

Normality of JSE Returns: Macro-outliers, Micro-outliers: an Empirical Evaluation



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Abstract

Previous work on the empirical distribution of security returns has found that equity returns are not normally distributed. These findings have brought the applicability of certain asset allocation and pricing frameworks into question. This study examines whether the removal of *a priori* macro-outliers and micro-outliers leads to improved fits to the Gaussian distribution for single-listed equities on the Johannesburg Stock Exchange (JSE). Single-listed equities refer to stocks (i) listed on the JSE Main Board over the period covered in this study, (ii) that comprise of the exchange's largest 100 stocks by market capitalisation, and (iii) have been determined, by comparing American Depository Receipt (ADR) trading volume to JSE trading volume, to be mainly exposed to the South African market. Regarding the predetermined outliers, the study categorises macro-outliers as days related to predictable market announcements which are US nonfarm payrolls announcement days. Similarly, micro-outliers are classified as days linked to predictable sector-specific and firm-specific news, which are sectoral announcement, and company earnings announcement days, respectively. The study aims to contribute to the empirical and theoretical literature on the distributional properties of South African equity returns.

This study makes use of a filter to narrow the sample of stocks for empirical investigation over the period from 1 January 2016 to 31 December 2017, and analyses daily stock returns on a 65-day rolling basis. Using only those equities, an evaluation of the goodness-of-fit methodology is conducted using graphical methods, and statistical goodness-of-fit tests sorted into (i) empirical distribution function, (ii) regression and correlation, and (iii) moment tests. It is found that the majority of the data exhibits significant departures from normality in empirical distribution function, and regression and correlation tests. The results were statistically significant at three confidence levels. However, in the case of moment tests, the results show a clear divergence between the methods. It is further demonstrated that while the daily stock returns have improved fits to the normal distribution, they remain predominantly positively-skewed and thick-tailed even after the removal of the *a priori* outliers. On this basis, it is argued that some downside risk measures, and asset allocation frameworks may not be applicable in the South African context.

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Contents

1	Introduction	1
2	Literature Review	4
2.1	Return Distributions in Empirical Finance	4
2.2	Normality of Returns on the JSE	8
2.3	Normality and Downside Risk	10
2.4	Predetermined Events of Increased Volatility	13
2.4.1	Red Letter Days	13
2.4.2	Blue Letter Days	16
2.5	Empirical Evaluation	18
3	Data and Sample Selection	23
3.1	Data	23
3.1.1	Return Interval	24
3.1.2	Equity Sample Period	25
3.1.3	Equity Sample Selection	25
3.1.4	Index Sample Selection	26
3.1.5	Removal of Red and Blue Letter Days	27
3.2	Potential Biases and Adjustments	28
3.2.1	Survivorship Bias	28
3.2.2	Data Snooping	29
3.2.3	Dividend Considerations	29
4	Methodology	31
4.1	Graphical Methods	31
4.1.1	Histogram	31
4.1.2	Normal Quantile-Quantile Plot	33
4.2	Empirical Distribution Function Tests	34
4.2.1	Anderson-Darling Test	34
4.2.2	Lilliefors Test	35
4.3	Regression and Correlation Tests	36
4.3.1	Shapiro-Wilk Test	36
4.4	Moment Tests	37
4.4.1	Jarque-Bera Test	37

4.4.2	D’Agostino-Pearson Test	37
5	Empirical Results	39
5.1	Return Behaviour of the Original Data	39
5.2	Return Behaviour after the removal of Red Letter Days	46
5.3	Return Behaviour after the removal of Red and Blue Letter Days	52
5.4	Discussion of Results	60
6	Conclusion	64
6.1	Considerations for Future Research	65
	Bibliography	67
A	Stocks analysed and/or used in the Data Analysis	83
A.1	Top 100 stocks on the JSE Main Board as of 31 December 2015, listed by market capitalisation	83
A.2	South African Equities used in the Econometric Analysis	87
A.3	FTSE/JSE Africa Sector Indices used in the Econometric Analysis	89
B	Descriptive Statistics of the Data	93
B.1	Summary Statistics of the Original Data	93
B.2	Summary Statistics of the Data after the removal of Red Letter Days	96
B.3	Summary Statistics of the Data after the removal of Red and Blue Letter Days	99
C	Empirical Results from the Original Data	103
C.1	SASOL	103
C.2	MTN Group	107
C.3	FirstRand Group	111
C.4	Vodacom Group	115
C.5	Standard Bank Group	119
C.6	Aspen Pharmacare	123
C.7	Sanlam	127
C.8	Remgro	131
C.9	ABSA Group	135
C.10	Bidvest Group	139
C.11	Nedbank Group	143

C.12 Discovery	147
C.13 Shoprite Holdings	151
C.14 RMB Holdings	155
C.15 Capitec Bank Holdings	159
C.16 Tiger Brands	163
C.17 RMI Holdings	167
C.18 Mr Price Group	171
C.19 PSG Group	175
C.20 Anglo American Platinum	179
C.21 Netcare	183
C.22 Truworths International	187
C.23 Pioneer Foods Group	191
C.24 Life Healthcare	195
C.25 MMI Holdings	199
C.26 Sappi	203
C.27 Telkom SA SOC	207
C.28 Liberty Holdings	211
C.29 Spar Group	215
C.30 Pick 'n Pay Stores	219
C.31 AVI	223
C.32 TFG (The Foschini Group)	227
C.33 Tsogo Sun Holdings	231
C.34 Imperial Logistics	235
C.35 Clicks Group	239
C.36 Santam	243
C.37 Massmart Holdings	247
C.38 Curro Holdings	251
C.39 Coronation Fund Managers	255
C.40 Impala Platinum	259
C.41 EOH Holdings	263
C.42 Nampak	267
C.43 KAP Industrial Holdings	271
C.44 Exxaro Resources	275
C.45 Oceana Group	279

C.46 Super Group	283
C.47 Northam Platinum	287
C.48 Kumba Iron Ore	291
C.49 Barloworld	295
C.50 Famous Brands	299
C.51 Tongaat Hulett	303
C.52 Reunert	307
C.53 Italtile	311
C.54 Hosken Consolidated Investments	315
C.55 JSE Limited	319
C.56 AECI	323
D Empirical Results after the removal of Red Letter Days	327
D.1 SASOL	327
D.2 MTN Group	331
D.3 FirstRand Group	335
D.4 Vodacom Group	339
D.5 Standard Bank Group	343
D.6 Aspen Pharmacare	347
D.7 Sanlam	351
D.8 Remgro	355
D.9 ABSA Group	359
D.10 Bidvest Group	363
D.11 Nedbank Group	367
D.12 Discovery	371
D.13 Shoprite Holdings	375
D.14 RMB Holdings	379
D.15 Capitec Bank Holdings	383
D.16 Tiger Brands	387
D.17 RMI Holdings	391
D.18 Mr Price Group	395
D.19 PSG Group	399
D.20 Anglo American Platinum	403
D.21 Netcare	407
D.22 Truworths International	411

D.23 Pioneer Foods Group	415
D.24 Life Healthcare	419
D.25 MMI Holdings	423
D.26 Sappi	427
D.27 Telkom SA SOC	431
D.28 Liberty Holdings	435
D.29 Spar Group	439
D.30 Pick 'n Pay Stores	443
D.31 AVI	447
D.32 TFG (The Foschini Group)	451
D.33 Tsogo Sun Holdings	455
D.34 Imperial Logistics	459
D.35 Clicks Group	463
D.36 Santam	467
D.37 Massmart Holdings	471
D.38 Curro Holdings	475
D.39 Coronation Fund Managers	479
D.40 Impala Platinum	483
D.41 EOH Holdings	487
D.42 Nampak	491
D.43 KAP Industrial Holdings	495
D.44 Exxaro Resources	499
D.45 Oceana Group	503
D.46 Super Group	507
D.47 Northam Platinum	511
D.48 Kumba Iron Ore	515
D.49 Barloworld	519
D.50 Famous Brands	523
D.51 Tongaat Hulett	527
D.52 Reunert	530
D.53 Italtile	534
D.54 Hosken Consolidated Investments	538
D.55 JSE Limited	542
D.56 AECI	546

E	Empirical Results after the removal of Red and Blue Letter Days	549
E.1	Banks	549
E.1.1	FirstRand	549
E.1.2	Standard Bank Group	551
E.1.3	ABSA Group	553
E.1.4	Nedbank Group	555
E.1.5	RMB Holdings	557
E.1.6	Capitec Bank Holdings	559
E.1.7	Results from Goodness-of-Fit Tests	561
E.2	Chemicals	562
E.2.1	SASOL	562
E.2.2	AECI	564
E.2.3	Results from Goodness-of-Fit Tests	566
E.3	Electronic and Electrical Equipment	567
E.3.1	Reunert	567
E.3.2	Results from Goodness-of-Fit Tests	569
E.4	Equity Investment Instruments	570
E.4.1	RMI Holdings	570
E.4.2	Hosken Consolidated Investments	572
E.4.3	Results from Goodness-of-Fit Tests	574
E.5	Fixed Line Telecommunications	575
E.5.1	Telkom SA SOC	575
E.5.2	Results from Goodness-of-Fit Tests	577
E.6	Food and Drug Retailers	578
E.6.1	Shoprite Holdings	578
E.6.2	Spar Group	580
E.6.3	Pick 'n Pay Stores	582
E.6.4	Clicks Group	584
E.6.5	Results from Goodness-of-Fit Tests	586
E.7	Food Producers	587
E.7.1	Tiger Brands	587
E.7.2	Pioneer Foods Group	589
E.7.3	AVI	591
E.7.4	Oceana Group	593

E.7.5	Tongaat Hulett	595
E.7.6	Results from Goodness-of-Fit Tests	597
E.8	Forestry and Paper	598
E.8.1	Sappi	598
E.8.2	Results from Goodness-of-Fit Tests	600
E.9	General Financials	601
E.9.1	PSG Group	601
E.9.2	Coronation Fund Managers	603
E.9.3	JSE Limited	605
E.9.4	Results from Goodness-of-Fit Tests	607
E.10	General Industrials	608
E.10.1	Remgro	608
E.10.2	Bidvest Group	610
E.10.3	Nampak	612
E.10.4	KAP Industrial Holdings	614
E.10.5	Barloworld	616
E.10.6	Results from Goodness-of-Fit Tests	618
E.11	General Retailers	619
E.11.1	Mr Price Group	619
E.11.2	Truworths International	621
E.11.3	TFG	623
E.11.4	Massmart Holdings	625
E.11.5	Curro Holdings	627
E.11.6	Italtile	629
E.11.7	Results from Goodness-of-Fit Tests	631
E.12	Healthcare Equipment and Services	632
E.12.1	Netcare	632
E.12.2	Life Healthcare	634
E.12.3	Results from Goodness-of-Fit Tests	636
E.13	Industrial Metals	637
E.13.1	Kumba Iron Ore	637
E.13.2	Results from Goodness-of-Fit Tests	639
E.14	Industrial Transportation	640
E.14.1	Imperial Logistics	640

E.14.2	Super Group	642
E.14.3	Results from Goodness-of-Fit Tests	644
E.15	Life Insurance/Assurance	645
E.15.1	Sanlam	645
E.15.2	MMI Holdings	647
E.15.3	Discovery	649
E.15.4	Liberty Holdings	651
E.15.5	Results from Goodness-of-Fit Tests	653
E.16	Mining	654
E.16.1	Anglo American Platinum	654
E.16.2	Impala Platinum	656
E.16.3	Exxaro Resources	658
E.16.4	Northam Platinum	660
E.16.5	Results from Goodness-of-Fit Tests	662
E.17	Non-Life Insurance	663
E.17.1	Santam	663
E.17.2	Results from Goodness-of-Fit Tests	665
E.18	Pharmaceuticals and Biotechnology	666
E.18.1	Aspen Pharmacare	666
E.18.2	Results from Goodness-of-Fit Tests	668
E.19	Software and Computer Services	669
E.19.1	EOH Holdings	669
E.19.2	Results from Goodness-of-Fit Tests	671
E.20	Travel and Leisure	672
E.20.1	Tsogo Sun Holdings	672
E.20.2	Famous Brands	674
E.20.3	Results from Goodness-of-Fit Tests	676
E.21	Wireless Telecom Services	677
E.21.1	MTN Group	677
E.21.2	Vodacom Group	679
E.21.3	Results from Goodness-of-Fit Tests	681

List of Figures

1	Histogram demonstrates that the data is normally distributed (Freeman, n.d.).	32
2	Histogram demonstrates that the data is not normally distributed (University of Florida Health, n.d.).	32
3	Normal Quantile-Quantile Plot demonstrates that the data is normally distributed.	33
4	Normal Quantile-Quantile Plot demonstrates that the data is not normally distributed.	34
5	Histogram and Normal Quantile-Quantile Plot of Truworths International . .	41
6	Histogram and Normal Quantile-Quantile Plot of EOH Holdings	43
7	Histograms of Kumba Iron Ore (a) using the original data, and (b) after the removal of red letter days	46
8	Normal Quantile-Quantile Plots of Kumba Iron Ore (a) using the original data, and (b) after the removal of red letter days	47
9	Histograms of Truworths International (a) using the original data, and (b) after the removal of red letter days	47
10	Normal Quantile-Quantile Plots of Truworths International (a) using the original data, and (b) after the removal of red letter days	48
11	Normal Quantile-Quantile Plots of EOH Holdings (a) using the original data, and (b) after the removal of red letter days	50
12	Histograms of Truworths International (a) using the original data, (b) after the removal of red letter days, and (c) after the removal of red and blue letter days	53
13	Normal Quantile-Quantile Plots of Truworths International (a) using the original data, (b) after the removal of red letter days, and (c) after the removal of red and blue letter days	54
14	Normal Quantile-Quantile Plots of Kumba Iron Ore (a) using the original data, (b) after the removal of red letter days, and (c) after the removal of red and blue letter days	56

List of Tables

1	Common Goodness-of-Fit Tests categorised into three categories	19
2	Analysis of Sample Selection	24

3	Descriptive Statistics of the Five Stocks from the Original Data	40
4	Goodness-of-fit test results of the five stocks from the original data	44
5	Descriptive Statistics of the Five Stocks from the Data after the Removal of Red Letter Days	48
6	Goodness-of-fit test results of the five stocks from the data after removing red letter days	51
7	Descriptive Statistics of the Five Stocks from the Data after the Removal of Red and Blue Letter Days	55
8	Goodness-of-fit test results of the five stocks from the data after removing red and blue letter days	58
9	Number of equities with daily returns that are statistically significant at a 90% confidence level ($\alpha = 0.10$) and reject the null hypothesis of Gaussianity	60
10	Number of equities with daily returns that are statistically significant at a 95% confidence level ($\alpha = 0.05$) and reject the null hypothesis of Gaussianity	61
11	Number of equities with daily returns that are statistically significant at a 99% confidence level ($\alpha = 0.01$) and reject the null hypothesis of Gaussianity	61

1 Introduction

The standard Gaussian distribution is the most widely used distribution in classical statistics and has applications in computer science, ecology and chemistry (Crow and Shimizu, 1987). In financial economics, normality is an assumption that underpins several asset pricing models including the Capital Asset Pricing Model (CAPM) (Treyner, 1962; Sharpe, 1964; Lintner, 1965; Mossin, 1966) and the Black-Scholes options pricing model (Black and Scholes, 1973). As such, there has been extensive investigation into the propriety of this assumption (Fama, 1965; Clark, 1973; Fama, 1976; Bookstaber and McDonald, 1987; Affleck-Graves and McDonald, 1989). With reference to equity returns, the subsequent conclusion drawn from the aforementioned literature is that returns do not follow a Gaussian distribution; thus, it casts doubt on results that depend primarily on this assumption.

The distribution of stock returns has been widely researched in empirical research (Lux, 1996; Mandelbrot, 1997; Gopikrishnan et al., 2000; Gabaix et al., 2003; Farmer and Lillo, 2004). This has increasingly become of interest to academics and investment professionals due to the 2008 Great Recession, which saw investors experiencing higher likelihoods of suffering significant losses relative to what conventional asset pricing models would suggest. In modelling the estimated frequency of “bank failures”, Goldman Sachs abandoned the normal distribution to model non-crisis states in the markets in favour of a lognormal distribution (Strongin et al., 2014). With respect to downside risk, this implies asymmetry with the stock return distribution (Xiong, 2010).

As a persistent concern in empirical finance research, outliers (which are observations that deviate significantly from the data) are known to have the power to yield misrepresentative descriptive statistics and/or biased coefficient estimates in least-squares regressions (Edgeworth, 1887; Adams et al., 2014). The purpose of this study is to explore whether removing predictable macro-outliers and micro-outliers from daily JSE stock return data will result in improved goodness-of-fit to the Gaussian distribution. By extension, the equities are expected to demonstrate lower and more symmetric standard deviations. These outliers will be categorised as: (i) “red letter days”, which refers to days of planned information releases within the financial markets; and (ii) “blue letter days”, which are days relating to pre-determined firm-specific and/or sector-specific news. The details of each category will be explained further in the study.

Extensive research has been conducted on the normality of stock returns and the postulated empirical distribution thereof. As such, there are varying opinions on the distribution of stock returns; however, there is little to no literature investigating this in the South African context. Bowie and Bradfield (1993) and Tolikas (2011) however find that South African daily stock returns are highly leptokurtic and demonstrate significant deviations from normality. Additionally, although the normality hypothesis is rejected by Prakash et al. (2003) and Chi3n et al. (2008) this study may deliver interesting results in the South African market environment, especially with the removal of *a priori* macro-outliers and micro-outliers.

This study is conducted in an attempt to contribute to the literature on the distributional properties of South African single-listed equities after the 2008 Great Recession. Furthermore, there are fewer studies locally, relative to those conducted in offshore markets, which detail the effect of predetermined macro-outliers and micro-outliers on security prices and returns (Jefferis and Smith, 2005; Yartey and Adjasi, 2007; Mlonzi et al., 2011; Afego, 2013).

The objective of this study is to determine whether removing *a priori* macro-outliers and micro-outliers creates improved fits to the Gaussian distribution. This will be done using graphical methods, including density histograms. Additionally, five goodness-of-fit tests will be implemented to support the graphical methods. These tests are categorised into (i) empirical distribution function, (ii) regression and correlation, and (iii) moment tests. These tests will be used to determine which equities have returns that are not statistically significant, and can be concluded that normality is a reasonable assumption for them. This will be carried out using a sample of data from the South African equity market that comprises of single-listed stocks. The research conducted by Peiro (1994), Prakash et al. (2003) and Chi3n et al. (2008) used the goodness-of-fit methodology to test for normality. The contribution of this study will also determine whether the results are consistent with the international research. It must be highlighted that a sampling filter is applied in this study, which is a similar approach to that proposed by Van Rensburg (2002).

The rest of the dissertation is organised as follows: **Chapter 2** presents the existing body of theoretical and empirical literature; **Chapter 4** describes the research methodology; **Chapter 5** demonstrates the findings from the quantitative analysis and lastly, **Chapter 6** concludes the study and discusses the scope for future research. The technicalities and

considerations of the data are outlined in **Chapter 3**.

2 Literature Review

Economic and financial theories fundamentally depend on a particular parameterisation of the distributions of which their parameters are meant to illustrate the “macroscopic” entities that economic and/or market participants are sensitive to (Malevergne et al., 2005). As such, this chapter will present the relevant literature. It must be emphasised that the amount of empirical and theoretical research in this field does not permit for an exhaustive assessment of all the facets of the literature.

Section 2.1 will provide an outline of the asset pricing environment and background to the various asset return distributions, then the evidence from the JSE will be presented in **Section 2.2**. The aspects relating to the impact of non-normality on risk management and volatility will be discussed in **Section 2.3**, then **Section 2.4** will explain the *a priori* macro-outliers and micro-outliers in detail. Additionally, the subsequent empirical evaluation of the various normality measures will be reviewed in **Section 2.5**.

2.1 Return Distributions in Empirical Finance

In the existing body of finance literature, the Gaussian distribution has been regarded as the *sine qua non* for theoretical and empirical methods whilst also assuming that its parameters are stationary over time. Kon (1984) states that the axioms of normality and parameter stationarity forms the basis of the econometric techniques that are conventionally used in quantitative research. Krishnamoorthy (2006) states that a random variable X follows a Gaussian/normal distribution and is thus defined by the probability density function

$$f(x|\mu, \sigma) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{(x - \mu)^2}{2\sigma^2}\right], \quad -\infty < x < \infty, \quad -\infty < \mu < \infty, \quad \sigma > 0 \quad (1)$$

where μ represents the mean and σ represents the standard deviation. The Gaussian distribution is frequently denoted by $N(\mu, \sigma^2)$. Additionally, the cumulative distribution function is described by

$$F(x|\mu, \sigma) = \int_{-\infty}^x f(t|\mu, \sigma) dt. \quad (2)$$

The normal random variable with $\mu = 0$ and $\sigma = 1$ is known as the standard normal random variable, and its cumulative distribution function is represented by $\Phi(z)$. Keeping (1962) and Krishnamoorthy (2006) state that if X is a normal random variable with mean μ and standard deviation σ , then

$$P(X \leq x) = P\left(Z \leq \frac{x - \mu}{\sigma}\right) = \int_{-\infty}^{(x-\mu)/\sigma} \exp\left(\frac{-t^2}{2}\right) dt = \Phi\left(\frac{x - \mu}{\sigma}\right). \quad (3)$$

The mean serves as the location parameter, and the standard deviation is the scale parameter. The Gaussian distribution function is symmetric and mesokurtic, which implies that $\gamma_1(X) = 0$ and $\gamma_2(X) = 3$, respectively. This also represents perfect goodness-of-fit for several financial time series.

Nevertheless, the underlying assumption of normality in trading volume and asset returns has been disputed. It must be noted that most conventional periods of trading may justify the normality assumption, but Bohrmann (2014) highlights that the tails of the empirical distribution display significant departures from normality. Equivalently, McDonald (1996) states that higher values of kurtosis are prevalent in financial return data. A distribution with $\gamma_2(X)$ less than 3 is said to be platykurtic; conversely, a leptokurtic distribution has a $\gamma_2(X)$ greater than 3 (Stuart and Ord, 1987). As such, these tails (commonly referred to as “fat tails” or “heavy tails”) include a higher number of events in comparison to the Gaussian distribution.

Furthermore, Xiong (2010) argues that the Gaussian distribution model assumes that a stock return that lies three standard deviations (typically referred to as a “three-sigma event”) below its mean has a 0.13% likelihood of occurring. However, between January 1926 and April 2009, the S&P 500 demonstrated a monthly mean return and standard deviation of 0.91% and 5.55%, respectively. Also, the literature (ibid.) states that the abovementioned index would incur a monthly loss of 15.74% due to a negative three-sigma event; however, the S&P 500 experienced ten monthly returns that exceeded this amount. This further implies that, from operating on a Gaussian distribution model, the likelihood of a three-sigma event is eight times greater than an investor would expect. As such, the standard normal distribution fails to explain the fat tails of plausible asset returns (Bohrmann, 2014).

The genesis of research into the distribution of asset returns is linked to Bachelier (Davis et al.,

2011) where the underlying assumption of normality in asset returns was originally proposed. Essentially, if transactions can be assumed to be independent and identically distributed random variables with finite variances, then it can be demonstrated via the Central Limit Theorem that, over longer horizons, the aggregate number of independent random variables will tend towards normality (Fama, 1963; Harris and Küçüközmen, 2001; Bohrmann, 2014). “Brownian motion”, originally used in physics to illustrate the irregular motion of particles of matter suspended in a fluid or gas, was also implemented in finance to describe stock market movements by Osborne (1959). The literature further states price movements are independent and the sizes of those fluctuations followed a Gaussian distribution.

Mandelbrot (1963) made a pioneering contribution through concluding that the “empirical distributions of price changes are usually too ‘peaked’ to be relative to samples from Gaussian populations.” Essentially, the literature (ibid.) regarded Brownian motion to not necessarily be applicable to stock price changes at all times because the tails of the empirical distribution are greater than those of the Gaussian distribution. It may be highlighted that, by assuming Brownian motion, the stock prices ought to follow a normal distribution (Osborne, 1959). Moreover, Mandelbrot (1963) proposed a new model of price movements called “stable Paretian distributions” and implemented the model to cotton price changes which showed that, in the tails, the Gaussian distribution is inappropriate. This class of distributions is defined by the logarithm of the characteristic function as

$$\log[f(t)] = i\delta t - |ct|^\alpha \left(1 + \frac{i\beta t}{|t|} \omega(t, \alpha) \right) \quad (4)$$

where $i = \sqrt{-1}$, $\omega(t, \alpha) = \tan(\pi\alpha/2)$ if $\alpha \neq 1$, $\omega(t, \alpha) = (2\log|t|)/\pi$ if $\alpha = 1$ and α, β, c and δ are parameters associated with the first four moments of the distribution (Fama, 1963; Peiro, 1994). The magnitude of the tails of the distribution are reflected in the characteristic exponent, α , which validates $0 < \alpha \leq 2$. Therefore, the stable Paretian distribution becomes a $N(\delta, 2c^2)$ distribution when $\alpha = 2$. Also, the variance infinite when $\alpha < 2$.

Following Mandelbrot’s research, Fama (1963) investigated the validity of the stable Paretian hypothesis as its veracity bears significant consequences on the fundamental understanding of speculative markets and the appropriate statistical methods concerning speculative prices. Moreover, Fama (1965) surveyed the thirty stocks of the Dow Jones Industrial Average

(DJIA) and confirmed the hypothesis that a stable Paretian distribution with $\alpha < 2$ actually illustrates asset returns better relative to a Gaussian distribution. The literature further states that the standard deviation of the latter distribution understates the risk of stocks. Furthermore, Aparicio and Estrada (2001) argue that if stock returns emulate a stable Paretian distribution and the variance is infinite, then the conventional statistical methods may provide fallacious answers.

The above literature demonstrates the importance of retaining the tail data, even when it does not follow a Gaussian distribution. The main reason behind this is that the tail events are the most important occurrences for an investor to be circumspect of and prepare accordingly. Xiong (2010) emphasises that these kind of events are the stock market crashes linked to the Great Depression, Great Recession and the consequent failure of the stock market after the demise of Long Term Capital Management (LTCM) in 1998.

Although power laws are not explicitly mentioned by Mandelbrot (1963), the model is premised on the “stable Paretian” class of probability laws; notwithstanding that the standard normal distribution is a special form of a stable distribution. However, Gabaix (2009) notes that other non-Gaussian kinds of stable distributions resemble power law distributions with heavy tails. In essence, non-Gaussian extreme events follow a power law distribution. Literature on power law distributions comes from an emerging field of “econophysics”, a term referring to the utilisation of mechanisms created for physics in economics (Plerou et al., 2000). While valid, the arguments proposed by Mandelbrot (1963), Fama (1965), Aparicio and Estrada (2001), and Gabaix (2009) fall outside the scope of this dissertation.

Despite the wealth of literature invalidating the normal distribution, there is still no general consensus on the empirical distribution of stock returns. Furthermore, abandoning the normal distribution as a primary model assumption would mean that alternative asset pricing models will be needed to replace the existing ones, including the mean-variance analysis (Markowitz, 1952) and CAPM. However, the explicit and implicit costs involved in switching from the normal distribution to adopting the hypothetical Paretian distributions may exceed the prospective gains. This may also mean that the Gaussian distribution has a “lock-in” effect in the financial markets; therefore, there is a quasi-irreversibility of investment in the asset pricing models that are premised on the abovementioned distribution (David, 1985). Additionally, the technical interrelatedness of these models ensures that researchers and

market participants continue to derive generalised increasing returns from using the Gaussian distribution as a fundamental assumption in financial economics (ibid.).

It is critical to note that this study will examine whether the daily return distribution of South African equities will demonstrate improved fits to normality. This consequently implies that if the hypothesis is true at a pre-specified confidence level, then the various indicators and models (viz. the Sharpe Ratio) will become more reliable when applied to financial time series.

2.2 Normality of Returns on the JSE

Gilbertson and Roux (1977, 1978) pioneered the research into the return distribution of the JSE and discovered significant departures from normality. This literature also found that the empirical distribution for JSE returns was more leptokurtic relative to that of the New York Stock Exchange. This therefore means that there is a higher likelihood of large price movements occurring in the tails of the abovementioned empirical distribution than implied by the Gaussian distribution. In an analysis of measuring security price performance, Page (1993) attempted to explore the statistical features of JSE stock returns. The study confirmed the existence of non-normal return behaviour in 244 equities traded from February 1973 to March 1992. Furthermore, the literature used a wide variety of normality tests to arrive at the aforementioned conclusion; notwithstanding that 54 stocks in the sample were frequently traded.

In the post-Apartheid South African literature, Chen et al. (2003) use JSE monthly stock return data spanning from 25 August 1988 to 24 July 1999 to derive the distribution of security returns in an “upgraded” market. This study assumes that the stock market proxy follows a combination of Gaussian distributions. As such, it concludes that security returns follow a skew-normal distribution. Additionally, Jefferis and Smith (2005) found that weekly JSE security returns demonstrate significant deviations from normality, and similar to Gilbertson and Roux (1977, 1978), the empirical distributions were heavy-tailed.

Mangani (2007) investigated the distributional properties of 42 JSE security prices and returns using weekly data covering the period from 28 February 1973 to 5 April 2002. The literature (ibid.) replicated the approach used by Page (1993) and performed the Jarque-Bera normality tests. As such, the study (ibid.) reported unambiguous evidence of leptokurtosis,

and the unequivocal rejection of the normality hypothesis which supports the international evidence (Mandelbrot, 1963; Fama, 1965) as well as the JSE (Gilbertson and Roux, 1977, 1978; Page, 1993; Chen et al., 2003; Jefferis and Smith, 2005). Lastly, Tolikas (2011) explored the asymptotic distribution of the extreme daily security returns in four African markets over the period from 1996 to 2007. Moreover, the study concludes that JSE extreme daily stock returns exhibit significant non-Gaussian behaviour, and heavy tails. These findings are consistent with the abovementioned literature.

There appears to be a consensus in the related literature that South African stock returns, especially daily and weekly returns, are not normally distributed. They also demonstrate significant leptokurtosis. Consequently, joint multivariate normality is an unrealistic assumption for modelling JSE returns. It is also important to note that the Gaussianity of individual stock returns is a necessary, but not sufficient condition for the joint multivariate normality of all the returns (Kon, 1984; Richardson and Smith, 1993). Therefore, the non-normality of the stock returns brings the applicability of certain asset pricing models (including CAPM) to South African stock market into question. Furthermore, the abovementioned evidence affects downside risk measures which will be discussed in the next section.

The international and local literature assessed in this chapter either aims to (i) determine an official empirical distribution of stock returns, or (ii) explain the distributional properties of stock returns across several developed, emerging, and/or frontier markets. This study separates itself from the abovementioned research by investigating whether the removal of *a priori* macro-outliers and micro-outliers can result in improved fits to the normal distribution. The removal of red letter days allows academics and practitioners to understand the impact of US nonfarm payroll days on stock returns and whether the events expose South African stocks to increased downside risk. Equivalently, the removal of blue letter days in the study demonstrates the effect of sectoral news and company earnings announcements on equity returns, especially for single-listed stocks of companies that may have limited presence in other markets via American Depository Receipts (ADRs). Therefore, this study serves to equip practitioners with the knowledge on how the presence of heavy tails and skewness may compromise or benefit their investments in single-listed stocks, and expose financial institutions and regulators to increased downside risk.

2.3 Normality and Downside Risk

As intricate systems with interwoven components, financial markets can be split into two groups: (i) the traders, which include individual investors, mutual funds, brokerage firms and banks, and (ii) the assets, which include bonds, equities, futures and options. As previously discussed, the presence of fat tails in the empirical distribution of stock returns implies a higher likelihood of large price movements. Bekaert et al. (1998) argues that the above-mentioned observation is more pronounced in emerging markets relative to developed ones which may be attributed to liquidity issues, and other market inefficiencies. Consequently, investment professionals are interested in large price changes as these can decimate investment performance and value.

In the context of this study, the occurrence of extreme values can significantly diminish the advantages of risk diversification. Since assets become highly correlated during a market crash, it is therefore difficult to diversify away linked to extreme price changes. As such, the Bank for International Settlements and other financial regulators have also demonstrated their interest in determining the likelihood of large financial losses, and protecting the financial market system from such events (Tolikas, 2011). This therefore means that financial institutions are required to abide to capital adequacy requirements, which would insulate the financial market system from the probability of large losses owing to extreme events. In South Africa, the likelihood of extreme events occurring can have significant ramifications on economic development as stock markets are the main driver of growth for local firms (Alfaro et al., 2004; Ang and McKibbin, 2007).

Financial market volatility can result in severe consequences for the world economy as depicted by the 1997 Asian Financial Crisis, and 2008 Great Recession. Volatility refers to a measure of the average changes of market value over a specific time interval T , which is important as it gauges the risk relating to assets (Cizeau et al., 1997). However, Poon and Granger (2003) emphasises that volatility and risk are not the same. The former can be interpreted as uncertainty and used as an essential input to several investment choices and portfolio creations; the latter is often associated with small or negative returns. As such, individual and institutional investors and portfolio managers can tolerate certain risk levels, which implies that good volatility forecasts play an integral role in assessing investment risk.

In conventional finance theory, volatility is regarded as the standard deviation, σ , or variance,

σ^2 , which is calculated from a set of observations as

$$\hat{\sigma}^2 = \frac{1}{N-1} \sum_{t=1}^N (R_t - \bar{R})^2 \quad (5)$$

where \bar{R} is the average return and $\hat{\sigma}$ represents the sample standard deviation, which is a distribution-free parameter. The necessary probability density and cumulative probability density function can only be attained analytically if σ is linked to a standard distribution such as the Gaussian or Student's t distribution (Keeping, 1962). However, this view has evolved with the developments in statistics. Nonetheless, σ is an accurate measure of dispersion for a limited number of distributions, which has led to the suggestion of alternative measures including the inter-quantile range (Mittnik and Paoletta, 2003; Poon and Granger, 2003). Furthermore, the empirical violation of the normality assumption in asset returns arguably limits the use of σ in isolation; however, it does imply that downside risk measures in heavy-tailed distributions needs to be investigated as investors exhibit loss aversion (Box, 1953; Ang et al., 2006; Rosenberg and Schuermann, 2006). Semivariance is proposed by Markowitz (1991) as it utilises the squares of returns below the mean; however, it is a difficult measure to use in constructing portfolios.

Downside risk measures are defined as “*measures of 'the distance' between a risky situation and the corresponding risk-free situation when only unfavourable discrepancies contribute to the 'risk'*” (Dhaene et al., 2003). Ang et al. (2006) and Danielsson et al. (2006) attribute the early literature on downside risk measures to Roy (1952) where the “safety first” rule was forwarded. Given the renewed interest in downside risk measures and heavy-tail distributions, modern concepts including Value-at-Risk (VaR) and Expected Shortfall (ES) have been used for financial risk management and macroprudential regulation (Danielsson et al., 2006). VaR refers to the maximum loss that can occur during certain periods of time (usually one or ten days) given a specific confidence level (either one- or five-percent critical value); thus, it is a conditional quantile of the asset return loss distribution (Jorion, 1996). Gençay et al. (2003) and Rosenberg and Schuermann (2006) formally define Y_t as the portfolio value at time t , and k -period-ahead portfolio return as $r_{t+k} = \ln(Y_{t+k}) - \ln(Y_t)$. Therefore, at a $(1 - \alpha)\%$ quantile, $VaR_{t+k}(\alpha)$ is estimated at time t for a k -period-ahead return as

$$Pr\left(r_{t+k} < VaR_{t+k}(\alpha)\right) = \alpha. \quad (6)$$

Since 1988, the Basel Committee on Bank Supervision¹ has required VaR to become a key market risk management tool for financial institutions. Huisman et al. (1998) presents VaR-x, which factors the apparent tail fatness in asset returns into the VaR approximation, which improves the quality of the estimates. In the case of heavy-tailed distributions, the Extreme Value Theory will need to be incorporated in improving VaR estimations due to VaR focusing mainly on the asset return distribution in the tail; notwithstanding that this sentiment is supported by Danielsson and De Vries (2000), Xiong and Idzorek (2011), and Abad et al. (2014). Basel Committee (2012) has since released Fundamental Review of the Trading Book where “a shift from Value-at-Risk (VaR) to an Expected Shortfall (ES) measure of risk under stress” is mentioned. Expected Shortfall provides a more prudent estimate of “tail risk” for heavy-tailed distributions and Chang et al. (2016) motivates the shift as: (i) ES accounts for losses exceeding the VaR level and demonstrates sub-additivity, whereas VaR fails to do this and is not sub-additive; (ii) ES is mathematically-superior to VaR as it is less susceptible to over- and under-estimating tail risk.

Conclusively, the link that risk has to the standard deviation of the empirical distribution means that any risk considerations are related to the deviations of returns from the mean (Ang et al., 2006). As such, in the case of non-normal heavy-tailed distributions, risk may imply the likelihood of extreme events occurring. Therefore, the invalidation of the normality assumption means that using standard deviation as a stand-alone measure of downside risk may be inappropriate. Furthermore, it could lead to the misestimation of security prices, especially if the suitable distributions have three or more parameters (Chi on et al., 2008). For financial institutions and regulators, this also implies that more rigorous risk estimates including Expected Shortfall are needed to protect the financial system.

¹The Basel Committee on Bank Supervision mainly comprises of G10 countries and covers 45 institutions from 28 jurisdictions. “BCBS” or “the Committee” will be used interchangeably from this point thereafter (Jorion, 1996).

2.4 Predetermined Events of Increased Market Volatility

2.4.1 Red Letter Days

In capital asset pricing theory, macroeconomic announcements are regarded as one of the most important systematic risk factors due to the state of an economy serving as a driver of unsystematic risk (Sharpe, 1964; Lintner, 1965; Esin and Gupta, 2017). Scholarly interest in the effect of macroeconomic announcements on stock prices and other financial market variables started to grow in the 1980s. With a focus on the United States, the literature (Pearce and Roley, 1985; Hardouvelis, 1987; Jain, 1988) assessed which kind of macroeconomic announcements had a considerable impact on asset prices. Since red letter days are premised on pre-determined dates, the market is able to foresee these news and formulate its expectations. Conventionally, the exact dates and times are released to the financial market community well ahead of the time. In the US, the Bureau for Labour Statistics releases the total nonfarm employment or “nonfarm payrolls” statistic on the first Friday of every month at 08:30 Eastern Standard Time (which would be 14:30 in South Africa) (Funke and Matsuda, 2006). Conversely, the South African Reserve Bank’s Monetary Policy Committee (MPC) convenes six times a year on preordained dates made available to the public beforehand and releases the Monetary Policy Statement at 15:00 Central African Time (South African Reserve Bank, n.d.).

Monthly comparisons of nonfarm payrolls are used as a measure of economic standing; notwithstanding that it assists policymakers and the National Bureau of Economic Research (NBER) in assessing and predicting aggregate economic activity. Moreover, the nonfarm payrolls represents the unemployment statistics for the US labour market, including the labour force participation rate (Federal Reserve Bank of San Francisco, 2004). As part of the transmission mechanism of monetary policy, the South African Reserve Bank (SARB) runs a repurchase agreement (repo) system with an inflation targeting framework, where the repo rate is used as the primary instrument. Essentially, the repo rate represents the rate charged by the SARB for catering to the cash requirements of commercial banks; notwithstanding that the Monetary Policy Statement details any adjustment to the repo rate, which is a proxy for inflation (Mohr and Fourie, 2004; Sichei, 2005).

Theoretically, macroeconomic announcements affect stock returns if the news has an effect on the drivers of stock prices. As such, Duffie (2010) states that asset prices (P_t) represents the

present value of expected dividends (d) subject to the available information at time t (Ω_t):

$$P_t = E\left(\sum_{t=1}^{\infty} \frac{d_{t+\tau}}{1 + r_{t+\tau}} \middle| \Omega_t\right) \quad (7)$$

$$\Rightarrow R_t = \frac{P_{t+\tau} - P_t}{P_t} \quad \text{where } \tau \geq 0 \quad (8)$$

where the discount rate (r_t) comprises of the risk-free rate and equity risk premium.

In an investigation of the S&P500 covering the period between 1957 and 2009, Boyd et al. (2005) finds that on average, stock prices increase when the unemployment rate fall during expansions, yet stock prices respond negatively to rising unemployment during contractions in the business cycle. This supports the research conducted by McQueen and Roley (1993) where the literature investigates the daily percentage changes of the S&P500 index from September 1977 to May 1988. The study (ibid.) finds that the US stock prices responds to macroeconomic announcements based on the state of the economy. The variation in stock price reactions across different economic cycles is linked to investors needing to form expectations about future economic activity and expected cashflows. However, these views are challenged by Funke and Matsuda (2006) in a comparative study between US and German stocks using daily data spanning from 1997 to 2002. The literature concluded that, at a five percent significance level, nonfarm payrolls are not statistically significant; thus, the indicator does not affect US stock prices. This further affirms the view held by Gilbert et al. (2010) that equities markets overreact to the release of the nonfarm payrolls; however, Lahaye et al. (2011) presents the evidence that the the bond markets are more responsive to the announcements.

Nikkinen et al. (2006) investigate 35 stock market reactions to predetermined US macro-announcements from July 1995 to March 2002. The stock markets are divided into six groups: G7 countries, non-G7 European countries, developed and emerging Asian countries, Latin American countries, and transition economies. The study (ibid.) concludes that the G7 countries, non-G7 European countries, developed Asian countries, and emerging Asian countries are closely linked to the world's stock market as the various regions are affected by the US macroeconomic news. Conversely, Latin American and transition economies show that they are not impacted by the US macro-announcements; thus, the literature argues

that the abovementioned regions are not integrated with the global stock markets. Savor and Wilson (2013) examines the trade-off between macroeconomic risk and US financial asset returns through prescheduled economic announcements covering the period 1958 to 2009. The literature (*ibid.*) finds that stock market mean excess returns are 11.4 basis points (bp) on days when macroeconomic announcements are scheduled to be released, but for non-announcement days, the average falls to 1.1 bp. The Sharpe ratio is ten times higher on announcement days; notwithstanding that the difference between the average excess returns and Sharpe ratios are much higher during periods of high risk. Consequently, Savor and Wilson (2013) finds that investors demand higher expected returns on risky assets as compensation for the risks linked to macroeconomic news. Stotz (2016) supports the conclusions reached by Savor and Wilson (2013), and develops macroeconomic investment strategies based on this using announcement days from January 1962 to February 2014.

The existing literature (Betlehem, 1972; Roome, 1986; Firer and McLeod, 1999; Jorion and Goetzmann, 1999; Eita, 2012) examining the link between inflation and South African stock market returns has determined that equities function as a long-term hedge against inflation. Bethlehem (1972) is regarded as the first study to assess the relationship between inflation and stock market returns in South Africa. Using a randomly-selected sample of 20 industrial shares from the JSE during the period 1951 to 1971, the study deduces that South African equities were excellent hedges against inflation in the period examined; however, it must be noted that inflation was low due to the exclusion of South Africa from the world economy. In addition, Roome (1986) and Firer and McLeod (1999) support the deduction brought forward by Bethlehem (1972) that South African stocks serve as hedges against inflation; notwithstanding that Firer and McLeod (1999) carried out the study over the period from 1925 to 1998.

In a study spanning from 1947 to 1996, Jorion and Goetzmann (1999) concluded that inflation and South African stock market returns are negatively related. Furthermore, Eita (2012) performs an econometric analysis covering the period 1980 to 2008 and finds that the results are consistent with the abovementioned works (Betlehem, 1972; Roome, 1986; Firer and McLeod, 1999) on South Africa; thus, inflation and stock market returns are positively related and the causality is bi-directional when the JSE All-Share Index (ALSI) is used. Moreover, in an event study covering from 2002 to 2011, Gupta and Reid (2013) perform an empirical test on the sensitivity of ten industry-specific stock returns to monetary policy and macroeconomic

news. The literature (ibid.) finds that a basis point change in the repo rate induces a fall in the return of the several equities indices varying from 2.374 and 3.834 percent. Also, the repo rate is statistically significant across three significance levels ($\alpha = 0.10$, $\alpha = 0.05$, and $\alpha = 0.01$); thus, indicating the considerable effect that the variable has on stock returns. Additionally, using the daily JSE All-Share Index (ALSI) returns from 31 May 1994 to 8 March 2016, Esin and Gupta (2017) find that an unexpected rise in the US unemployment rate and drop in inflation leads to a riskier South African stock market. The study (ibid.) further states the South African stock market is less risky when the US unemployment rate falls. Furthermore, the study deduces that the abovementioned effect is asymmetric and favours the impact associated with the rise in US unemployment. It must be therefore be highlighted that this relationship deteriorates the financial conditions in South Africa, and consequently impacts the real economy negatively.

2.4.2 Blue Letter Days

Earnings announcements serve as a benchmark that can be used by the market to determine the profitability and wealth of a firm (Mlonzi et al., 2011). Aharony and Swary (1980) argue that earnings figures are one of the most important signalling tools in the market and the underlying assumption behind this argument is that managers have access to material non-public information regarding the prospects of the firms. Black (1980) furthers this argument by emphasising that the users of financial statements anticipate earnings to be an indicator of absolute value, rather than marginal value. In addition, Kim and Verrecchia (1991) finds that the price movement at the time of an earnings announcement is proportional to both (i) the unforeseen component of the announcement, and (ii) its comparative importance to the *a priori* assumptions of traders. Consequently, security prices are more volatile on earnings announcement days than on non-announcement days as the information influences the prices after the scheduled announcement (Nikkinen and Sahlström, 2004).

Previous research (Ro, 1983; Chambers and Penman, 1984; Kross and Schroeder, 1984) has deduced that firm size is inversely related to the absolute stock returns around the earnings announcements day. Kross and Schroeder (1984) also found that the timing of earnings announcements was linked to abnormal equity returns on the earnings announcement day. Moreover, the relationship was found to be driven by whether the earnings announcement (i) included good or bad news, (ii) was issued by a small or large company, (iii) was a

final or interim announcement, or (iv) included relatively bad or good news. Potter (1992) researched the US stock market from 1979 to 1985, and found a positive relationship between the size of institutional ownership and variation in stock prices around quarterly earnings announcements dates when firm size is controlled. This view is supported by Bartov et al. (2000) through investigating US listed firms from 1989 to 1993.

In a study using a very large sample of observations from the New York and American Stock Exchange (NYSE-AMEX), Ball and Kothari (1991) present the evidence that on the day of a quarterly earnings announcement, the average stock return rises by 0.084 percent. Furthermore, after controlling for risk shifts, security returns increase by 0.066 percent on the day of the announcement, which is anomalous and violates the uncertainty resolution hypothesis (Epstein and Turnbull, 1980). Although the literature assess the UK stock market, Ryan and Taffler (2004) find that 70 percent of all the corporate preliminary and final earnings announcements that have been released actually lead to economically-significant price movements ranging from -4.1 to 4.6 percent. Cheon et al. (2001) counters the US evidence and compares the conventional NYSE, and over-the-counter NASDAQ markets. The study reported that NASDAQ companies' earnings announcements result in higher abnormal returns relative to NYSE companies' earnings announcements. This was linked to the differences in (i) the expected earnings growth between NASDAQ and NYSE companies, (ii) investor sensitivity to growth prospects in NASDAQ and NYSE companies, and (iii) the pre-disclosure information environment between NASDAQ and NYSE firms. This literature (ibid.) contrasts with the Australian evidence that larger companies significantly more positively to earnings announcements (Chan et al., 2005).

Moreover, using the NYSE-AMEX and NASDAQ exchanges, it is confirmed by Clement et al. (2003) that earnings announcements result in an abnormal average increase of 0.73 percent in daily stock returns. However, the anomalous behaviour of stock returns after earnings announcements (viz. post-earnings announcement drift) has been attributed to the flaw of CAPM as an asset pricing model, biased parameter approximations of the CAPM or to the research aims that presumed information was accessible to the market prior to its public release (Holthausen, 1983; Foster et al., 1984; Bartov et al., 2000). Mian and Sankaraguruswamy (2012) argue that the reaction of security prices to good news is higher in periods of positive market sentiment; however, the stock price reaction to bad news is higher in periods during negative sentiment. As such, the study (ibid.) found that investor

sentiment drives stock price movements in response to company earnings announcements.

In the case of South Africa and other developing African markets, relatively few studies on stock price reactions to earnings announcements have been conducted. As such, it must be noted that the above evidence may not necessarily apply to African markets. In comparison to developed markets, emerging markets tend to suffer from poor regulatory measures, low liquidity levels, and relatively few resources are allocated to securities research and analyses (Osei, 2002; Yartey and Adjasi, 2007). Afego (2013) investigates the security price reactions to yearly earnings announcements on the Nigerian Stock Exchange. The study (ibid.) found that stock returns demonstrated a downward trend on the announcement day which persists for 20 days after the release of the earnings information. Additionally, Afego (2013) attributes this to private acquisitions, and possibly, insider trading on the Nigerian stock market.

Prather-Kinsey (2006) conducted a comparative study between South Africa and Mexico for the years 1998 to 2000. The literature (ibid.) found that, on the day of the earnings announcement, South African securities will exhibit an abnormal return of 2.63 percent, which is statistically significant at the 99.9% confidence level. Further evidence on the South African stock market is presented by Mlonzi et al. (2011), and the study concludes that stock prices react negatively to earnings announcements on the JSE-AltX². However, the study does highlight that it used a relatively small sample ($n = 34$) as a caveat.

2.5 Empirical Evaluation

The assumption of normality forms the backbone of many statistical methods including analysis of variance (ANOVA), linear regression analysis, and t-tests. As such, the violation of the normality assumption means that the interpretation and conclusions drawn may be unreliable or invalid, in both cross-sectional and time series data (Wooldridge, 2015). In empirical research of this nature, it is important to emphasise that joint multivariate normality implies univariate normality, but the converse does not apply. Therefore, the rejection of univariate normality implies that joint multivariate normality cannot be a realistic assumption for approximating the daily return distribution of JSE stocks (Kon, 1984).

²JSE-AltX is an alternative board for small and medium-sized firms in South Africa which operates in parallel with and is entirely owned by Johannesburg Stock Exchange (JSE).

Razali and Wah (2011) outlines three common methods to verify the assumption of normality: (i) graphical methods, (ii) numerical methods, and (iii) statistical inference. Graphical methods include histograms, stem-and-leaf plots, and quantile-quantile (QQ) plots; however, the normal QQ plot is the most frequently used tool for verifying the normality of a sample. The graphical methods, however, cannot be used in isolation to conclude whether a sample of n observations is normally distributed. As such, the more formal numerical methods and normality tests are used to support the graphical methods in drawing a conclusion about the normality of the sample (Underhill and Bradfield, 1996). The numerical methods incorporate skewness and kurtosis coefficients; notwithstanding that normality tests follow formal statistical procedures to test whether the underlying distribution of a random variable follows a Gaussian distribution (Baghban et al., 2013).

The earliest and best understood techniques to detect non-normality were performed by Pearson (1895) through working on the skewness and kurtosis coefficients (Althouse et al., 1998). Approximately 40 normality tests exist in the statistical literature (Dufour et al., 1998). As such, Seier (2002) highlights that normality tests differ according to the (i) features of the normal distribution they focus on, (ii) its distribution function, and (iii) the linearity between the distribution of the variable and the standard normal variable, Z [as shown in **Equation** (3)]. The literature (ibid.) further states that tests also vary in the level at which they compare the empirical distribution with the Gaussian distribution, in the intricacy of the test statistic and the style of the distribution in question. Additionally, Razali and Wah (2011) emphasises that different normality tests may yield contradicting results; thus, the choice of tests to be used is of paramount importance.

Table 1: Common Goodness-of-Fit Tests categorised into three categories

Empirical Distribution Function	Regression and Correlation	Moments
Anderson-Darling	Shapiro-Wilk	D'Agostino-Pearson
Cramer-von-Mises		Jarque-Bera
Kolmogorov-Smirnov		
Lilliefors		

Normality tests can be divided into four categories: chi-square type tests, moment ratio techniques, tests grounded on correlation, and tests based on the empirical distribution function (EDF) (Arshad et al., 2003). However, Park (2008) categorises the tests for normality into two classes which are “descriptive statistics” and “theory-driven methods”. The former refers to skewness and kurtosis coefficients, while the latter includes normality tests. Furthermore, the normality tests that are commonly available in statistical software are the: (i) Anderson-Darling (AD) test, (ii) Cramer Von Mises (CVM) test, (iii) D’Agostino-Pearson (DP) test, (iv) Jarque-Bera (JB) test, (v) Kolmogorov-Smirnov (KS) test, (vi) Lilliefors (LF) test, and (vii) Shapiro-Wilk (SW) test (Dufour et al., 1998; Seier, 2002; Arshad et al., 2003). Following the example of Razali and Wah (2011), the tests have been categorised into EDF, regression and correlation, and moments tests as shown in **Table 1**.

EDF tests are defined as tests that are based on a measure of dissimilarity between the empirical and hypothesised distribution (Dufour et al., 1998). Seier (2002) and Arshad et al. (2003) argue that the most commonly known EDF tests are the Anderson-Darling, Cramer Von Mises, Kolmogorov-Smirnov and Lilliefors tests. Regression and correlation tests are described by Dufour et al. (1998) as tests that are based on a ratio of two weighted least-squares (WLS) approximations of scale derived from order statistics. In other words, the approximations are the normally distributed WLS estimates and the sample variance from another population (Razali and Wah, 2011). Regression and correlation tests include the Ryan-Joiner, Shapiro-Francia and Shapiro-Wilk tests; however, this study will only discuss the Shapiro-Wilk test (Shapiro and Wilk, 1965). Additionally, moment tests are described by Seier (2002) as tests that are derived from the acknowledgement that the non-normality may

be detected based on the third and fourth sample moments, i.e. skewness and kurtosis. The most commonly known moment tests in statistical literature are the D’Agostino-Pearson and Jarque-Bera tests (D’Agostino and Pearson, 1973; Jarque and Bera, 1987).

The existing literature (D’Agostino and Pearson, 1973; D’Agostino and Stephens, 1986; D’Agostino et al., 1990) presents a comprehensive explanation, and investigates the power of goodness-of-fit tests, including the KS test, DP test, and LF test (Kolmogorov, 1933; Lilliefors, 1967; D’Agostino and Pearson, 1973). D’Agostino et al. (1990) proposes the D’Agostino-Pearson test as a powerful and informative normality test due to the K^2 omnibus test statistic of normality. “Omnibus” means that the test is able to detect departures from normality due to either skewness or kurtosis.

The Anderson-Darling test is considered to one of the most powerful EDF tests, and its performance is comparable with the Shapiro-Wilk test (Arshad et al., 2003; Razali and Wah, 2011). The literature (ibid.) further states that the Lilliefors test consistently outperforms the Kolmogorov-Smirnov test; however, it is less powerful than the SW and JB tests. Furthermore, Steinskog et al. (2007) warns against the use of the KS test as a goodness-of-fit test due to its relatively low power as its p-values exhibit a strong upward bias. This is consistent with the findings of Baghban et al. (2013), where the literature recommends the LF test in lieu of the KS test.

Thadewald and Büning (2007) conclude that the Cramer Von Mises and Kolmogorov-Smirnov tests are highly conservative in approximating the distribution parameters. The study (ibid.) also finds that the Jarque-Bera test behaves very well for symmetric distributions with medium-to-long tails and slightly skewed distributions with long tails. In a comparative study using Monte-Carlo procedures on 50,000 simulated samples, Yap and Sim (2011) finds that the Shapiro-Wilk test possesses strong power over a large range of asymmetric distributions, then followed by the Anderson-Darling test. Furthermore, literature concludes that the SW and DP tests are powerful tests for symmetric short-tailed distributions. The Anderson-Darling, Jarque-Bera and Shapiro-Wilk tests work well with a symmetric long-tailed distribution. This findings of the abovementioned studies are consistent with the results of Mendes and Pala (2003), Keskin (2006), Romao et al. (2010), and Razali and Wah (2011) that the Shapiro-Wilk test is the most powerful normality test.

Given the abovementioned critique of the statistical literature, this dissertation will use the following tests in the empirical analysis: Anderson-Darling, D'Agostino-Pearson, Jarque-Bera, Lilliefors, and Shapiro-Wilk tests. These tests will be used to support the graphical methods (histograms and QQ plots). Furthermore, the methodology behind these tests will be explained in **Chapter 4**.

3 Data and Sample Selection

The data presented in the following section will be used in the ensuing analysis. This section will further explain the methods used to make adjustments to the data in order to remove any irrelevant information and perform the relevant econometric analysis. Moreover, the data was collected and formatted correctly in Microsoft Excel, such that it could be imported into the relevant econometrics program. *R* (Version 3.5.2) statistical software was used to perform the statistical inference and generate the necessary output.

3.1 Data

Two datasets are used to conduct the analysis. The first of these is the time series of closing prices of the 100 largest equities listed on JSE as of 31 December 2015. The second of these is the 100 shares that comprise of the Industry Classification Benchmark (ICB) industry and sector indices that constitute the *FTSE/JSE Africa All Share Index* as of 31 December 2015. For both datasets, the shares were ranked by marked capitalisation; notwithstanding that the second dataset will be used in analysing the effect of blue letter days on the original data. It is important to highlight that the daily returns were calculated using the following formula:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \quad \text{where } t \geq 1 \quad (9)$$

The abovementioned data was obtained from the JSE Limited in Johannesburg, and the *Bloomberg* application program interface (API), which is extracted from the terminal at Chancellor Oppenheimer Library at the University of Cape Town. The latter was exported from the *Bloomberg* add-in on *Microsoft Excel* after which the return data was imported to *R*. *Bloomberg* was chosen as a data source due to its broad coverage and availability of data in non-US equity markets. Ince and Porter (2006) argues that individual equity return data collected using *Thomson Datastream* for non-US markets demands serious care as a result of potential drawbacks in the data.

Table 2: Analysis of Sample Selection

	Stocks
Original sample considered	100
Acquired and delisted equities	(5)
Excluded for liquidity concerns	(25)
General sample	70
No value in period under analysis	(1)
Inaccessible equities	(7)
Excluded on the basis of significant ADR exposure	(6)
Sample used in econometric analysis	56

3.1.1 Return Interval

As previously stated in **Section 3.1**, the time series of closing prices of the equities was extracted and exported for the analysis. For as long as the data is available for the time series, equity returns can be computed over any time or investment horizon. As such, they can be calculated over daily, weekly, monthly or yearly periods. Levy (1972) argued that a quantitative study that is based on annual rates of return data will provide different results from a study using monthly rates of return data. Furthermore, Prakash et al. (1997) found that the investment horizon selected affects the approximated value of the moments of the return distribution in question.

Berry et al. (1990) argues that using daily return data raises methodological issues as it may yield results that model short-term phenomena or a spurious correlation. However, daily intervals increase statistical power of the study through higher degrees of freedom. Additionally, daily return data plays an instrumental role in modelling daily trends on reactions to “specific events days” (ibid.). Consequently, a daily return interval is used in the forthcoming analysis as it is utilised in the most of the relevant international literature. Ideally, this will allow the empirical results to be more comparable between the related literature.

3.1.2 Equity Sample Period

Part of the aim of creating relevant and accurate financial research is to source the data from a period that is long enough to provide coherent results. Although practitioners question the limitation of short sampling periods, it must be noted that longer sampling periods may lead to time-varying findings. In case of the JSE, this is of paramount importance as the historical dominance of resource equities has diminished with the rapid growth of the South African market; thus, it has led to non-resource equities assuming a larger stake of the exchange that they did before (Van Rensburg, 2002). Consequently, this could imply that conclusions reached using longer sampling periods may depict realities that are instantaneous to the sample period instead of demonstrating consistent phenomena.

The sample period of this study starts from 1 January 2016 until 31 December 2017 using a 65-day rolling basis. The rolling day basis was chosen with the intent of increasing the number of data points in the sample, and ensuring that any lagged macroeconomic data (for example, *Statistics South Africa* sectoral reports) was considered in the data analysis. Since daily returns are being investigated, the sample period provides power to the econometric analysis done in the following chapter as there are enough data points to deliver meaningful results. Furthermore, this period chosen offers insight into the behaviour of South African equities after the 2008 Great Recession.

3.1.3 Equity Sample Selection

Initially, the 100 largest equities on the JSE *Main Board* were considered for inclusion in the sample as shown in Appendix A.1 and Table 2. The stocks selected to conduct the relevant analysis are current or former constituents of the *FTSE/JSE Africa All Share Index*. This provided the best representation of liquid stocks on the JSE; however, five equities which were delisted or acquired during the period under consideration were therefore excluded. Namely, the Pick'n Pay Holdings stock was removed from the sample as it had been delisted from the JSE on 14 June 2016 due to an unbundling. Beverage producer, Distell, also delisted from the JSE in October 2017 due to the restructuring of its ownership structure. This leaves 95 stocks remaining in the sample. Due to liquidity concerns, companies with market capitalisations less than 10 billion Rand (ZAR) as of 1 January 2016 were excluded from the sample. As such, companies including ADVTECH and Astral Foods were removed, and the sample was reduced to 70 equities. This method is broadly similar to the approach used by Van Rensburg and Robertson (2003); however, the literature used average monthly trading

volume to filter the stocks as the authors were concerned with thin trading. Additionally, not all of the equities are useful for the analysis or some equities are accessible to a small group of investors. For this reason, eight stocks were removed including NewGold Issuer and Vukile Property Fund; thus, leaving 62 equities remaining in the sample.

Some of the remaining stocks including Investec Limited have a significant presence on other international exchanges through their dual listings. Other remaining JSE-listed stocks including Woolworths Holdings have ADR listings in the United States. As such, the stocks need to be evaluated for their ADR listings. Patro (2000) defines ADRs as “*negotiable certificates representing shares of a foreign corporation*”. Since they are regarded as a conventional security that is accessible to US investors, this implies that equities with significant ADR listings are exposed to material systematic risk with their domestic and foreign markets. ADRs often allow firms operating in emerging markets to escape detrimental domestic politico-economic factors. This results in firms obtaining higher valuations and improved liquidity in US markets (Karolyi, 2004).

For the purposes of finding single-listed JSE stocks, these stocks need to be removed from the sample; however, a decision rule will be implemented. In other words, if the average trading daily volume of the JSE-listed stock’s ADR is less than 25% of the actual stock’s average trading daily volume, the stock in question will be included in the sample; otherwise, it will be removed. The ADR volume and average daily volume of the equities were sourced from *Bloomberg*. The rationale behind the decision rule was that since ADRs imply that the remaining 62 equities are trading in the US financial markets, a significant ADR holding would impede the efforts of this study to analyse single-listed JSE stocks. After implementing the decision rule, six equities including AngloGold Ashanti and Woolworths Holdings were excluded from the sample and this leaves 56 stocks to be used in the econometric analysis for this study shown in Appendix A.2. Each equity will carry 567 data points and this sample size provides the necessary robustness required to perform the statistical goodness-of-fit tests in the next chapter.

3.1.4 Index Sample Selection

Theoretically, indices serve as benchmarks for the market-at-large. They aggregate and categorise stocks on the basis of some criteria. In the context of this study, they will help to identify sector leaders and analyse the effect of blue letter days on each industry and equity.

Furthermore, when classifying the 56 stocks in the sample according to the indices, this study uses 20 JSE indices.

Bloomberg provides information on the constituents and member weightings of the JSE indices; however, viewing the constituents of some indices, including *General Industrials* (JSE Index Code J272) require permission from the JSE. It must be highlighted that the leading constituent of an index might not be included in the equity sample. Therefore, for the purposes of this study, the sector leader will be determined by the stock with the largest market capitalisation among the equities used in Appendix A.3.

3.1.5 Removal of Red and Blue Letter Days

As previously discussed in **Section 2.4**, days with predetermined information releases will be regarded as (i) red letter days, and (ii) blue letter days. For red letter days, the release dates of the Monetary Policy Statements from January 2016 are sourced from the South African Reserve Bank website. Equivalently, the release dates of the US nonfarm payrolls are obtained from the US Bureau of Labor Statistics. After the dates are collected, the corresponding returns for each equity in the sample were removed from the dataset on *Microsoft Excel*. This amounts to 42 red letter days and leaves 525 observations for each stock in the sample. The adjusted data was imported to *R* and the relevant analysis will be conducted as discussed in the next chapter.

For the purposes of this study, blue letter days will refer to industry and firm-specific news: (i) interim earnings announcements, (ii) final earnings announcements, (iii) the release of quarterly company trading reports and (iv) Statistics South Africa sectoral reports. The publication dates of interim and final earnings announcements for each equity were extracted from *Bloomberg*; however, SENS can release earnings announcements after the close of the JSE. This also means that the effect of those announcements may be realised on the next business day in South Africa. As such, the time and dates of the blue letter days is instrumental in determining the removal of these micro-outliers.

Moreover, the release of company trading reports will be included in this study. Most firms issue these voluntary reports on a quarterly basis in accordance with JSE Listing Requirements (Johannesburg Stock Exchange., 2011). According to Regulation 43(1)(e)(iii) relating to banks, all banking institutions are required to compile and release quarterly disclosures

relating to Pillar 3 of Basel rules. This means that banks are required to disclose qualitative information regarding their capital adequacy and liquidity ratios on a quarterly basis (South African Reserve Bank, 2012). Similar to the earnings announcements, the time and dates of these trading reports are provided by SENS and are extracted from *Bloomberg*.

Additionally, Statistics South Africa releases monthly production and/or sales publications on various sectors of the economy, including manufacturing and mining. The *Mining: Production and Sales* (Statistics South Africa Publication Code P2041) and *Retail Trade Sales* (Statistics South Africa Publication Code P6242.1) report dates will be used in this dissertation. Future publication dates are made available to the general public on the Statistics South Africa website. Furthermore, the abovementioned statistical releases are published at 11:30 CAT for mining, and at 13:00 CAT for retail (Statistics South Africa, n.d.). As such, there are 27 blue letter days respectively. In accordance with the Statistics South Africa definition of “retail”, the retail blue letter days will affect the constituents of the following indices: (i) *Food and Drug Retailers* (JSE Index Code J533), and (ii) *General Retailers* (JSE Index Code J537). Equivalently, the mining blue letter days will affect the constituents of the *Mining Index* (JSE Index Code J177) (Johannesburg Stock Exchange, n.d.).

The returns corresponding to the blue letter days were removed on *Microsoft Excel*. This results in the remaining observations decreasing from 525 to varying between 485 and 522 in the sample. The augmented data is imported again to *R* for the analysis to be conducted.

3.2 Potential Biases and Adjustments

3.2.1 Survivorship Bias

Survivorship bias in empirical research occurs when variables (equities in this case) which have failed to survive are removed from the sample (Haugen and Baker, 1996). In financial research, this implies that delisted and/or inactive stocks are excluded. Ferreira and Krige (2011) argues that this results in successful companies being left in the sample; thus, the returns can exhibit upward bias in a performance analysis. Furthermore, this may not affect the outcome of the research materially, but Gilbert and Strugnell (2010) suggests that including data on delisted securities will probably have a considerable impact on the results obtained.

Survivorship bias is regarded as the most frequent cause of inaccurate conclusions deduced in

financial analysis. However, this dissertation is analysing the historical price series of each equity and building the return series individually. There is little propensity for survivorship bias. Furthermore, the stocks were excluded from the sample on account of (i) acquisitions, (ii) delistings, (iii) illiquidity, (iv) inaccessibility to general investors, and (v) high ADR exposure. Additionally, only five equities were removed due to (i) and (ii) over the entire period in question; notwithstanding that the use of daily equity returns implies that having a complete series of observations is paramount for the empirical analysis in Chapter 5. Lastly, survivorship bias would be a material concern if this dissertation were investigating equity indices or pursuing a portfolio approach in the data analysis.

3.2.2 Data Snooping

Data snooping occurs when a study is conducted within a specific database, and the output is tested within the sample of the very database (Haugen and Baker, 1996). The bias may misrepresent the results due to the intrinsic nature of the data in lieu of fundamental reasoning. Although data snooping may reveal itself in this dissertation, the literature (Lo, 1994; Haugen and Baker, 1996) proposes conducting out-of-sample tests to generate the robustness and validity of empirical results. Sullivan et al. (1999) proposes the Whites Reality Check as a common adjustment tool in academia, and it is recommended for future research in ameliorating the robustness of results affected by data snooping. Due to the complexity of out-of-sample tests, they will not be included in the study; however, this project follows the methodological approaches from the existing literature.

3.2.3 Dividend Considerations

Equity prices are generally known to decline on the ex-dividend date, when the equity no longer trades with the right to the next dividend pay-out (Koski and Scruggs, 1998). This implies that a price return series may demonstrate an inaccurate reflection of investor returns, which Toerien et al. (2014) argues to be relevant for the JSE as it is a market with a high dividend yield. As such, ignoring dividends in the calculation of a price return series may lead to spurious outliers. It must be acknowledged that while some outliers may have the possibility of being linked to ex-dividend events, days of unplanned information releases in emerging markets like South Africa can play a major role in the existence of those outlying return values. Furthermore, share returns will not be adjusted for ex-dividend dates in this

study; however, additional care will be exercised in analysing the remaining observations in the variables, and any outlying values will be checked with their corresponding dates to see whether they coincide with dividend announcements.

4 Methodology

This chapter presents the methods used to analyse the data as previously discussed in **Section 2.5**. *R* (R Core Team, 2018) is used to reach the results as discussed in the next section. The programming is performed in RStudio (Version 1.1.463) as it is a mature platform for data analysis. Furthermore, there is a wide variety of statistical packages available in *R*.

The first part of the analysis was conducted by running graphical tests for normality or deviations from normality. It must be emphasised that most analysts tend to deduce that a dataset follows a Gaussian or non-normal distribution graphically via normal quantile-quantile (QQ) plots and/or histograms; however, these methods fail to supply objective and conclusive proof regarding the distribution of the data. But Chambers et al. (1983) highlights that graphical methods provide a general hint about the cause of the rejection of the normality hypothesis. As such, numerical methods and statistical inference procedures are implemented to support the graphical methods. All of the histograms and QQ plots displayed as part of the empirical results are generated in *R*.

The second part of the analysis incorporates goodness-of-fit tests in order to detect any departures from normality. For the sake of consistency, the methodology is divided into four sections: (i) graphical methods in **Section 4.1**, (ii) EDF tests in **Section 4.2**, (iii) regression and correlation tests in **Section 4.3**, and (iv) moment tests in **Section 4.4**.

4.1 Graphical Methods

4.1.1 Histogram

As previously discussed, the histogram is one of the most commonly graphical methods used for normality assumption checking. The histogram plots the frequency distribution or density curve of observed values and visually demonstrates whether the distribution resembles a bell-shaped curve or not. It also provides insights into outliers and gaps in the data. Furthermore, it shows the level of skewness or asymmetry in the data (Keeping, 1962; Das and Imon, 2016). This study used density histograms.

Figure 1 demonstrates that the data resembles a bell-shaped curve; thus it is said to be normally-distributed. As such, the second graph represents the data where it is not normally

distributed as shown in Figure 2.

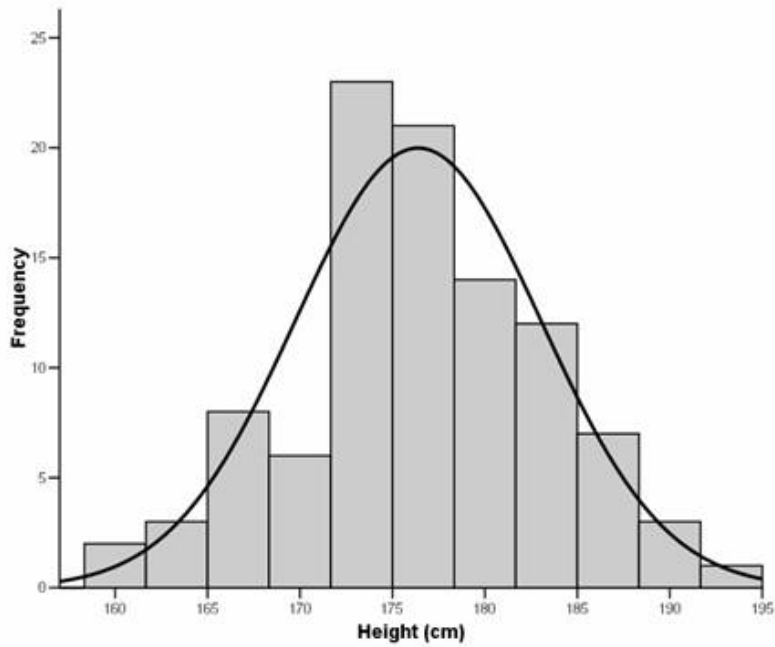


Figure 1: Histogram demonstrates that the data is normally distributed (Freeman, n.d.).

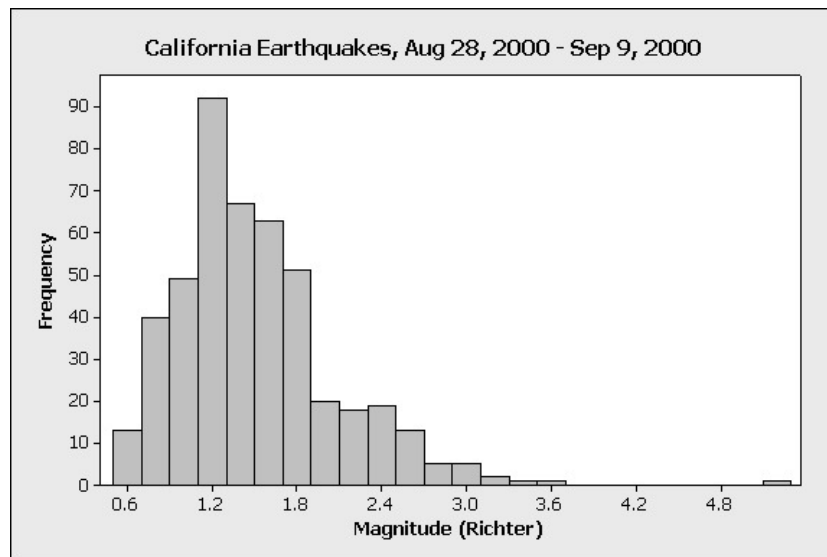


Figure 2: Histogram demonstrates that the data is not normally distributed (University of Florida Health, n.d.).

4.1.2 Normal Quantile-Quantile Plot

Das and Imon (2016) describe a QQ plot as a graphical representation that compares the “*quantiles of the empirical data distribution with the quantiles of a standardised theoretical distribution from a special family of distributions*”. Therefore, a normal QQ plot compares the quantiles of one distribution against quantiles of the Gaussian distribution.

The literature (ibid.) states that when the quantiles of two distributions are met, the plotting dots face with the line $y = x$. If the normal QQ plot demonstrates the curve size is increasing from left to right and curve size diminishing from left to right, it reveals that the distribution of the data is skewed to the left (negative-skewed distribution). Normal QQ plots presented below in Figures 3 and 4 are taken from Bogart and Robbins (2019). The first graph demonstrates a normality pattern while the second plot shows non-normality and the presence of outliers.

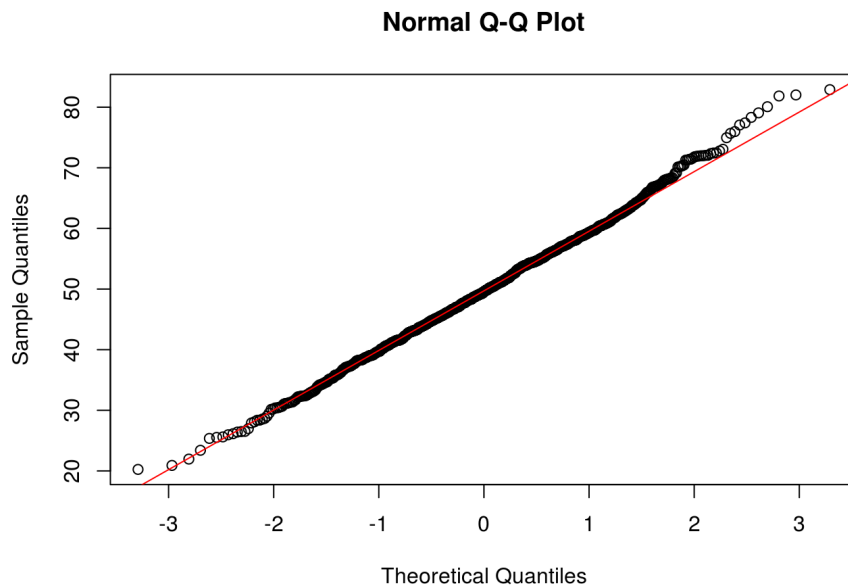


Figure 3: Normal Quantile-Quantile Plot demonstrates that the data is normally distributed.

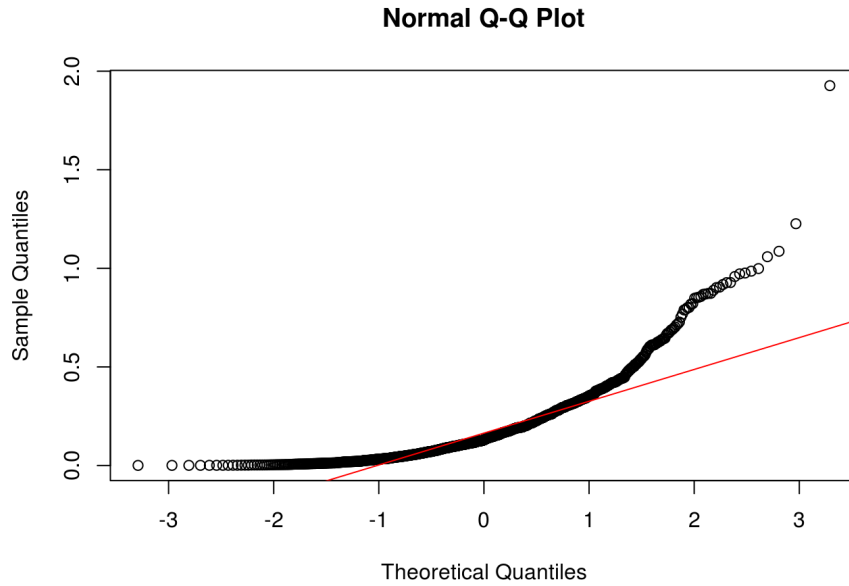


Figure 4: Normal Quantile-Quantile Plot demonstrates that the data is not normally distributed.

4.2 Empirical Distribution Function Tests

4.2.1 Anderson-Darling Test

As an adaptation of the Cramer-von Mises test (CVM) (Smirnov, 1936; Von Mises, 1932; Cramér, 1928), the Anderson-Darling test (AD) (Anderson and Darling, 1954) is an example of an empirical distribution function (EDF) test, which compares the distribution of the dataset to the cumulative distribution function (CDF) of a Gaussian distribution and ascertains the goodness-of-fit between the two. Yap and Sim (2011) states that the AD test assigns more weight to the tail distribution relative to CVM test; however, the latter is a non-parametric test whereas the former employs the exact postulated distribution when computing its critical values. Consequently, AD test is relatively more sensitive than the CVM test; notwithstanding that a disadvantage of the former is that those critical values have to be computed for every specific distribution.

The AD test statistic is defined as (Anderson and Darling, 1954),

$$\mathbf{AD} = n \int_{-\infty}^{\infty} \left[F_n(x) - F^*(x) \right]^2 \Psi(F(x)) dF(x), \quad (10)$$

where

$$\Psi[F(x)] = \left[F(x)[1 - F(x)] \right]^{-1}. \quad (11)$$

The test statistic is a weighted mean of the square difference $\left[F_n(x) - F^*(x) \right]^2$ and weighted by $\Psi[F(x)]$. It is worth noting that when $\Psi[F(x)]$ is equal to one, the AD statistic reduces to the CVM statistic:

$$n\mathbf{w}^2 = n \int_{-\infty}^{\infty} \left[F_n(x) - F^*(x) \right]^2 dF(x). \quad (12)$$

If $X_{(1)} \leq X_{(2)} \leq \dots \leq X_{(n)}$ refers to the ordered observations in a sample size n , then the AD statistic is calculated as

$$\mathbf{AD} = - \sum \left[\frac{(2i - 1)(\log P_i + \log(1 - P_{n+1-i}))}{n} \right] - n \quad (13)$$

where P_i represents the CDF of the particular distribution. To test for Gaussianity, set $P_i = \Phi(Y_{(i)})$ where $Y_{(i)} = \frac{(X_{(i)} - \bar{X})}{S}$, as the standardised variable and \bar{X} and S is the sample mean and deviation, respectively.

4.2.2 Lilliefors Test

As a correction of the Kolmogorov-Smirnov test, the Lilliefors test is appropriate when the parameters need to be approximated based on the sample data whereas the KS test requires the parameters of the hypothesised distribution to be known (Lilliefors, 1967). The LF test is also less conservative than the KS test; thus, for a sample of n observations, the LF statistic is defined as (ibid.),

$$\mathbf{D} = \max_x [F^*(X) - S_n(X)] \quad (14)$$

where $F^*(X)$ refers to the cumulative normal distribution function with the sample mean, $\mu = \bar{X}$, and $S_n(X)$ is the sample CDF, and the sample variance, s^2 , is defined with the denominator $n - 1$ (Razali and Wah, 2011).

Although the KS and LF statistics are the same, the table for the latter's critical values is different which yields different findings regarding the normality of a dataset (Mendes and Pala, 2003). The table of critical values for the Lilliefors test can be found in a statistics textbook authored by Conover (1999). It is important to note that if the LF statistic is greater than the corresponding critical value in the aforementioned table, then the null hypothesis of normality is rejected at the relevant significance level (Lilliefors, 1967).

4.3 Regression and Correlation Tests

4.3.1 Shapiro-Wilk Test

The Shapiro-Wilk test was initially restricted to a sample size of $n \leq 50$. This spurred on the creation of SW test variations which include revisions by Shapiro and Francia (1972) and Rahman and Govindarajulu (1997). If an ordered arbitrary sample size n follow a Gaussian distribution such that $X_{(1)} \leq X_{(2)} \leq \dots \leq X_{(n)}$, then let $\mathbf{m}' = (m_1, m_2, \dots, m_n)$ refer to the vector of expected values of the Gaussian order statistics. Therefore, $\mathbf{V} = (v_{ij})$ denotes the $n \times n$ covariance matrix of these order statistics. Moreover, let $\mathbf{Y}' = (Y_{(1)}, Y_{(2)}, \dots, Y_{(n)})$ represent the vector of arranged arbitrary observations from a random population; thus, if $Y_{(i)}$'s are ordered observations from a Gaussian distribution with unknown parameters, then $Y_{(i)} = \mu + \sigma X_{(i)}$ ($i = 1, 2, \dots, n$) (Yap and Sim, 2011). As such, the literature (ibid.) defines the SW test statistic as

$$\mathbf{SW} = \frac{\left[\sum_{i=1}^n a_i Y_{(i)} \right]^2}{\left[\sum_{i=1}^n (Y_i - \bar{Y})^2 \right]}, \quad (15)$$

where

$$\mathbf{a}' = \mathbf{m}'\mathbf{V}^{-1}(\mathbf{m}'\mathbf{V}^{-1}\mathbf{m})^{1/2} \quad (16)$$

and

$$0 \leq \mathbf{SW} \leq 1 \tag{17}$$

Furthermore, $a_{(i)}$ refers to the weights derived from (Shapiro and Wilk, 1965) for the original sample size. Also, when the test statistic equals one, it implies that the data follows a Gaussian distribution. Conversely, small values of the SW test statistic result in the rejection of normality. Royston (1982*a,b,c*, 1992) modified the SW test to widen the sample size restriction to 2000 through providing the algorithm AS181. Furthermore, Royston (1995) released algorithm AS R94 which can be utilised for any n in the range $3 \leq n \leq 5000$. This dissertation used the algorithm AS R94.

4.4 Moment Tests

4.4.1 Jarque-Bera Test

Jarque and Bera (1987) asserts that the Jarque-Bera test (JB) possesses optimum asymptotic power characteristics and satisfactory countable sample performance. This test is derived from the use of the Lagrangian multiplier procedure on the Pearson system of distributions to acquire tests for Gaussianity of normality of findings and linear regression residuals (Yap and Sim, 2011). Bowman and Shenton (1975) suggests the JB statistic as a test statistic; notwithstanding that the JB statistic converges to a Pearson's chi-squared distribution with two degrees of freedom. The JB statistic is premised on sample skewness and kurtosis and is defined as

$$\mathbf{JB} = n \left(\frac{(\sqrt{b_1})^2}{6} + \frac{(b_2 - 3)^2}{24} \right). \tag{18}$$

As such, the JB statistic is negligible for a symmetric Gaussian distribution; thus, high values of skewness and kurtosis exceeding three result in the null hypothesis of normality being rejected (McDonald, 1996; Stuart and Ord, 1987).

4.4.2 D'Agostino-Pearson Test

D'Agostino and Pearson (1973) observed that the sample skewness ($\sqrt{b_1}$) and kurtosis (b_2) are utilised separately in skewness and kurtosis tests to determine whether random samples

are taken from a normal population. The literature (ibid.) proposed the K^2 test statistic to overcome this shortcoming. The test statistic is defined as

$$\mathbf{K}^2 = Z^2(\sqrt{b_1}) + Z^2(b_2) \tag{19}$$

where $Z(\sqrt{b_1})$ and $Z(b_2)$ are the normal approximations to the abovementioned sample skewness and kurtosis, respectively (D'Agostino and Stephens, 1986). As previously mentioned in Section 2.5, the K^2 statistic is an omnibus test of normality and follows a chi-squared distribution with two degrees of freedom when the population is normally distributed. Large values of the test statistic results in the rejection of the null hypothesis of normality (D'Agostino and Pearson, 1973; D'Agostino and Stephens, 1986; D'Agostino et al., 1990; Das and Imon, 2016).

5 Empirical Results

This chapter will evaluate the results from the analysis conducted using the methodology explained in Chapter 4. The first part of the results is discussing the normality tests results of the original data. Appendices C to E detail the graphical and statistical output of the equities, and Appendix B includes the descriptive statistics. The results from the original data will be used as groundwork for the results after the macro-outliers and micro-outliers are removed, respectively. The quantitative results arrived at follow a relatively similar approach to Peiro (1999), Prakash et al. (2003) and Chi3n et al. (2008) which utilise the normality tests discussed in Chapter 4 to detect non-normality in stock returns. The second and third sections include results (i) after the removal of red letter days, and (ii) red and blue letter days, respectively. Moreover, the third section discusses the results in terms of the sectoral indices as classified by the JSE as shown in Appendix A.3.

5.1 Return Behaviour of the Original Data

Appendix B.1 presents the summary statistics of the original data for the daily equities returns. Approximately 70% of the stocks in the sample have positive mean returns for daily data. Table 3 shows the descriptive statistics of five equities from the sample. These stocks cover different industries, including banks, and general retailers. For the sake of consistency, these stocks will also be used in the Sections 5.2 and 5.3 for explanatory purposes. Kumba Iron Ore Limited had the highest mean return (0.003380) in the entire sample and EOH Holdings had the lowest mean return (-0.001929); thus, the effective range was 0.005309. When evaluating the standard deviation, Kumba Iron Ore Limited demonstrated the highest volatility (0.042567) and the Vodacom Group showed the lowest volatility (0.012526).

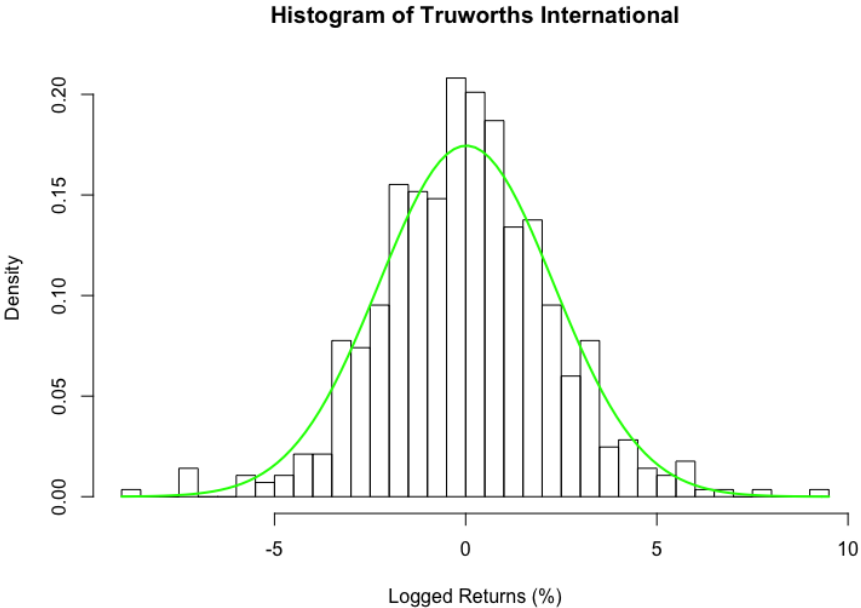
Table 3: Descriptive Statistics of the Five Stocks from the Original Data

Equity	Mean	Standard Deviation	Skewness	Kurtosis	Standard Error
EOH Hold-ings	-0.001929	0.033293	-3.846743	52.079504	0.001398
Kumba Iron Ore	0.003380	0.042567	0.534197	5.417860	0.001788
Nedbank Group	0.000731	0.018093	0.006468	0.862577	0.000760
Truworths International	0.000164	0.022859	0.045534	1.034871	0.000960
Vodacom Group	-0.000045	0.012526	-0.135078	4.218090	0.000526

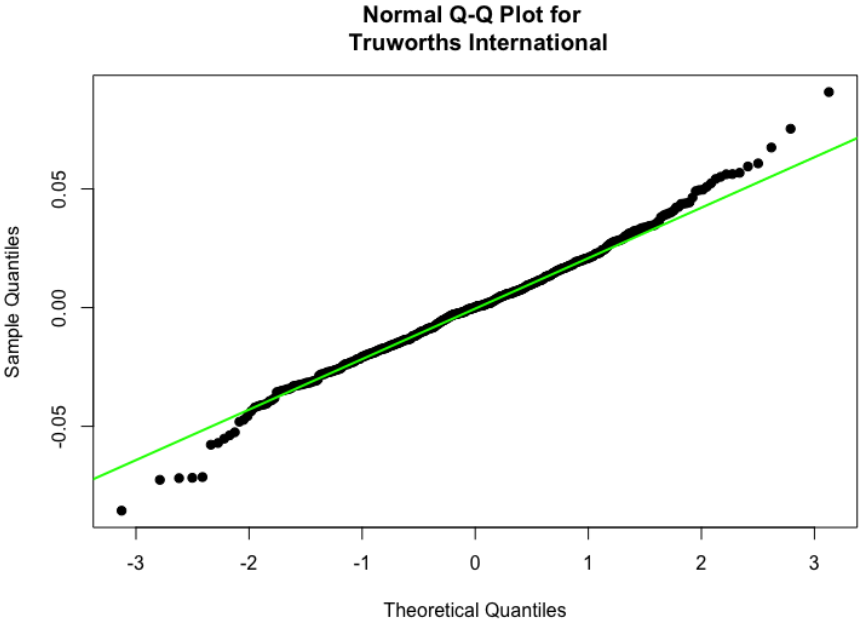
In the abovementioned appendix, the values of skewness and kurtosis for every equity are shown. Skewness and kurtosis denotes the third and fourth standardised moments, respectively. Additionally, it must be highlighted that any moments exceeding the third cannot be justified and are to be ignored (Kraus and Litzenberger, 1976; Prakash and Bear, 1986; Prakash et al., 2003). Although the entire sample exhibited skewness, positive skewness was especially dominant in this study. 57% of the equities demonstrated positive skewness. This therefore implies that deviations from the mean will be positive, and the distribution of the daily returns is asymmetrical with a positive skew.

Statistical tests were carried out on with the aim of assessing the distribution of the stocks before the relevant outliers were removed. The histograms in Appendix C show the approximate probability distribution of the data, which is relatively normal; however, upon superimposing a normal density curve on each histogram, it becomes apparent that the majority of the stocks exhibit a high degree of skewness. As a continuation of the visual evaluation of normality, the

normal Q-Q plots aim to benchmark the empirical results to that of a normal distribution.



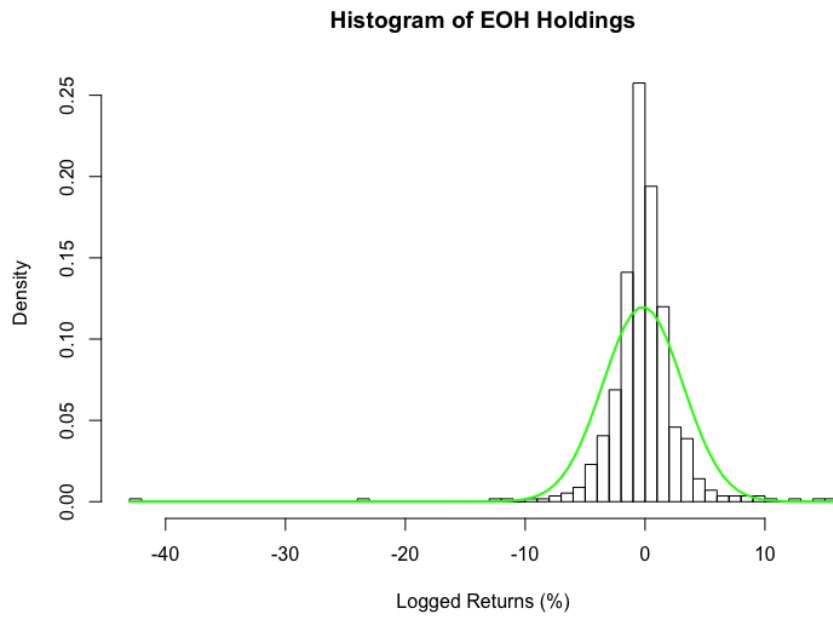
(a) Histogram



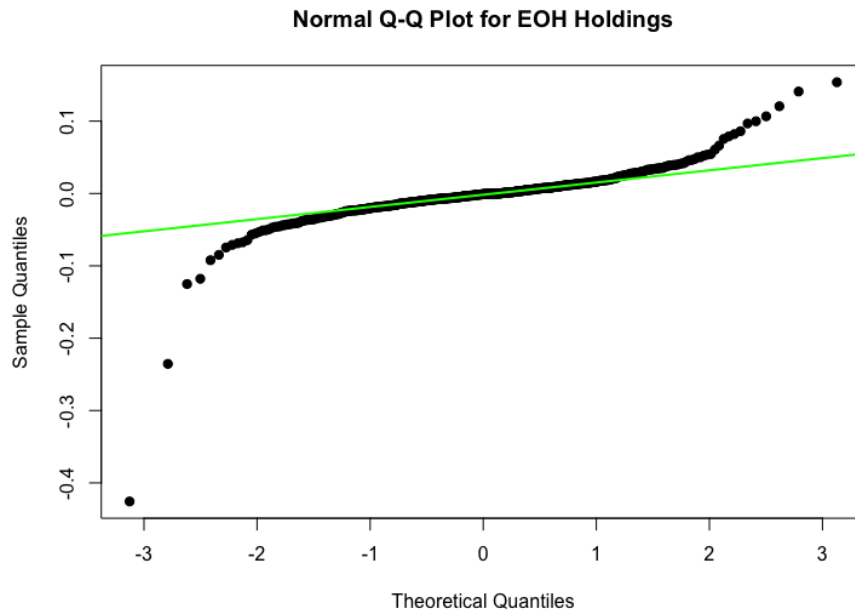
(b) QQ plot

Figure 5: Histogram and Normal Quantile-Quantile Plot of Truworthis International

Truworths International strongly resembles the Gaussian distribution accompanied by a positive mean, and slight skewness and kurtosis. This is confirmed by the density histogram. Furthermore, the normal QQ plot shows that the majority of the data points lie on the line, which adds credibility to the suggestion that Truworths International is normally distributed. However, the statistical inference methods will either disprove or fail to reject the null hypothesis of normality.



(a) Histogram



(b) QQ plot

Figure 6: Histogram and Normal Quantile-Quantile Plot of EOH Holdings

As seen in Figure 6, EOH Holdings demonstrates negative skewness. However, it must be noted that EOH Holdings has a negative mean which (with the negative skewness) means that

the overall performance of the stock is negative; thus, the outliers are most likely negative. The normal Q-Q plot further reveals that the data is overdispersed relative to that of a normal distribution, as demonstrated by the reverse S-shape. This is often accompanied by an increased number of outliers in the sample. The normal QQ plot confirms this and demonstrates a presence of large negative outliers in EOH Holdings. Although the abovementioned tools provide insight into the behaviour of the data, statistical goodness-of-fit tests are more reliable and objective as previously discussed in Chapter 4.

Table 4: Goodness-of-fit test results of the five stocks from the original data

		Normality Test Statistics				
		AD	LF	SW	JB	DP
EOH	Hold-ings	26.772***	0.13772***	0.71212***	64320***	-18.3010***
Kumba	Iron Ore	4.2981***	0.069048***	0.95104***	705.47***	4.94100***
Nedbank	Group	0.84146**	0.031314	0.99301***	16.85***	0.0635110
Truworths	International	0.96859**	0.031371	0.99106***	24.544***	0.446910
Vodacom	Group	3.8503 ***	0.065976***	0.95957***	412.61 ***	-1.32070

*p < 0.1

** p < 0.05

*** p < 0.01

In the Anderson-Darling test, all of the equities have returns that are statistically significant across two significance levels ($\alpha = 0.10$, and $\alpha = 0.05$), which is indicative of departures from normality. However, at a one percent significance level, Table 4 shows that the Nedbank Group and Truworths International stocks fail to reject the null hypothesis of the Gaussian

distribution. Moreover, for the Lilliefors test, the test fails to detect deviations from normality for two stocks at a 90% confidence level ($\alpha = 0.10$): the Nedbank Group and Truworths International. It is worth noting that these stocks fail to reject normality for both EDF tests in this study. Nonetheless, majority of the sample rejects the null hypothesis at a five percent significance level ($\alpha = 0.05$). However, when the significance level is lowered to one percent, the RMB Holdings and AVI Limited stocks also fail to reject the null hypothesis of normality. Across both EDF tests, at least 50 stocks reject normality at a 99% confidence level.

In the Shapiro-Wilk test, majority of the stocks produced W test statistics that were greater than or equal to 0.90, which is indicative of convergence to normality as some of the test statistics are approaching 1. An exception to this observation was EOH Holdings (as seen in Table 4) which had a test statistic of 0.7212. Nonetheless, the entire sample of 56 equities rejects the null hypothesis of normality across three significance levels ($\alpha = 0.10$, $\alpha = 0.05$, and $\alpha = 0.01$).

