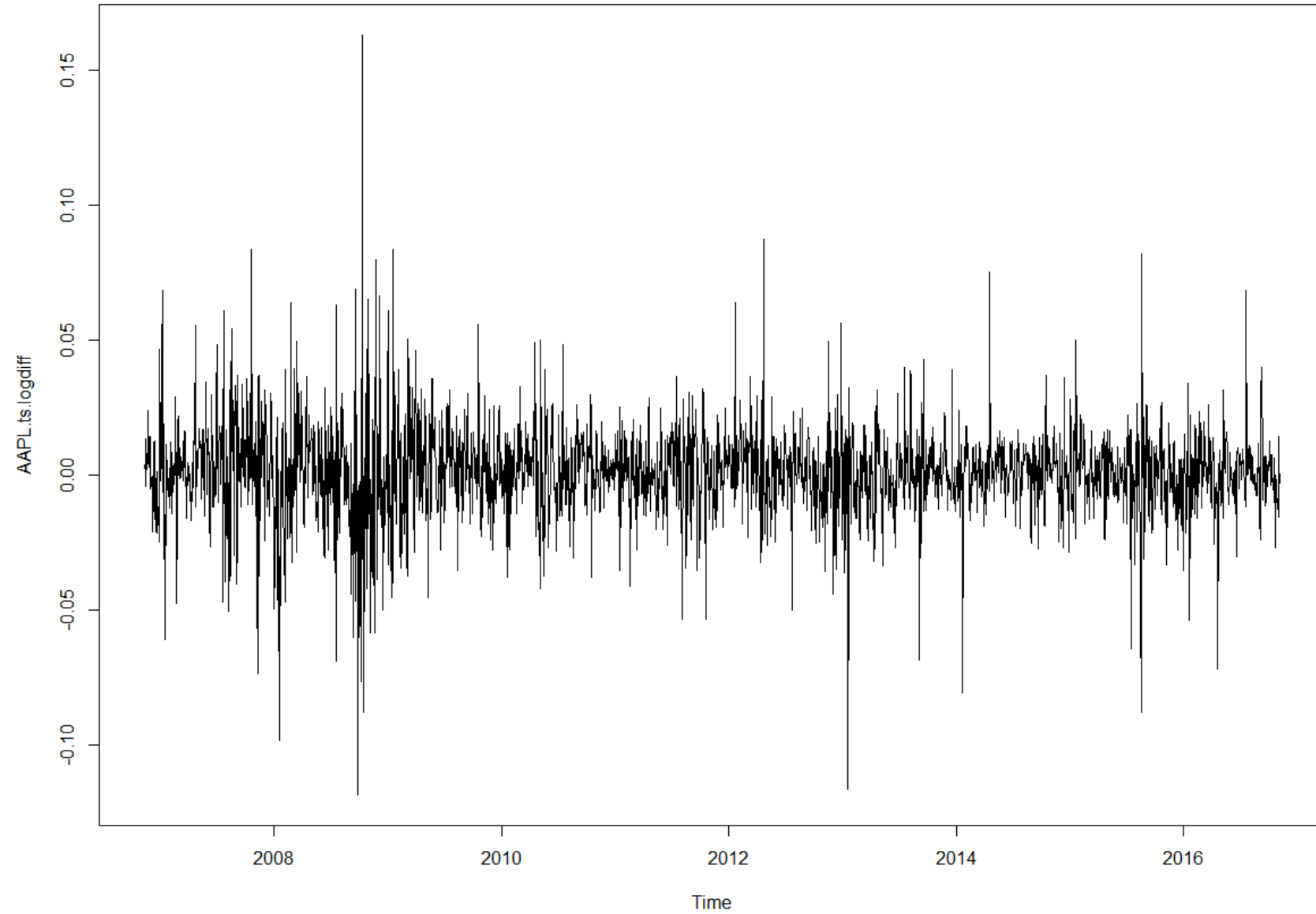
ACF of Log Transformed AAPL Data



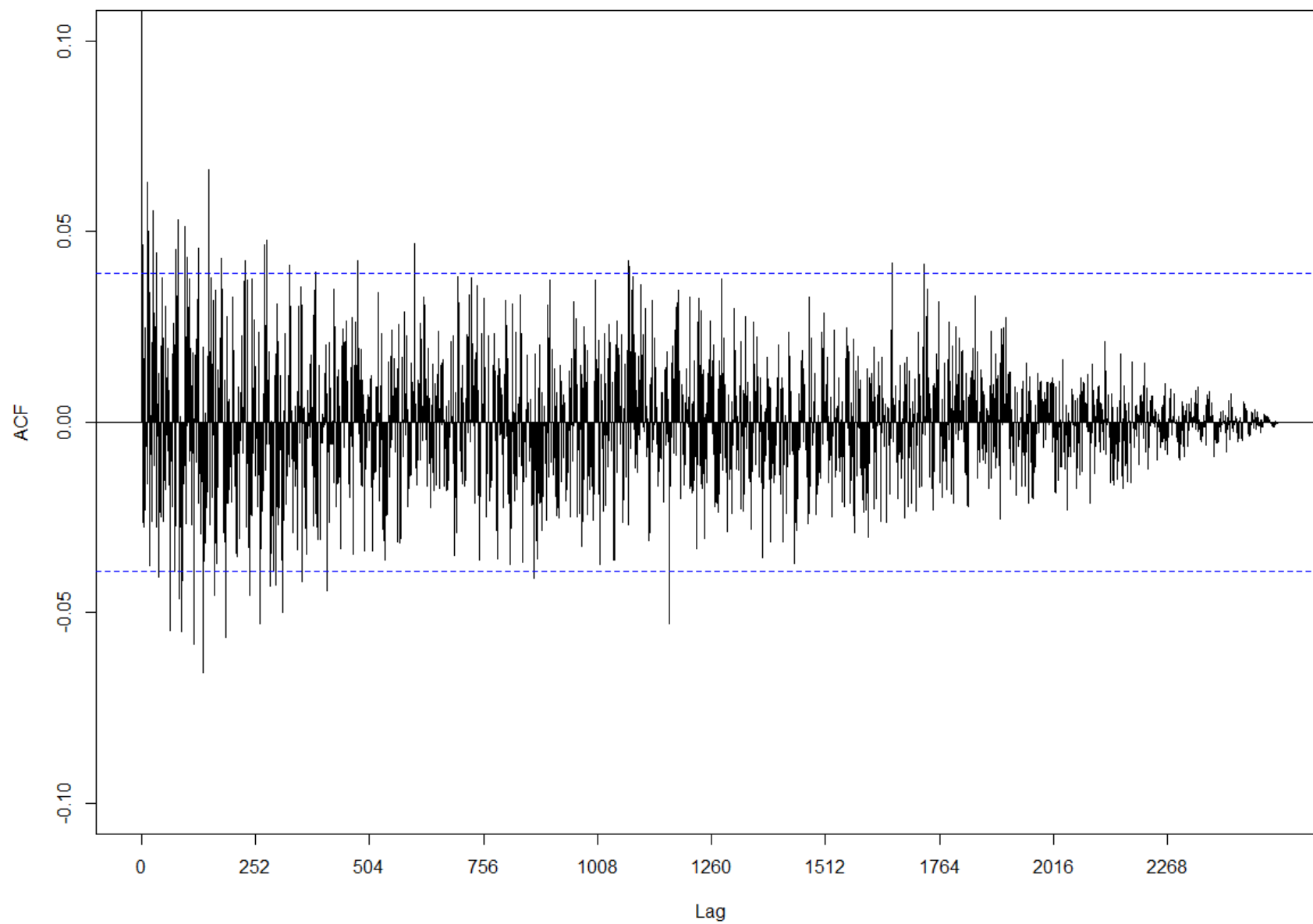
PACF of Log Transformed AAPL Data



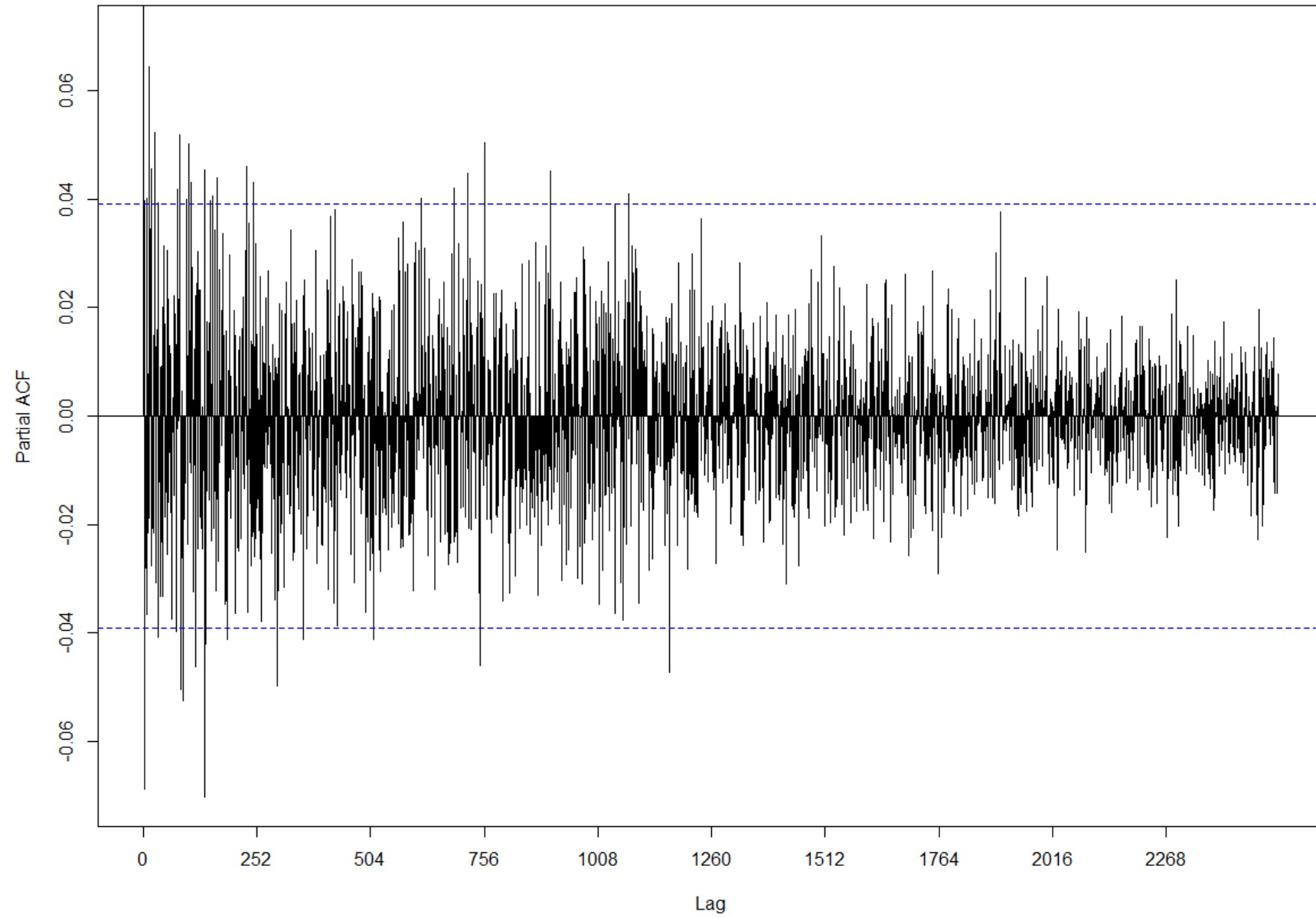
Log Difference of Daily Average Price
of AAPL over 10 Years