Similar to the previous results, the Jarque-Bera test yields strong evidence in favour of rejecting the null hypothesis at a ten percent significance level and five percent significance level across all stocks. However, at a 99% confidence level, the Pick 'n Pay Stores equity is the only stock that fails to reject the null hypothesis. As such, it can be said that the Jarque-Bera test detects departures from normality at a one percent significance level for the remaining 55 stocks in the sample. For the D'Agostino-Pearson test, the test fails to reject the null hypothesis of normality at a 90% confidence level for 20 stocks. The stocks include the Nedbank Group, Truworths International, and the Vodacom Group. This means that, at a ten percent significance level ($\alpha = 0.10$), the test fails to detect deviations from normality through the sample moments, namely: skewness and kurtosis. Moreover, the DP test fails to reject the normality at a 95% confidence level for five more stocks, including Sanlam and Reunert. When the significance level is lowered to one percent, the DP test fails to reject the null hypothesis for five more stocks, including Remgro and Hosken Consolidated Investments. Although some of the stocks strongly exhibit departures from normality, it is apparent that the Nedbank Group and Truworths International stocks are arguably close to a normal distribution with minimal skewness and kurtosis.

Some of the goodness-of-fit tests yielded results where the entire sample strongly rejected the null hypothesis of normality. This could be attributed to the sensitivity of the above tests to outliers in the sample. Nonetheless, the graphical and statistical methods show that,

before the removal of macro-outliers and micro-outliers, the distribution of daily equity returns is asymmetrical and mainly positively-skewed which may impact the distribution of risk.

5.2 Return Behaviour after the removal of Red Letter Days

Appendix B.2 presents the summary statistics of the data for the daily equities returns after the removal of red letter days. From an initial inspection, the abovementioned descriptive statistics show that the stocks are still skewed and thick-tailed, including Kumba Iron Ore as shown in Figure 7. Figure 9 demonstrates the near-perfect symmetry of the Truworths International’s daily return distribution after the initial removal of red letter days; notwithstanding its mean daily returns have dropped by more than 40%. However, outliers remain persistent in the data as confirmed by Figures 8 and 10.

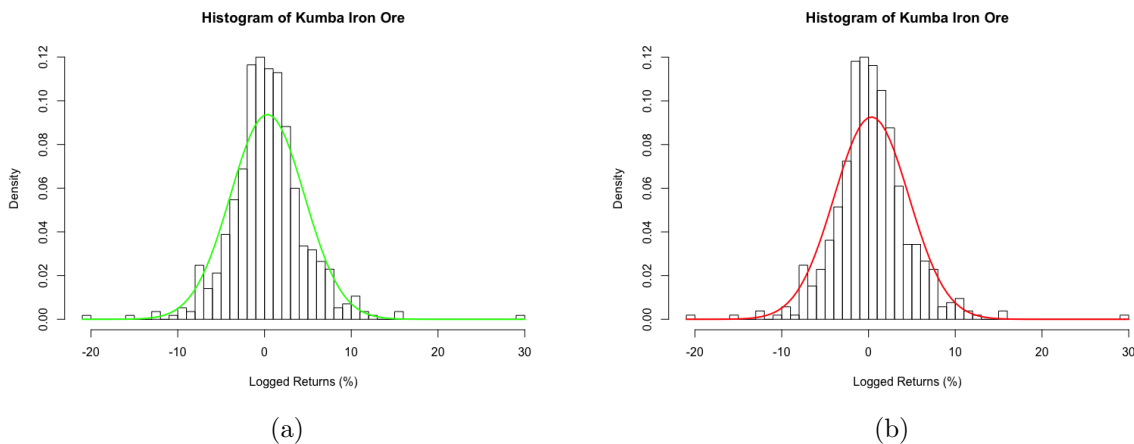


Figure 7: Histograms of Kumba Iron Ore (a) using the original data, and (b) after the removal of red letter days

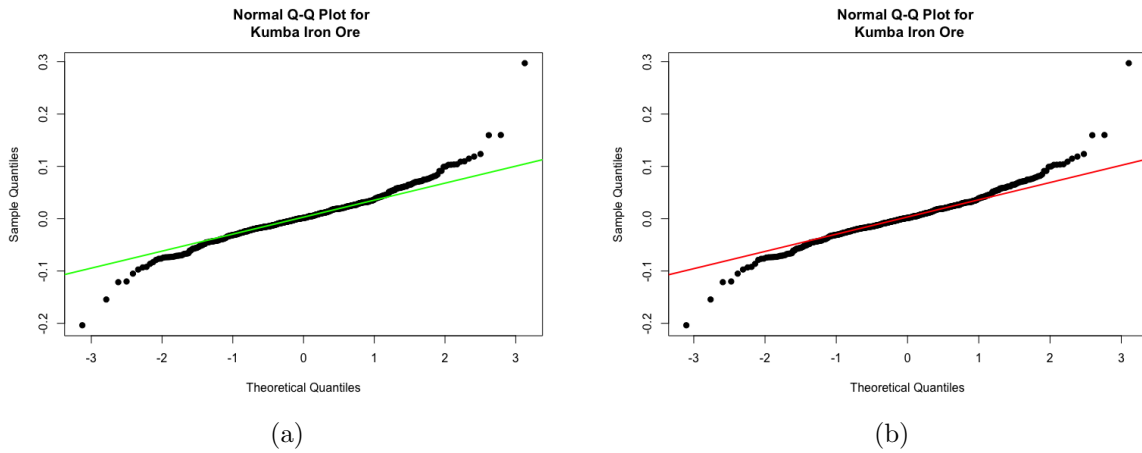


Figure 8: Normal Quantile-Quantile Plots of Kumba Iron Ore (a) using the original data, and (b) after the removal of red letter days

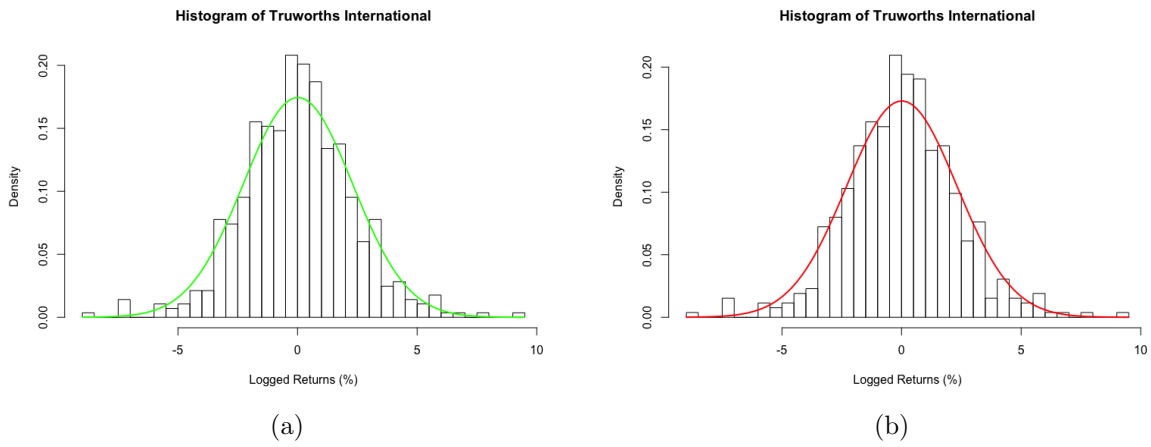


Figure 9: Histograms of Truworths International (a) using the original data, and (b) after the removal of red letter days

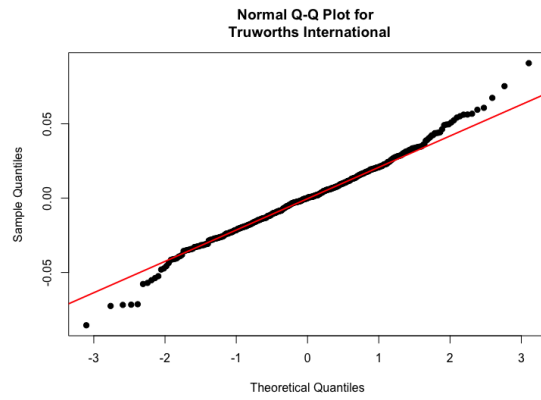
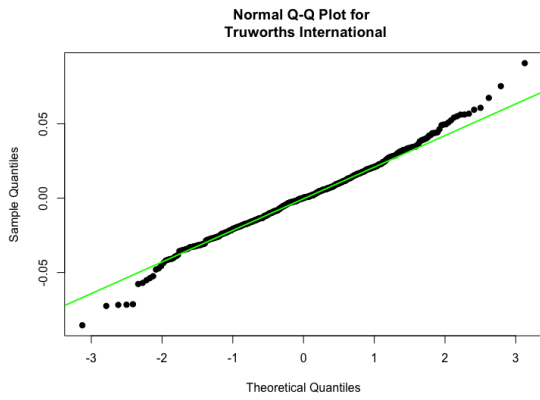


Figure 10: Normal Quantile-Quantile Plots of Truworths International (a) using the original data, and (b) after the removal of red letter days

Table 5: Descriptive Statistics of the Five Stocks from the Data after the Removal of Red Letter Days

Equity	Mean	Standard Deviation	Skewness	Kurtosis	Standard Error
EOH Holdings	-0.001975	0.033962	-3.901860	51.857344	0.001482
Kumba Iron Ore	0.003537	0.043066	0.541045	5.523215	0.001880
Nedbank Group	0.000590	0.018008	-0.043331	0.969872	0.000786
Truworths International	0.000097	0.023066	0.043729	1.089774	0.001007
Vodacom Group	-0.000075	0.012593	-0.184124	4.452341	0.000550

Approximately 68% of the stocks in the sample demonstrate positive mean returns for the daily data. Table 5 shows the descriptive statistics of five equities after the red letter days were removed. Kumba Iron Ore Limited again had the highest mean return (0.003537) and EOH Holdings had the lowest mean return (-0.001975); thus, the effective range was 0.005512. The effective range increased by more than 60%. The increase in the range may be linked to the fact that 34 out of the 56 equities in the sample reported a decrease in the mean daily returns after the removal of red letter days. Furthermore, Figure 11 below demonstrates that there is a large negative outlier in EOH Holdings. Tongaat Hulett reported a decrease of approximately 179% in the mean daily returns after the macro-outliers were omitted from the data. When evaluating the standard deviation, Kumba Iron Ore Limited also demonstrated the highest volatility (0.043066) and the Vodacom Group showed the lowest volatility (0.012593). It is interesting to note that approximately 54% of the sample demonstrated an increase in the standard deviation after the removal of macro-outliers.

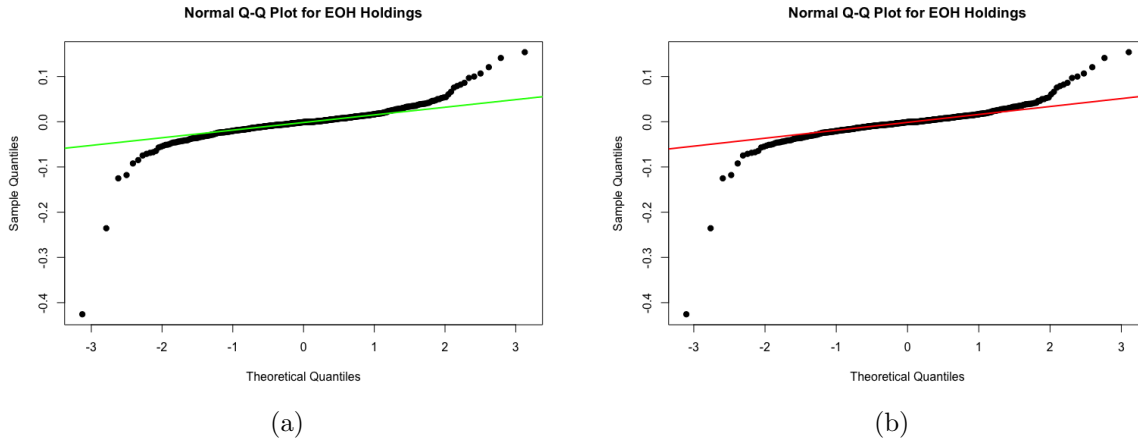


Figure 11: Normal Quantile-Quantile Plots of EOH Holdings (a) using the original data, and (b) after the removal of red letter days

Following the results of the original data, the adjusted sample demonstrated skewness. Positive skewness dominated 55% of the sample; thus implying that deviations from the mean will be positive, and the distribution of the daily returns after the removal of red letter days is asymmetrical and positively-skewed. Nonetheless, the removal of red letter days does appear to have a “smoothing” effect on the distribution of the stocks at a visual level. However, outliers are still present in the data as confirmed by the histograms and QQ plots in Figures 7 to 11, and Appendix D altogether.

In the Anderson-Darling test, the whole sample rejects the null hypothesis across two significance levels ($\alpha = 0.10$ and $\alpha = 0.05$). However, when the significance level is lowered to one percent, Table 6 shows two equities failing to reject the null hypothesis: Nedbank Group Limited and Truworths International. As such, this means that the remaining 54 stocks have returns that are statistically significant at a 99% confidence level and reject normality. Furthermore, in the Lilliefors test, the Truworths International stock fail to reject the null hypothesis at a ten percent significance level. When the confidence level is increased to 95%, two more stocks (including the Nedbank Group) fail to reject normality. It is worth noting that the Nedbank Group and Truworths International stocks failed to reject the null hypothesis for both EDF tests at a 95% confidence level. Coincidentally, this is consistent with the results of the original data. Additionally, when the significance level is lowered to one percent, the Lilliefors test fails to reject normality for three more stocks: the Pioneer

Foods Group, RMB Holdings, and RMI Holdings. This also means that approximately 90% of the sample is statistically significant at a one percent level; thus, it rejects normality. Moreover, it is apparent that both EDF tests detect departures from normality for at least 50 stocks in the sample, which corresponds with the results from the original data.

Table 6: Goodness-of-fit test results of the five stocks from the data after removing red letter days

		Normality Test Statistics				
		AD	LF	SW	JB	DP
EOH	Hold-ings	25.508***	0.13923***	0.70424***	59013***	-17.7520***
Kumba	Iron Ore	4.0932***	0.068137***	0.94946***	677.44***	4.8135***
Nedbank	Group	1.0301**	0.037285*	0.99145***	19.874***	-0.409570
Truworths	International	1.0064**	0.031136	0.99012***	25.118***	0.413320
Vodacom	Group	3.7003***	0.062281***	0.95689***	426.19***	-1.7274*

*p < 0.1

** p < 0.05

*** p < 0.01

For the Shapiro-Wilk test, all 56 equities in the sample have returns that are statistically significant across three significance levels ($\alpha = 0.10$, $\alpha = 0.05$, and $\alpha = 0.01$) as seen in Appendix D. Table 6 confirms the observation, which may imply that the sample observations are poorly correlated with the associated normal scores (Das and Imon, 2016). Moreover, these results are consistent with the findings in the previous section.

Across three significance levels ($\alpha = 0.10$, $\alpha = 0.05$, and $\alpha = 0.01$), the sample strongly rejects the null hypothesis of normality for the Jarque-Bera test, respectively. This consistent with the findings of the original data in Section 5.1. In the D'Agostino-Pearson test, 21 stocks failed to reject the null hypothesis at a 90% confidence level. These stocks included Reunert and Sanlam, which is consistent with the results of the original data. Furthermore, the Vodacom Group stock is the only additional equity that fails to reject normality at a five significance level as seen in Table 6. However, when the confidence level is increased to 99%, the DP test fails to detect non-normality through the sample moments in eleven more stocks, including Remgro and Hosken Consolidated Investments. This therefore means that, at a 99% confidence level, 33 out of 56 stocks fail to reject the null hypothesis of normality. This number grew from 30 equities, which could imply that the removal of red letter may have led to less asymmetry and thinner tails.

While the D'Agostino-Pearson test may yield interesting results, it is important to highlight that the other goodness-of-fit tests demonstrate that at least $\pm 90\%$ of the sample has returns that are statistically significant at a 99% confidence level after red letter days have been removed from the dataset. This could be attributed to the presence of micro-outliers in the sample; notwithstanding that it must be acknowledged that, despite the power of these goodness-of-fit tests, they are very sensitive to outlying values. Also, for large samples, the likelihood of the null hypothesis being rejected increases as the sample size increases.

5.3 Return Behaviour after the removal of Red and Blue Letter Days

Appendix B.3 shows the descriptive statistics of the daily stock returns after the removal of red and blue letter days. From initial observations, the summary statistics still demonstrate a presence of skewness and excess kurtosis in the equities. Similar to the previous section, Figures 12 and 13 represents Truworths International's daily return distribution resembling that of a perfect Gaussian distribution after the removal of blue letter days. Moreover, it is interesting to note that Truworths International's mean daily returns have fallen by 150% relative to the original data as a result of removing the macro-outliers and micro-outliers.

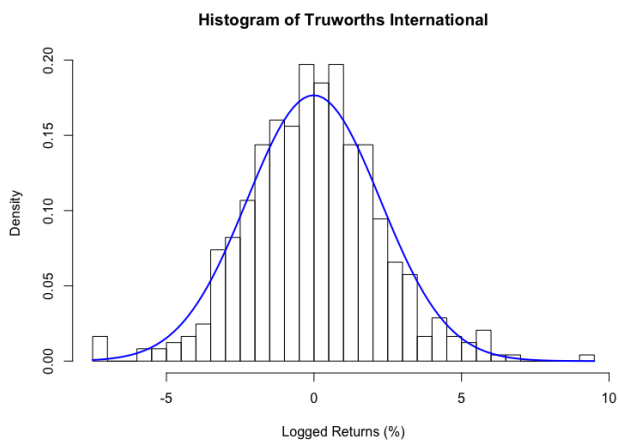
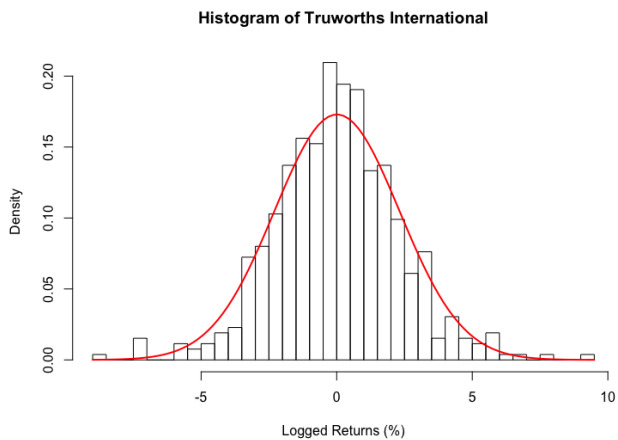
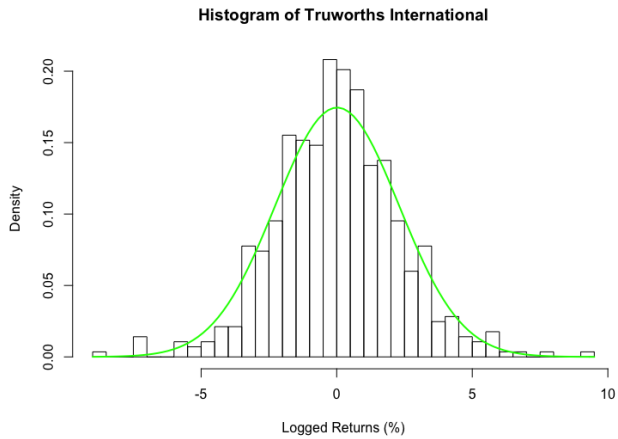
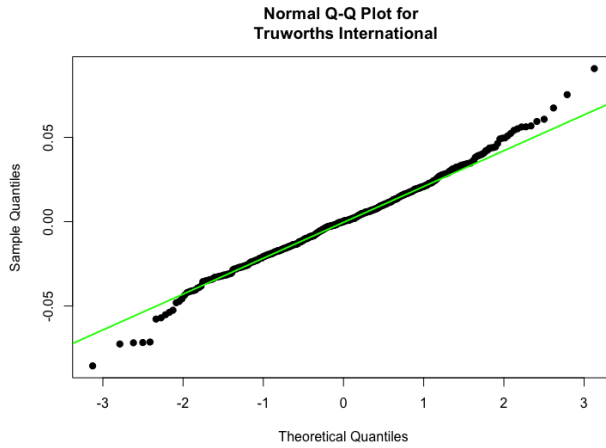
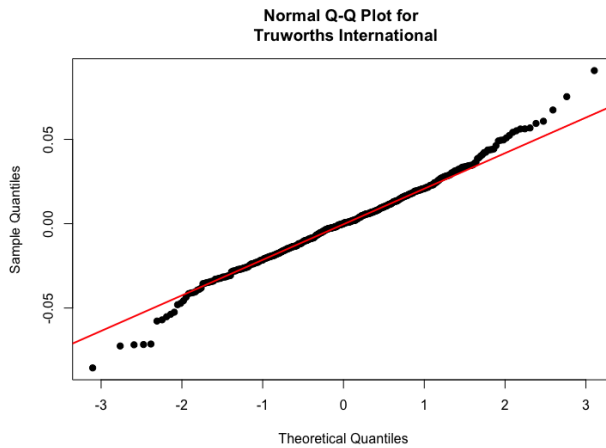


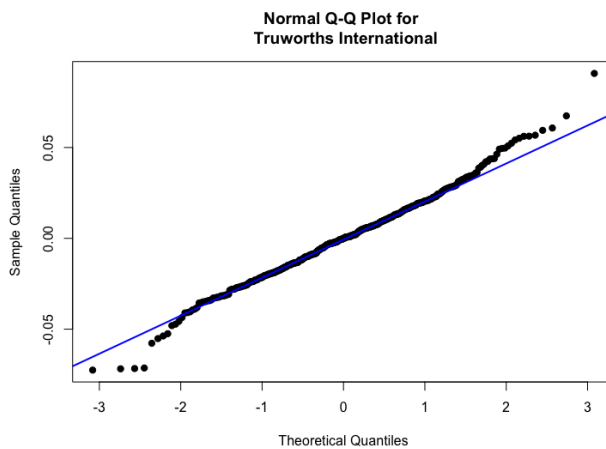
Figure 12: Histograms of Truworths International (a) using the original data, (b) after the removal of red letter days, and (c) after the removal of red and blue letter days



(a)



(b)



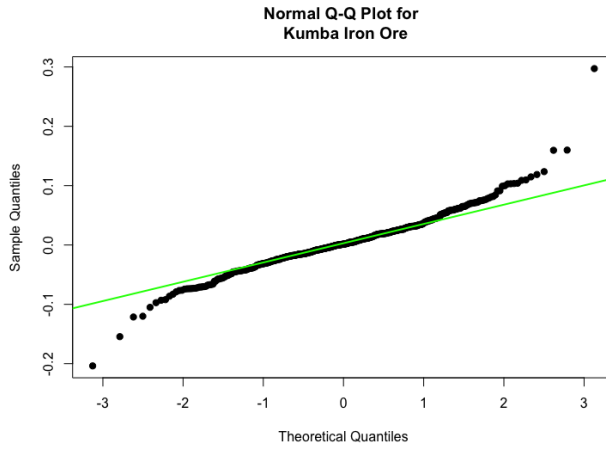
(c)

Figure 13: Normal Quantile-Quantile Plots of Truworths International (a) using the original data, (b) after the removal of red letter days, and (c) after the removal of red and blue letter days

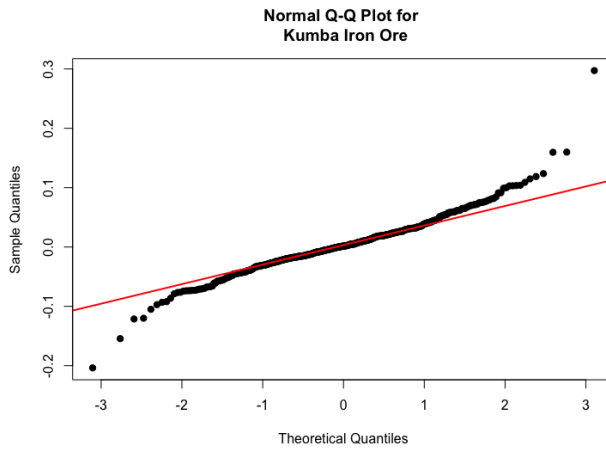
Table 7: Descriptive Statistics of the Five Stocks from the Data after the Removal of Red and Blue Letter Days

Equity	Mean	Standard Deviation	Skewness	Kurtosis	Standard Error
EOH Holdings	-0.001832	0.033981	-3.928957	52.212005	0.001489
Kumba Iron Ore	0.003263	0.041718	0.532439	6.174376	0.001844
Nedbank Group	0.000545	0.017728	-0.090962	0.860605	0.000780
Truworths International	-0.000083	0.022585	0.111664	0.907658	0.001023
Vodacom Group	0.000044	0.012461	-0.160272	4.694274	0.000546

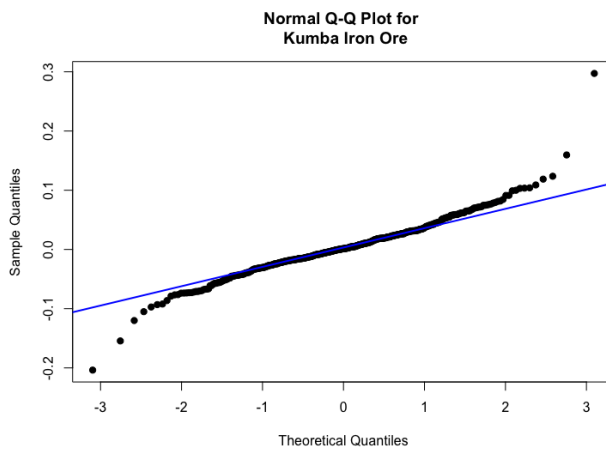
More than 66% of the equities in the sample show positive mean daily returns. Table 7 shows that Kumba Iron Ore once again had the highest mean return (0.003263) which could be attributed to the larger positive outlier as demonstrated by Figure 14. EOH Holdings had the lowest mean return (-0.001832); thus, the effective range was 0.005095 which is less than the effective range as reported in Section 5.2. However, the effective range after the removal of red and blue days is significantly larger than of the original data. This could be linked to the fact that 30 out of the 56 stocks included in the sample reported a fall in the mean daily returns after red and blue letter days were removed.



(a)



(b)



(c)

Figure 14: Normal Quantile-Quantile Plots of Kumba Iron Ore (a) using the original data, (b) after the removal of red letter days, and (c) after the removal of red and blue letter days

Upon scrutinising the standard deviation, Kumba Iron Ore once again showed the highest volatility (0.041718) and the Vodacom Group also demonstrated the lowest volatility (0.012461). It is important to highlight that more than 82% of the sample reported a decrease in the standard deviation after red and blue letter days were removed from the data. This may imply that the removal of macro-outliers and micro-outliers from daily equity return data leads results in decreased volatility.

The largest JSE indices used in this study include: *Banks* (JSE Index Code J835), *Food and Drug Retailers* (JSE Index Code J533), *Food Producers* (JSE Index Code J537), *General Industrials* (JSE Index Code J272), *General Retailers* (JSE Index Code J537), and *Mining* (JSE Index Code J177). RMB Holdings was the only stock in the *Banks Index* that reported a mean daily return (0.00097) beating that of the sector leader, FirstRand Limited (0.000869). Despite representing the lowest mean daily return in the index, Absa Group demonstrated the highest volatility (0.020602); thus exceeding that of FirstRand (0.019641).

In terms of mean daily returns, the Clicks Group (0.001534) and Pick ‘n Pay Stores stocks (0.000105) beat the *Food and Drug Retailers Index*’s leader, Shoprite Holdings (0.00001). However, Shoprite Holdings reported the highest volatility (0.017484) in the index. Additionally, in the *Food Producers Index*, AVI Limited (0.000949) is the only equity that outperformed the sector leader, Tiger Brands Limited (0.0003), in terms of daily returns while the rest reported negative figures. Pioneer Foods Group (0.019677) and the Oceana Group (0.000105) stocks also demonstrated volatilities exceeding that of the Tiger Brands.

In the *General Industrials Index*, three stocks beat the sector leader, Remgro, in terms of mean daily returns: Bidvest Group (0.001650), KAP Industrial Holdings (0.000063), and Barloworld (0.0013). With respect to the standard deviation, all of the member stocks reported higher volatilities than Remgro. Furthermore, as the sector leader of the *General Retailers Index*, Mr Price Group (0.000860) retained the lead while Curro Holdings (-0.000231) reported negative daily returns. Massmart Holdings, TFG and Truworths International exceeded the sector leader, in terms of volatility.

Lastly, in the *Mining Index*, Exxaro Resources (0.0027) is the only stock in the index that beat the leader, Anglo American Platinum (0.000611), with respect to mean daily returns. It is worth noting that the index is more volatile relative to its counterparts. Impala Platinum

(0.000105) and Exxaro Resources (0.031370) were more volatile than the sector leader.

The augmented sample exhibited skewness in the entire sample, especially positive skewness dominated by approximately 61%. This therefore implies that the distribution of daily equity returns, after the removal of macro-outliers and micro-outliers, continues to be asymmetrical and positively-skewed. As such, deviations from the mean have a stronger likelihood of being positive.

Table 8: Goodness-of-fit test results of the five stocks from the data after removing red and blue letter days

		Normality Test Statistics				
		AD	LF	SW	JB	DP
EOH	Hold-ings	25.653***	0.14097***	0.70136***	59358***	-17.7400***
Kumba	Iron Ore	3.6622***	0.064371***	0.94722***	818.53***	4.68740***
Nedbank	Group	0.84013**	0.036294	0.99269**	15.903***	-0.851240
Truworths	International	0.76449**	0.028376	0.99125***	16.937***	1.01480
Vodacom	Group	3.7651***	0.06353***	0.95454***	468.23***	-1.49940

*p < 0.1

** p < 0.05

*** p < 0.01

The Anderson-Darling test reveals that all 56 equities have returns that are statistically significant across two significance levels ($\alpha = 0.10$, and $\alpha = 0.05$). However, at a one percent significance level, Table 8 shows that three equities fail to reject the null hypothesis

including the Nedbank Group and Truworths International. This means that the remaining 53 stocks in the sample have returns that are statistically significant at a 99% confidence level and reject normality. Moreover, the Lilliefors test fails to reject three stocks, again including the Nedbank Group and Truworths International, at a ten percent significance level. This is consistent with previous findings for both EDF tests. Furthermore, at a 95% confidence level, one more stock is statistically significant: RMB Holdings. However, when the level of confidence increases to 99%, seven more stocks reject the null hypothesis. These stocks include the Pioneer Foods Group, and RMI Holdings which corresponds with the results from previous sections. This also means that 45 equities still reject the null hypothesis of Gaussianity at a 99% confidence level after the removal of macro-outliers and micro-outliers.

Similar to the Anderson-Darling test, the Shapiro-Wilk test strongly rejects the null hypothesis across two significance levels ($\alpha = 0.10$, and $\alpha = 0.05$) for the whole sample. At a one percent significance level, however, the test reveals that the Nedbank Group and JSE Limited stocks fail to reject the null hypothesis. This implies that 96% of the sample has returns that are statistically significant at a 99% confidence level and exhibits departures from normality. Moreover, these results are consistent with the previous sections.

For the Jarque-Bera test, the JSE Limited stock is the only equity in the sample that fails to reject the null hypothesis at a 90% confidence level. The remaining 55 stocks strongly reject the null hypothesis of Gaussianity across two significance levels ($\alpha = 0.10$, and $\alpha = 0.05$). This consistent with the findings of the original data in Sections 5.1 and 5.2. Additionally, the D'Agostino-Pearson test reveals that 22 stocks fail to reject the null hypothesis at 90% confidence level. These stocks include JSE Limited, the Nedbank Group, Sanlam, and Truworths International. Furthermore, when the confidence level is increased to 95%, two more stocks fail to reject the null hypothesis. Likewise, at a one percent significance level, eight more stocks fail to reject the null hypothesis. The stocks include Hosken Consolidated Investments, Remgro, and Reunert. Moreover, the D'Agostino-Pearson test demonstrates that approximately 59% of the sample fails to reject normality at a 99% confidence level. Equivalently, the test detected deviations from normality via the sample moments in 24 equities; notwithstanding these results are in line with the previous sections. This could mean that the omission of macro-outliers and micro-outliers from the data results in increased symmetry, and lower kurtosis.

Similar to the previous sections, the goodness-of-fit tests (except the D’Agostino-Pearson) highlight that at least 80% of the sample rejects the null hypothesis of normality after the removal of red and blue letter days at a 99% confidence level. As previously explained, this could be attributed to the presence of outliers in the data. The outlying values could represent unforeseen events of increased market and/or sectoral volatility.

5.4 Discussion of Results

The above empirical results demonstrate a trend that is consistent with the related international literature (Kon, 1984; Brown and Warner, 1985; Berry et al., 1990; Peiro, 1999). South African daily return data for single-listed equities is primarily positively-skewed and thick-tailed. For some stocks, the omission of *a priori* macro-outliers and micro-outliers from the dataset has resulted in closer fits to normality as seen in the histograms and QQ plots. Moreover, the removal of red and blue letter days from the original data resulted in a decreased standard deviation for more than 80% of the sample. From a sectoral perspective, the Banks Index demonstrated the most stability out of all the indices, in terms of mean daily returns and standard deviation.

Table 9: Number of equities with daily returns that are statistically significant at a 90% confidence level ($\alpha = 0.10$) and reject the null hypothesis of Gaussianity

	Data Categories		
	Original Data	Data after Removing Red Letter Days	Data after Removing Red and Blue Letter Days
Anderson-Darling	56	56	56
Lilliefors	54	55	53
Shapiro-Wilk	56	56	56
Jarque-Bera	56	56	55
D’Agostino-Pearson	36	35	34

Table 10: Number of equities with daily returns that are statistically significant at a 95% confidence level ($\alpha = 0.05$) and reject the null hypothesis of Gaussianity

Data Categories			
	Original Data	Data after Removing Red Letter Days	Data after Removing Red and Blue Letter Days
Anderson-Darling	56	56	56
Lilliefors	56	54	55
Shapiro-Wilk	56	56	56
Jarque-Bera	56	56	56
D'Agostino-Pearson	51	55	54

Table 11: Number of equities with daily returns that are statistically significant at a 99% confidence level ($\alpha = 0.01$) and reject the null hypothesis of Gaussianity

Data Categories			
	Original Data	Data after Removing Red Letter Days	Data after Removing Red and Blue Letter Days
Anderson-Darling	54	54	53
Lilliefors	52	50	45
Shapiro-Wilk	56	56	54
Jarque-Bera	55	56	55
D'Agostino-Pearson	26	23	24

When testing for normality using empirical distribution function tests, 92% of the stocks in the original data in Section 5.1 have returns that are statistically significant at 90%, 95%,

and 99% confidence levels. Furthermore, the omission of macro-outliers from the original data yielded the same results as demonstrated in Section 5.2. Additionally, the removal of micro-outliers from the augmented dataset produced relatively the same output; however, in the Lilliefors test, the number of equities with returns that are statistically significant at $\alpha = 0.01$ decreased by approximately 13% relative to the results from the original data in Section 5.1. Nonetheless, Table 11 shows that at least 45 stocks in the sample rejected the null hypothesis at a 99% confidence level for both EDF tests. However, the Nedbank Group and Truworths International stocks demonstrated relatively good fits to the normal distribution across all three data categories.

As a correlation-based goodness-of-fit test, Tables 9, 10, and 11 show that the Shapiro-Wilk test consistently rejected the null hypothesis of normality for at least 96% of the sample across all three significance levels and data categories. Since the SW test is regarded to be the most powerful normality test, it can be said that majority of South African single-listed equities in the sample are highly non-normal.

Across all three data categories, the Jarque-Bera test produced statistically significant results where at least 98% of the sample rejected the null hypothesis at either a 90%, 95%, or 99% confidence level as demonstrated by Tables 9, 10, and 11. This means that, through the sample moments, single-listed stocks on the JSE demonstrate significant departures from normality. In other words, they exhibit skewness and/or excess kurtosis which means that asset allocation frameworks assuming the Gaussian distribution may lead to a quantifiable misestimation of portfolio risk (Sheikh and Qiao, 2009). This is consistent with the related literature on the JSE (Page, 1993; Jefferis and Smith, 2005; Mangani, 2007).

In contrast to the results from the abovementioned tests and graphical methods, the D'Agostino-Pearson test yields different results. At a 90% confidence level, at least 35% of the sample failed to reject the null hypothesis across all three data categories. Furthermore, when the confidence level is increased to 99%, no more than 46% of the sample fails to reject the normality hypothesis. Also, the number of stocks with statistically significant results decreases across the data categories. This may imply that the removal of macro-outliers and micro-outliers results in the failure of the DP test to detect departures from normality via the sample skewness and kurtosis at certain confidence levels. Moreover, the D'Agostino-Pearson test results in Sections 5.1 to 5.3 may imply that the omission of red and blue letter days leads

to decreased sample skewness and kurtosis. Thus it reinforces the argument that the removal of the macro-outliers and micro-outliers leads to improved fits to the normal distribution. Additionally, the contrasting results emphasises that normality tests may yield contradicting results, which means that the choice, power, and sensitivity of the test is of paramount importance to an empirical study (Razali and Wah, 2011). However, it is crucial to note that the D'Agostino-Pearson test is the only test out of five goodness-of-fit tests used in this study that is producing these kind of results.

With reference to the histograms and QQ plots, it is important to note that outliers remained present in the data even after the removal of the *a priori* outliers. Although this is beyond the scope of this study, the further presence of outliers may be linked to unforeseen market and/or sector-specific events. Unforeseen events of heightened market and/or sectoral volatility in South Africa have come in the form of policy uncertainty, and industrial action in key sectors, namely manufacturing and mining. In particular, the questionable firing of Nhlanhla Nene as the Finance Minister in December 2015 (locally known as “*Nenegate*”) booted the Rand into a tailspin, causing it to weaken substantially. However, Kotze (2017) argues that the depreciation of the Rand had gained momentum since 2011 prior to *Nenegate*. The subsequent Cabinet reshuffles shattered investor confidence which eventually resulted in *S&P Global Ratings* downgrading the long-term outlook for the country’s foreign currency debt and local currency sovereign debt (Karodia and Soni, 2016).

South African single-listed equities are non-normal on the basis of the following goodness-of-fit criteria: (i) empirical distribution functions, (ii) regression and correlation, and (iii) moments. Furthermore, the stocks exhibit non-normality across three different categories: (i) original data, (ii) data after the omission of predetermined macro-outliers, and (iii) data after the omission of *a priori* macro-outliers and micro-outliers. This means that asset pricing models and/or asset allocation frameworks which are premised on the Gaussian distribution (including CAPM) misestimate the frequency and magnitude of extreme negative events, as well as their impact on portfolio efficiency and returns (Sheikh and Qiao, 2009; Ward and Muller, 2012). It also highlights the need for asset pricing models and asset allocation frameworks that factor non-normality, and the asymmetric risk preferences of investors (Sharpe, 1964; Lintner, 1965; Mossin, 1966; Sharpe, 1994).

6 Conclusion

This study has carried out an investigation into whether the removal of *a priori* outliers from South African single-listed equities results in improved fits to the normal distribution. This has required not only an empirical evaluation of goodness-of-fit methodologies, but also an examination of the various aspects relating to the normality assumption in finance. In doing this, it has been shown how interrelated the components are with each other.

The study utilised the daily returns of 56 stocks over the period 1 January 2016 to 31 December 2017 on a 65-day rolling basis. Since normality is one of the core tenets in financial economics, it would be of interest for investors, asset managers, and the academic community to know how the omission of *a priori* macro-outliers and micro-outliers affects the return distribution of equities. The macro-outliers consisted of US nonfarm payrolls and South African Reserve Bank repo rate announcements. Moreover, the micro-outliers included preliminary and final earnings announcements. The single-listed equities in the sample were filtered on the basis of the following criteria: (i) acquired and delisted equities, (ii) liquidity concerns, (iii) consistent values for the sample period, (iv) accessibility by investors, and (v) the magnitude of ADR exposure. This study omitted the outliers, and thereafter implemented graphical methods and five statistical goodness-of-fit tests to determine whether the stocks follow the Gaussian distribution. Furthermore, the goodness-of-fit tests were categorised into (i) empirical distribution function, (ii) regression and correlation, and (iii) moment tests.

Upon fitting the normal distribution to the data, it became apparent that the majority of the data exhibited fat tails and positive skewness. Furthermore, this persisted despite the removal of macro-outliers and micro-outliers; however, the normal quantile-quantile plots, and histograms clearly show improved fits to normality as a result of the outlier removal. As such, it is important to note that the positive skewness implies that deviations from the mean have a stronger probability of being positive, which appeals to investors. Moreover, the fat tails will tend to overestimate the likelihood of attaining the mean return.

The empirical results demonstrated that at least 90% of South African single-listed equities in the sample demonstrated significant departures from normality across three data categories: (i) original data, (ii) data after the omission of predetermined macro-outliers, and (iii) data after the omission of predetermined macro-outliers and micro-outliers. However, in the

D'Agostino-Pearson test, normality was found to be a reasonable assumption for 41% of the stocks in the sample across the data categories. This divergent result was found to be attributed to the decreased asymmetry and kurtosis after the removal of the *a priori* data. Thus it affirms the view that the removal of the red and blue letter days has resulted in improved fits to the Gaussian distribution. Furthermore, the contrasting result highlighted the differences in the power, sensitivity, and underlying assumptions of normality tests. Overall, despite the removal of the predetermined macro-outliers and micro-outliers, the empirical results are consistent with international and local evidence (Page, 1993; Peiro, 1994; Aparicio and Estrada, 2001; Mangani, 2007). This also affirms the need for asset allocation and pricing models that consider non-normality, and the loss averse and irrational nature of investors in financial decision-making.

6.1 Considerations for Future Research

This study observed that outlying values continued to be present in the stock return data even after the red and blue letter days were removed. The outliers could be attributed to unforeseen firm and/or market events. The sample period used in this study included several unpredictable market events, including *Nenegate*, Donald Trump's presidential win, and industrial action in the South African platinum sector. As such, there is potential for addressing the removal of the unforeseen "outliers" as an extension of this research. Furthermore, special attention would need to be given to the methodology and ensuring the robustness thereof. Moreover, this study could be replicated in different countries. Additionally, another research avenue would be examining the goodness-of-fit of daily, weekly, and monthly return data on the Johannesburg Stock Exchange (JSE) to a certain empirical distribution. This would build on Chen et al. (2003) and Mangani (2007) in order to determine whether the goodness-of-fit results vary with time.

As mentioned in Chapter 2, a concern in the research was the paucity of literature on the equity return distributions in South Africa and other emerging markets. Although there is a general consensus on the non-Gaussian behaviour of stock market returns, heavy-tailed distributions need to be considered in the South African context. Furthermore, stock market returns in developed markets were proven to follow a power law distribution, which has created a lacuna in the academic literature as to whether the aforementioned is true for emerging markets like South Africa. More research should be focused in this field as this

study mainly dealt with the distributional properties of JSE returns; notwithstanding that this research would be building on Fama (1963, 1965), Mandelbrot (1963), and Gabaix et al. (2003).

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A Stocks analysed and/or used in the Data Analysis

A.1 Top 100 stocks on the JSE Main Board as of 31 December 2015, listed by market capitalisation

Ranking	Company Name	Market Capitalisation in ZAR
1.	Naspers	929 807 597 568
2.	SASOL	273 192 763 392
3.	MTN Group	245 247 606 784
4.	FirstRand	237 674 004 480
5.	Vodacom Group	226 779 070 464
6.	Standard Bank Group	183 671 619 584
7.	Aspen Pharmacare	141 231 620 096
8.	Sanlam	131 158 212 608
9.	Remgro	126 678 605 824
10.	ABSA Group	121 643 745 280
11.	Mediclinic International	116 509 138 944
12.	Bidvest Group	110 083 014 656
13.	Investec	99 444 203 520
14.	Woolworths Holdings	95 961 382 912
15.	Nedbank Group	93 251 035 136
16.	Discovery	86 075 539 456
17.	Shoprite Holdings	82 069 635 072
18.	RMB Holdings	78 504 820 736
19.	Growthpoint Properties	63 451 062 272
20.	Capitec Bank Holdings	62 272 073 728
21.	Tiger Brands	60 778 590 208
22.	RMI Holdings	57 510 998 016
23.	Mr Price Group	53 425 790 976
24.	Fortress REIT	51 906 932 736
25.	PSG Group	51 579 006 976
26.	Anglo American Platinum	49 982 840 832
27.	Netcare	49 400 999 936

<i>continued from previous page</i>		
28.	Redefine Property	47 049 740 288
29.	Resilient REIT	44 518 719 488
30.	AngloGold Ashanti	43 232 219 136
31.	Truworths International	39 162 720 256
32.	Pioneer Foods Group	37 016 616 960
33.	Life Healthcare	36 769 542 144
34.	Distell Group	36 645 822 464
35.	MMI Holdings	34 604 748 800
36.	Sappi	34 098 350 080
37.	Telkom SA SOC	33 898 608 640
38.	Liberty Holdings	32 964 788 224
39.	Gold Fields	32 837 281 792
40.	Spar Group	31 898 603 520
41.	Pick 'n Pay Stores	31 749 271 552
42.	AVI	26 856 232 960
43.	TFG	25 959 987 200
44.	Tsogo Sun Holdings	25 390 190 592
45.	Hyprop Investment	25 140 516 864
46.	Oakbay Resources & Energy	24 231 999 488
47.	Imperial Logistics	24 204 091 392
48.	Clicks Group	21 906 259 968
49.	Santam	21 817 403 392
50.	Massmart Holdings	21 713 633 280
51.	Sibanye Gold	20 933 812 224
52.	Curro Holdings	20 623 386 624
53.	Coronation Fund Managers	18 504 372 224
54.	Impala Platinum	18 398 851 072
55.	EOH Holdings	18 130 001 920
56.	Nampak	17 085 059 072
57.	KAP Industrial Holdings	16 842 460 160
58.	Exxaro Resources	15 771 186 176
59.	NewGold Issuer	15 545 400 320

<i>continued from previous page</i>		
60.	Pick n Pay Holdings	14 762 974 208
61.	Oceana Group	13 984 560 128
62.	Attacq	13 640 287 232
63.	Super Group	13 623 701 504
64.	Northam Platinum	13 453 126 656
65.	Kumba Iron Ore	13 269 942 272
66.	Barloworld	13 180 559 360
67.	Famous Brands Ld	12 975 616 000
68.	Tongaat Hulett	12 576 271 360
69.	Reunert	12 548 020 224
70.	Italtile	12 193 327 104
71.	Hosken Consolidated Investments	12 150 446 080
72.	JSE	11 120 290 816
73.	Vukile Property Fund	10 945 576 960
74.	AECI	10 926 559 232
75.	Datatec	10 786 580 480
76.	SA Corporate Realty	10 521 595 904
77.	Sun International	10 161 453 056
78.	Investec Property Fund	10 127 835 136
79.	PSG Konsult	9 977 165 824
80.	African Rainbow	9 469 257 728
81.	PPC	9 322 846 208
82.	Zeder Investment	9 182 802 944
83.	Omnia Holdings	9 091 893 248
84.	Adcock Ingram Holdings	8 783 887 360
85.	Assore	8 669 594 624
86.	Grindrod	8 609 226 752
87.	Capevin Holdings	8 492 996 608
88.	Emira Property Fund	8 276 016 640
89.	Blue Label Telecommunications	8 195 284 992
90.	Alexander Forbes	7 954 661 888
91.	Arrowhead Property	7 893 451 264

<i>continued from previous page</i>		
92.	Trencor	7 879 526 400
93.	Mpact	7 790 097 408
94.	Ilovo Sugar (Pty)	7 786 346 496
95.	SATRIX 40	7 677 830 144
96.	Cashbuild	7 556 943 360
97.	Wilson Bayly Homes	7 156 906 496
98.	Transaction Capital	7 038 203 392
99.	Harmony Gold Mining	6 813 922 816
100.	Advtech	6 627 766 784

A.2 South African Equities used in the Econometric Analysis

Ranking	Company Name	Market Capitalisation in ZAR
1.	SASOL	273 192 763 392
2.	MTN Group	245 247 606 784
3.	FirstRand	237 674 004 480
4.	Vodacom Group	226 779 070 464
5.	Standard Bank Group	183 671 619 584
6.	Aspen Pharmacare	141 231 620 096
7.	Sanlam	131 158 212 608
8.	Remgro	126 678 605 824
9.	ABSA Group	121 643 745 280
10.	Bidvest Group	110 083 014 656
11.	Nedbank Group	93 251 035 136
12.	Discovery	86 075 539 456
13.	Shoprite Holdings	82 069 635 072
14.	RMB Holdings	78 504 820 736
15.	Capitec Bank Holdings	62 272 073 728
16.	Tiger Brands	60 778 590 208
17.	RMI Holdings	57 510 998 016
18.	Mr Price Group	53 425 790 976
19.	PSG Group	51 579 006 976
20.	Anglo American Platinum	49 982 840 832
21.	Netcare	49 400 999 936
22.	Truworths International	39 162 720 256
23.	Pioneer Foods Group	37 016 616 960
24.	Life Healthcare	36 769 542 144
25.	MMI Holdings	34 604 748 800
26.	Sappi	34 098 350 080
27.	Telkom SA SOC	33 898 608 640
28.	Liberty Holdings	32 964 788 224
29.	Spar Group	31 898 603 520
30.	Pick 'n Pay Stores	31 749 271 552
31.	AVI	26 856 232 960

<i>continued from previous page</i>		
32.	TFG	25 959 987 200
33.	Tsogo Sun Holdings	25 390 190 592
34.	Imperial Logistics	24 204 091 392
35.	Clicks Group	21 906 259 968
36.	Santam	21 817 403 392
37.	Massmart Holdings	21 713 633 280
38.	Curro Holdings	20 623 386 624
39.	Coronation Fund Managers	18 504 372 224
40.	Impala Platinum	18 398 851 072
41.	EOH Holdings	18 130 001 920
42.	Nampak	17 085 059 072
43.	KAP Industrial Holdings	16 842 460 160
44.	Exxaro Resources	15 771 186 176
45.	Oceana Group	13 984 560 128
46.	Super Group	13 623 701 504
47.	Northam Platinum	13 453 126 656
48.	Kumba Iron Ore	13 269 942 272
49.	Barloworld	13 180 559 360
50.	Famous Brands	12 975 616 000
51.	Tongaat Hulett	12 576 271 360
52.	Reunert	12 548 020 224
53.	Italtile	12 193 327 104
54.	Hosken Consolidated Investments	12 150 446 080
55.	JSE Limited	11 120 290 816
56.	AECI	10 926 559 232

A.3 FTSE/JSE Africa Sector Indices used in the Econometric Analysis

Stocks used in the data analysis as shown in Appendix A.2 have been classified according to their member indices, and ordered by market capitalisation.

1. Banks

1.1 FirstRand

1.2 Standard Bank Group

1.3 ABSA Group

1.4 Nedbank Group

1.5 RMB Holdings

1.6 Capitec Bank Holdings

2. Chemicals

2.1 SASOL

2.2 AECL

3. Electronic and Electrical Equipment

3.1 Reunert

4. Equity Investment Instruments

4.1 RMI Holdings

4.2 Hosken Consolidated Investments

5. Fixed Line Telecommunications

5.1 Telkom SA SOC

6. Food and Drug Retailers

6.1 Shoprite Holdings

6.2 Spar Group

- 6.3 Pick 'n Pay Stores
- 6.4 Clicks Group
- 7. Food Producers
 - 7.1 Tiger Brands
 - 7.2 Pioneer Foods Group
 - 7.3 AVI
 - 7.4 Oceana Group
 - 7.5 Tongaat Hulett
- 8. Forestry and Paper
 - 8.1 Sappi
- 9. General Financials
 - 9.1 PSG Group
 - 9.2 Coronation Fund Managers
 - 9.3 JSE Limited
- 10. General Industrials
 - 10.1 Remgro
 - 10.2 Bidvest Group
 - 10.3 Nampak
 - 10.4 KAP Industrial Holdings
 - 10.5 Barloworld
- 11. General Retailers
 - 11.1 Mr Price Group
 - 11.2 Truworths International
 - 11.3 TFG
 - 11.4 Massmart Holdings

- 11.5 Curro Holdings
- 11.6 Italtile
- 12. Healthcare Equipment and Services
 - 12.1 Netcare
 - 12.2 Life Healthcare
- 13. Industrial Metals
 - 13.1 Kumba Iron Ore
- 14. Industrial Transportation
 - 14.1 Imperial Logistics
 - 14.2 Super Group
- 15. Life Insurance/Assurance
 - 15.1 Sanlam
 - 15.2 MMI Holdings
 - 15.3 Discovery
 - 15.4 Liberty Holdings
- 16. Mining
 - 16.1 Anglo American Platinum
 - 16.2 Impala Platinum
 - 16.3 Exxaro Resources
 - 16.4 Northam Platinum
- 17. Non-Life Insurance
 - 17.1 Santam
- 18. Pharmaceuticals and Biotechnology
 - 18.1 Aspen Pharmacare

19. Software and Computer Services

19.1 EOH Holdings

20. Travel and Leisure

20.1 Tsogo Sun Holdings

20.2 Famous Brands

21. Wireless Telecom Services

21.1 MTN Group

21.2 Vodacom Group

B Descriptive Statistics of the Data

B.1 Summary Statistics of the Original Data

Equity	Mean	Standard Deviation	Skewness	Kurtosis	Standard Error
SASOL	0.000016	0.018865	-0.323452	3.321094	0.000792
MTN Group	-0.000248	0.023431	-0.766116	11.889182	0.000984
FirstRand	0.000767	0.019785	0.103324	1.585797	0.000831
Vodacom Group	-0.000045	0.012526	-0.135078	4.218090	0.000526
Standard Bank Group	0.001076	0.018986	0.091942	1.092060	0.000797
Aspen Pharm- care	-0.000317	0.017959	0.744702	5.244732	0.000754
Sanlam	0.000518	0.020191	-0.193354	2.152035	0.000848
Remgro	-0.000175	0.015269	0.258953	0.608372	0.000641
ABSA Group	0.000370	0.020764	0.146080	2.134608	0.000872
Bidvest Group	0.001467	0.017977	0.193460	1.251972	0.000755
Nedbank Group	0.000731	0.018093	0.006468	0.862577	0.000760
Discovery	0.000441	0.017730	0.080666	2.466256	0.000745
Shoprite Hold- ings	0.000943	0.019017	0.504349	2.901165	0.000799
RMB Holdings	0.000553	0.017848	0.138591	1.452201	0.000750
Capitec Bank Holdings	0.000812	0.018591	-0.509688	6.817335	0.000781
Tiger Brands	0.000364	0.016404	-0.593871	2.506043	0.000689
RMI Holdings	0.000067	0.015381	-0.050208	0.849432	0.000646
Mr Price Group	0.000542	0.024589	-1.291940	11.733644	0.001033
PSG Group	-0.000045	0.020450	-0.384604	1.732582	0.000859
Anglo American Platinum	0.000918	0.029957	0.625456	3.211431	0.001258
Netcare	-0.000356	0.016300	-0.511572	4.622544	0.000685
Truworths Inter- national	0.000164	0.022859	0.045534	1.034871	0.000960

<i>continued from previous page</i>					
Pioneer Foods Group	-0.000411	0.019947	0.197664	2.023130	0.000838
Life Healthcare	-0.000334	0.015762	0.029329	1.426984	0.000662
MMI Holdings	0.000047	0.018272	-0.053187	1.561057	0.000767
Sappi	0.000295	0.019331	0.321392	0.933185	0.000812
Telkom SA SOC	-0.000247	0.021294	-0.206078	2.310700	0.000894
Liberty Holdings	0.000170	0.017846	-0.871278	4.243928	0.000749
Spar Group	0.000164	0.016631	0.016909	1.779454	0.000698
Pick 'n Pay Stores	0.000024	0.017184	-0.023801	0.633556	0.000722
AVI	0.000608	0.014394	-0.272779	1.158876	0.000604
TFG (The Foschini Group)	0.000953	0.023622	0.151343	2.555918	0.000992
Tsogo Sun Holdings	-0.000184	0.016496	0.347934	1.965708	0.000693
Imperial Logistics	0.001195	0.025780	-0.012221	2.174582	0.001083
Clicks Group	0.001315	0.016311	0.265903	1.840058	0.000685
Santam	0.000885	0.015770	0.904997	5.909035	0.000662
Massmart Holdings	0.000897	0.024907	0.248511	1.218348	0.001046
Curro Holdings	-0.000907	0.018409	-0.025422	1.747302	0.000773
Coronation Fund Managers	0.000807	0.019350	0.353880	2.254246	0.000813
Impala Platinum	-0.000075	0.036339	0.309756	2.269068	0.001526
EOH Holdings	-0.001929	0.033293	-3.846743	52.079504	0.001398
Nampak	-0.001077	0.024657	-0.154672	4.241481	0.001035
KAP Industrial Holdings	0.000307	0.017239	-0.499537	5.123352	0.000724
Exxaro Resources	0.001602	0.031791	0.186491	3.588149	0.001335
Oceana Group	-0.000585	0.018814	-0.135630	4.580253	0.000790

<i>continued from previous page</i>					
Super Group	-0.000032	0.015850	0.056439	2.311063	0.000666
Northam Platinum	0.000492	0.027849	0.322536	1.440966	0.001170
Kumba Iron Ore	0.003380	0.042567	0.534197	5.417860	0.001788
Barloworld	0.001731	0.025630	0.351386	1.278311	0.001076
Famous Brands	-0.000345	0.017415	-0.795036	4.617983	0.000731
Tongaat Hulett	0.000096	0.015214	0.391403	1.799405	0.000639
Reunert	0.000235	0.013171	-0.173610	1.757362	0.000553
Italtile	0.000419	0.019072	0.039762	2.395407	0.000801
Hosken Consolidated Investments	0.000401	0.014819	0.251344	1.557760	0.000622
JSE Limited	0.000715	0.016939	-0.026041	0.769532	0.000711
AECI	0.000412	0.013769	0.318816	2.689190	0.000578

B.2 Summary Statistics of the Data after the removal of Red Letter Days

Equity	Mean	Standard Deviation	Skewness	Kurtosis	Standard Error
SASOL	0.000051	0.018809	-0.349650	3.644424	0.000821
MTN Group	-0.000313	0.023879	-0.781721	11.860776	0.001042
FirstRand	0.000801	0.019602	0.088072	1.703841	0.000856
Vodacom Group	-0.000075	0.012593	-0.184124	4.452341	0.000550
Standard Bank Group	0.001040	0.019019	0.072343	1.213130	0.000830
Aspen Pharmacecare	-0.000214	0.018293	0.737919	5.204310	0.000798
Sanlam	0.000780	0.019959	-0.065887	1.736667	0.000871
Remgro	-0.000191	0.015331	0.217033	0.604603	0.000669
ABSA Group	0.000092	0.020694	0.128835	2.267524	0.000903
Bidvest Group	0.001561	0.017859	0.226455	1.401848	0.000779
Nedbank Group	0.000590	0.018008	-0.043331	0.969872	0.000786
Discovery	0.000595	0.017713	0.116020	2.635097	0.000773
Shoprite Holdings	0.000969	0.018972	0.496577	3.169058	0.000828
RMB Holdings	0.000760	0.017687	0.125833	1.554194	0.000772
Capitec Bank Holdings	0.000573	0.018160	-0.844451	7.134585	0.000793
Tiger Brands	0.000059	0.016371	-0.649610	2.768877	0.000714
RMI Holdings	0.000237	0.015450	-0.010684	0.846918	0.000674
Mr Price Group	0.000327	0.024953	-1.339020	11.871147	0.001089
PSG Group	-0.000013	0.020312	-0.389901	1.684905	0.000886
Anglo American Platinum	0.000795	0.029880	0.627902	3.530201	0.001304
Netcare	-0.000328	0.015520	-0.240887	1.930212	0.000677
Truworths International	0.000097	0.023066	0.043729	1.089774	0.001007

<i>continued from previous page</i>					
Pioneer Foods Group	-0.000377	0.020043	0.267221	1.965055	0.000875
Life Healthcare	-0.000421	0.015763	0.083428	1.586369	0.000688
MMI Holdings	0.000022	0.018159	-0.085547	1.738827	0.000793
Sappi	0.000250	0.019195	0.338738	0.895940	0.000838
Telkom SA SOC	-0.000446	0.021406	-0.276122	2.326612	0.000934
Liberty Holdings	0.000587	0.017019	-0.454266	1.886564	0.000743
Spar Group	0.000084	0.016789	-0.009043	1.810361	0.000733
Pick 'n Pay Stores	0.000300	0.017216	-0.056006	0.705036	0.000751
AVI	0.000851	0.014433	-0.259846	1.225880	0.000630
TFG (The Foschini Group)	0.001004	0.023591	0.136982	2.740960	0.001030
Tsogo Sun Holdings	-0.000106	0.016633	0.327753	1.952932	0.000726
Imperial Logistics	0.001138	0.026008	-0.006058	2.254544	0.001135
Clicks Group	0.001612	0.016312	0.280403	1.996627	0.000712
Santam	0.000876	0.015950	0.933462	6.076401	0.000696
Massmart Holdings	0.001034	0.024864	0.243330	1.211380	0.001085
Curro Holdings	-0.000639	0.018503	0.048760	1.659044	0.000808
Coronation Fund Managers	0.000447	0.019087	0.254899	2.205909	0.000833
Impala Platinum	-0.000077	0.036050	0.356643	2.462228	0.001573
EOH Holdings	-0.001975	0.033962	-3.901860	51.857344	0.001482
Nampak	-0.001379	0.024901	-0.138843	4.413792	0.001087
KAP Industrial Holdings	0.000321	0.017526	-0.529864	5.128910	0.000765
Exxaro Resources	0.002005	0.031584	0.283678	3.594619	0.001378
Oceana Group	-0.000453	0.018493	0.254321	2.918026	0.000807

<i>continued from previous page</i>					
Super Group	-0.000124	0.015594	-0.065197	2.257630	0.000681
Northam Platinum	0.000436	0.027064	0.293957	1.484304	0.001181
Kumba Iron Ore	0.003537	0.043066	0.541045	5.523215	0.001880
Barloworld	0.001279	0.025746	0.371064	1.373374	0.001124
Famous Brands	-0.000292	0.017601	-0.798057	4.759503	0.000768
Tongaat Hulett	-0.000076	0.015106	0.370593	1.989608	0.000659
Reunert	0.000114	0.013289	-0.150731	1.812390	0.000580
Italtile	0.000368	0.019287	0.019341	2.337117	0.000842
Hosken Consolidated Investments	0.000302	0.014988	0.255695	1.592561	0.000654
JSE Limited	0.000679	0.017185	-0.030993	0.763610	0.000750
AECI	0.000420	0.013629	0.220116	1.980797	0.000595

B.3 Summary Statistics of the Data after the removal of Red and Blue Letter Days

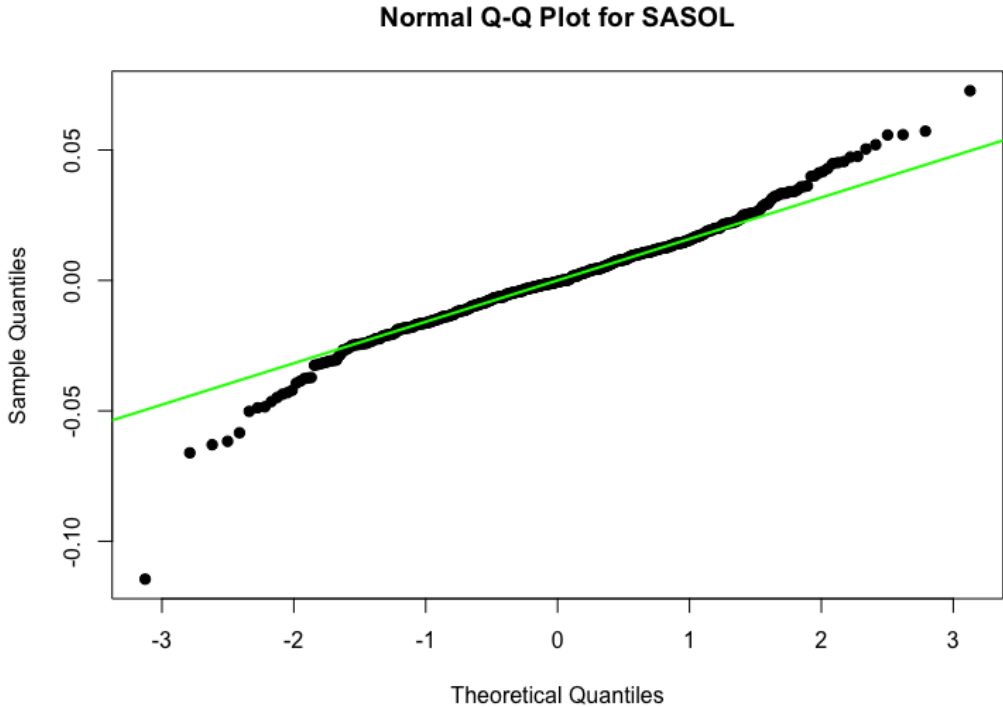
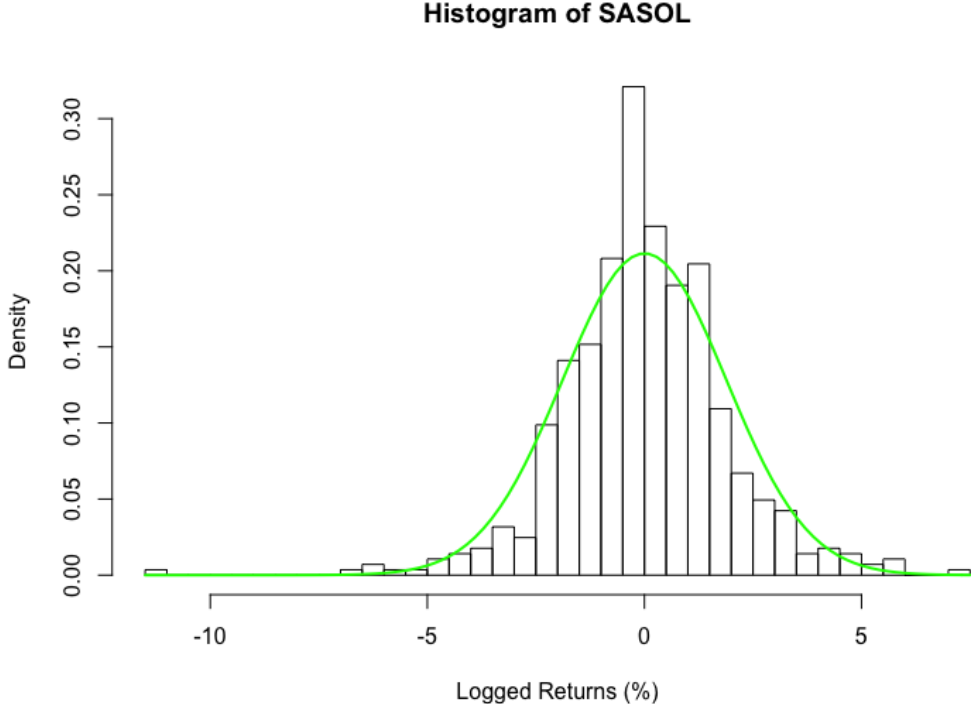
Equity	Mean	Standard Deviation	Skewness	Kurtosis	Standard Error
SASOL	-0.000141	0.018820	-0.354040	3.665312	0.000828
MTN Group	-0.000636	0.023258	-1.042537	12.819864	0.001023
FirstRand	0.000869	0.019641	0.087294	1.713128	0.000863
Vodacom Group	0.000044	0.012461	-0.160272	4.694274	0.000546
Standard Bank Group	0.000644	0.018481	-0.101751	0.936115	0.000814
Aspen Pharm- care	-0.000491	0.017970	0.643621	5.089671	0.000788
Sanlam	0.001045	0.019757	-0.028453	1.798924	0.000870
Remgro	-0.000032	0.015234	0.235759	0.613394	0.000667
ABSA Group	0.000179	0.020602	0.136974	2.354266	0.000907
Bidvest Group	0.001650	0.017933	0.213422	1.374196	0.000787
Nedbank Group	0.000545	0.017728	-0.090962	0.860605	0.000780
Discovery	0.000469	0.017536	0.116594	2.795380	0.000769
Shoprite Hold- ings	0.000010	0.017484	0.198005	1.498274	0.000794
RMB Holdings	0.000970	0.017455	0.221500	1.337555	0.000765
Capitec Bank Holdings	0.000641	0.018236	-0.855278	7.148862	0.000803
Tiger Brands	0.000300	0.016005	-0.553557	2.681599	0.000703
RMI Holdings	0.000166	0.015153	-0.044844	0.834132	0.000664
Mr Price Group	0.000860	0.021810	0.297086	1.762418	0.000984
PSG Group	-0.000092	0.020191	-0.412965	1.726457	0.000885
Anglo American Platinum	0.000611	0.029813	0.655956	3.600589	0.001352
Netcare	-0.000330	0.015094	-0.144203	1.677783	0.000663
Truworths Inter- national	-0.000083	0.022585	0.111664	0.907658	0.001023

<i>continued from previous page</i>					
Pioneer Foods Group	-0.000285	0.019677	0.352348	1.987850	0.000865
Life Healthcare	-0.000461	0.015089	0.016187	1.031371	0.000662
MMI Holdings	0.000113	0.017618	0.073828	1.184078	0.000775
Sappi	0.000062	0.018963	0.319241	0.937054	0.000835
Telkom SA SOC	-0.000545	0.020551	-0.347088	2.266793	0.000901
Liberty Holdings	0.000746	0.016517	-0.378343	1.688886	0.000726
Spar Group	-0.000097	0.016678	0.025499	1.861269	0.000750
Pick 'n Pay Stores	0.000105	0.017200	-0.015472	0.748323	0.000774
AVI	0.000949	0.014311	-0.170712	0.941485	0.000631
TFG	0.000691	0.023464	0.167618	3.064542	0.001058
Tsogo Sun Holdings	-0.000181	0.016491	0.277153	1.903303	0.000722
Imperial Logistics	0.000813	0.025759	-0.031972	2.358159	0.001130
Clicks Group	0.001534	0.016457	0.305827	2.042164	0.000740
Santam	0.000648	0.015678	0.855321	6.071924	0.000688
Massmart Holdings	0.000504	0.024393	0.105217	0.974978	0.001104
Curro Holdings	-0.000231	0.018106	0.194273	1.614888	0.000815
Coronation Fund Managers	0.000371	0.018928	0.228006	2.276453	0.000829
Impala Platinum	0.000158	0.036225	0.350947	2.580363	0.001636
EOH Holdings	-0.001832	0.033981	-3.928957	52.212005	0.001489
Nampak	-0.001331	0.022958	-0.063886	1.216194	0.001009
KAP Industrial Holdings	0.000063	0.017363	-0.564726	5.359377	0.000761
Exxaro Resources	0.002700	0.031370	0.410548	3.623698	0.001413
Oceana Group	-0.000490	0.018276	0.333693	2.977331	0.000801
Super Group	0.000207	0.015026	0.259689	1.141403	0.000659

<i>continued from previous page</i>					
Northam Platinum	0.000491	0.027298	0.303240	1.518187	0.001229
Kumba Iron Ore	0.003263	0.041718	0.532439	6.174376	0.001844
Barloworld	0.001300	0.025300	0.419340	1.447270	0.001113
Famous Brands	-0.000247	0.017211	-0.679693	4.503384	0.000755
Tongaat Hulett	-0.000104	0.015130	0.372119	1.991683	0.000663
Reunert	-0.000099	0.013044	-0.253970	1.740947	0.000571
Italtile	0.000153	0.019310	-0.027119	2.352310	0.000871
Hosken Consolidated Investments	0.000266	0.015003	0.260799	1.606340	0.000657
JSE Limited	0.000884	0.016912	0.107063	0.264616	0.000742
AECI	0.000261	0.013353	0.095548	1.733425	0.000585

C Empirical Results from the Original Data

C.1 SASOL



*p <0.1

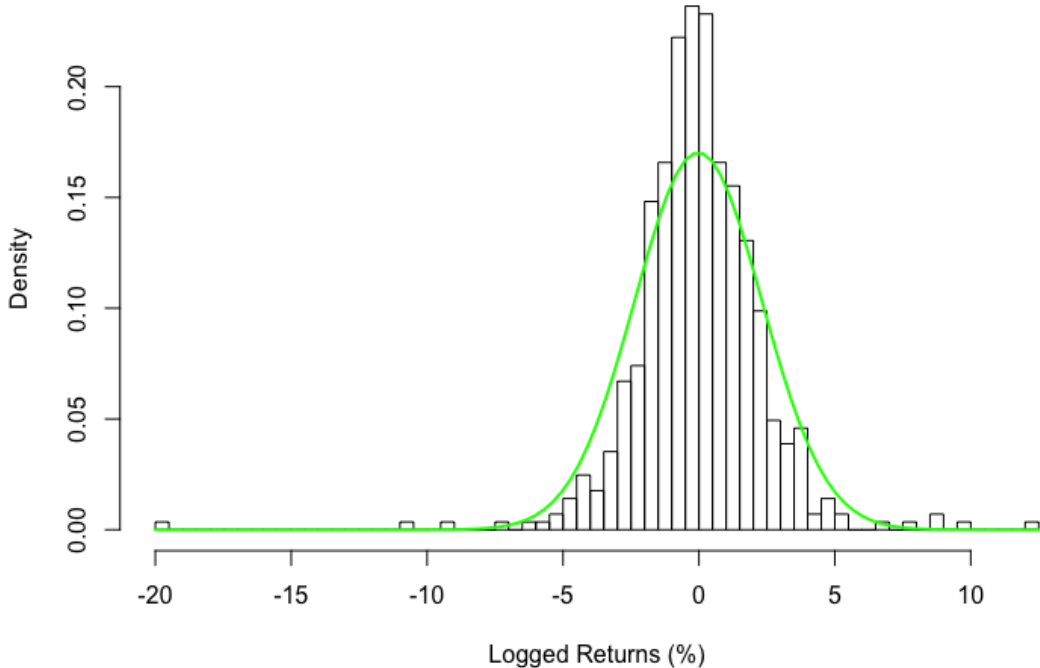
** p <0.05

*** p <0.01

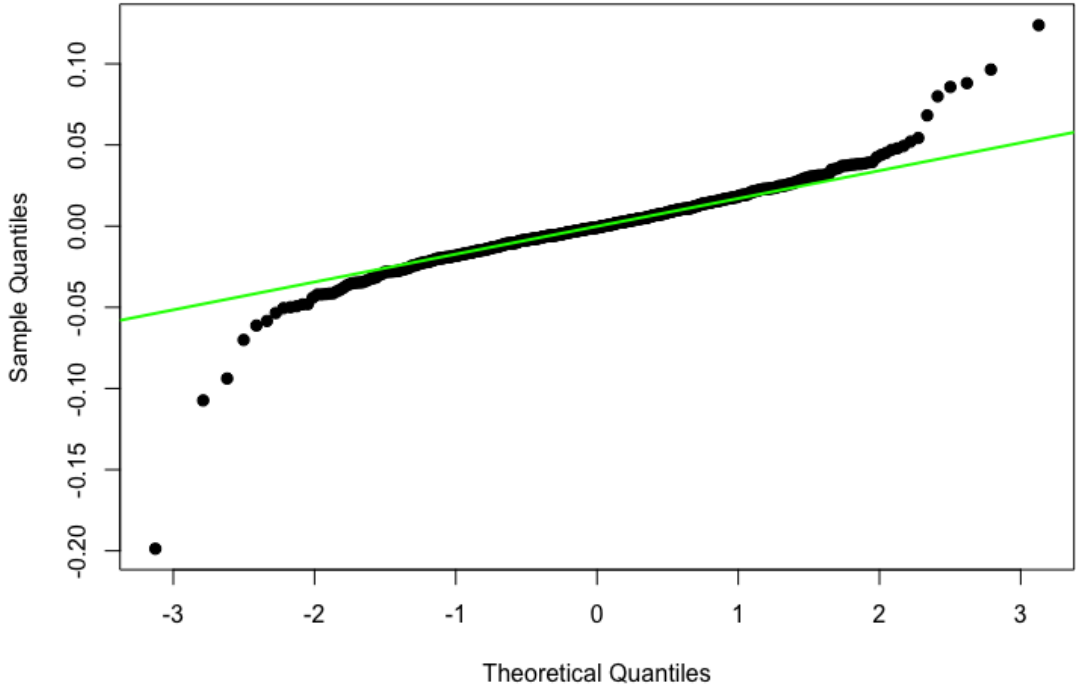
Normality Test Statistics					
	AD	LF	SW	JB	DP
SASOL	3.1762***	0.052299***	0.96721***	264.21***	-3.1017***

C.2 MTN Group

Histogram of MTN Group



Normal Q-Q Plot for MTN Group



*p <0.1

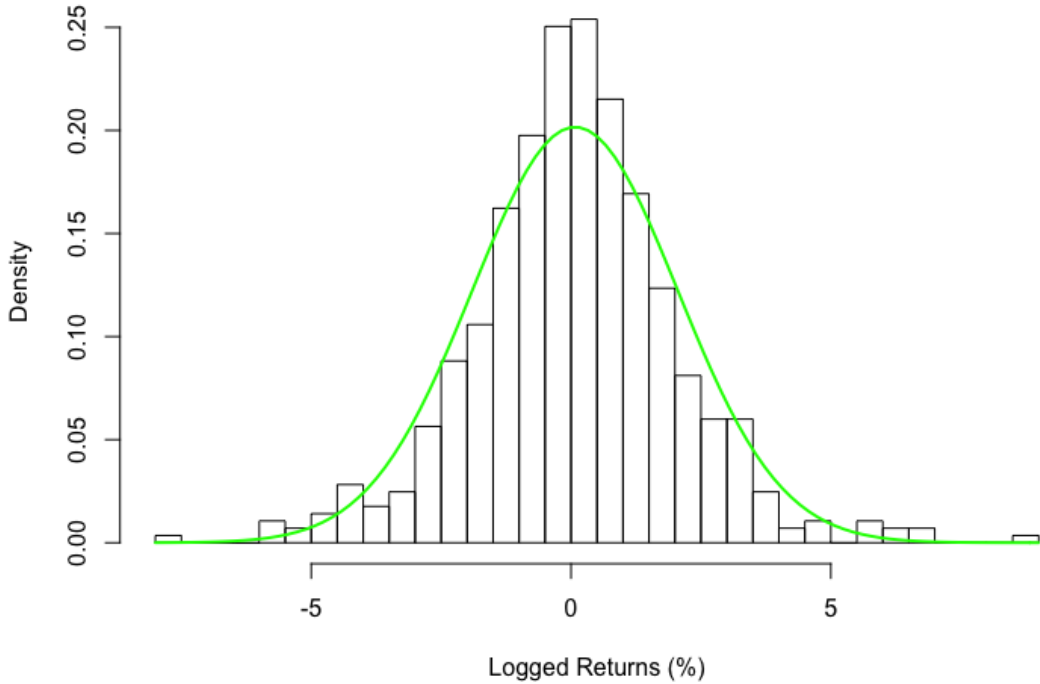
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*** p <0.01

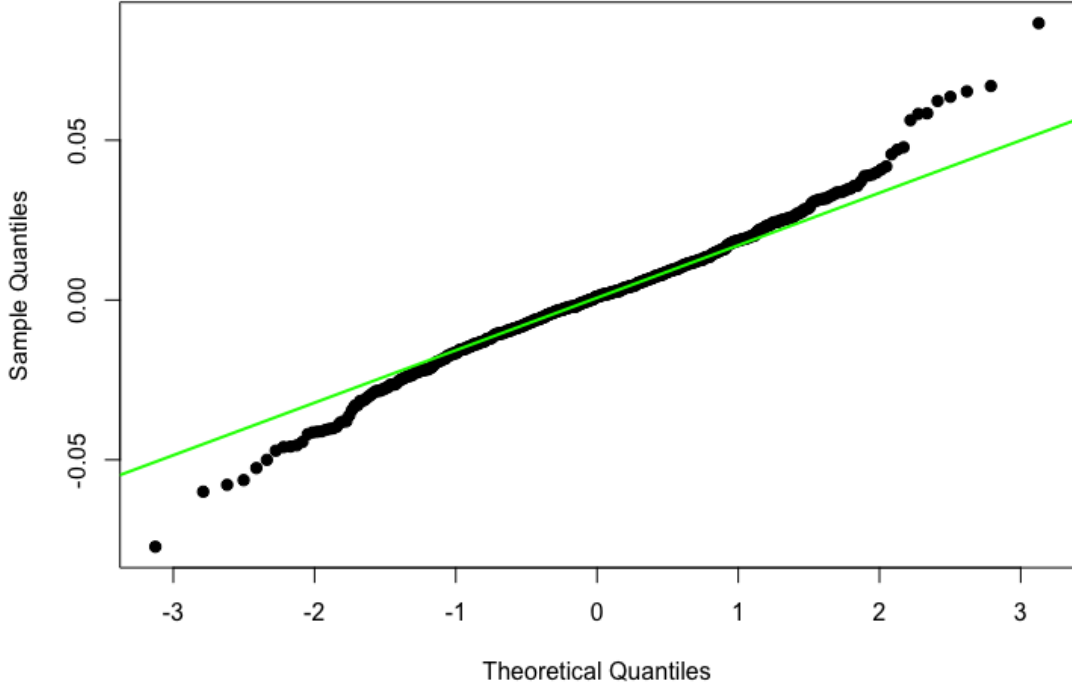
Normality Test Statistics					
	AD	LF	SW	JB	DP
MTN Group	6.8056***	0.071348***	0.90121***	3330.3***	-6.73830***

C.3 FirstRand Group

Histogram of FirstRand Group



Normal Q-Q Plot for FirstRand Group



*p <0.1

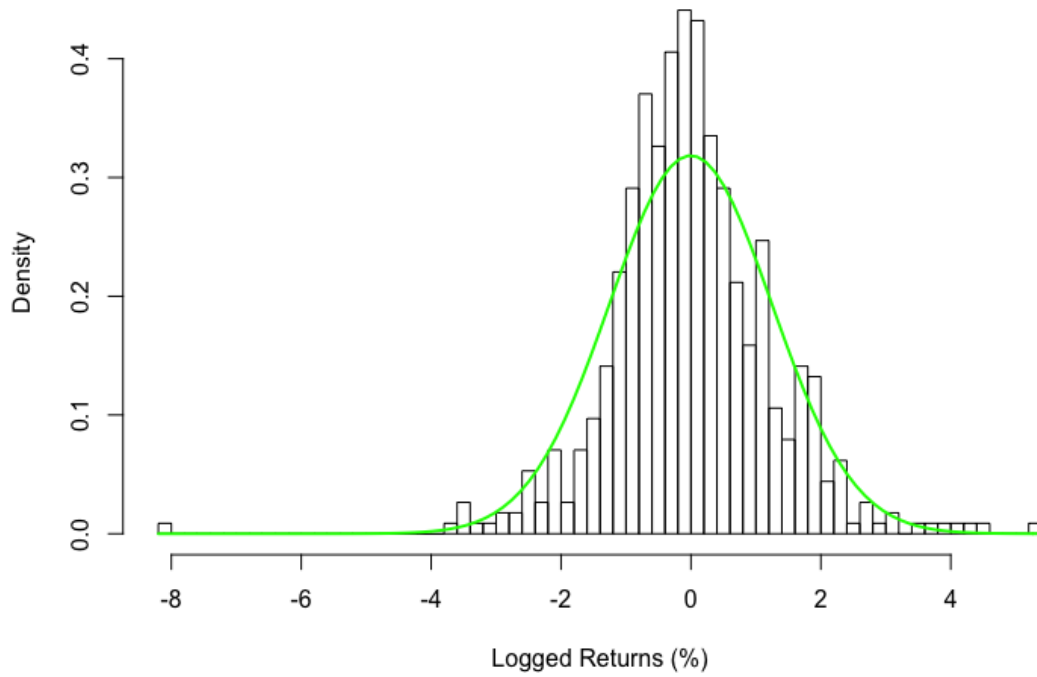
** p <0.05

*** p <0.01

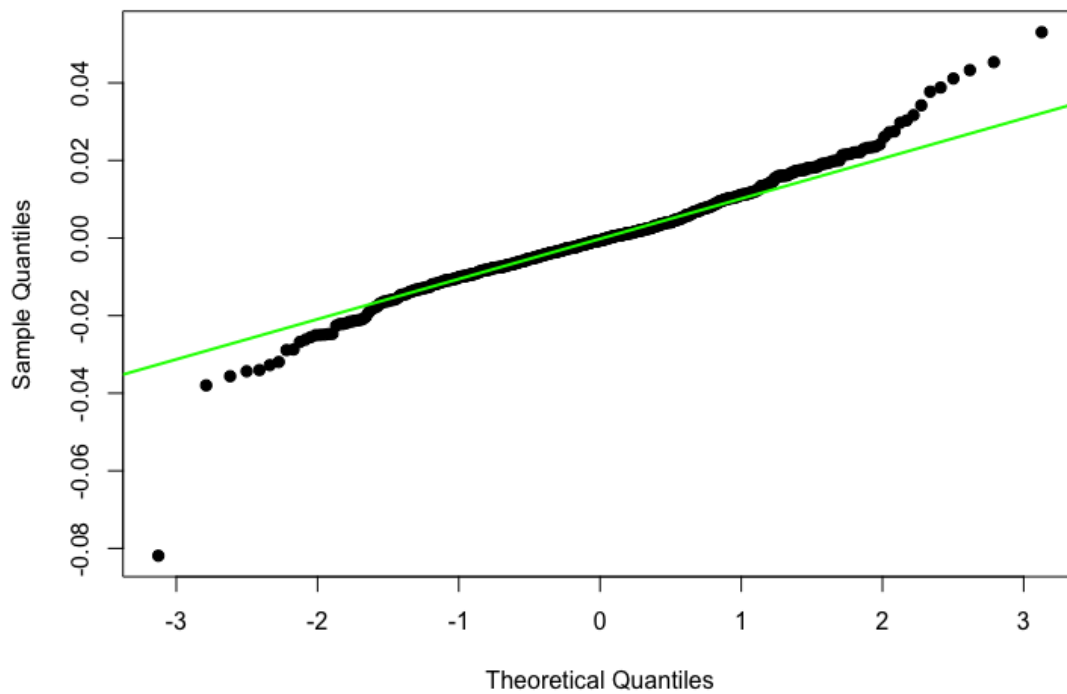
Normality Test Statistics					
	AD	LF	SW	JB	DP
FirstRand Group	2.246***	0.047673***	0.98324***	58.592***	1.01200

C.4 Vodacom Group

Histogram of Vodacom Group



Normal Q-Q Plot for Vodacom Group



*p <0.1

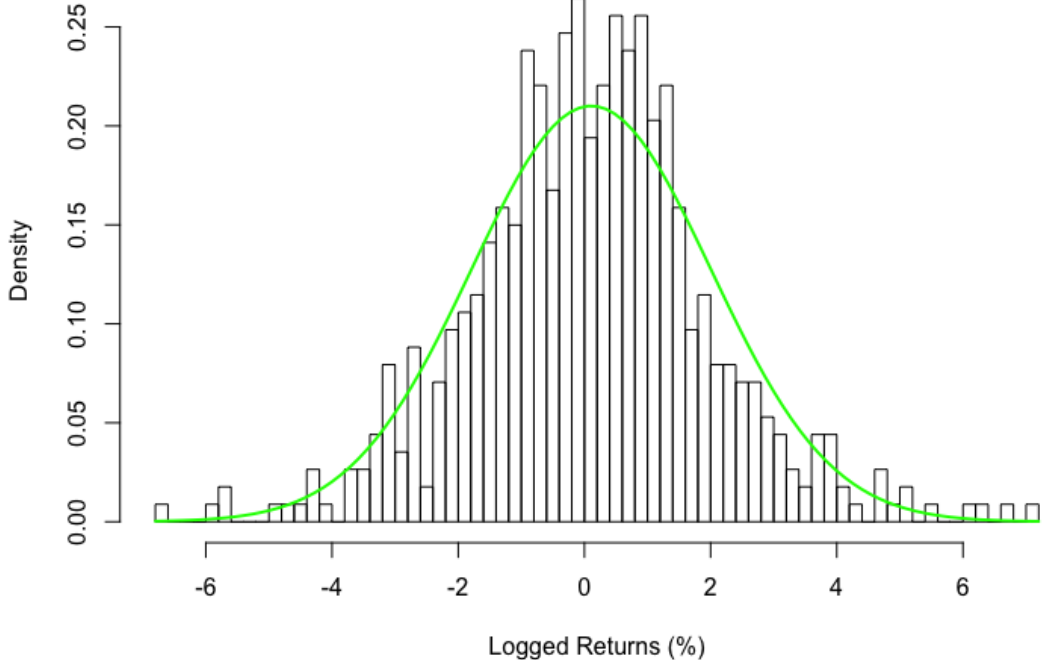
** p <0.05

*** p <0.01

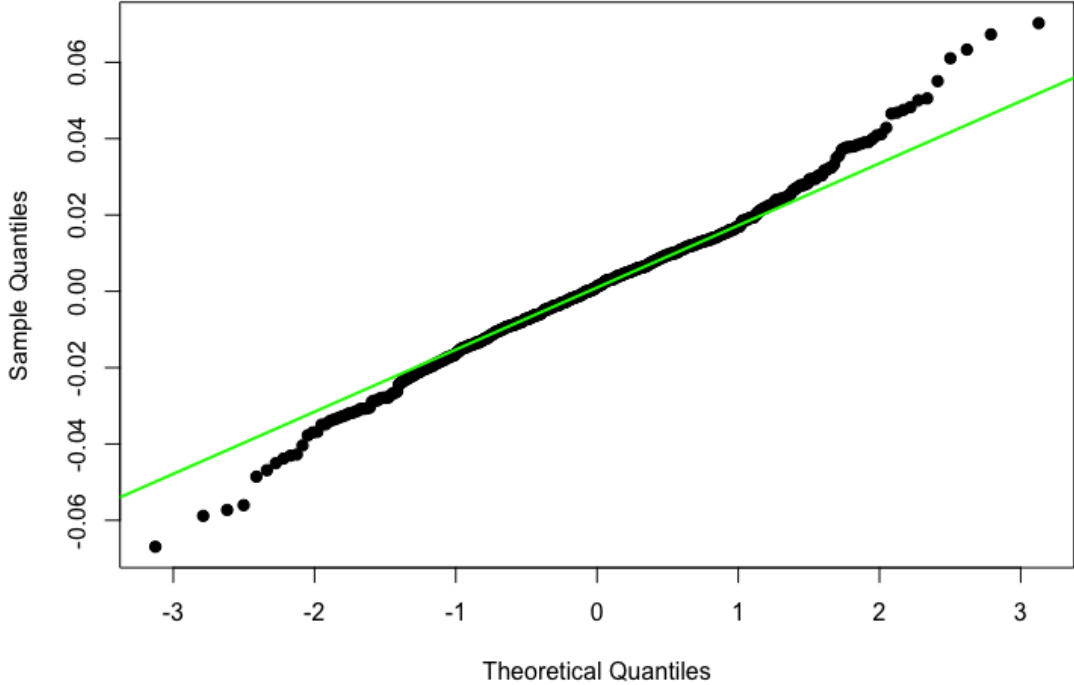
Normality Test Statistics					
	AD	LF	SW	JB	DP
Vodacom Group	3.8503 ***	0.065976***	0.95957***	412.61 ***	-1.32070

C.5 Standard Bank Group

Histogram of Standard Bank Group



Normal Q-Q Plot for Standard Bank Group



		Normality Test Statistics				
		AD	LF	SW	JB	DP
Standard Group	Bank	1.5837***	0.065976***	0.98888 ***	27.939 ***	0.901030

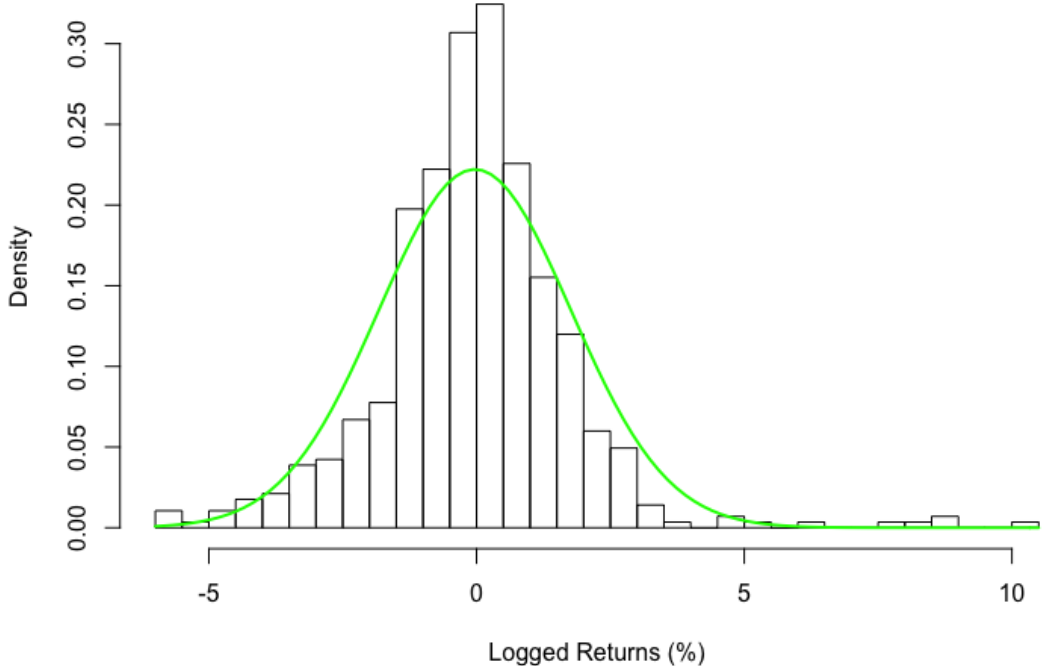
*p <0.1

** p <0.05

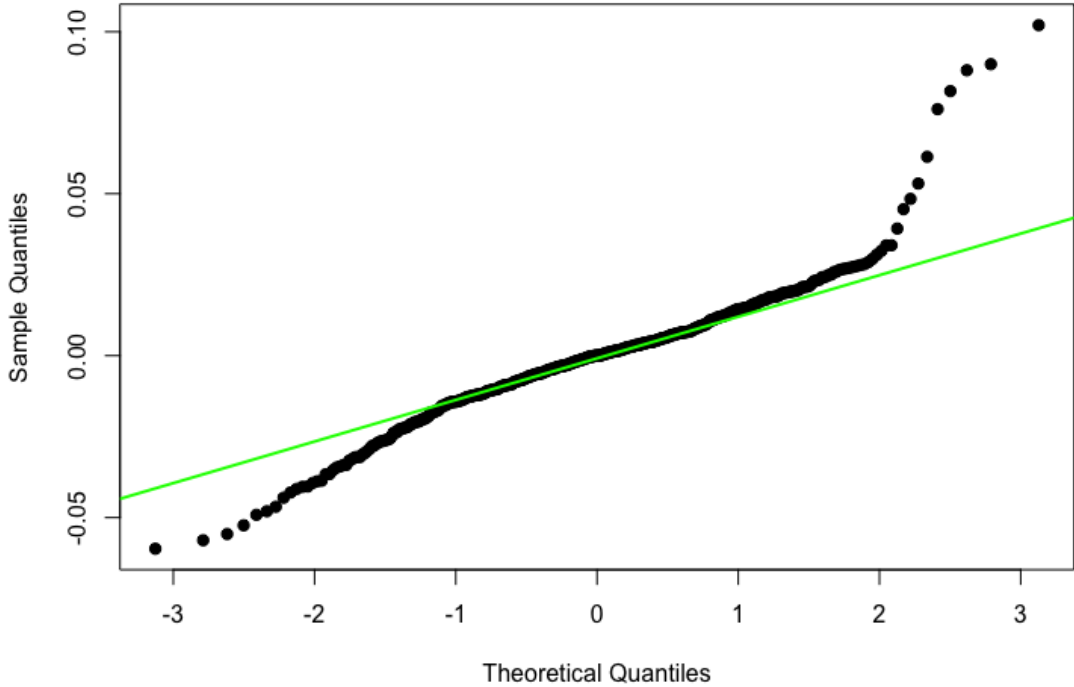
*** p <0.01

C.6 Aspen Pharmacare

Histogram of Aspen Pharmacare



Normal Q-Q Plot for Aspen Pharmacare



*p <0.1

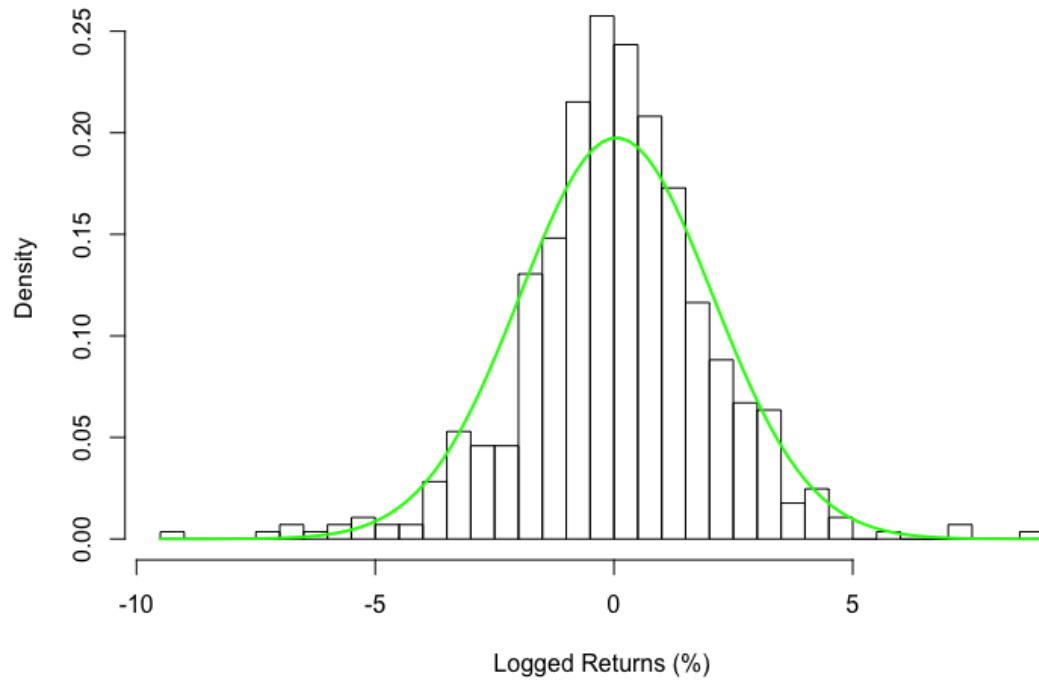
** p <0.05

*** p <0.01

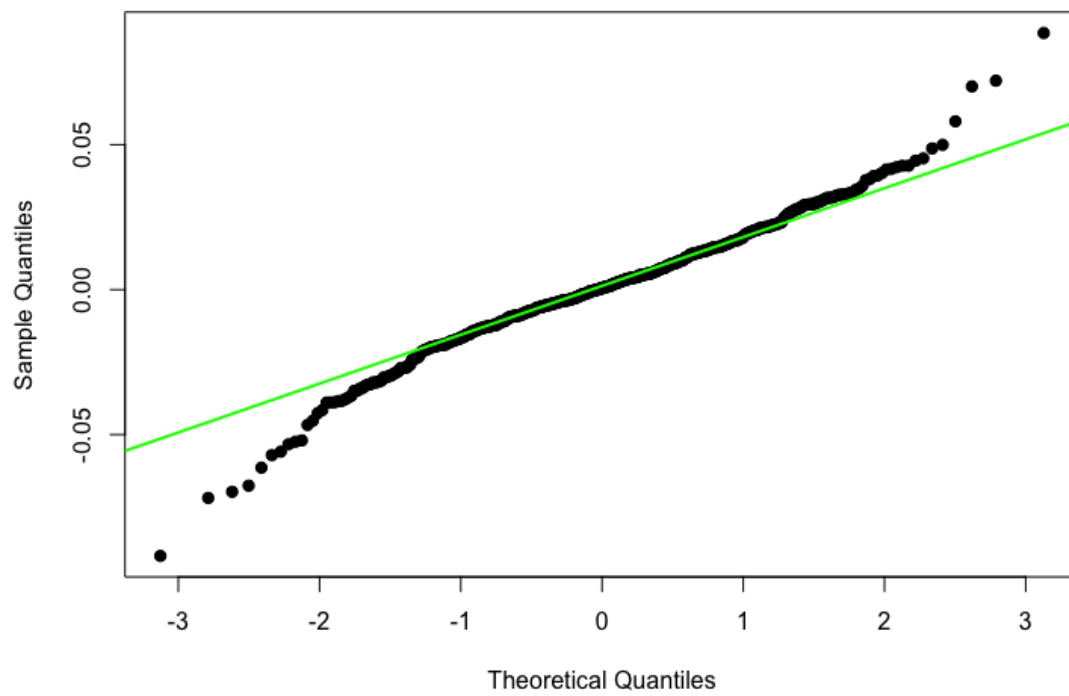
Normality Test Statistics					
	AD	LF	SW	JB	DP
Aspen Pharmacare	6.692 ***	0.077787***	0.92915 ***	688.01 ***	6.58230***