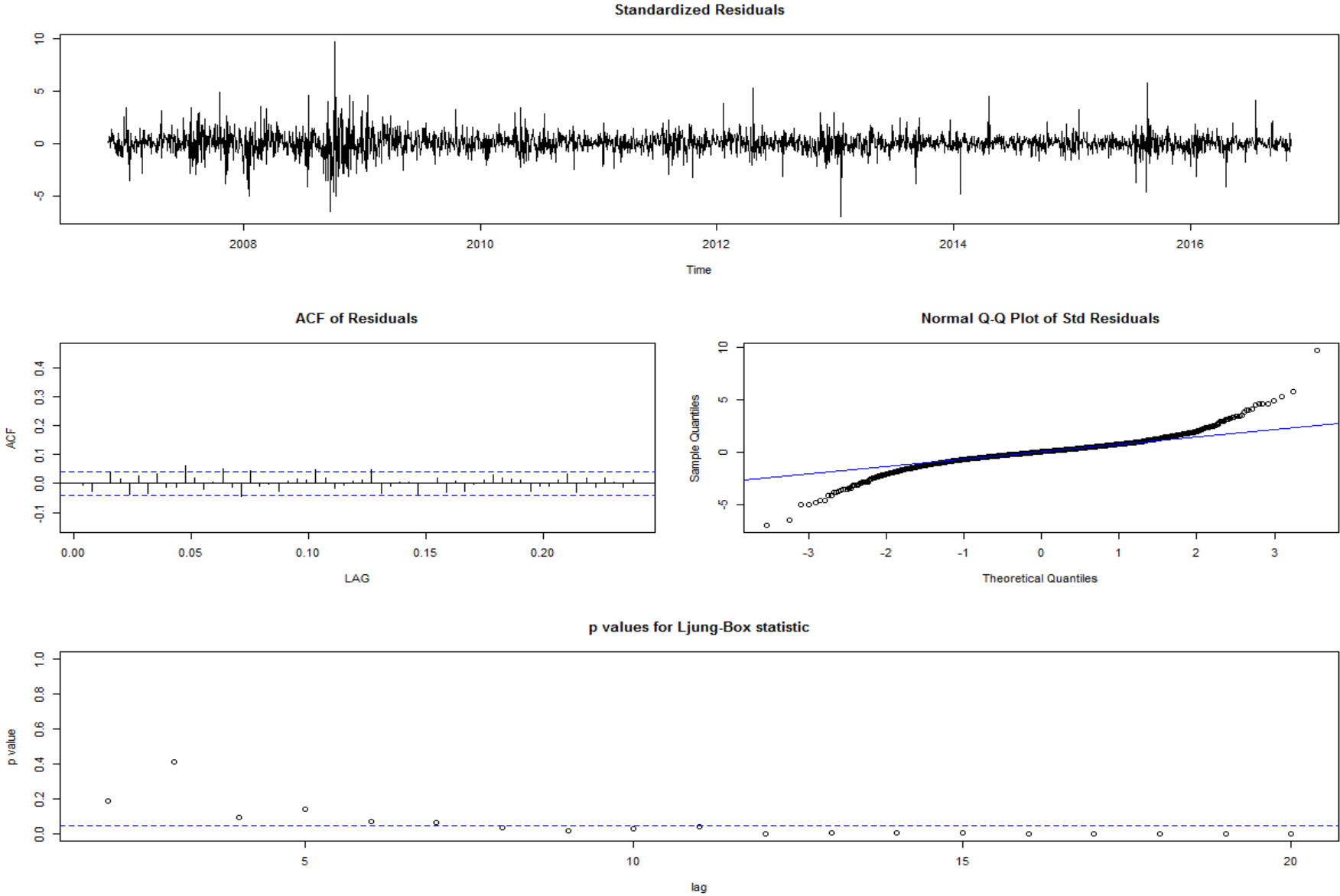
ACF of Growth Rate of AAPL Data

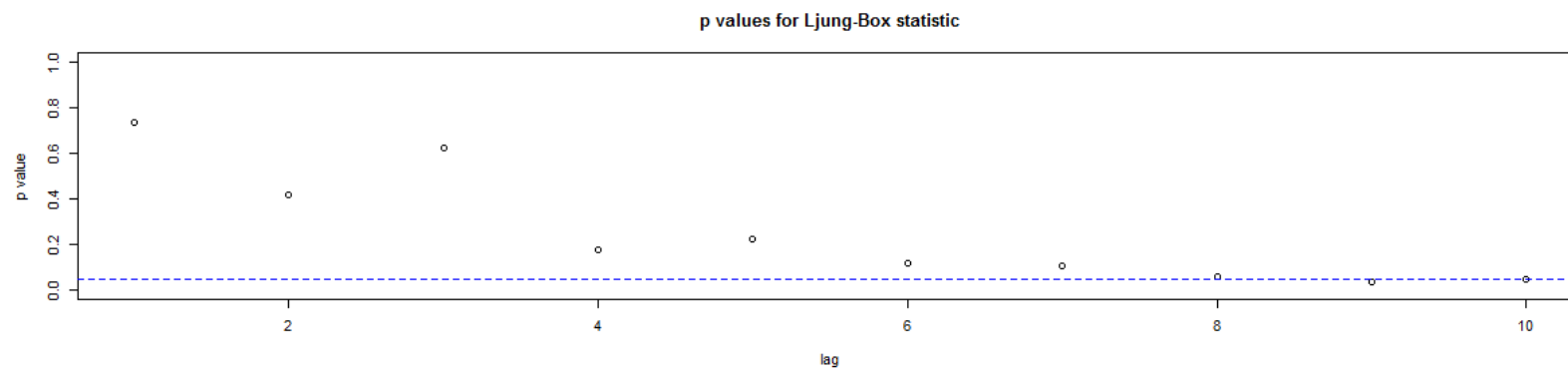
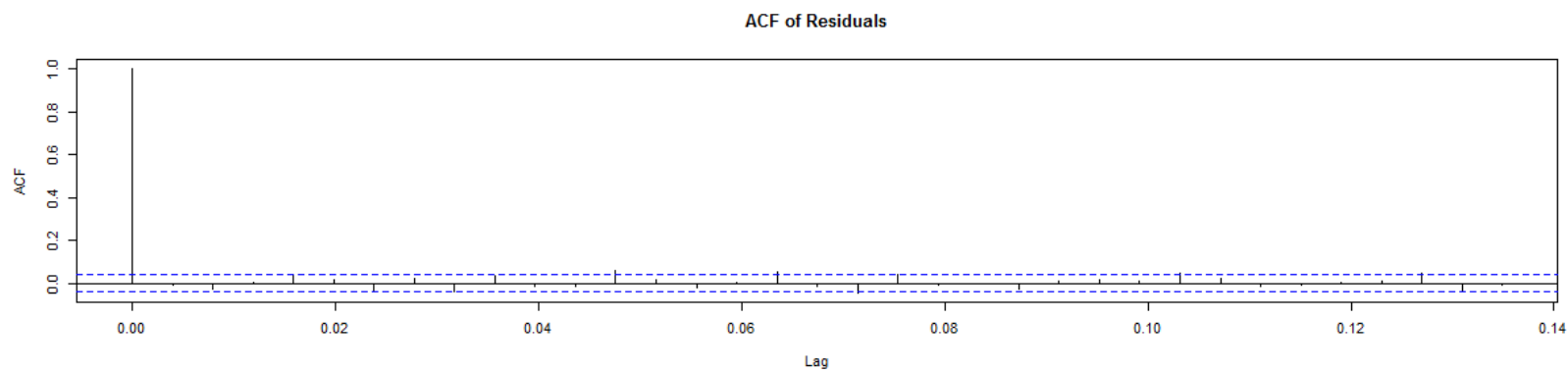
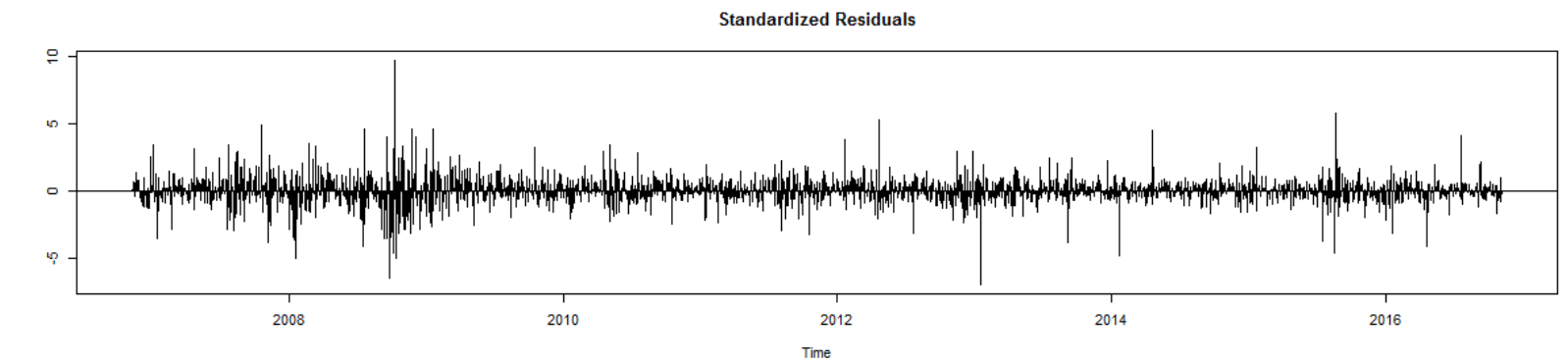