C.7 Sanlam

Histogram of Sanlam



Normal Q-Q Plot for Sanlam



*p <0.1

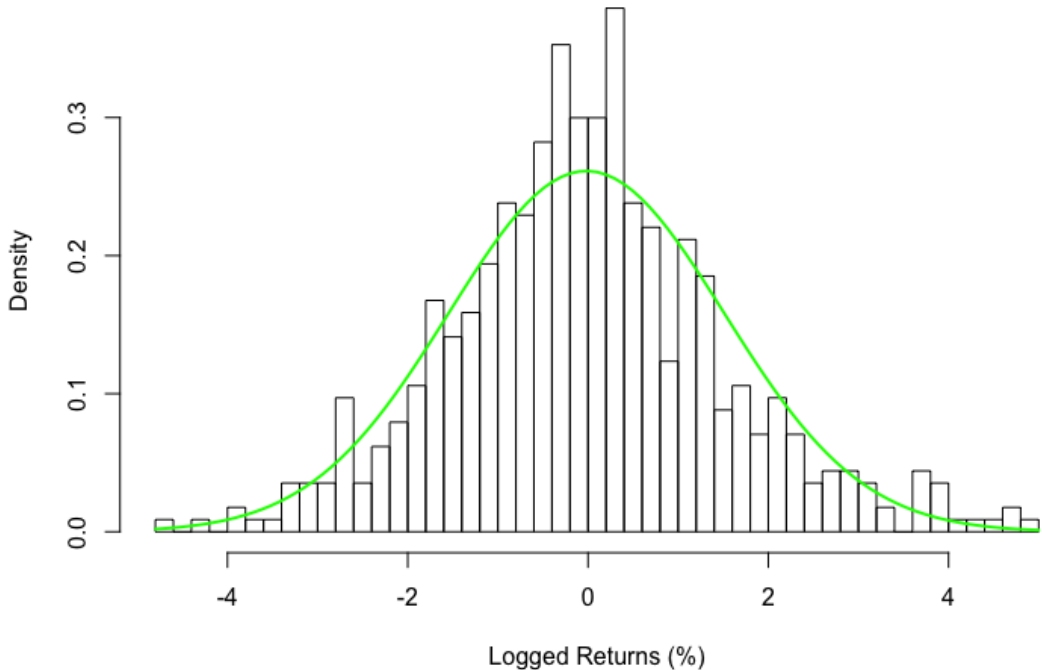
** p <0.05

*** p <0.01

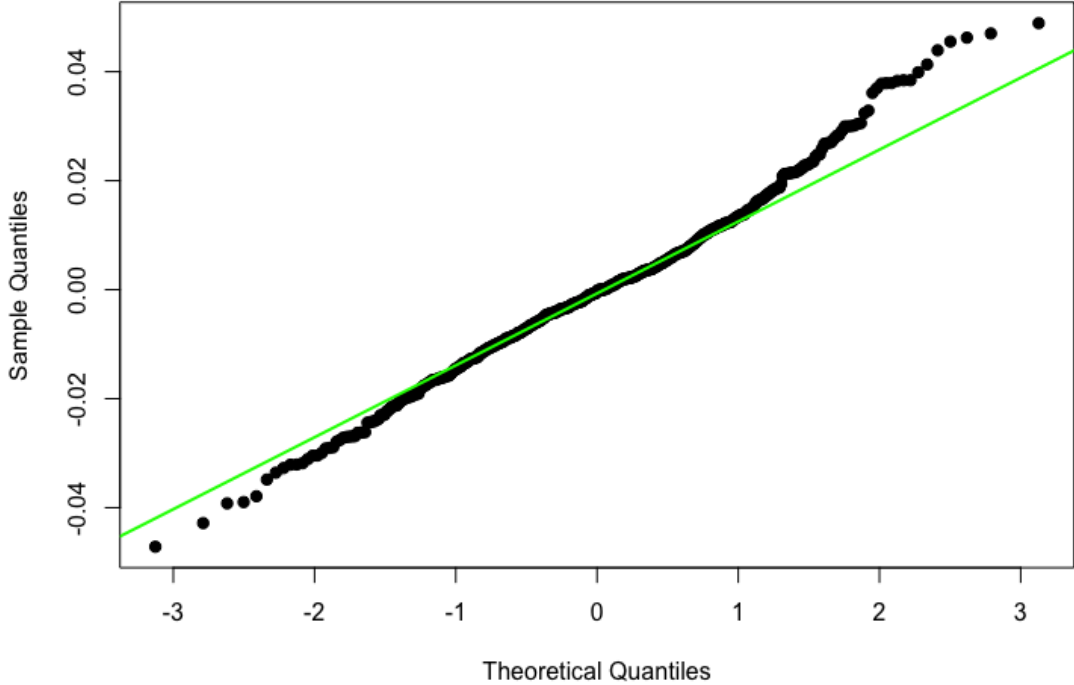
Normality Test Statistics					
	AD	LF	SW	JB	DP
Sanlam	2.771 ***	0.05436***	0.97636 ***	109.95 ***	-1.88210*

C.8 Remgro

Histogram of Remgro



Normal Q-Q Plot for Remgro



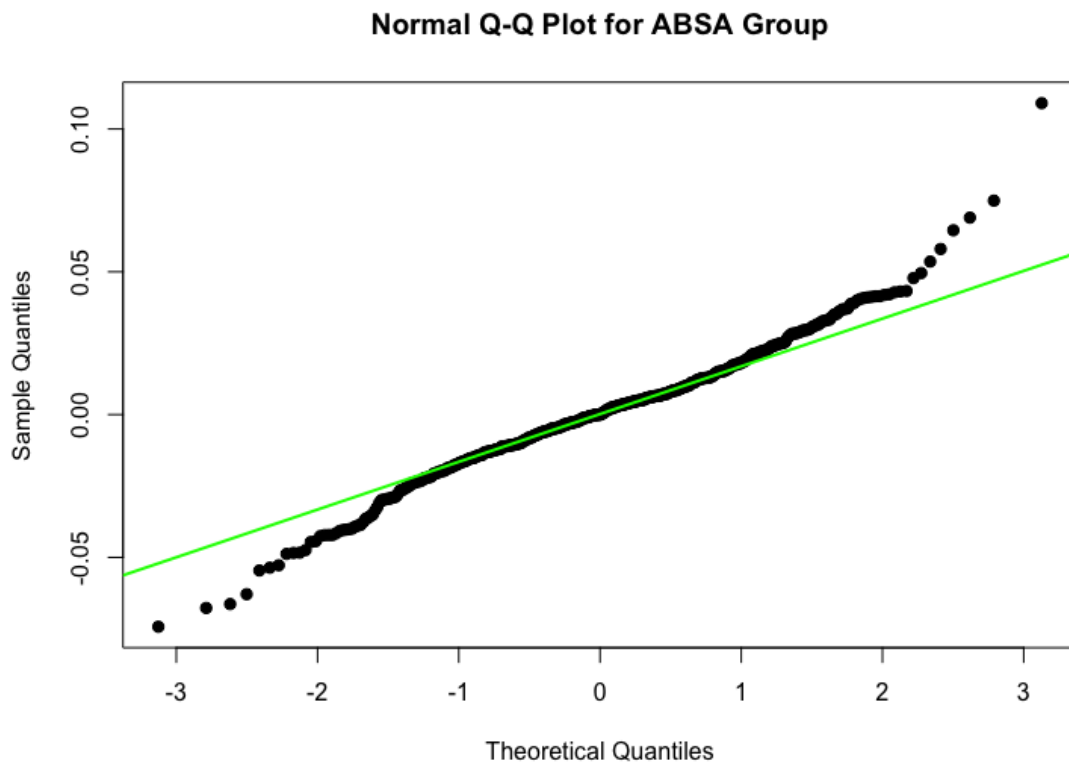
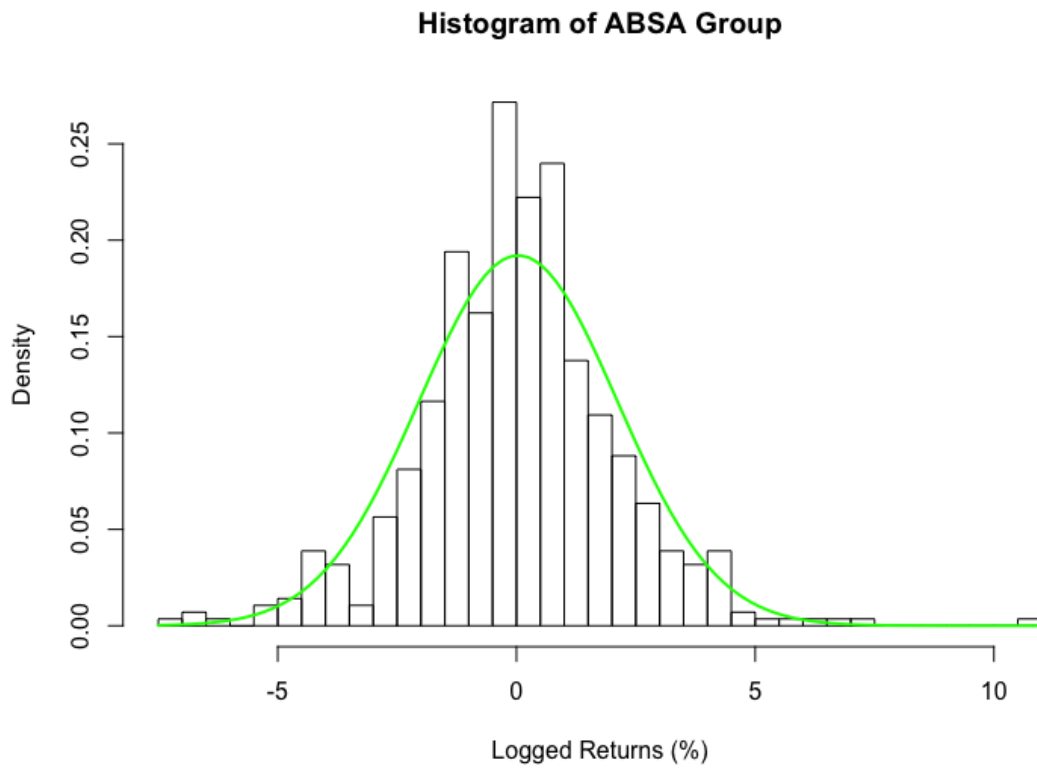
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Remgro	1.7498***	0.050461***	0.98978***	14.596 ***	2.50370**

C.9 ABSA Group



*p <0.1

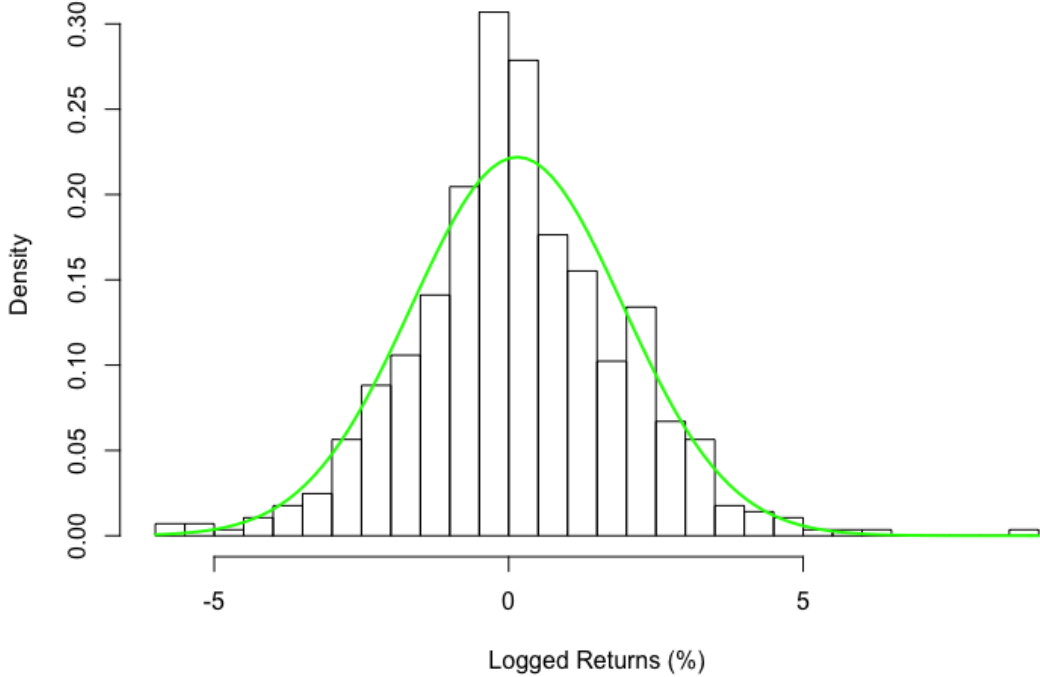
** p <0.05

*** p <0.01

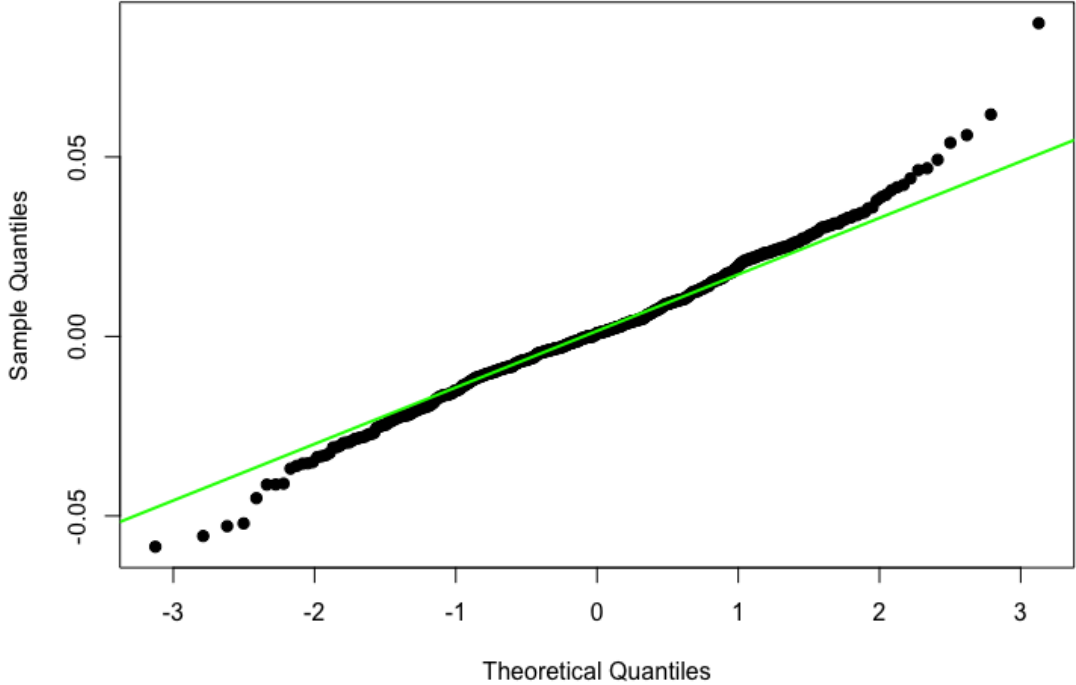
Normality Test Statistics					
	AD	LF	SW	JB	DP
ABSA Group	2.922***	0.054786***	0.97751***	106.72***	1.42720

C.10 Bidvest Group

Histogram of Bidvest Group



Normal Q-Q Plot for Bidvest Group



*p <0.1

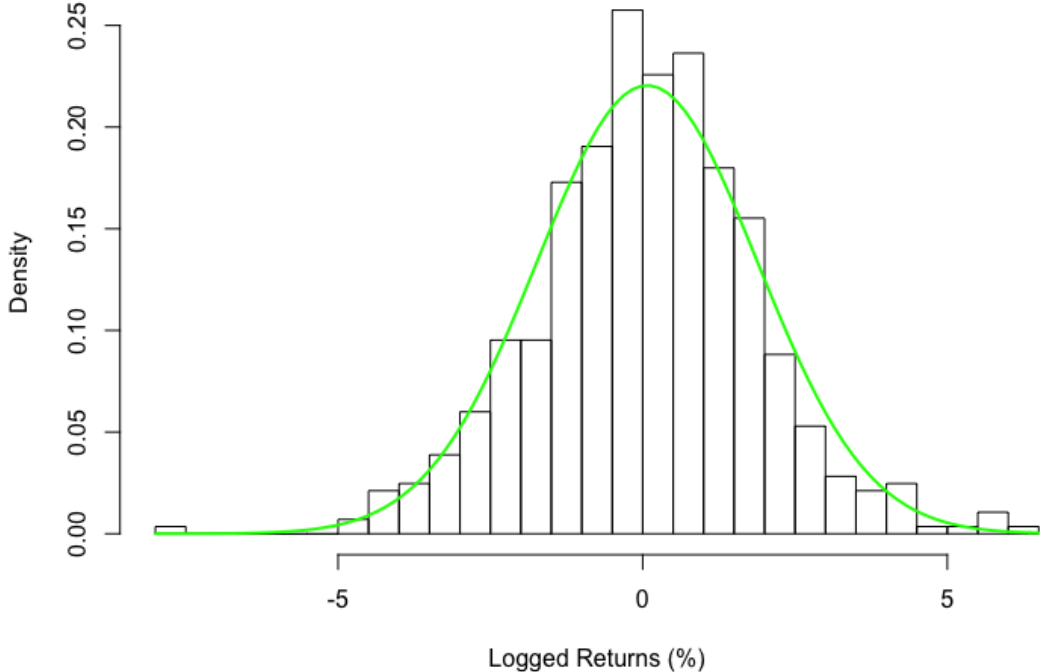
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*** p <0.01

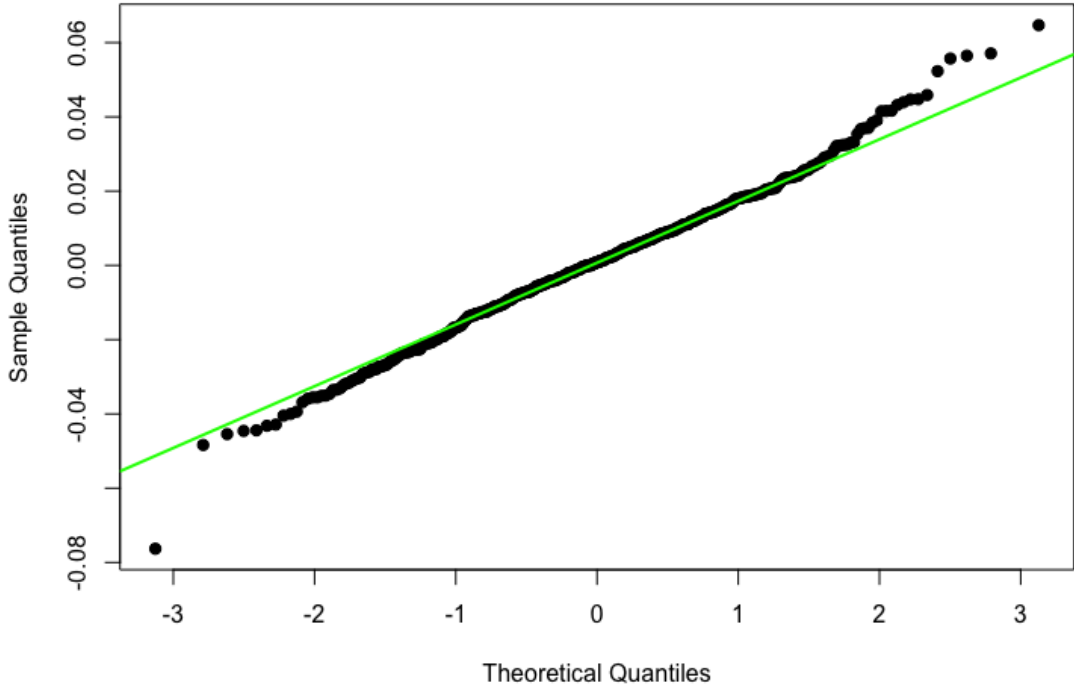
Normality Test Statistics					
	AD	LF	SW	JB	DP
Bidvest Group	1.4804***	0.052024***	0.98878***	39.283***	1.88310*

C.11 Nedbank Group

Histogram of Nedbank Group



Normal Q-Q Plot for Nedbank Group



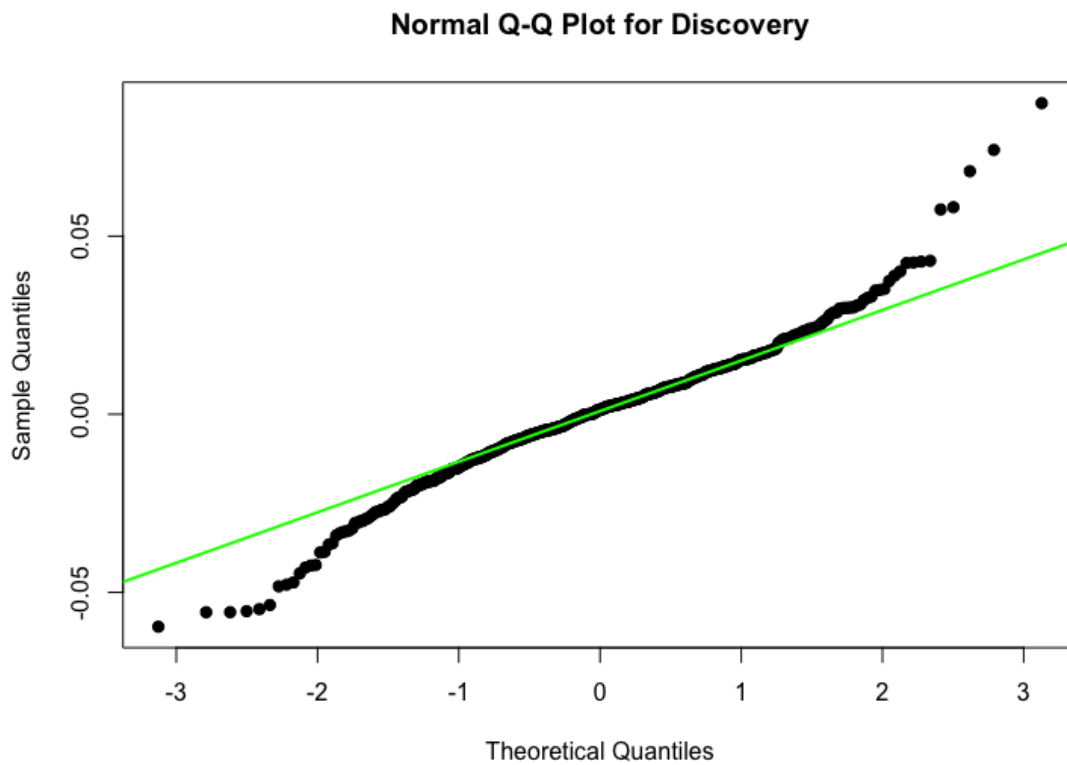
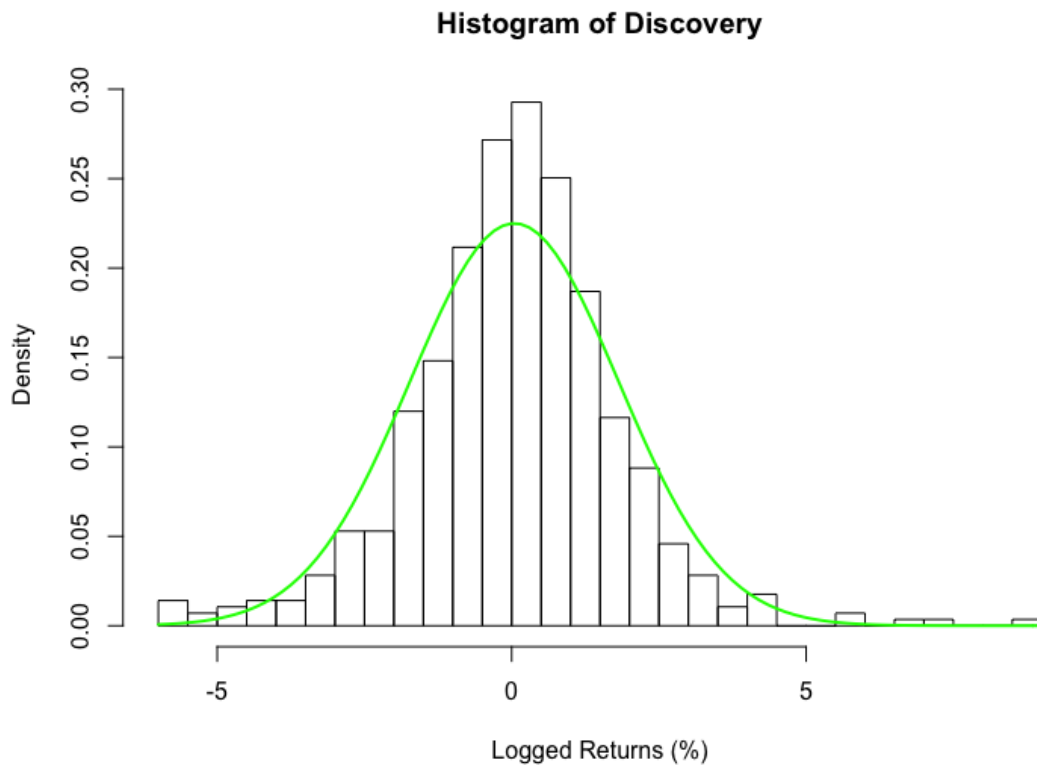
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Nedbank Group	0.84146**	0.031314	0.99301***	16.85***	0.0635110

C.12 Discovery



*p <0.1

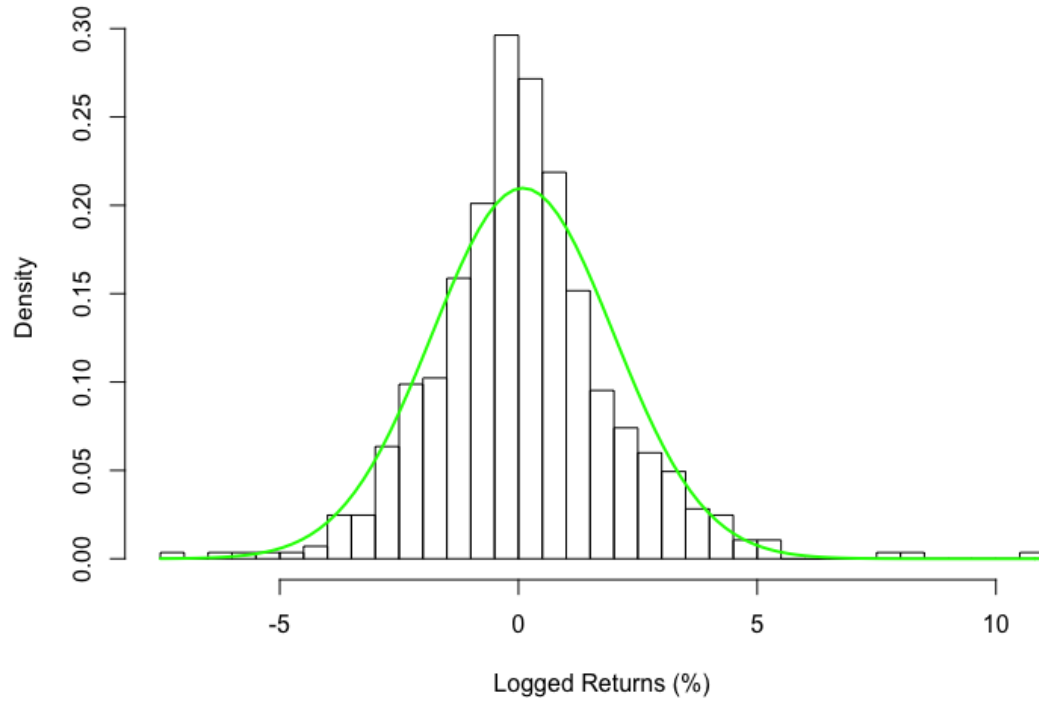
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*** p <0.01

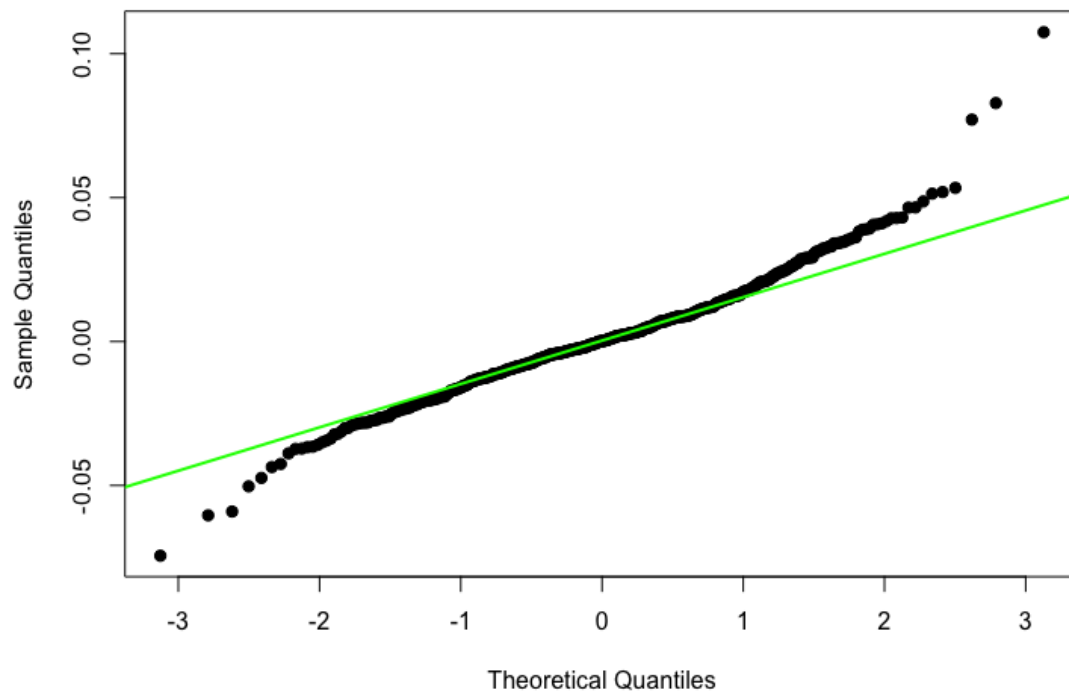
Normality Test Statistics					
	AD	LF	SW	JB	DP
Discovery	3.7027***	0.057318***	0.9686***	140.57***	0.790890

C.13 Shoprite Holdings

Histogram of Shoprite Holdings



Normal Q-Q Plot for Shoprite Holdings



*p <0.1

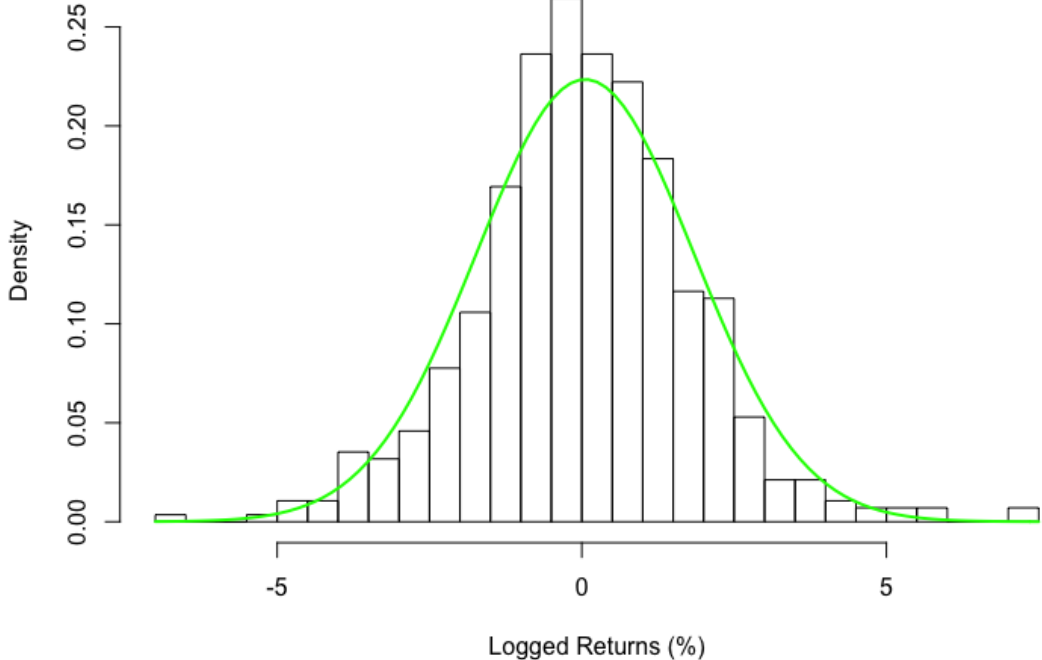
** p <0.05

*** p <0.01

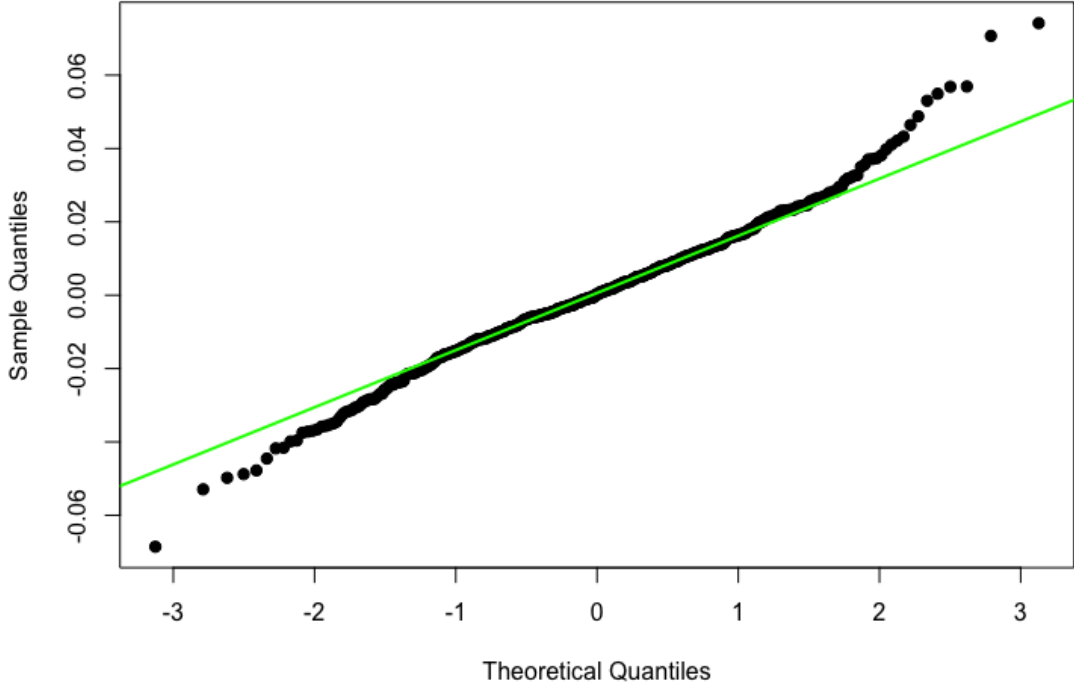
Normality Test Statistics					
	AD	LF	SW	JB	DP
Shoprite Holdings	3.2456***	0.066768***	0.96922***	217.84***	4.69220***

C.14 RMB Holdings

Histogram of RMB Holdings



Normal Q-Q Plot for RMB Holdings



*p <0.1

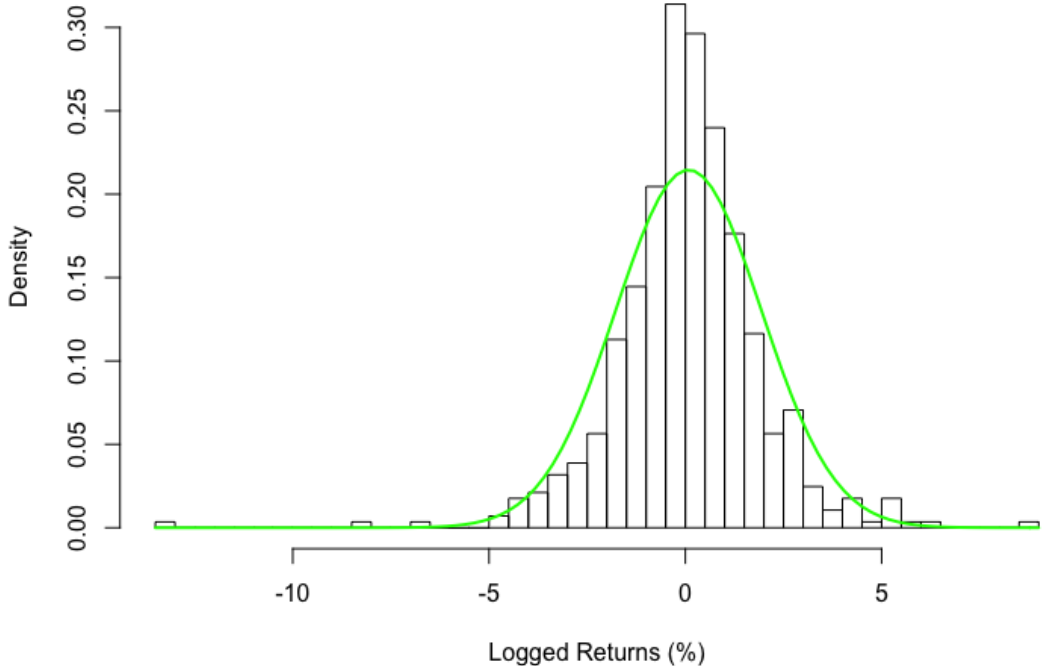
** p <0.05

*** p <0.01

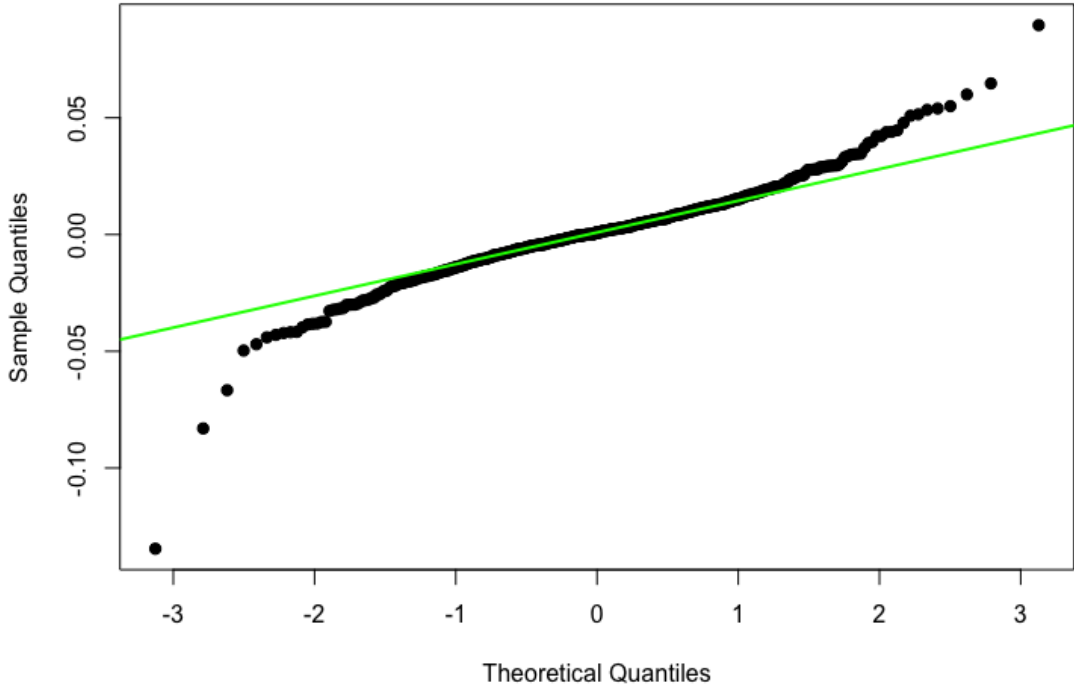
Normality Test Statistics					
	AD	LF	SW	JB	DP
RMB Holdings	1.7047***	0.043095**	0.98569***	50.039***	1.35470

C.15 Capitec Bank Holdings

Histogram of Capitec Bank



Normal Q-Q Plot for Capitec Bank



Normality Test Statistics					
	AD	LF	SW	JB	DP
Capitec Bank Holdings	6.2222***	0.071212***	0.93548***	1099.8***	-4.73700***

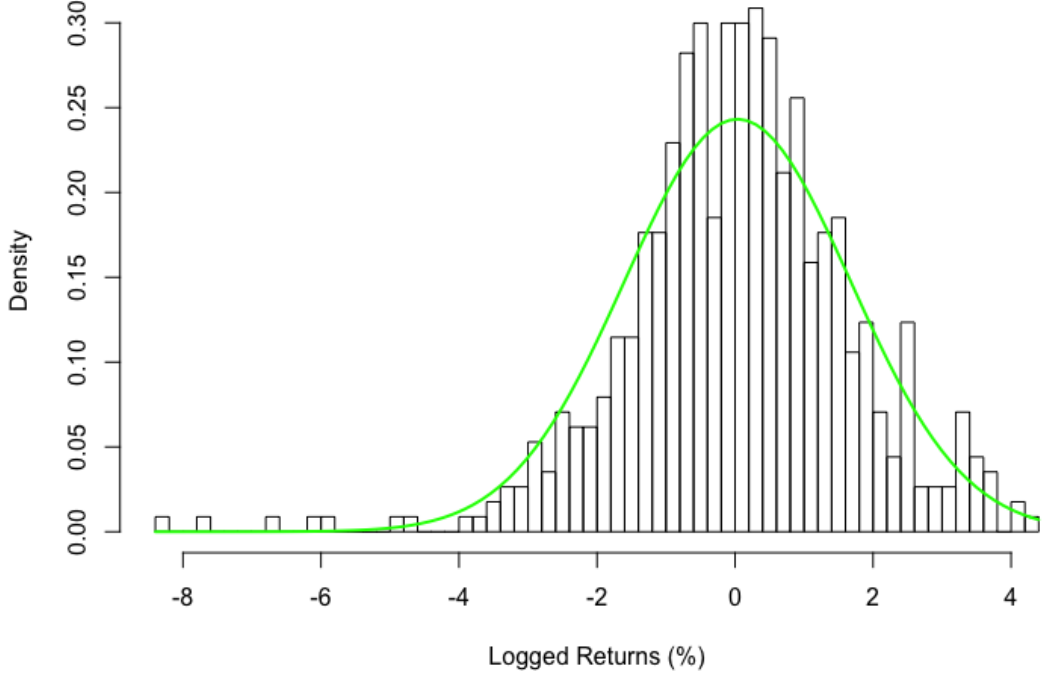
*p <0.1

** p <0.05

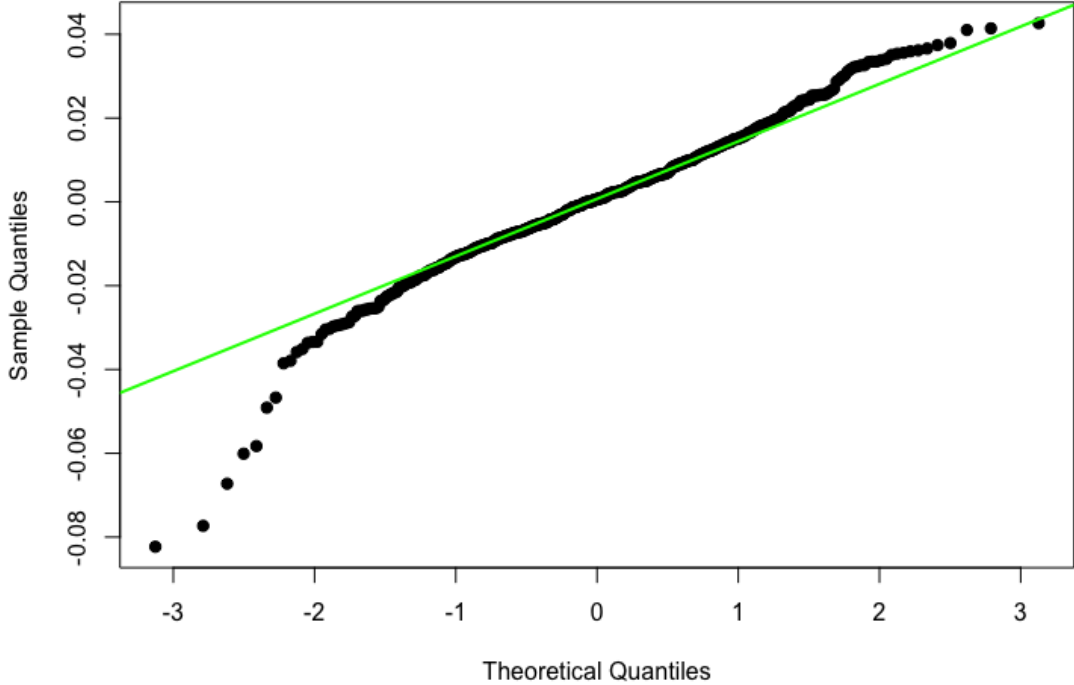
*** p <0.01

C.16 Tiger Brands

Histogram of Tiger Brands



Normal Q-Q Plot for Tiger Brands



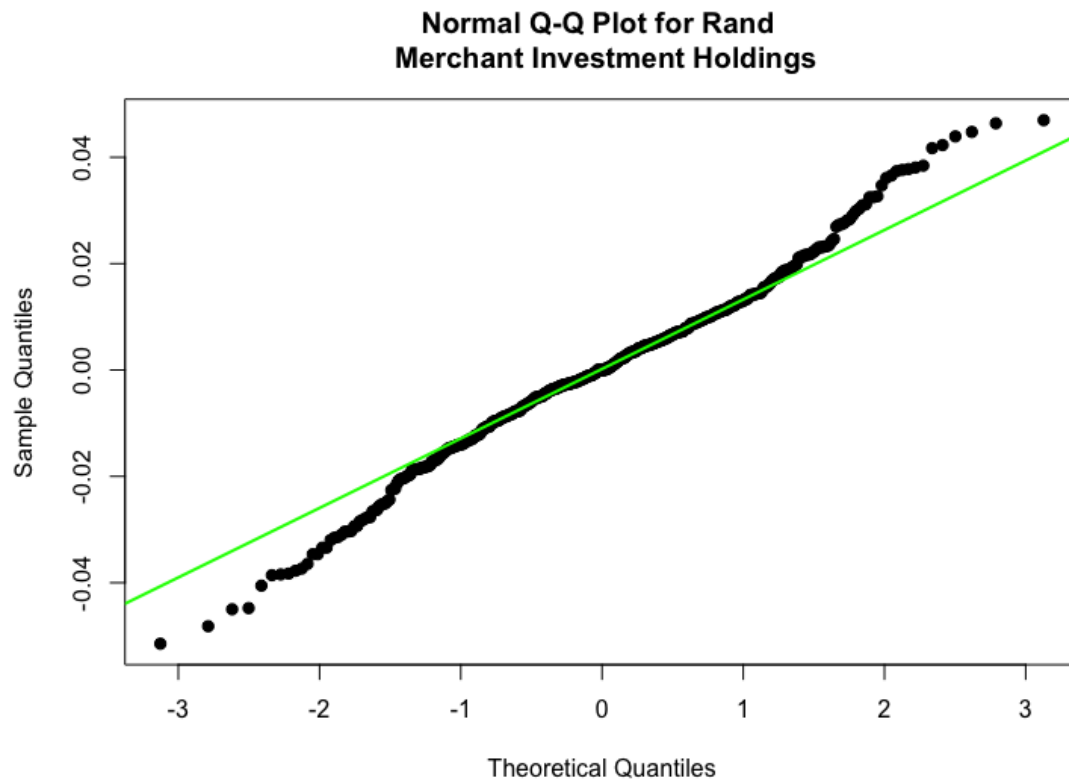
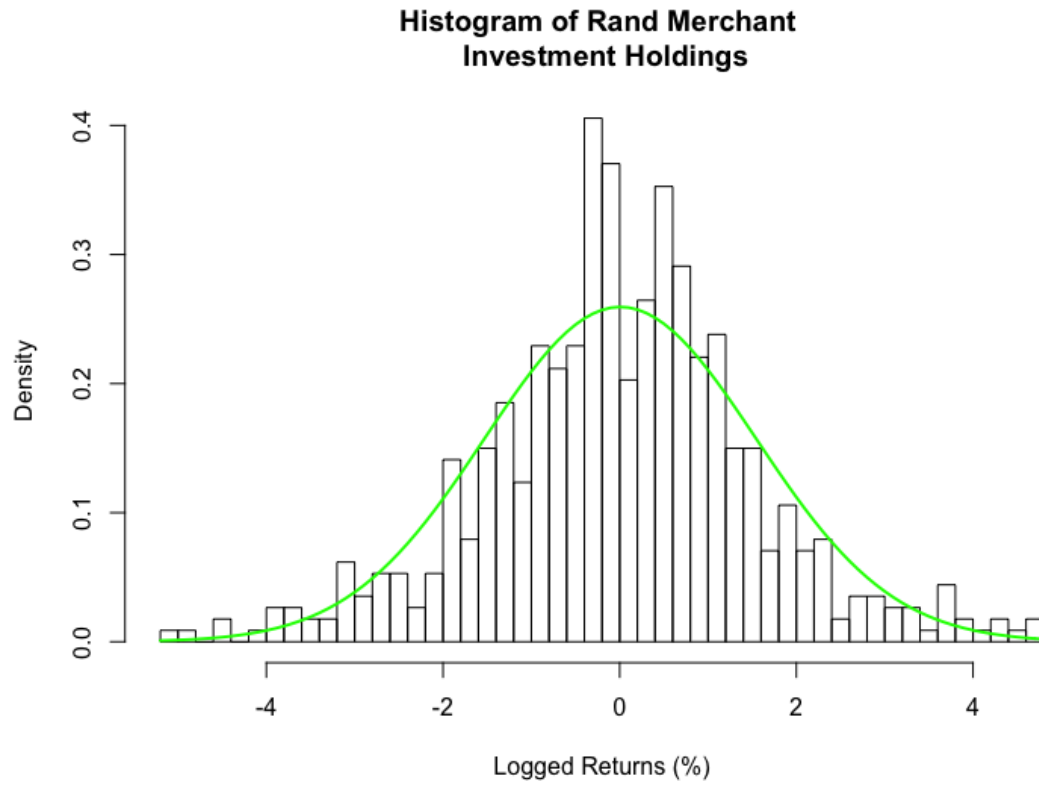
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Tiger Brands	2.1821***	0.049929***	0.96907***	177.69***	-5.4266***

C.17 RMI Holdings



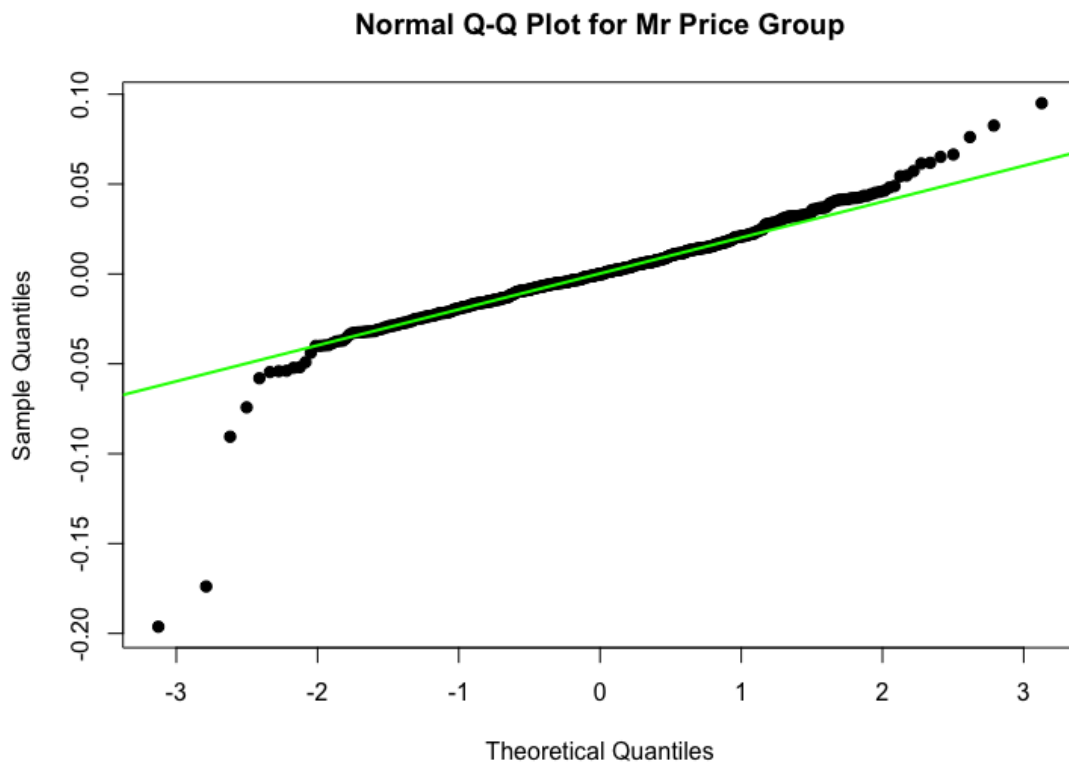
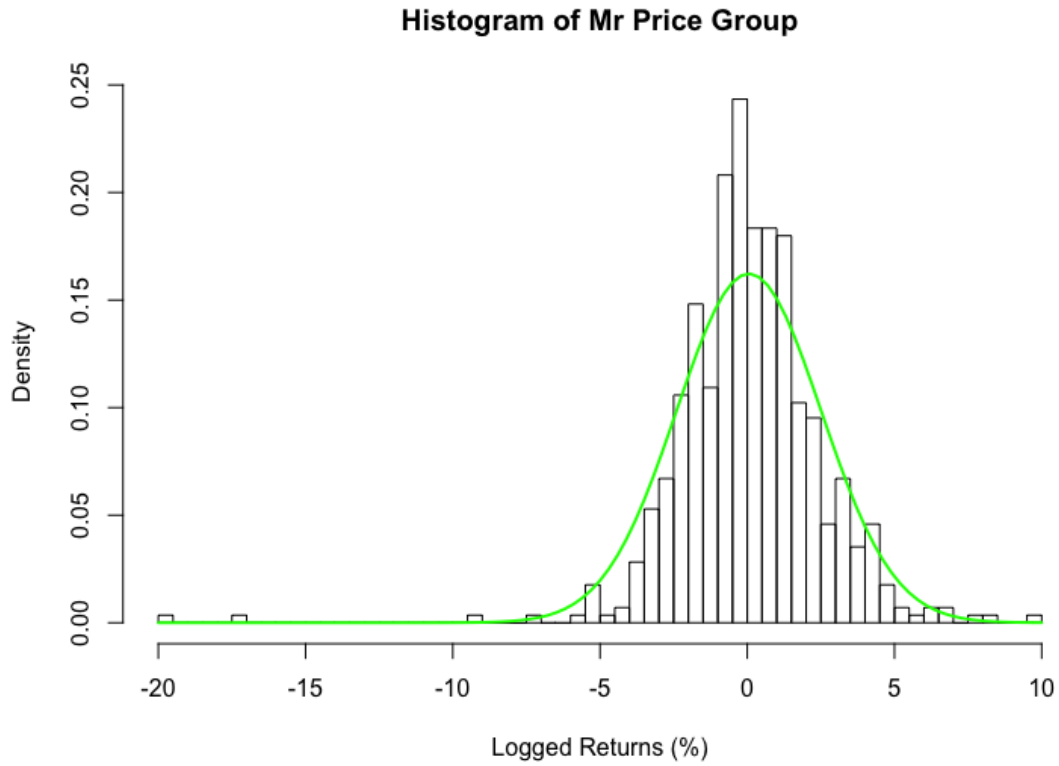
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
RMI Holdings	2.2614***	0.049164***	0.98751***	16.567***	-0.492730

C.18 Mr Price Group



*p <0.1

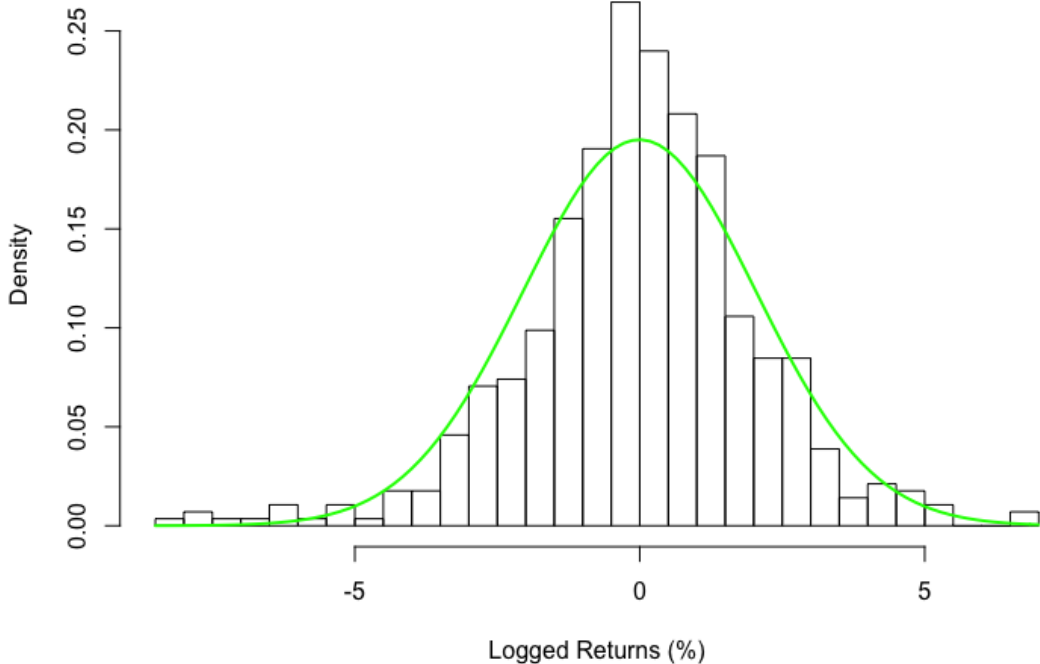
** p <0.05

*** p <0.01

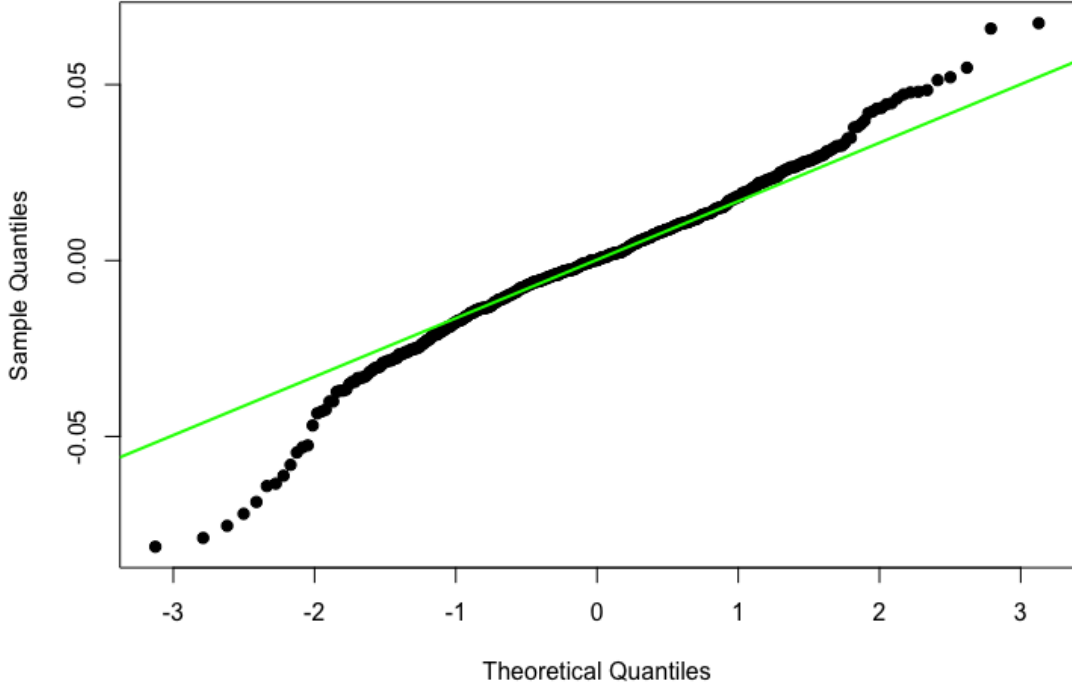
Normality Test Statistics					
	AD	LF	SW	JB	DP
Mr Price Group	5.1545***	0.060047***	0.9048***	3346.8***	-10.0080***

C.19 PSG Group

Histogram of PSG Group



Normal Q-Q Plot for PSG Group



*p <0.1

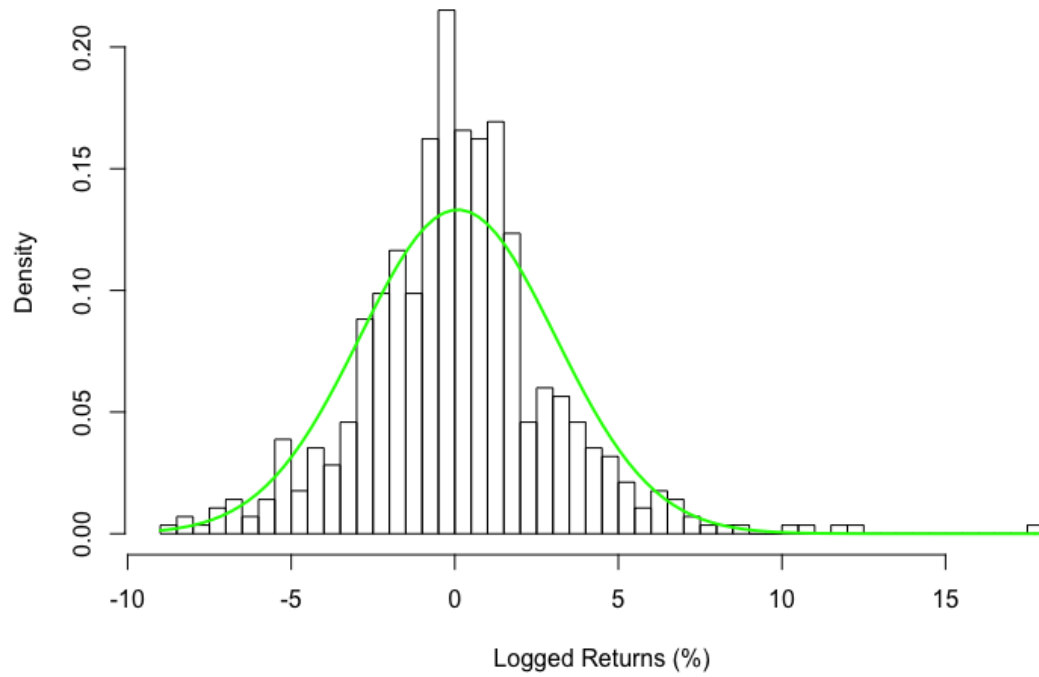
** p <0.05

*** p <0.01

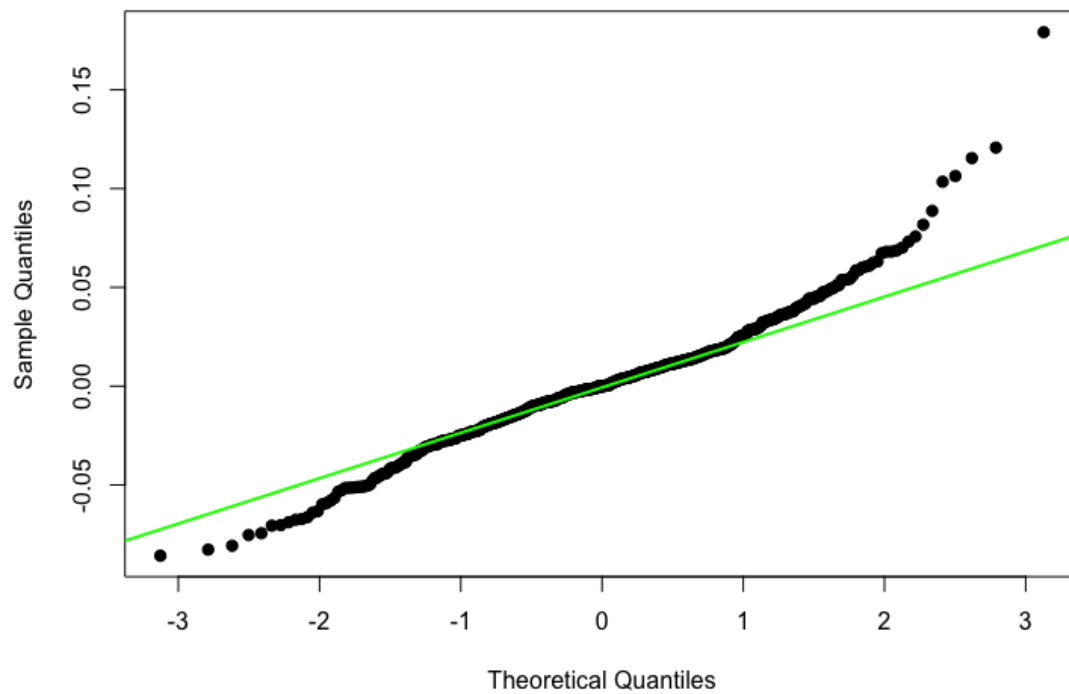
Normality Test Statistics					
	AD	LF	SW	JB	DP
PSG Group	2.9601***	0.058597***	0.97602***	82.726***	-3.65450***

C.20 Anglo American Platinum

Histogram of Anglo American Platinum



**Normal Q-Q Plot for
Anglo American Platinum**



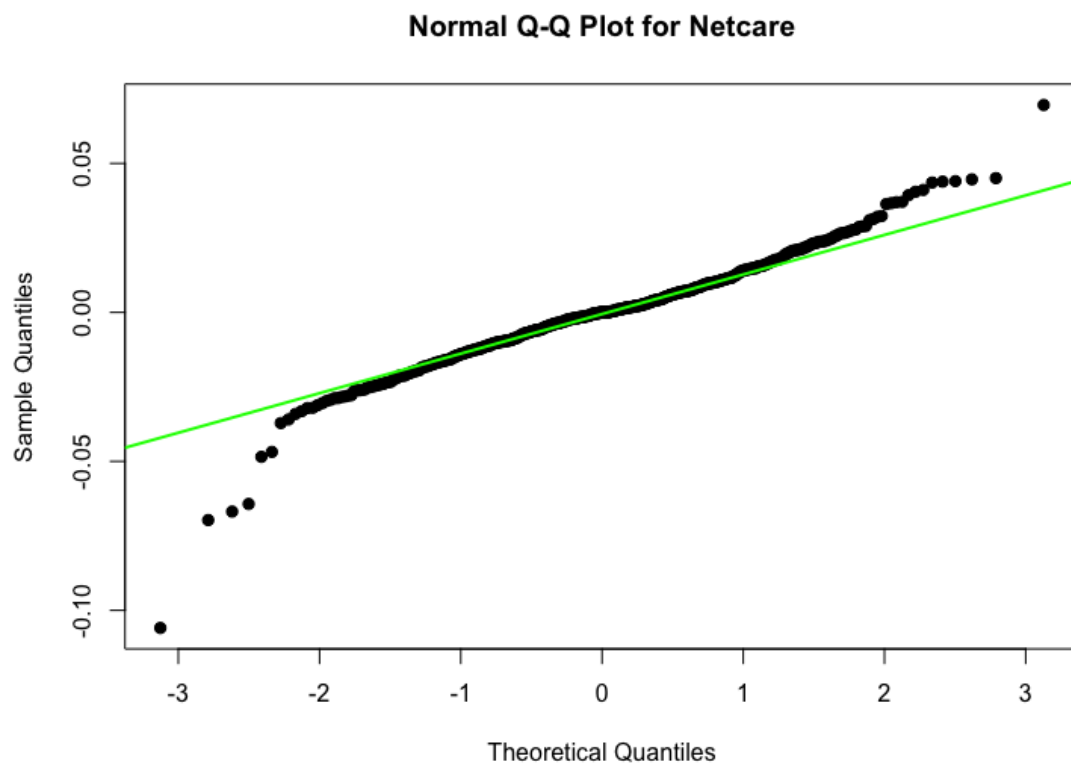
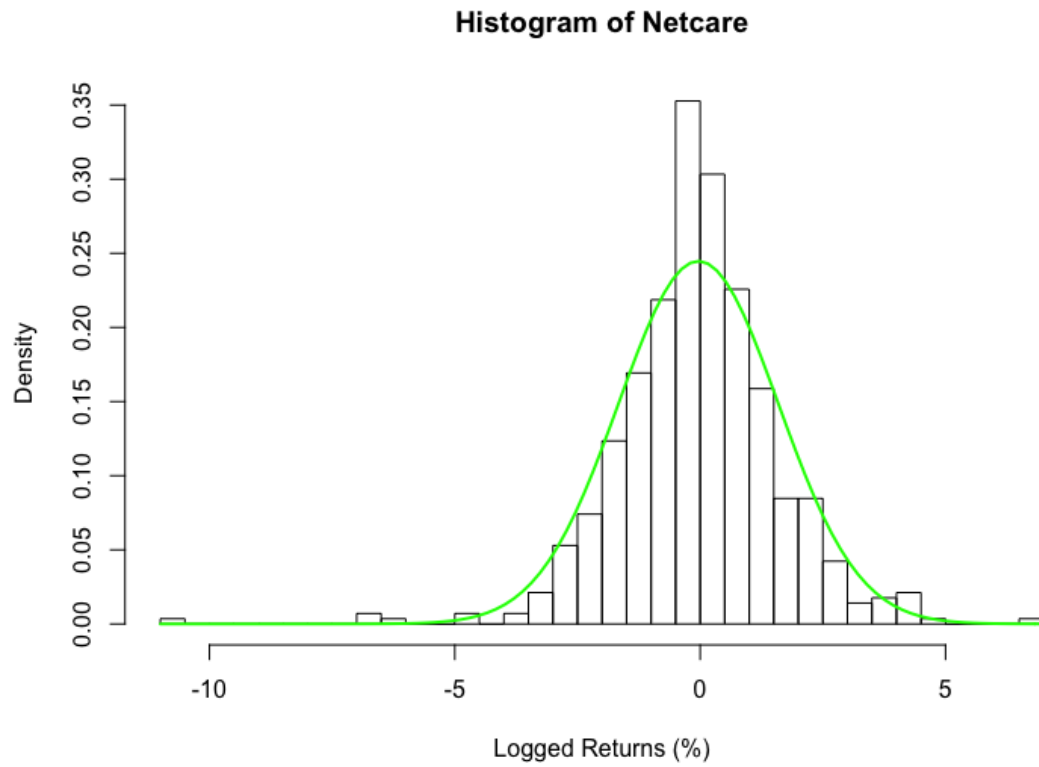
		Normality Test Statistics				
		AD	LF	SW	JB	DP
Anglo Platinum	American	4.2117***	0.078756***	0.96273***	274.57***	5.6771***

*p < 0.1

** p < 0.05

*** p < 0.01

C.21 Netcare



*p <0.1

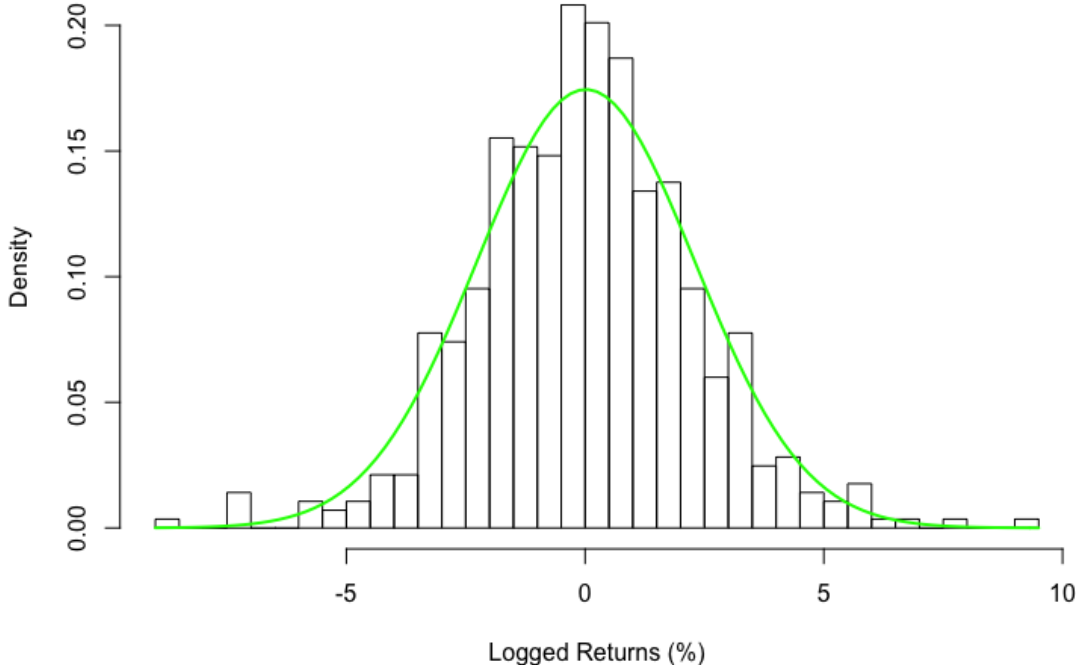
** p <0.05

*** p <0.01

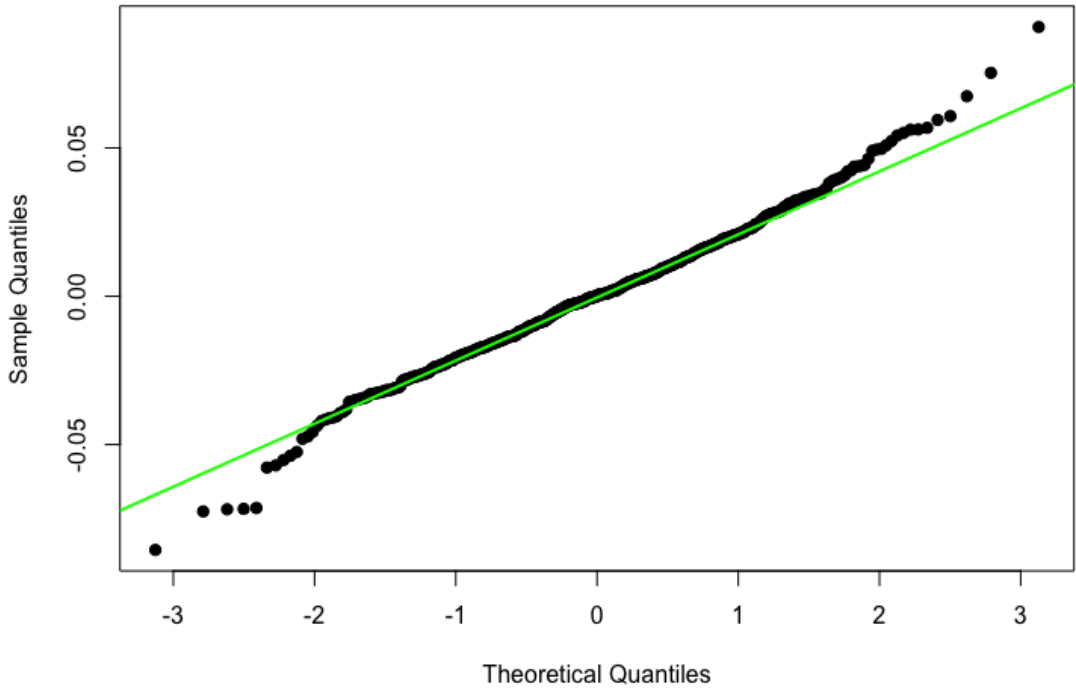
Normality Test Statistics					
	AD	LF	SW	JB	DP
Netcare	3.8306***	0.053758***	0.9542***	518.29***	-4.75270***

C.22 Truworths International

Histogram of Truworths International



Normal Q-Q Plot for Truworths International



Normality Test Statistics					
	AD	LF	SW	JB	DP
Truworths International	0.96859**	0.031371	0.99106***	24.544***	0.446910

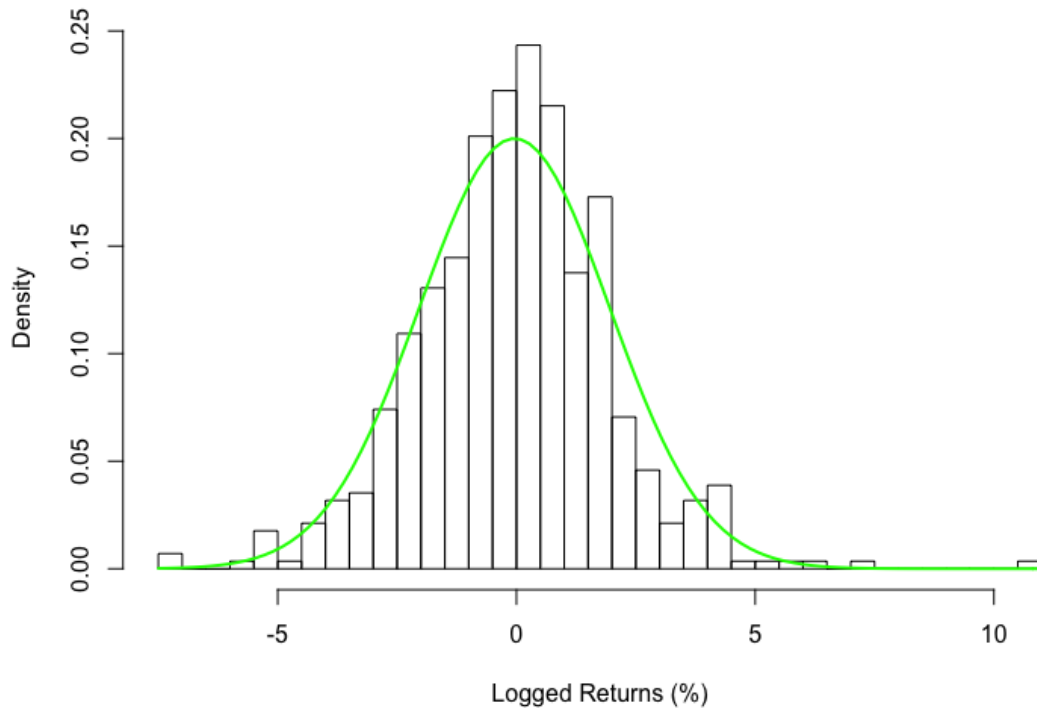
*p < 0.1

** p < 0.05

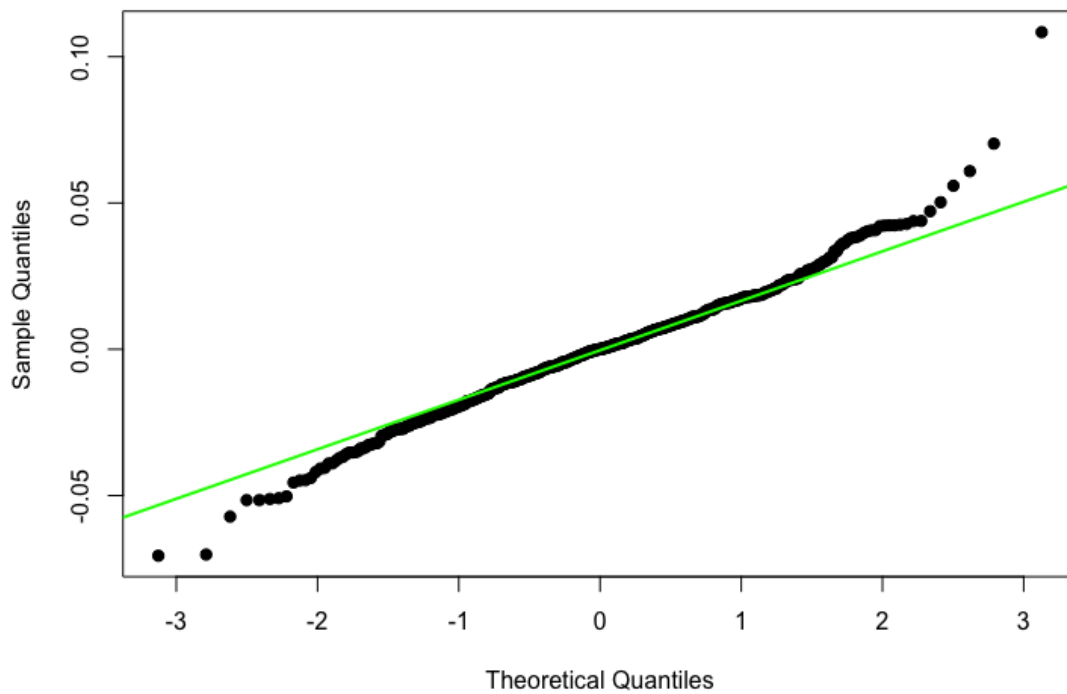
*** p < 0.01

C.23 Pioneer Foods Group

Histogram of Pioneer Foods Group



Normal Q-Q Plot for Pioneer Foods Group



		Normality Test Statistics				
		AD	LF	SW	JB	DP
Pioneer Group	Foods	1.5833***	0.044793***	0.98253***	97.679***	1.92330*

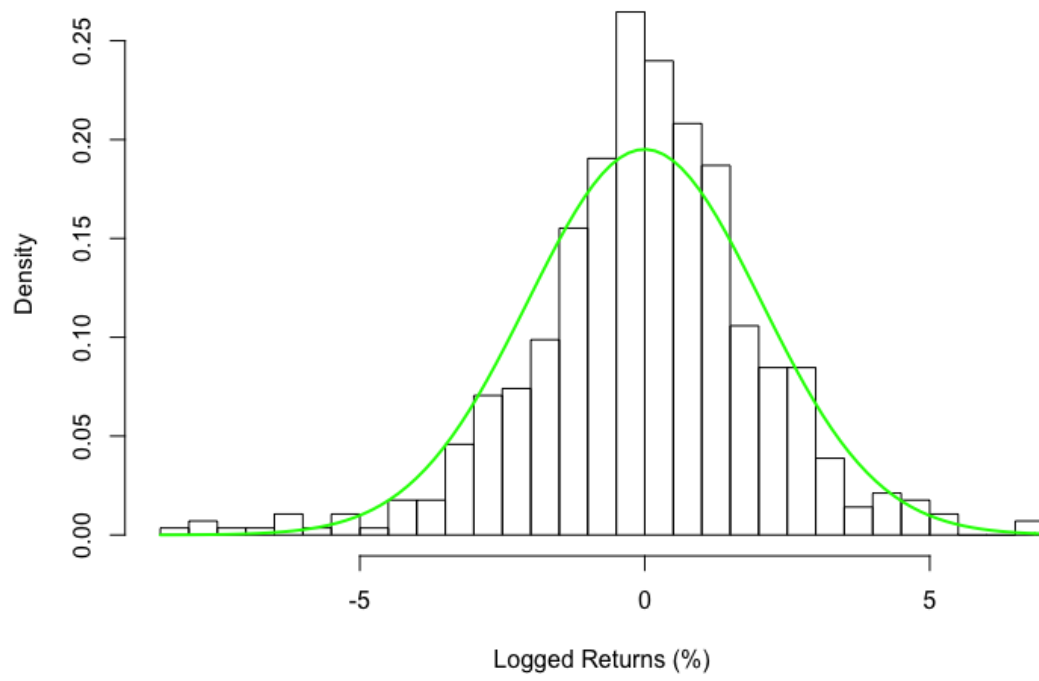
*p <0.1

** p <0.05

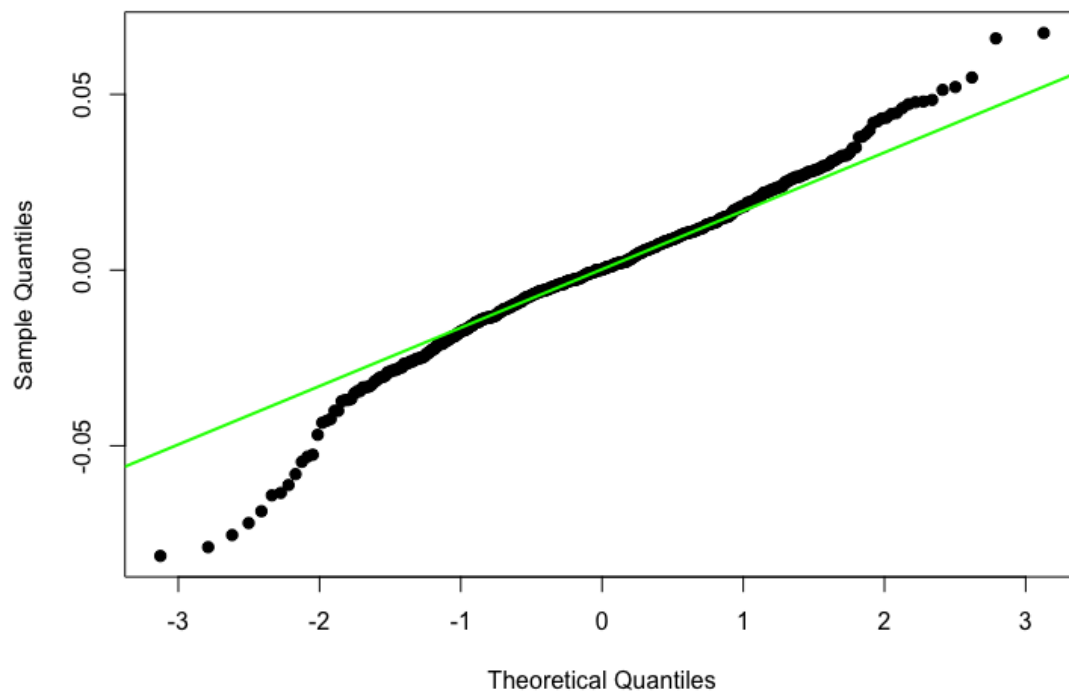
*** p <0.01

C.24 Life Healthcare

Histogram of PSG Group



Normal Q-Q Plot for PSG Group



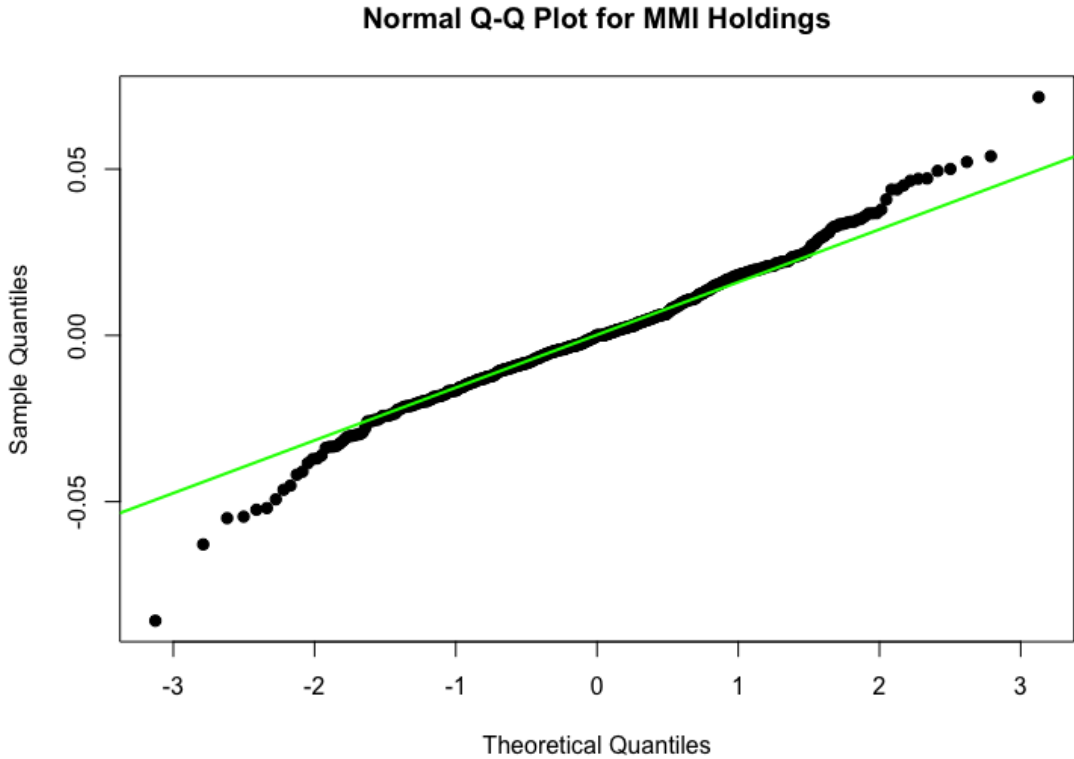
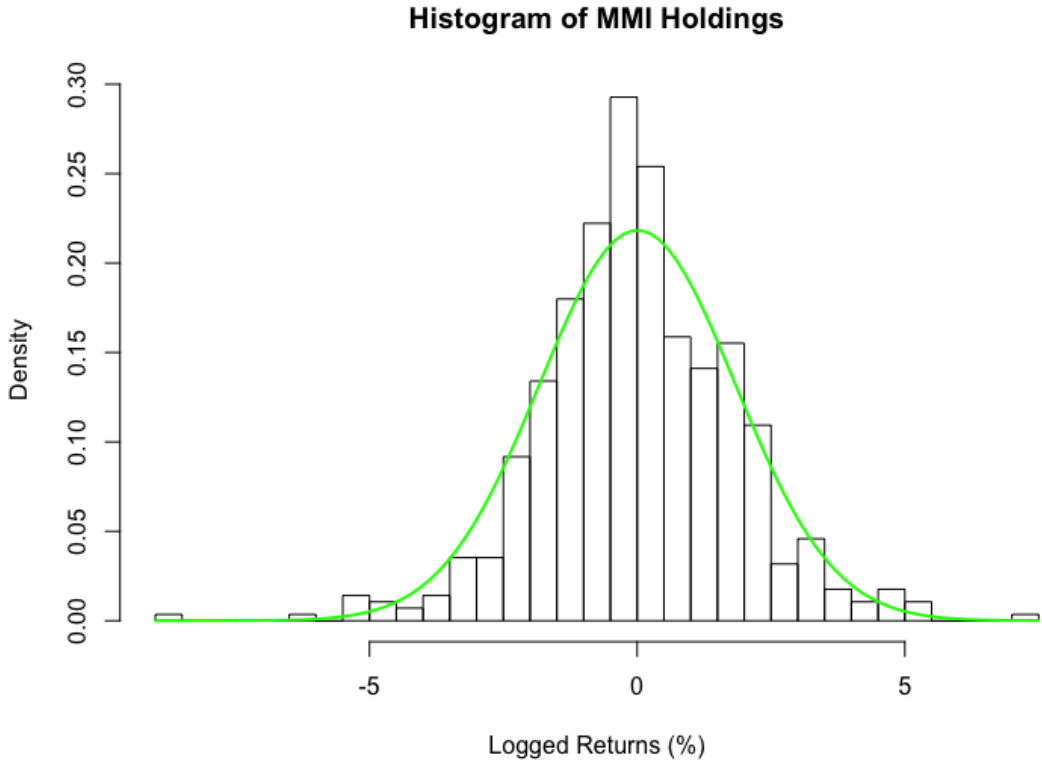
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Life Healthcare	2.4578 ***	0.052664***	0.98353***	46.642***	0.287940

C.25 MMI Holdings



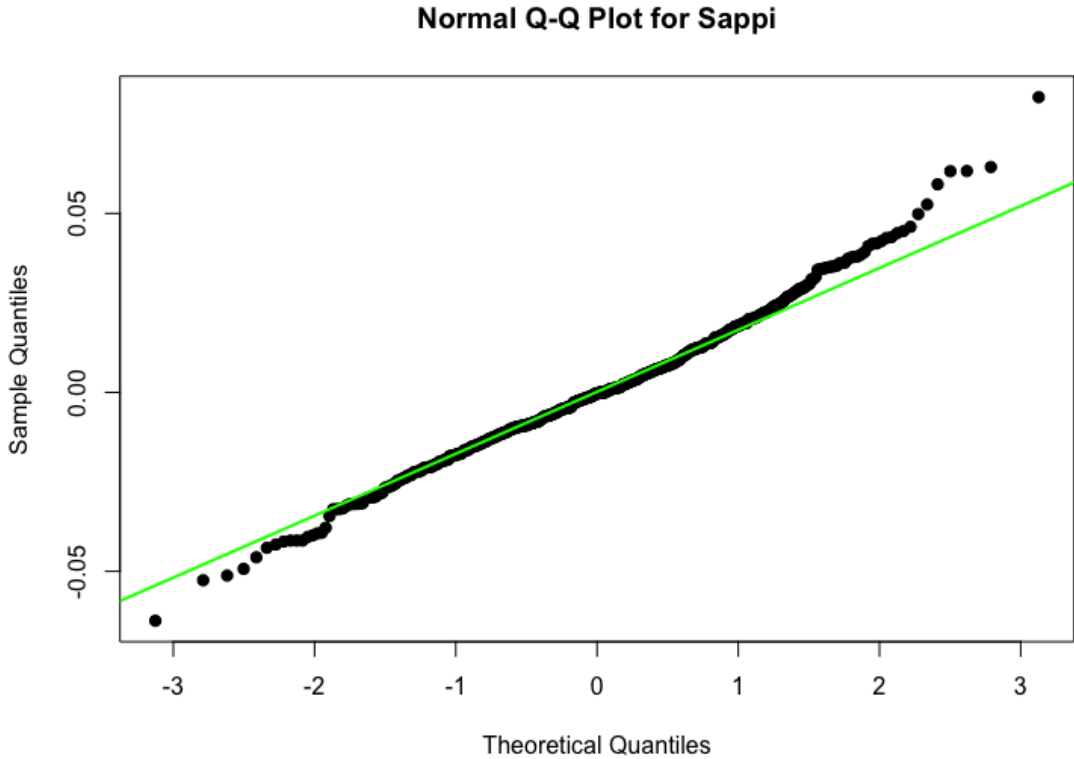
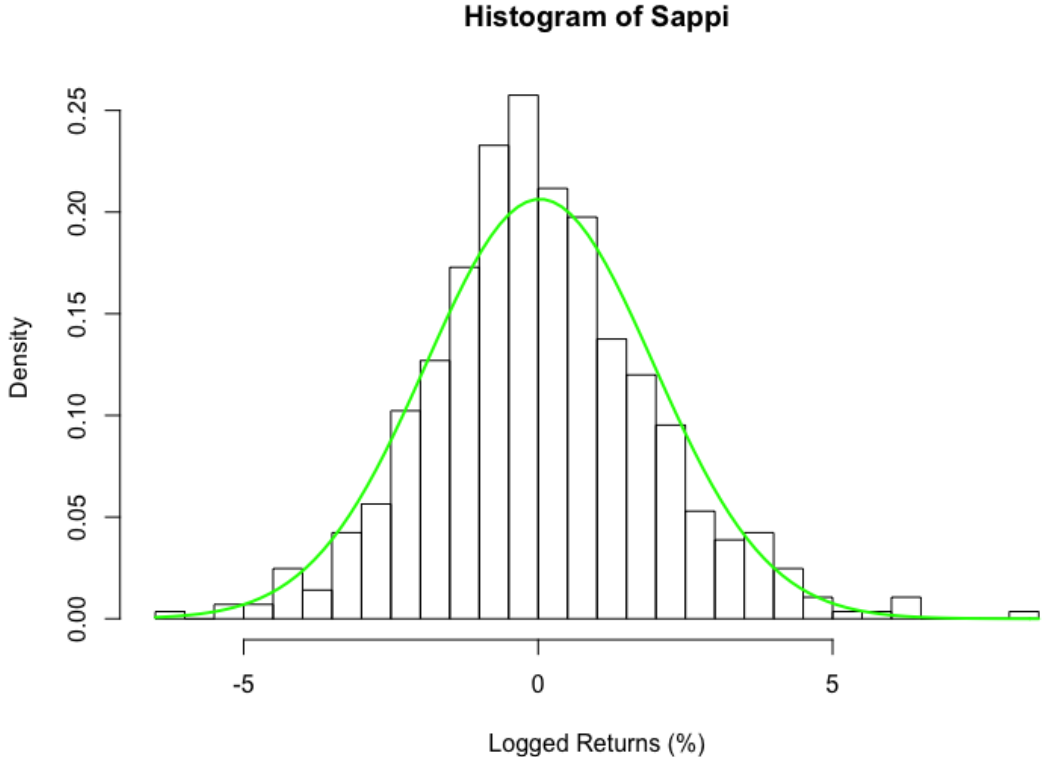
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
MMI Holdings	1.8613***	0.052478***	0.98457***	56.06***	-0.521930

C.26 Sappi



*p <0.1

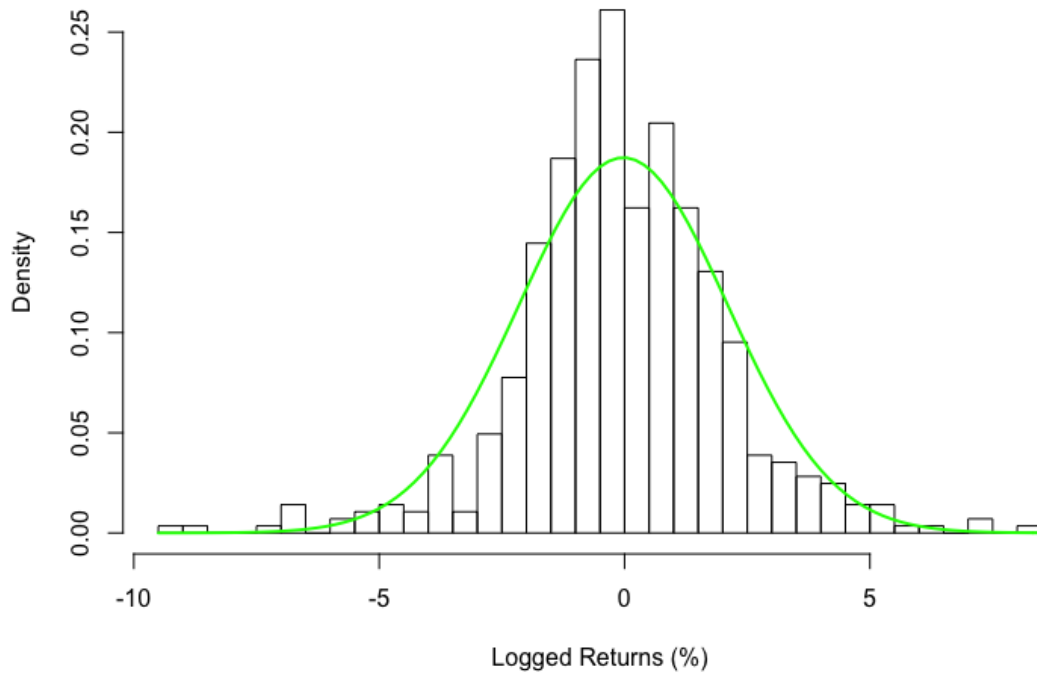
** p <0.05

*** p <0.01

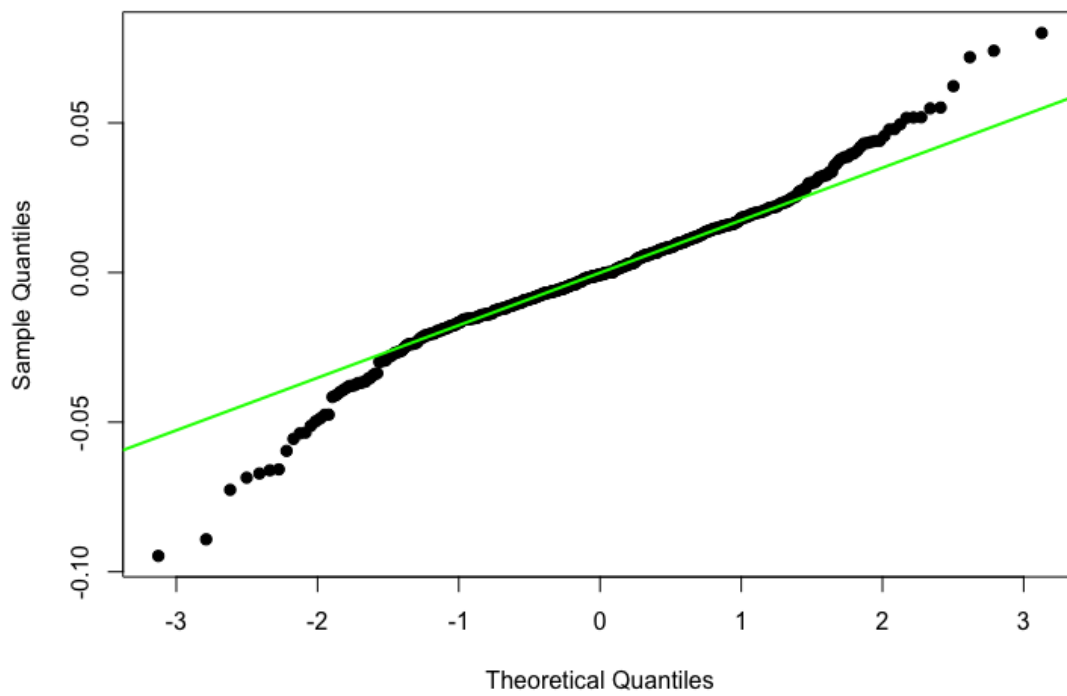
Normality Test Statistics					
	AD	LF	SW	JB	DP
Sappi	1.6069***	0.049558***	0.98933***	29.464***	3.08280***

C.27 Telkom SA SOC

Histogram of Telkom SA SOC



Normal Q-Q Plot for Telkom SA SOC



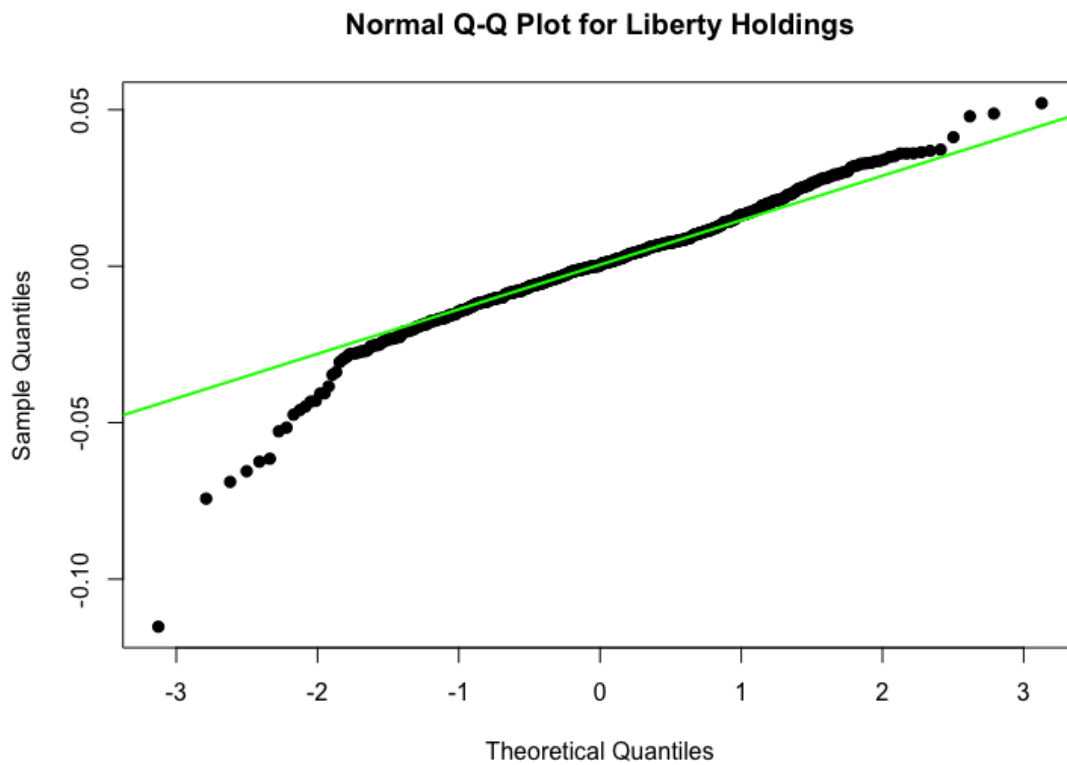
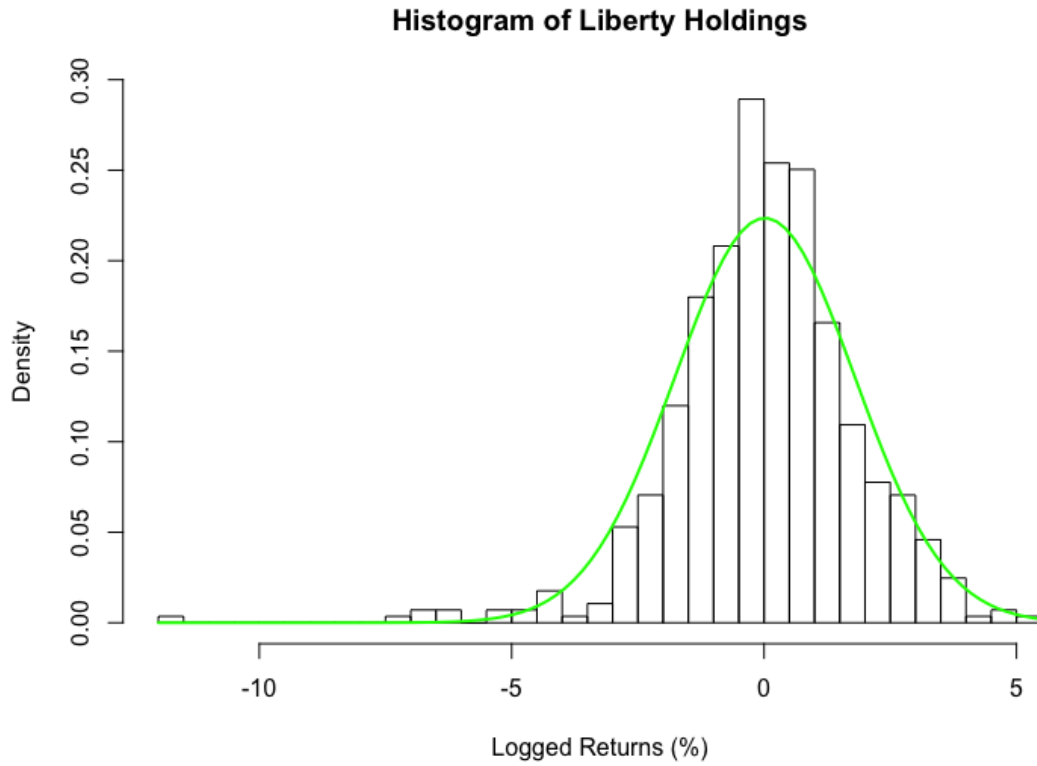
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Telkom SA SOC	4.0151***	0.067847***	0.96891***	126.78***	-2.00360**

C.28 Liberty Holdings



*p <0.1

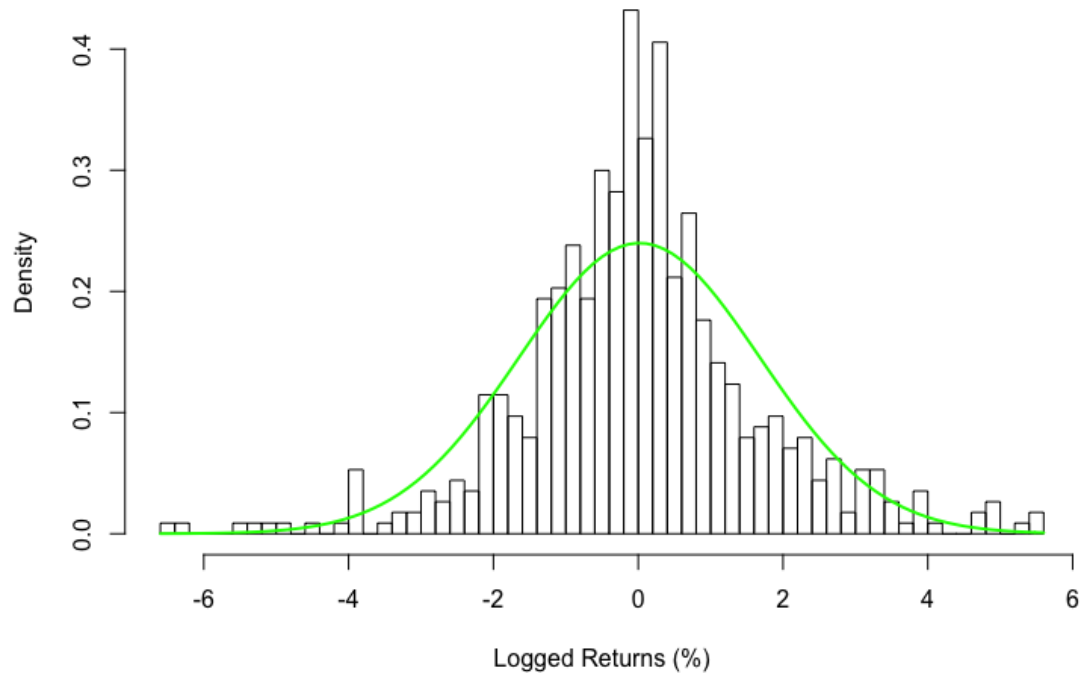
** p <0.05

*** p <0.01

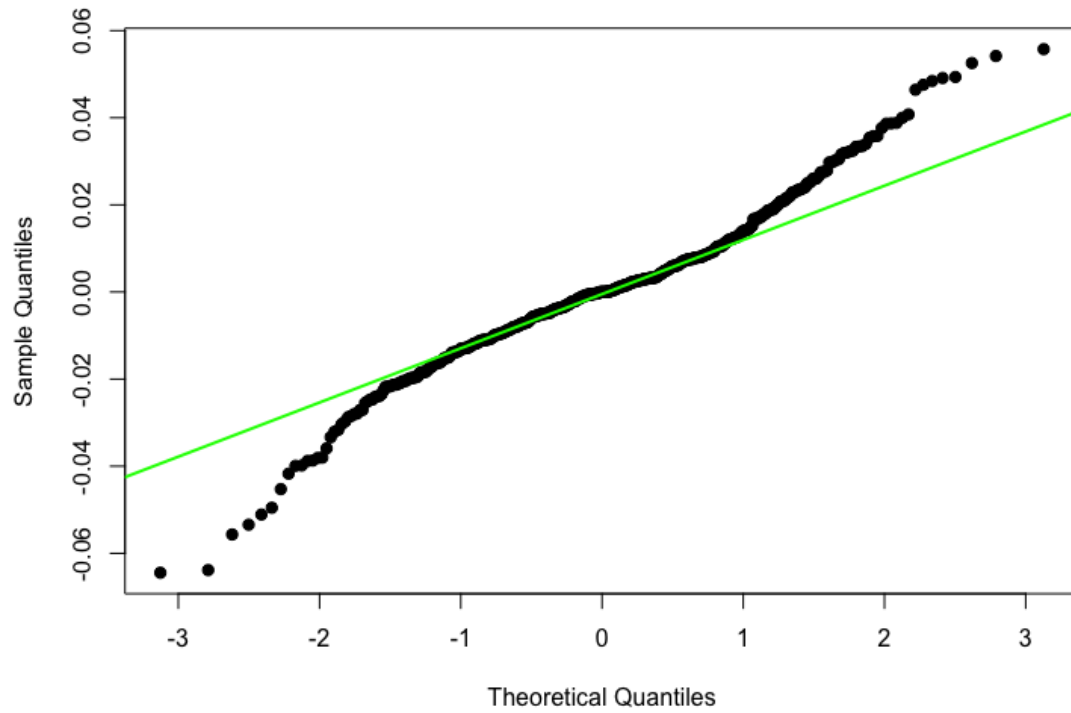
Normality Test Statistics					
	AD	LF	SW	JB	DP
Liberty Holdings	3.5694***	0.057655***	0.95288***	487.32***	-7.47570***

C.29 Spar Group

Histogram of Spar Group



Normal Q-Q Plot for Spar Group



*p <0.1

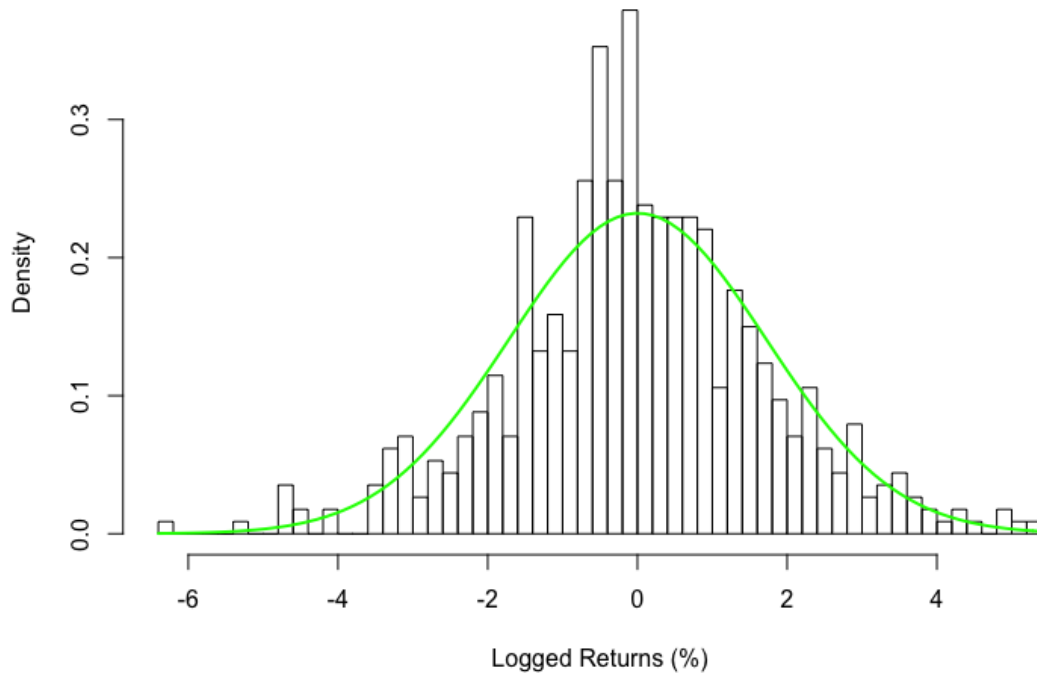
** p <0.05

*** p <0.01

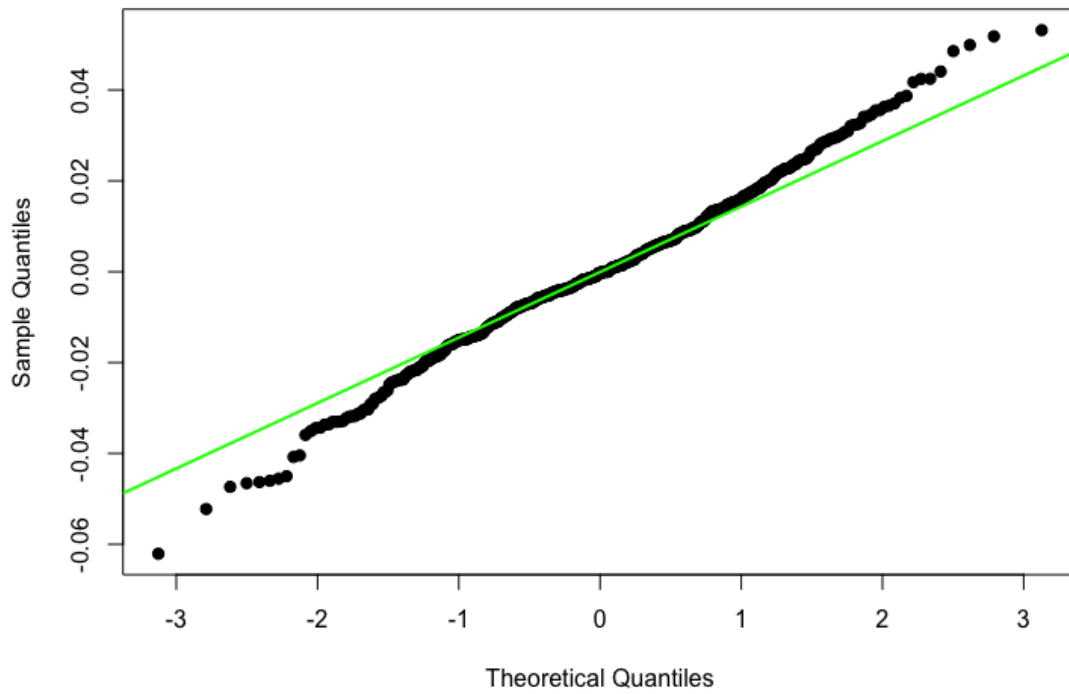
Normality Test Statistics					
	AD	LF	SW	JB	DP
Spar Group	5.3161***	0.077803***	0.97019***	72.646***	0.166030

C.30 Pick 'n Pay Stores

Histogram of Pick'n Pay Stores



**Normal Q-Q Plot for
Pick'n Pay Stores**



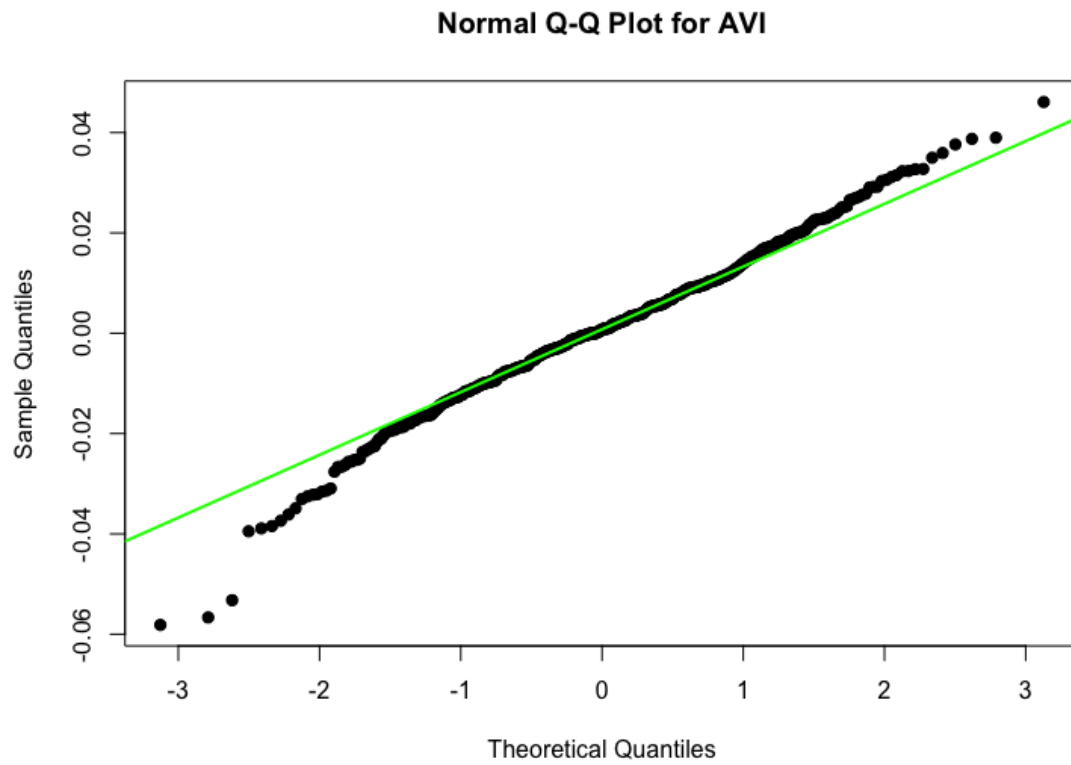
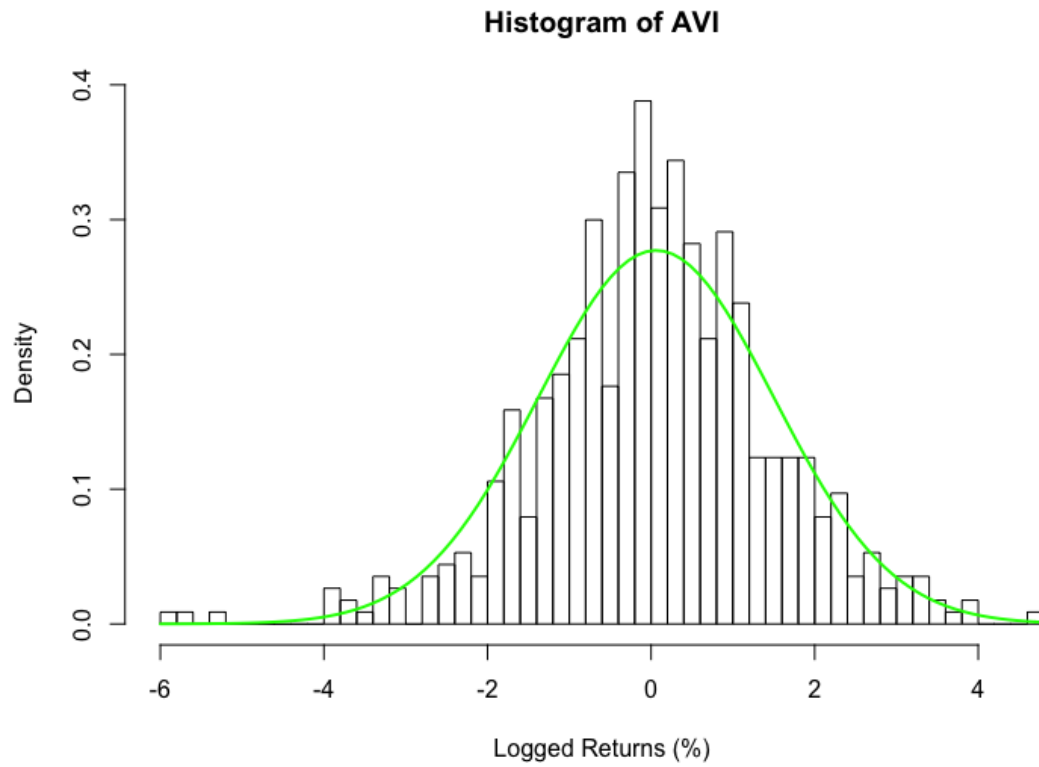
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Pick 'n Pay Stores	1.4263***	0.046792***	0.99292***	9.0593**	-0.233690

C.31 AVI



*p <0.1

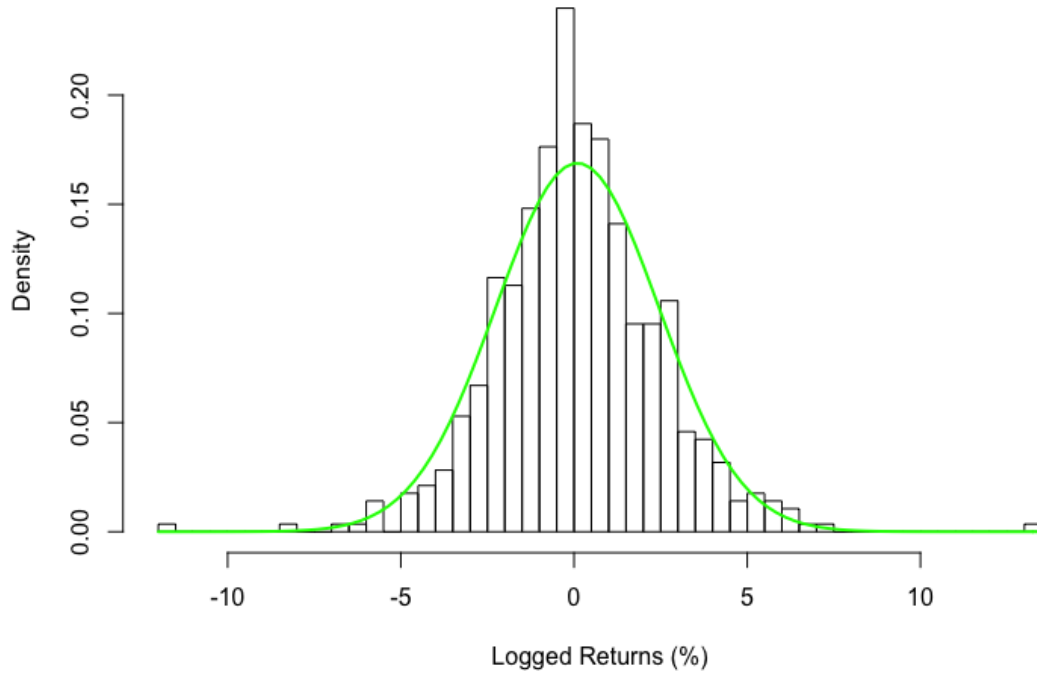
** p <0.05

*** p <0.01

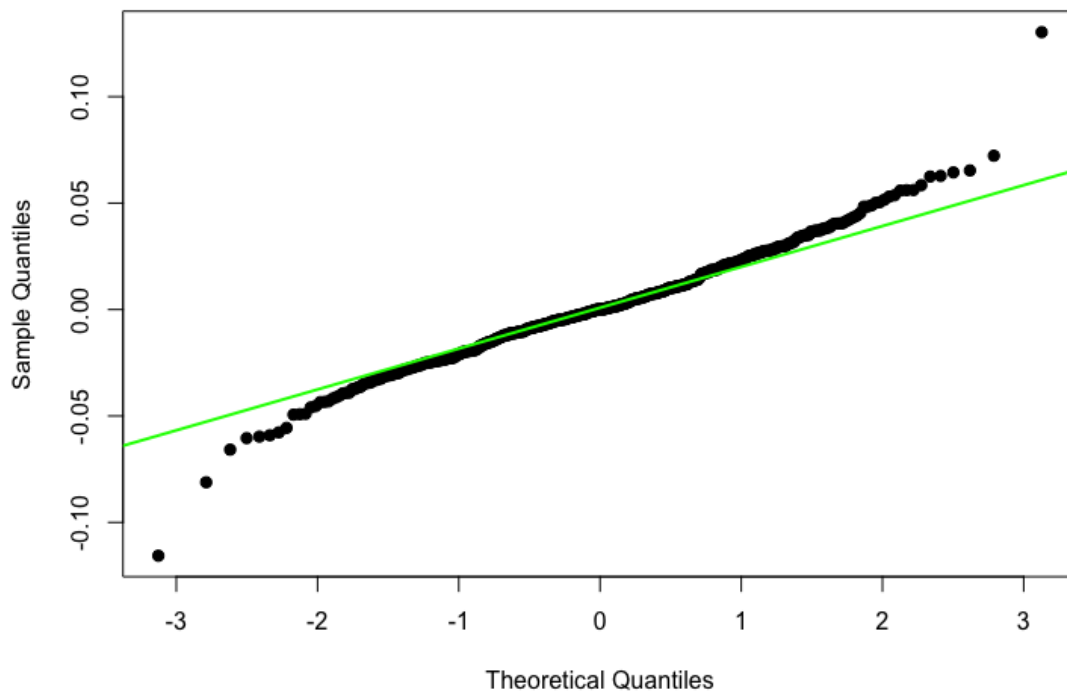
Normality Test Statistics					
	AD	LF	SW	JB	DP
AVI	1.3931***	0.038786**	0.98761***	37.596 ***	-2.63310***

C.32 TFG (The Foschini Group)

Histogram of TFG (The Foschini Group)



**Normal Q-Q Plot for
TFG (The Foschini Group)**



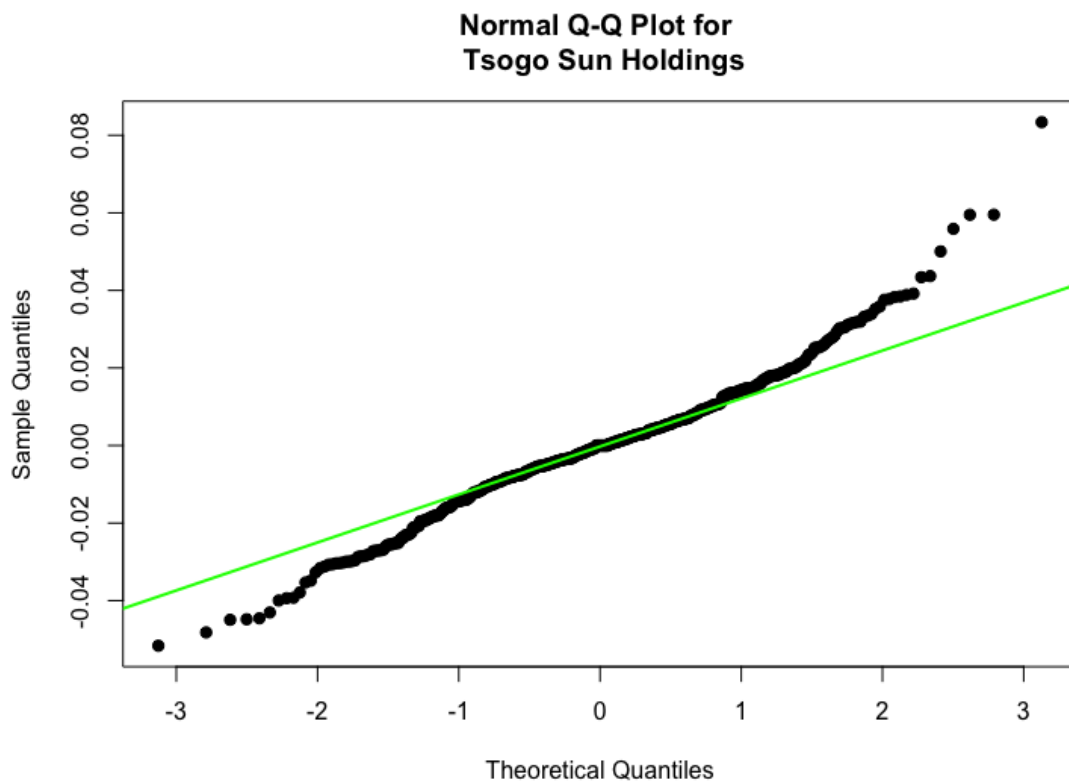
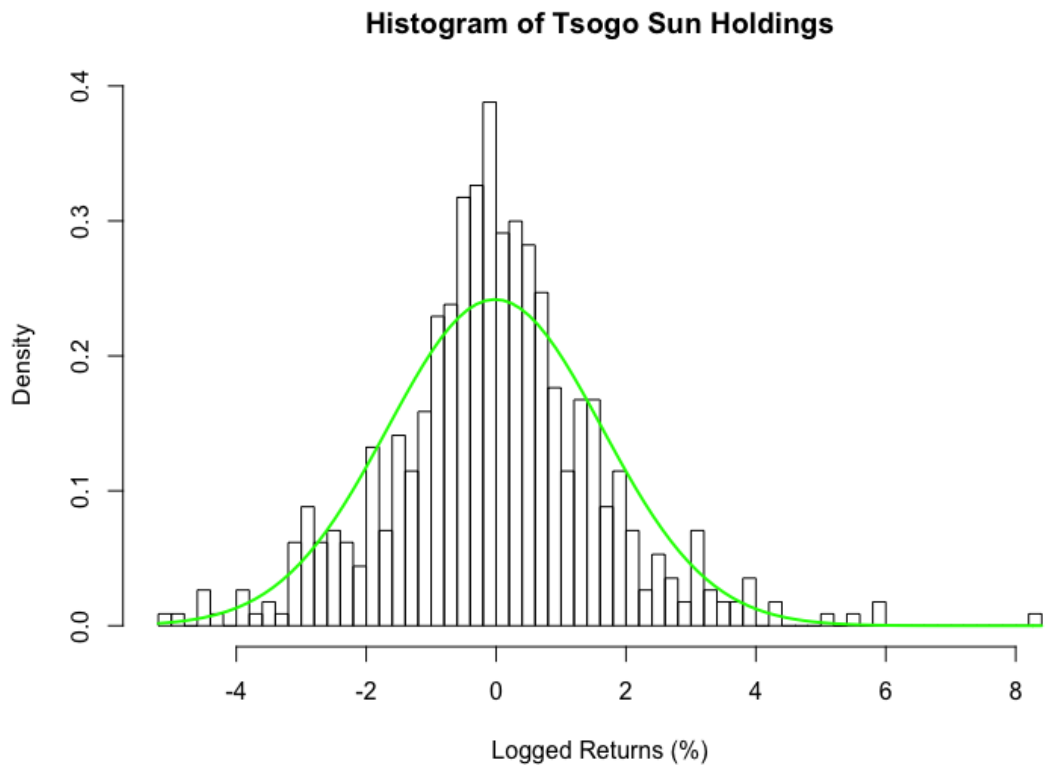
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
TFG	1.9546***	0.053612***	0.97809***	152.52***	1.47810

C.33 Tsogo Sun Holdings



*p <0.1

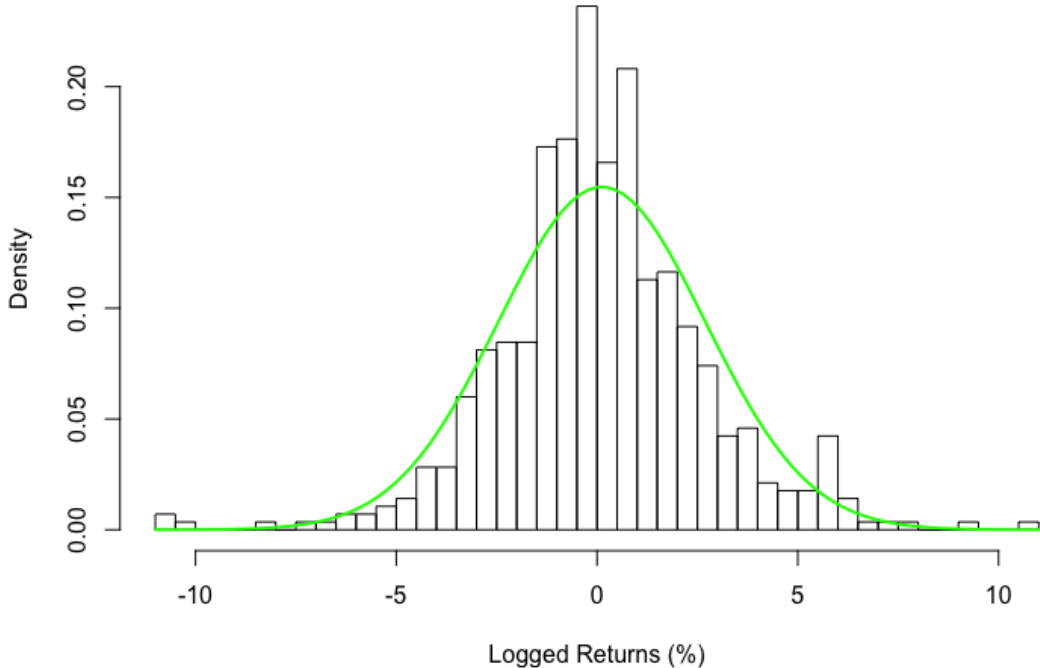
** p <0.05

*** p <0.01

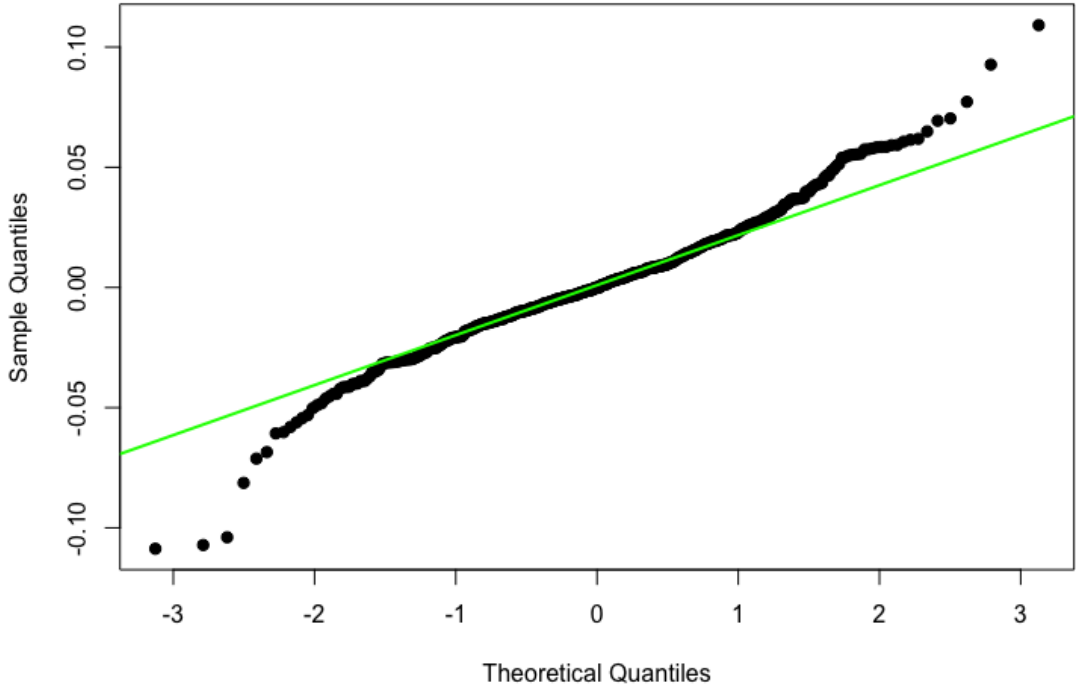
Normality Test Statistics					
	AD	LF	SW	JB	DP
Tsogo Sun Holdings	3.6326***	0.065546***	0.97537***	100.1***	3.32470***

C.34 Imperial Logistics

Histogram of Imperial Logistics



Normal Q-Q Plot for Imperial Logistics



*p <0.1

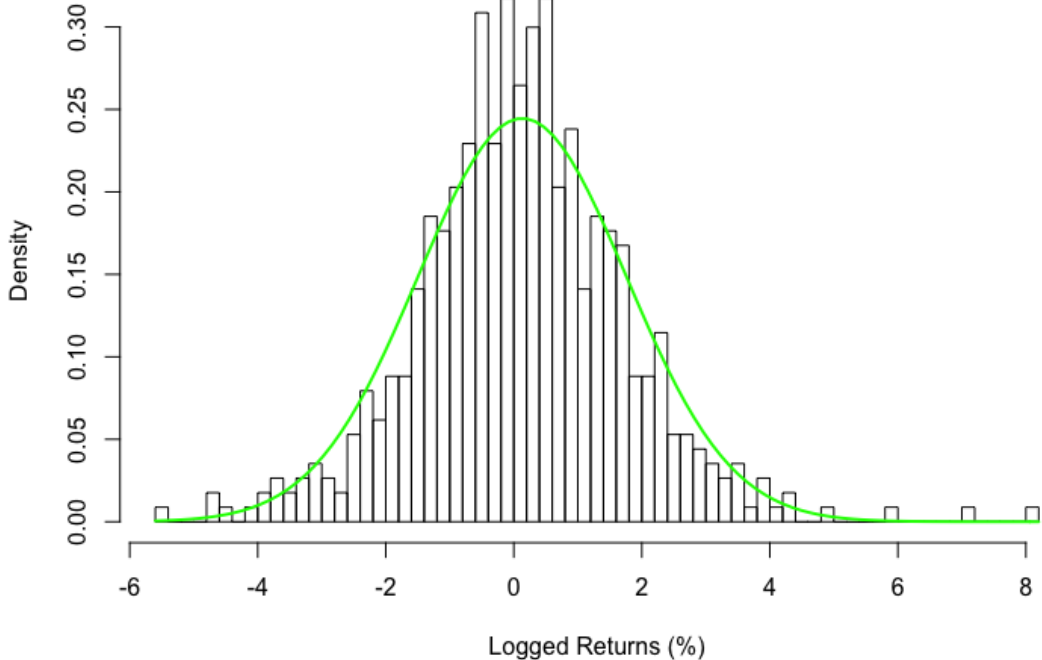
** p <0.05

*** p <0.01

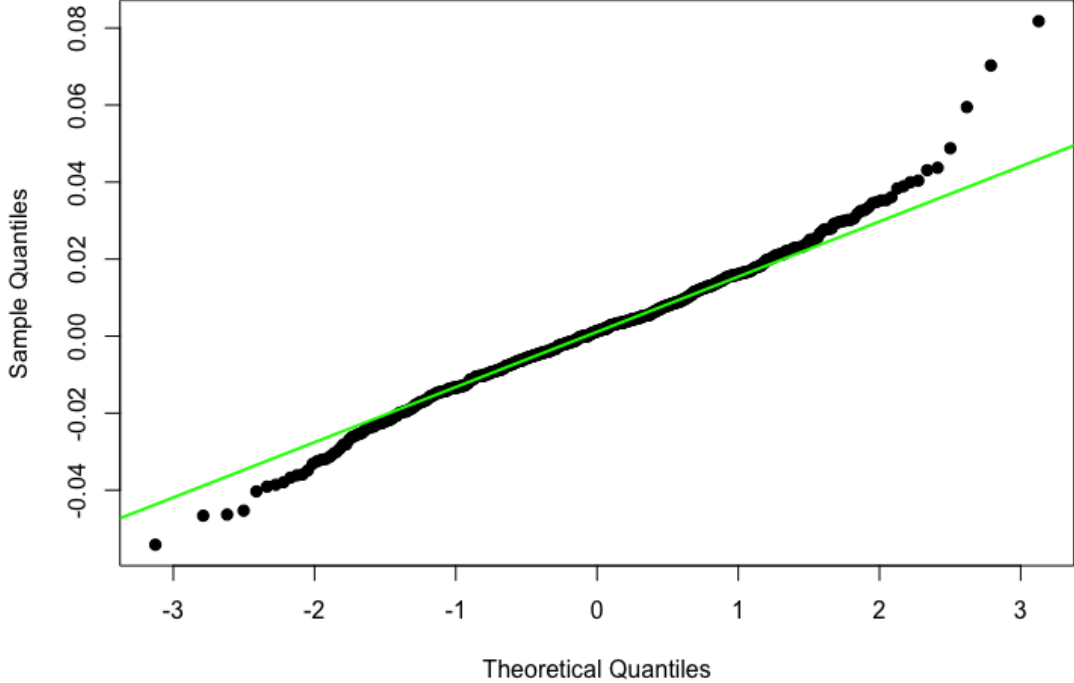
Normality Test Statistics					
	AD	LF	SW	JB	DP
Imperial Logistics	3.5949***	0.065828***	0.97264***	108.7***	-0.120010

C.35 Clicks Group

Histogram of Clicks Group



Normal Q-Q Plot for Clicks Group



*p <0.1

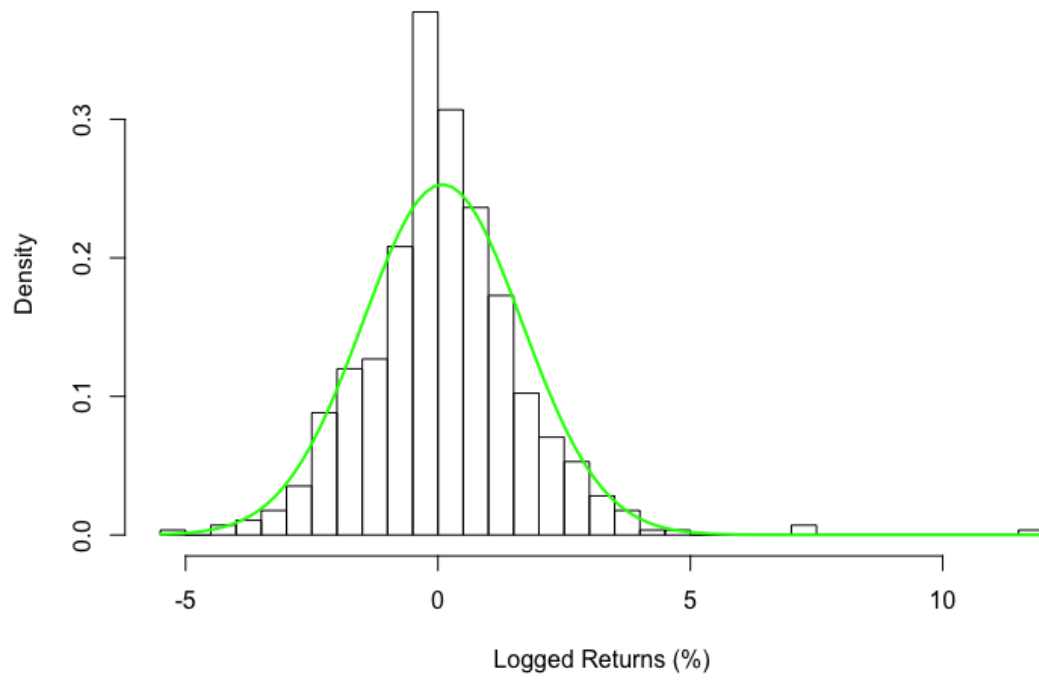
** p <0.05

*** p <0.01

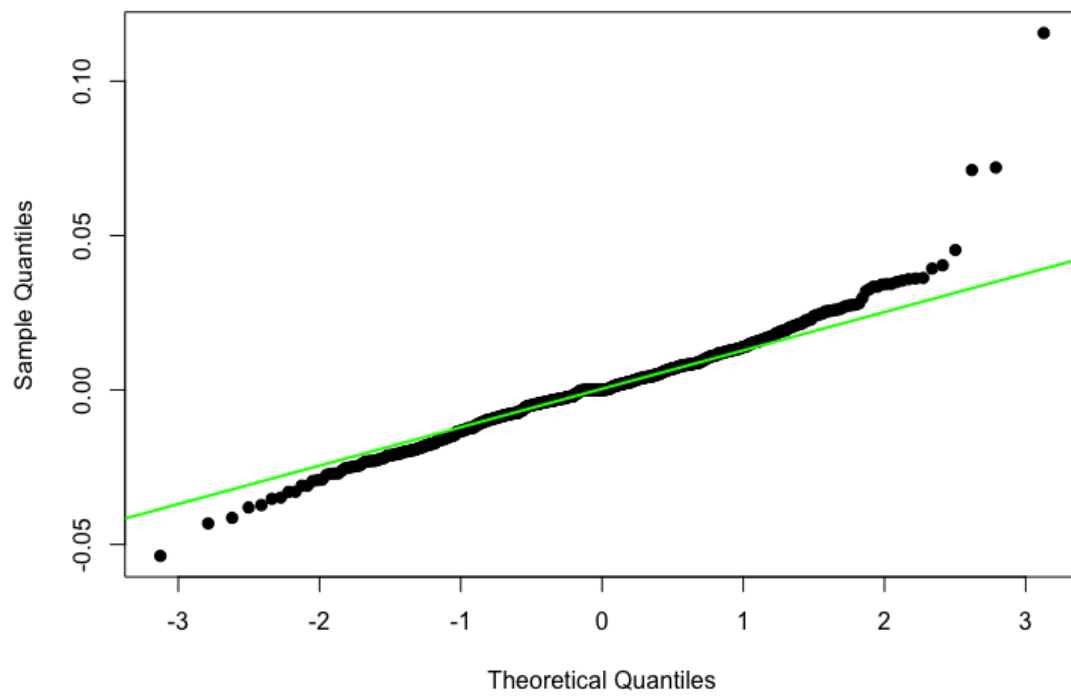
Normality Test Statistics					
	AD	LF	SW	JB	DP
Clicks Group	1.6546***	0.044631***	0.98273***	84.327***	2.5689**

C.36 Santam

Histogram of Santam



Normal Q-Q Plot for Santam



*p <0.1

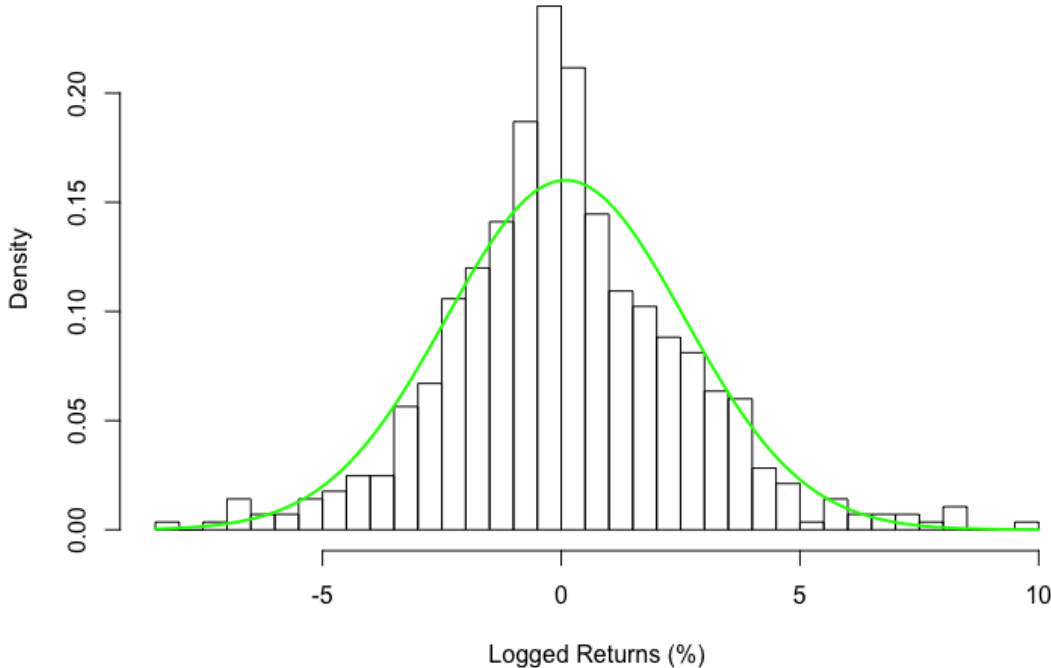
** p <0.05

*** p <0.01

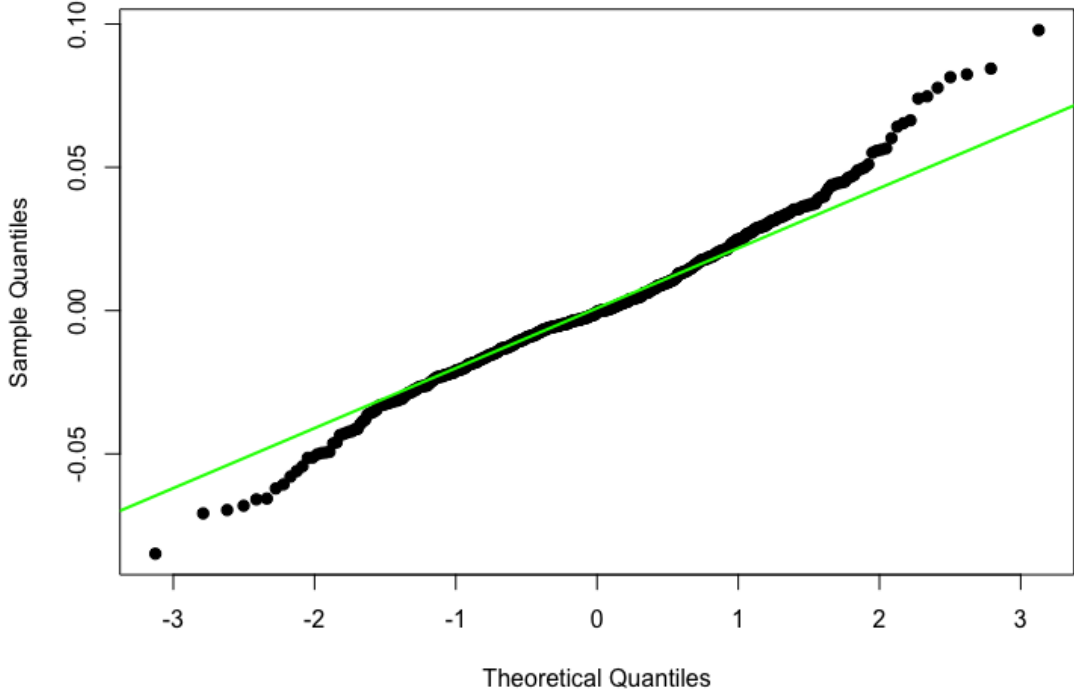
Normality Test Statistics					
	AD	LF	SW	JB	DP
Santam	3.2406***	0.061514***	0.94978***	884.53***	7.7025***

C.37 Massmart Holdings

Histogram of Massmart Holdings



Normal Q-Q Plot for Massmart Holdings



*p <0.1

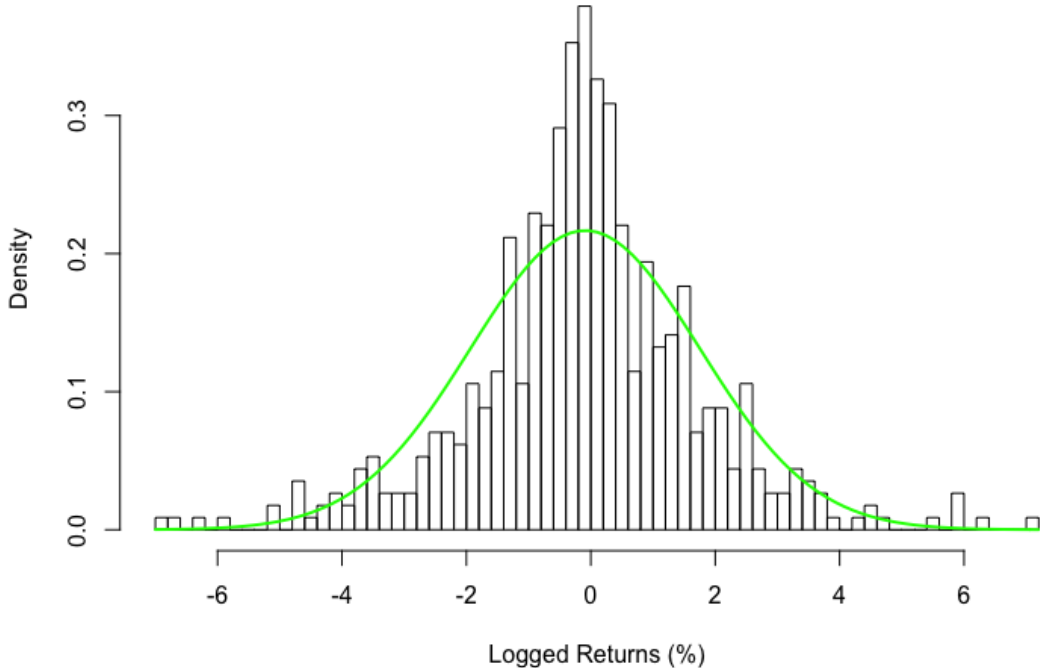
** p <0.05

*** p <0.01

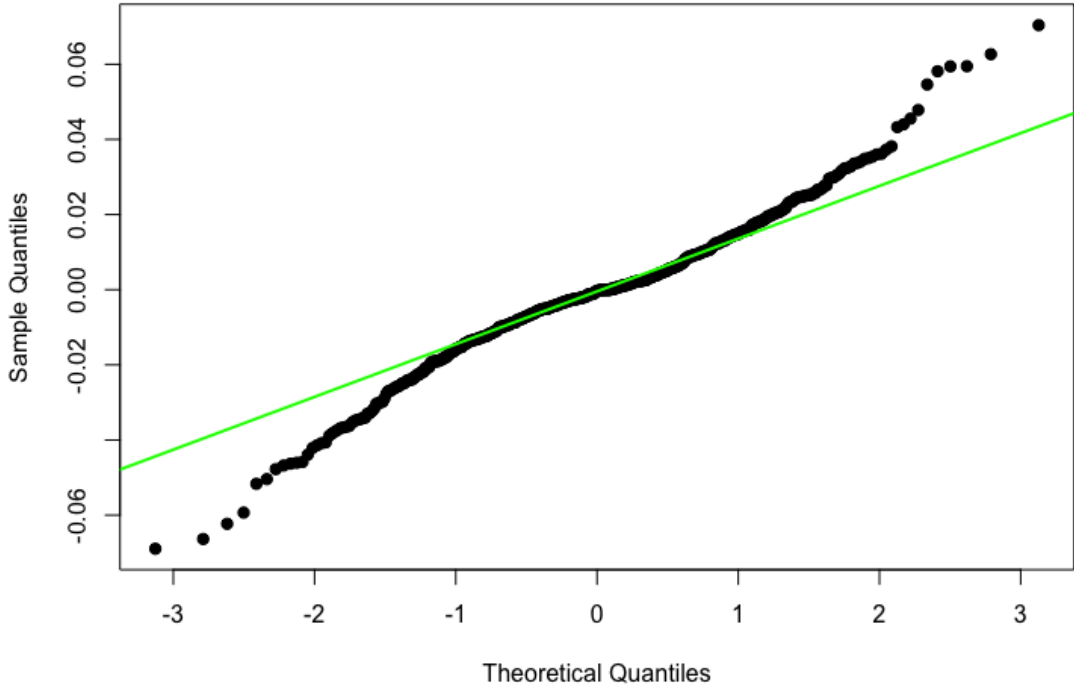
Normality Test Statistics					
	AD	LF	SW	JB	DP
Massmart Holdings	2.6566***	0.057927***	0.98388***	39.659***	2.40560**

C.38 Curro Holdings

Histogram of Curro Holdings



Normal Q-Q Plot for Curro Holdings



*p <0.1

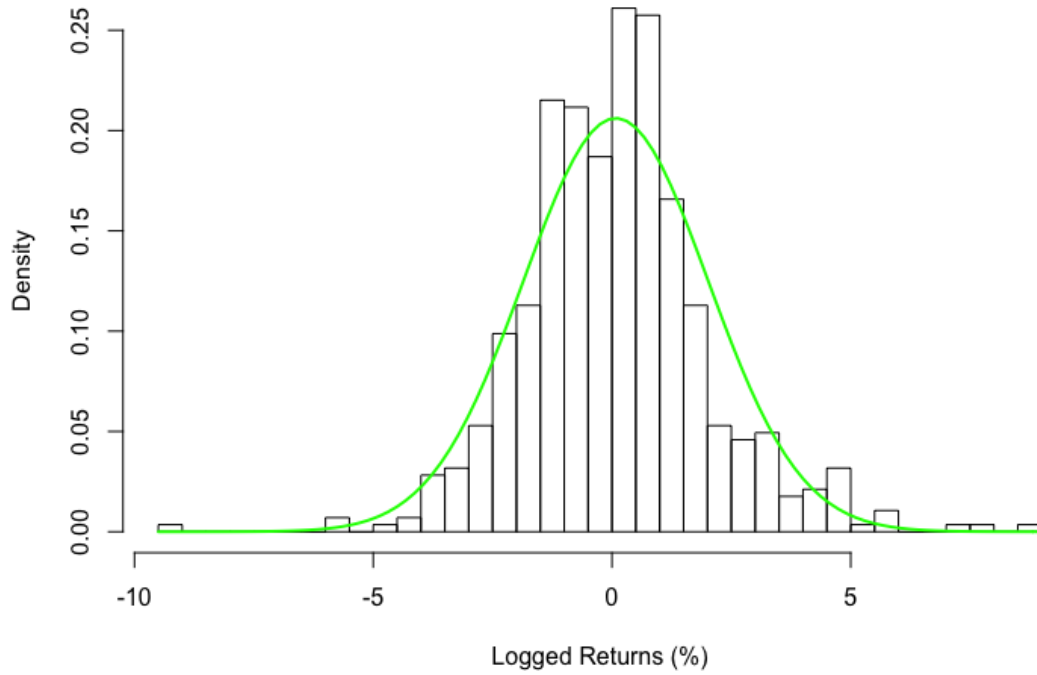
** p <0.05

*** p <0.01

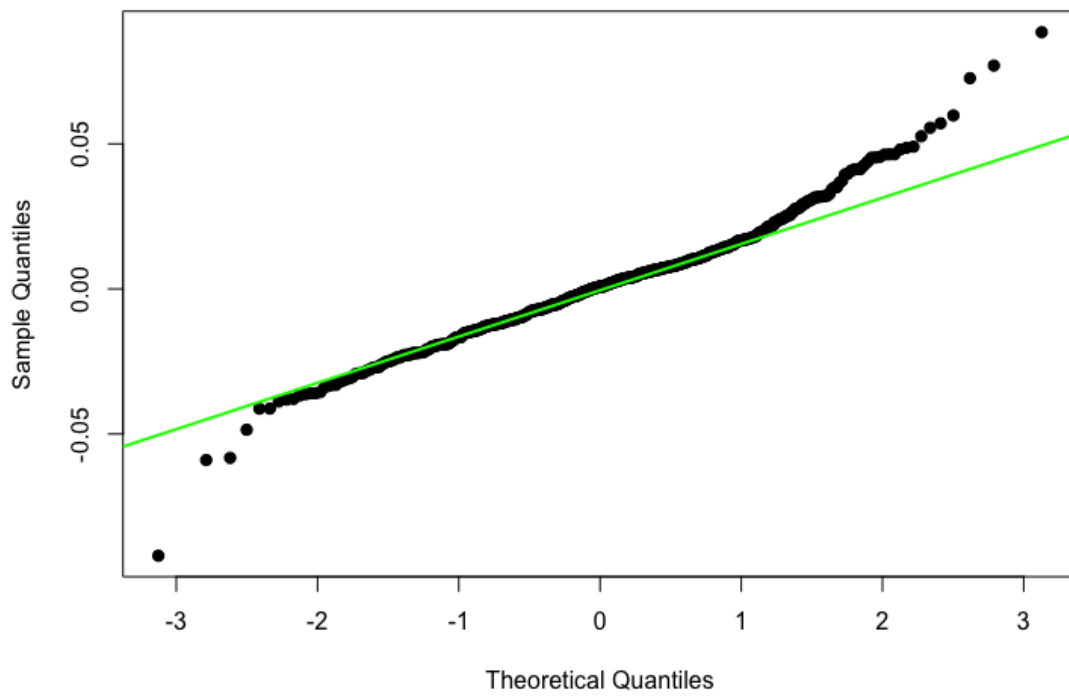
Normality Test Statistics					
	AD	LF	SW	JB	DP
Curro Holdings	4.9407***	0.068268***	0.97333***	70.064***	-0.249600

C.39 Coronation Fund Managers

Histogram of Coronation Fund Managers



Normal Q-Q Plot for Coronation Fund Managers



		Normality Test Statistics				
		AD	LF	SW	JB	DP
Coronation Managers	Fund	3.1531***	0.065418***	0.97266***	128.61***	3.37850***

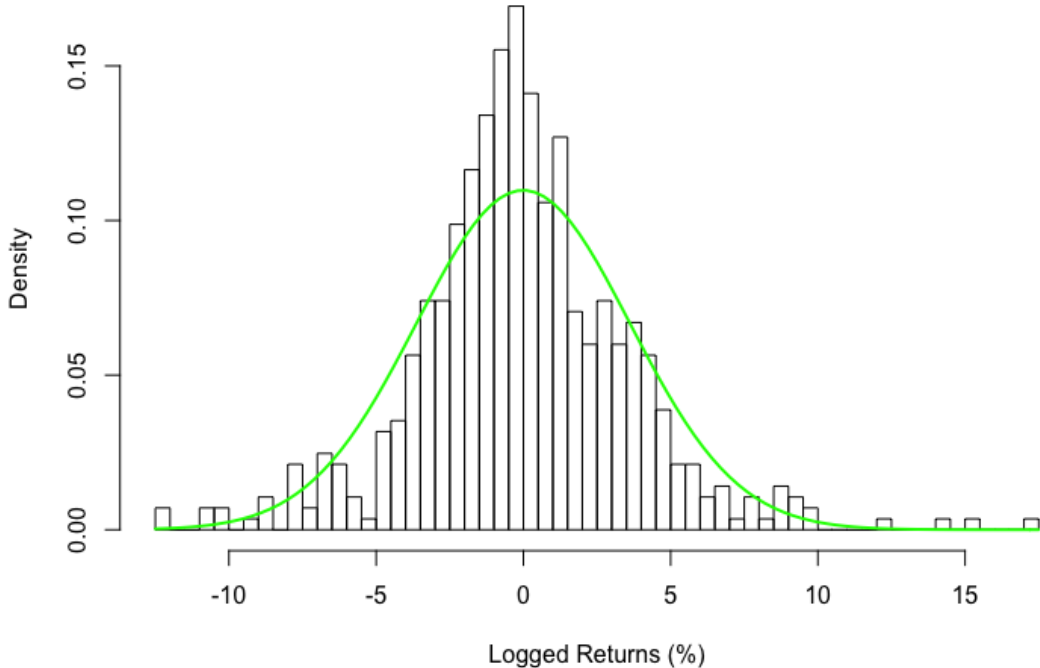
*p < 0.1

** p < 0.05

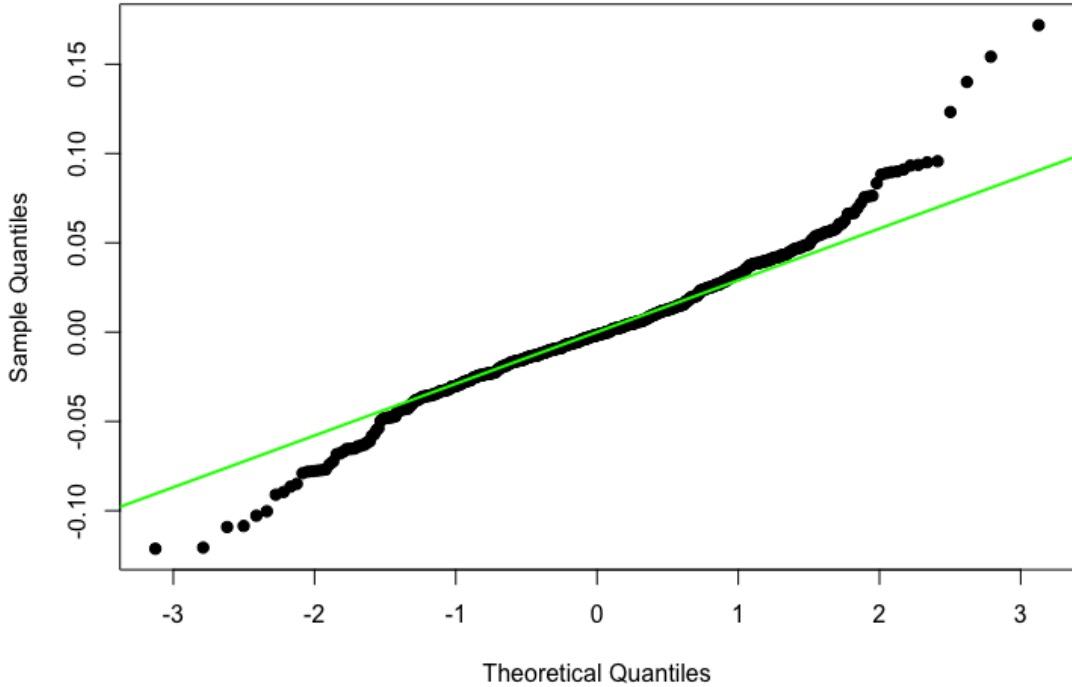
*** p < 0.01

C.40 Impala Platinum

Histogram of Impala Platinum



Normal Q-Q Plot for Impala Platinum



*p <0.1

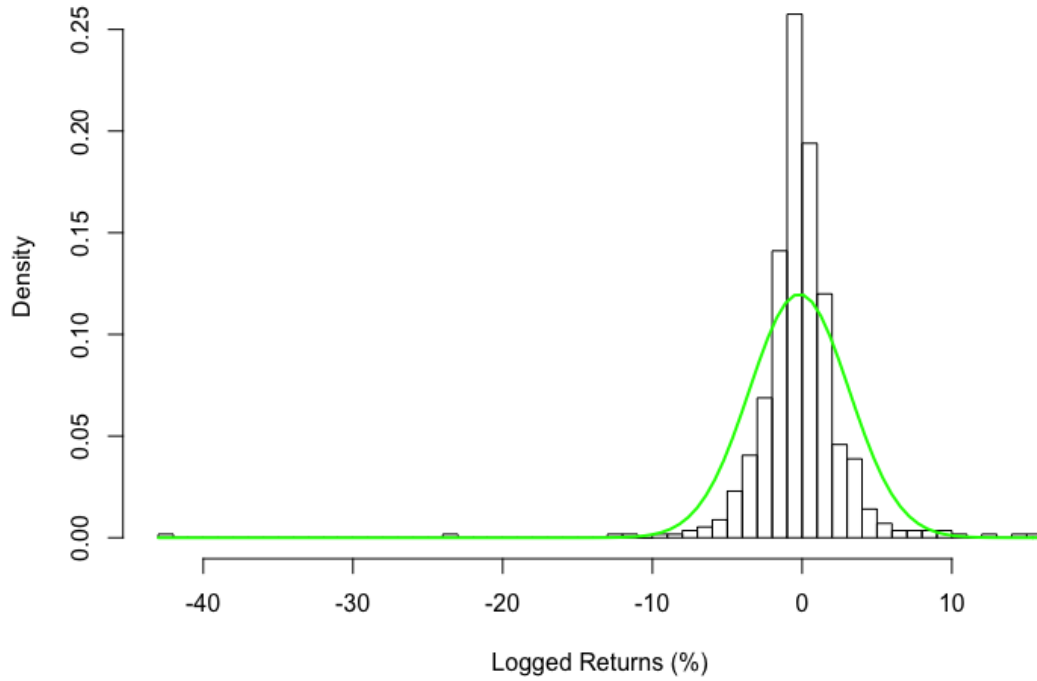
** p <0.05

*** p <0.01

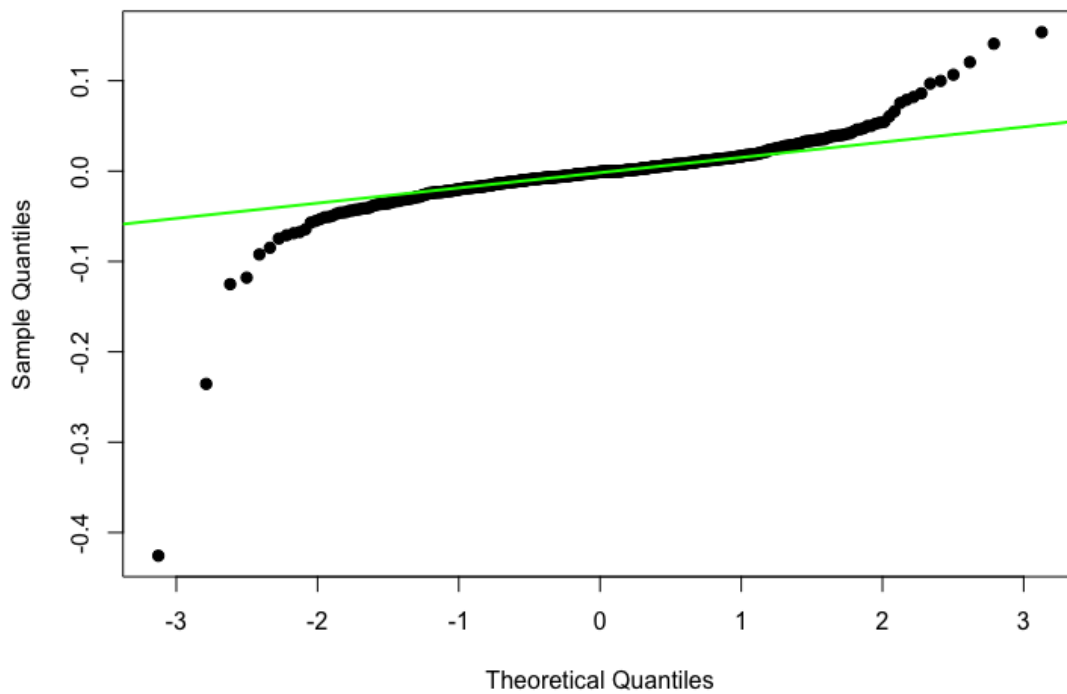
Normality Test Statistics					
	AD	LF	SW	JB	DP
Impala Platinum	3.9911***	0.064949***	0.97035***	127.41***	2.97590***

C.41 EOH Holdings

Histogram of EOH Holdings



Normal Q-Q Plot for EOH Holdings



*p <0.1

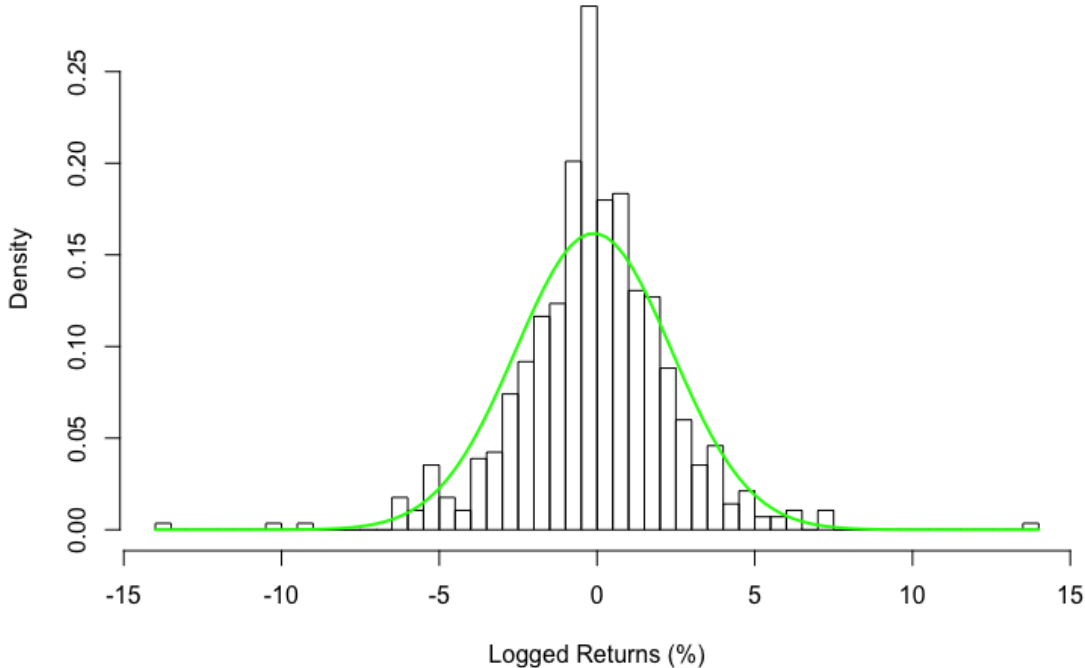
** p <0.05

*** p <0.01

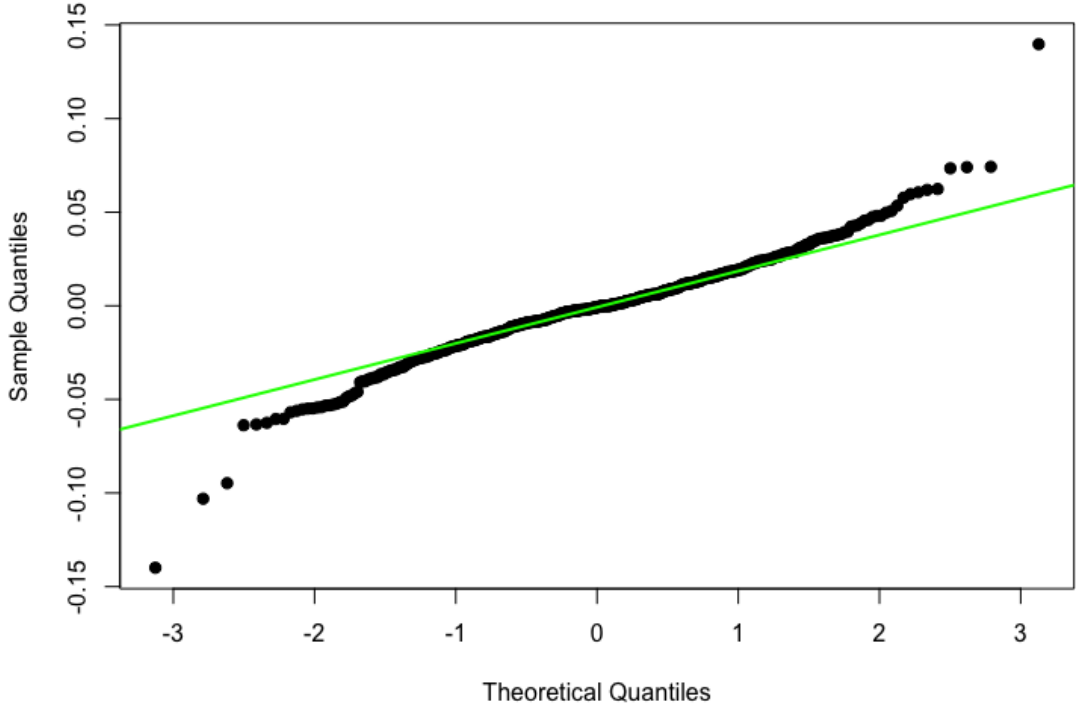
Normality Test Statistics					
	AD	LF	SW	JB	DP
EOH Holdings	26.772***	0.13772***	0.71212***	64320***	-18.3010***

C.42 Nampak

Histogram of Nampak



Normal Q-Q Plot for Nampak



*p <0.1

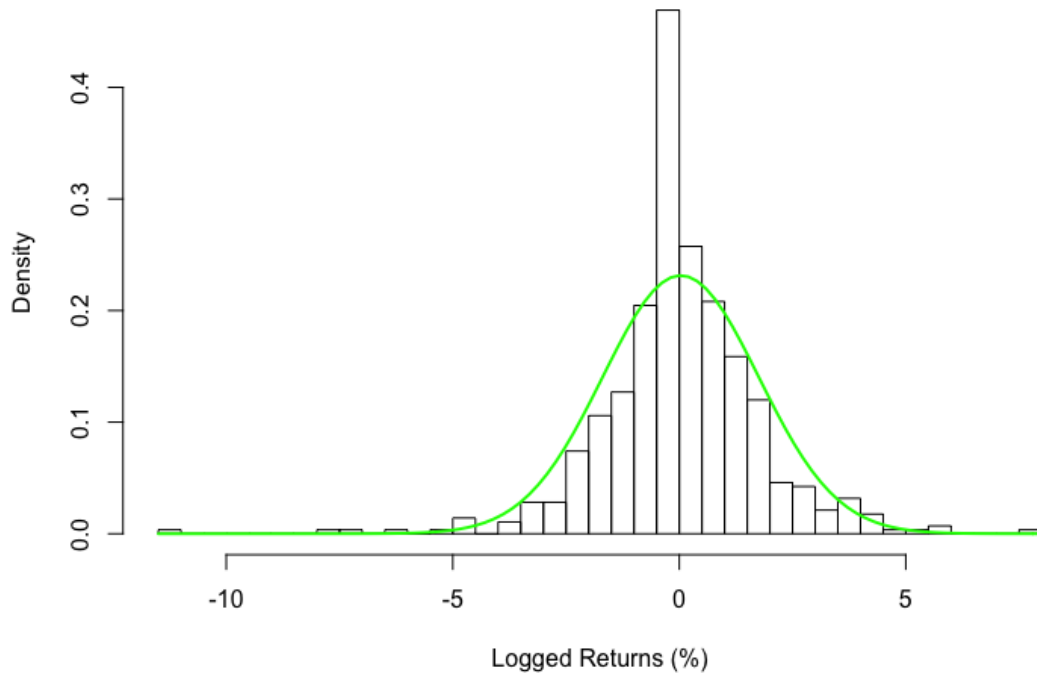
** p <0.05

*** p <0.01

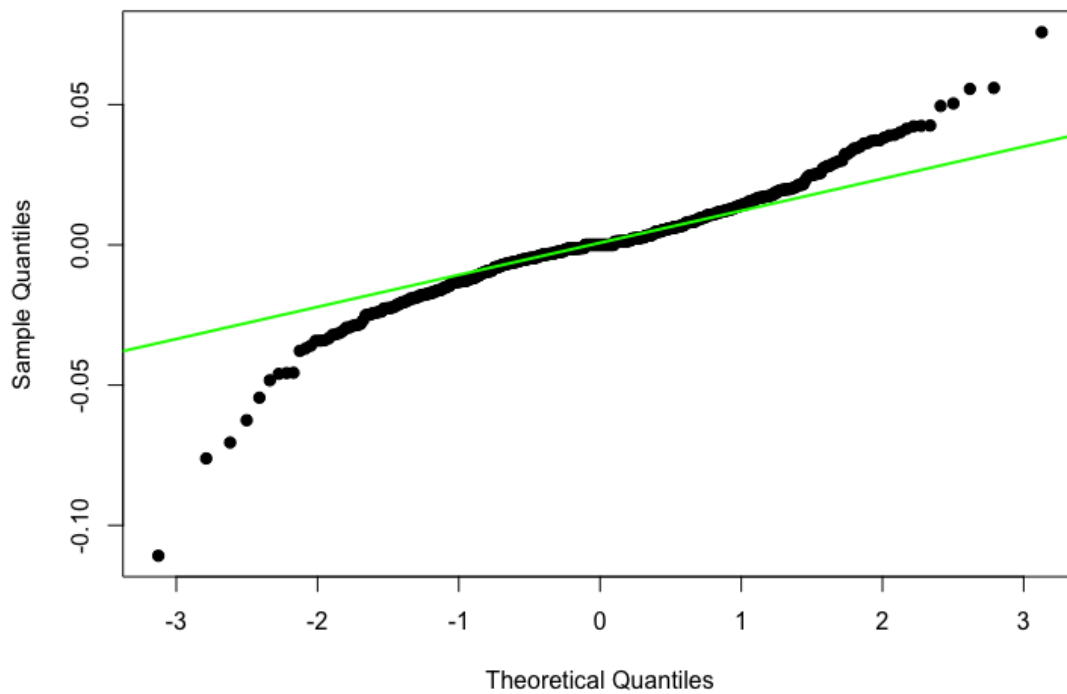
Normality Test Statistics					
	AD	LF	SW	JB	DP
Nampak	4.5906***	0.068784***	0.95649***	417.73***	-1.51030

C.43 KAP Industrial Holdings

Histogram of KAP Industrial Holdings



Normal Q-Q Plot for KAP Industrial Holdings



		Normality Test Statistics				
		AD	LF	SW	JB	DP
KAP Holdings	Industrial	8.028***	0.089126***	0.938***	630.19***	-4.65170***

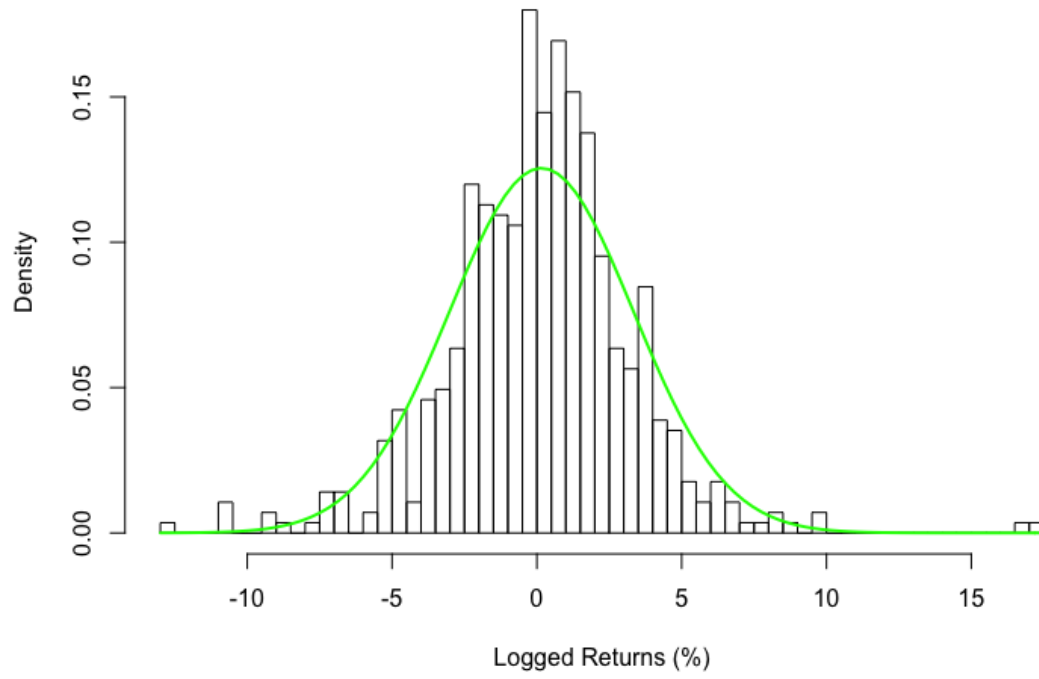
*p < 0.1

** p < 0.05

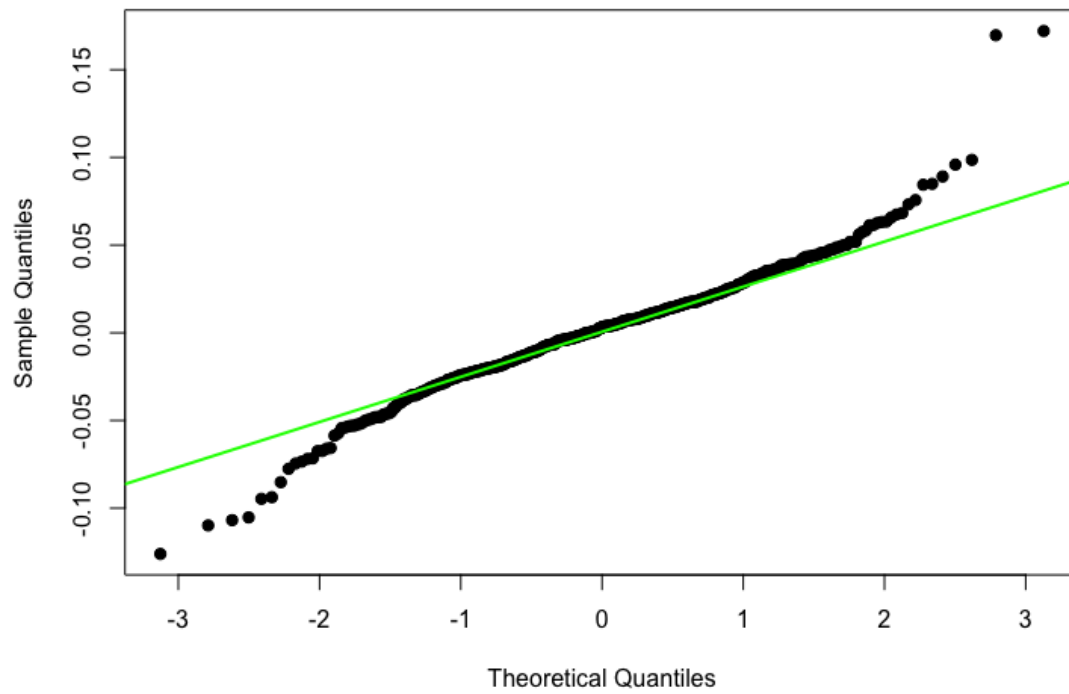
*** p < 0.01

C.44 Exxaro Resources

Histogram of Exxaro Resources



Normal Q-Q Plot for Exxaro Resources



*p <0.1

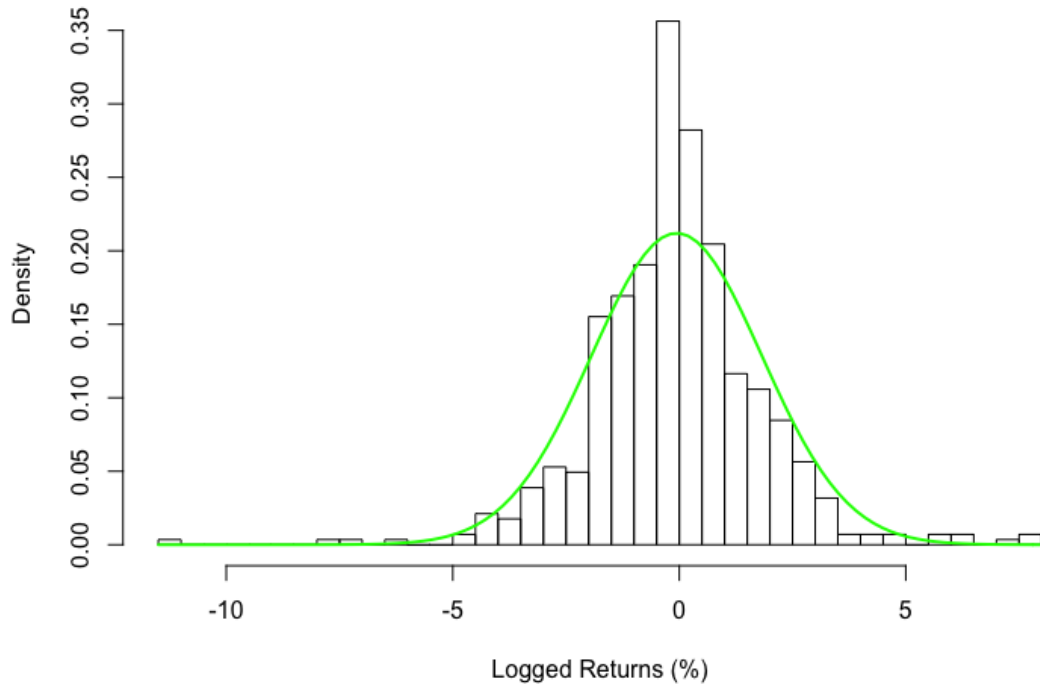
** p <0.05

*** p <0.01

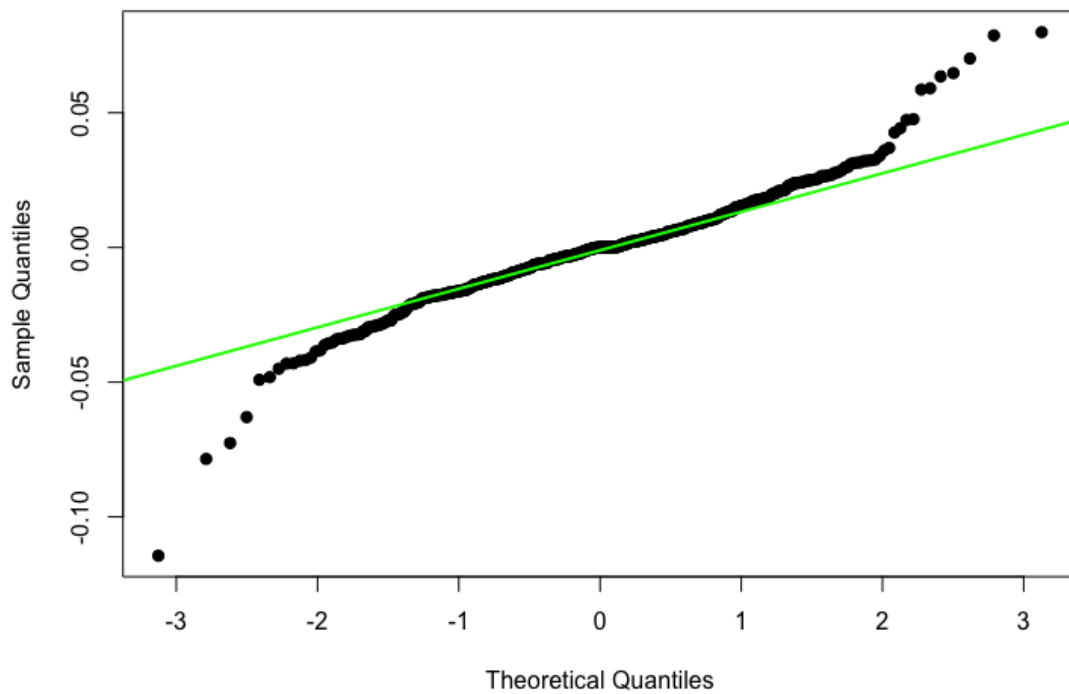
Normality Test Statistics					
	AD	LF	SW	JB	DP
Exxaro Resources	3.4722***	0.055107***	0.96101***	300.34***	1.8164*

C.45 Oceana Group

Histogram of Oceana Group



Normal Q-Q Plot for Oceana Group



*p <0.1

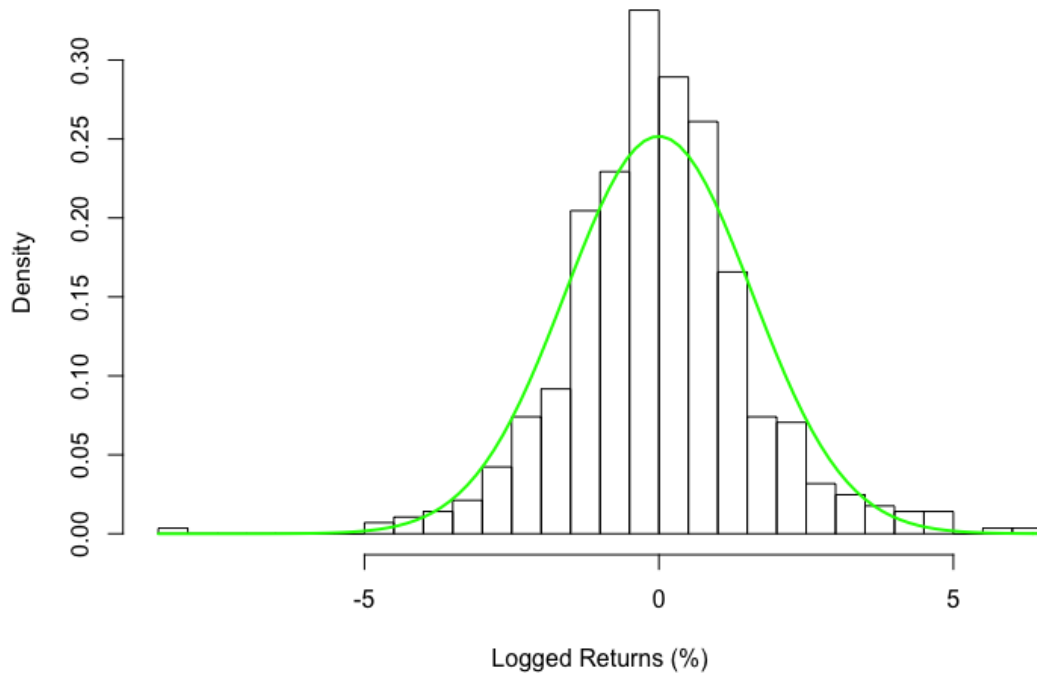
** p <0.05

*** p <0.01

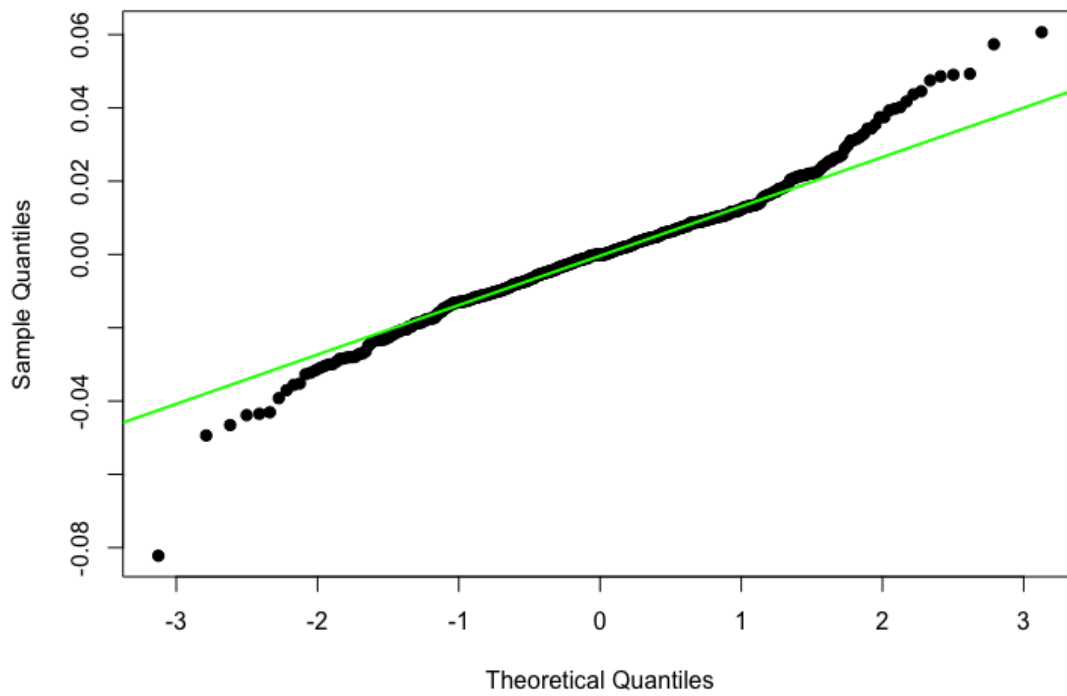
Normality Test Statistics					
	AD	LF	SW	JB	DP
Oceana Group	5.6905***	0.069167***	0.94602***	486.41***	-1.32610