PACF of Growth Rate of AAPL Data

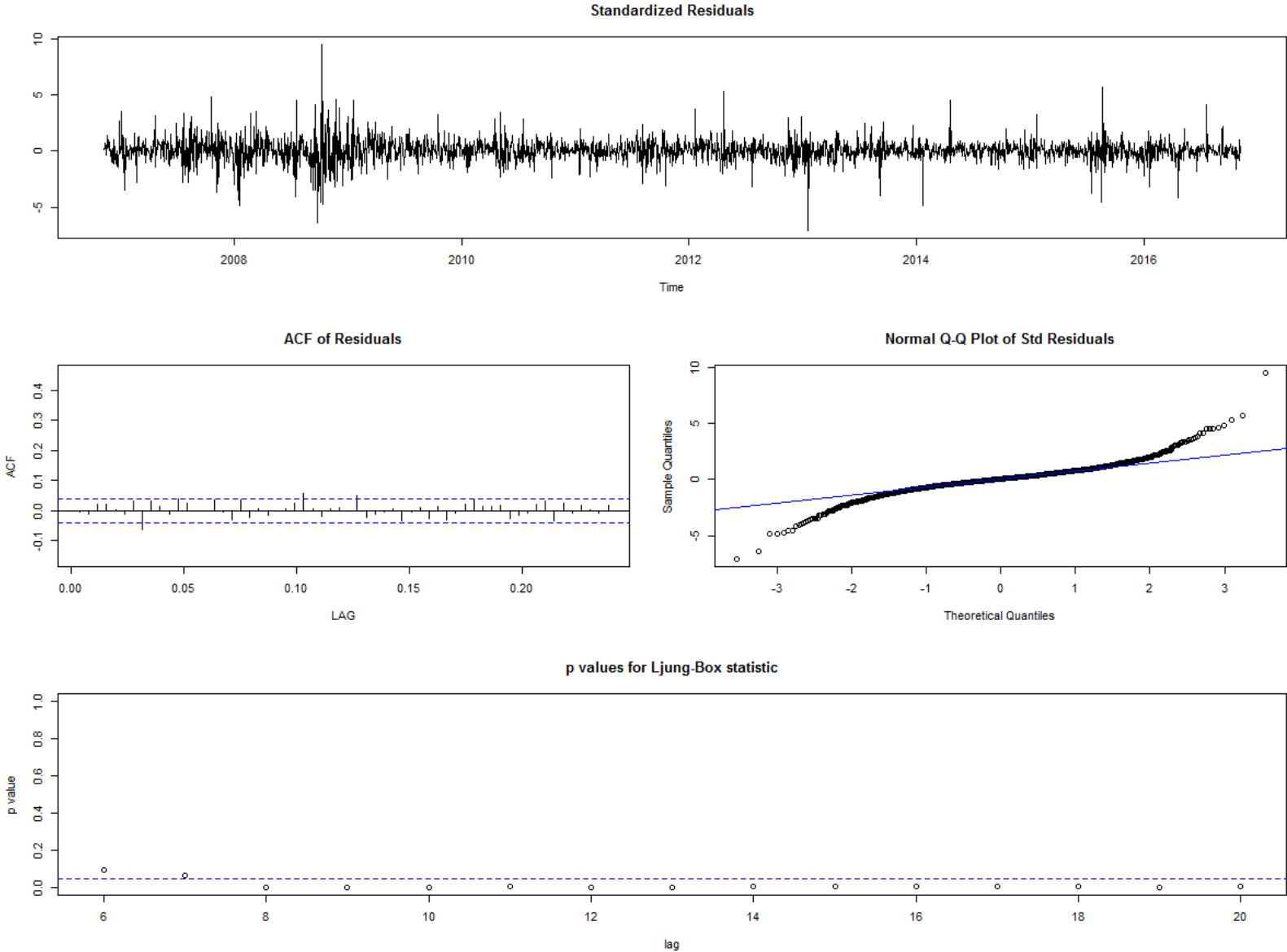


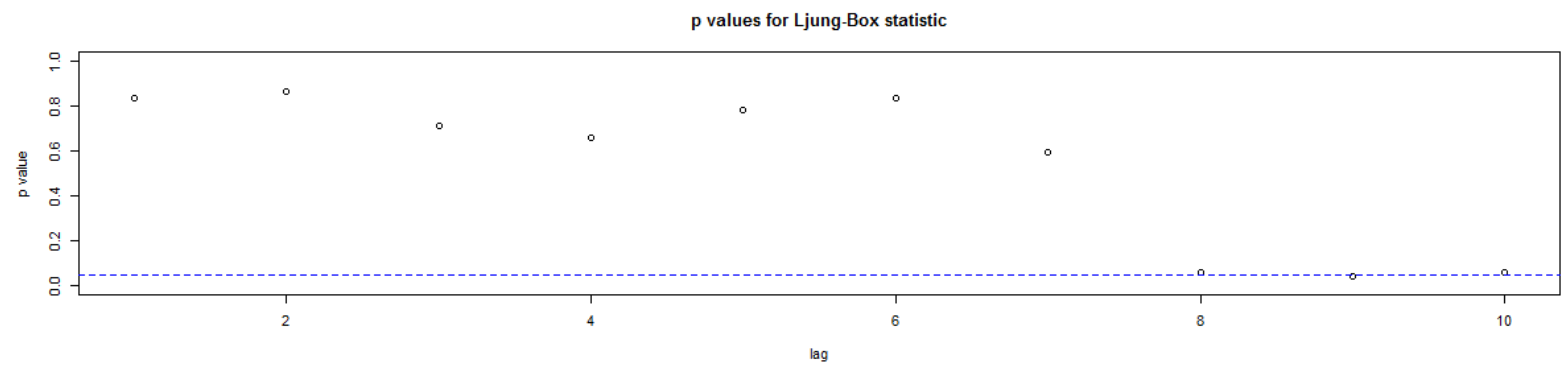
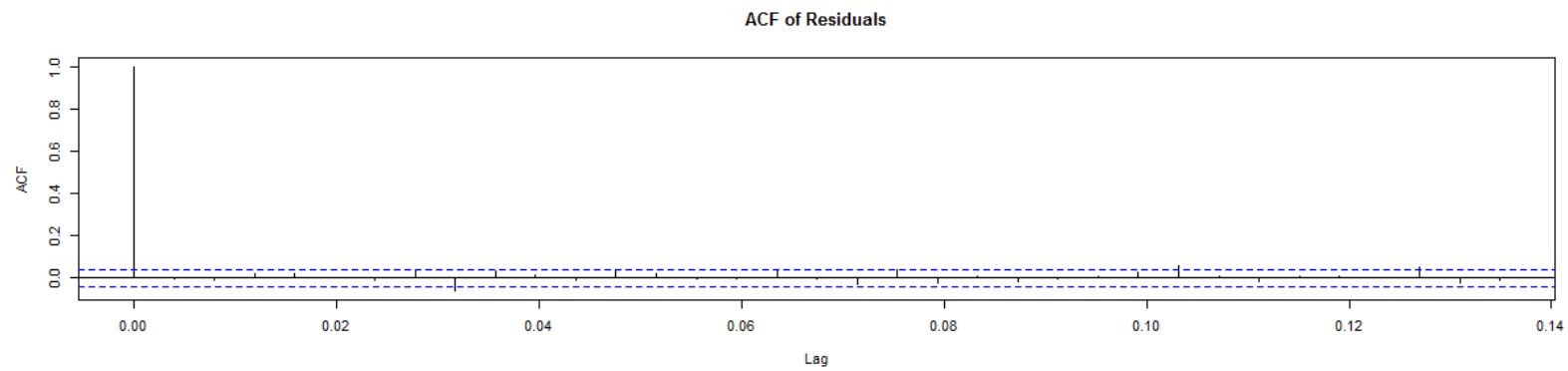
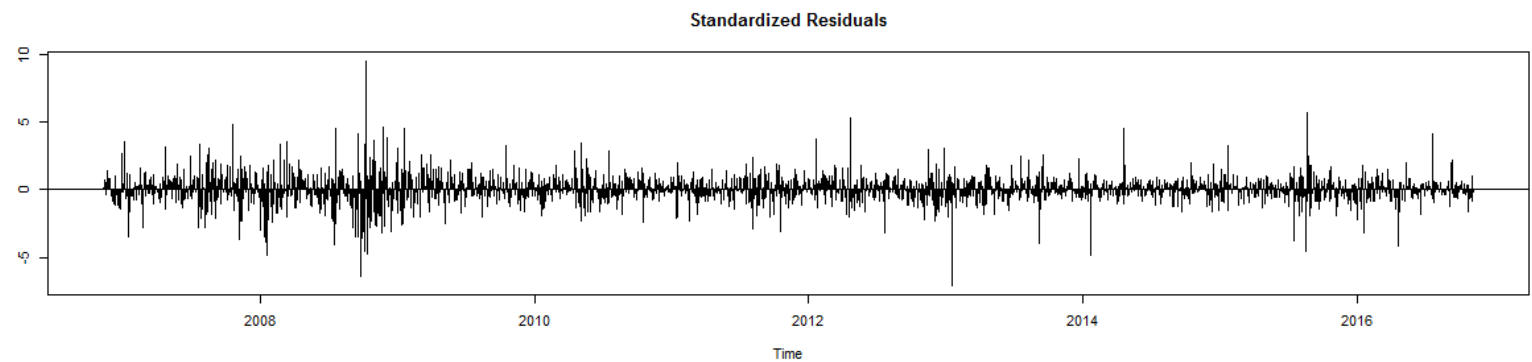
Summary Report for ARIMA(0,1,1)





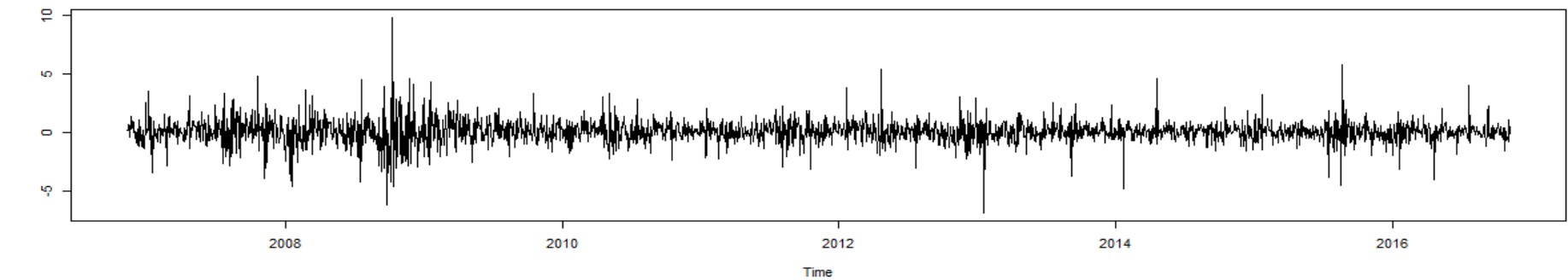
Summary Report of ARIMA(2,1,3)