C.46 Super Group

Histogram of Super Group



Normal Q-Q Plot for Super Group



*p <0.1

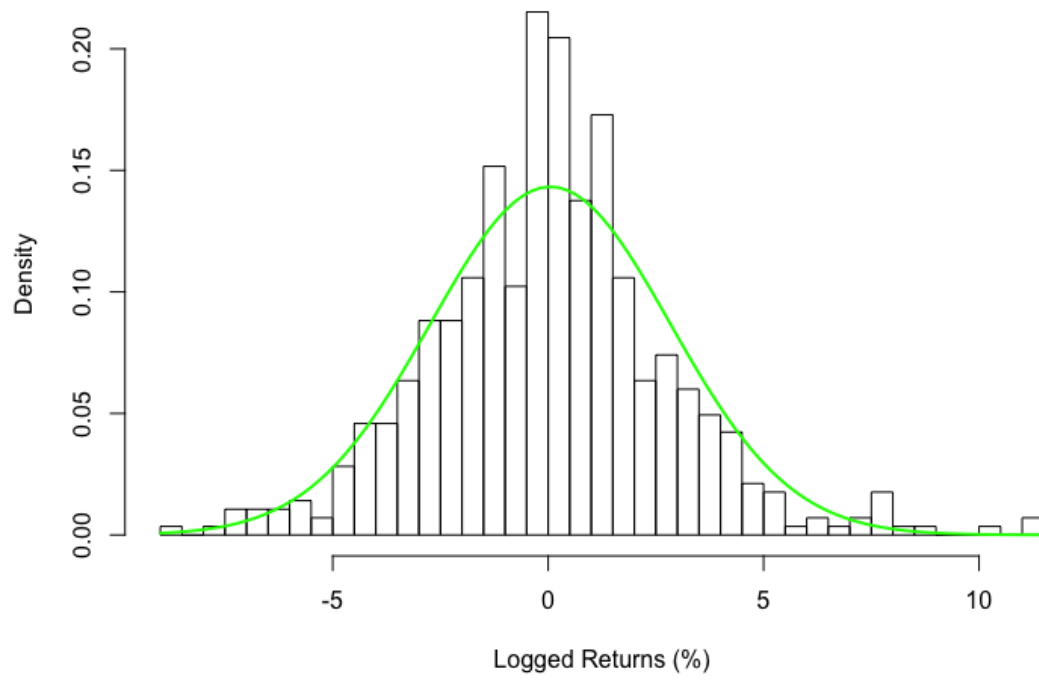
** p <0.05

*** p <0.01

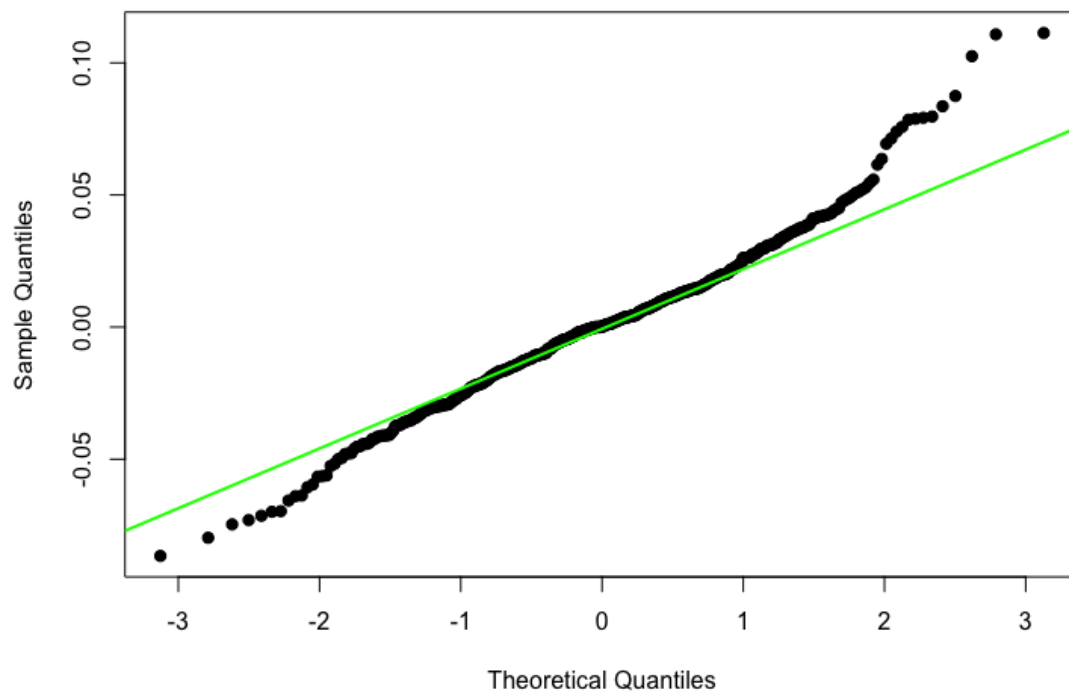
Normality Test Statistics					
	AD	LF	SW	JB	DP
Super Group	3.424***	0.063594***	0.97312***	123.13***	0.553790

C.47 Northam Platinum

Histogram of Northam Platinum



Normal Q-Q Plot for Northam Platinum



*p <0.1

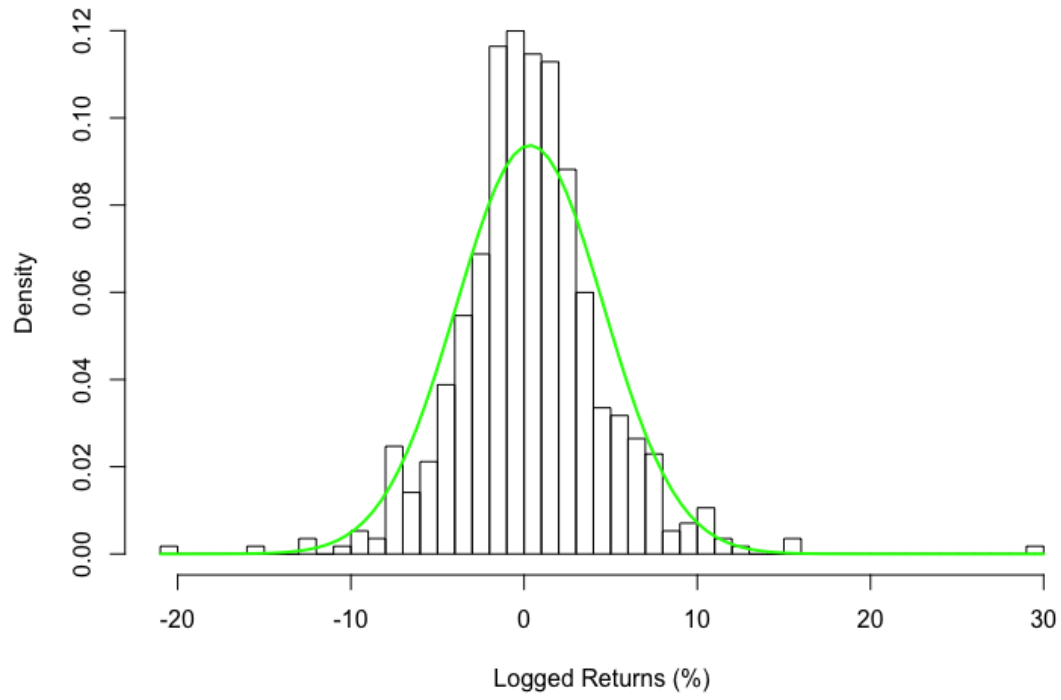
** p <0.05

*** p <0.01

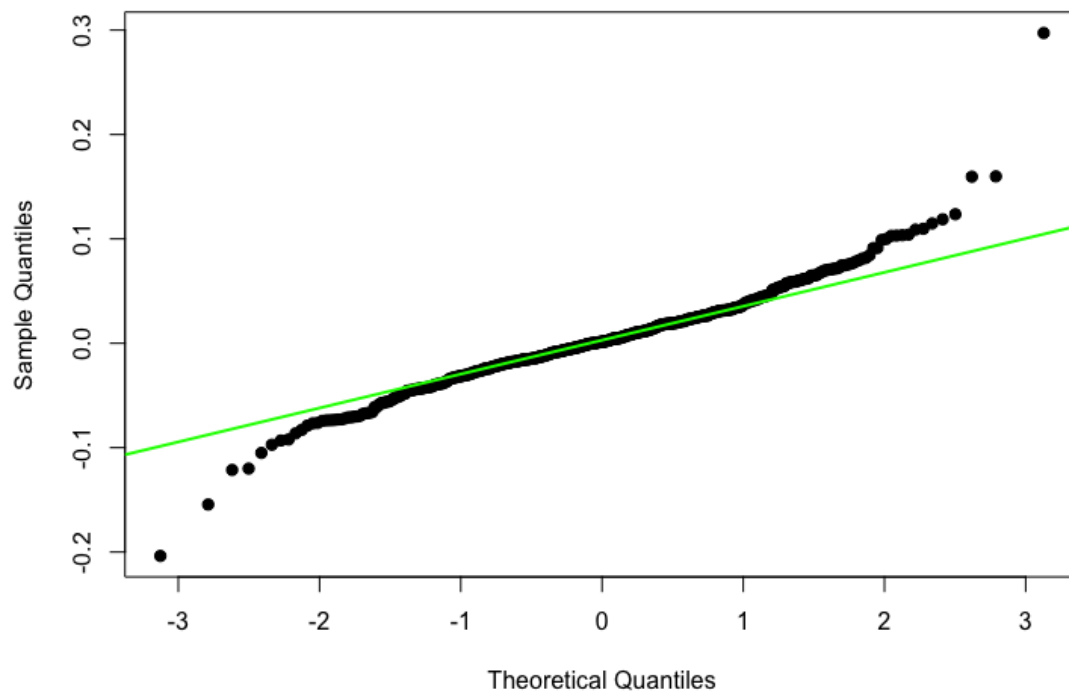
Normality Test Statistics					
	AD	LF	SW	JB	DP
Northam Platinum	2.4176***	0.057561***	0.98107***	57.264***	3.09330***

C.48 Kumba Iron Ore

Histogram of Kumba Iron Ore



Normal Q-Q Plot for Kumba Iron Ore



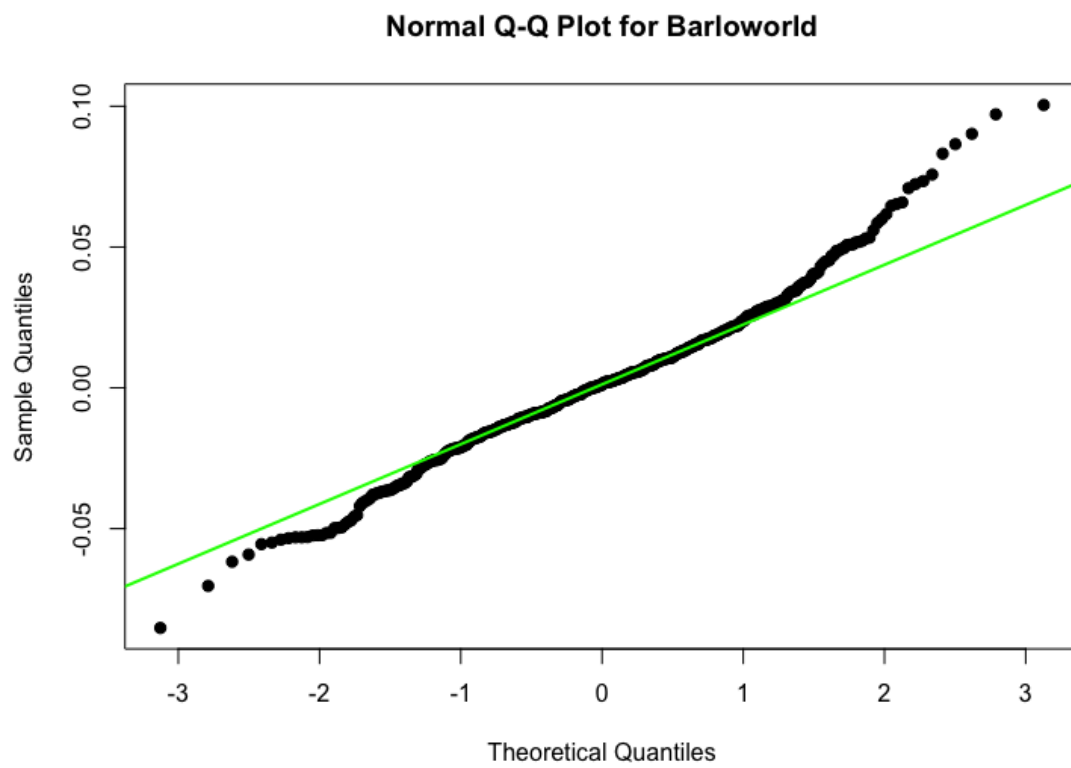
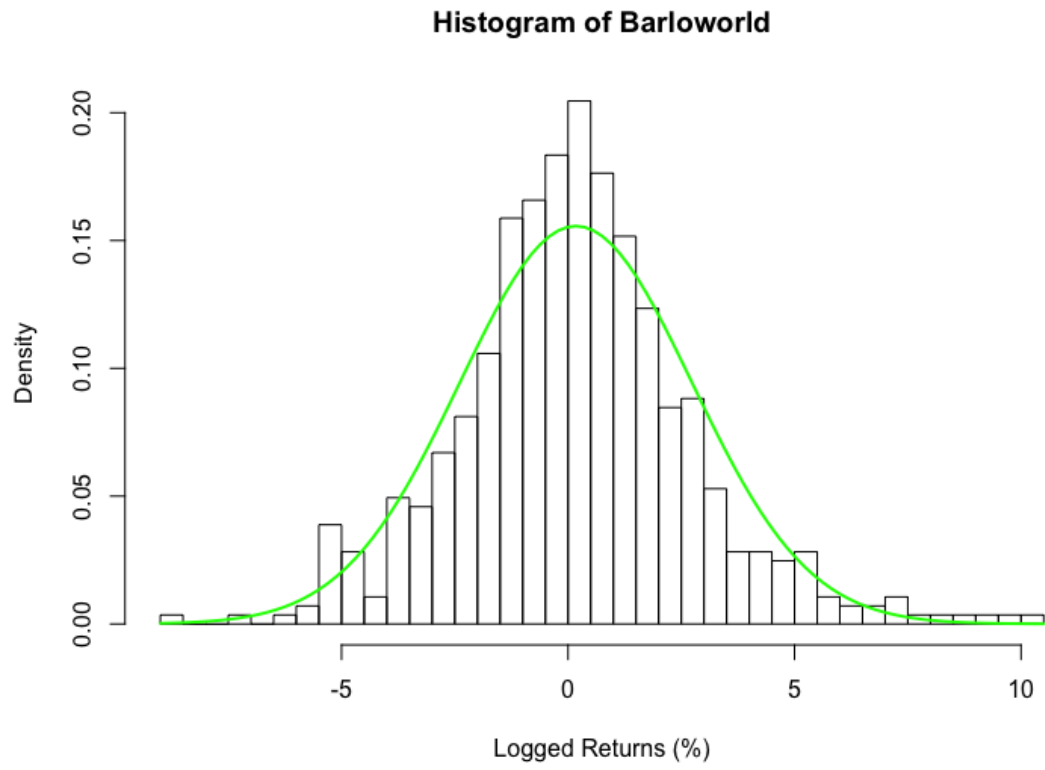
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Kumba Iron Ore	4.2981***	0.069048***	0.95104***	705.47***	4.94100***

C.49 Barloworld



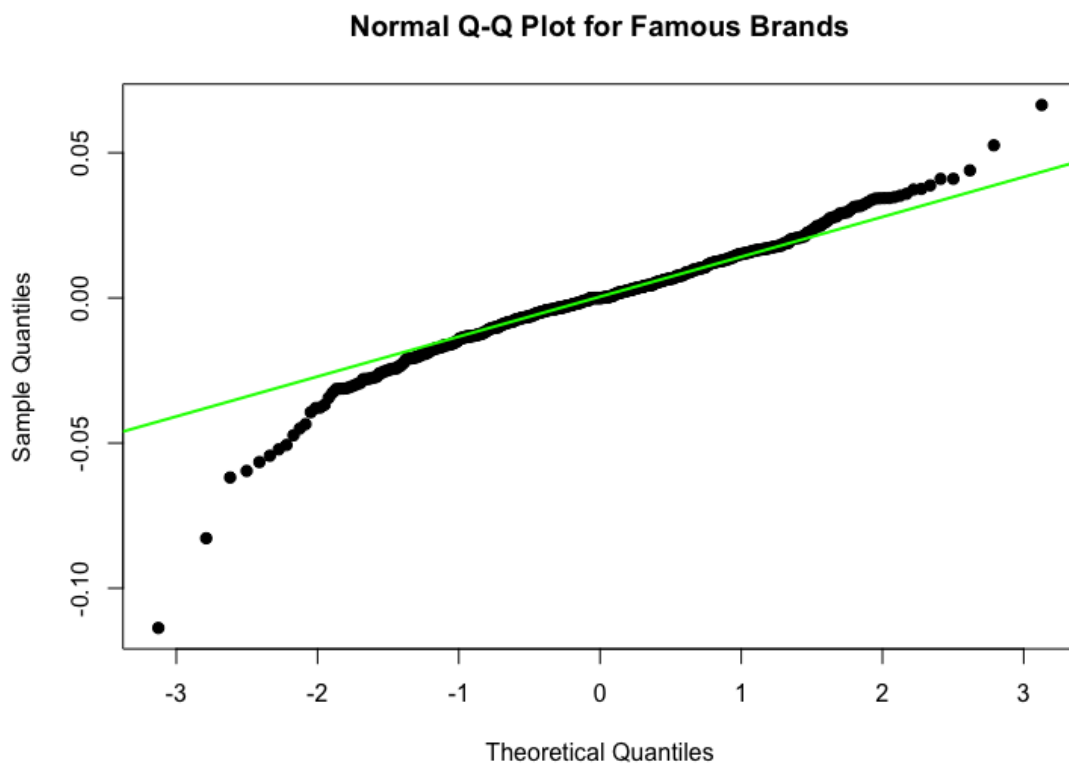
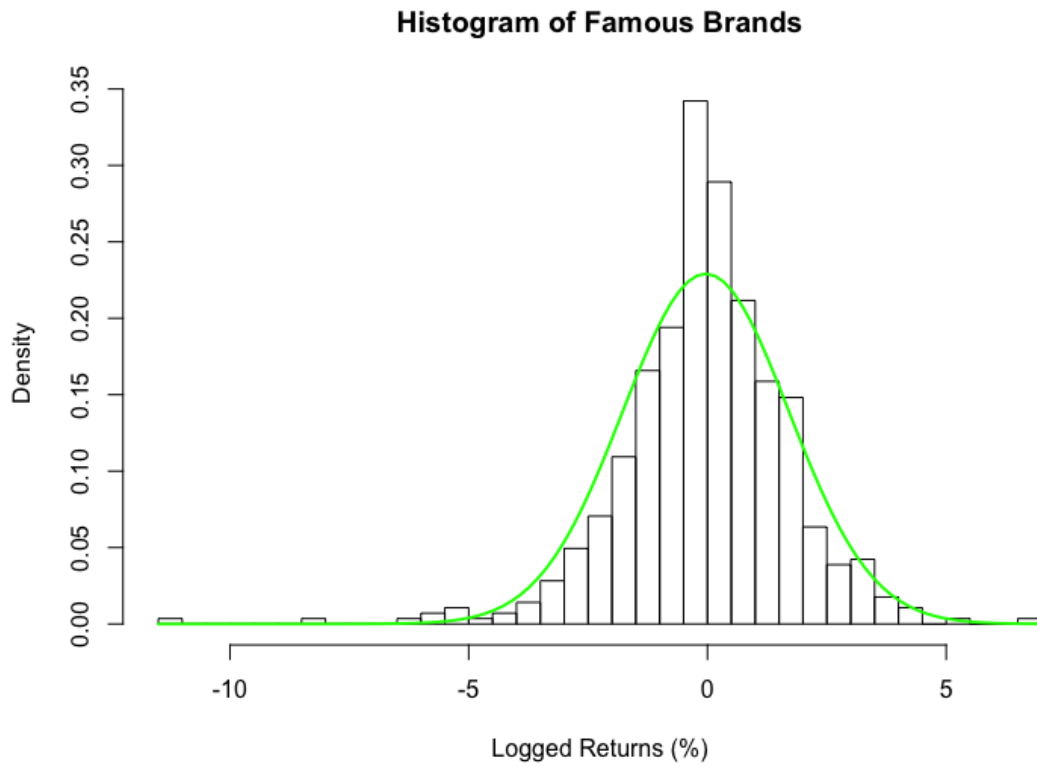
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Barloworld	2.6704***	0.053676***	0.98171***	48.906***	3.35600***

C.50 Famous Brands



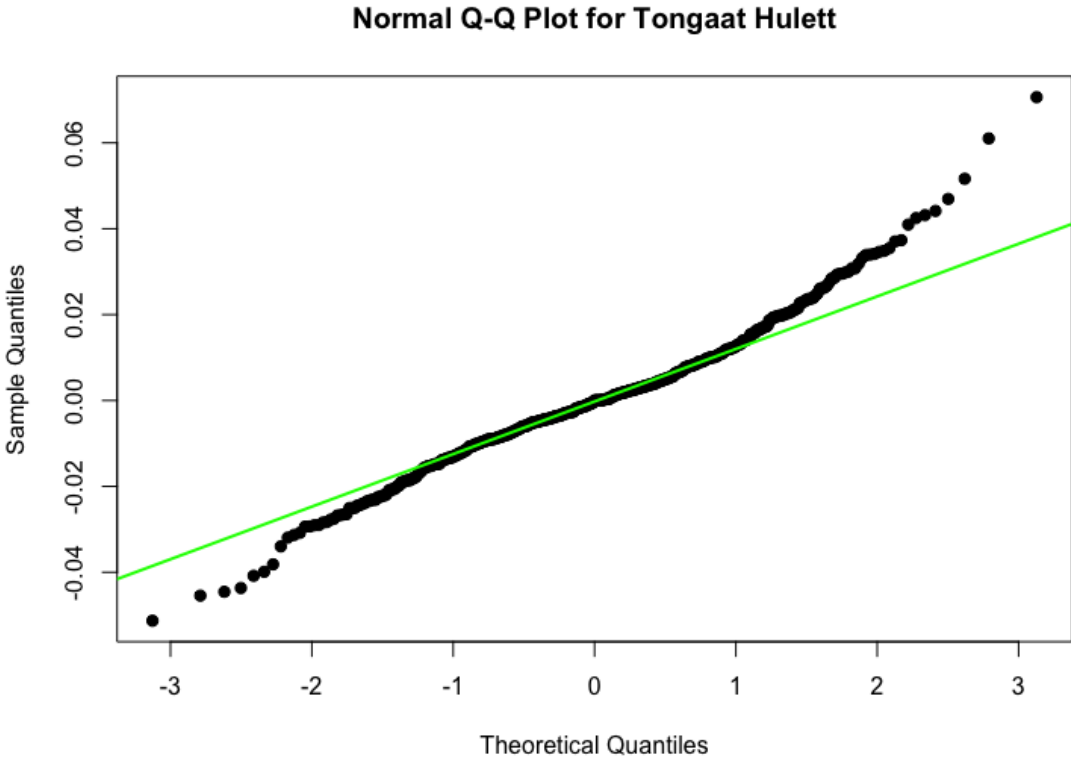
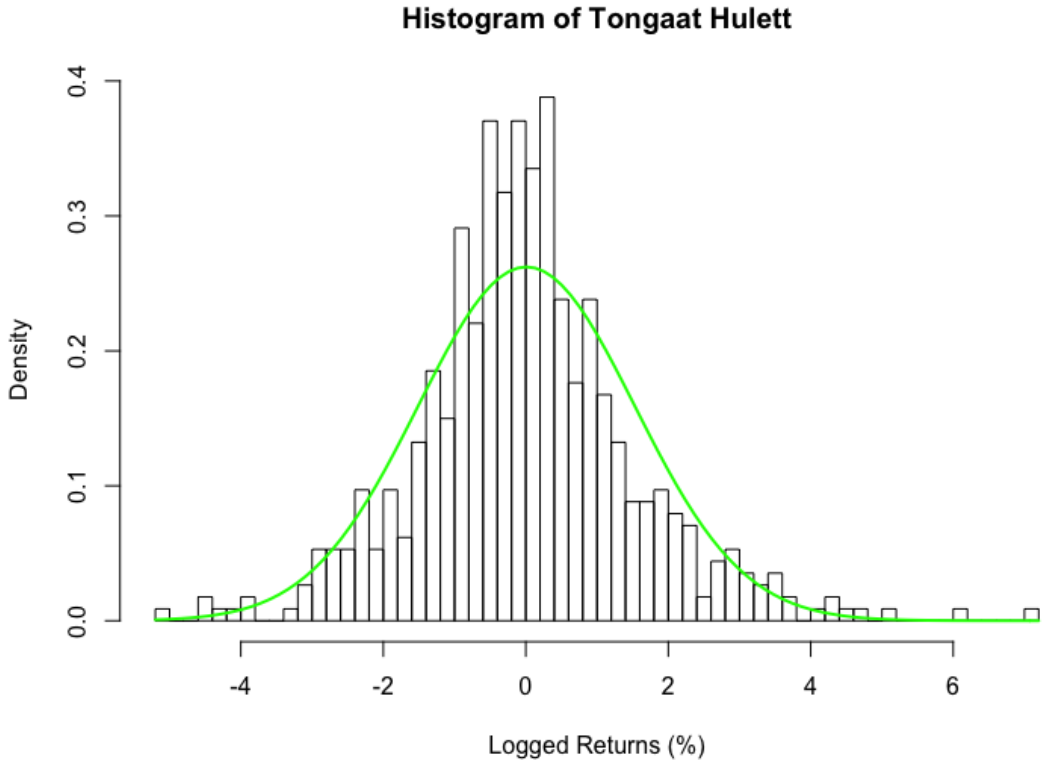
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Famous Brands	4.3227***	0.066902***	0.95201***	552.13***	-6.94570***

C.51 Tongaat Hulett



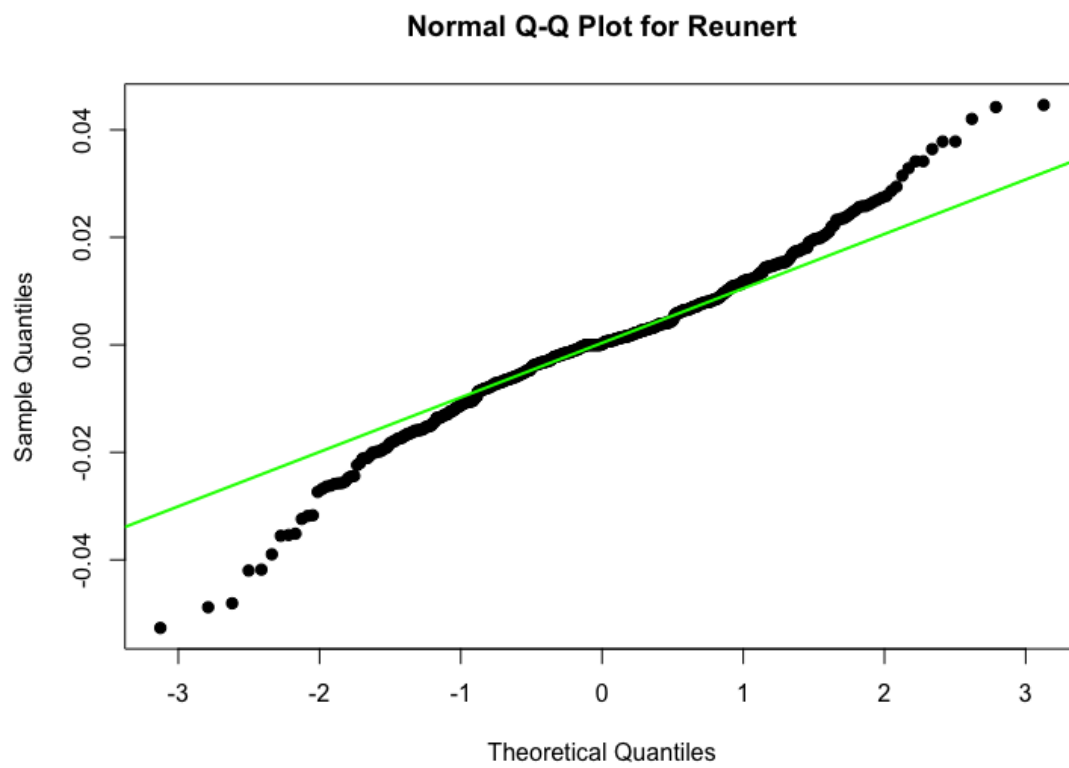
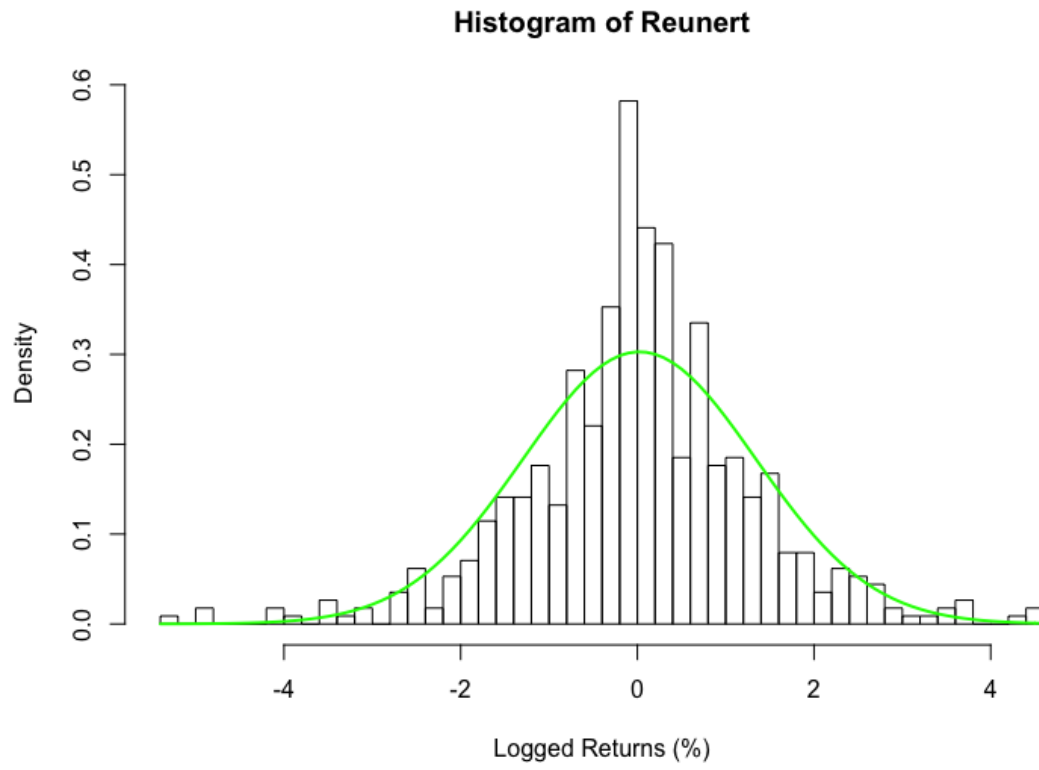
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Tongaat Hulett	3.8693***	0.070453***	0.97585***	88.667***	3.71500***

C.52 Reunert



*p <0.1

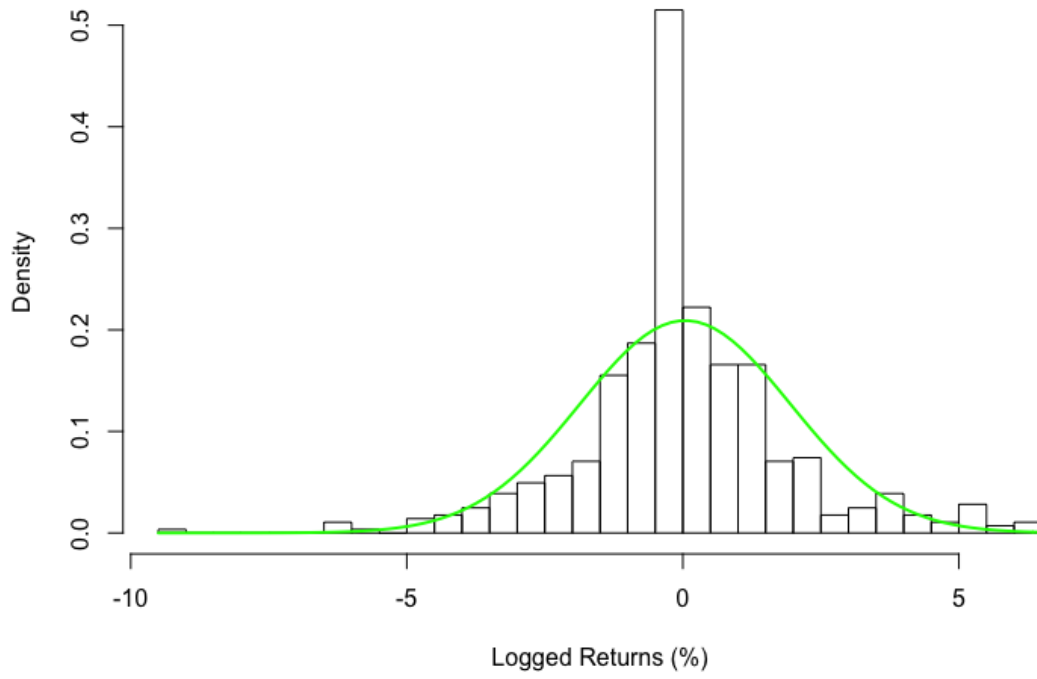
** p <0.05

*** p <0.01

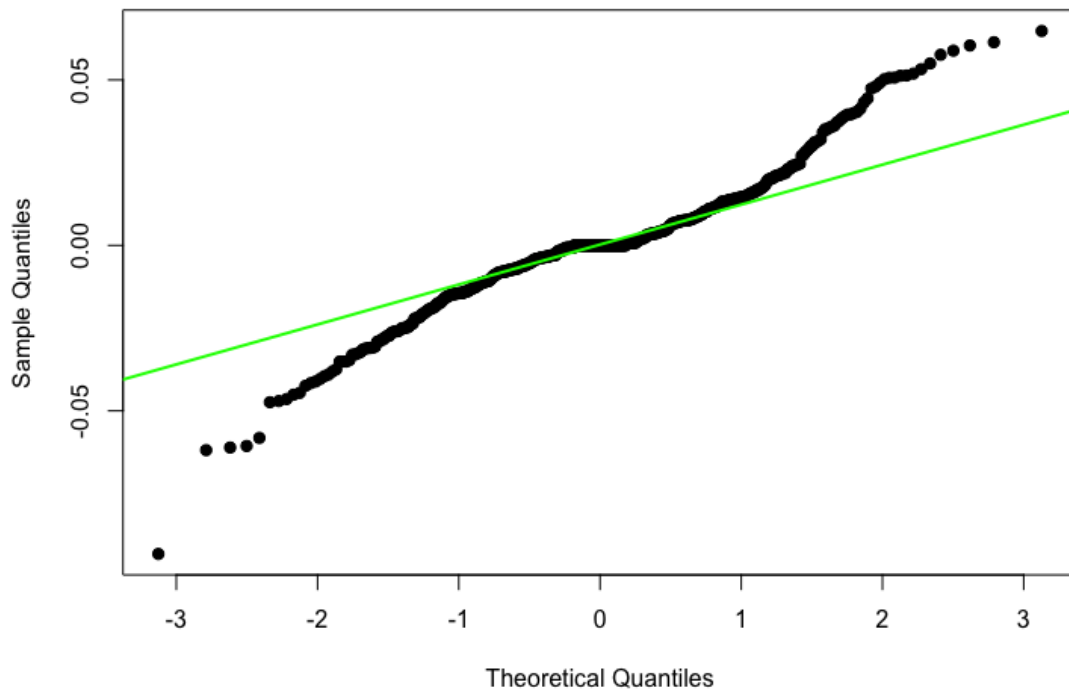
Normality Test Statistics					
	AD	LF	SW	JB	DP
Reunert	4.4186***	0.065955***	0.97423***	73.65***	-1.69270*

C.53 Italtile

Histogram of Italtile



Normal Q-Q Plot for Italtile



*p <0.1

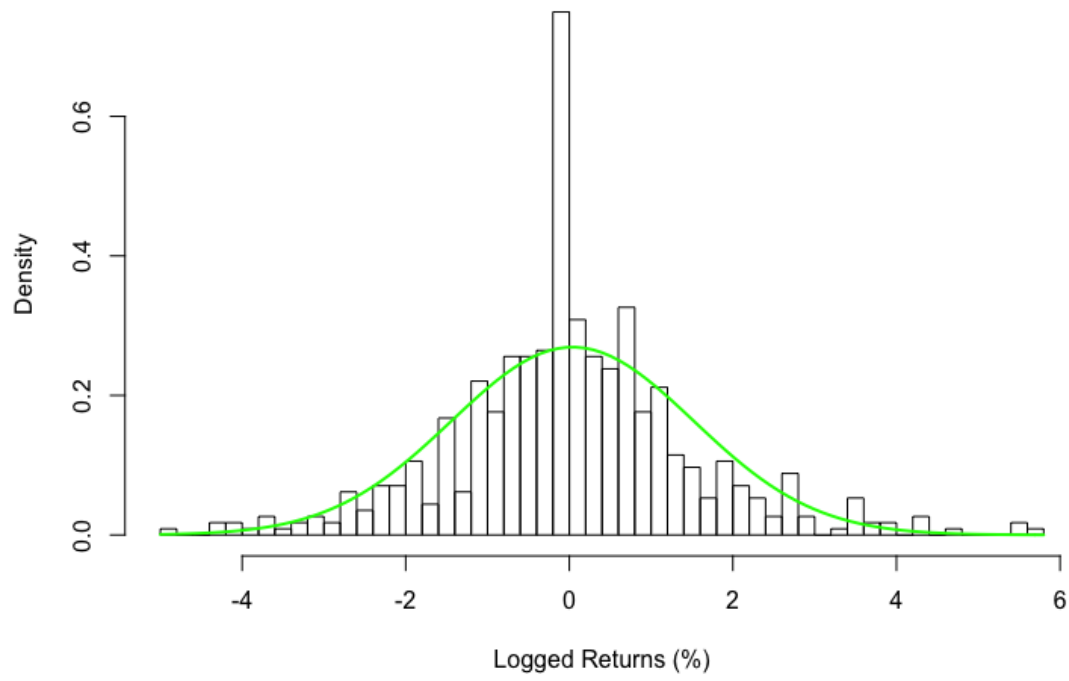
** p <0.05

*** p <0.01

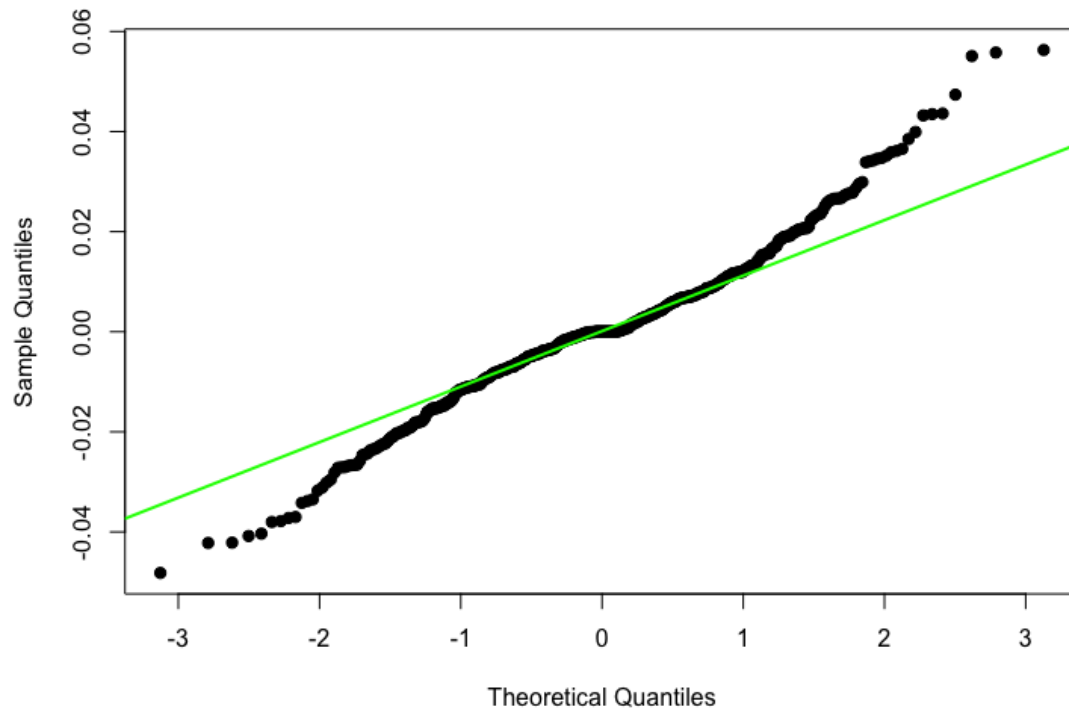
Normality Test Statistics					
	AD	LF	SW	JB	DP
Italtile	10.494***	0.093426***	0.94996***	132.15***	0.390300

C.54 Hosken Consolidated Investments

Histogram of Hosken Consolidated Investments



Normal Q-Q Plot for Hosken Consolidated Investments



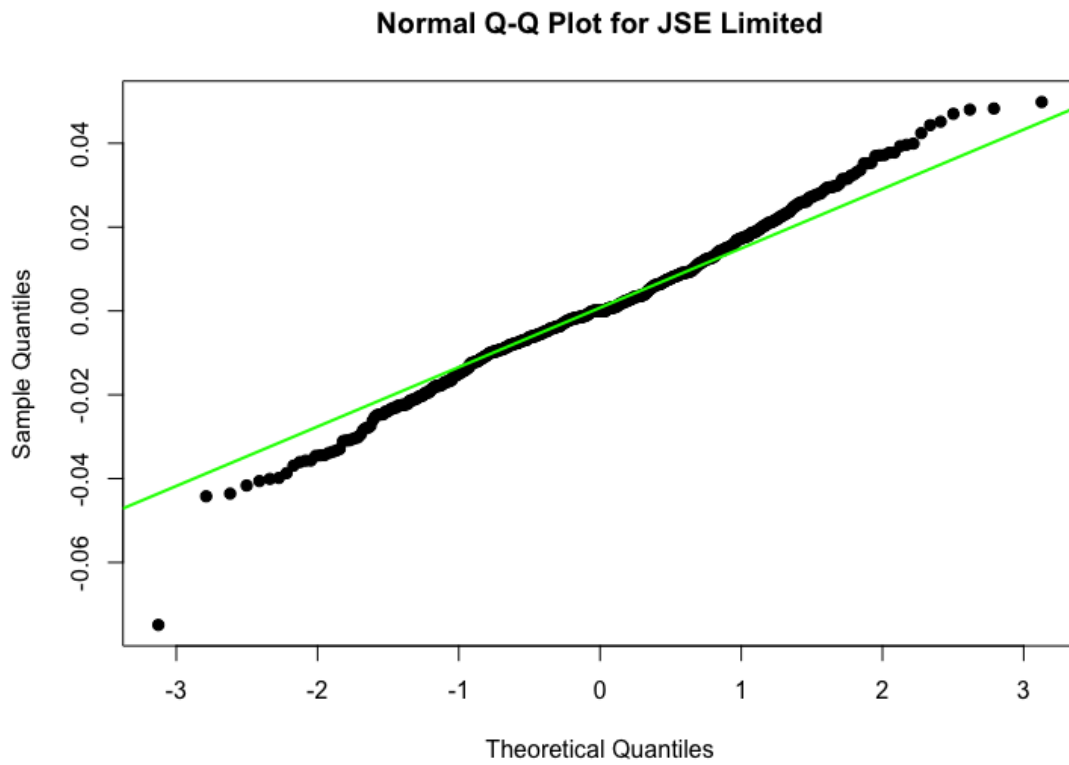
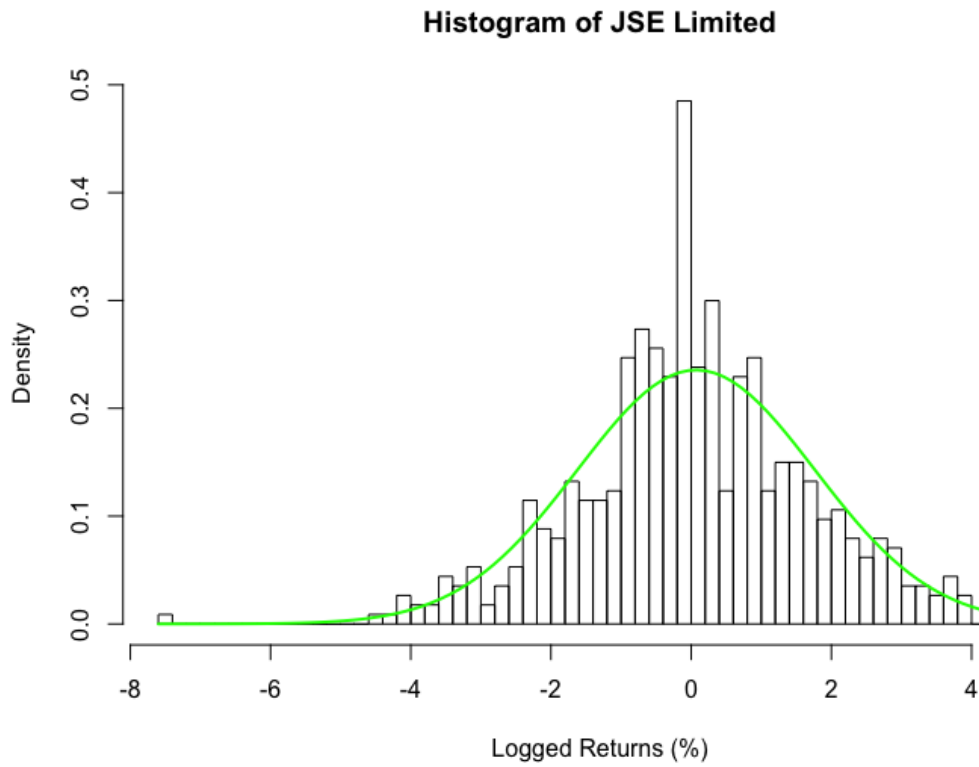
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Hosken Consolidated Investments	5.3041***	0.067934***	0.97272***	61.495***	2.43230**

C.55 JSE Limited



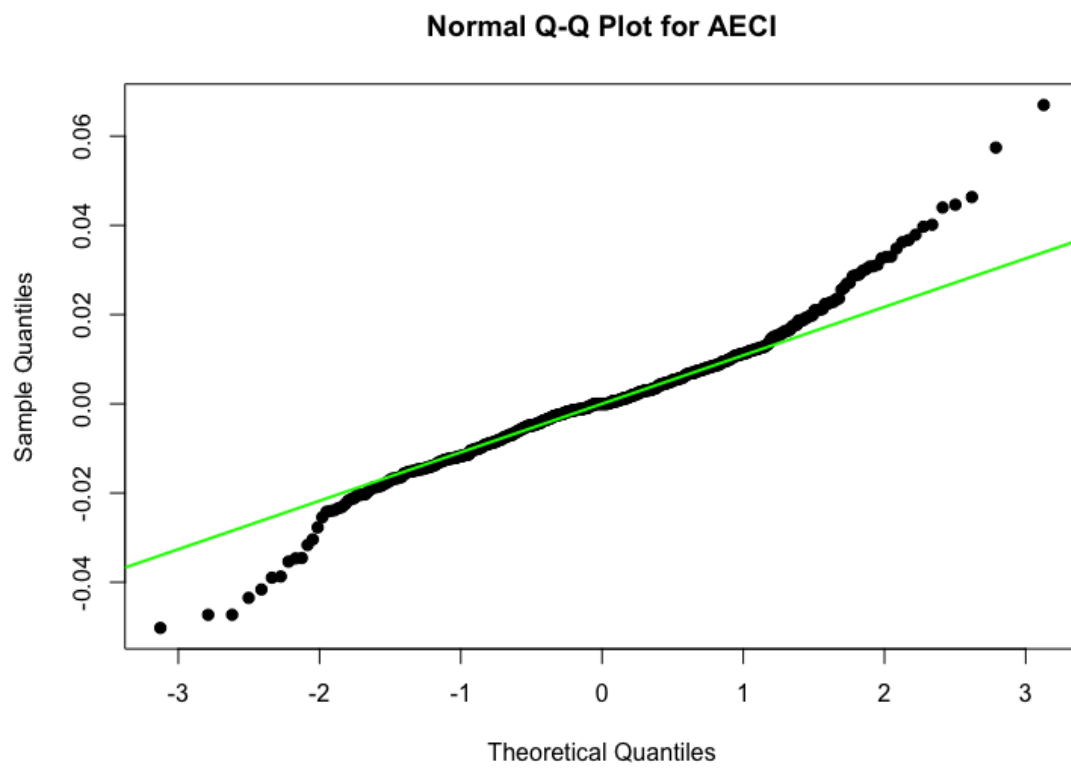
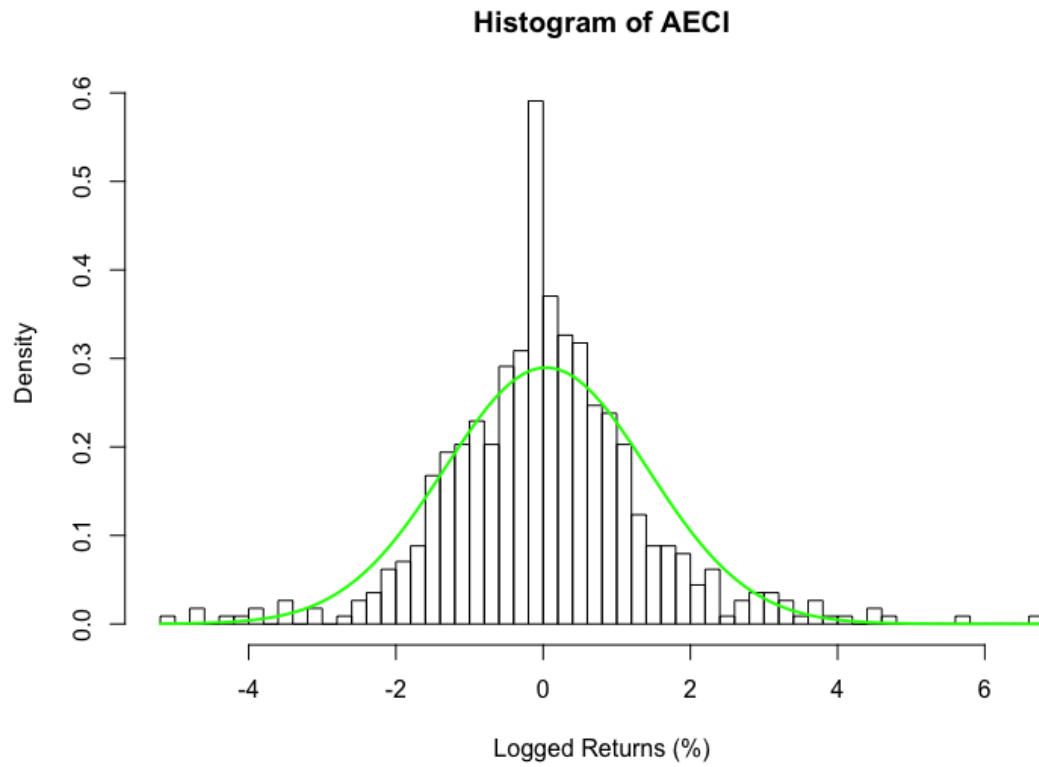
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
JSE Limited	1.6716***	0.049638***	0.99081***	13.431***	-0.255680

C.56 AECI



*p <0.1

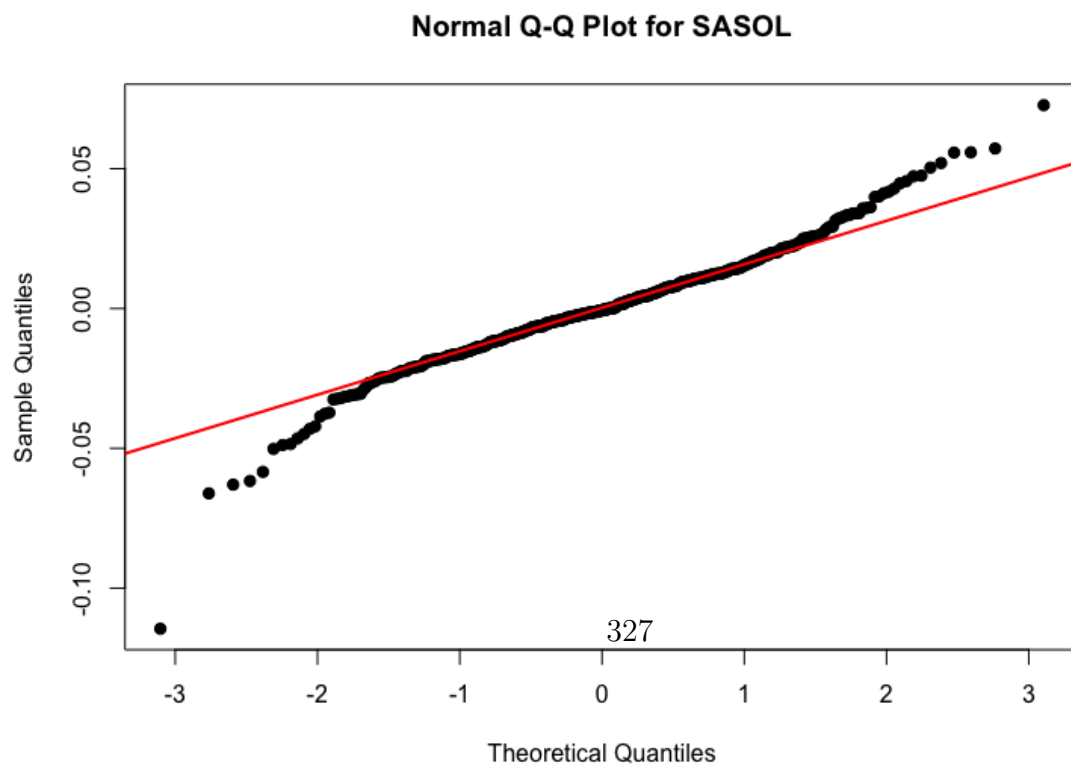
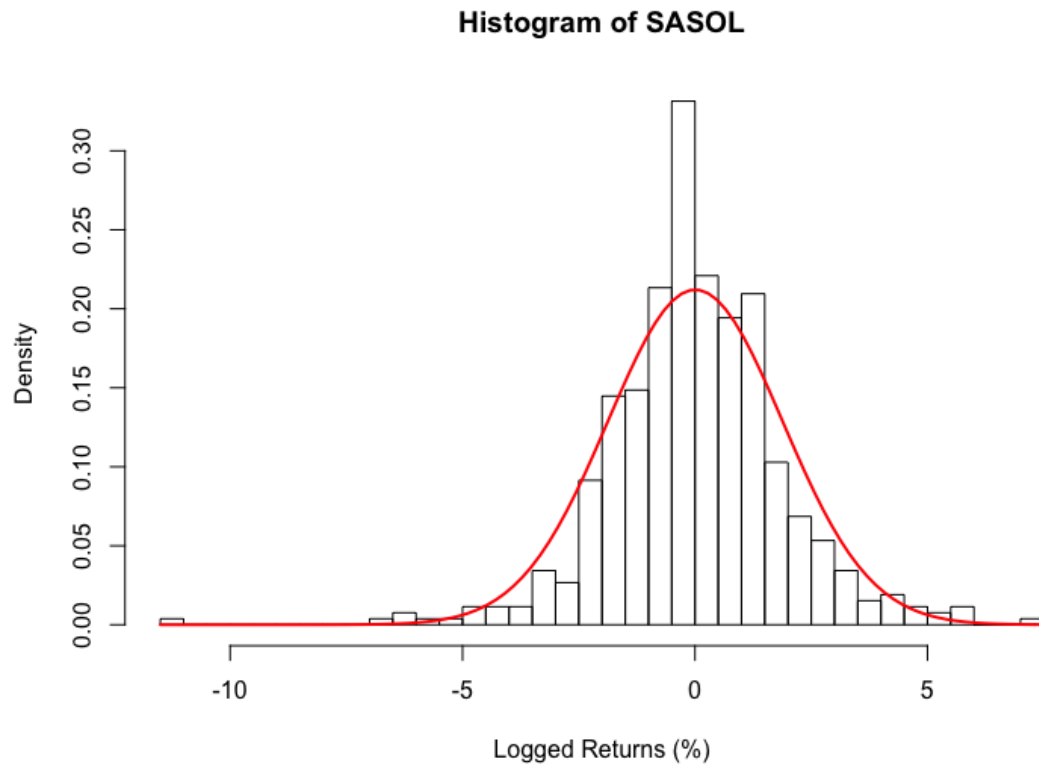
** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
AECI	5.4694***	0.068874***	0.96073***	176.08***	3.05920***

D Empirical Results after the removal of Red Letter Days

D.1 SASOL



*p <0.1

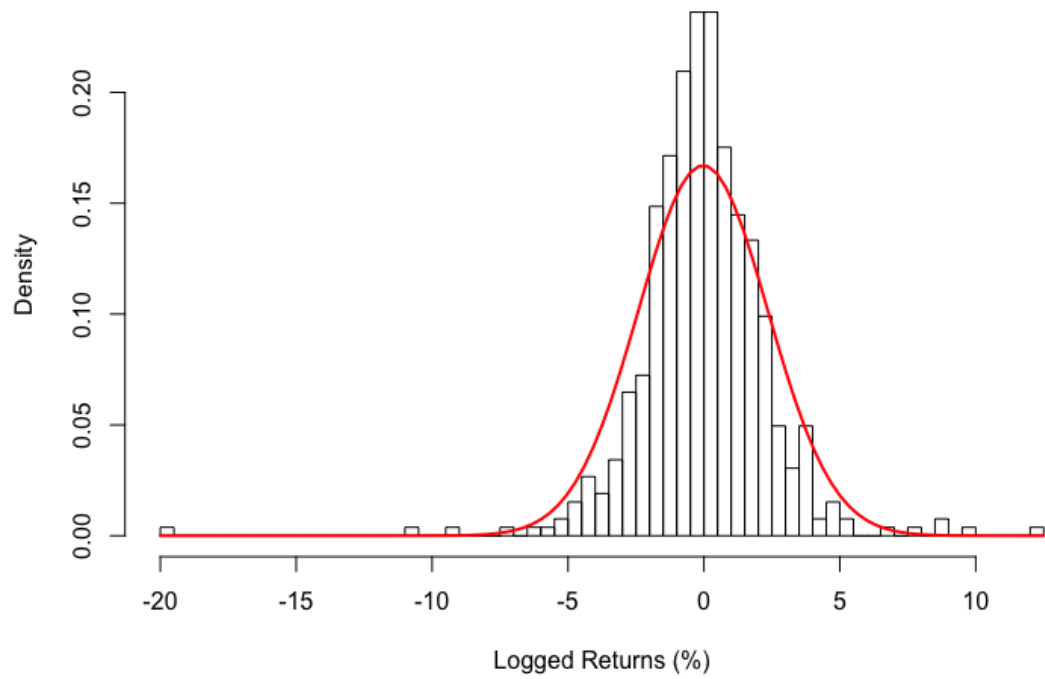
** p <0.05

*** p <0.01

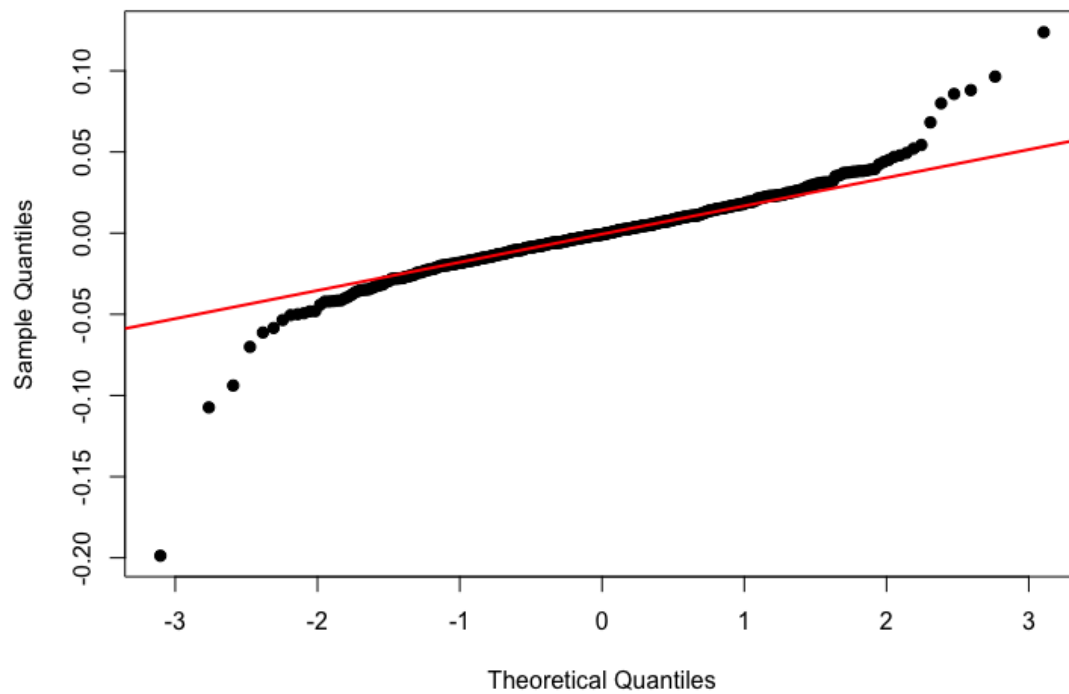
Normality Test Statistics					
	AD	LF	SW	JB	DP
SASOL	3.3123***	0.055906***	0.96276***	293.88***	-3.21690***

D.2 MTN Group

Histogram of MTN Group



Normal Q-Q Plot for MTN Group



*p <0.1

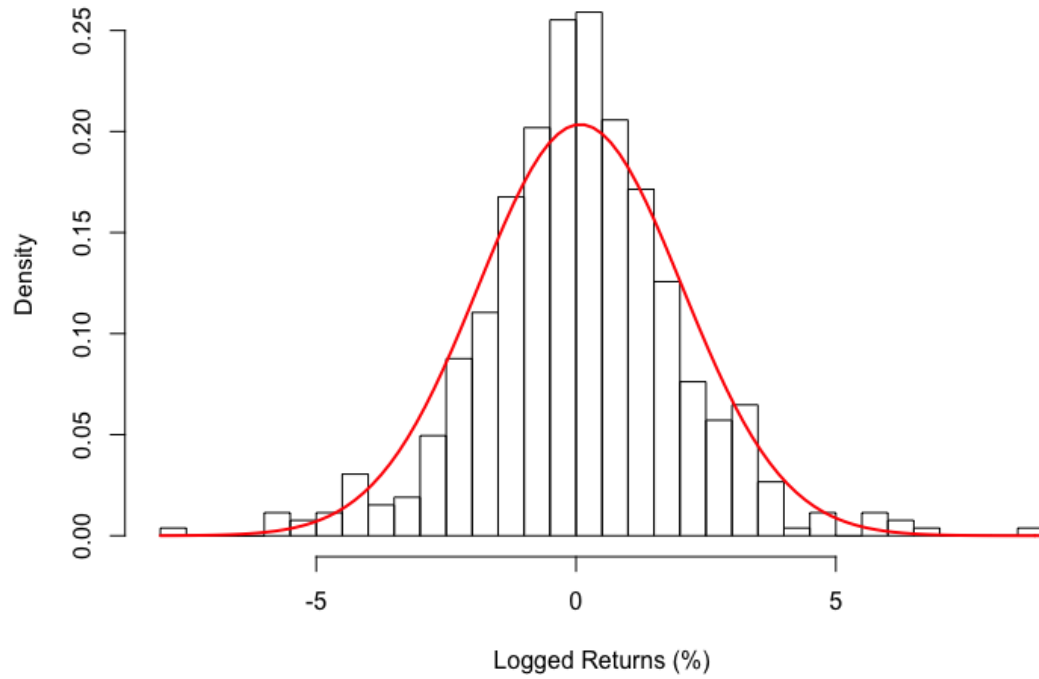
** p <0.05

*** p <0.01

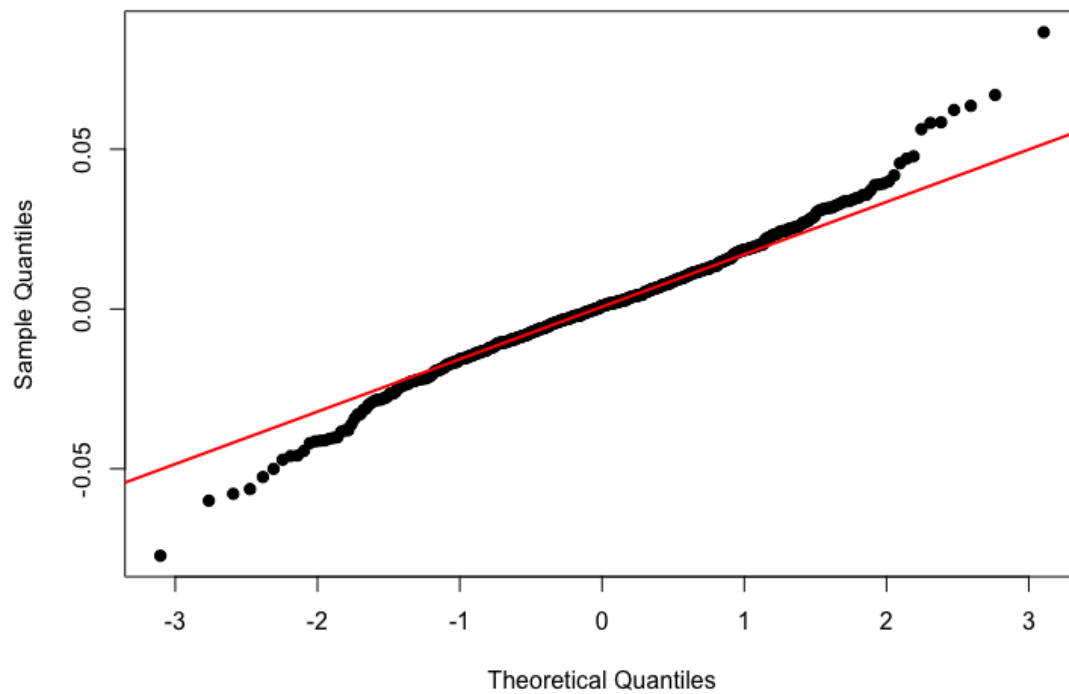
Normality Test Statistics					
	AD	LF	SW	JB	DP
MTN Group	6.8965***	0.075941***	0.89797***	3066.5***	-6.59920***

D.3 FirstRand Group

Histogram of FirstRand Group



Normal Q-Q Plot for FirstRand Group



*p <0.1

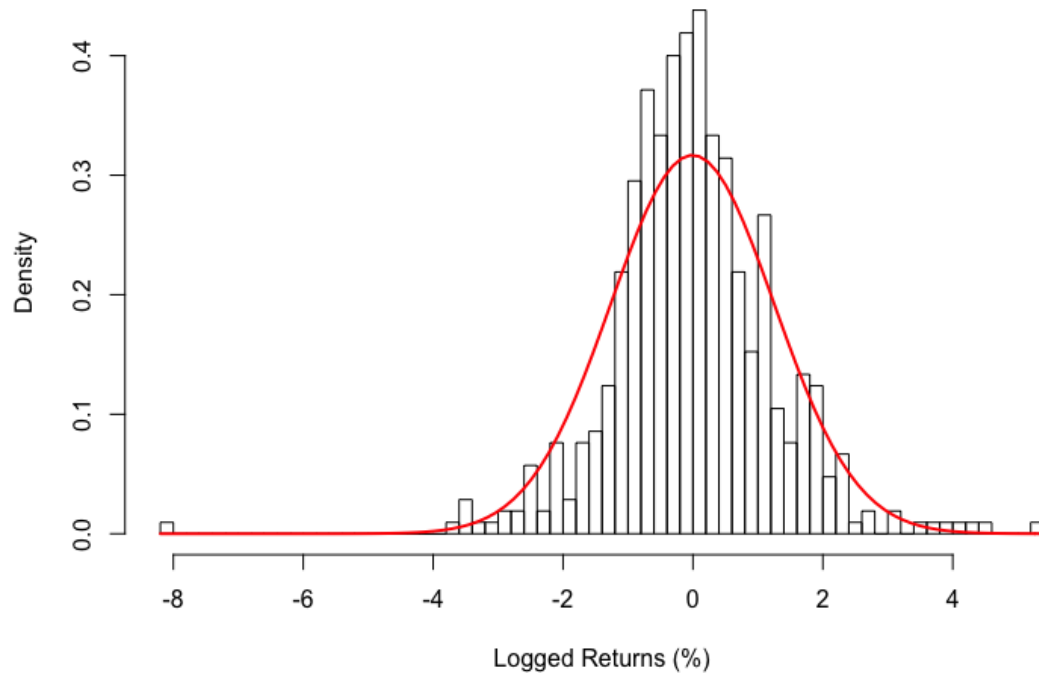
** p <0.05

*** p <0.01

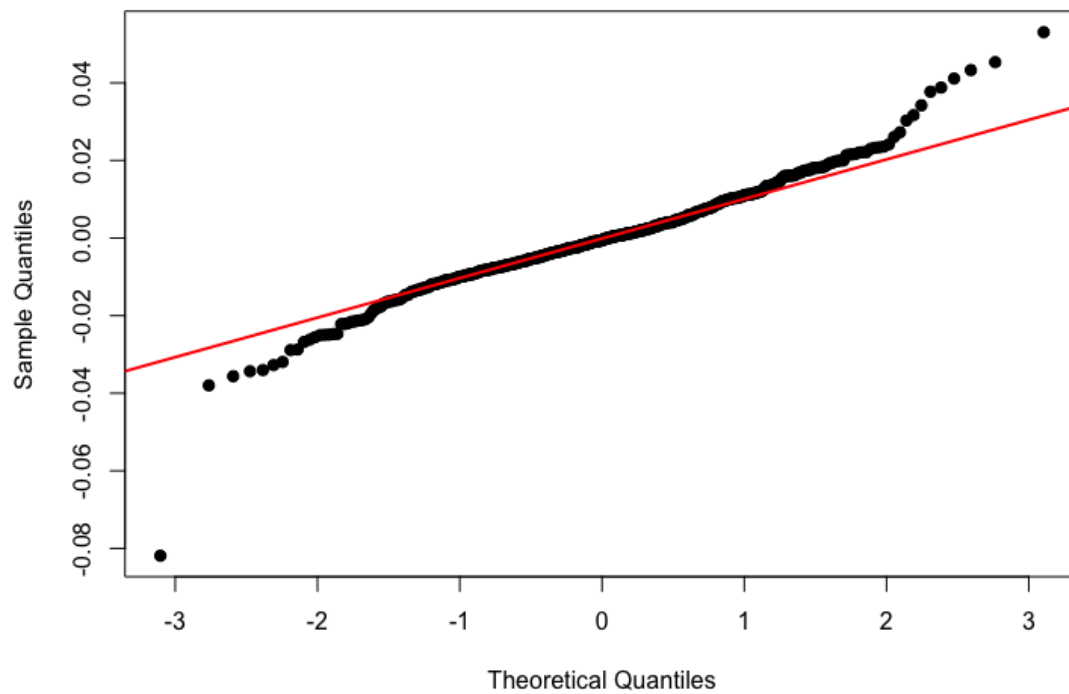
Normality Test Statistics					
	AD	LF	SW	JB	DP
FirstRand Group	2.2632***	0.048519***	0.98179***	62.14***	0.83130

D.4 Vodacom Group

Histogram of Vodacom Group



Normal Q-Q Plot for Vodacom Group



*p <0.1

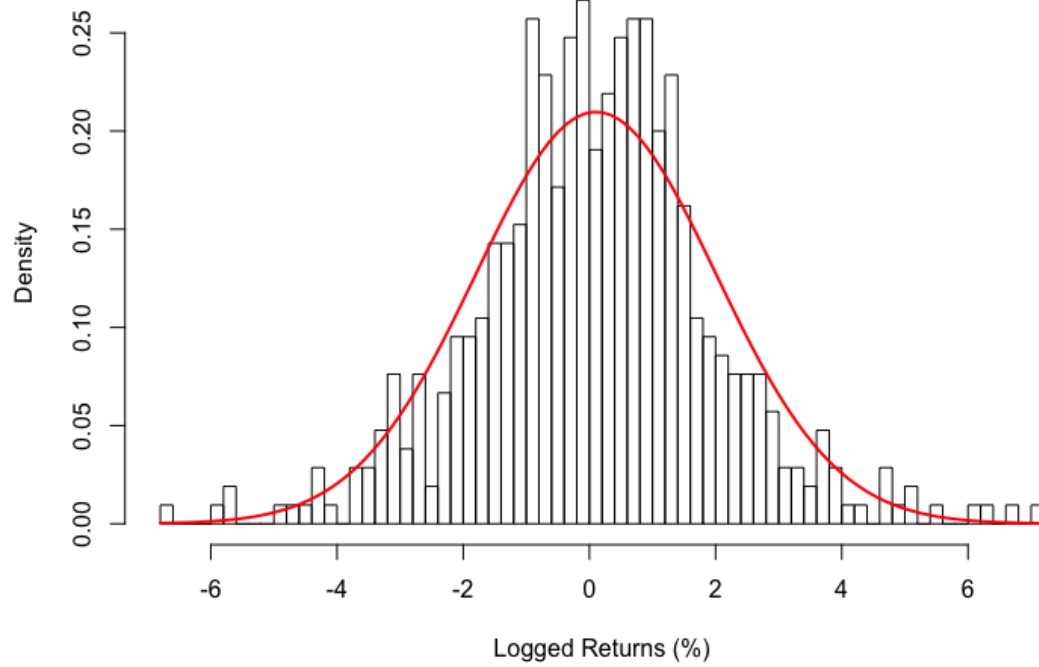
** p <0.05

*** p <0.01

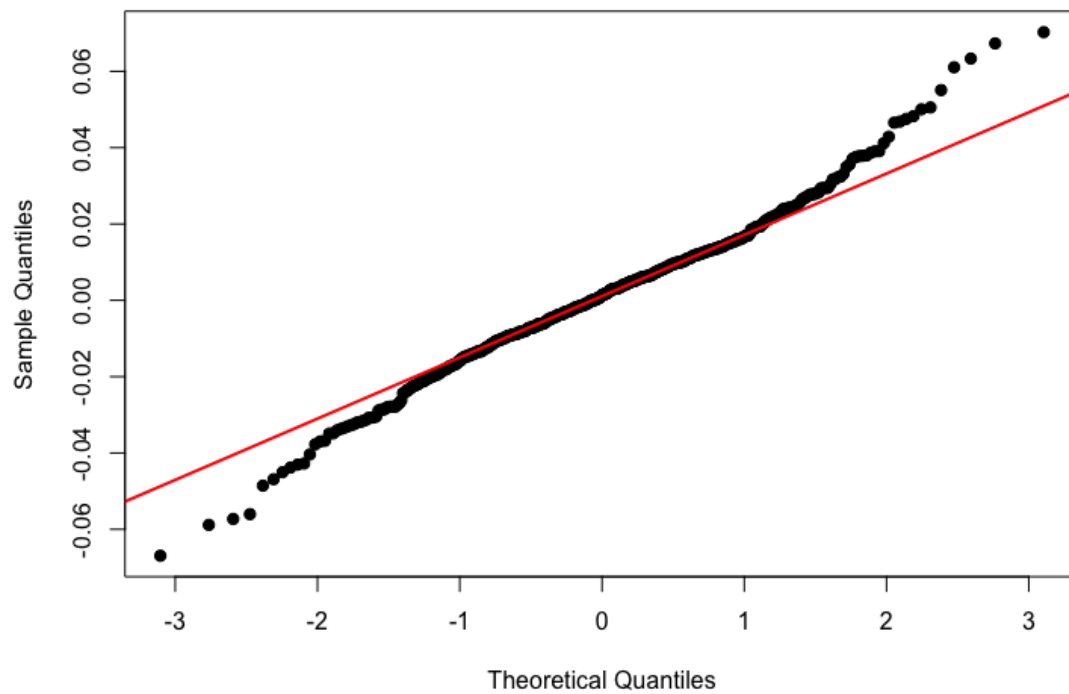
Normality Test Statistics					
	AD	LF	SW	JB	DP
Vodacom Group	3.7003***	0.062281***	0.95689***	426.19***	-1.7274*

D.5 Standard Bank Group

Histogram of Standard Bank Group



Normal Q-Q Plot for Standard Bank Group



		Normality Test Statistics				
		AD	LF	SW	JB	DP
Standard Group	Bank	1.8116***	0.051232***	0.98658***	31.443***	0.683240

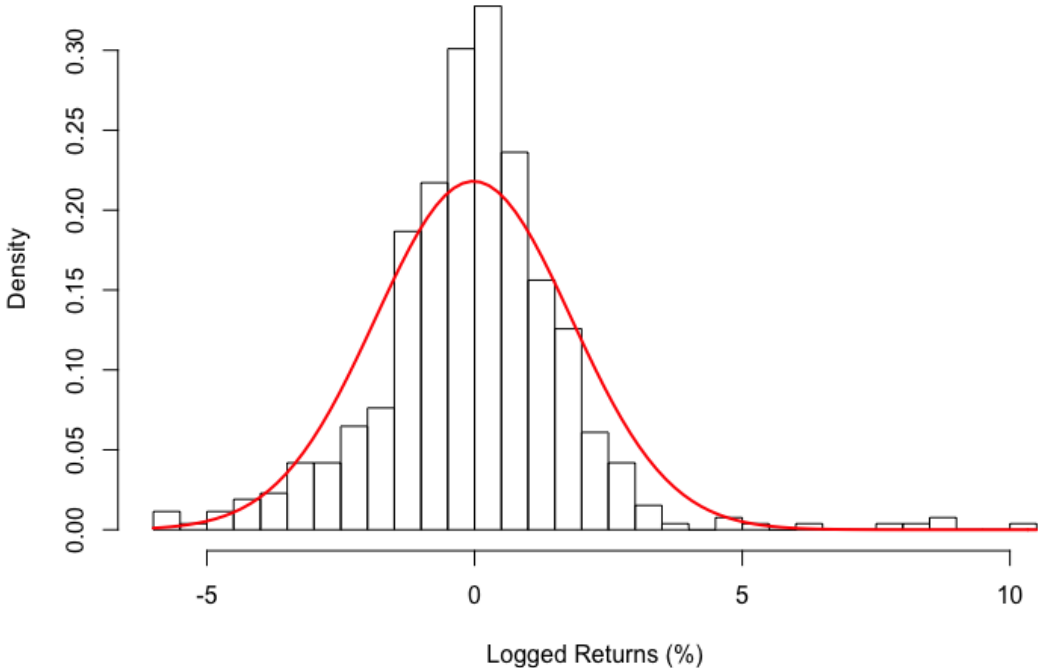
*p <0.1

** p <0.05

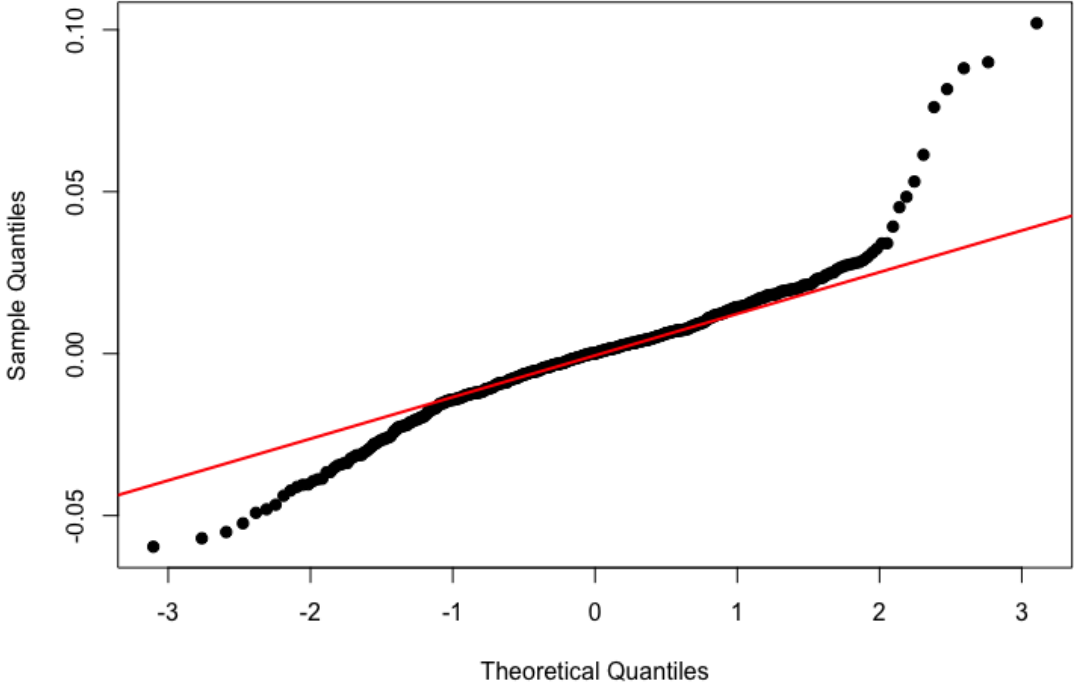
*** p <0.01

D.6 Aspen Pharmacare

Histogram of Aspen Pharmacare



Normal Q-Q Plot for Aspen Pharmacare



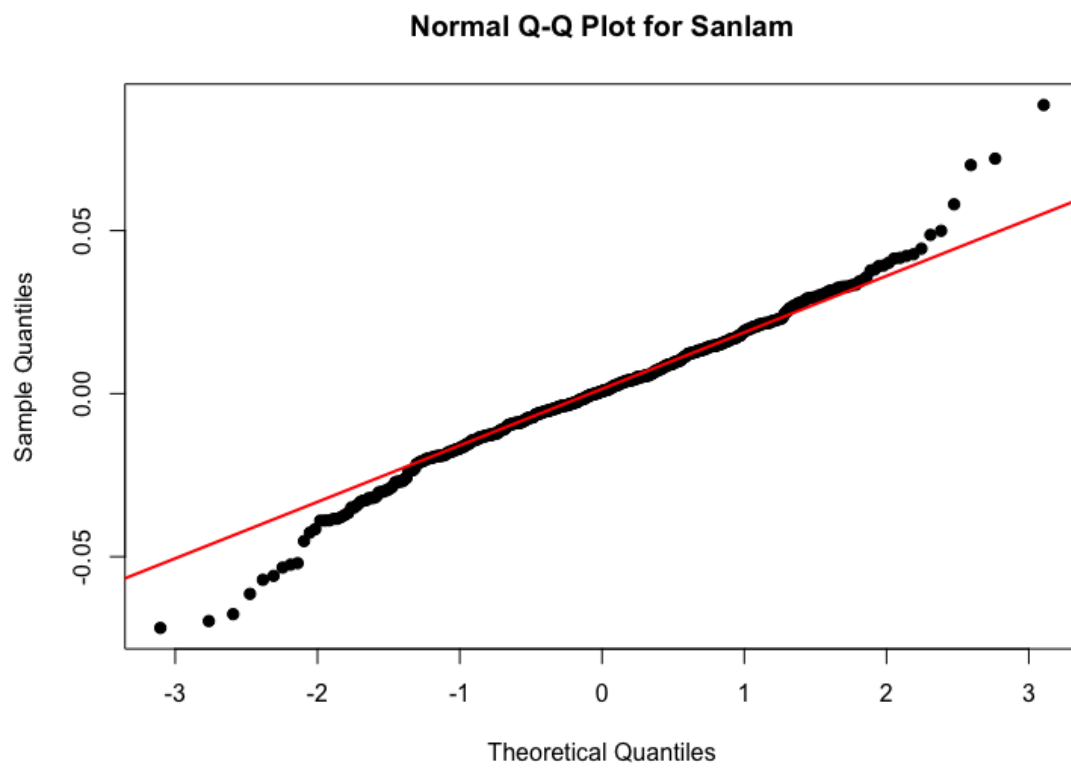
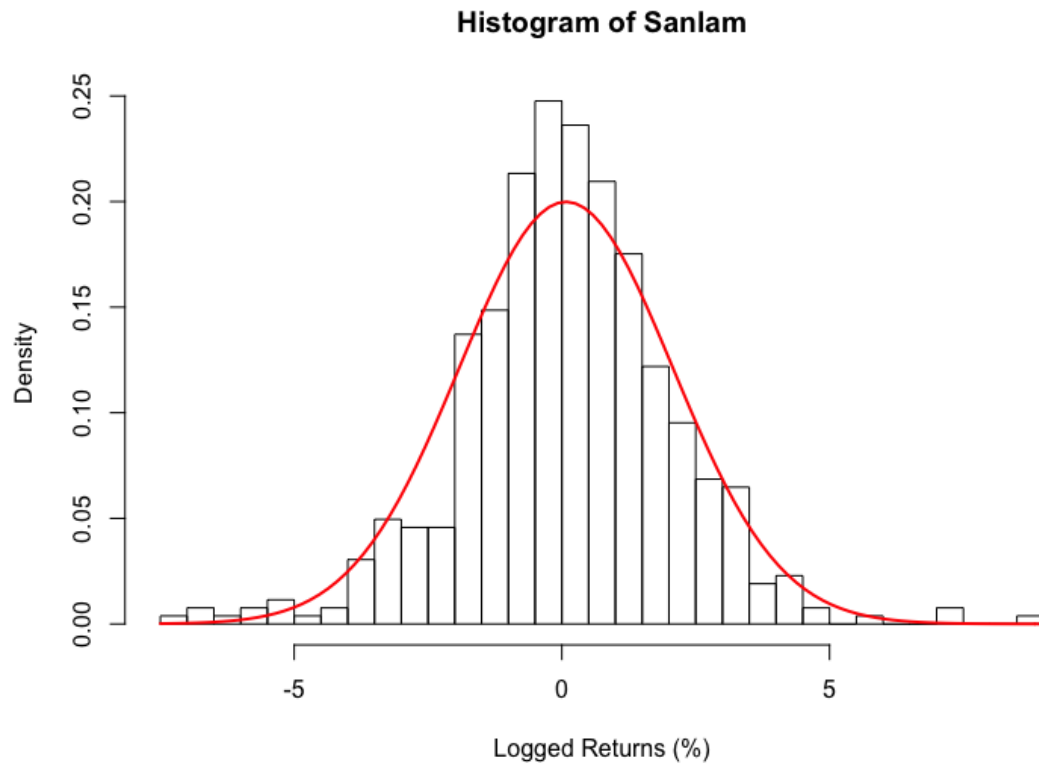
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Aspen Pharmacare	6.7751***	0.077799***	0.92634***	626.08***	6.29260***

D.7 Sanlam



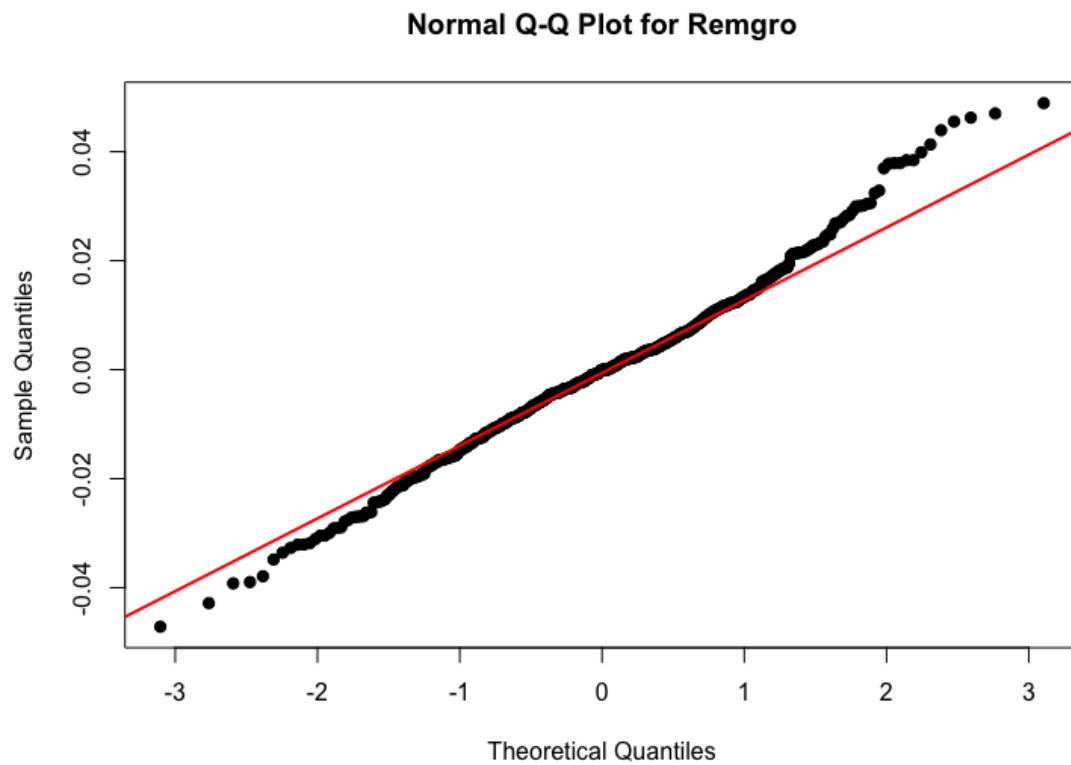
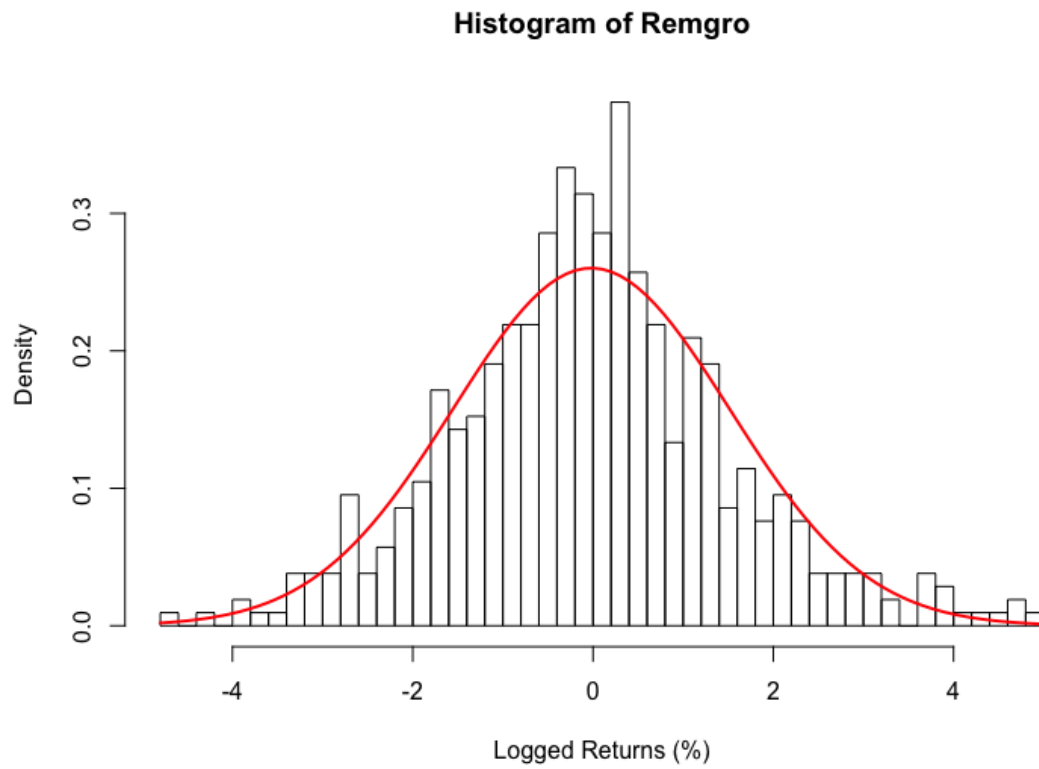
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Sanlam	1.9222***	0.046457***	0.98124***	64.25***	-0.622410*

D.8 Remgro



*p <0.1

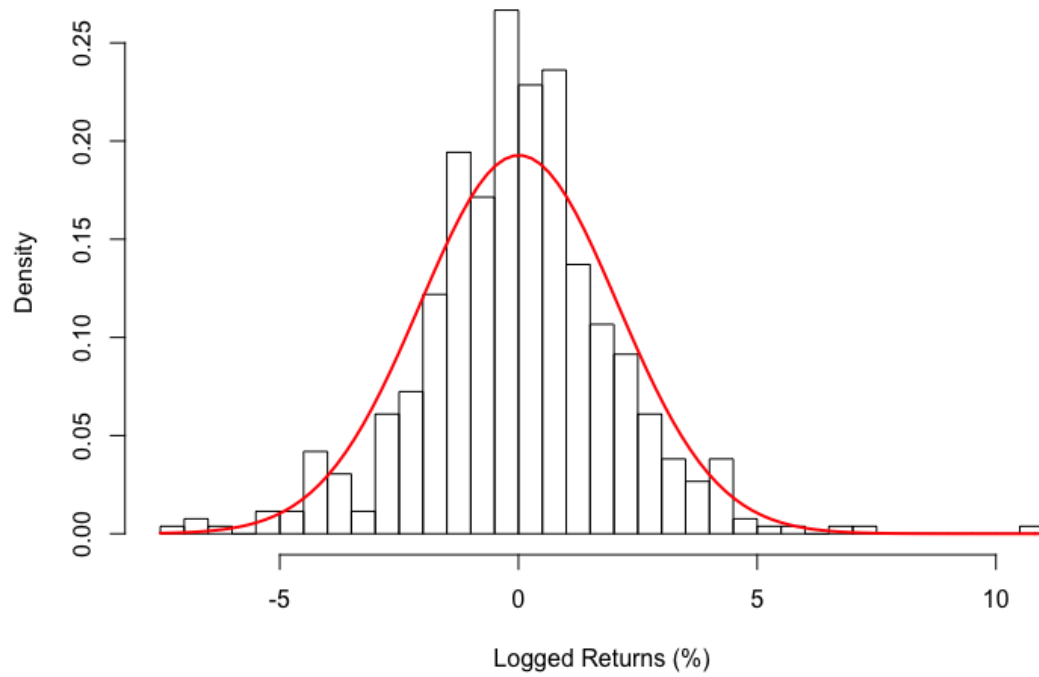
** p <0.05

*** p <0.01

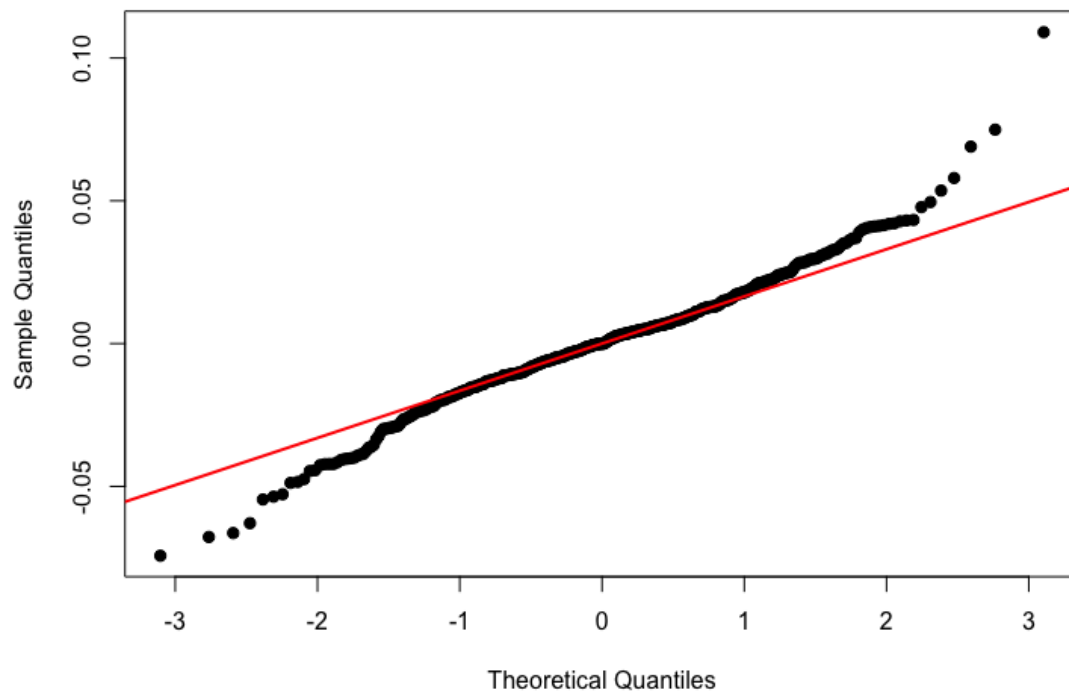
Normality Test Statistics					
	AD	LF	SW	JB	DP
Remgro	1.4097***	0.046616***	0.99084***	11.647***	2.03000**