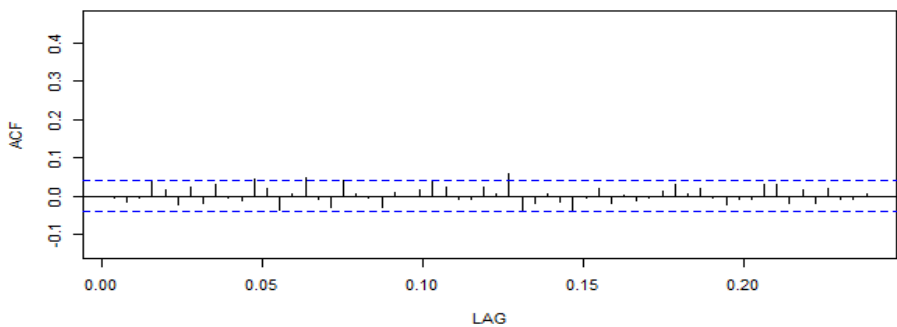


Summary Report of ARIMA(5,1,5)

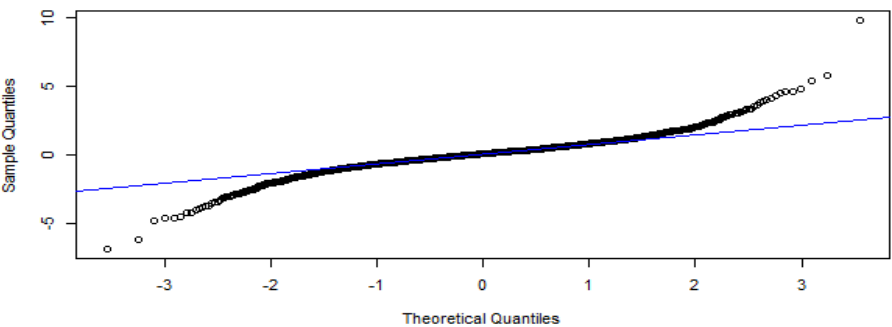
Standardized Residuals



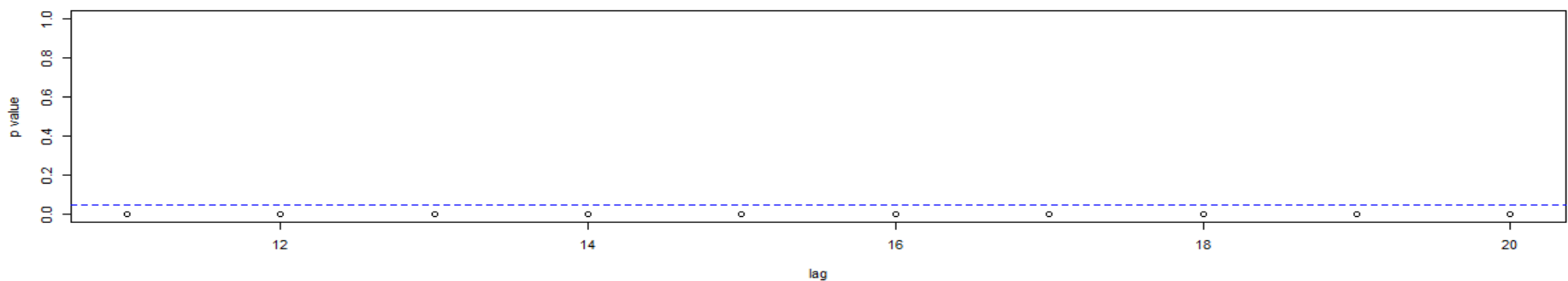
ACF of Residuals

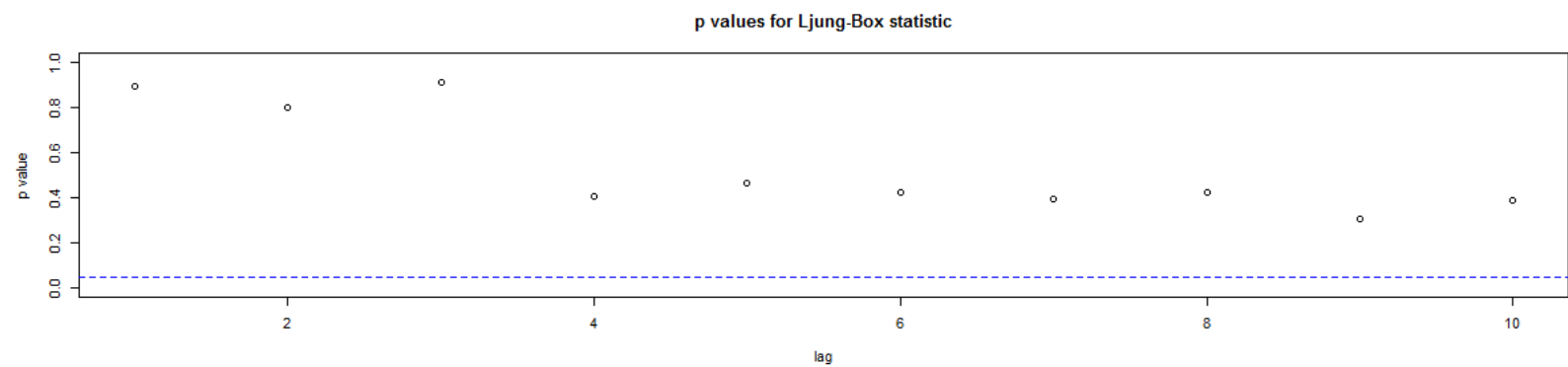
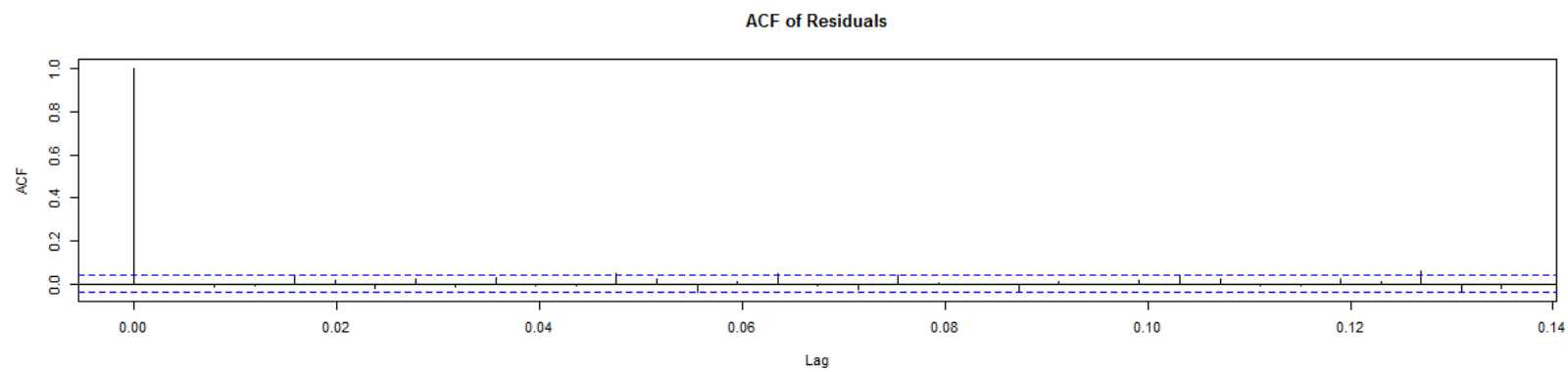
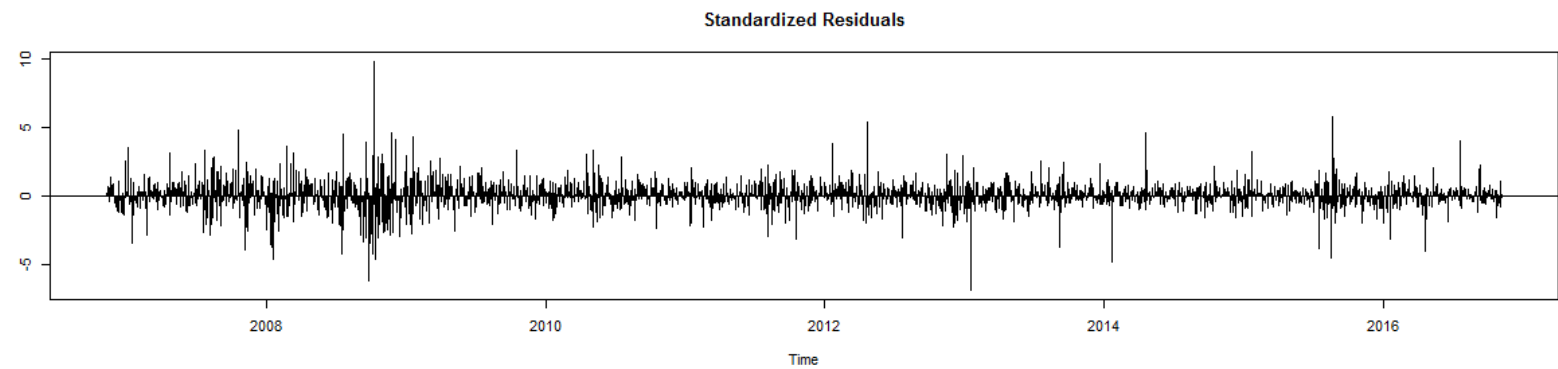


Normal Q-Q Plot of Std Residuals

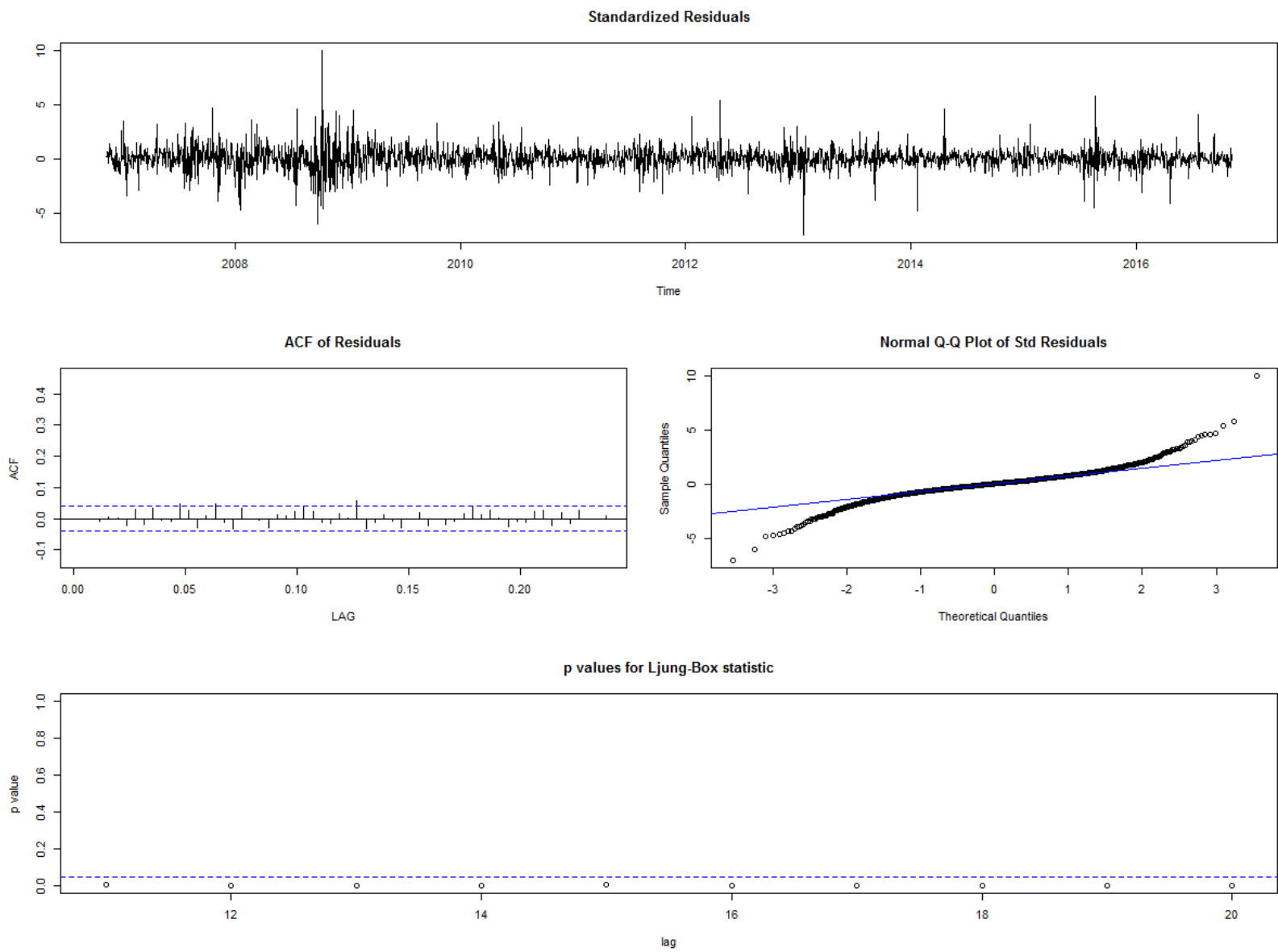


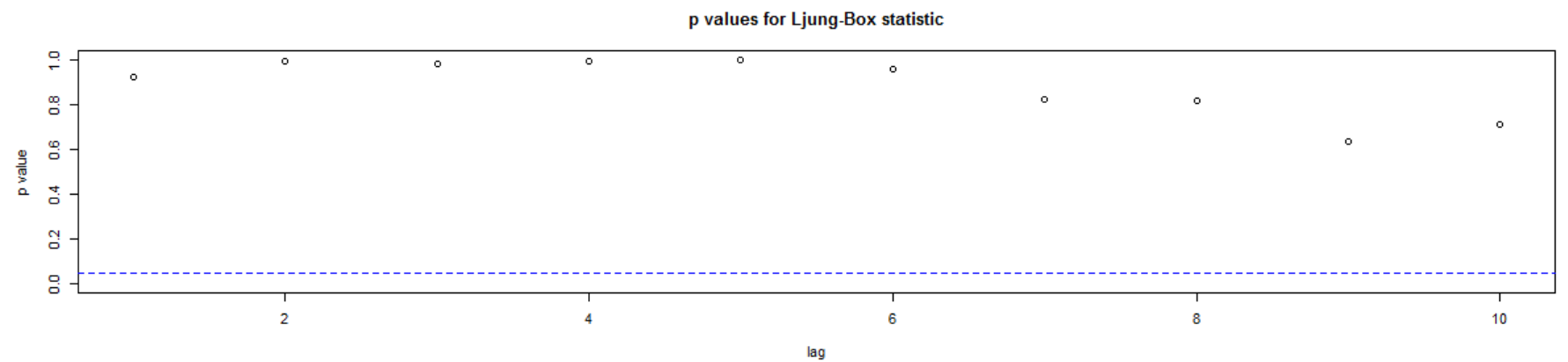
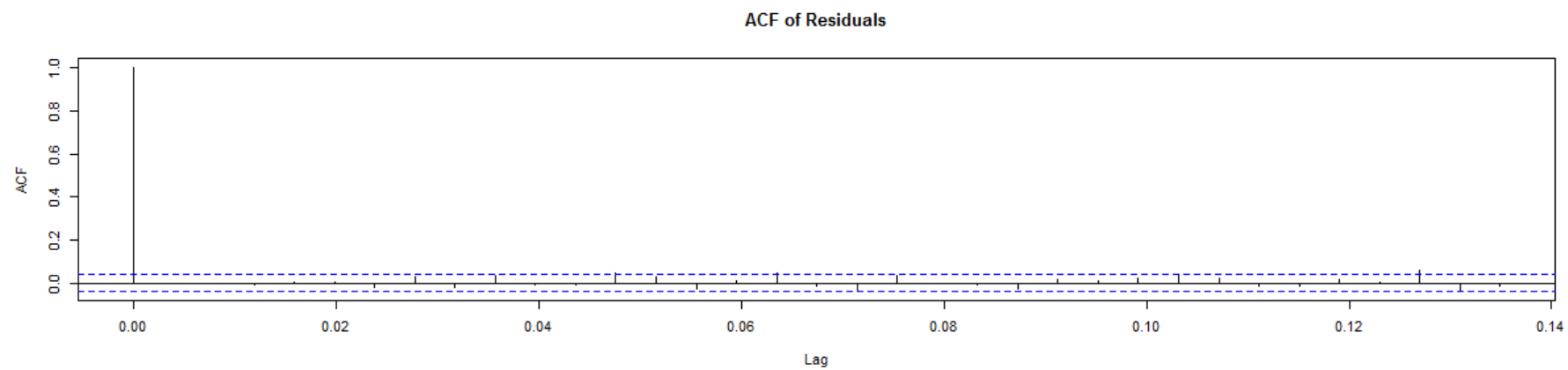
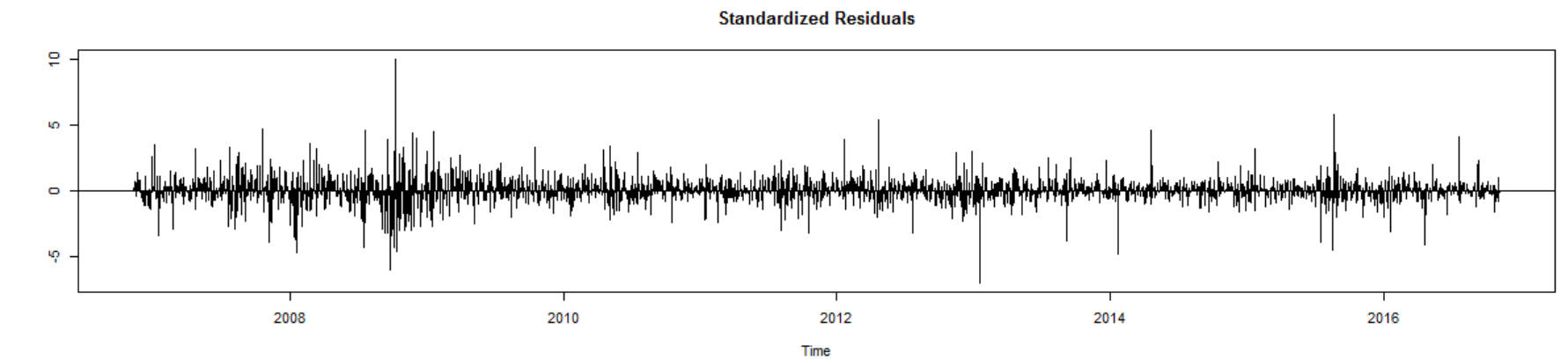
p values for Ljung-Box statistic