D.9 ABSA Group

Histogram of ABSA Group



Normal Q-Q Plot for ABSA Group



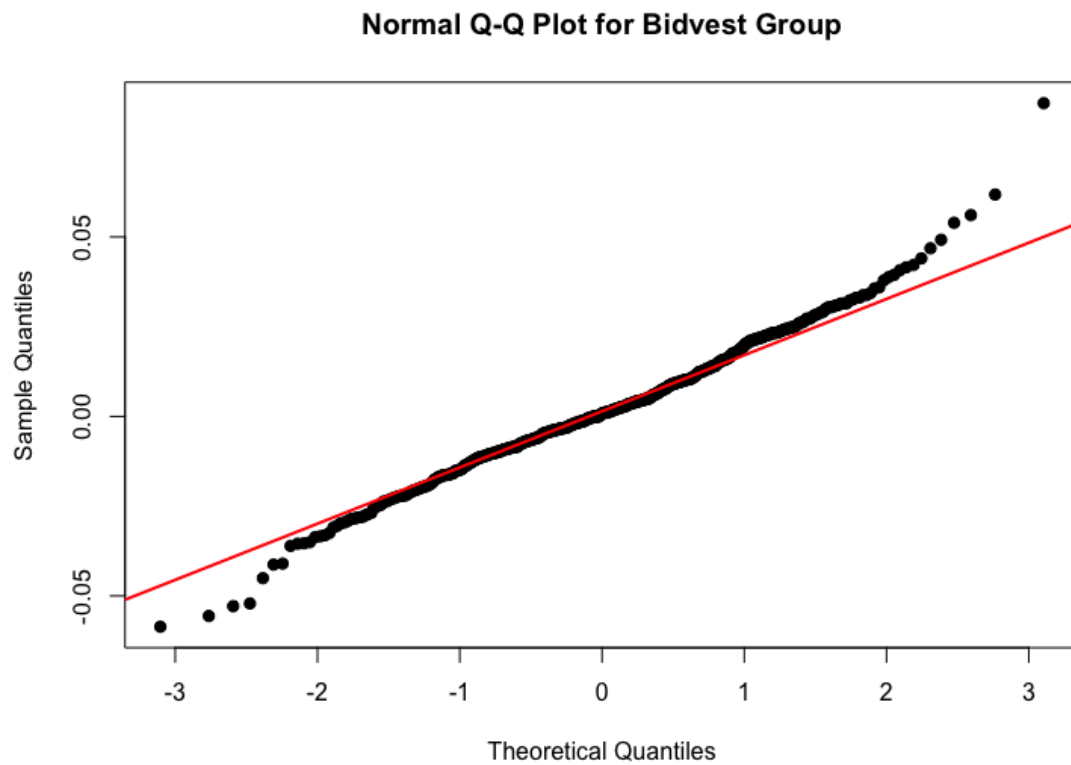
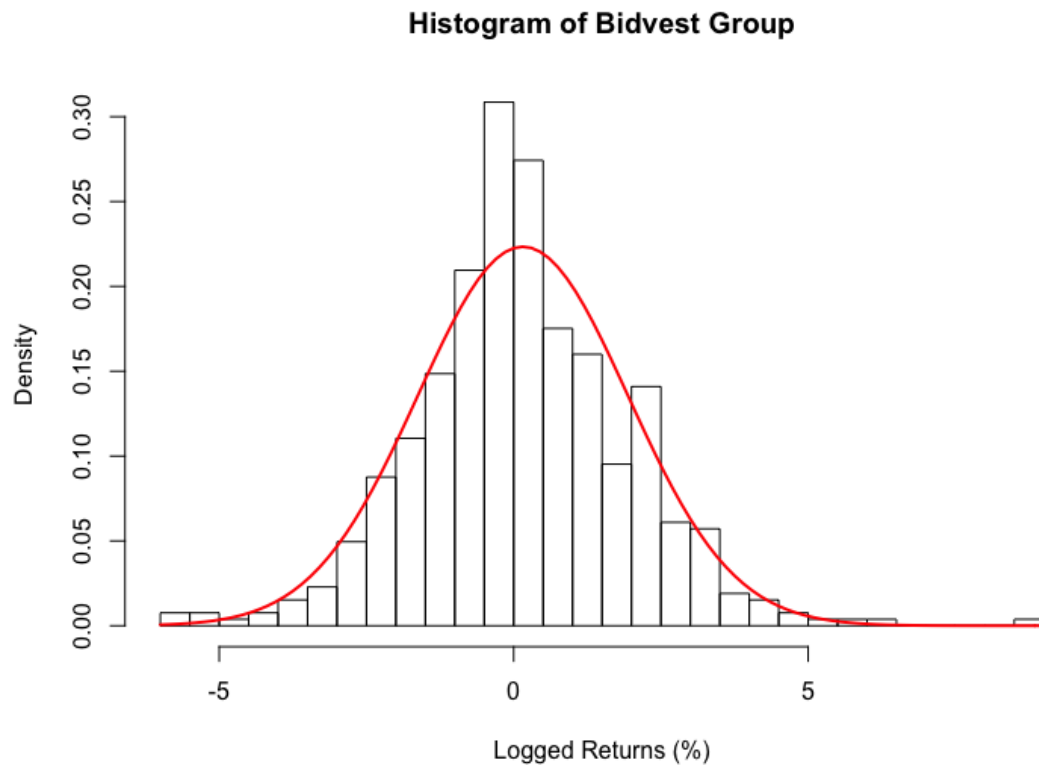
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
ABSA Group	2.7821***	0.054616***	0.97609***	110.67***	1.21350

D.10 Bidvest Group



*p <0.1

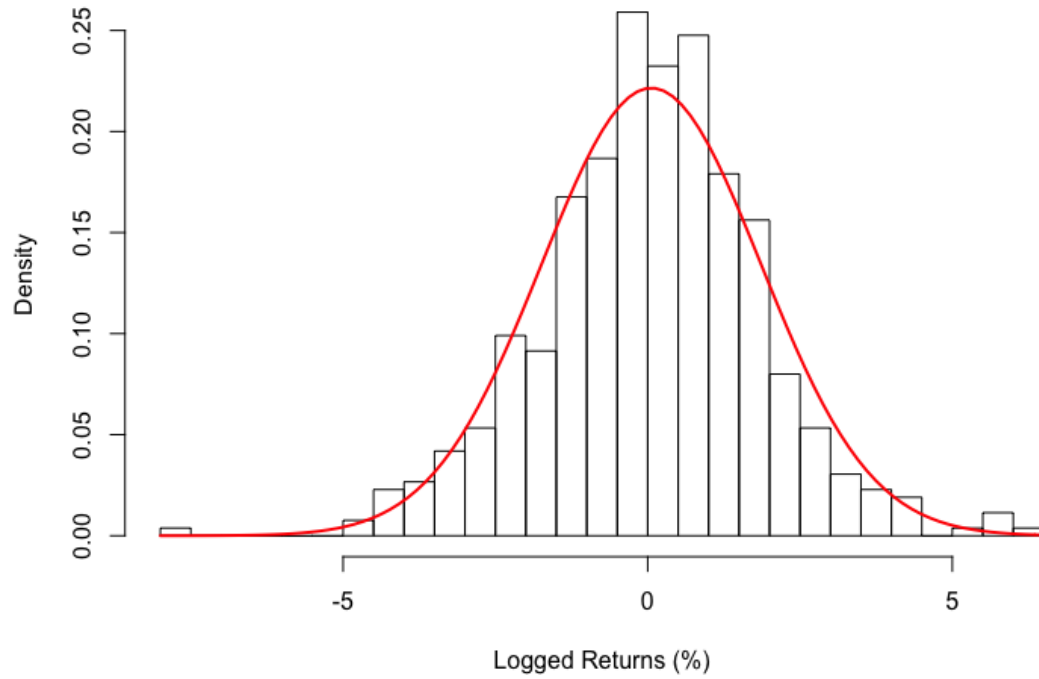
** p <0.05

*** p <0.01

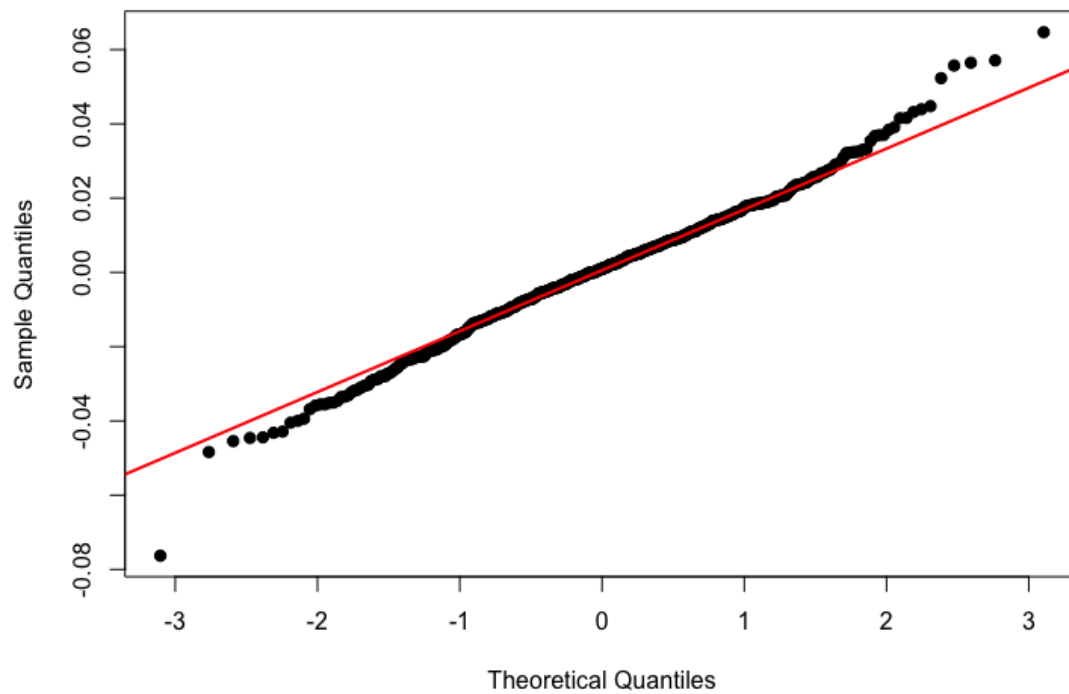
Normality Test Statistics					
	AD	LF	SW	JB	DP
Bidvest Group	1.5122***	0.054573***	0.98683***	45.947***	2.11610**

D.11 Nedbank Group

Histogram of Nedbank Group



Normal Q-Q Plot for Nedbank Group



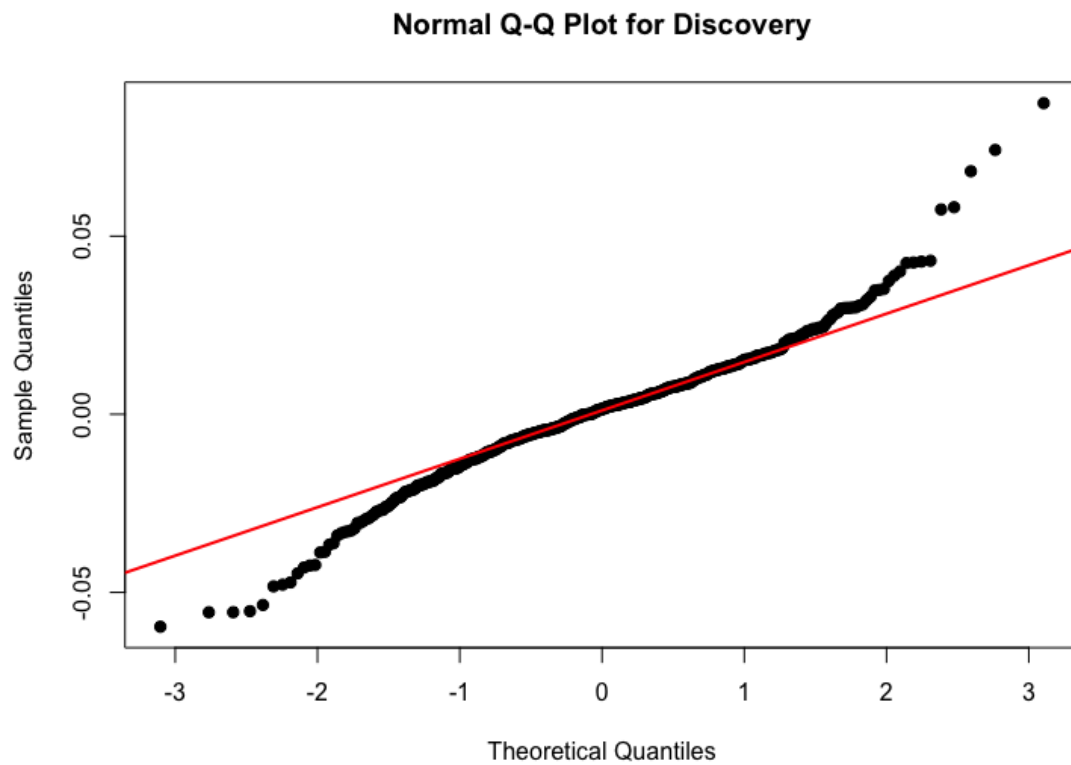
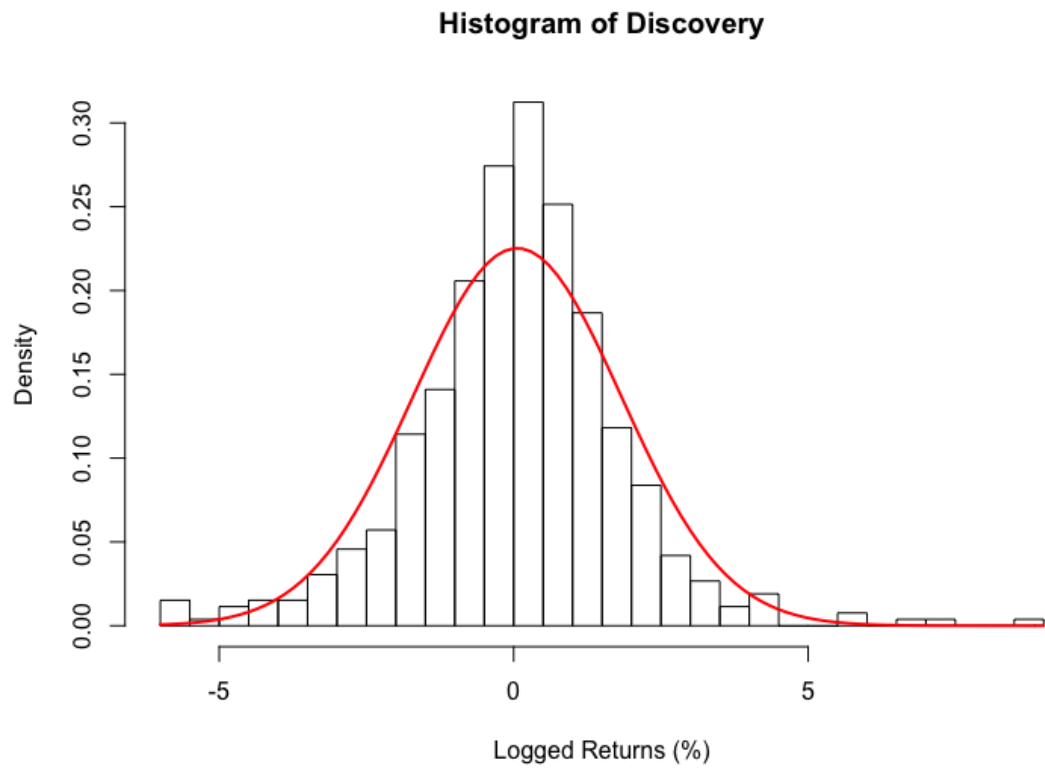
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Nedbank Group	1.0301**	0.037285*	0.99145***	19.874***	-0.409570

D.12 Discovery



*p <0.1

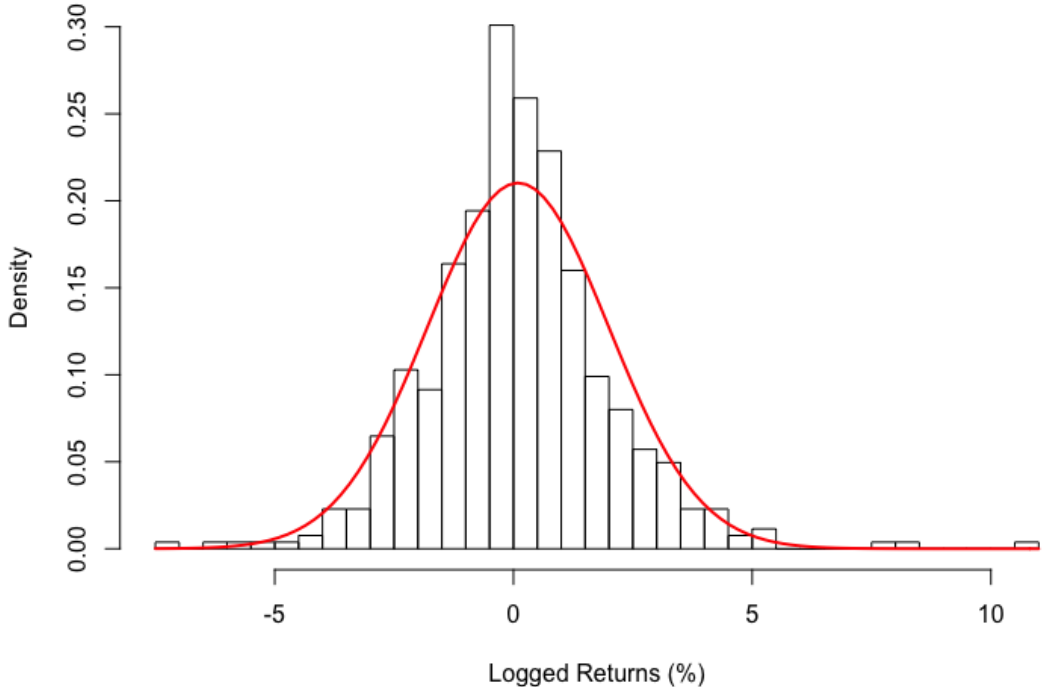
** p <0.05

*** p <0.01

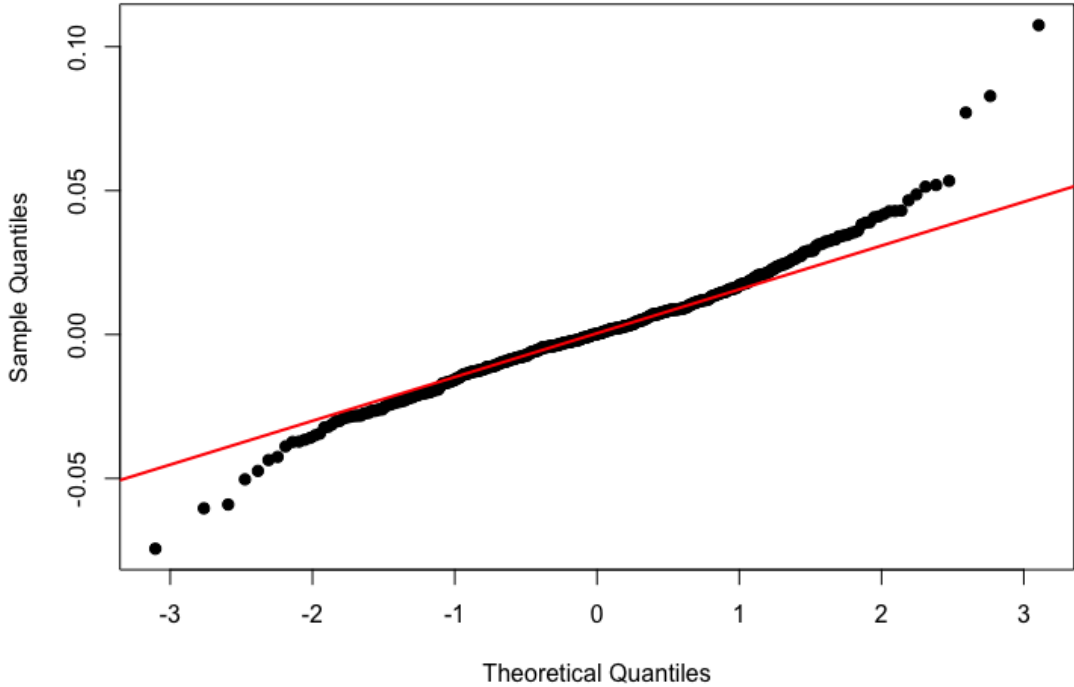
Normality Test Statistics					
	AD	LF	SW	JB	DP
Discovery	4.1481***	0.064291***	0.96474***	148.89***	1.09360

D.13 Shoprite Holdings

Histogram of Shoprite Holdings



Normal Q-Q Plot for Shoprite Holdings



*p <0.1

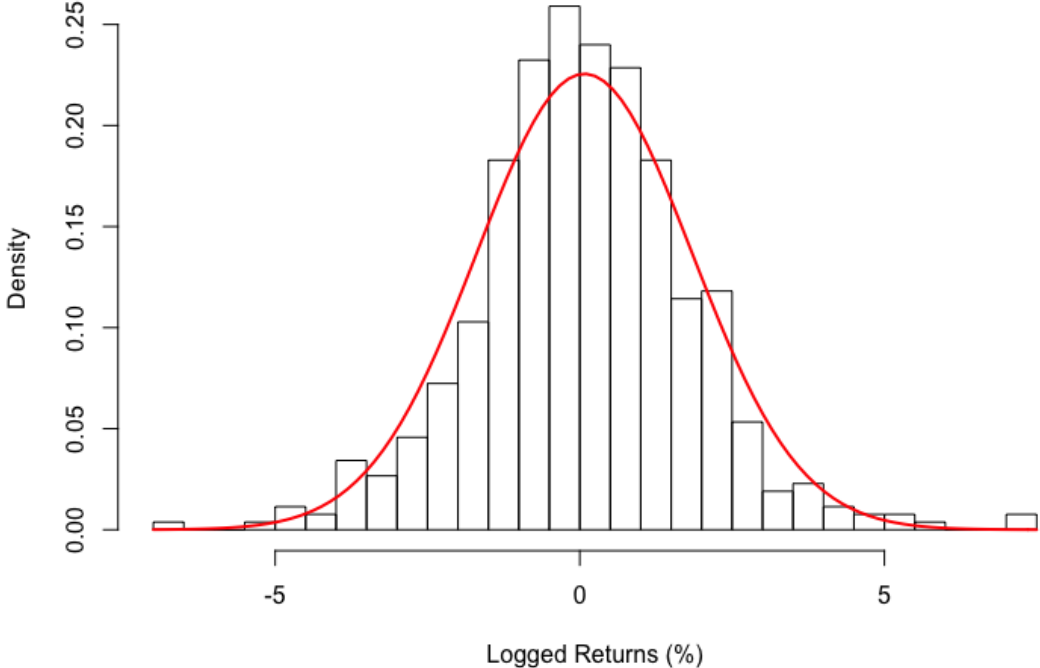
** p <0.05

*** p <0.01

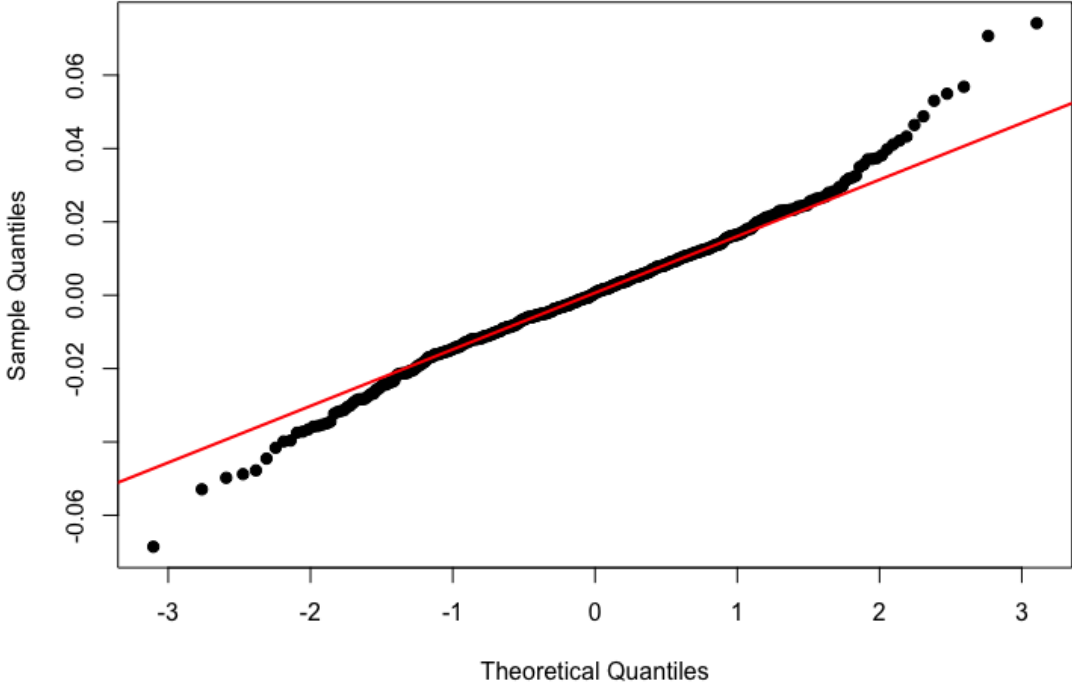
Normality Test Statistics					
	AD	LF	SW	JB	DP
Shoprite Holdings	2.9027***	0.065055***	0.96713***	235.43***	4.45620***

D.14 RMB Holdings

Histogram of RMB Holdings



Normal Q-Q Plot for RMB Holdings



*p <0.1

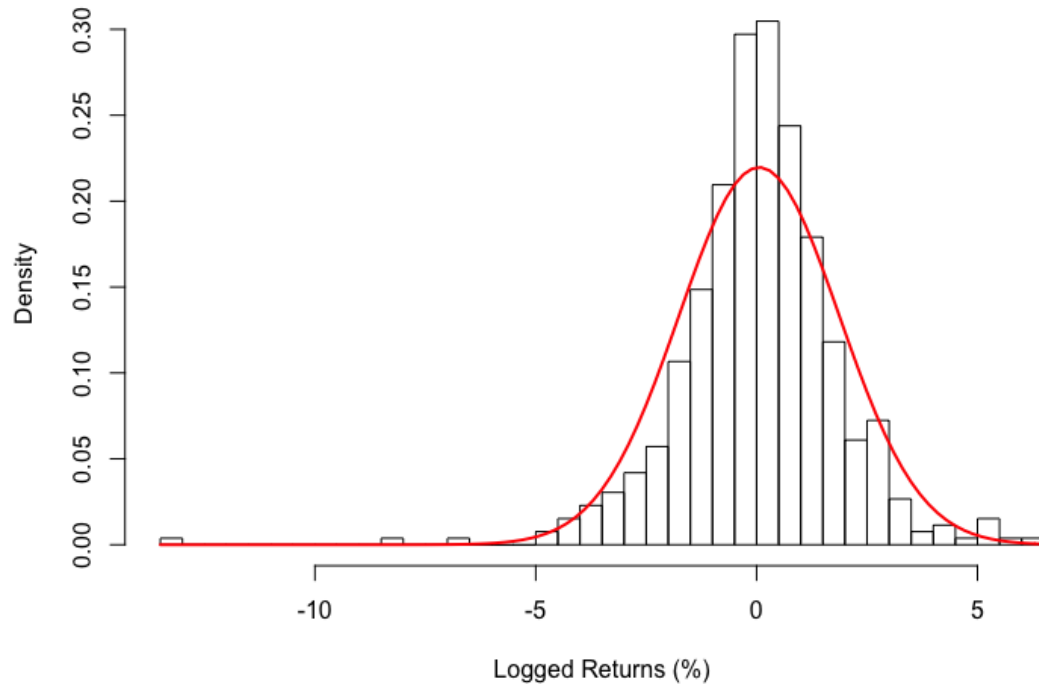
** p <0.05

*** p <0.01

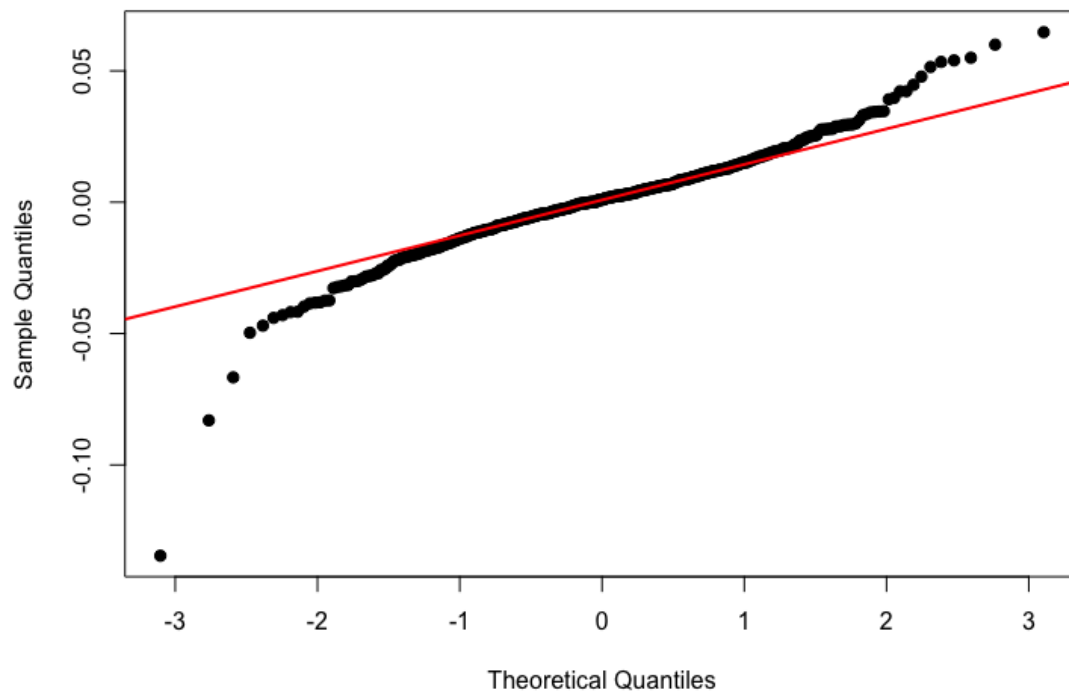
Normality Test Statistics					
	AD	LF	SW	JB	DP
RMB Holdings	1.5928***	0.042928**	0.98489***	52.453***	1.18550

D.15 Capitec Bank Holdings

Histogram of Capitec Bank



Normal Q-Q Plot for Capitec Bank



Normality Test Statistics					
	AD	LF	SW	JB	DP
Capitec Bank Holdings	5.1353***	0.069818***	0.93574***	1151***	-7.02450***

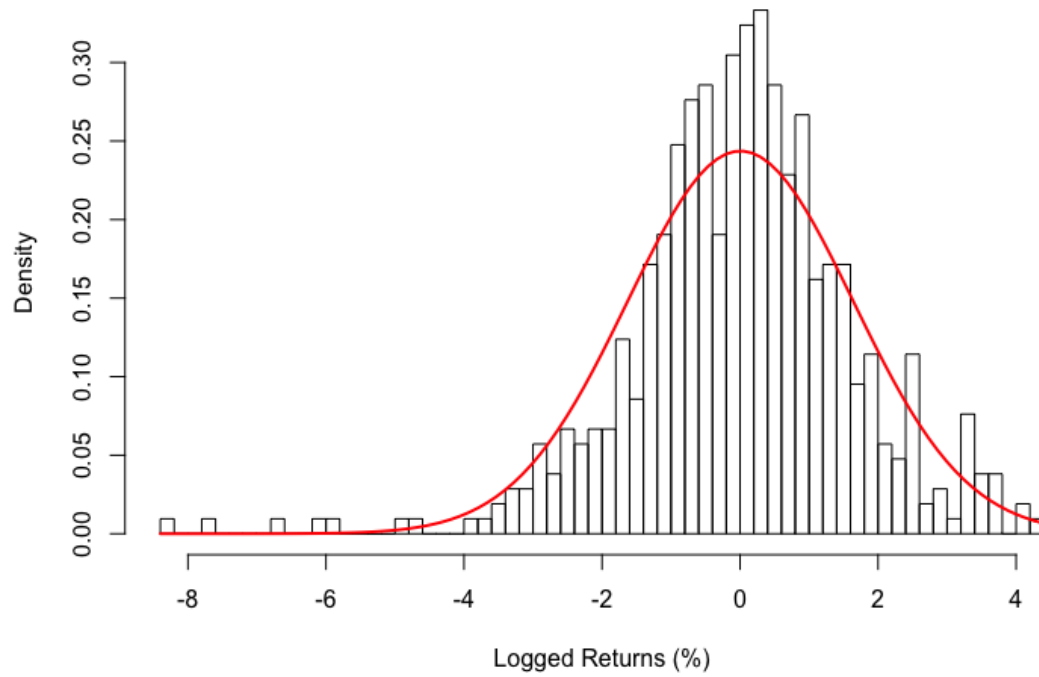
*p <0.1

** p <0.05

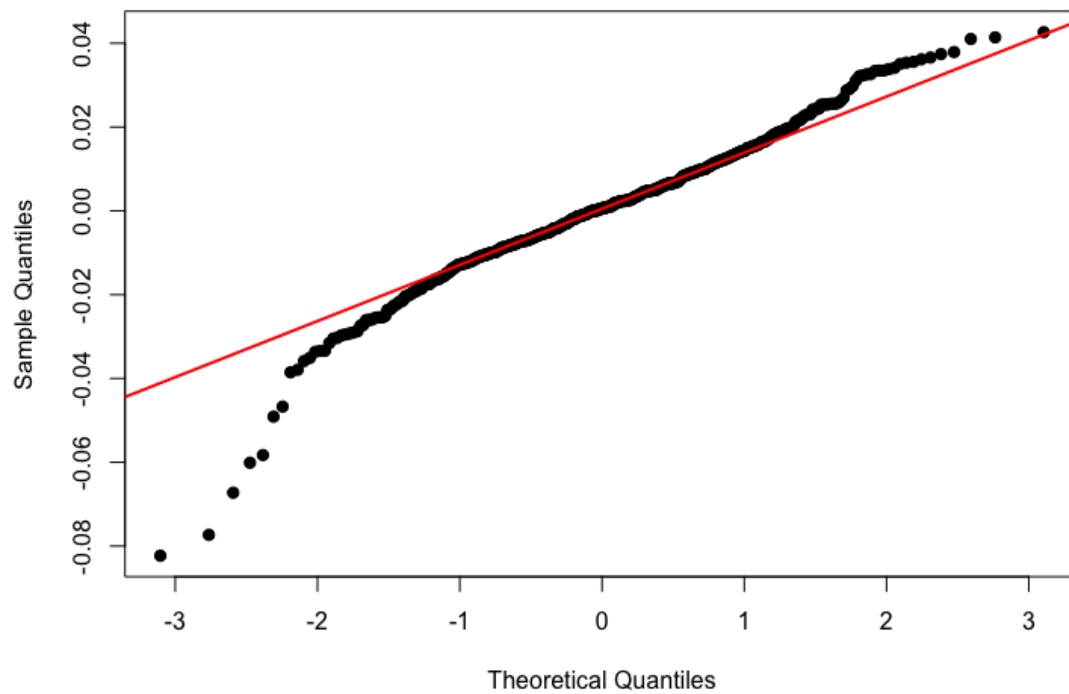
*** p <0.01

D.16 Tiger Brands

Histogram of Tiger Brands



Normal Q-Q Plot for Tiger Brands



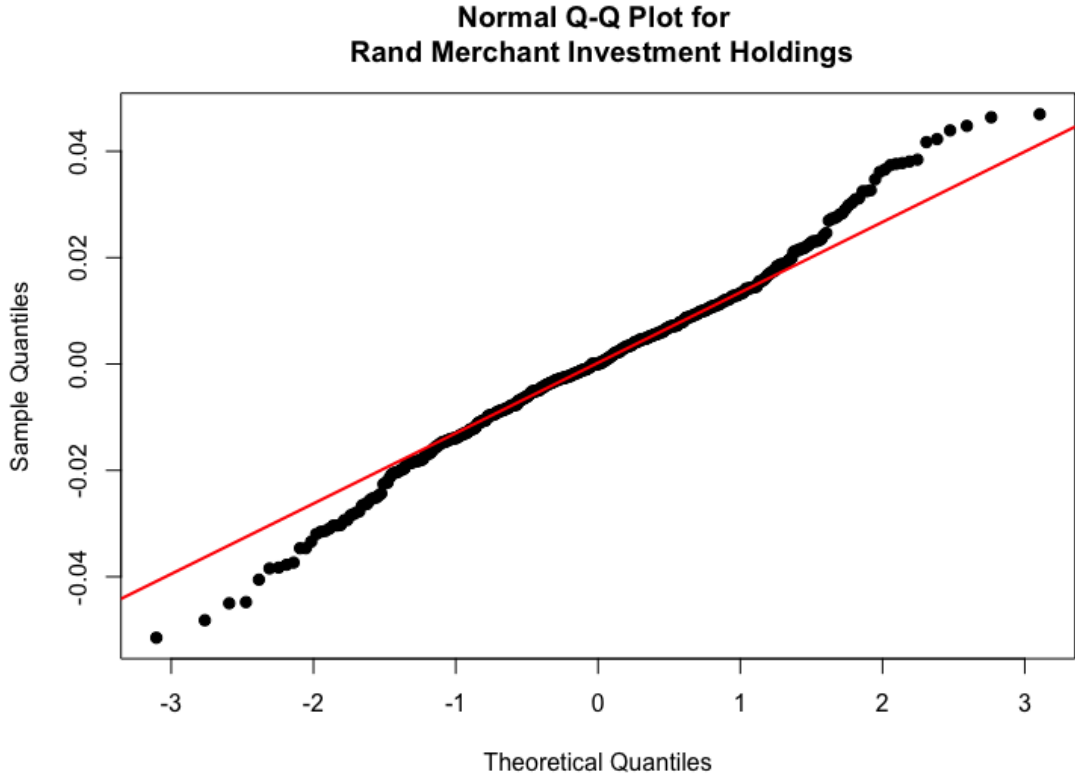
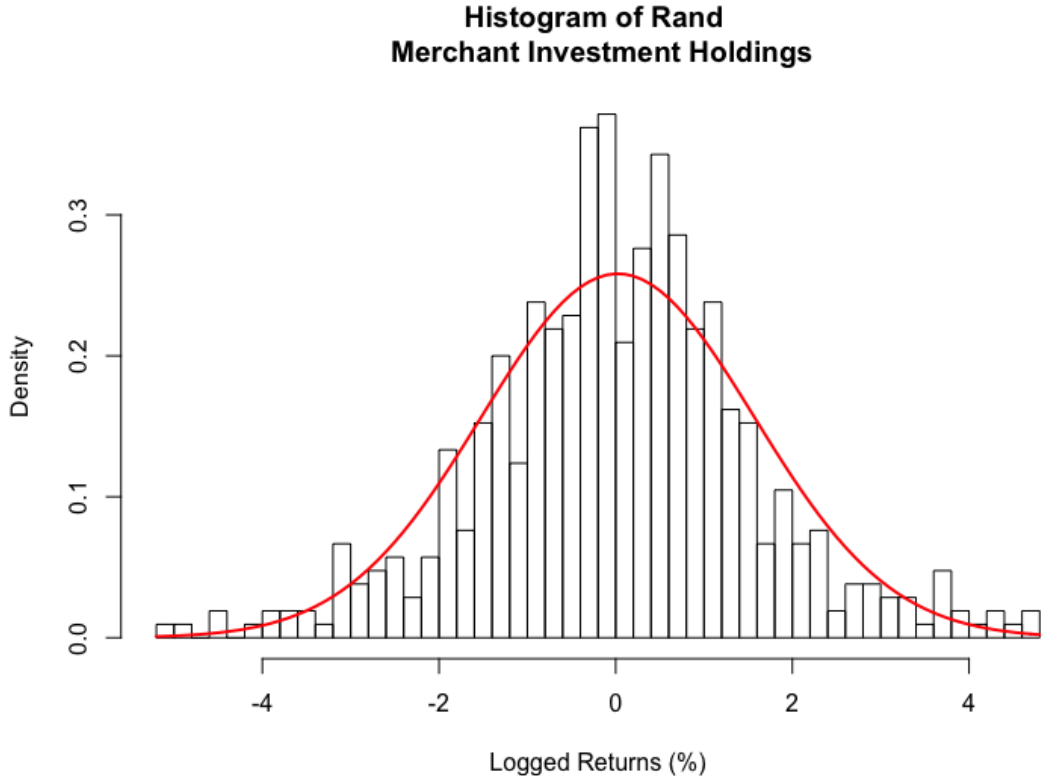
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Tiger Brands	2.8198***	0.060052***	0.96402***	199.89***	-5.64990***

D.17 RMI Holdings



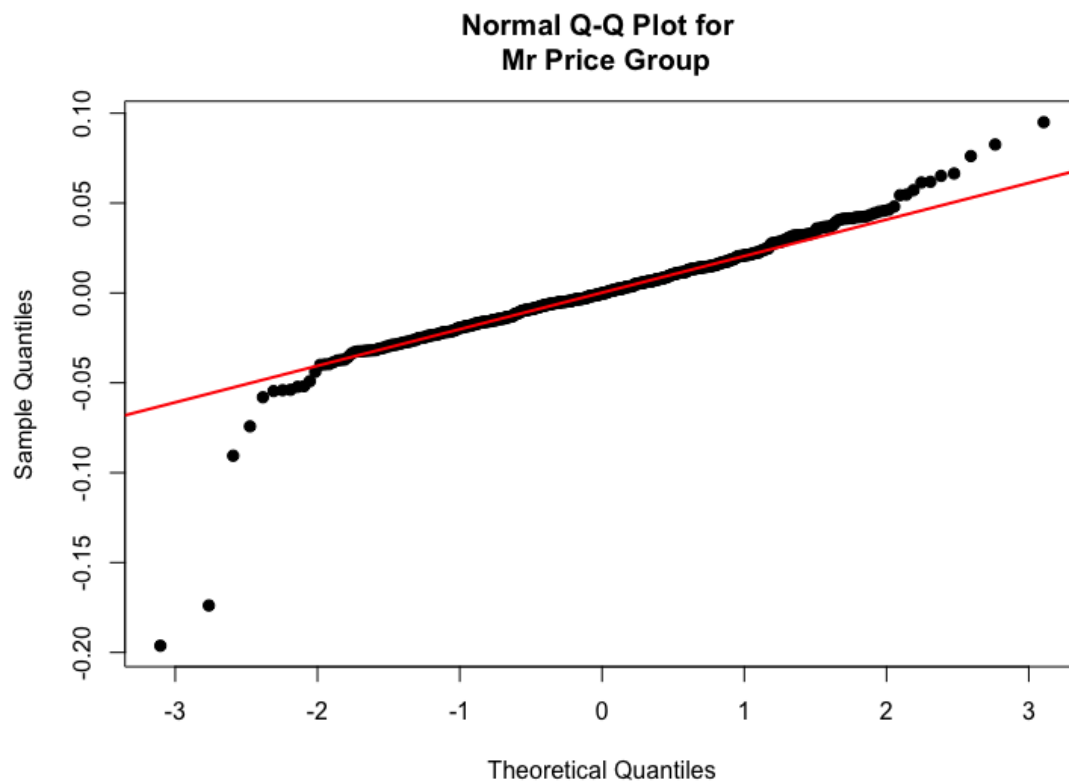
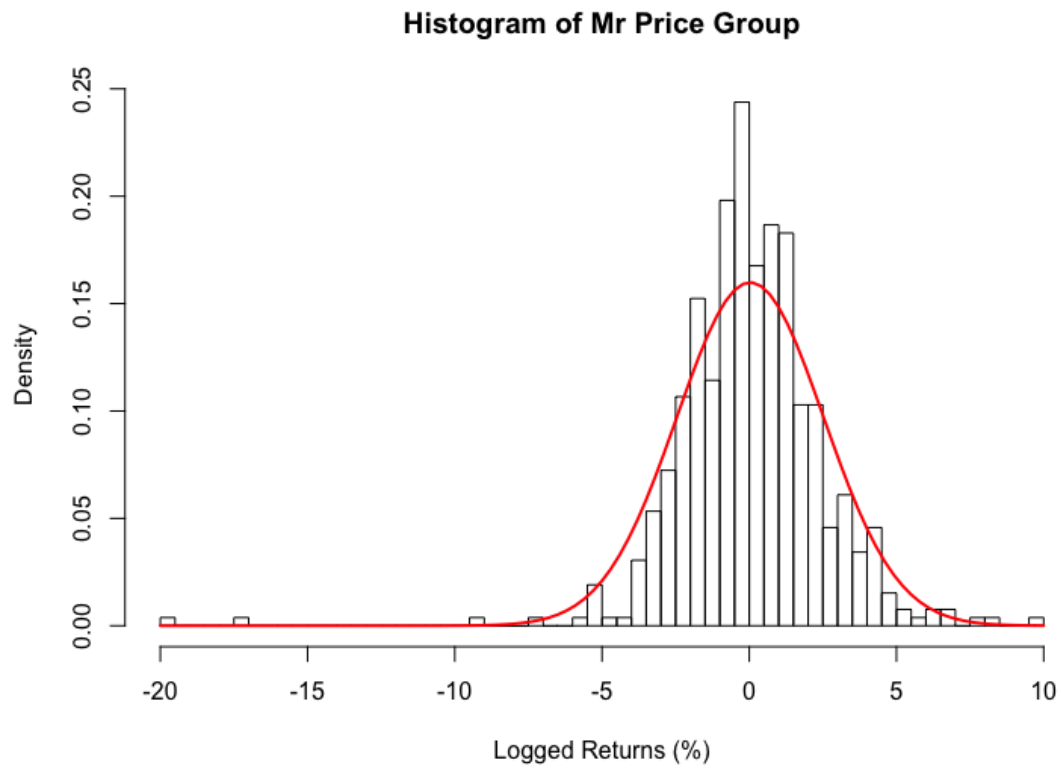
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
RMI Holdings	1.9275***	0.04558**	0.98805***	14.988***	-0.101030

D.18 Mr Price Group



*p <0.1

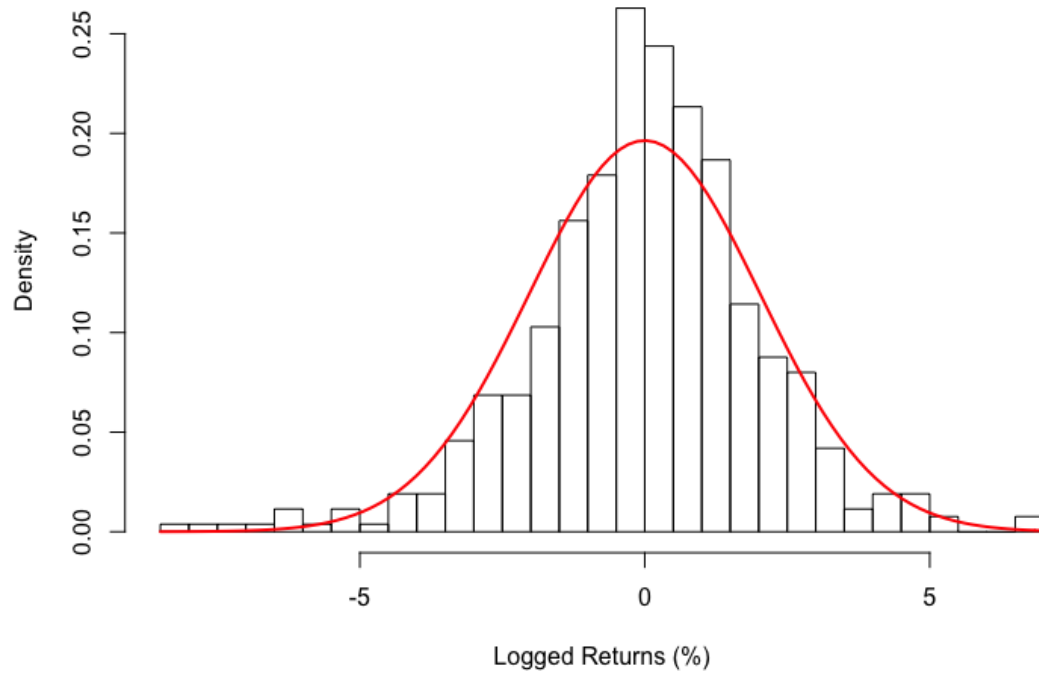
** p <0.05

*** p <0.01

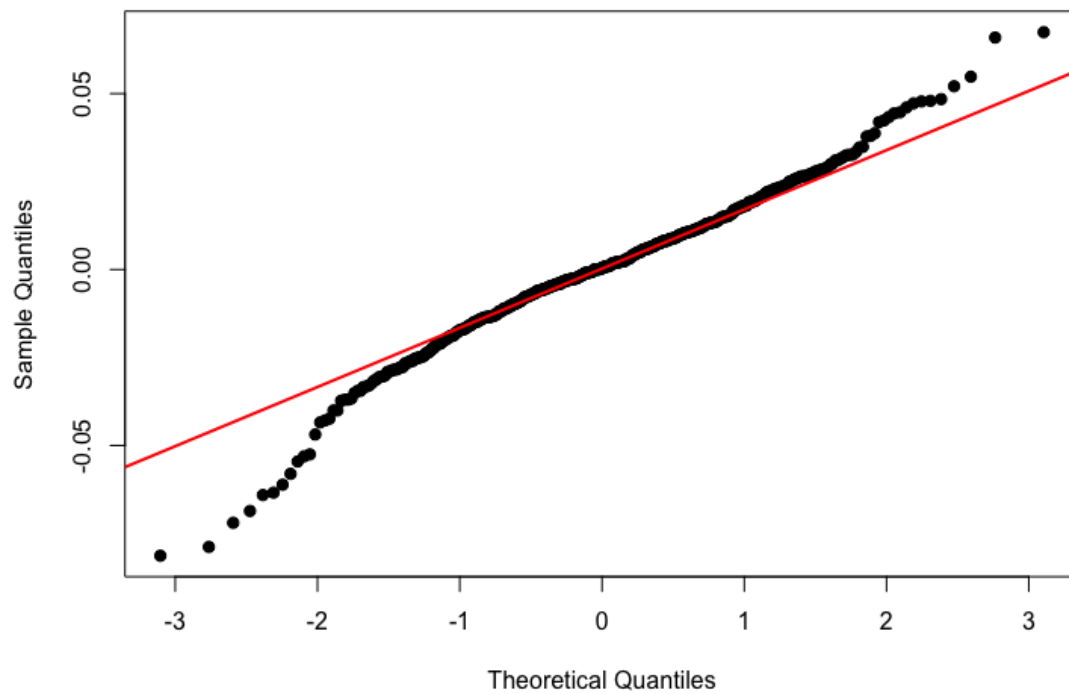
Normality Test Statistics					
	AD	LF	SW	JB	DP
Mr Price Group	4.9462***	0.059679***	0.90123***	3174.6***	-9.8821***

D.19 PSG Group

Histogram of PSG Group



Normal Q-Q Plot for PSG Group



*p <0.1

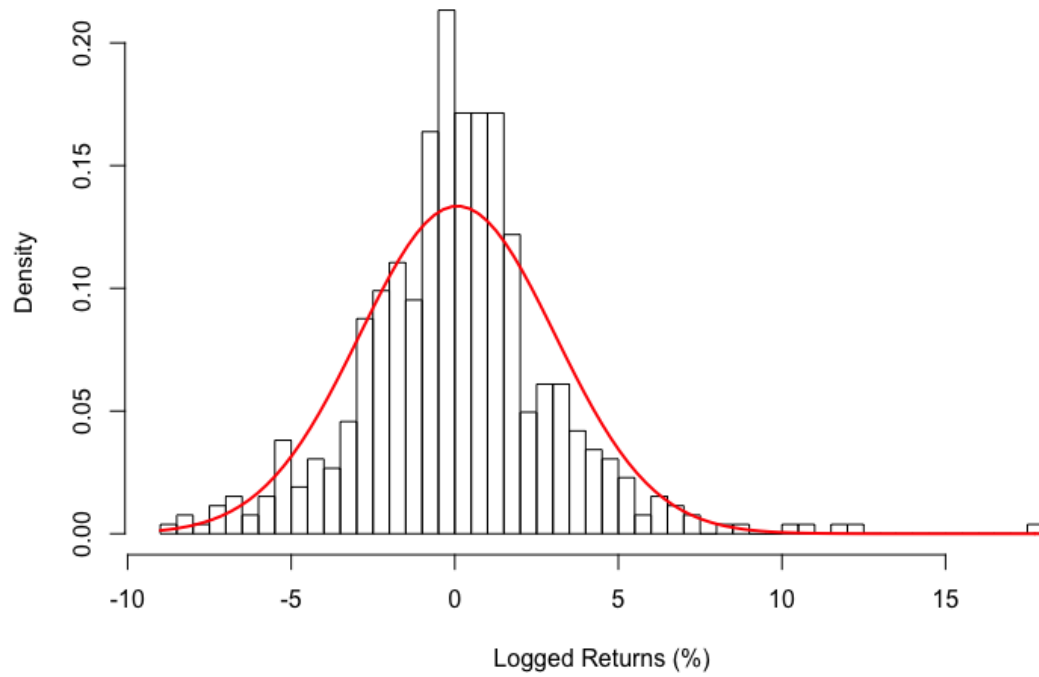
** p <0.05

*** p <0.01

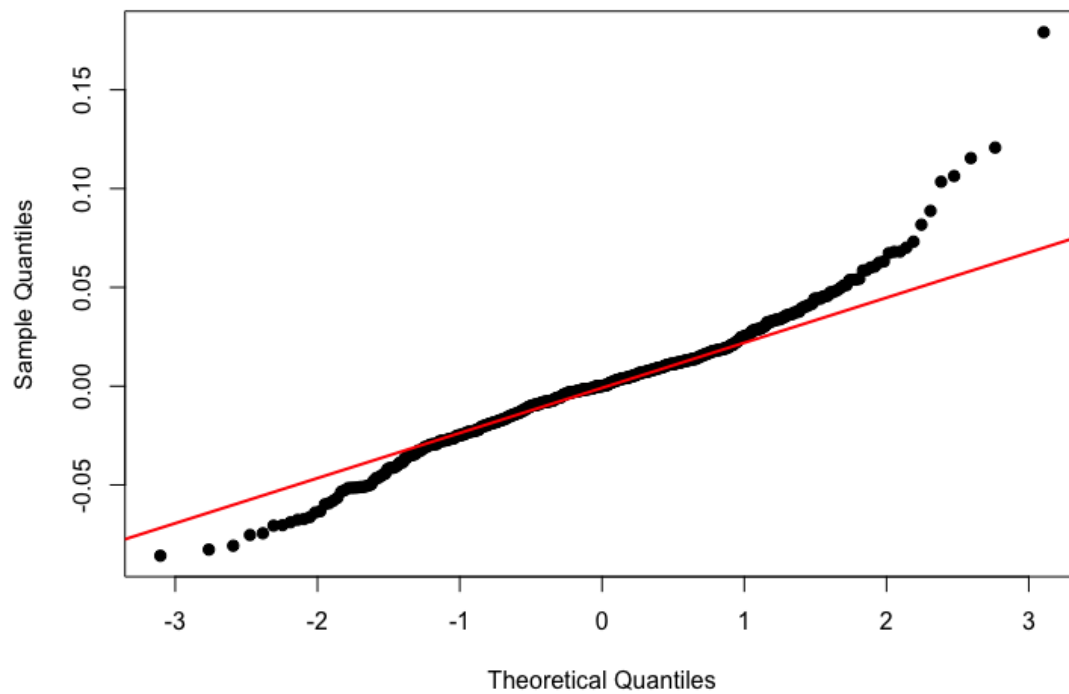
Normality Test Statistics					
	AD	LF	SW	JB	DP
PSG Group	2.6289***	0.059155***	0.97725***	73.323***	-3.56500***

D.20 Anglo American Platinum

Histogram of Anglo American Platinum



**Normal Q-Q Plot for
Anglo American Platinum**



		Normality Test Statistics				
		AD	LF	SW	JB	DP
Anglo Platinum	American	4.2954***	0.078644***	0.95831***	300.02***	5.48670***

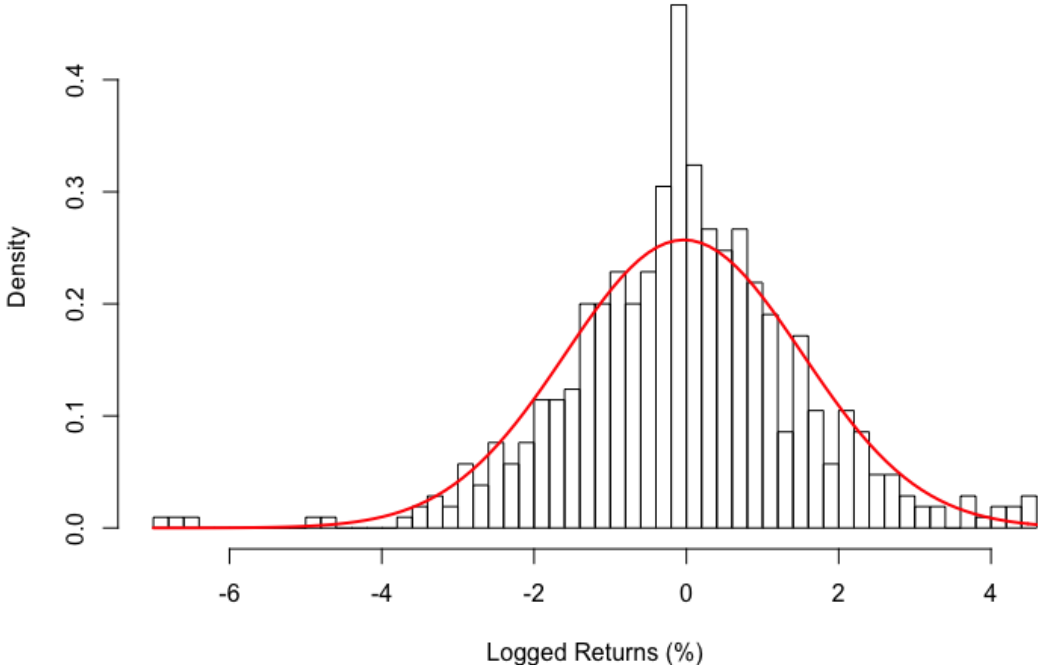
*p < 0.1

** p < 0.05

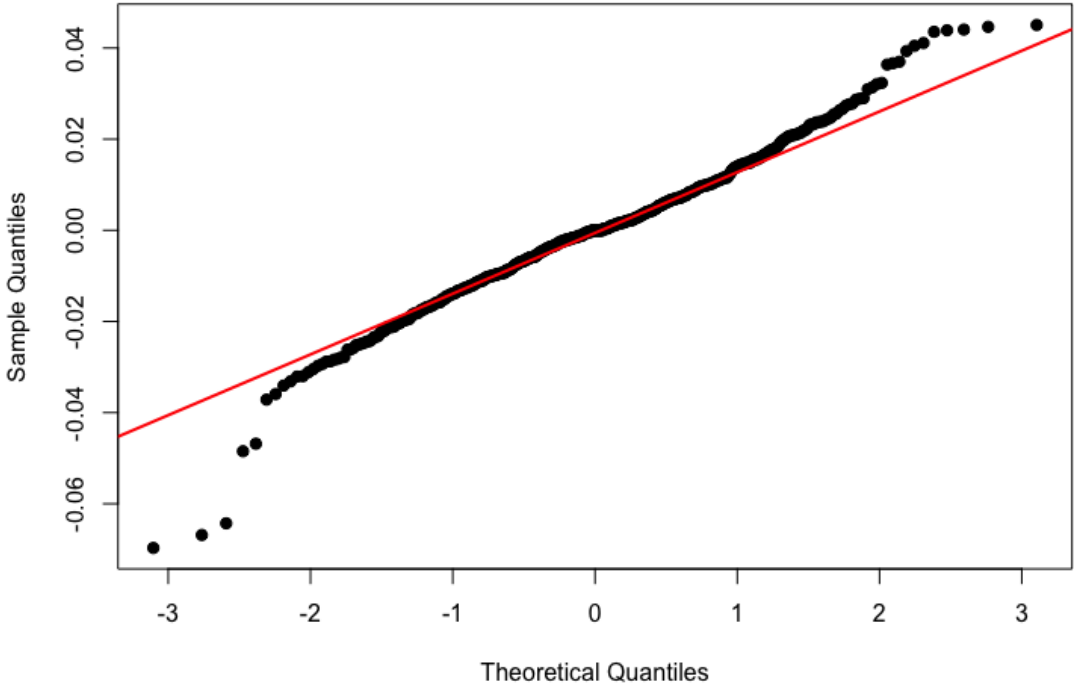
*** p < 0.01

D.21 Netcare

Histogram of Netcare



Normal Q-Q Plot for Netcare



*p <0.1

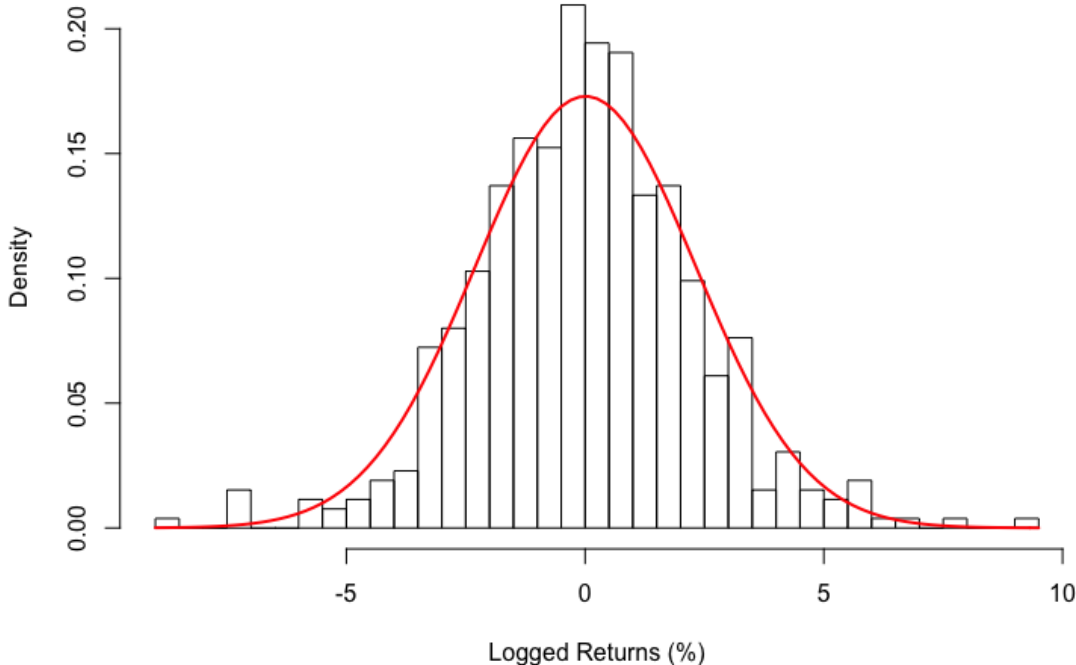
** p <0.05

*** p <0.01

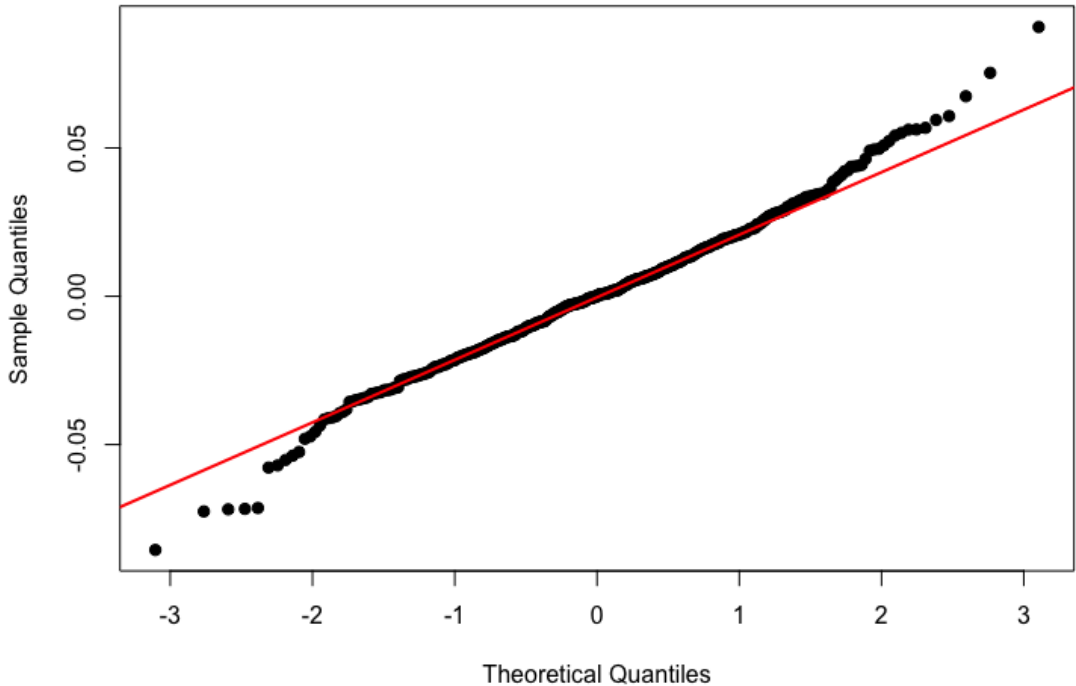
Normality Test Statistics					
	AD	LF	SW	JB	DP
Netcare	2.1864***	0.046104***	0.97704***	84.056***	-2.2475**

D.22 Truworths International

Histogram of Truworths International



Normal Q-Q Plot for Truworths International



Normality Test Statistics					
	AD	LF	SW	JB	DP
Truworths International	1.0064**	0.031136	0.99012***	25.118***	0.413320

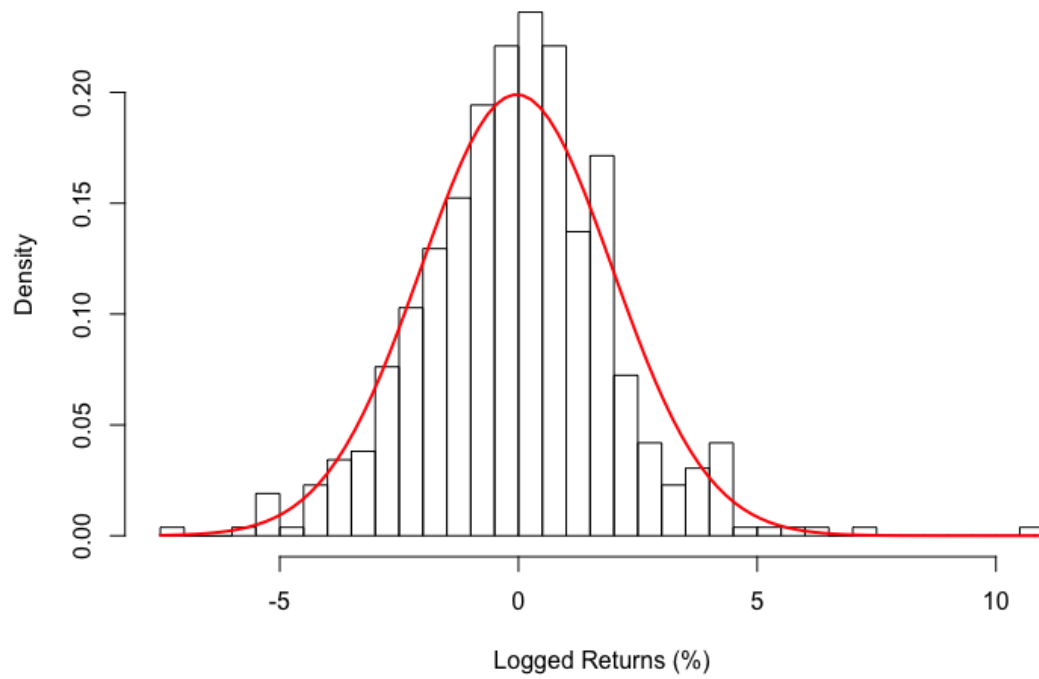
*p < 0.1

** p < 0.05

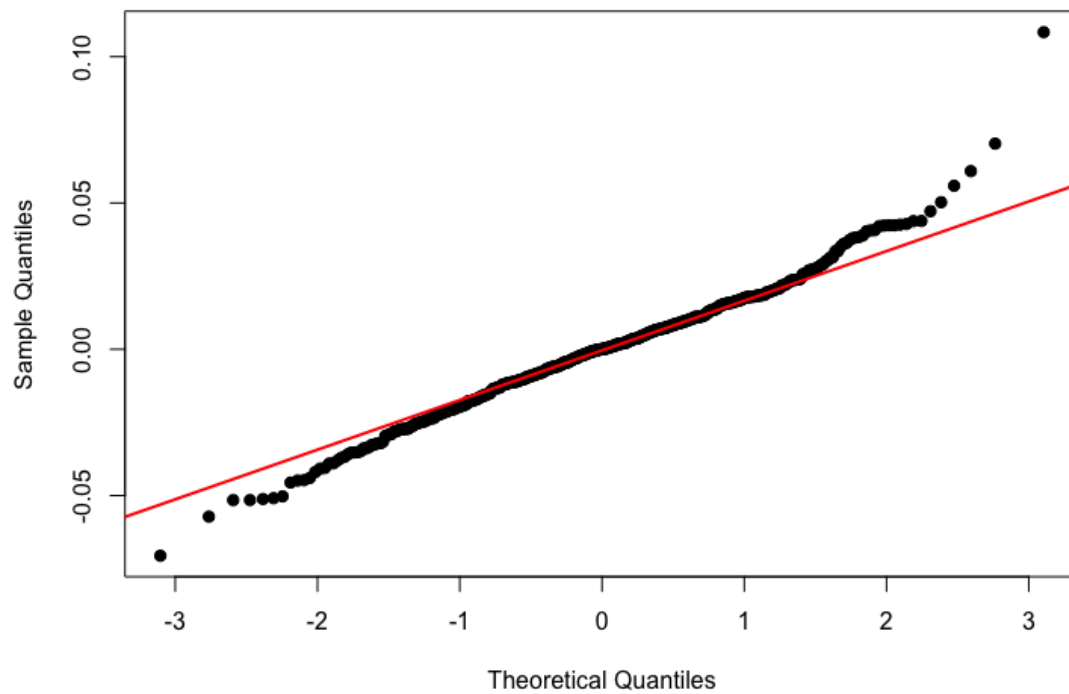
*** p < 0.01

D.23 Pioneer Foods Group

Histogram of Pioneer Foods Group



Normal Q-Q Plot for Pioneer Foods Group



		Normality Test Statistics				
		AD	LF	SW	JB	DP
Pioneer Group	Foods	1.4355***	0.045877**	0.98286***	88.116***	2.48580**

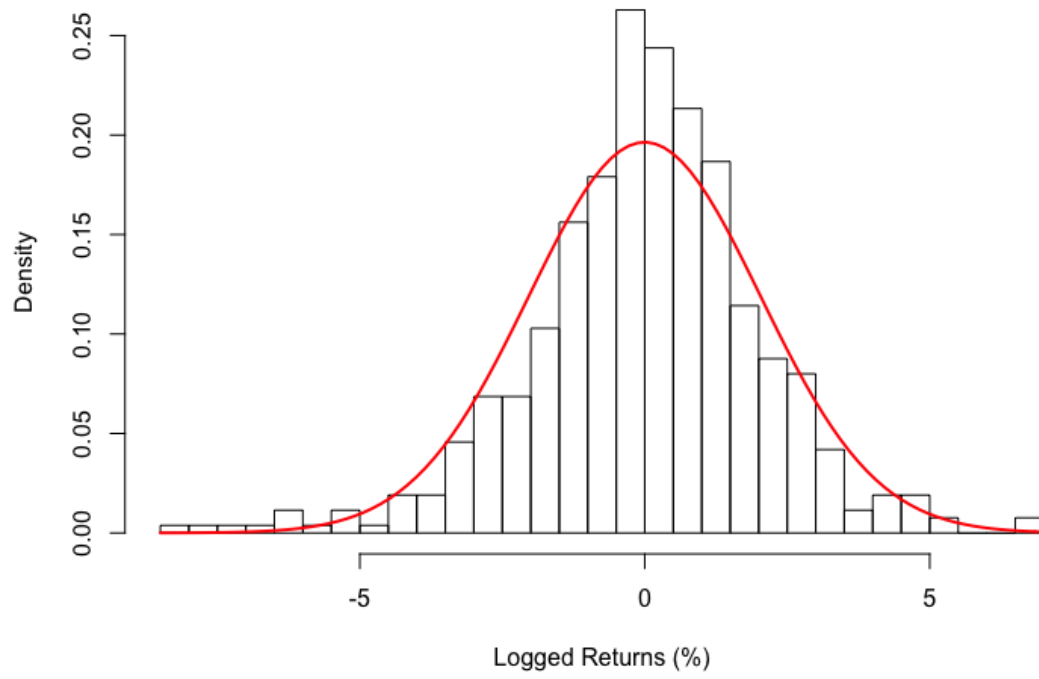
*p <0.1

** p <0.05

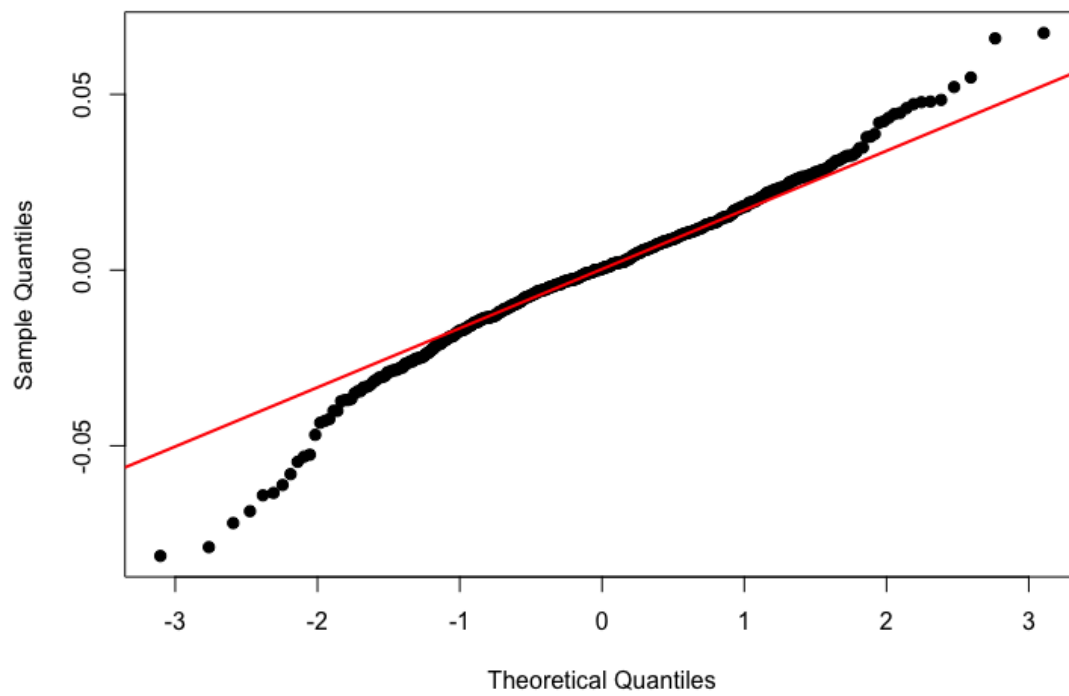
*** p <0.01

D.24 Life Healthcare

Histogram of PSG Group



Normal Q-Q Plot for PSG Group



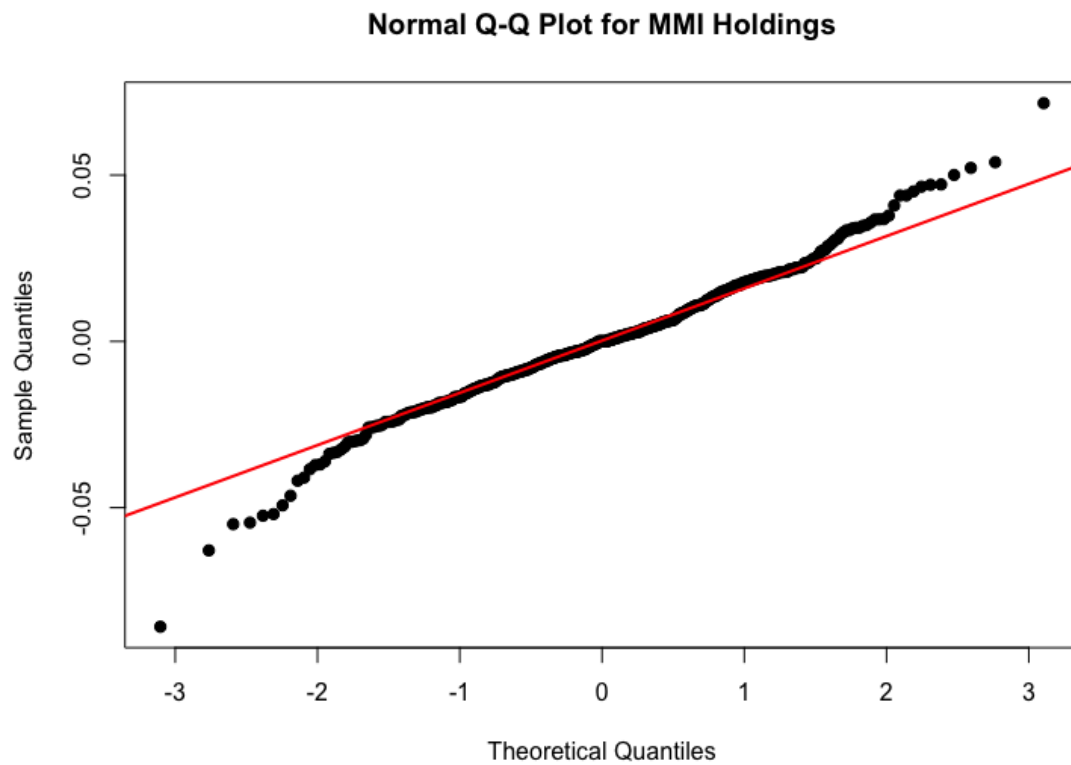
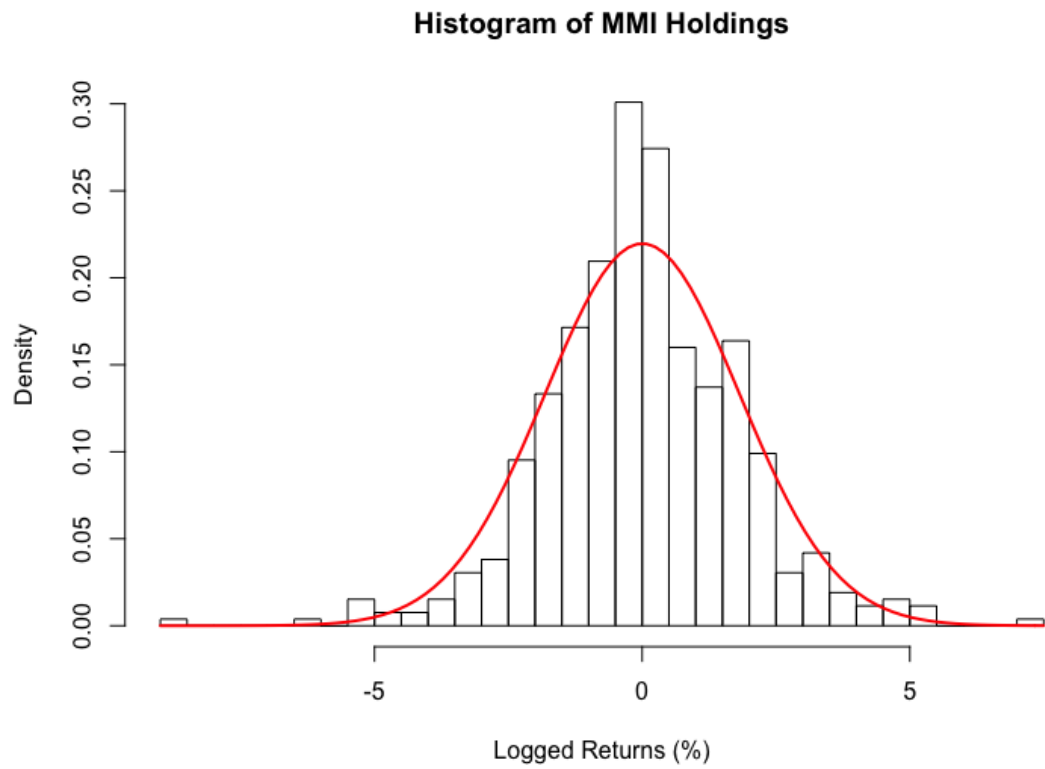
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Life Healthcare	2.8248***	0.062214***	0.98038***	53.833***	0.78762

D.25 MMI Holdings



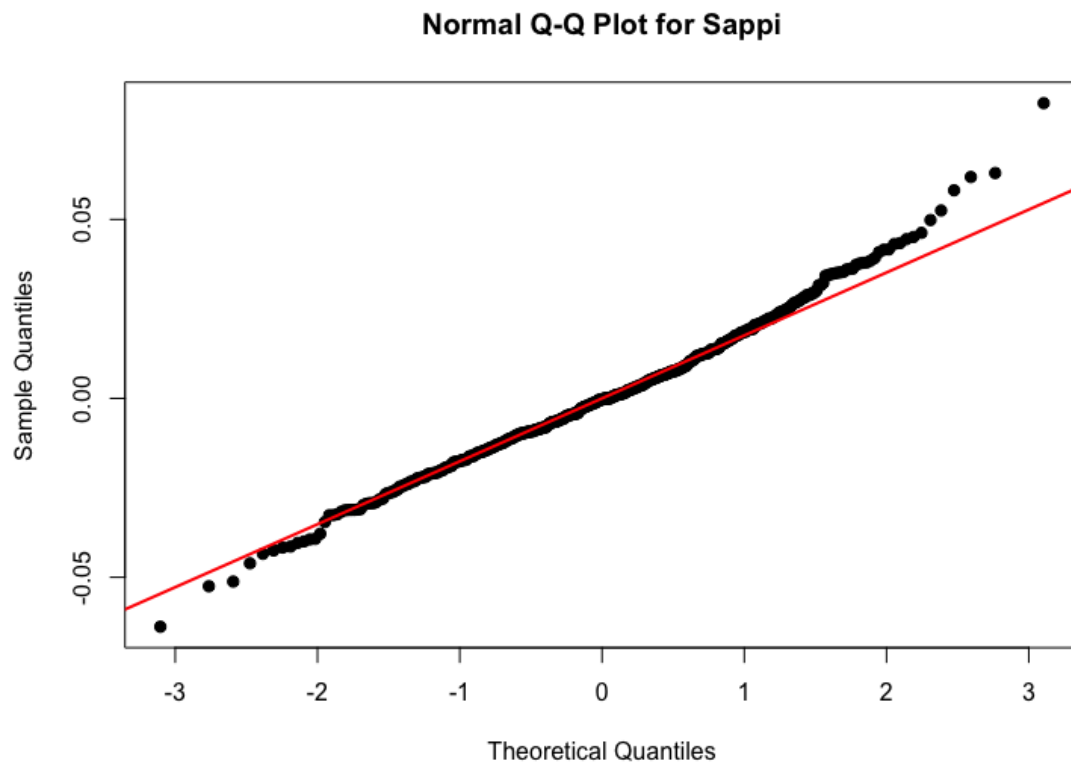
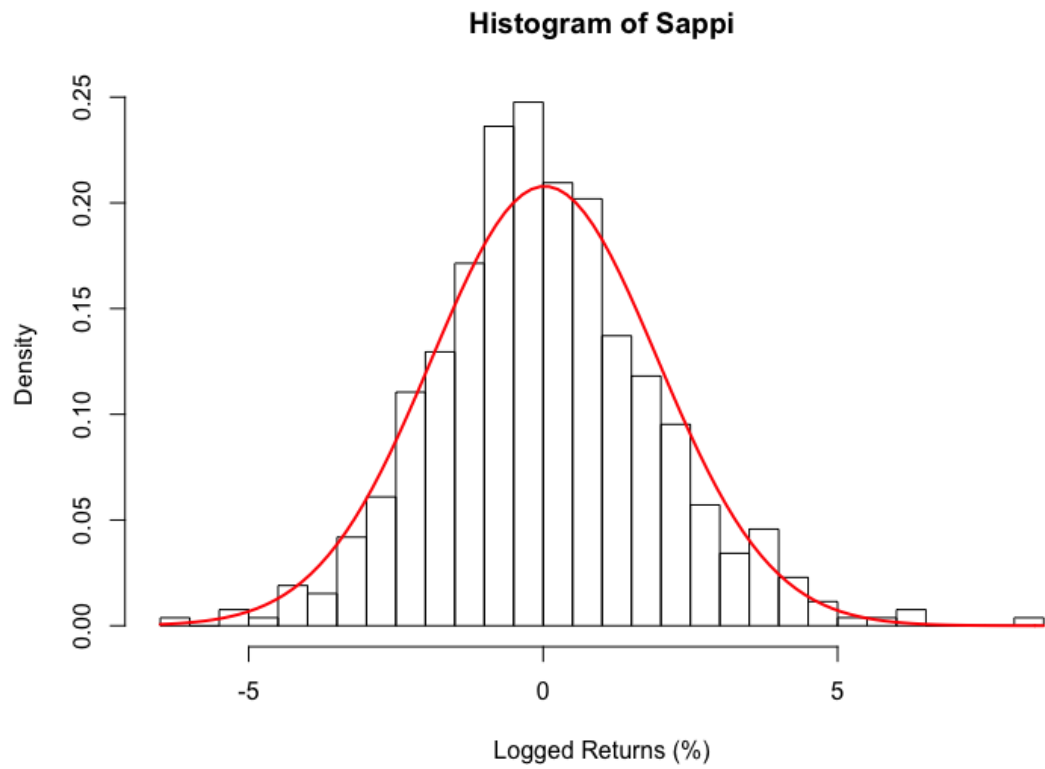
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
MMI Holdings	1.9239***	0.054876***	0.9824***	64.669***	-0.807550

D.26 Sappi



*p <0.1

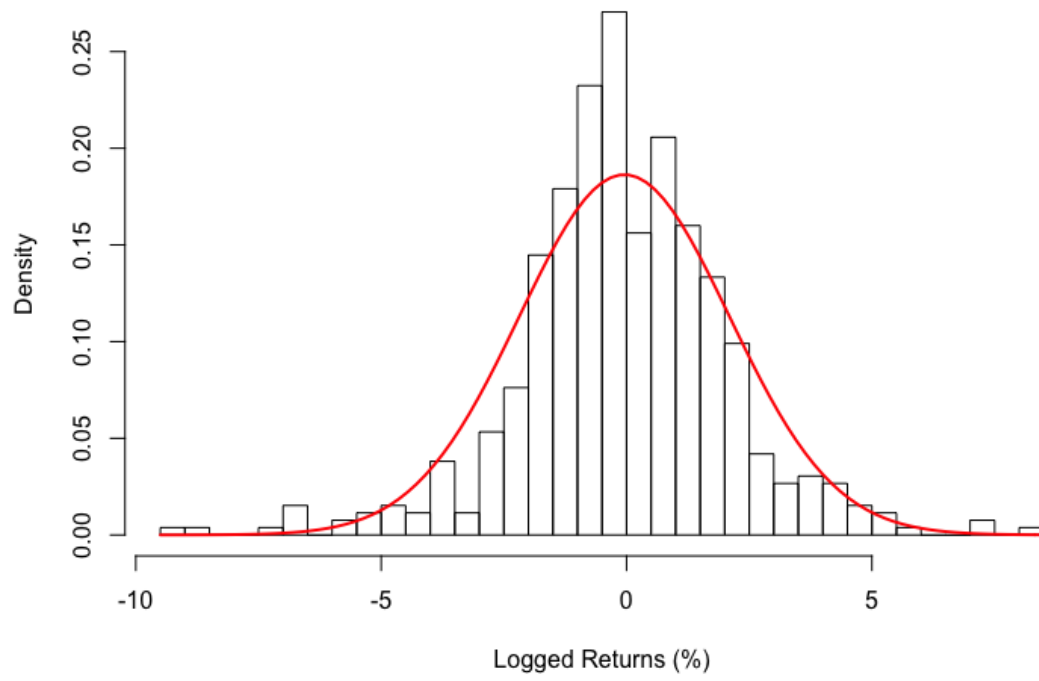
** p <0.05

*** p <0.01

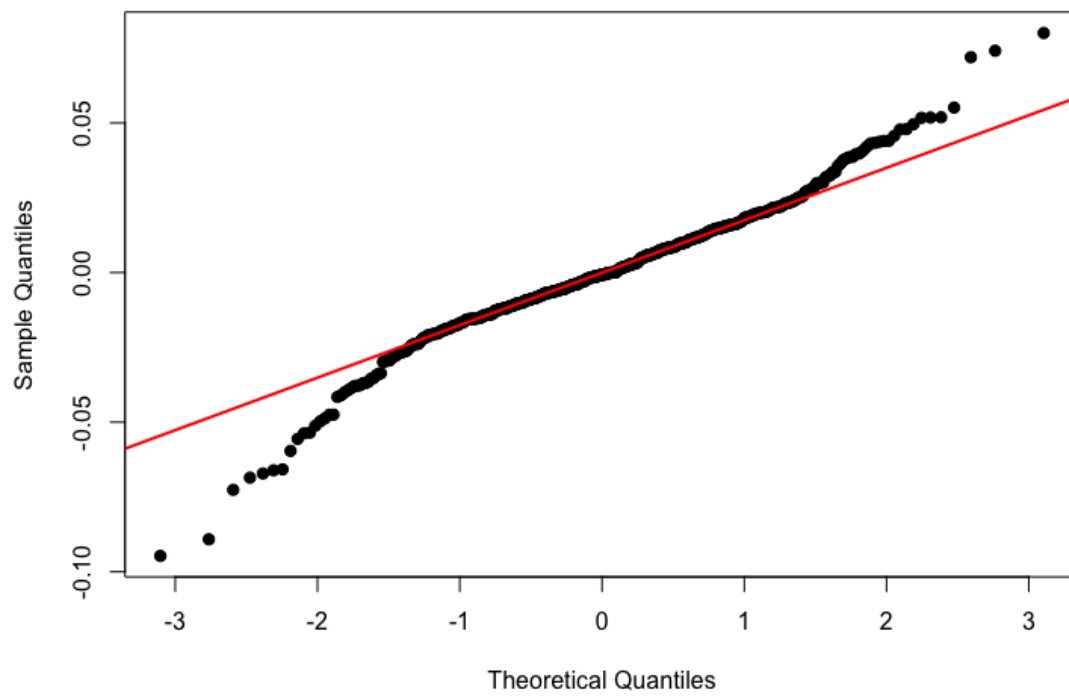
Normality Test Statistics					
	AD	LF	SW	JB	DP
Sappi	1.3368***	0.049558***	0.98992***	26.77***	3.12150***

D.27 Telkom SA SOC

Histogram of Telkom SA SOC



Normal Q-Q Plot for Telkom SA SOC



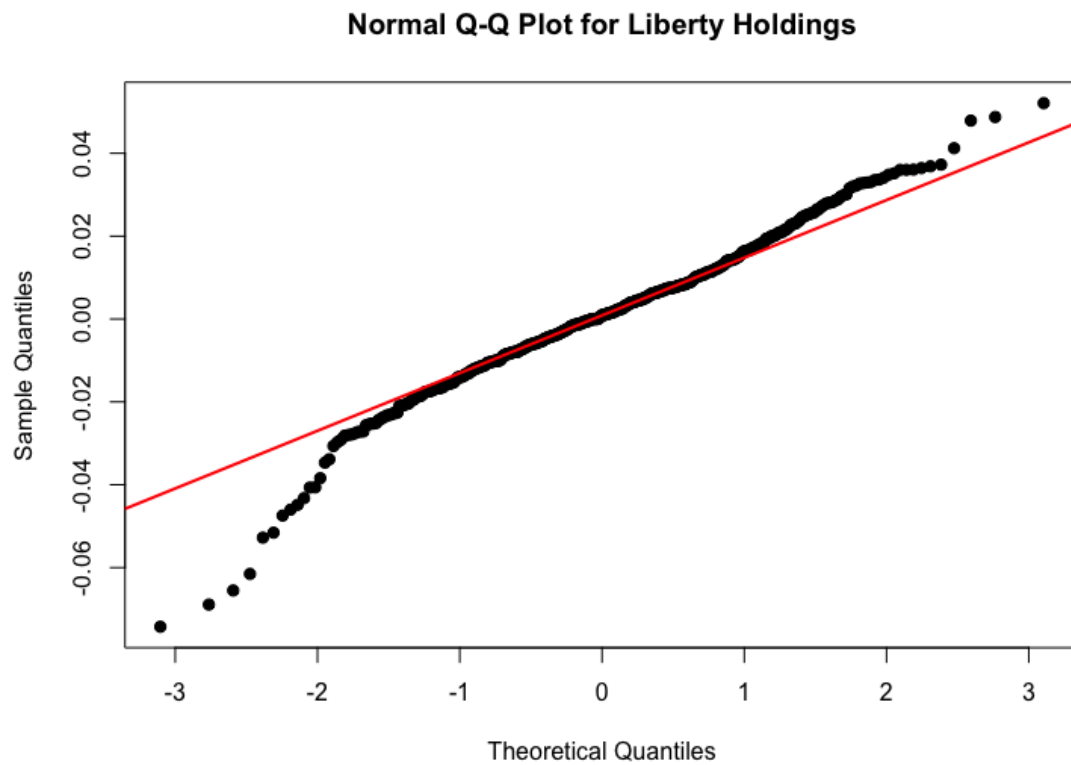
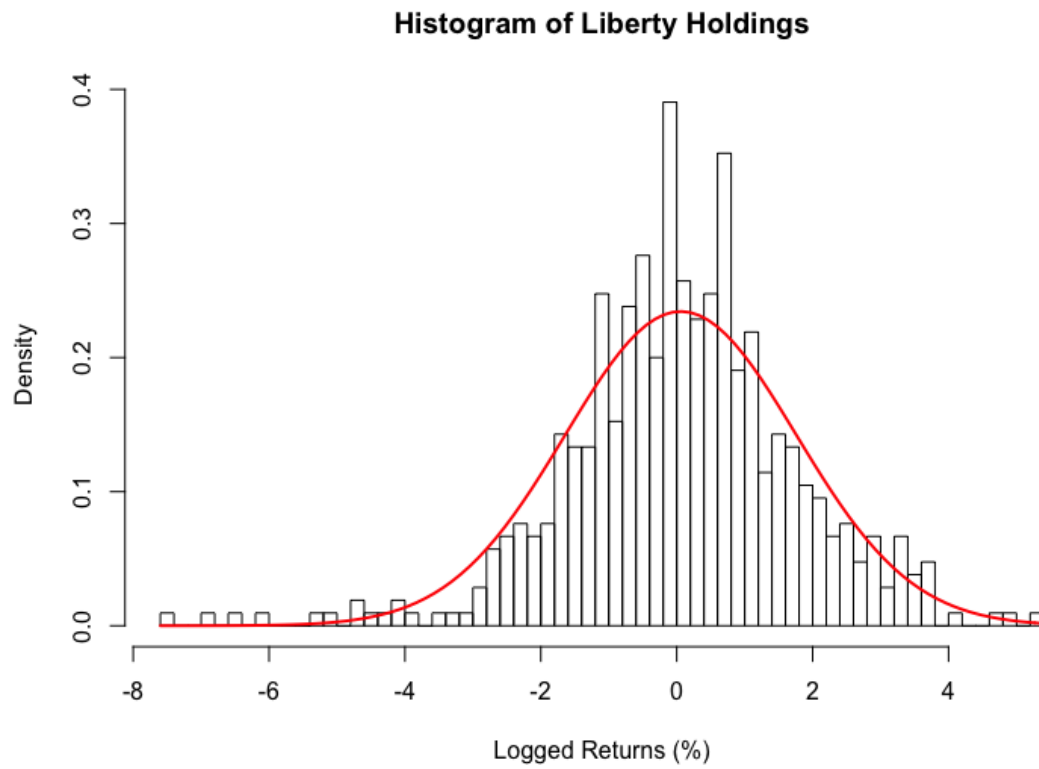
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Telkom SA SOC	3.7657***	0.06813***	0.96822***	121.66***	-2.56580**

D.28 Liberty Holdings



*p <0.1

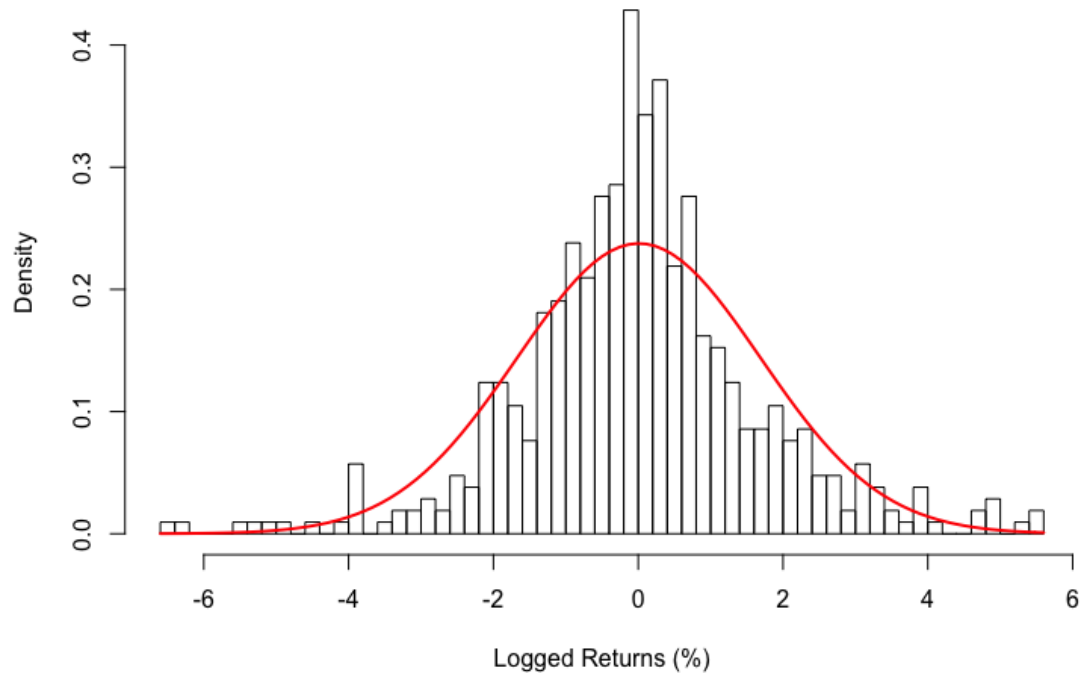
** p <0.05

*** p <0.01

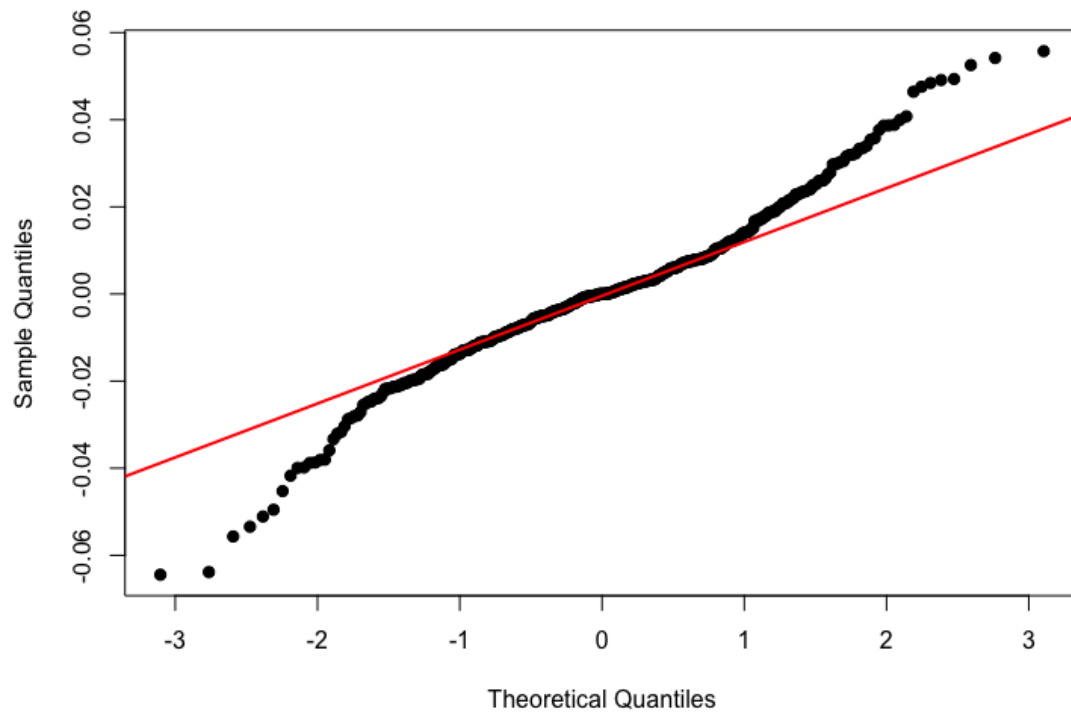
Normality Test Statistics					
	AD	LF	SW	JB	DP
Liberty Holdings	2.2935***	0.047618***	0.97493***	93.407***	-4.10840***