Summary Report of ARIMA(6,1,4)





Final Model Arima(6,1,4)

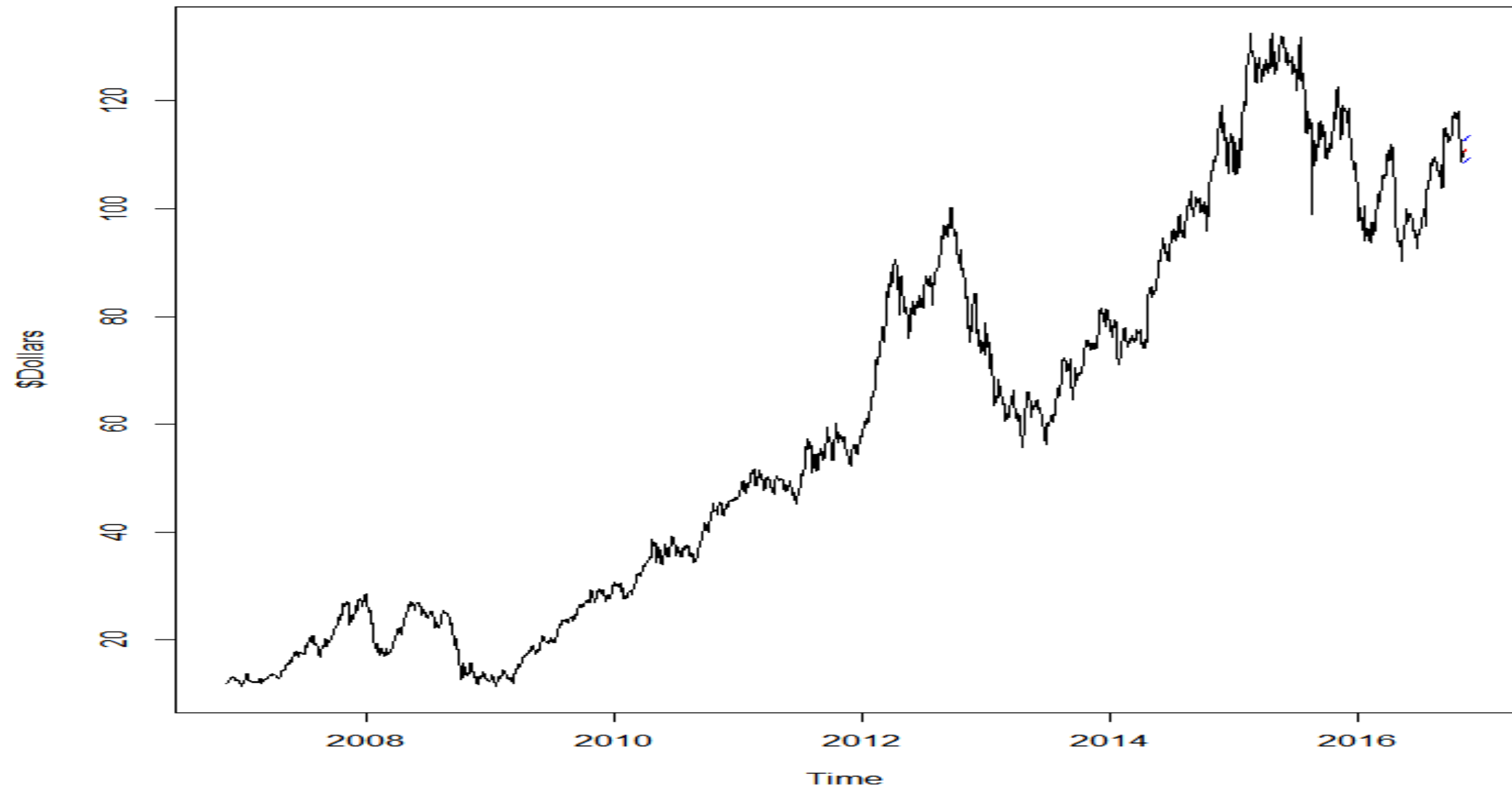
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$ttable
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	Estimate	SE	t.value	p.value
ar1	-0.2921	0.0618	-4.7277	0e+00
ar2	0.4448	0.0667	6.6644	0e+00
ar3	0.0878	0.0212	4.1394	0e+00
ar4	-0.5388	0.0282	-19.1128	0e+00
ar5	0.1486	0.0206	7.2070	0e+00
ar6	-0.0696	0.0207	-3.3562	8e-04
ma1	0.5144	0.0587	8.7654	0e+00
ma2	-0.4067	0.0766	-5.3063	0e+00
ma3	-0.1904	0.0138	-13.7885	0e+00
ma4	0.5775	0.0175	32.9111	0e+00