D.29 Spar Group

Histogram of Spar Group



Normal Q-Q Plot for Spar Group



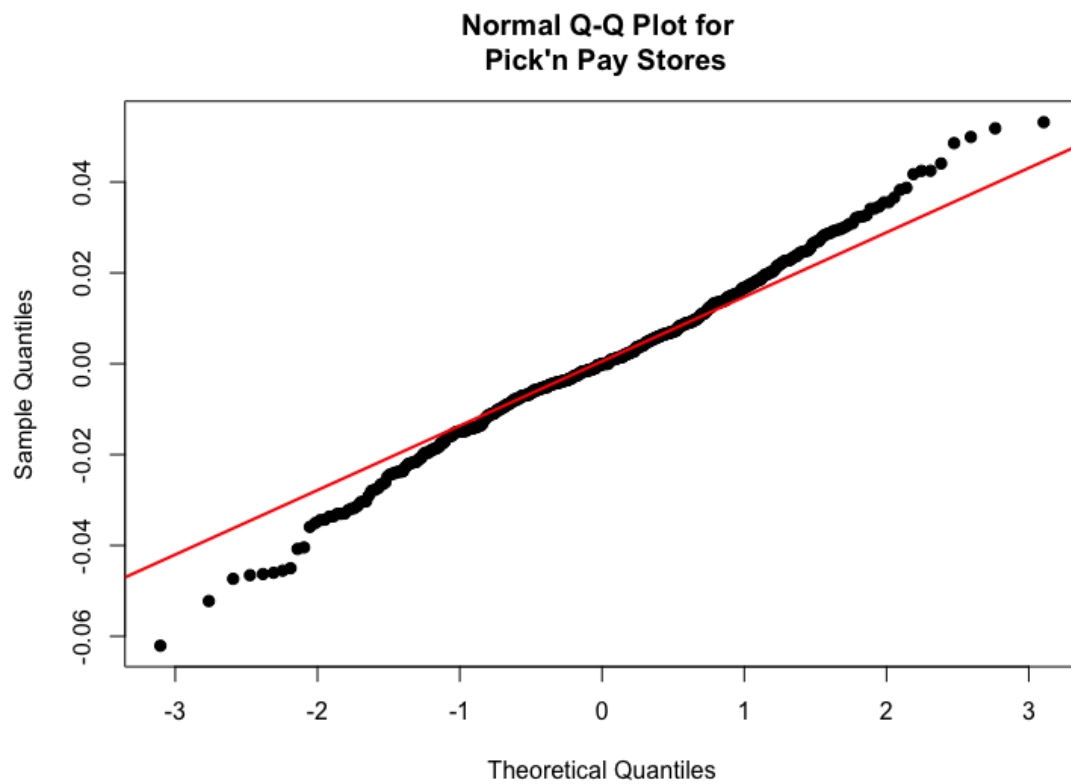
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Spar Group	4.8134***	0.078341***	0.97002***	69.453***	-0.0855070

D.30 Pick 'n Pay Stores



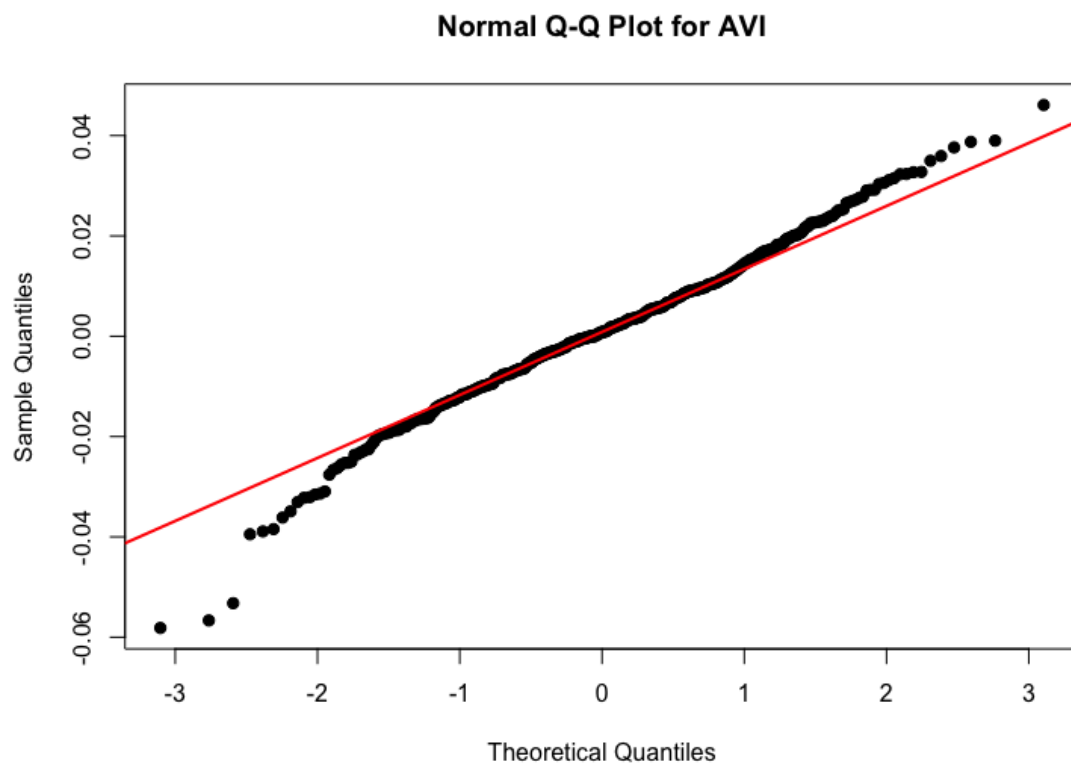
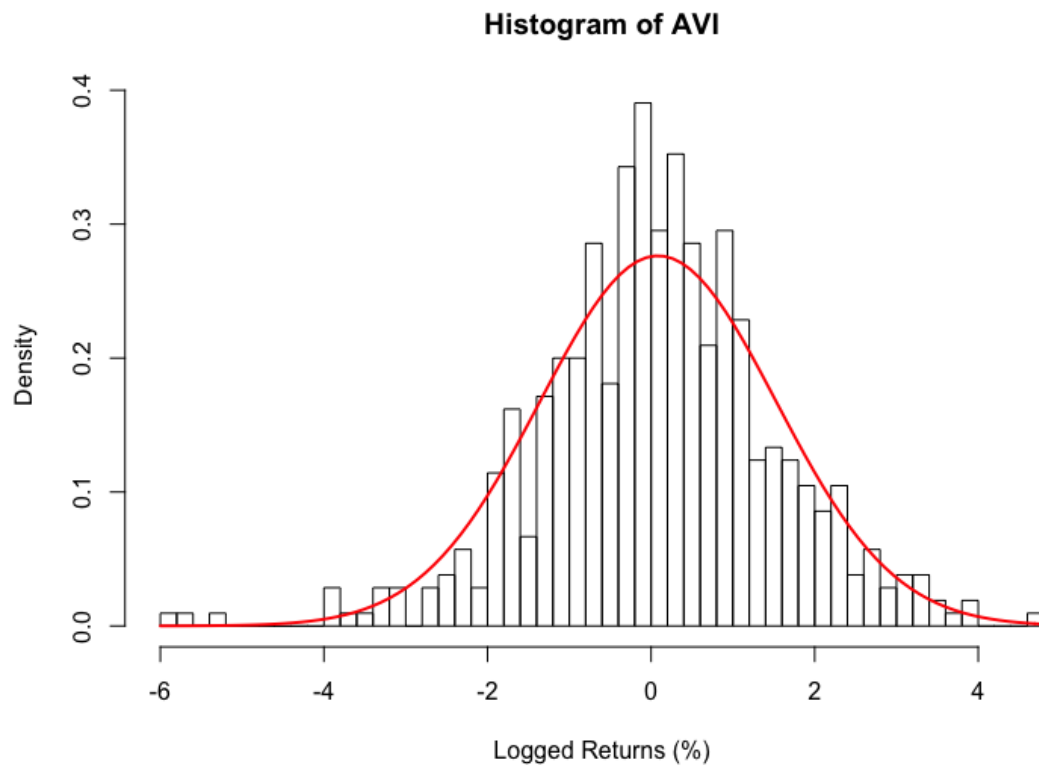
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Pick 'n Pay Stores	1.5317***	0.049831***	0.99169***	10.595***	-0.529220

D.31 AVI



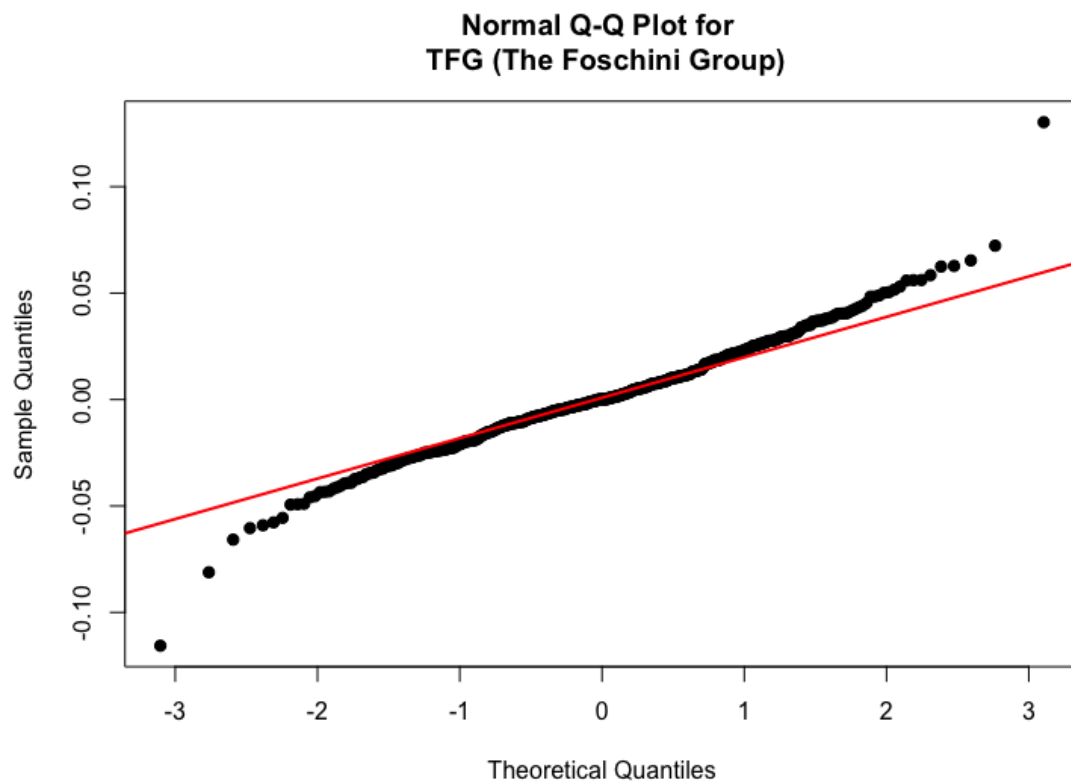
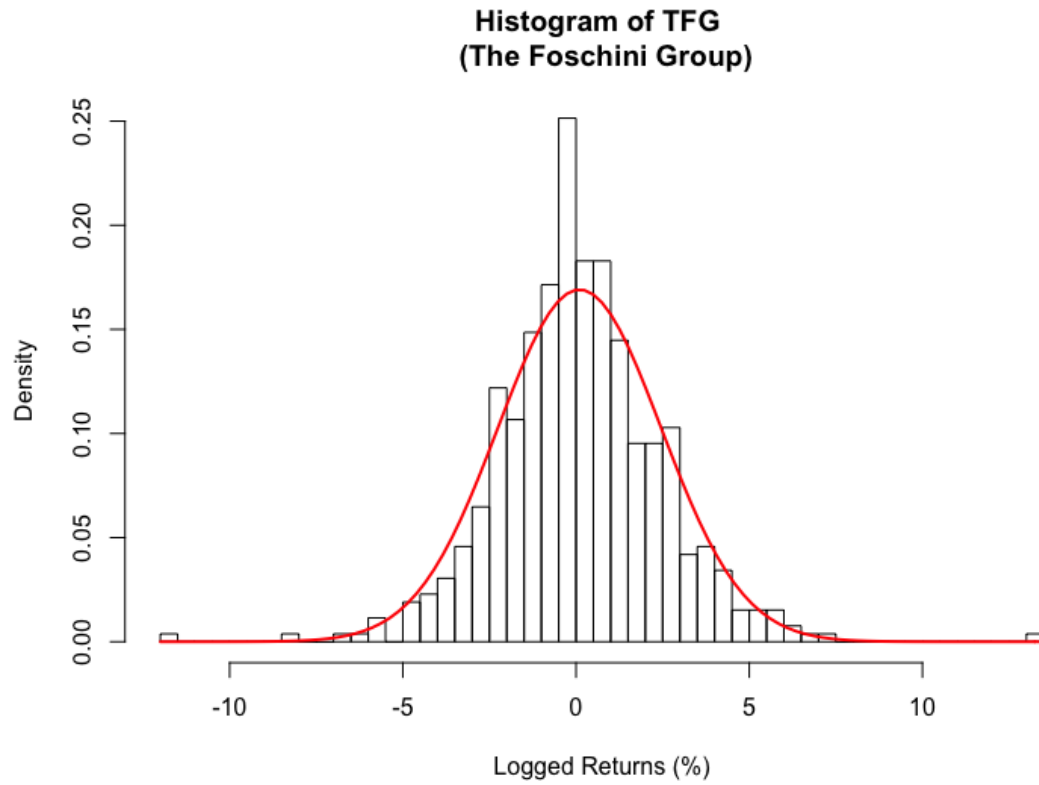
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
AVI	1.3139***	0.037929*	0.98676***	37.523***	-2.4193**

D.32 TFG (The Foschini Group)



*p <0.1

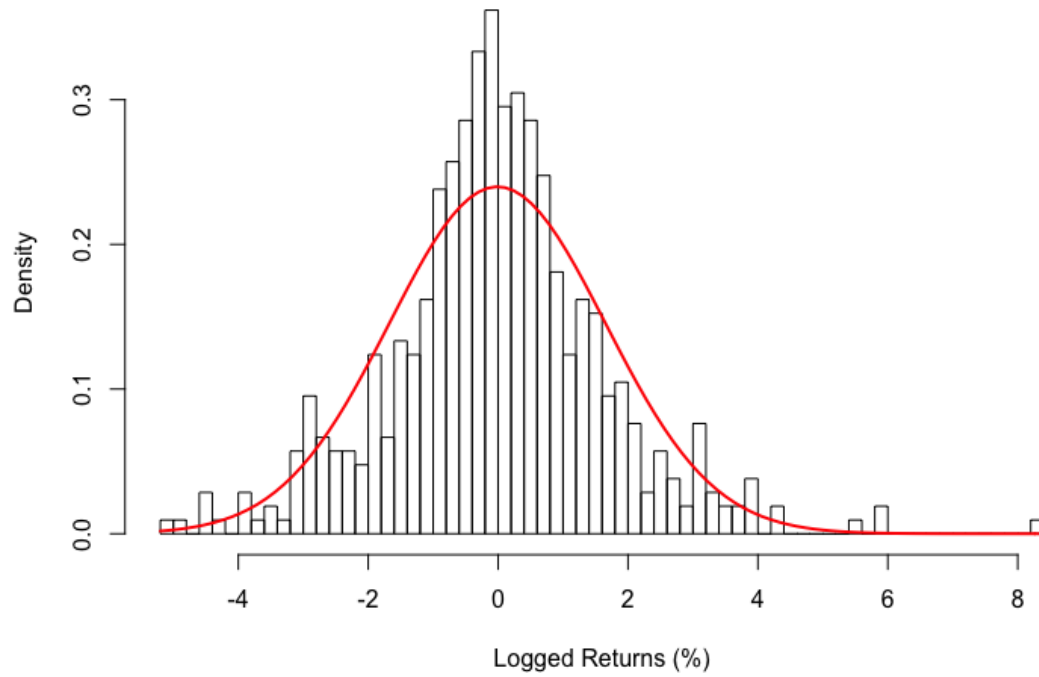
** p <0.05

*** p <0.01

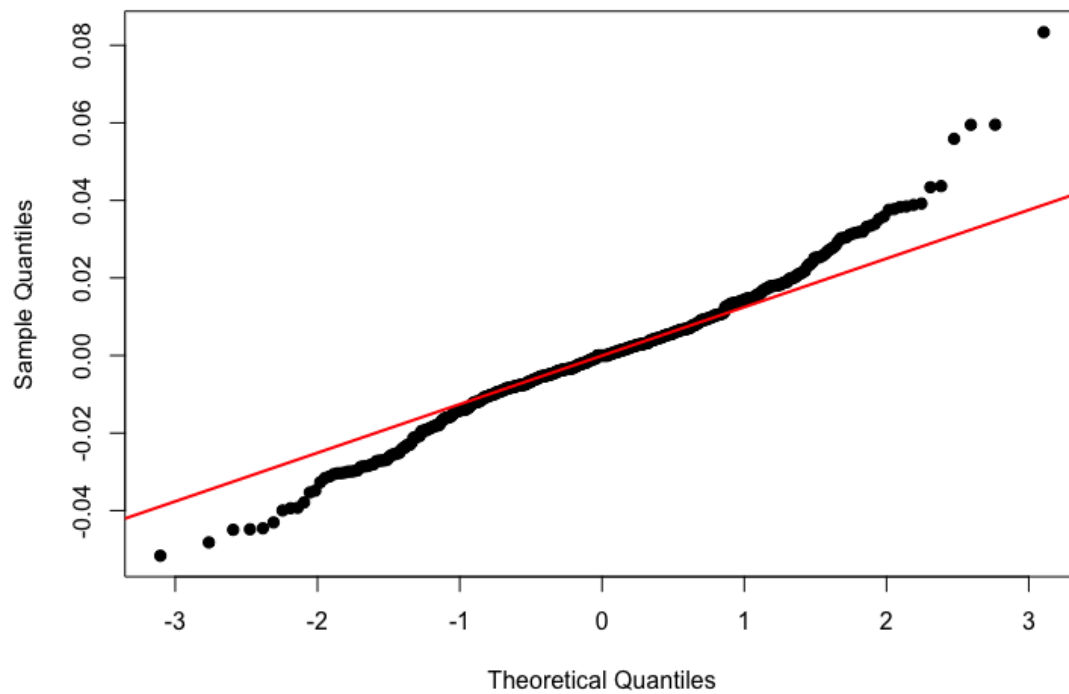
Normality Test Statistics					
	AD	LF	SW	JB	DP
TFG	1.8948***	0.053958***	0.97648***	161.52***	1.28960

D.33 Tsogo Sun Holdings

Histogram of Tsogo Sun Holdings



Normal Q-Q Plot for Tsogo Sun Holdings



*p <0.1

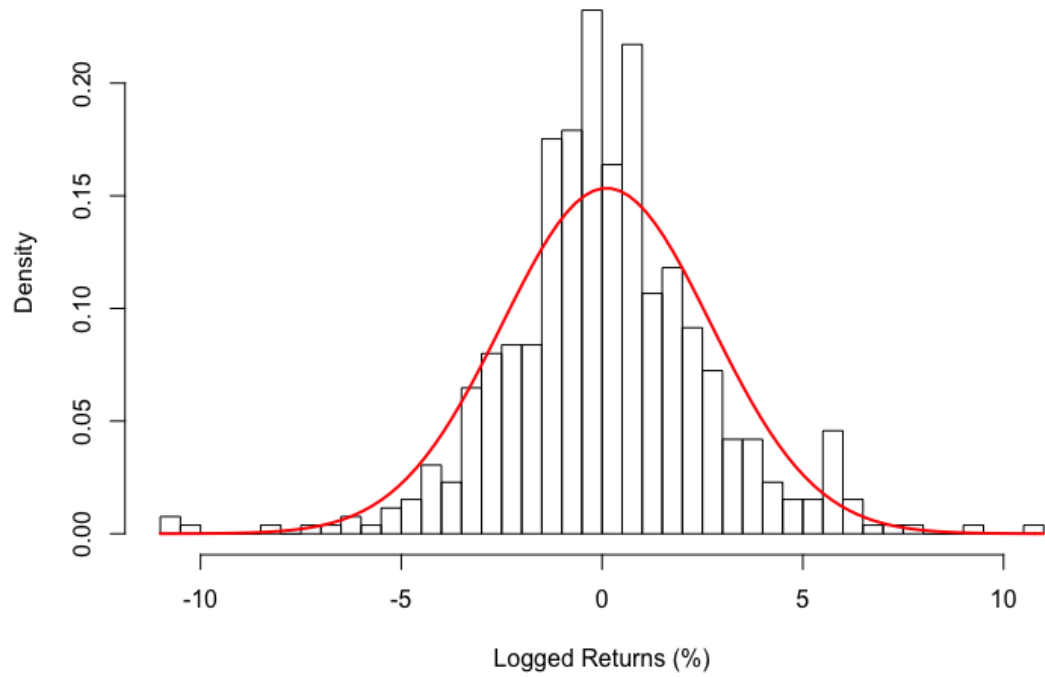
** p <0.05

*** p <0.01

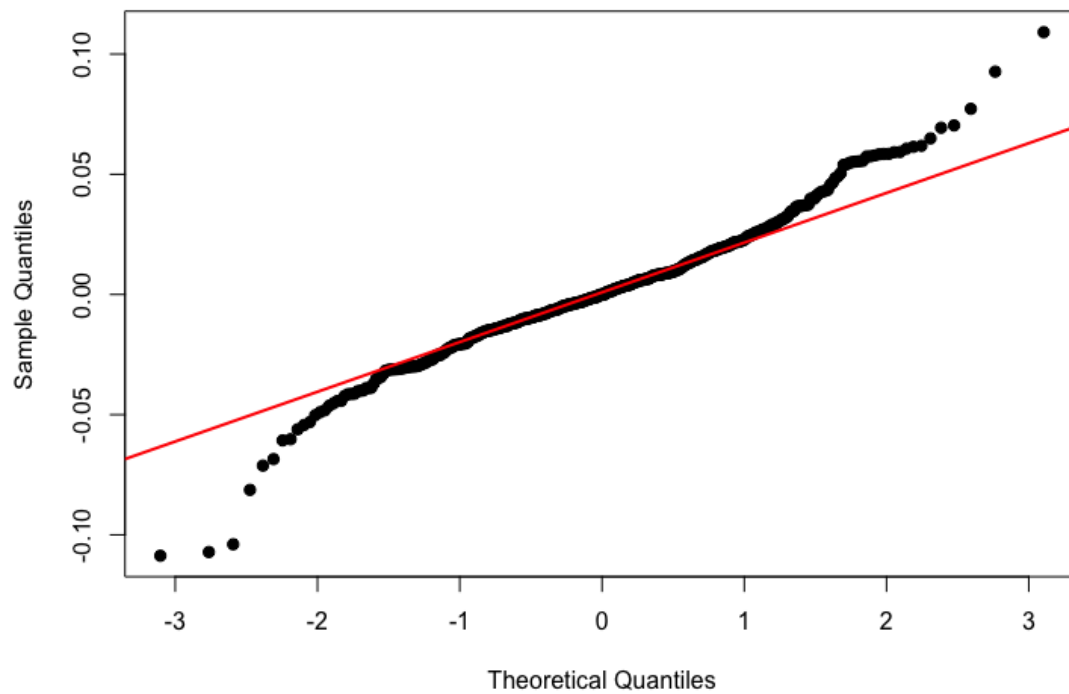
Normality Test Statistics					
	AD	LF	SW	JB	DP
Tsogo Sun Holdings	3.3695***	0.06506***	0.97558***	90.236***	3.02500***

D.34 Imperial Logistics

Histogram of Imperial Logistics



Normal Q-Q Plot for Imperial Logistics



*p <0.1

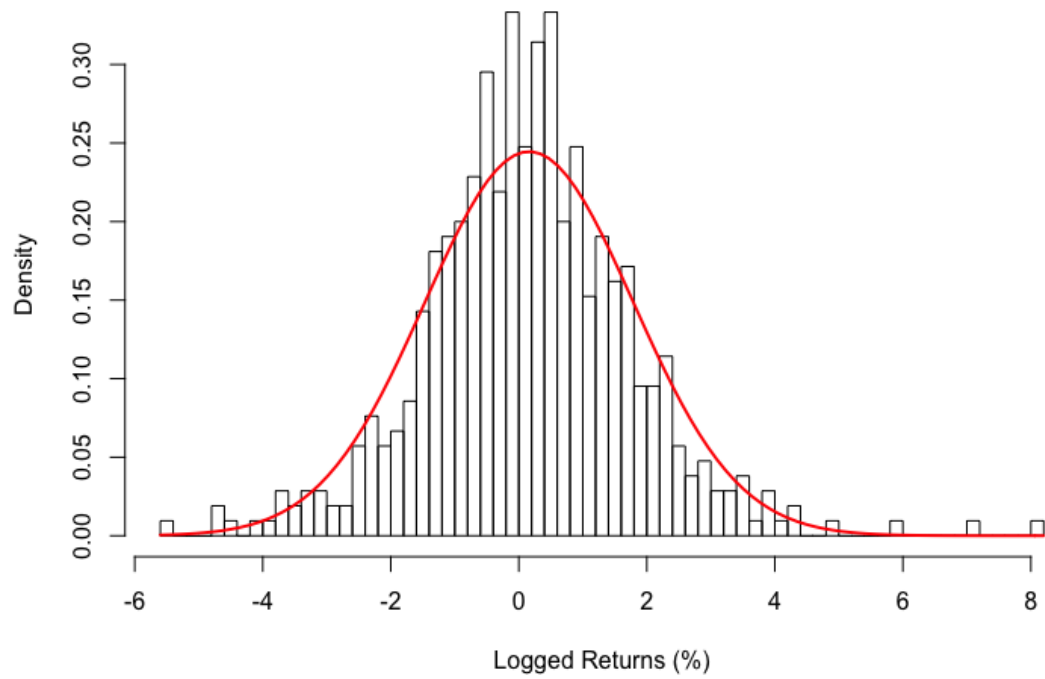
** p <0.05

*** p <0.01

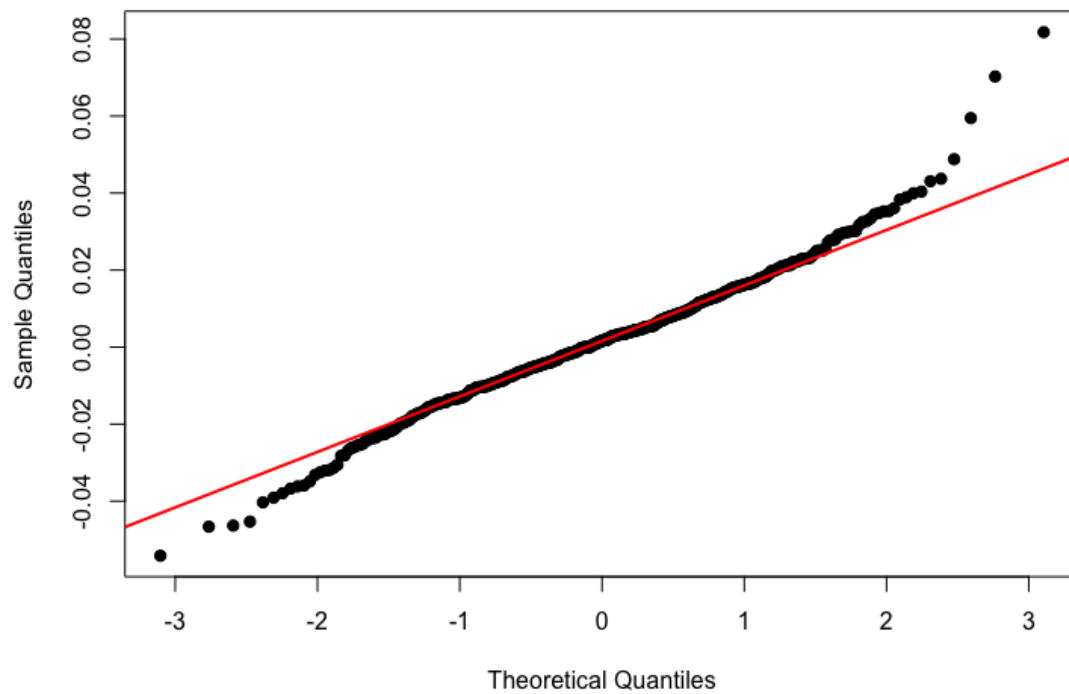
Normality Test Statistics					
	AD	LF	SW	JB	DP
Imperial Logistics	3.6888***	0.06709***	0.97028***	107.98***	-0.0572870

D.35 Clicks Group

Histogram of Clicks Group



Normal Q-Q Plot for Clicks Group



*p <0.1

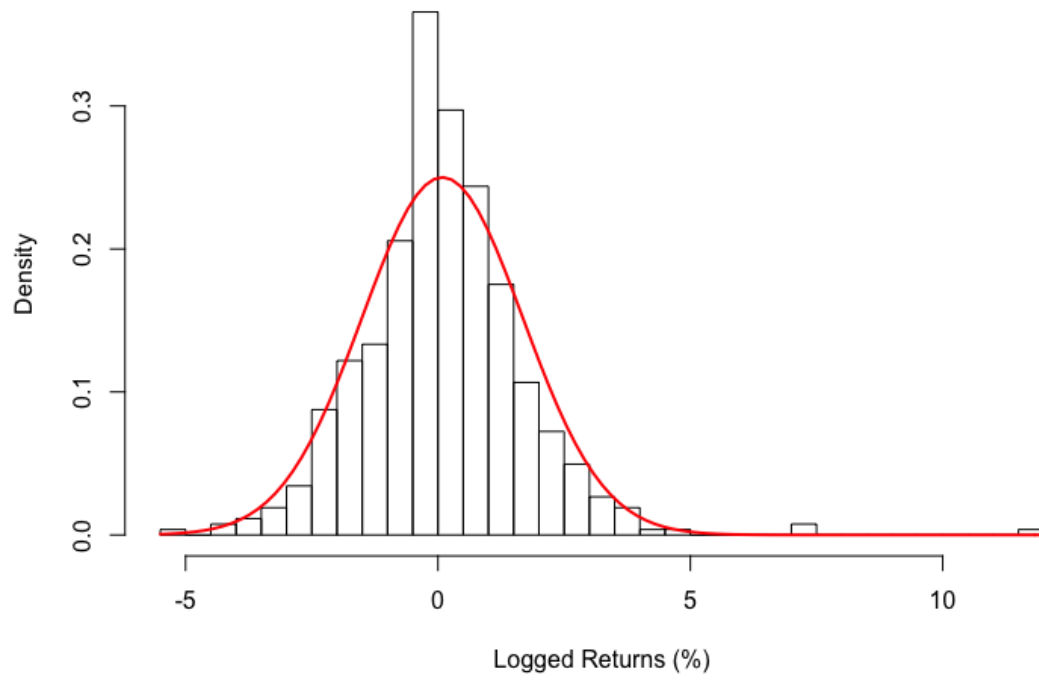
** p <0.05

*** p <0.01

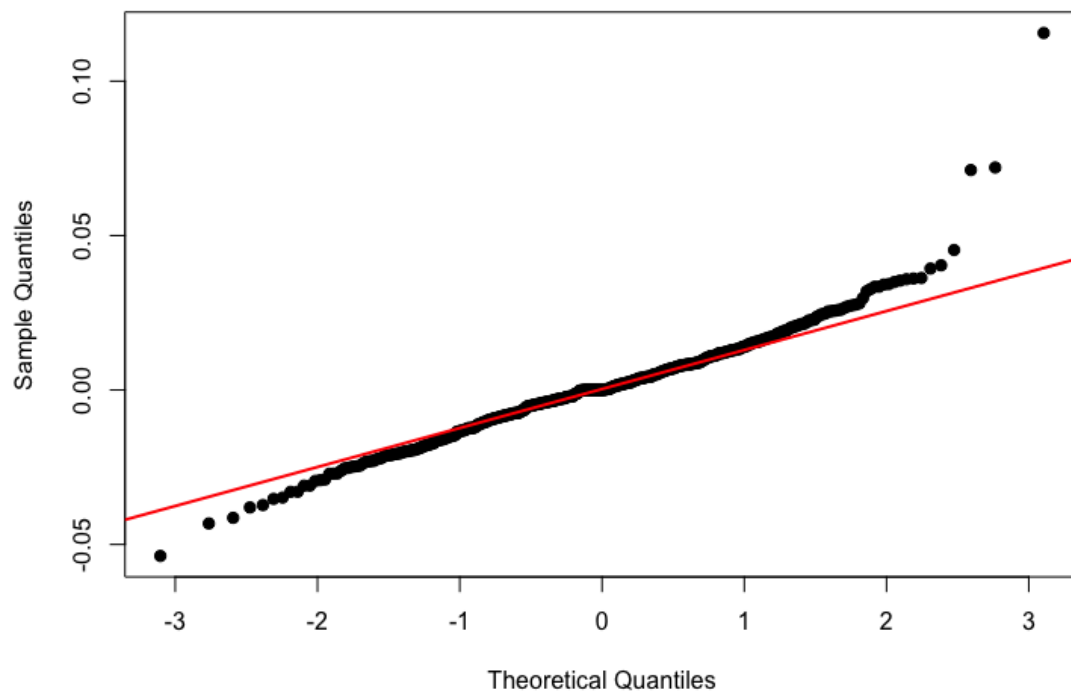
Normality Test Statistics					
	AD	LF	SW	JB	DP
Clicks Group	1.7876***	0.046316***	0.98036***	91.413***	2.6042***

D.36 Santam

Histogram of Santam



Normal Q-Q Plot for Santam



*p <0.1

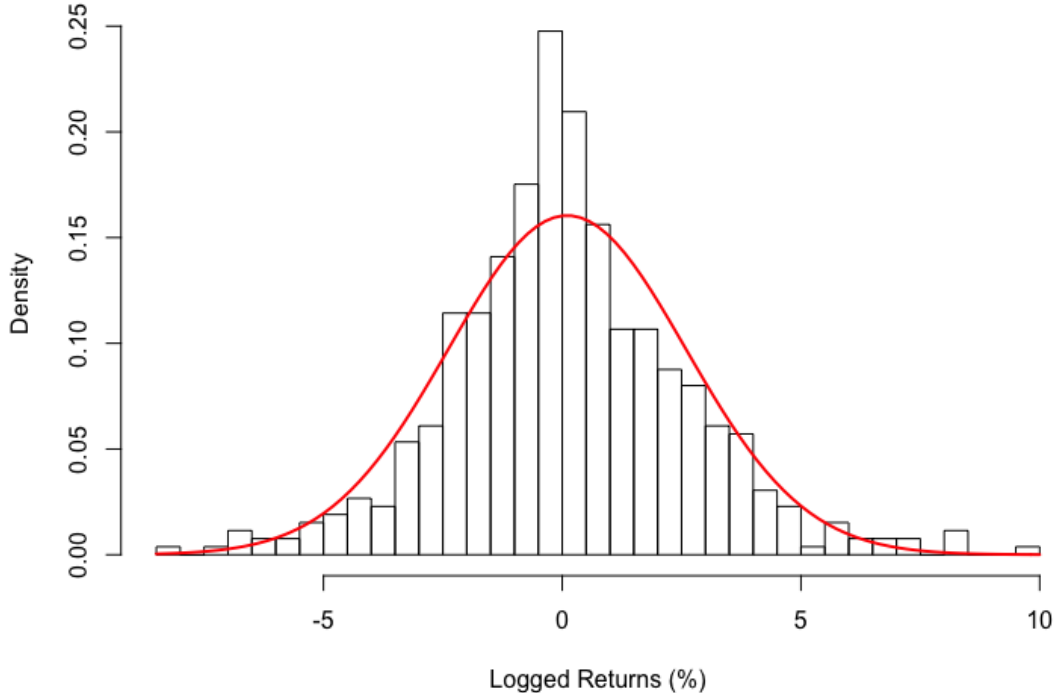
** p <0.05

*** p <0.01

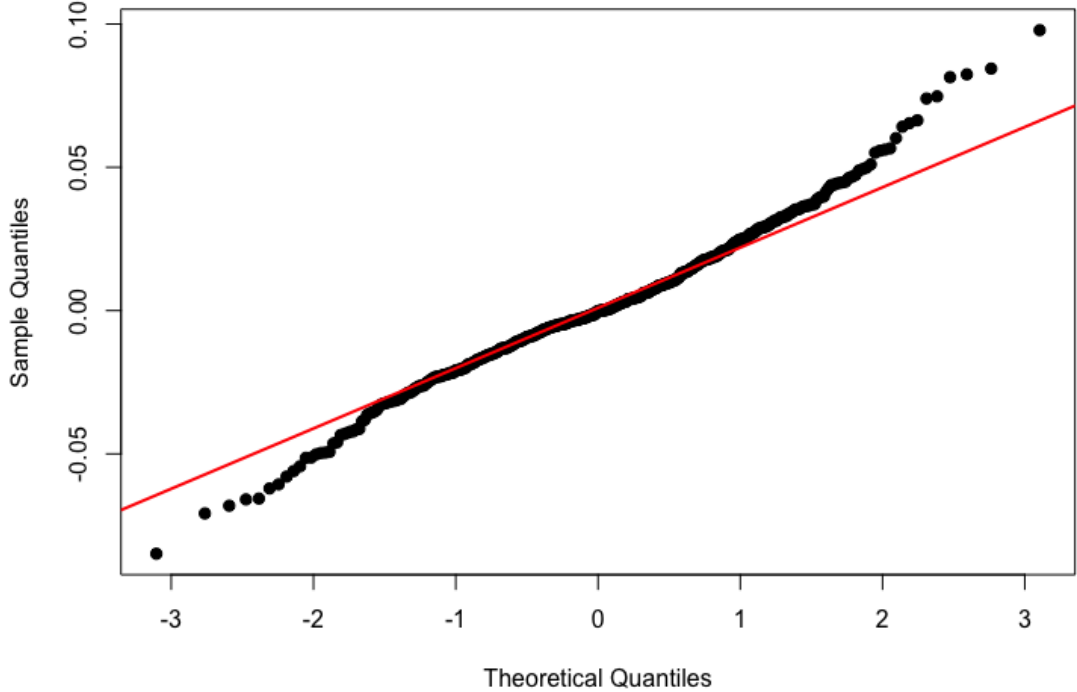
Normality Test Statistics					
	AD	LF	SW	JB	DP
Santam	3.0002***	0.061016***	0.94774***	865.22***	7.60140***

D.37 Massmart Holdings

Histogram of Massmart Holdings



Normal Q-Q Plot for Massmart Holdings



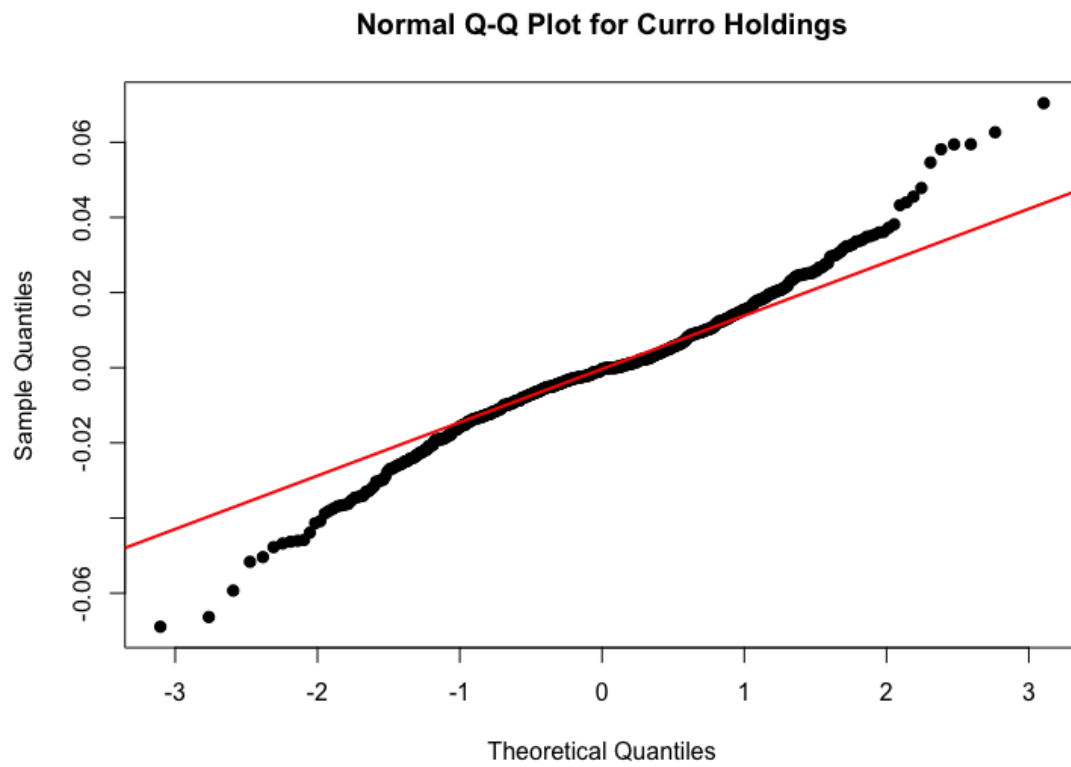
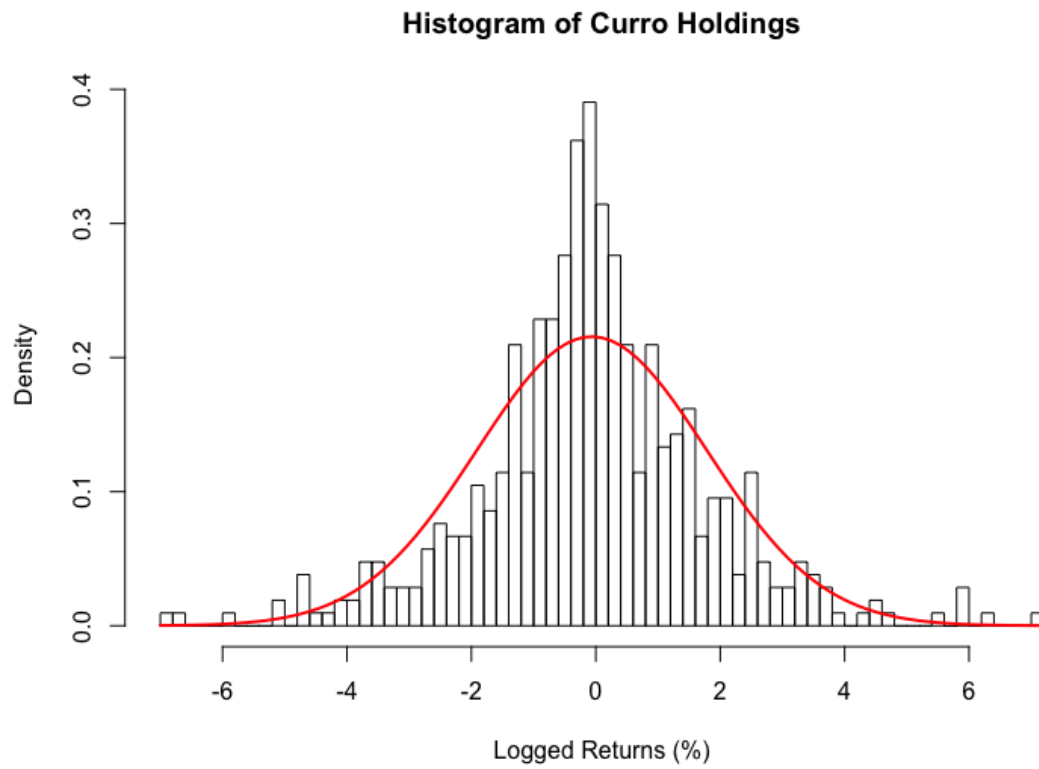
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Massmart Holdings	2.4081***	0.057014***	0.98449***	36.049***	2.26970**

D.38 Curro Holdings



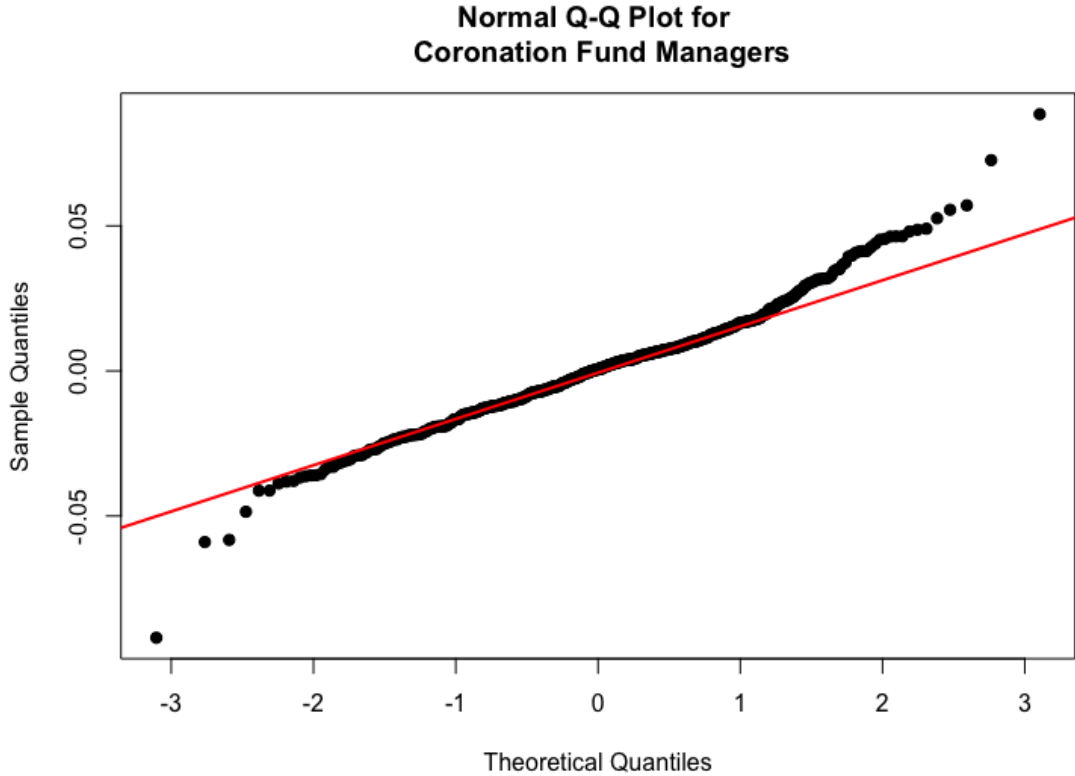
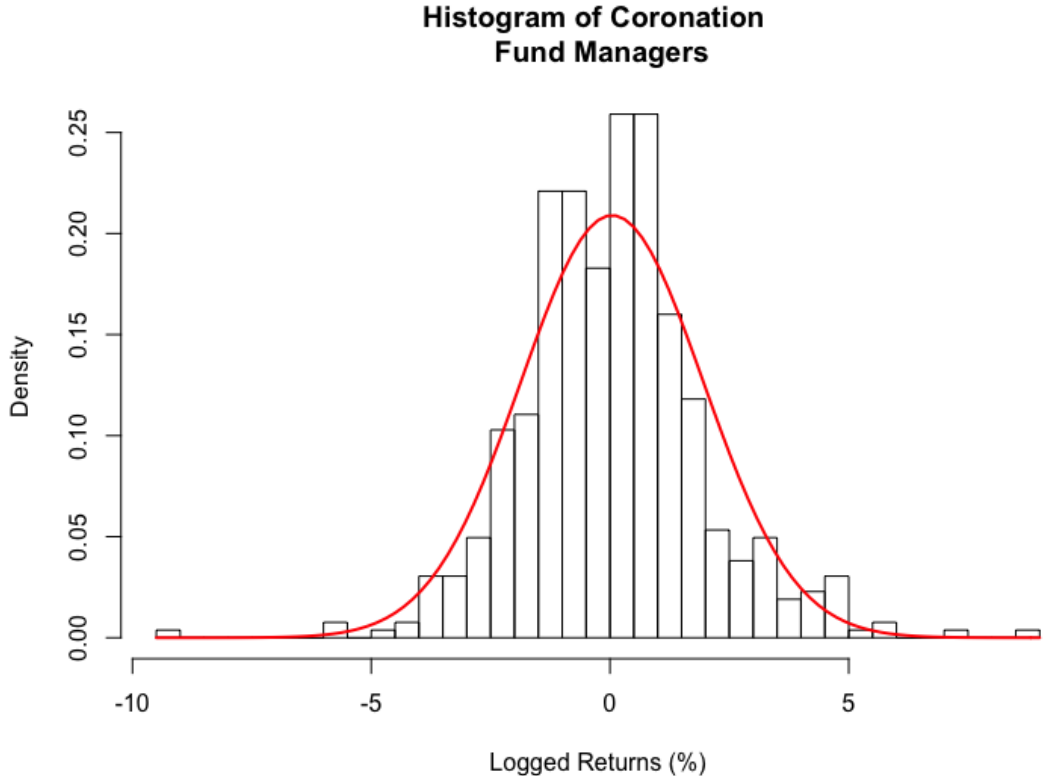
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Curro Holdings	4.216***	0.064994***	0.97558***	58.461***	0.460830

D.39 Coronation Fund Managers



		Normality Test Statistics				
		AD	LF	SW	JB	DP
Coronation Managers	Fund	2.6165***	0.061845***	0.97536***	109***	2.37460**

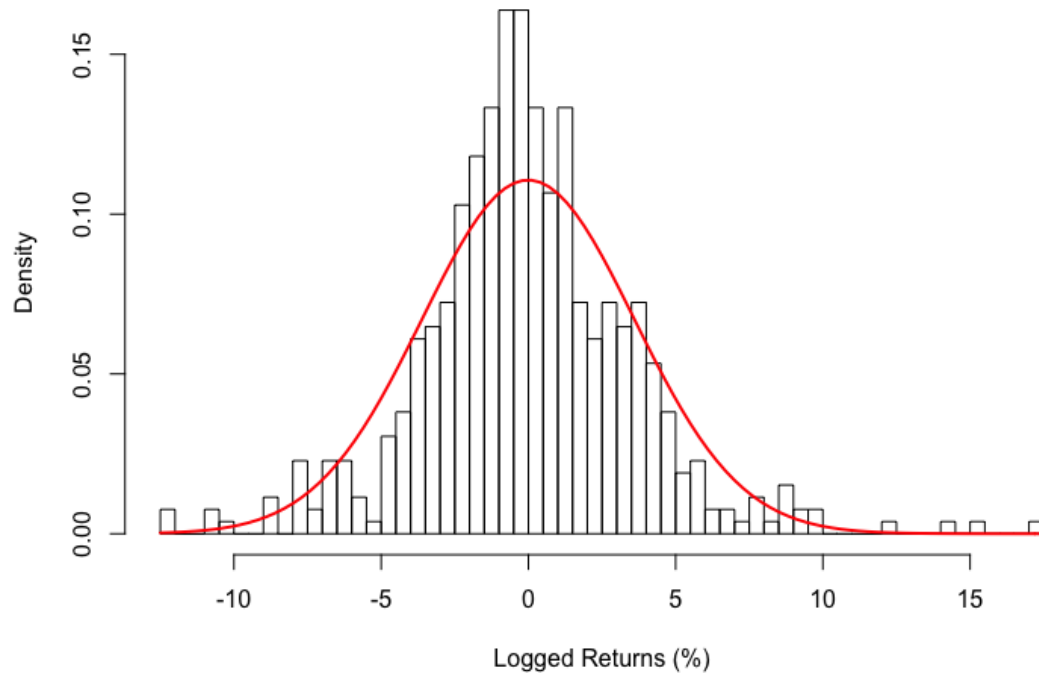
*p < 0.1

** p < 0.05

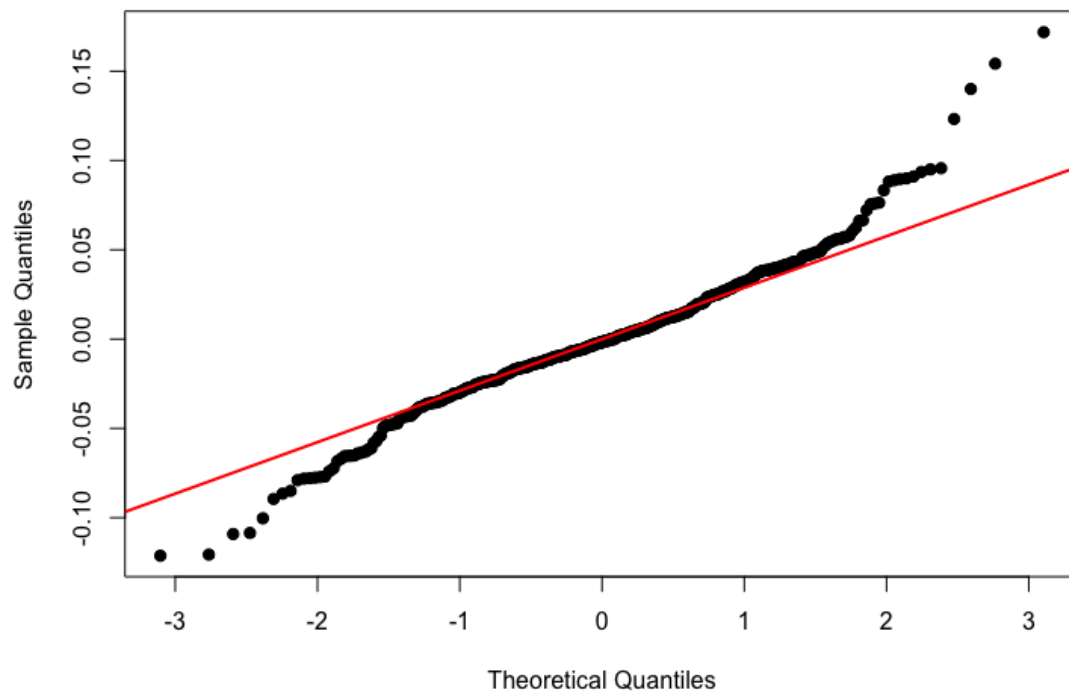
*** p < 0.01

D.40 Impala Platinum

Histogram of Impala Platinum



Normal Q-Q Plot for Impala Platinum



*p <0.1

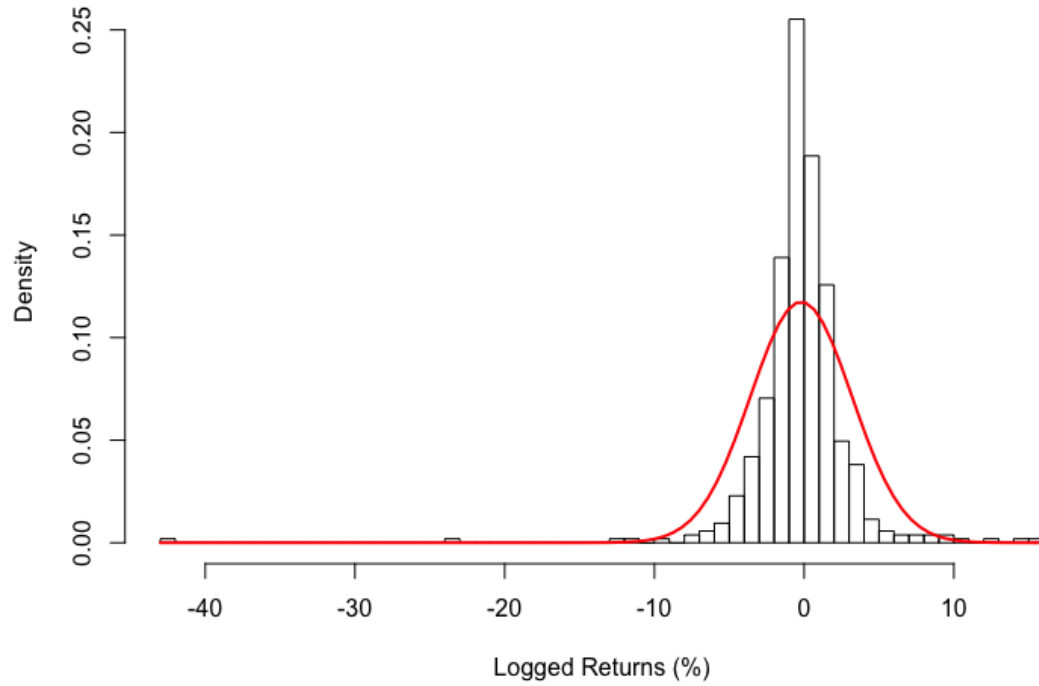
** p <0.05

*** p <0.01

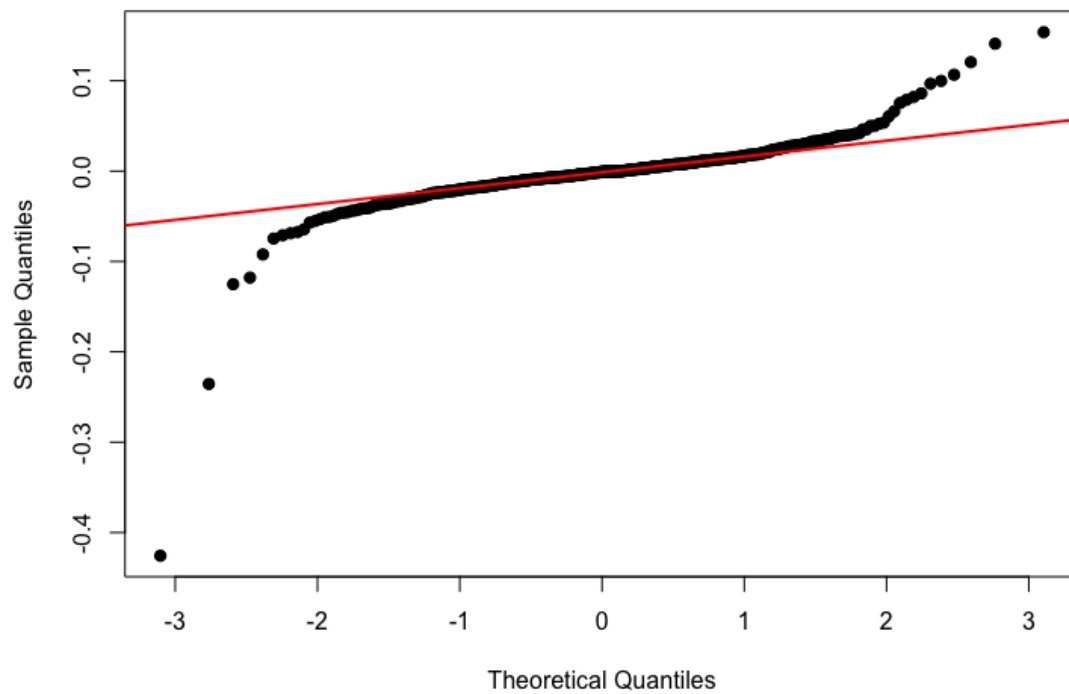
Normality Test Statistics					
	AD	LF	SW	JB	DP
Impala Platinum	3.7026***	0.063917***	0.96806***	139.96***	3.27790***

D.41 EOH Holdings

Histogram of EOH Holdings



Normal Q-Q Plot for EOH Holdings



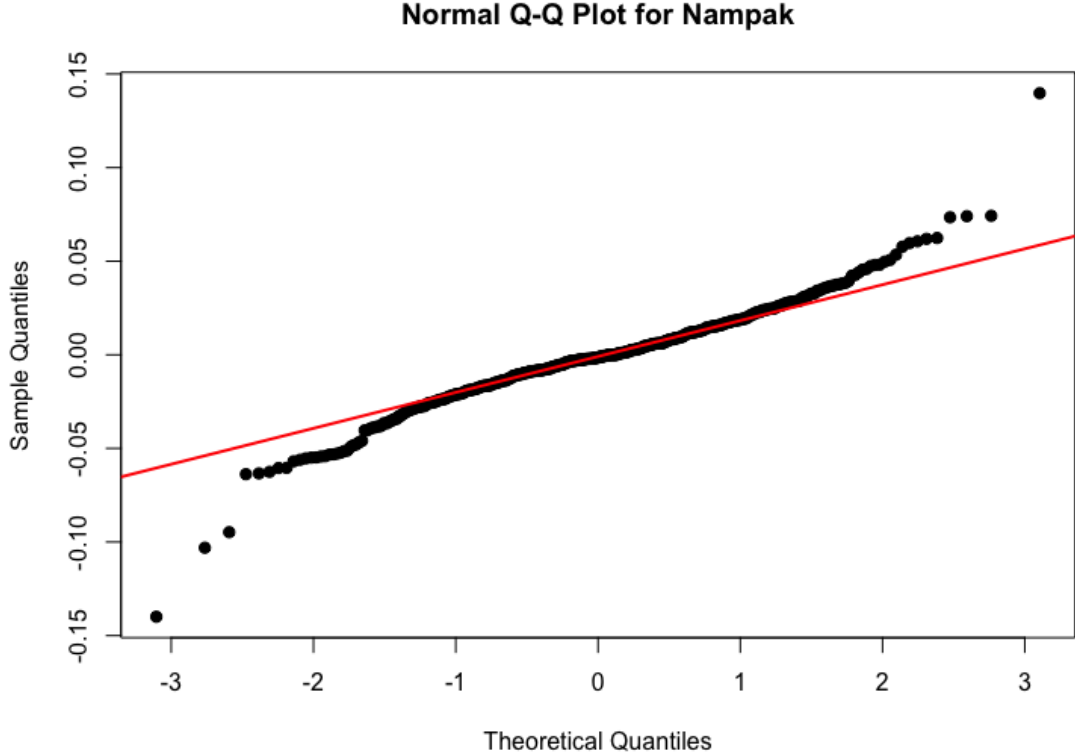
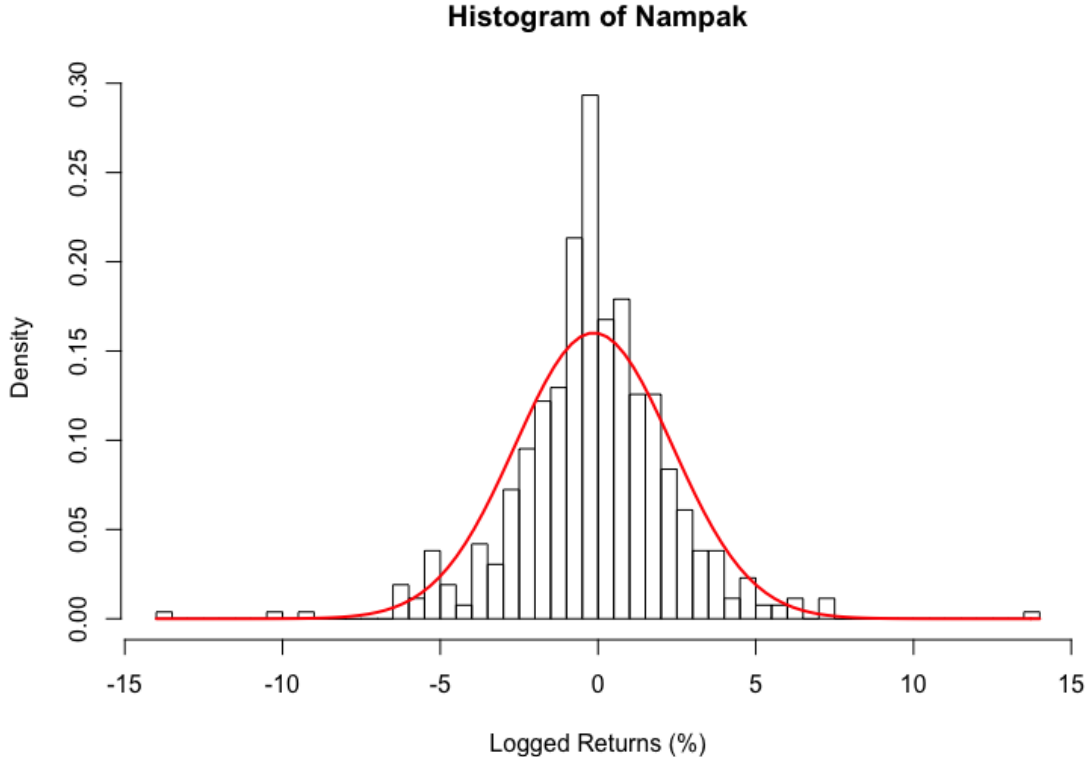
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
EOH Holdings	25.508***	0.13923***	0.70424***	59013***	-17.7520***

D.42 Nampak



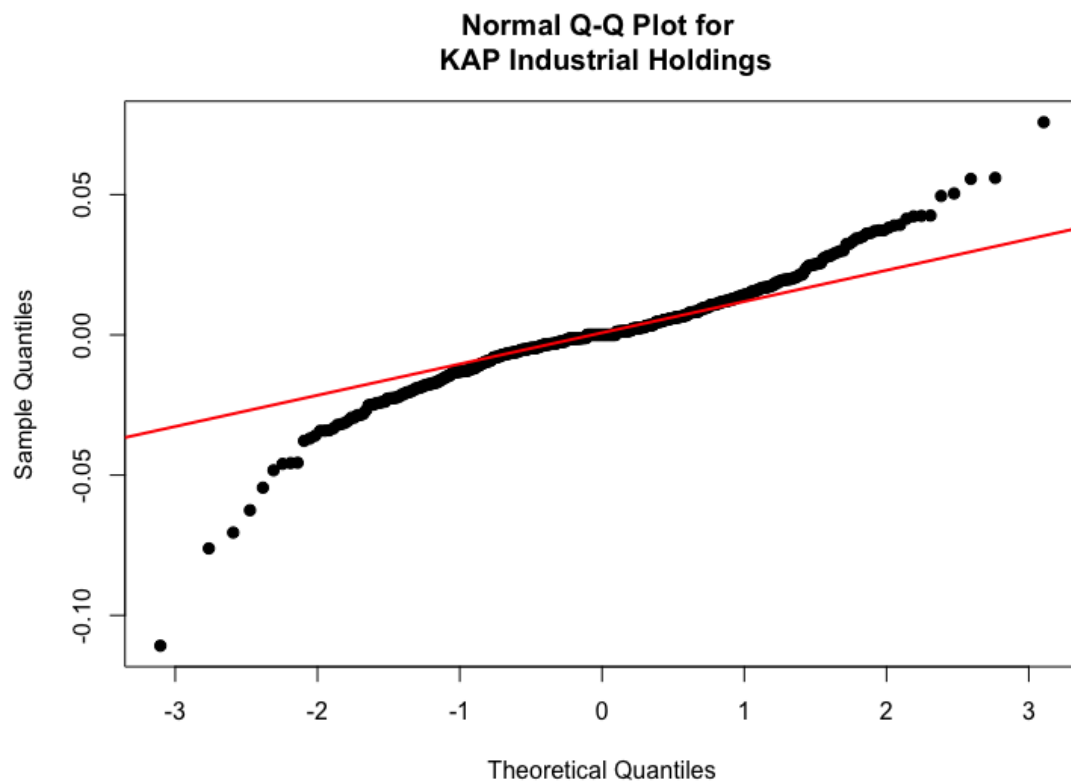
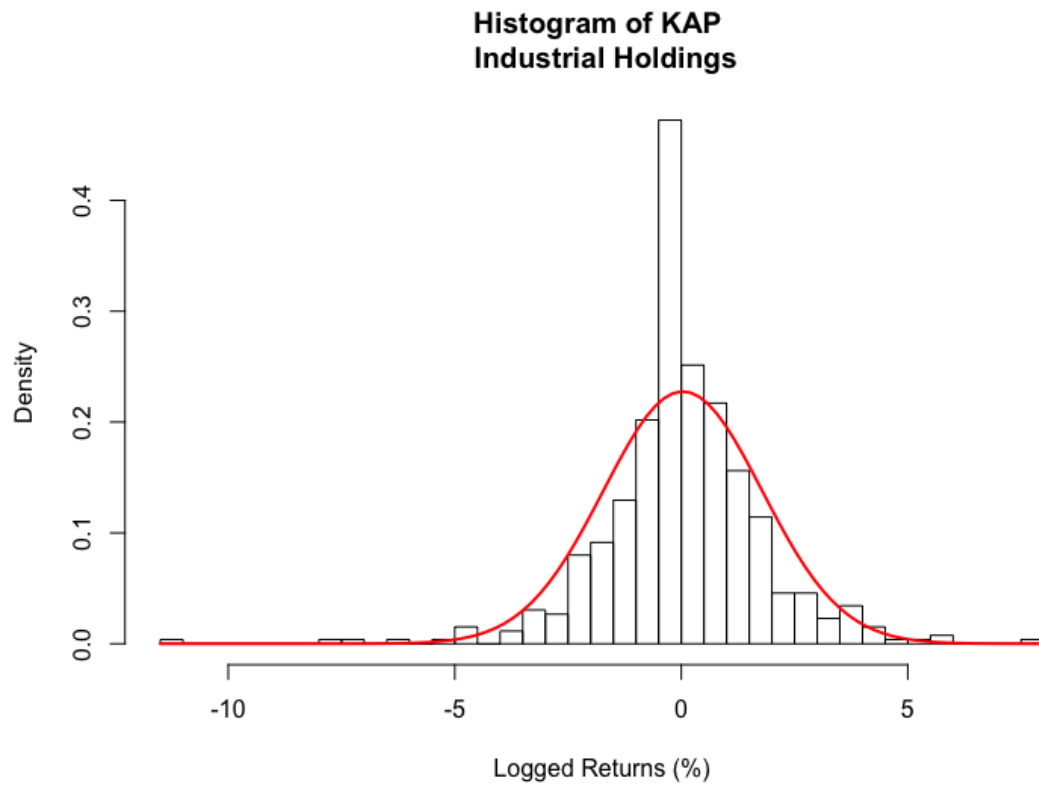
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Nampak	4.8791***	0.070909***	0.95252***	417.6***	-1.30700

D.43 KAP Industrial Holdings



		Normality Test Statistics				
		AD	LF	SW	JB	DP
KAP Holdings	Industrial	7.9099***	0.094578***	0.93605***	586.45***	-4.72450***

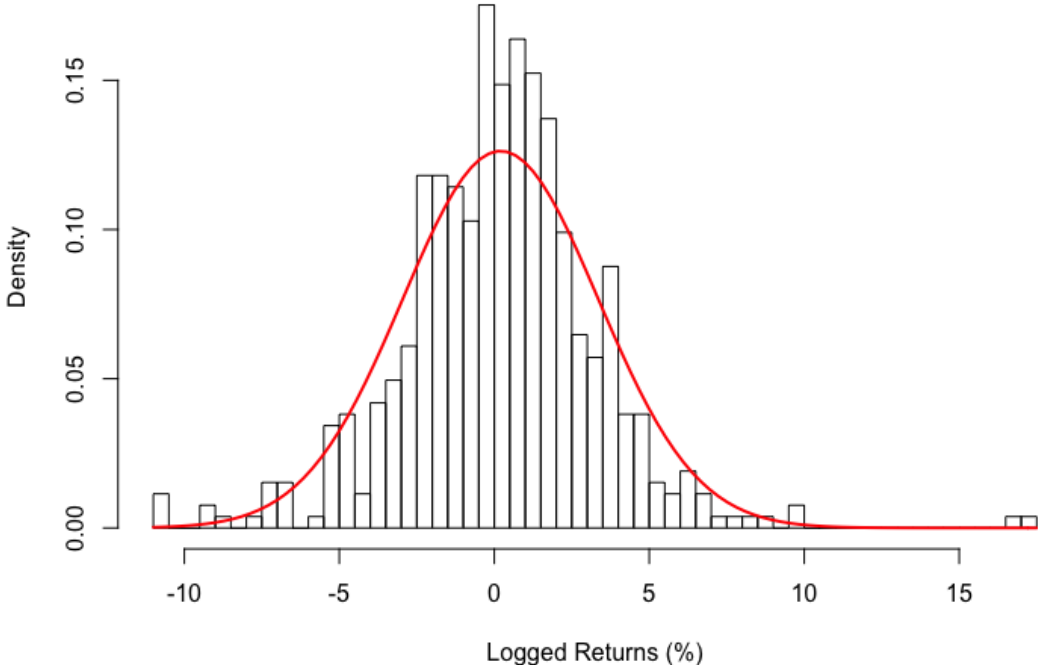
*p <0.1

** p <0.05

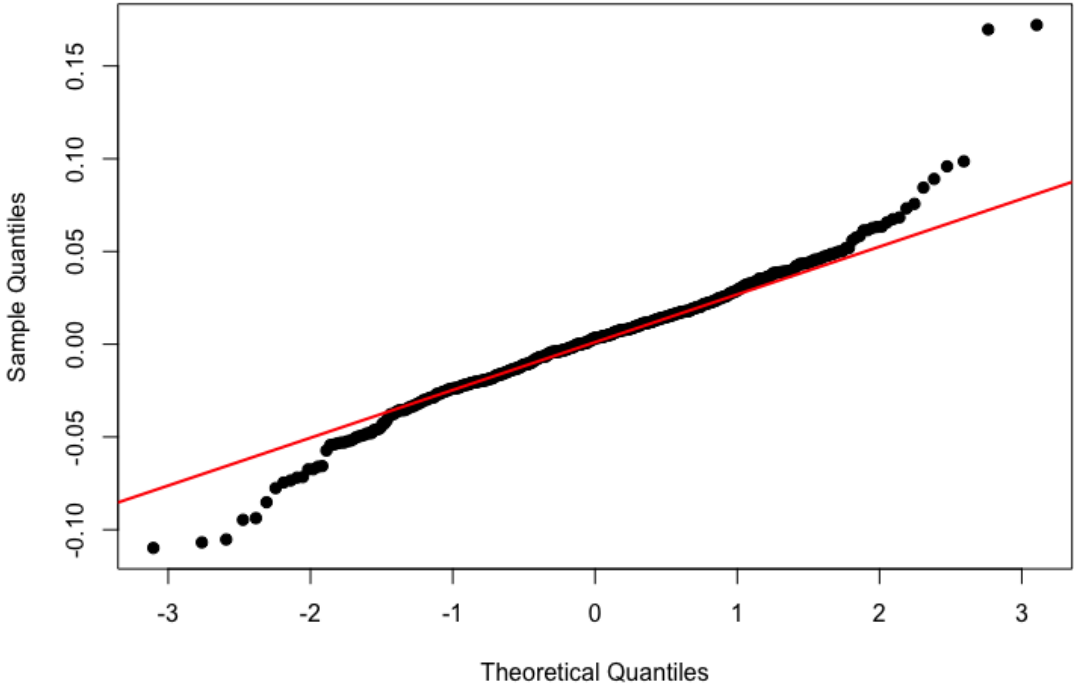
*** p <0.01

D.44 Exxaro Resources

Histogram of Exxaro Resources



Normal Q-Q Plot for Exxaro Resources



*p <0.1

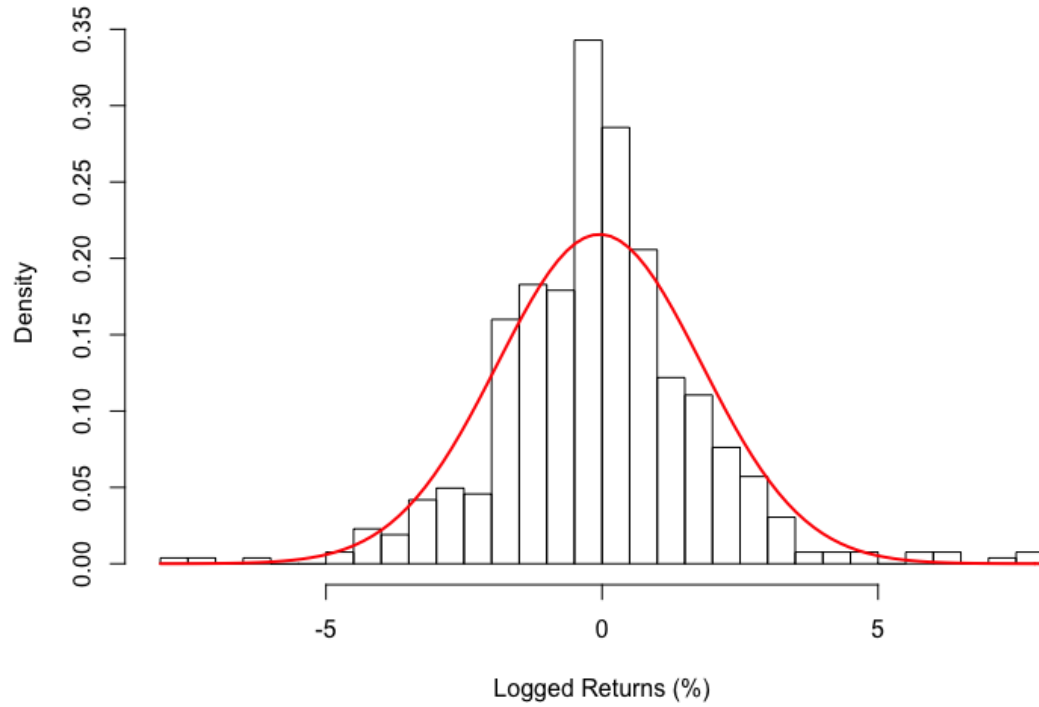
** p <0.05

*** p <0.01

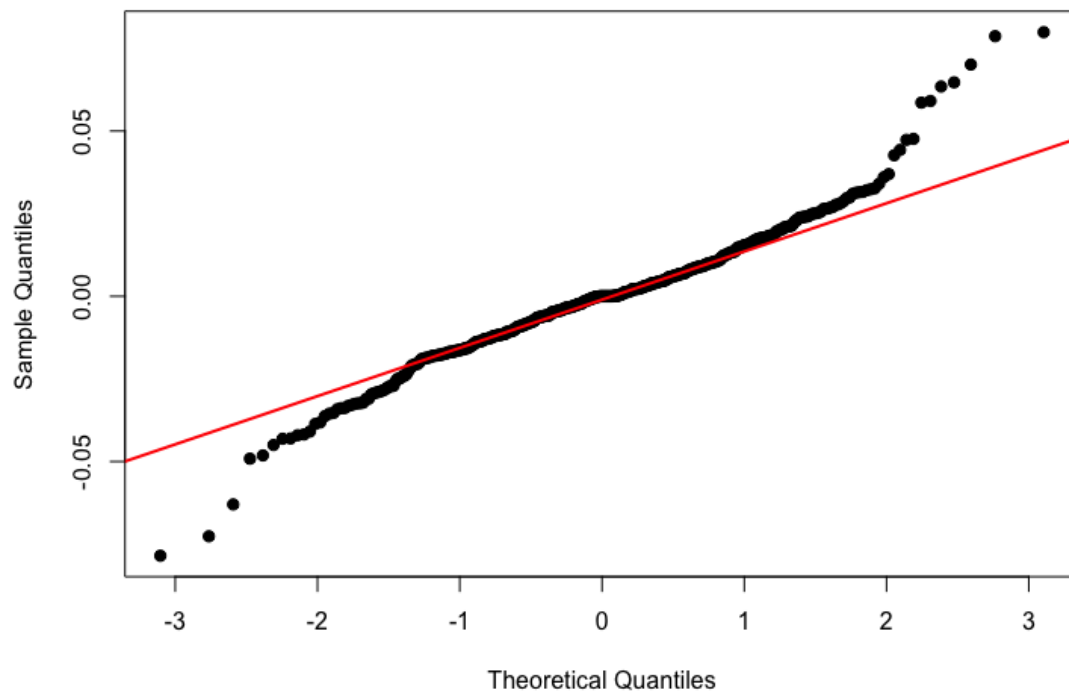
Normality Test Statistics					
	AD	LF	SW	JB	DP
Exxaro Resources	3.0197***	0.053527***	0.96107***	282.54***	2.63360***

D.45 Oceana Group

Histogram of Oceana Group



Normal Q-Q Plot for Oceana Group



*p <0.1

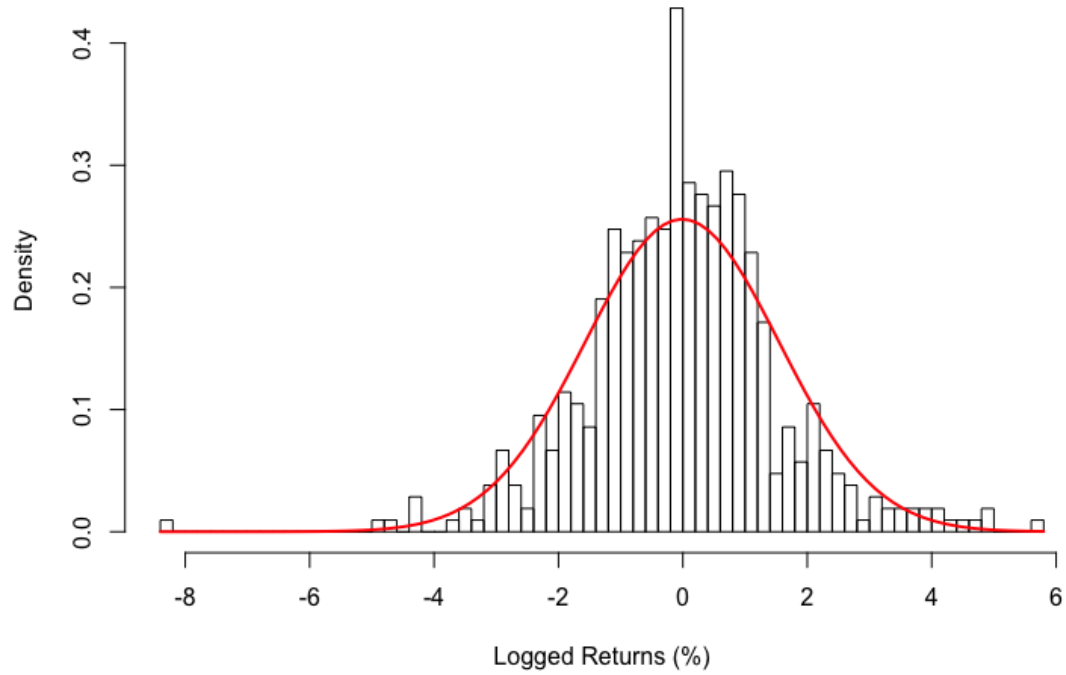
** p <0.05

*** p <0.01

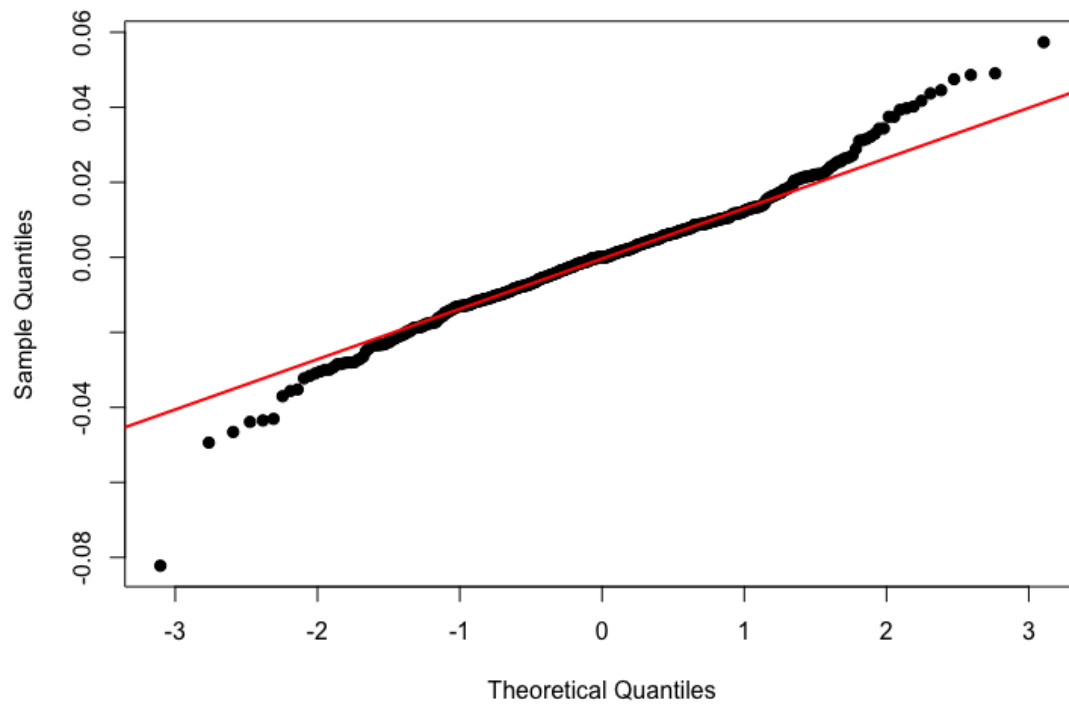
Normality Test Statistics					
	AD	LF	SW	JB	DP
Oceana Group	4.37***	0.066601***	0.96065***	186.93***	2.36930**

D.46 Super Group

Histogram of Super Group



Normal Q-Q Plot for Super Group



*p <0.1

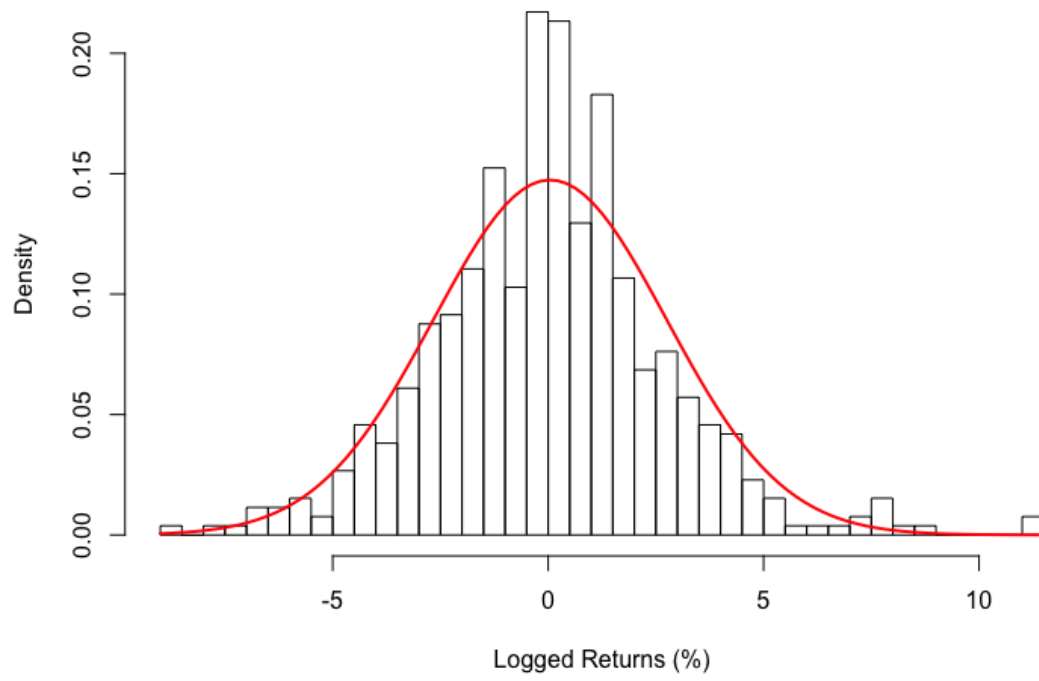
** p <0.05

*** p <0.01

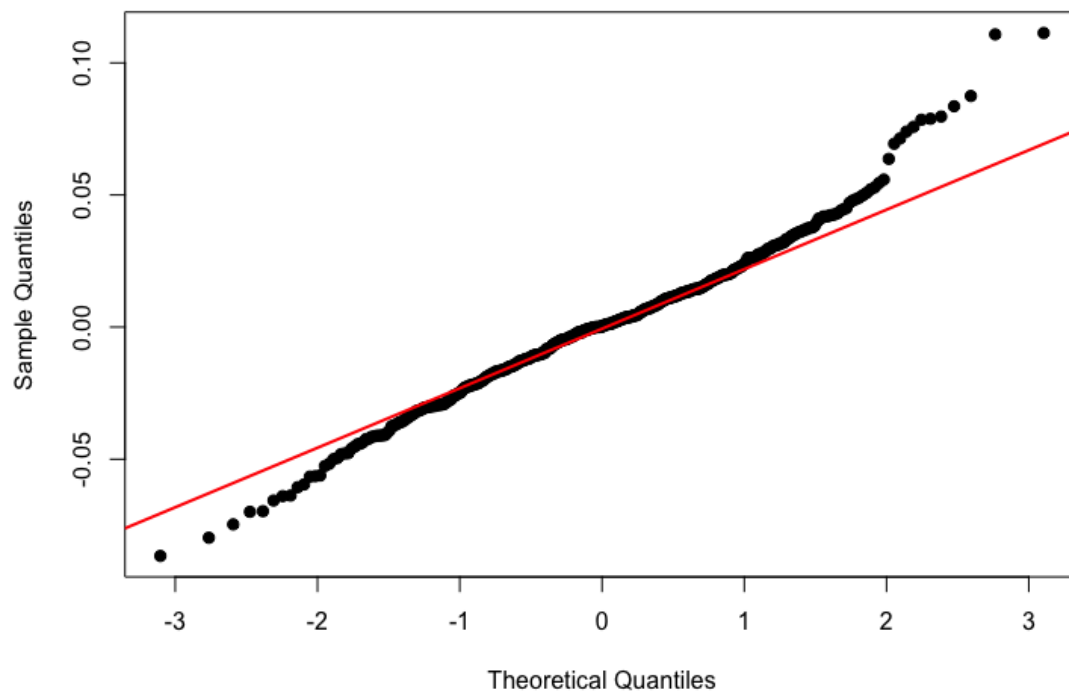
Normality Test Statistics					
	AD	LF	SW	JB	DP
Super Group	2.6568***	0.060437***	0.97584***	108.64***	-0.615900

D.47 Northam Platinum

Histogram of Northam Platinum



Normal Q-Q Plot for Northam Platinum



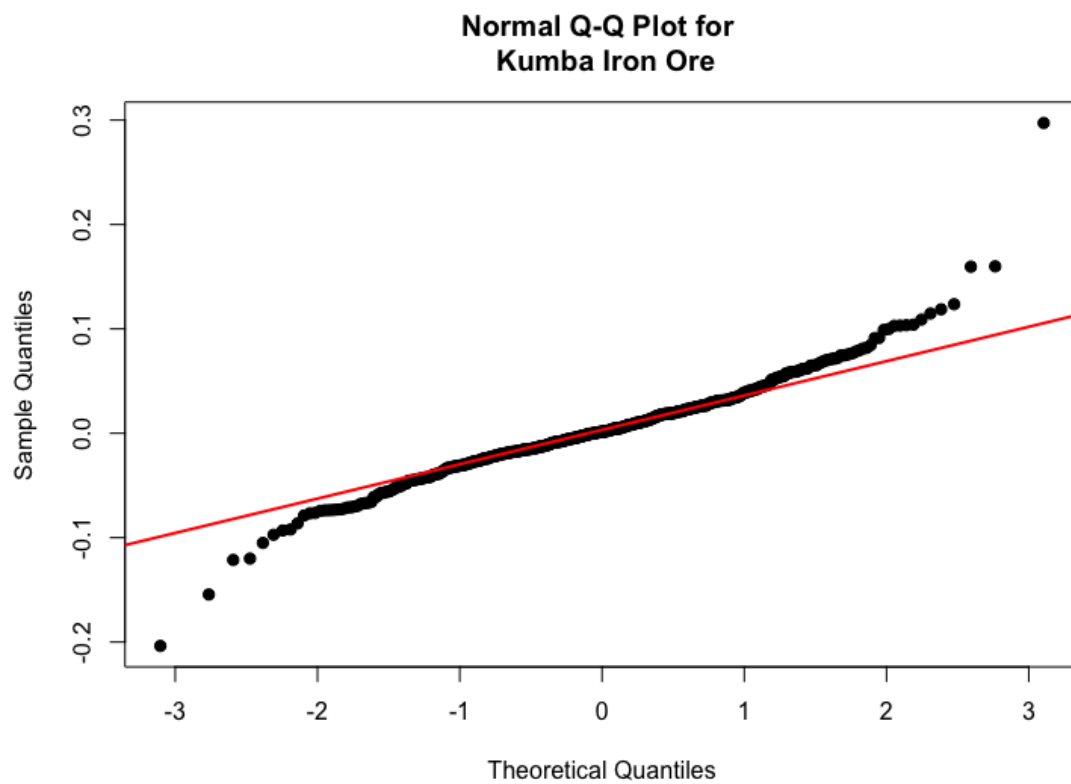
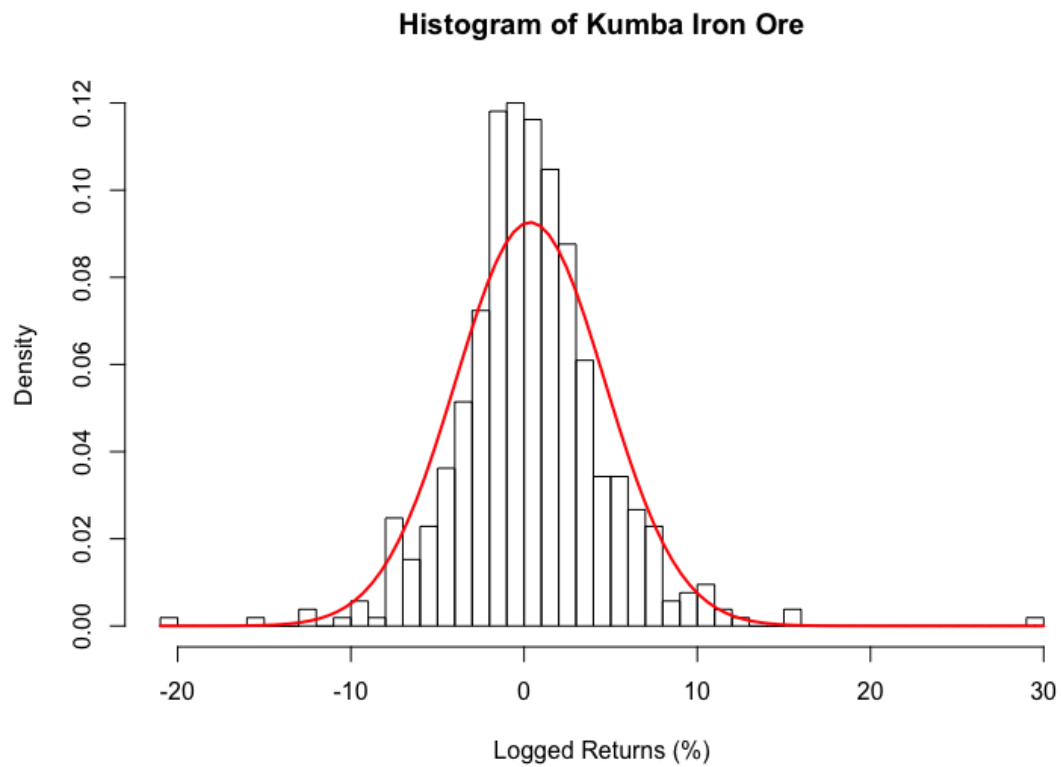
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Northam Platinum	2.0742***	0.054758***	0.982***	54.07***	2.72550***