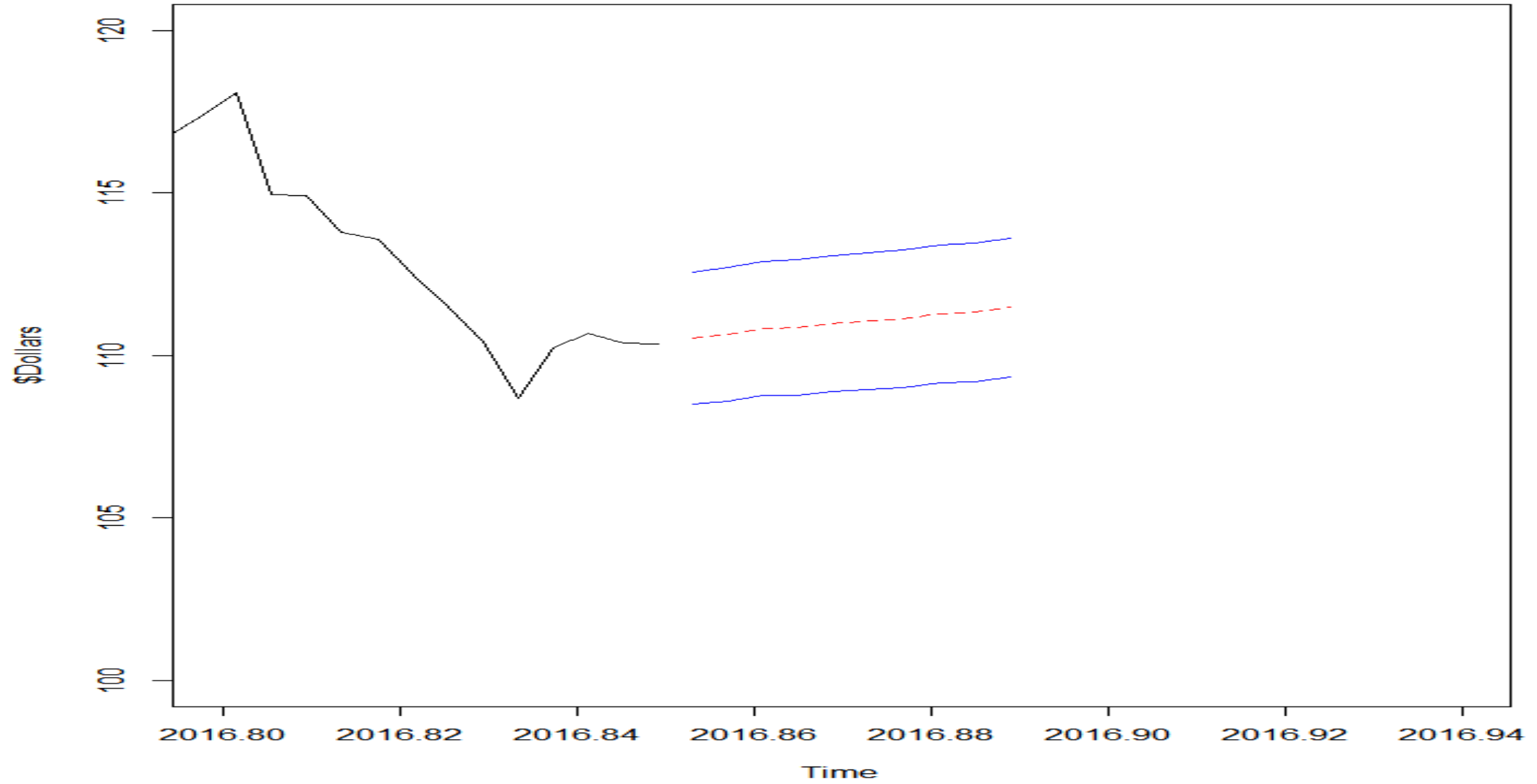
Let $x_t = \text{Difference of log average daily AAPL price.}$

$$x_t = -0.2921_{0.0618}x_{t-1} + 0.4448_{0.0667}x_{t-2} + 0.0878_{0.0212}x_{t-3} - 0.5388_{0.0282}x_{t-4} + 0.1486_{0.0206}x_{t-5} \\ - 0.0696_{0.0207}x_{t-6} + w_t + 0.5144_{0.0587}w_{t-1} - 0.4067_{0.0766}w_{t-2} - 0.1904_{0.0138}w_{t-3} + 0.5775_{0.0175}w_{t-4}$$

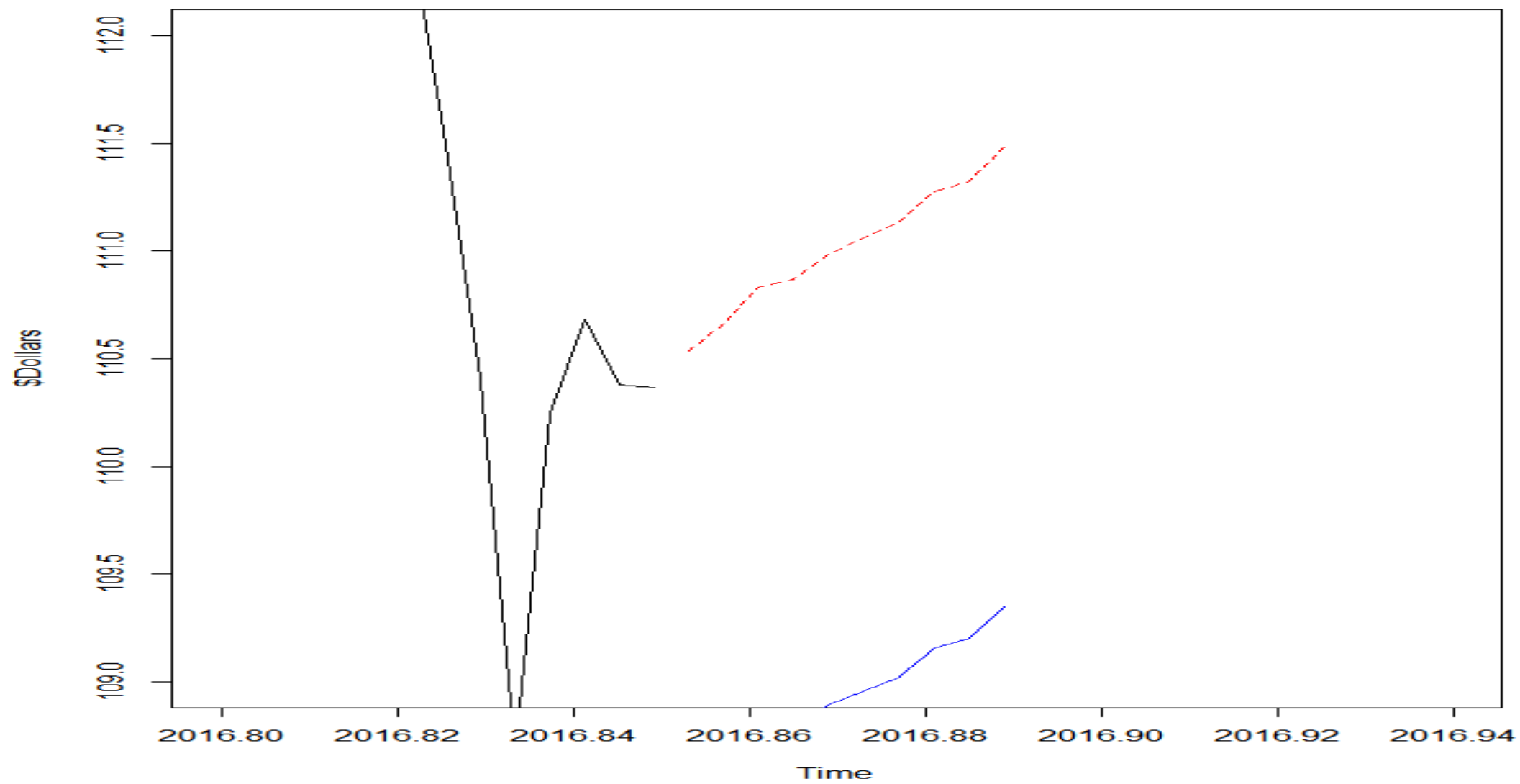
10 day Prediction of Daily AAPL Average Price



10 day Prediction of Daily AAPL Average Price



10 day Prediction of Daily AAPL Average Price



Forecast Results

Date	Predicted Value	Standard Error	Actual Value	% Error
2016-11-11	110.5361	1.02	107.775	2.56
2016-11-14	110.6624	1.03	106.710	3.70
2016-11-15	110.8316	1.03	106.840	3.74
2016-11-16	110.8675	1.04	108.345	2.34
2016-11-17	110.9838	1.05	109.880	1.00
2016-11-18	111.0573	1.05	109.890	1.06
2016-11-21	111.1289	1.06	110.925	0.18
2016-11-22	111.2733	1.06	111.875	0.53
2016-11-23	111.3259	1.06	111.295	0.03
2016-11-24	111.4815	1.07	111.460	0.02

Conclusion

- GARCH Modelling
- Applications of our model
- ARIMA Sufficiency

Conclusion

- GARCH Modelling
- Applications of our model
- ARIMA Sufficiency
- This is the REAL world!

Things don't always work out!



Thanks