D.48 Kumba Iron Ore



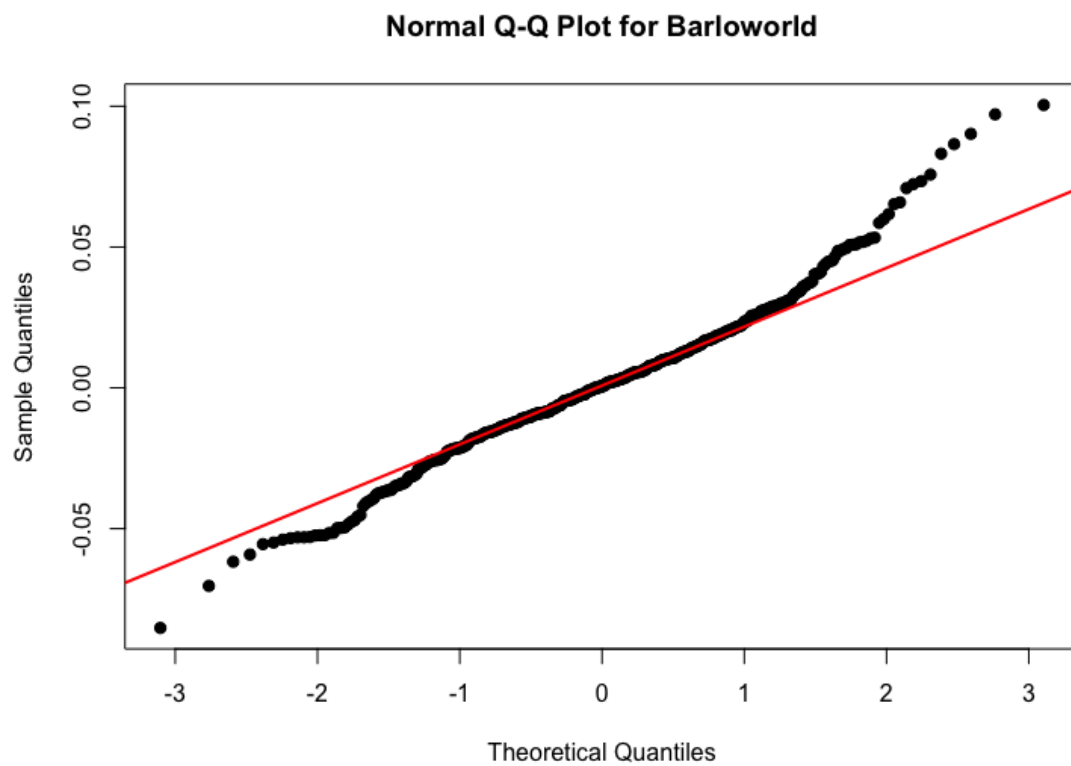
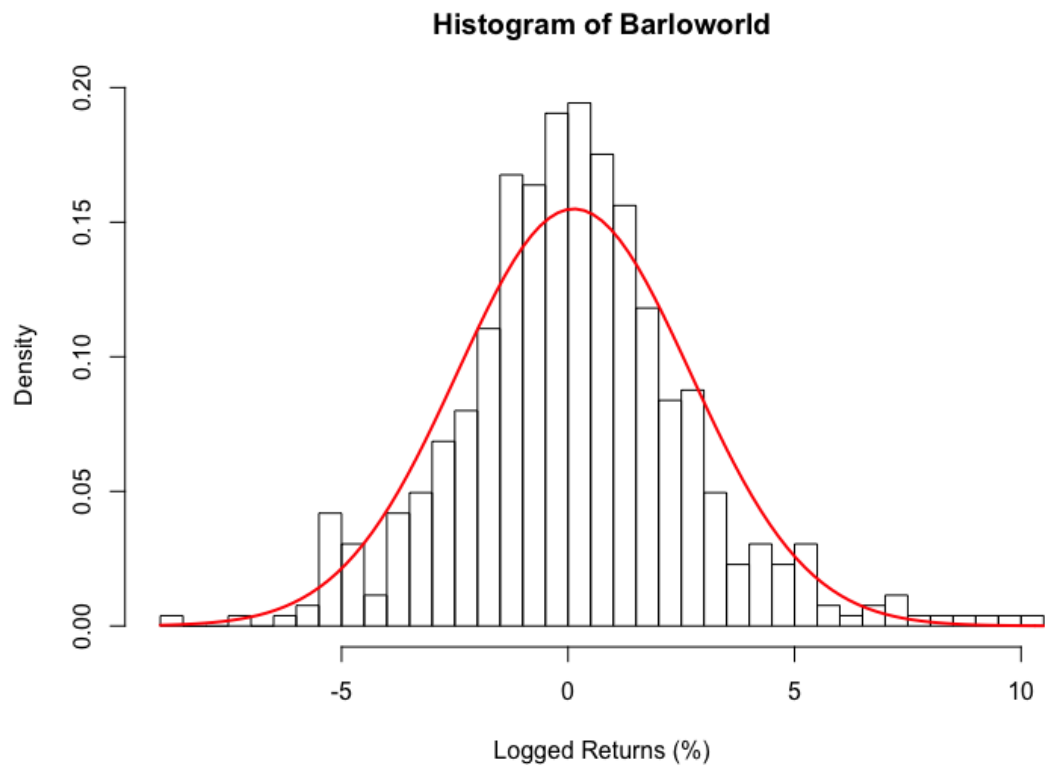
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Kumba Iron Ore	4.0932***	0.068137***	0.94946***	677.44***	4.8135***

D.49 Barloworld



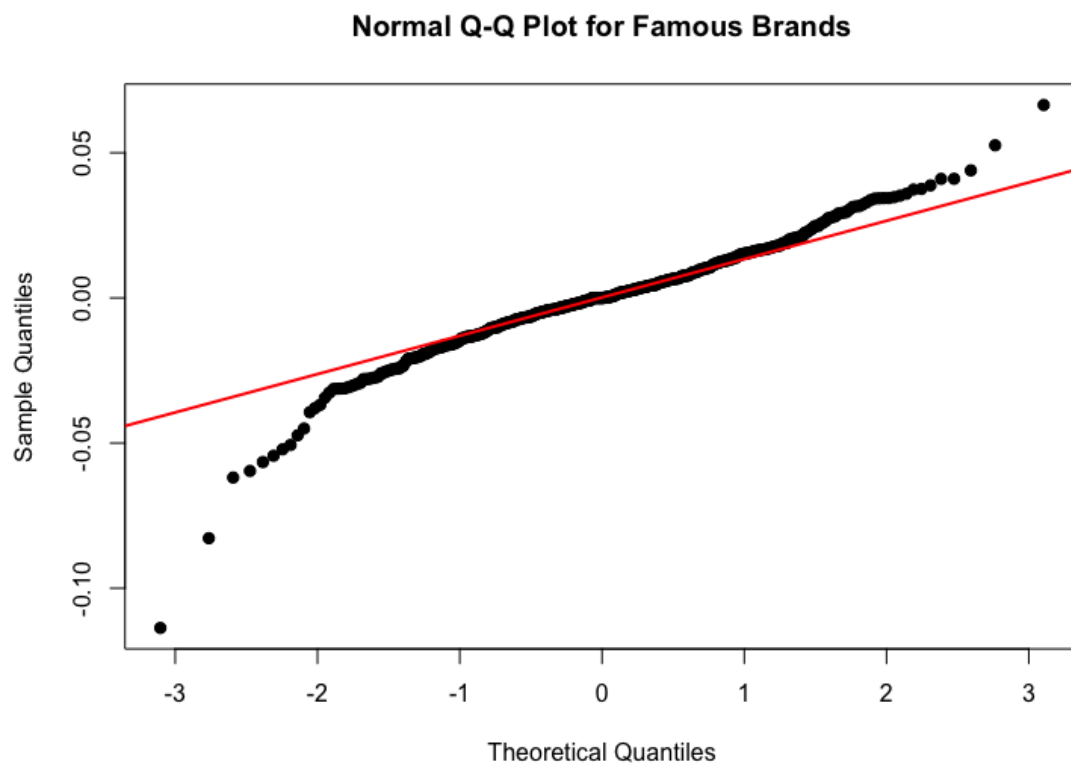
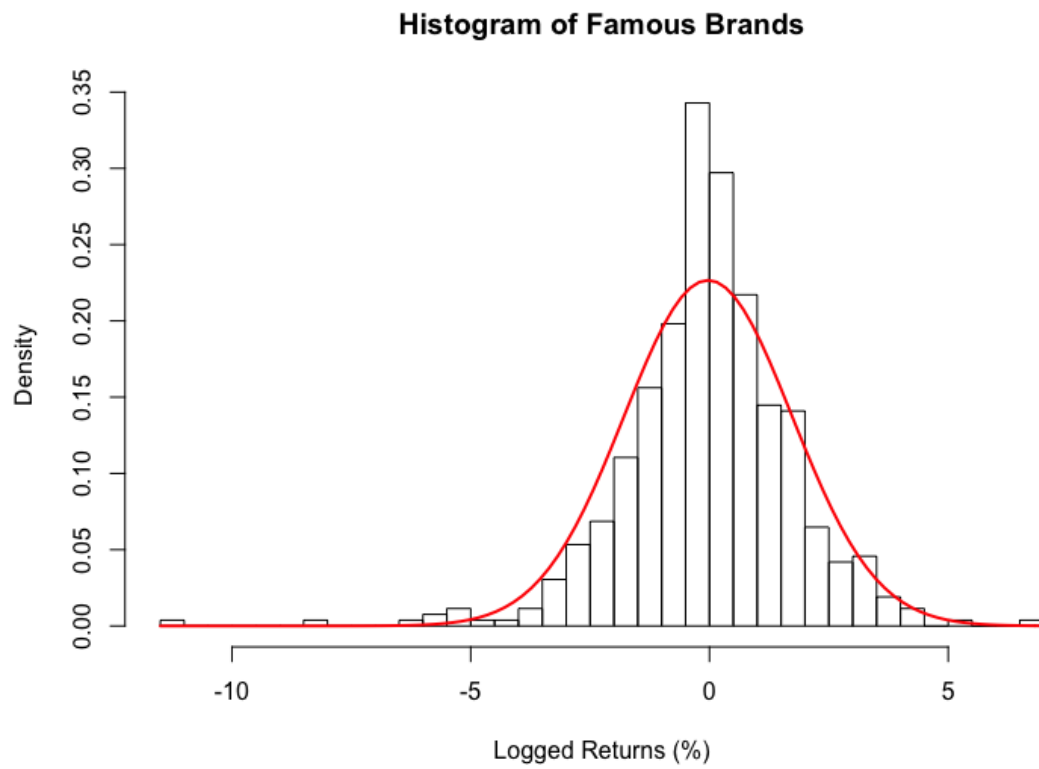
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Barloworld	2.6941***	0.053499***	0.97961***	51.783***	3.4029***

D.50 Famous Brands



*p <0.1

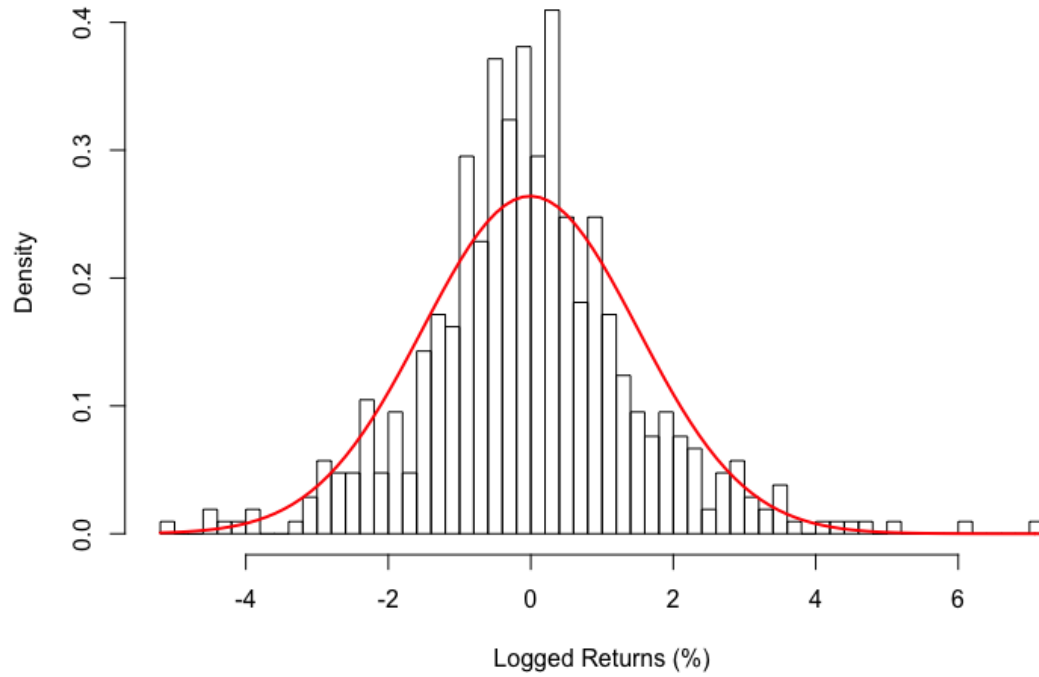
** p <0.05

*** p <0.01

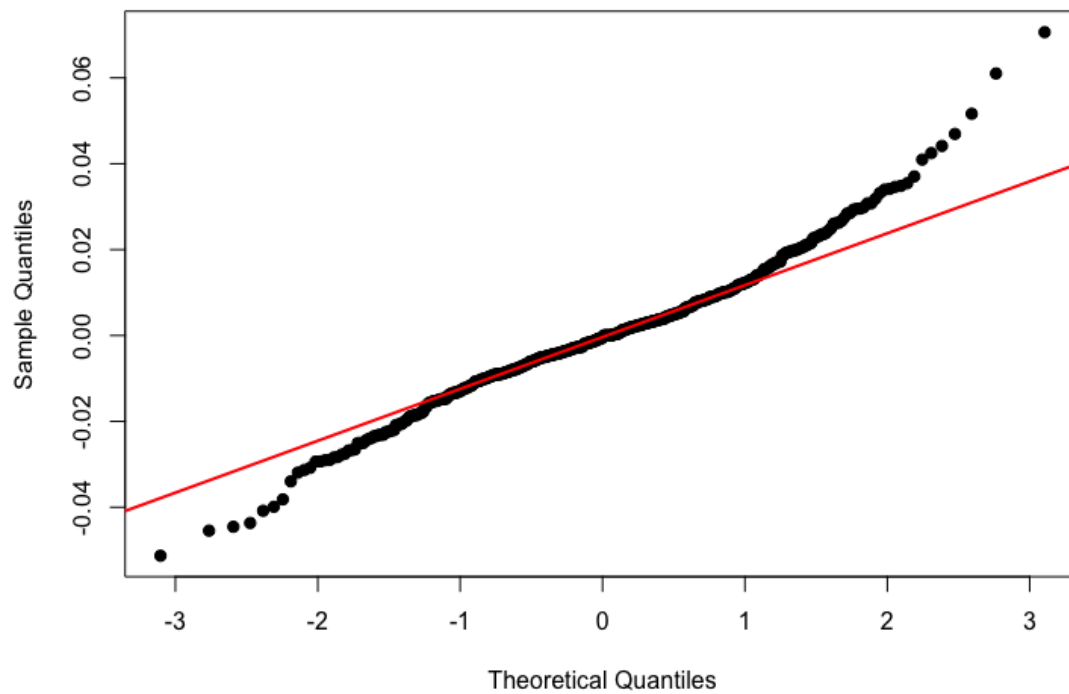
Normality Test Statistics					
	AD	LF	SW	JB	DP
Famous Brands	4.4625***	0.070113***	0.94913***	539.22***	-6.71150***

D.51 Tongaat Hulett

Histogram of Tongaat Hulett



Normal Q-Q Plot for Tongaat Hulett



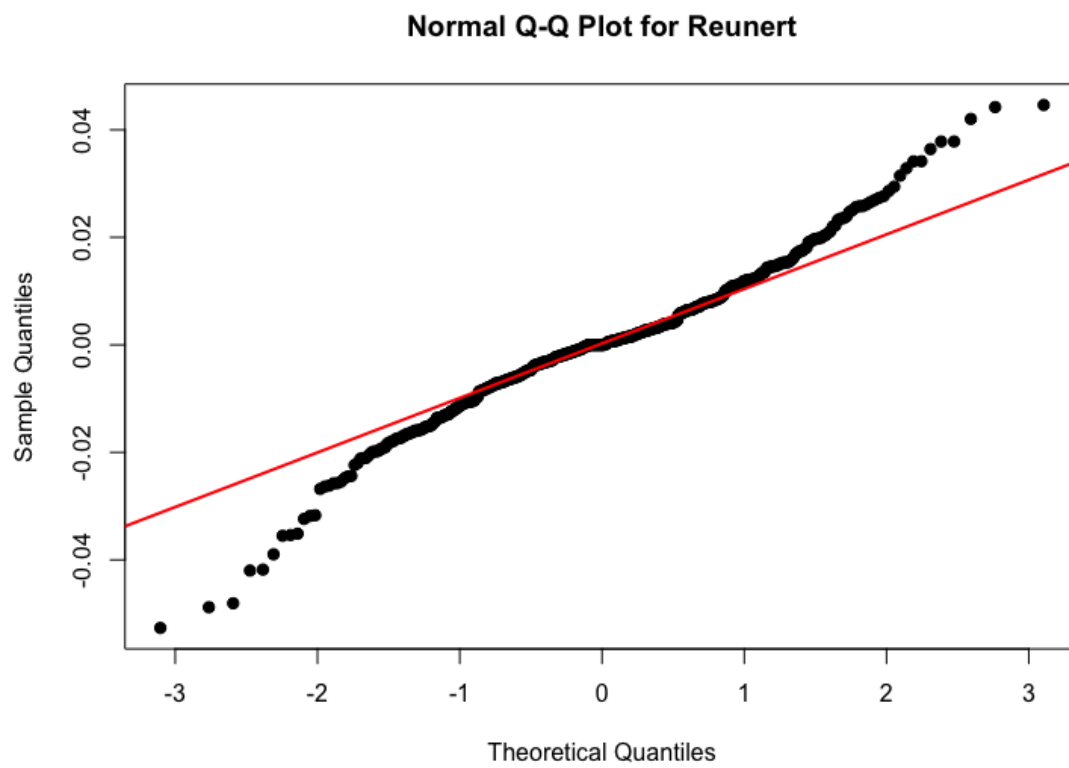
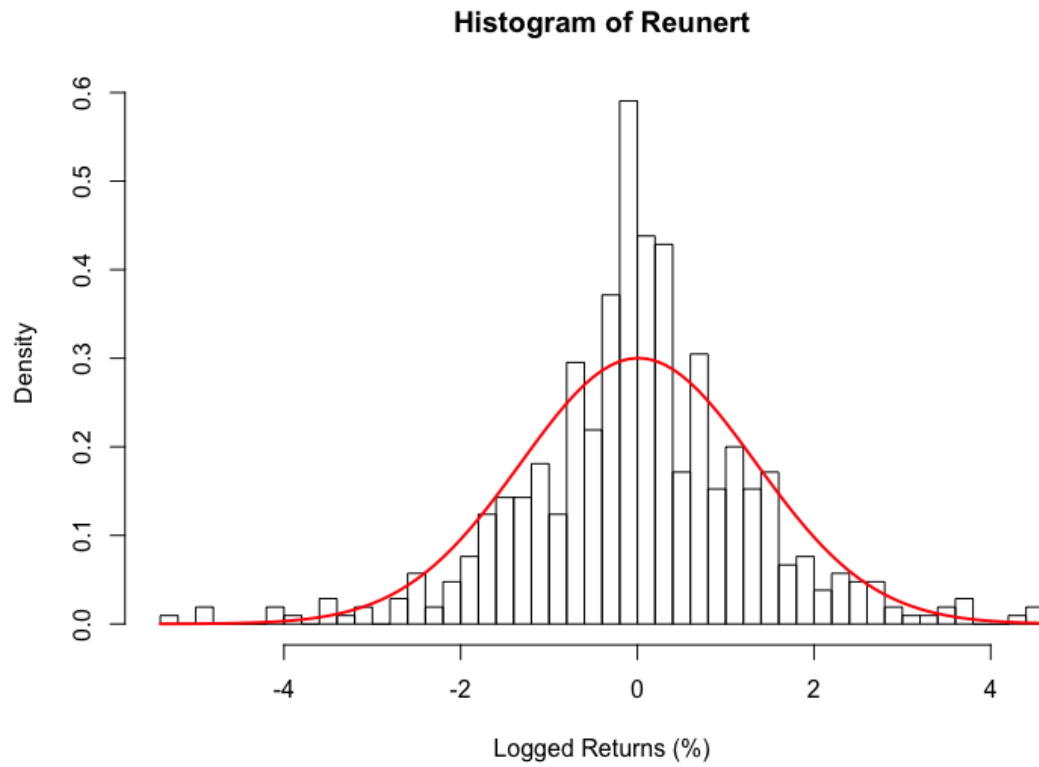
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Tongaat Hulett	3.6797***	0.068922***	0.97403***	95.924***	3.39880***

D.52 Reunert



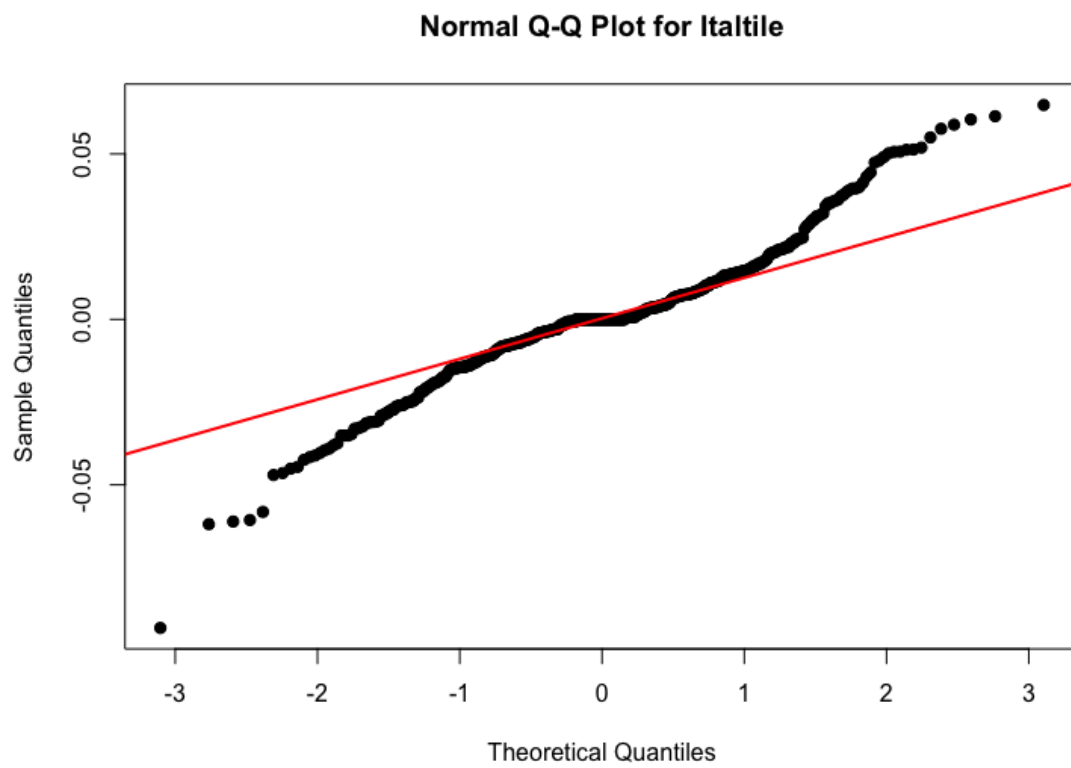
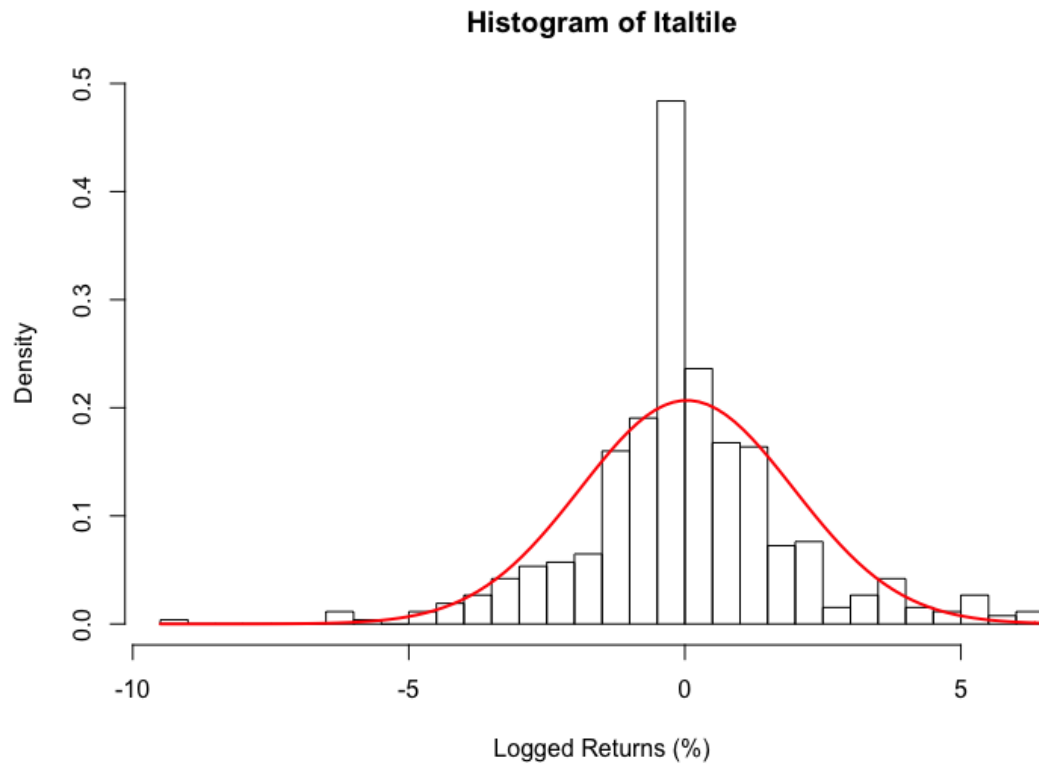
*p <0.1

** p <0.05

*** p <0.01

Normality Test Statistics					
	AD	LF	SW	JB	DP
Reunert	4.4171***	0.073616***	0.9723***	71.579***	-1.4178

D.53 Italtile



*p <0.1

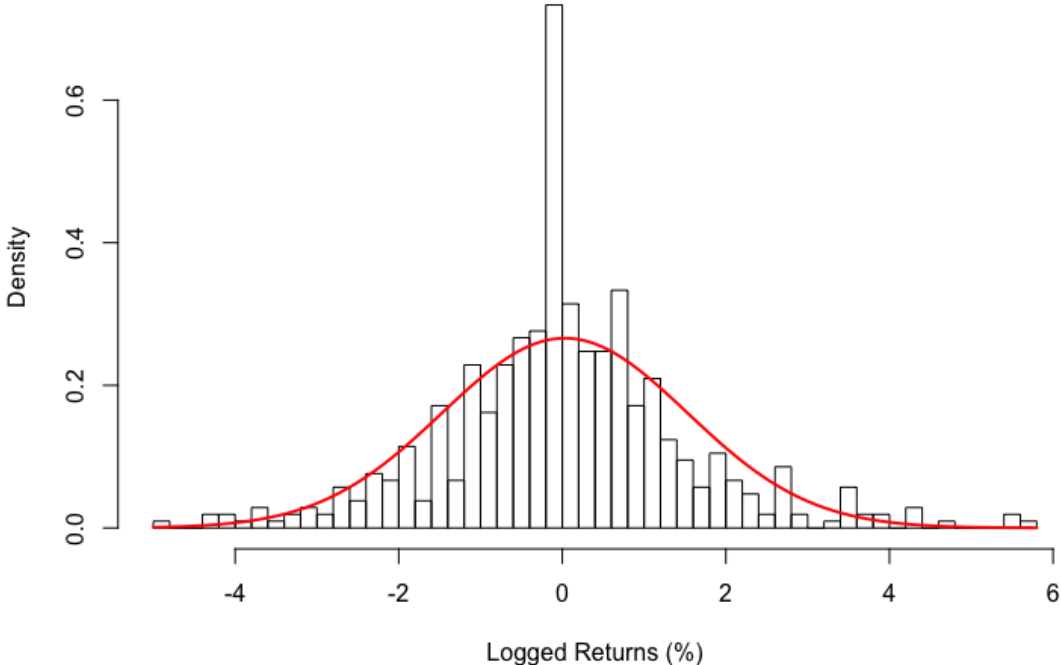
** p <0.05

*** p <0.01

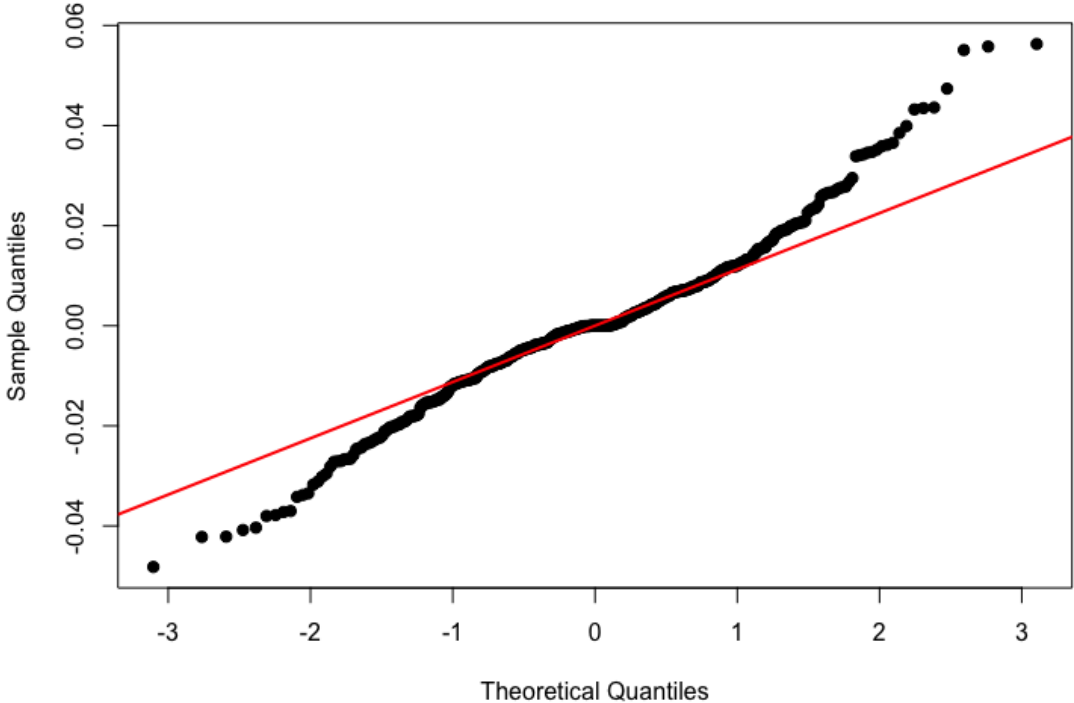
Normality Test Statistics					
	AD	LF	SW	JB	DP
Italtile	9.1443***	0.09034***	0.95254***	116.1***	0.182880

D.54 Hosken Consolidated Investments

Histogram of Hosken Consolidated Investments



Normal Q-Q Plot for Hosken Consolidated Investments



Normality Test Statistics					
	AD	LF	SW	JB	DP
Hosken Consolidated Investments	5.101***	0.0697***	0.9713***	59.335***	2.38180**

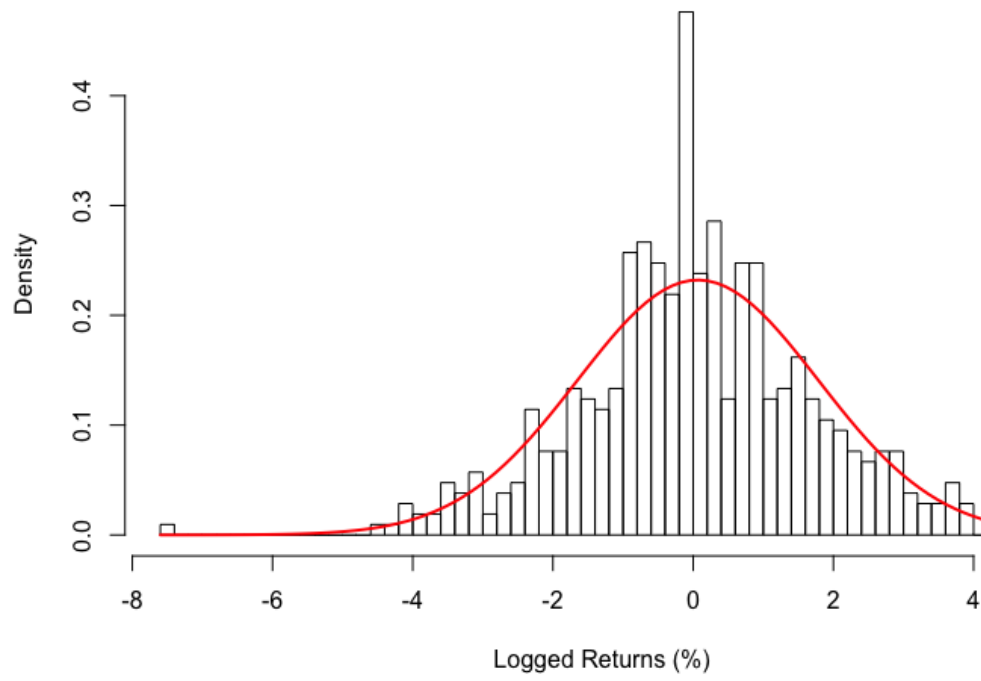
*p <0.1

** p <0.05

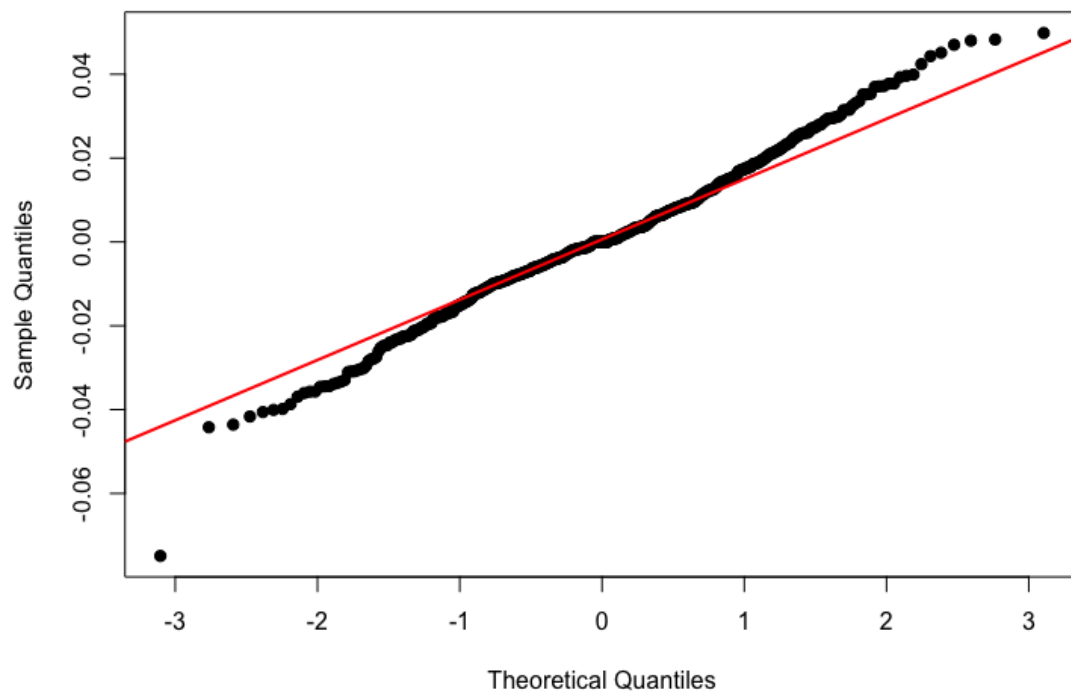
*** p <0.01

D.55 JSE Limited

Histogram of JSE Limited



Normal Q-Q Plot for JSE Limited



*p <0.1

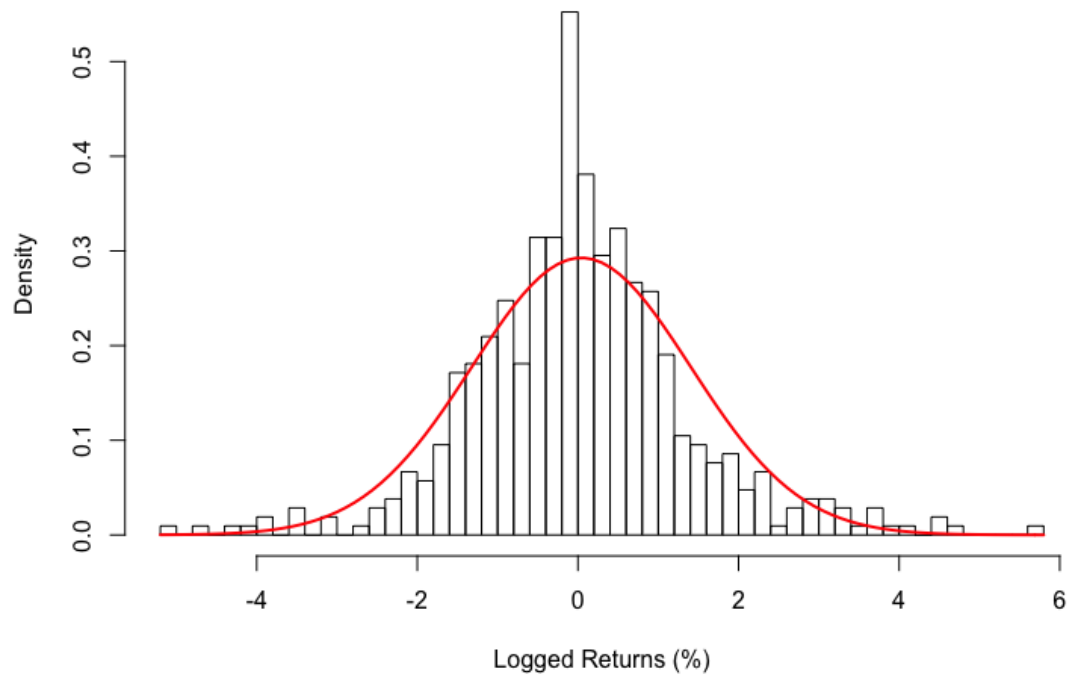
** p <0.05

*** p <0.01

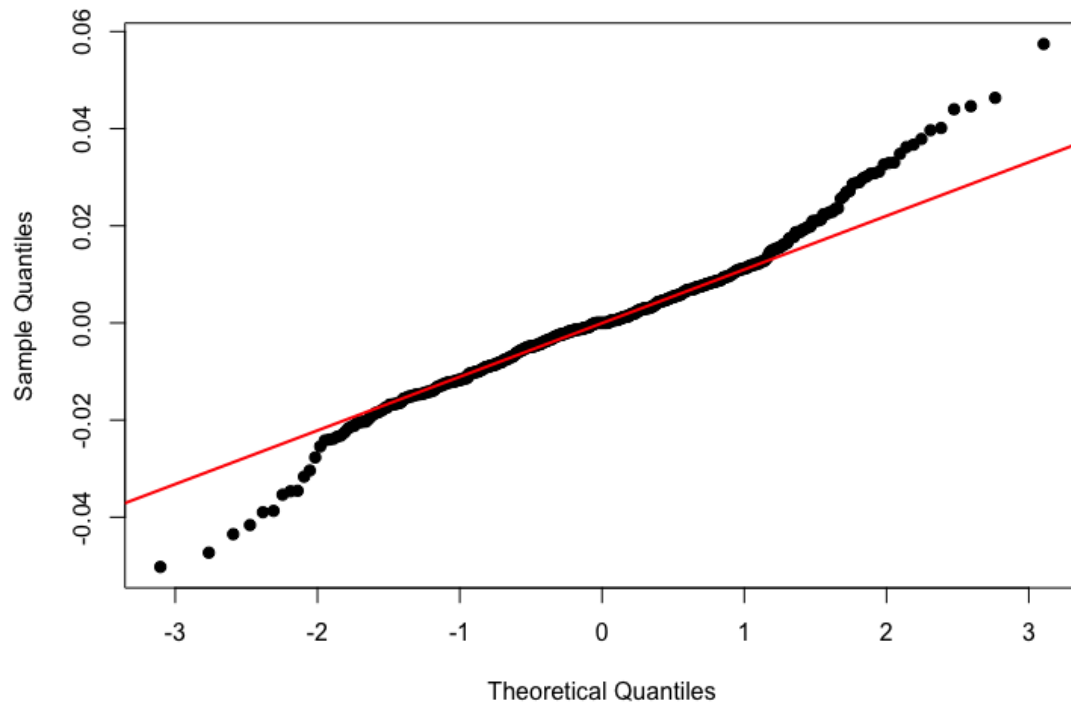
Normality Test Statistics					
	AD	LF	SW	JB	DP
JSE Limited	1.5577***	0.046478***	0.99062***	12.223***	0.293020

D.56 AECI

Histogram of AECI



Normal Q-Q Plot for AECI



*p <0.1

** p <0.05

*** p <0.01

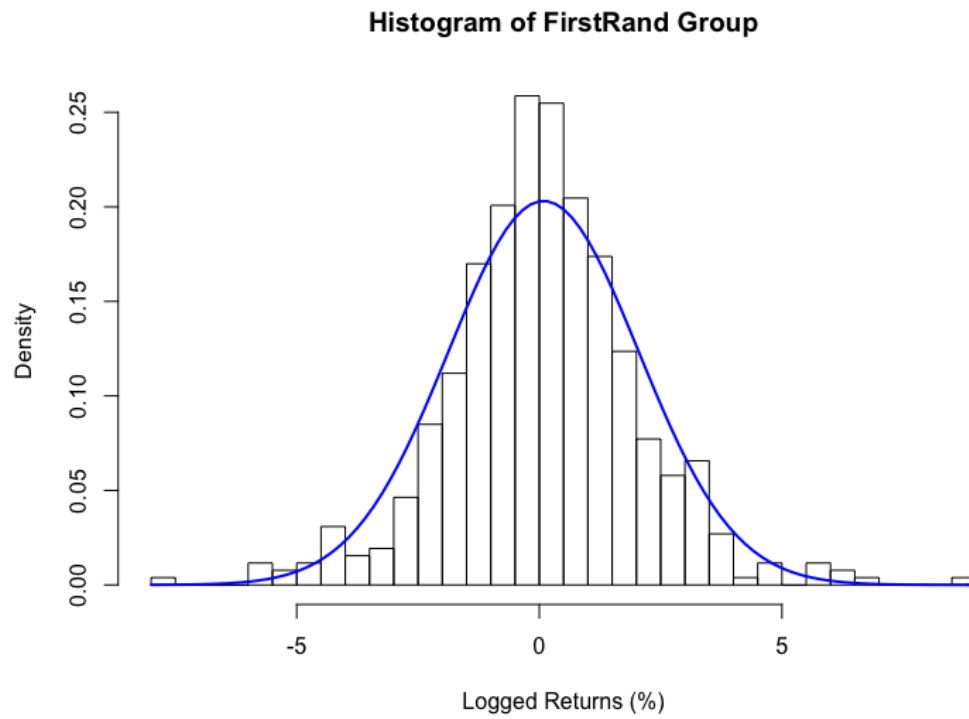
Normality Test Statistics					
	AD	LF	SW	JB	DP
AECI	4.3565***	0.067765***	0.96967***	87.444***	2.05820***

E Empirical Results after the removal of Red and Blue Letter Days

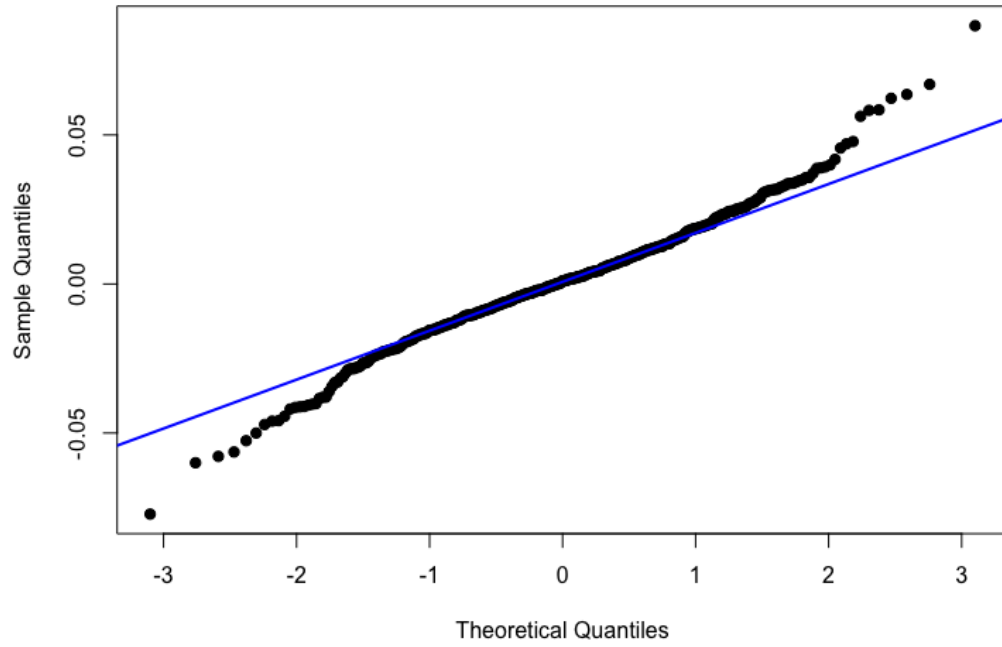
E.1 Banks

E.1.1 FirstRand

Number of Remaining Observations = 518

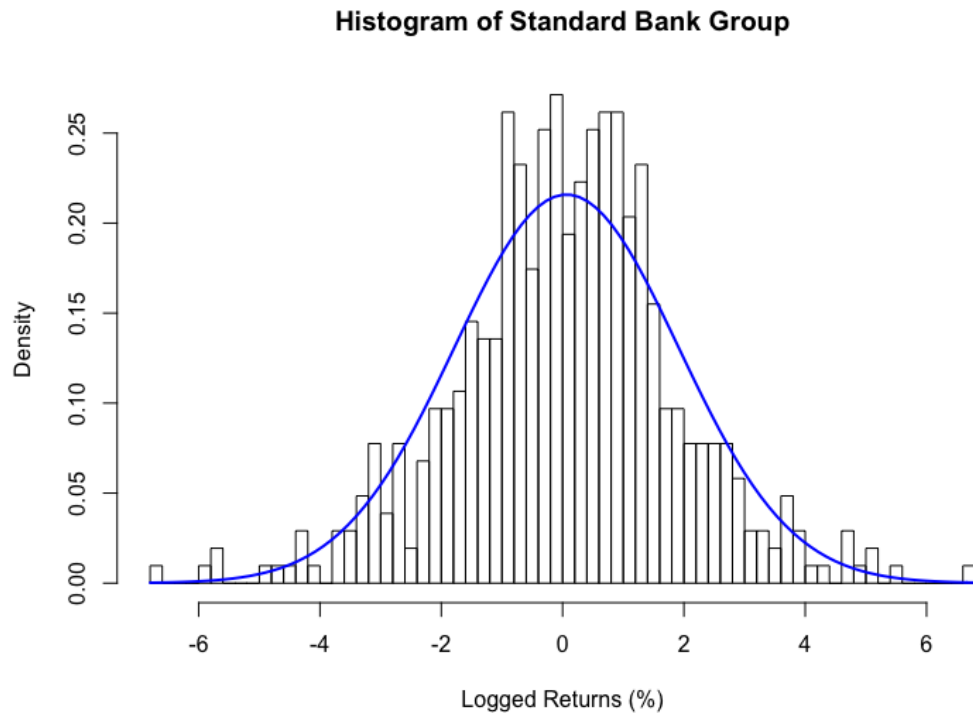


Normal Q-Q Plot for FirstRand Group

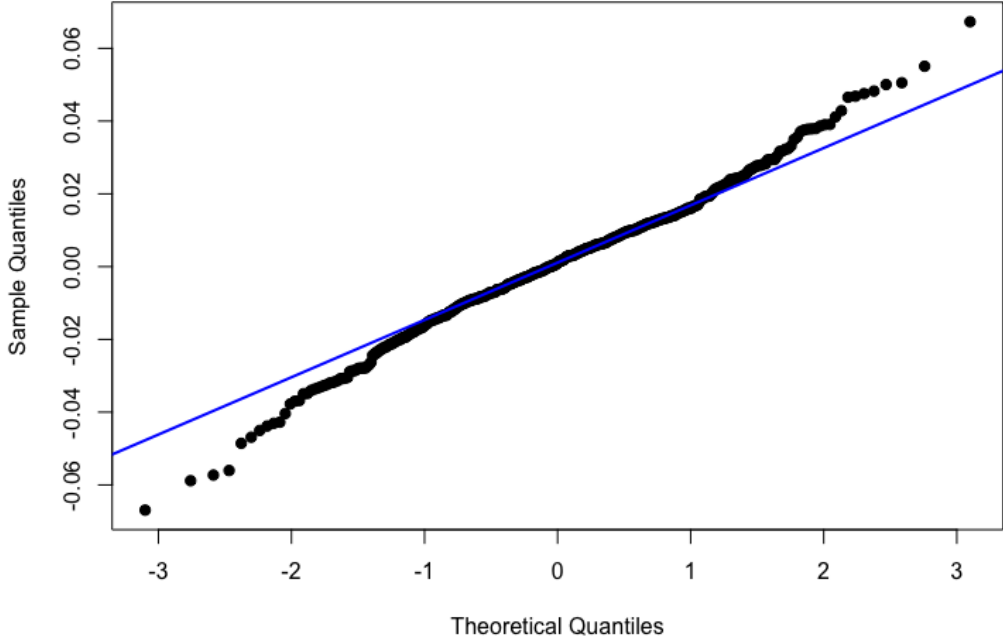


E.1.2 Standard Bank Group

Number of Remaining Observations = 516

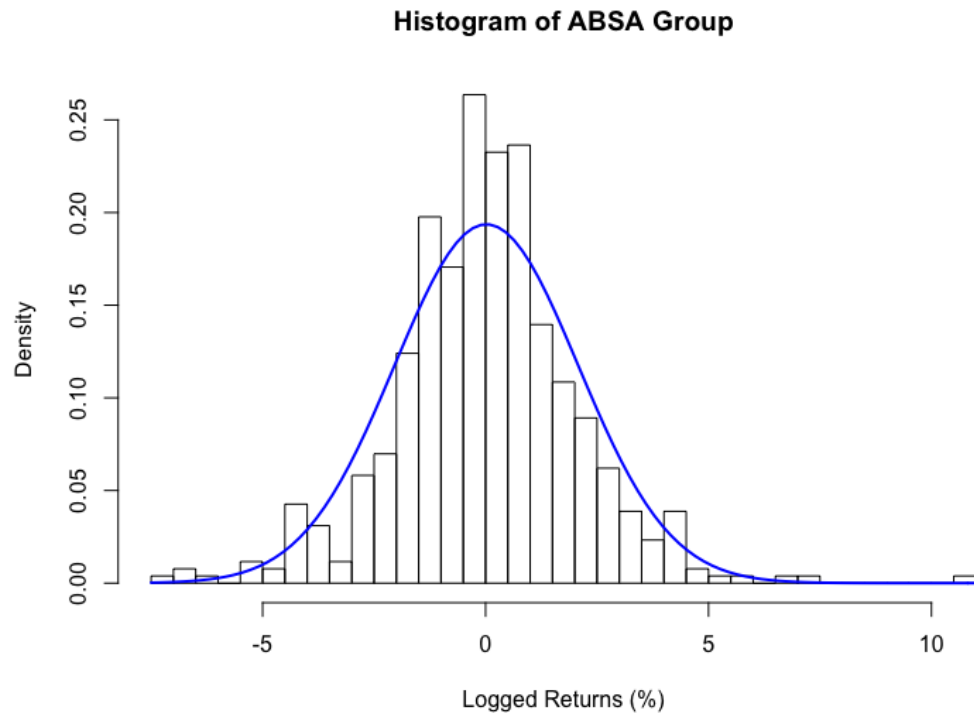


Normal Q-Q Plot for Standard Bank Group

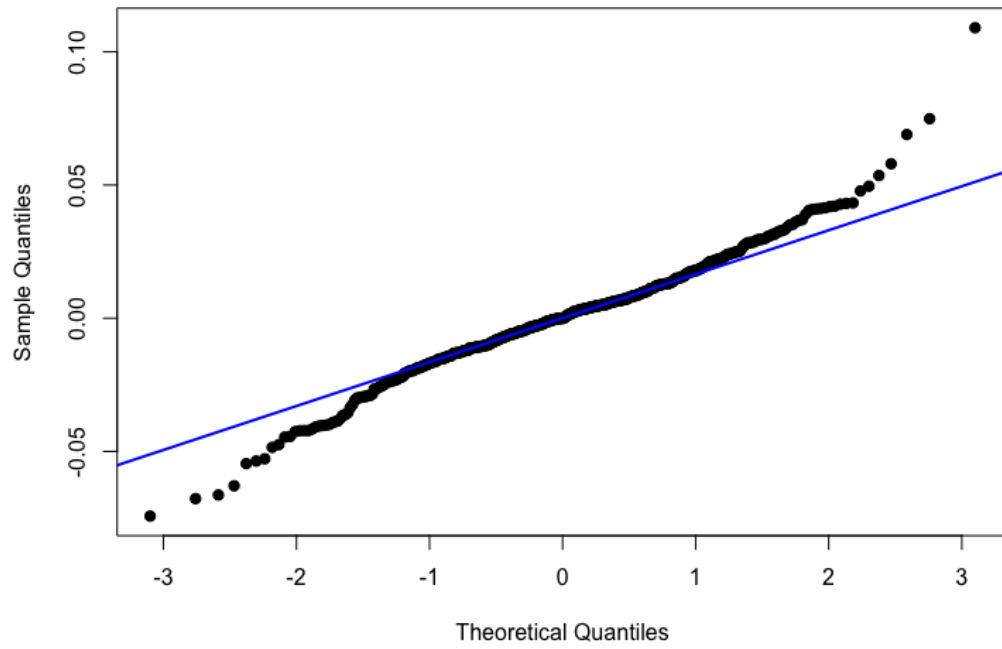


E.1.3 ABSA Group

Number of Remaining Observations = 516

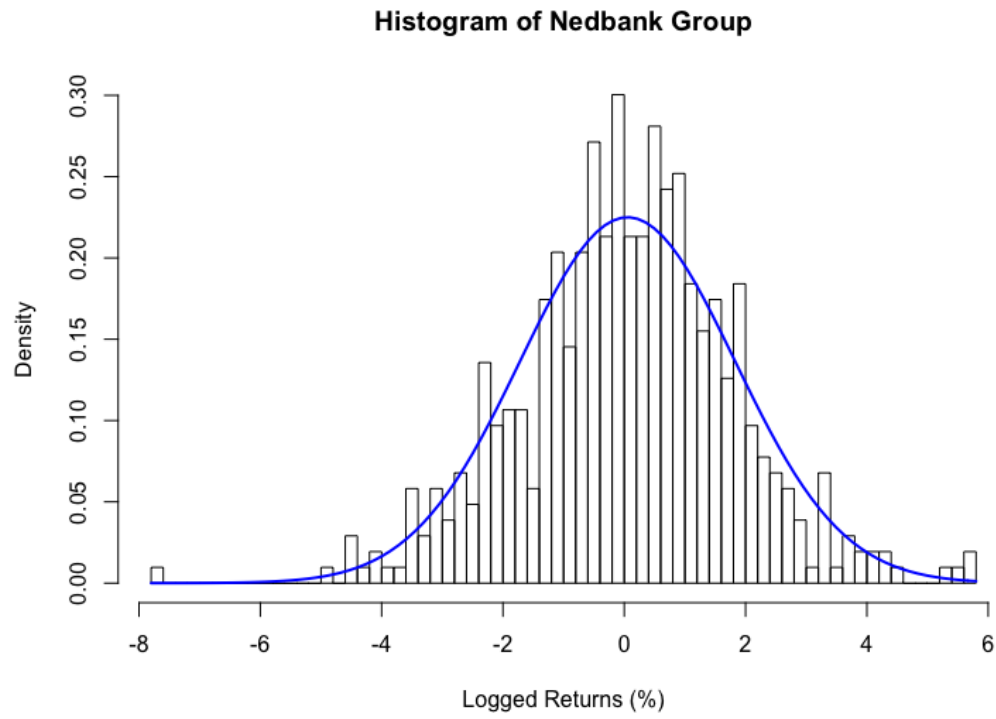


Normal Q-Q Plot for ABSA Group

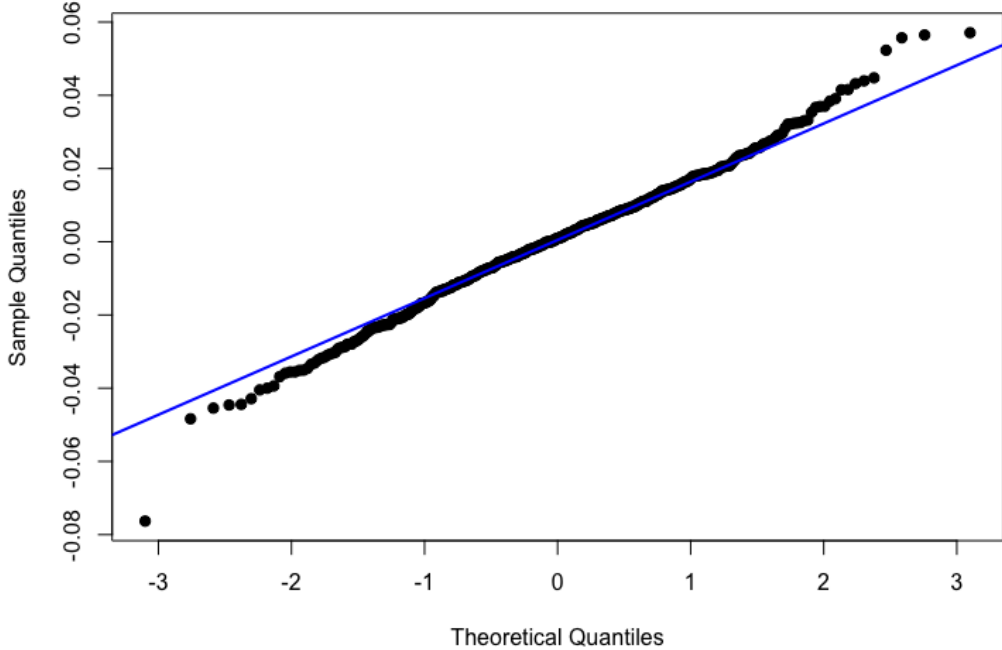


E.1.4 Nedbank Group

Number of Remaining Observations = 516

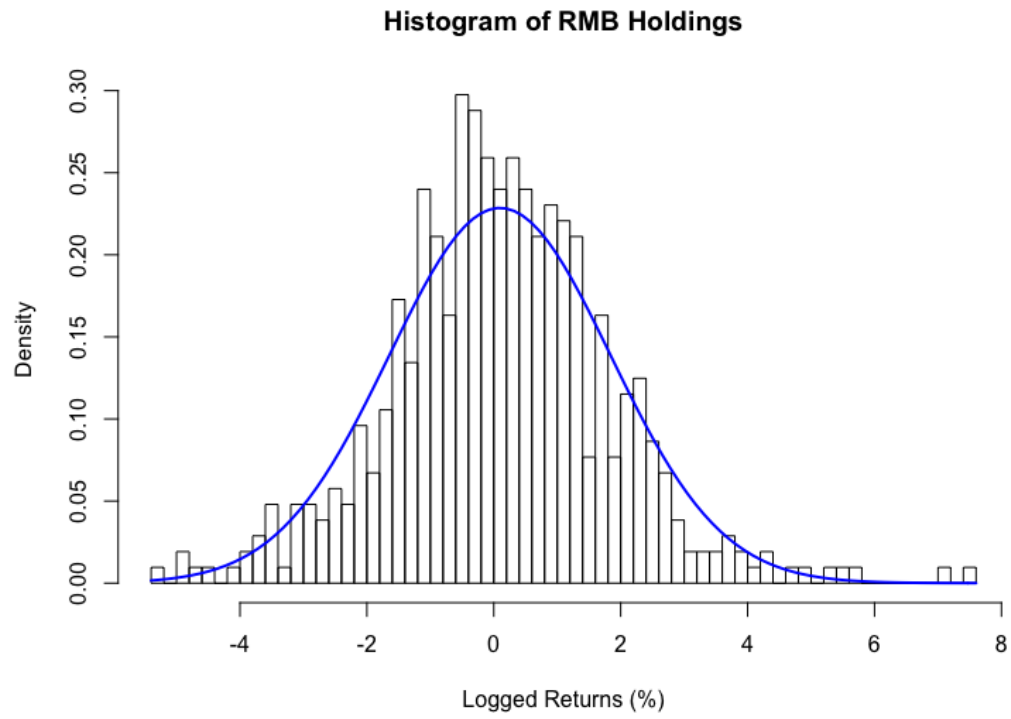


Normal Q-Q Plot for Nedbank Group

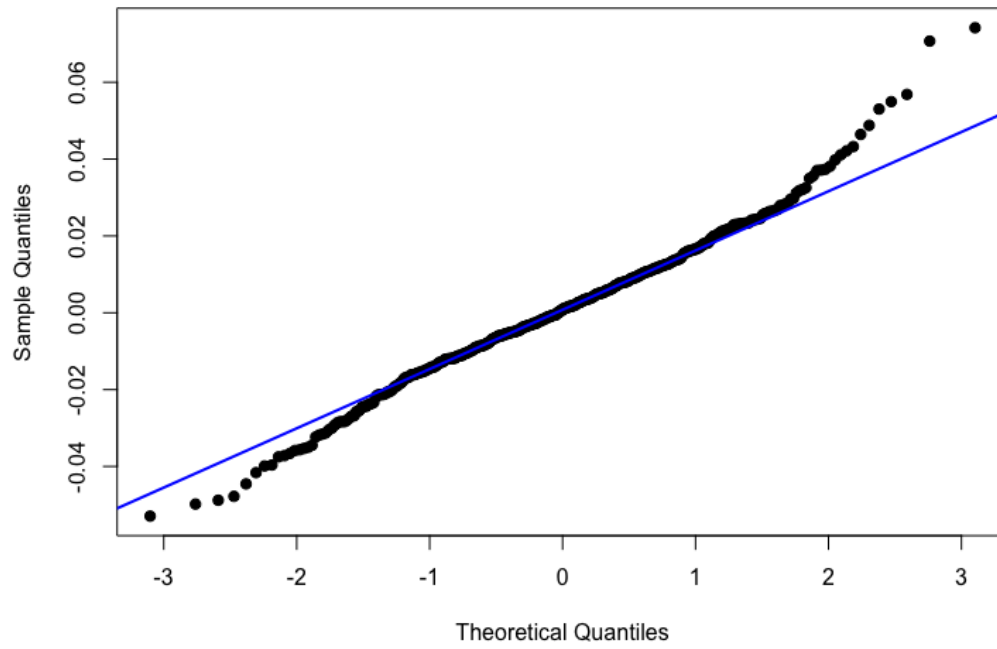


E.1.5 RMB Holdings

Number of Remaining Observations = 521

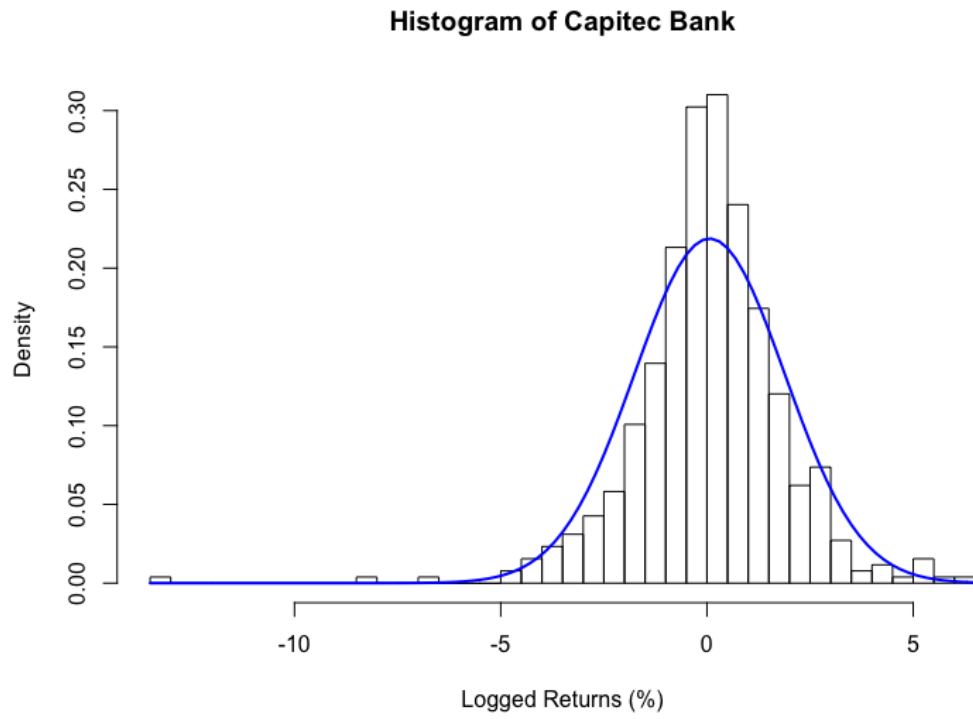


Normal Q-Q Plot for RMB Holdings

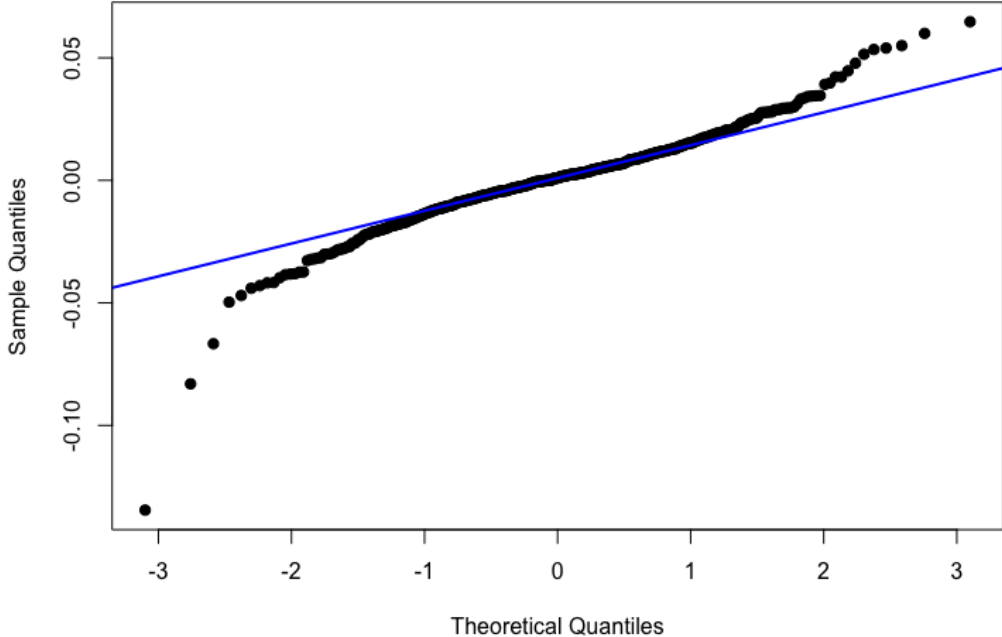


E.1.6 Capitec Bank Holdings

Number of Remaining Observations = 516



Normal Q-Q Plot for Capitec Bank



E.1.7 Results from Goodness-of-Fit Tests

		Normality Test Statistics				
		AD	LF	SW	JB	DP
FirstRand		2.3023 ***	0.049185***	0.98142***	61.94***	0.818590
Standard Group	Bank	1.4606***	0.045427**	0.99046***	18.904***	-0.95174
ABSA Group		2.8021***	0.055077***	0.97508***	117.32***	1.27870
Nedbank Group		0.84013**	0.036294	0.99269**	15.903***	-0.851240
RMB Holdings		1.395***	0.038744*	0.98602***	41.675***	2.06310**
Capitec Bank Holdings		5.3262***	0.074992***	0.93468***	1136.7***	-7.03710***

*p <0.1

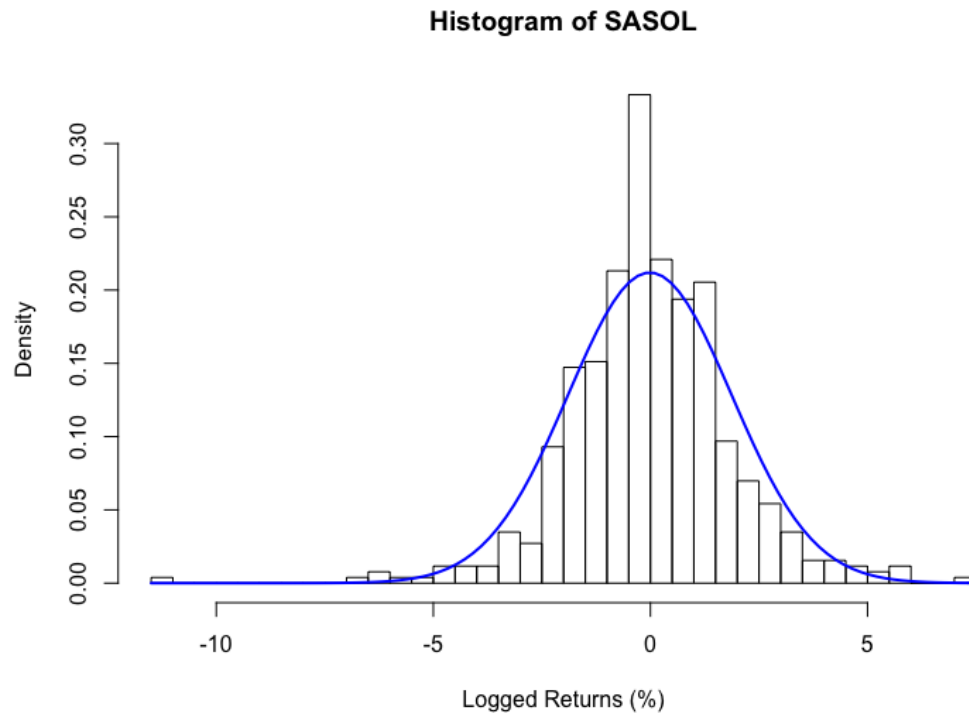
** p <0.05

*** p <0.01

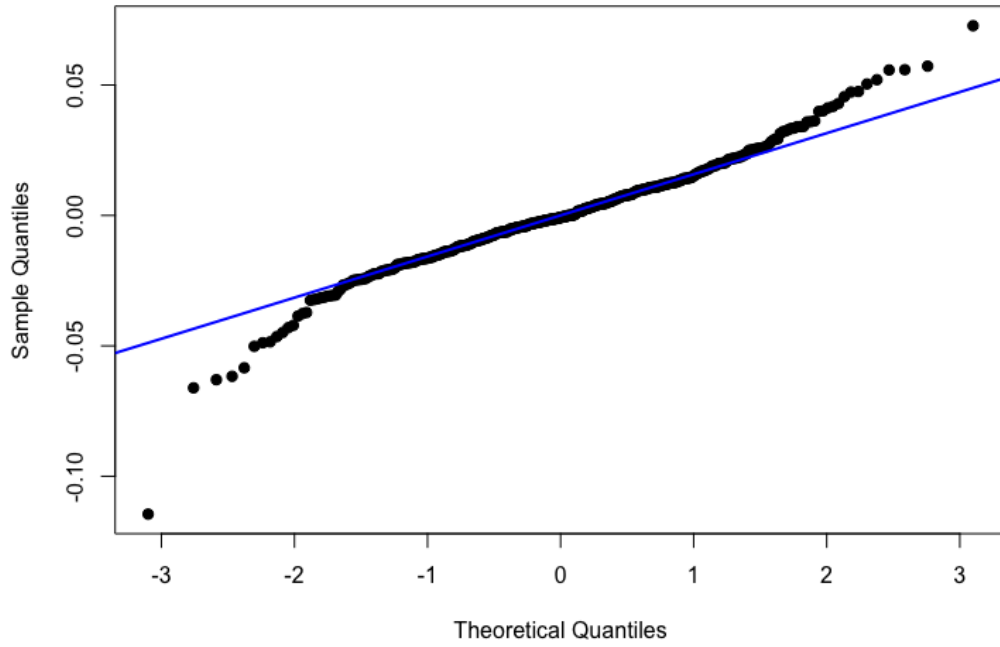
E.2 Chemicals

E.2.1 SASOL

Number of Remaining Observations = 516

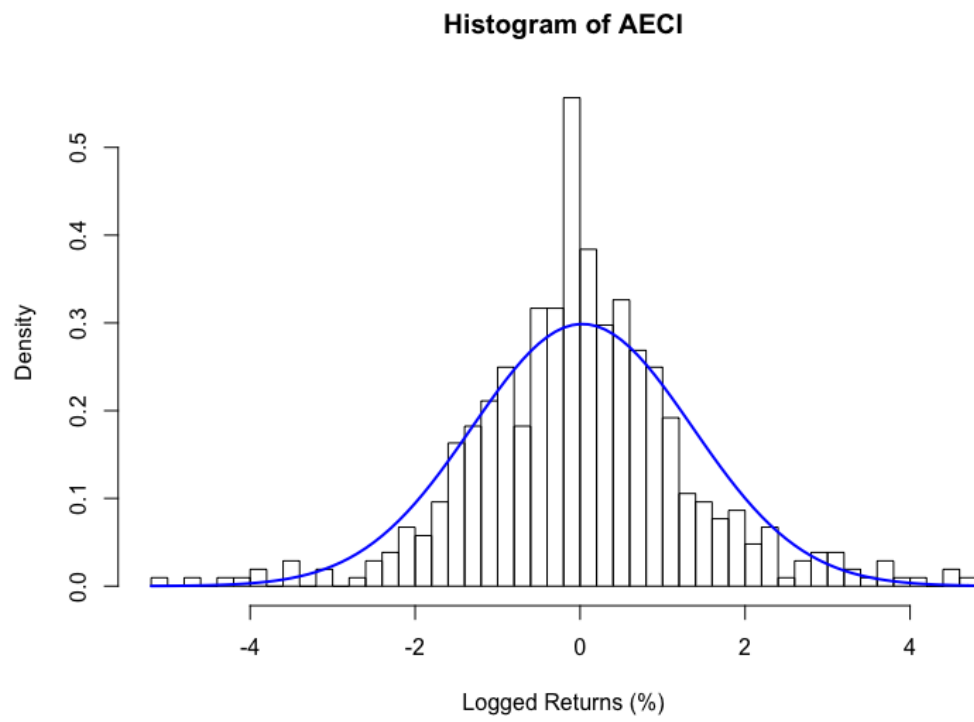


Normal Q-Q Plot for SASOL

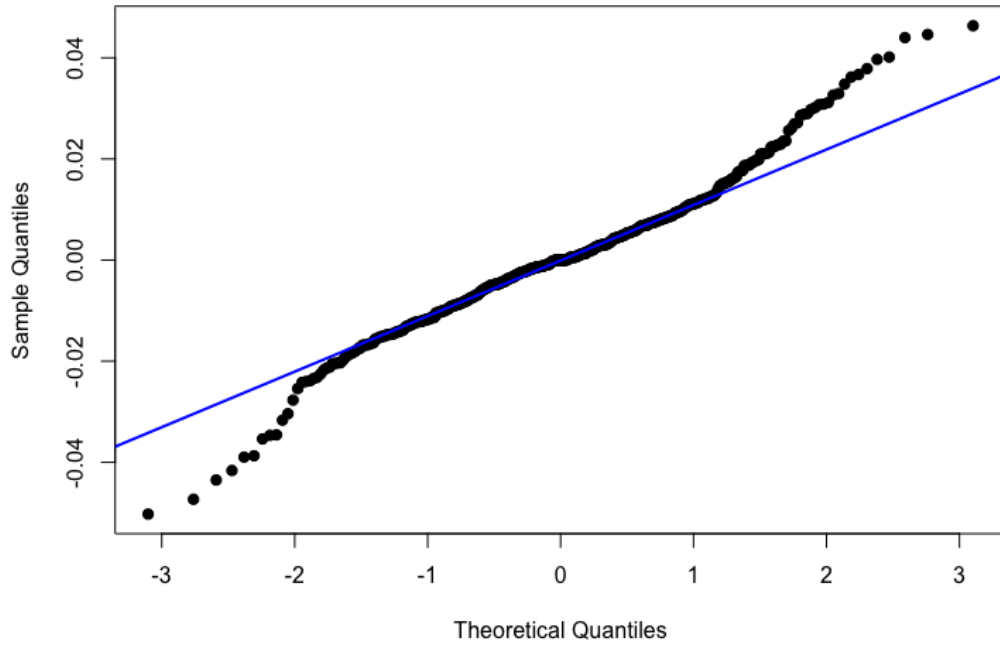


E.2.2 AECI

Number of Remaining Observations = 521



Normal Q-Q Plot for AECI



E.2.3 Results from Goodness-of-Fit Tests

566

Normality Test Statistics					
	AD	LF	SW	JB	DP
SASOL	3.2497***	0.055991***	0.96263***	292.19***	- 3.22780***
AECI	3.8556***	0.061985***	0.97297***	63.92***	0.898210

*p <0.1

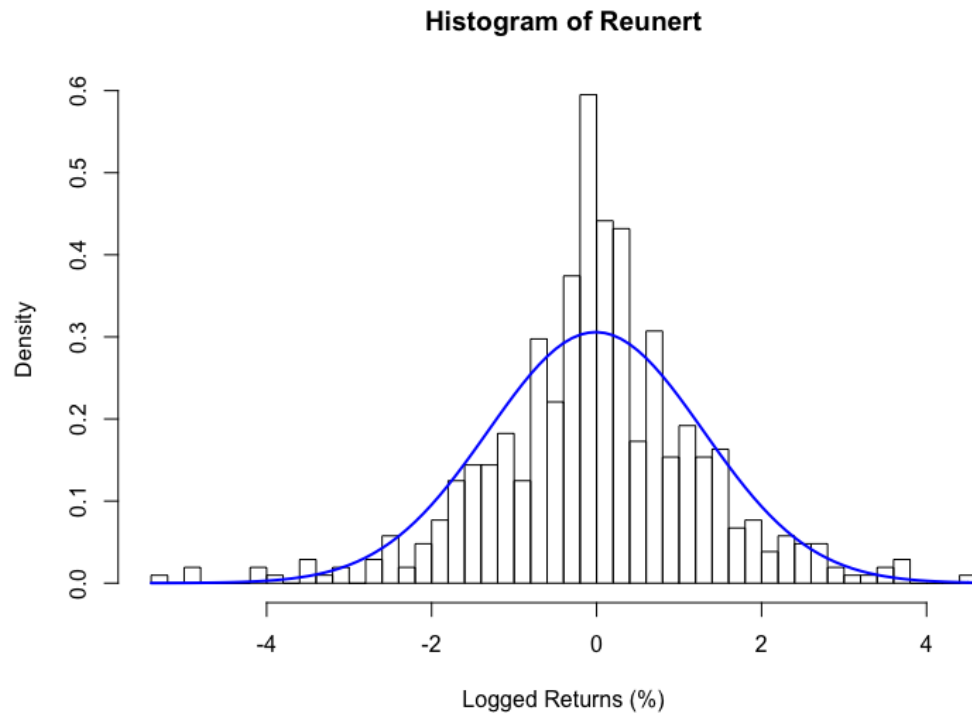
** p <0.05

*** p <0.01

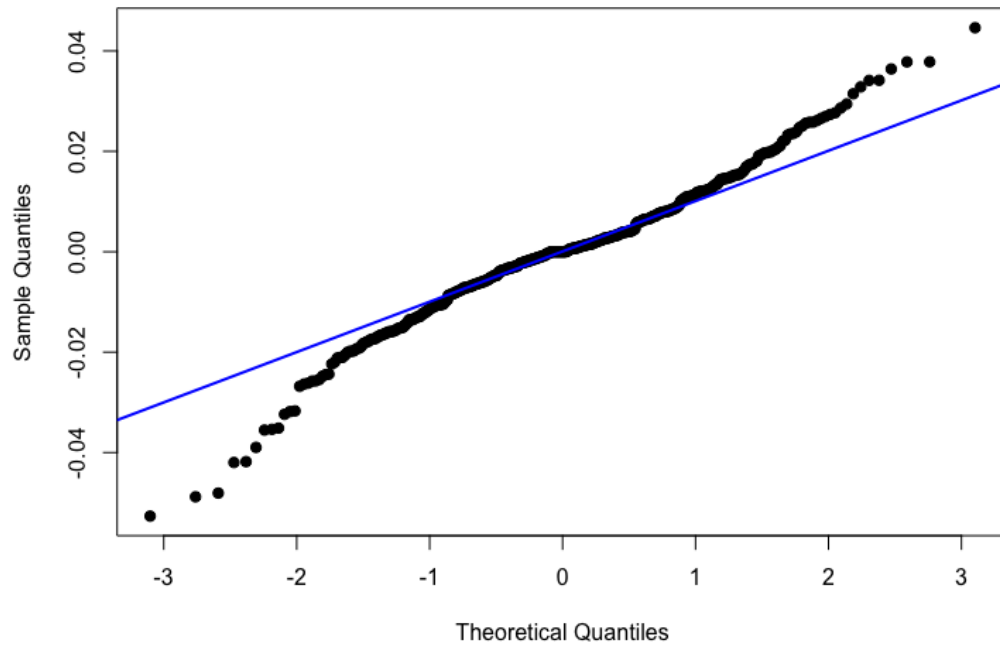
E.3 Electronic and Electrical Equipment

E.3.1 Reunert

Number of Remaining Observations = 521



Normal Q-Q Plot for Reunert



E.3.2 Results from Goodness-of-Fit Tests

569

Normality Test Statistics					
	AD	LF	SW	JB	DP
Reunert	4.1684***	0.070562***	0.97364***	69.253***	-2.35730**

*p < 0.1

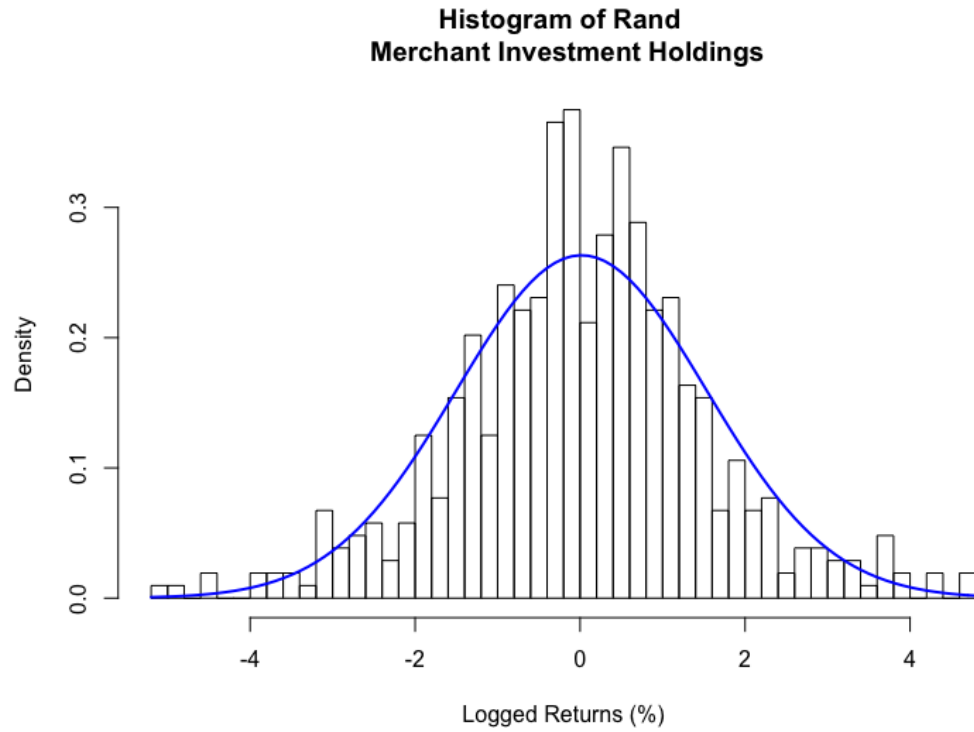
** p < 0.05

*** p < 0.01

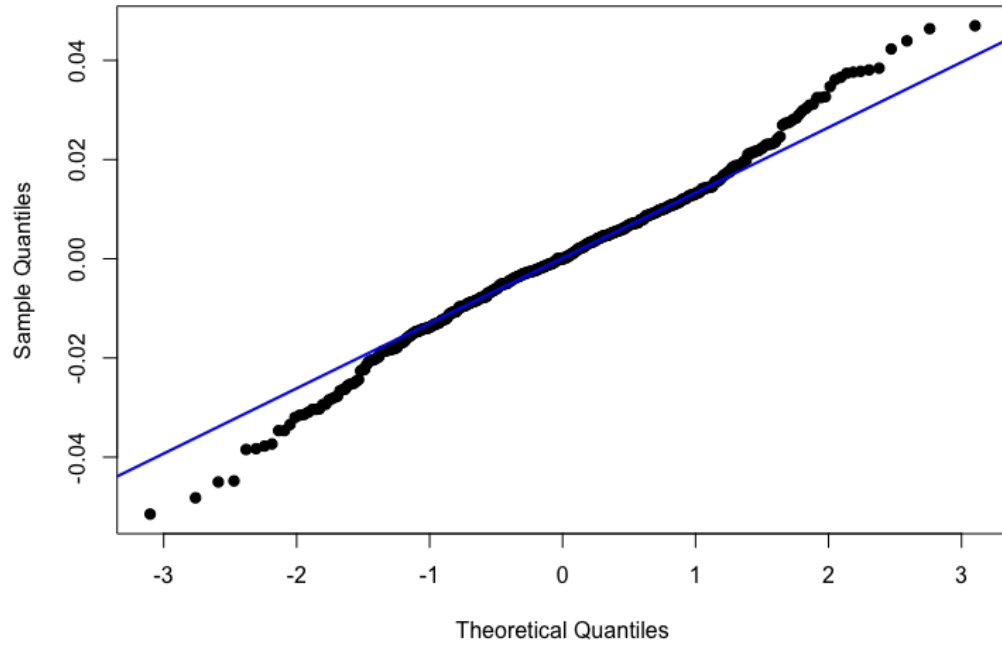
E.4 Equity Investment Instruments

E.4.1 RMI Holdings

Number of Remaining Observations = 520

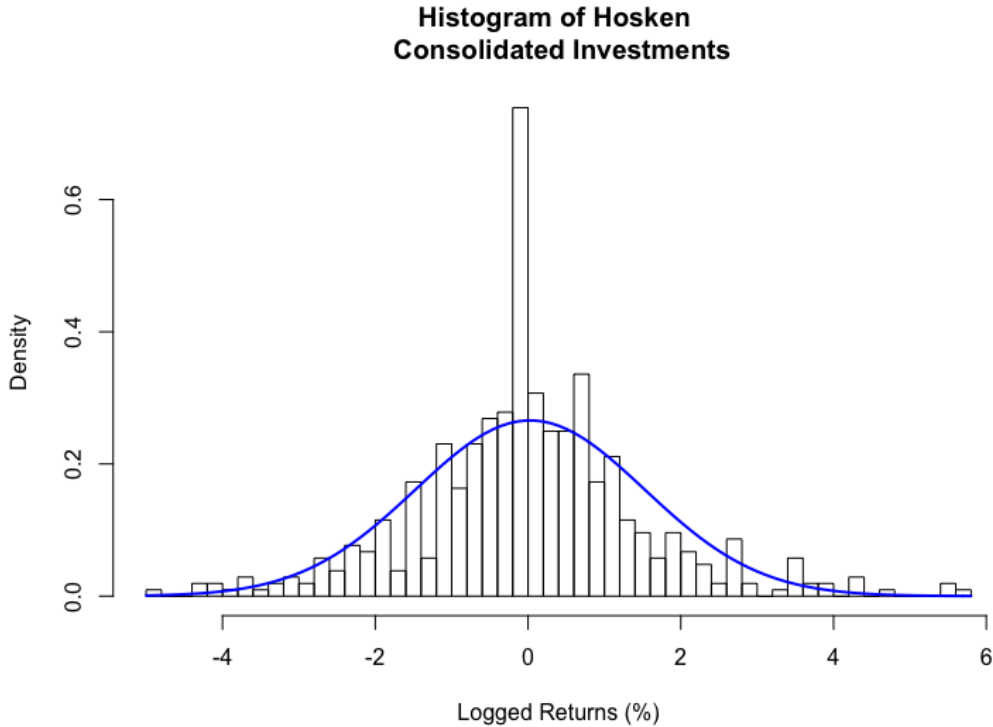


Normal Q-Q Plot for
Rand Merchant Investment Holdings

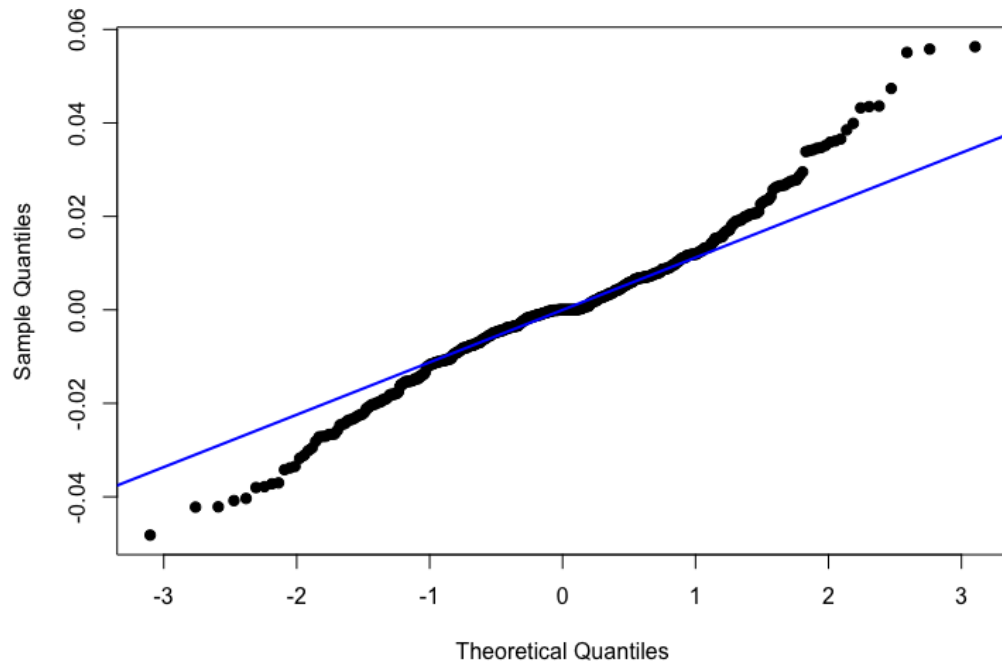


E.4.2 Hosken Consolidated Investments

Number of Remaining Observations = 521



Normal Q-Q Plot for
Hosken Consolidated Investments



E.4.3 Results from Goodness-of-Fit Tests

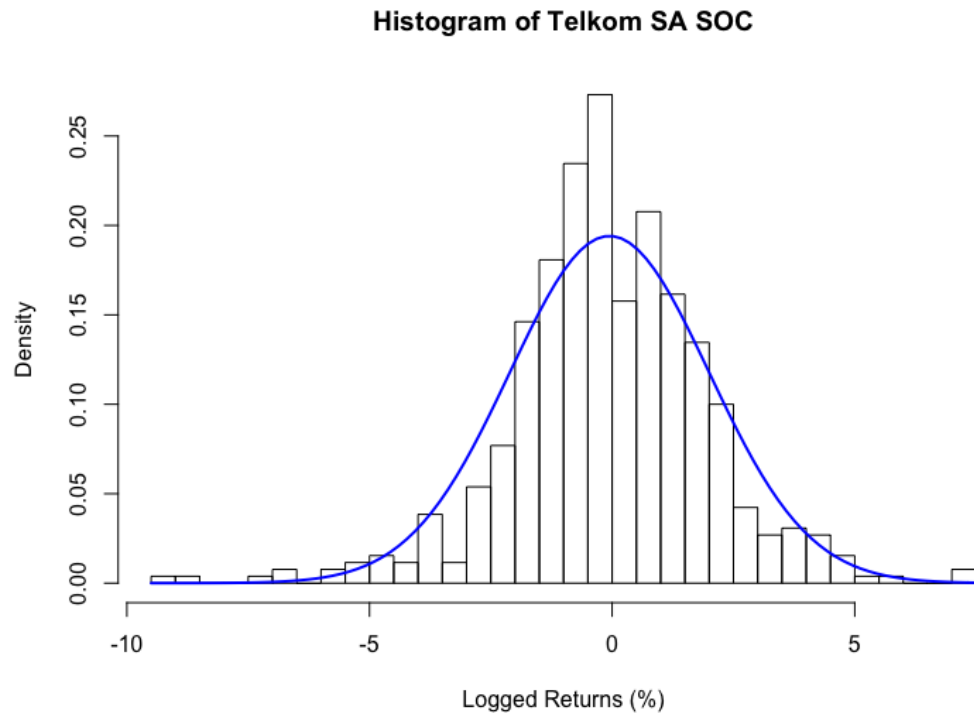
		Normality Test Statistics				
		AD	LF	SW	JB	DP
RMI Holdings		1.7271***	0.043025**	0.98922***	14.551***	-0.421880
Hosken	Consolidated Investments	5.2266***	0.071084***	0.97056***	60.028***	2.41880**

*p <0.1
 ** p <0.05
 *** p <0.01

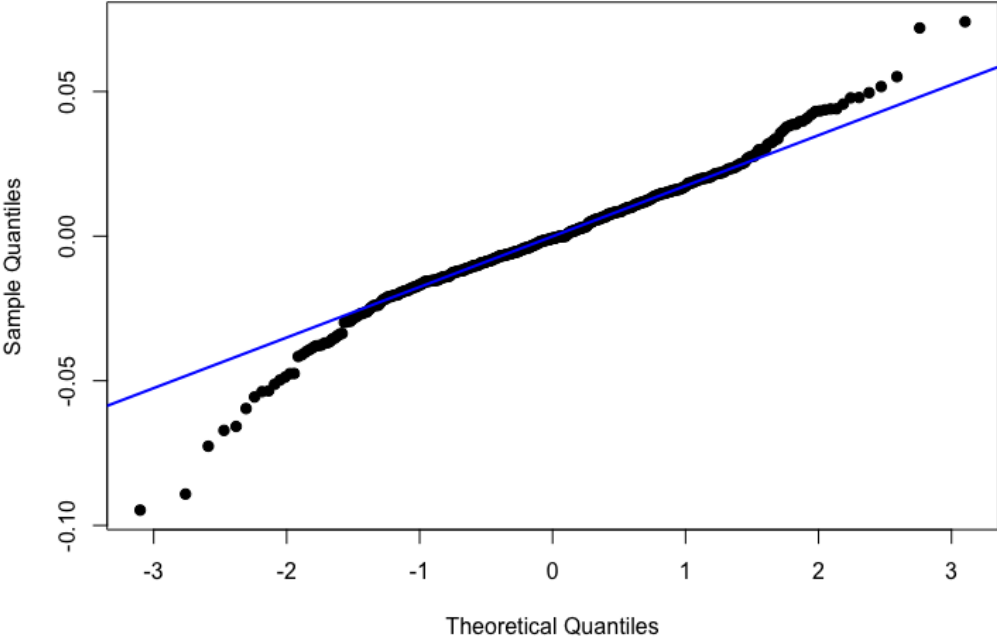
E.5 Fixed Line Telecommunications

E.5.1 Telkom SA SOC

Number of Remaining Observations = 520



Normal Q-Q Plot for Telkom SA SOC



E.5.2 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Telkom SA SOC	2.9468***	0.062722***	0.97189***	118.47***	-3.17970***

577

*p < 0.1

** p < 0.05

*** p < 0.01

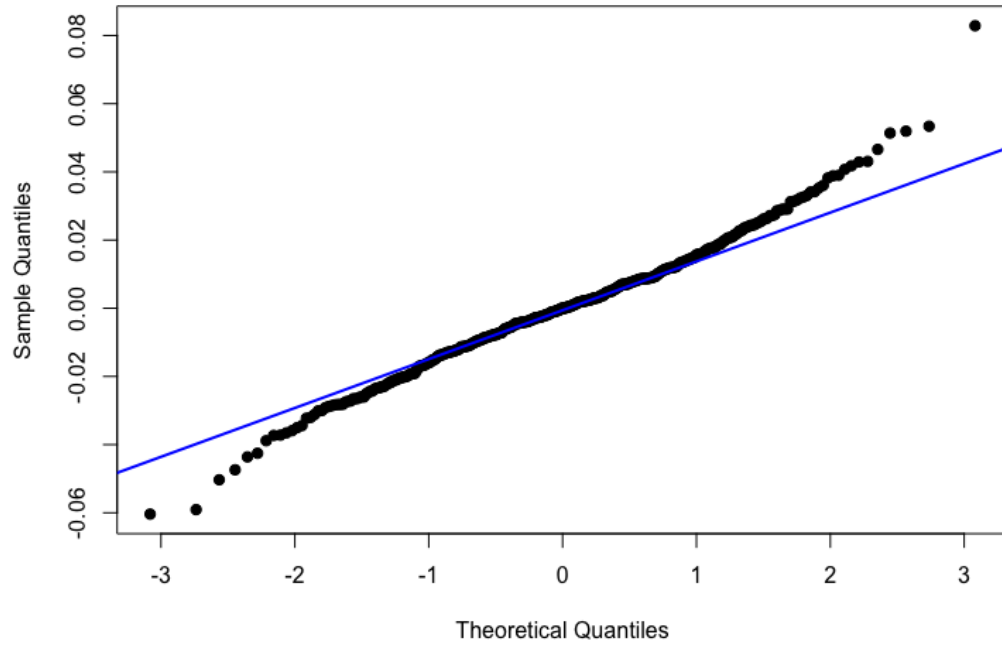
E.6 Food and Drug Retailers

E.6.1 Shoprite Holdings

Number of Remaining Observations = 485

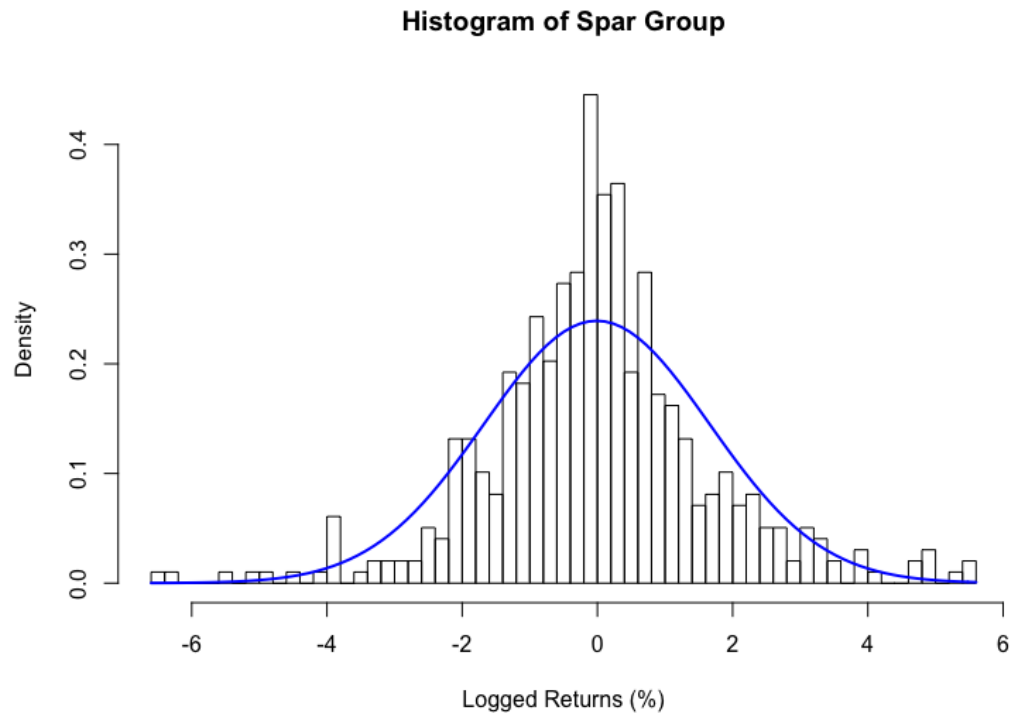


Normal Q-Q Plot for Shoprite Holdings

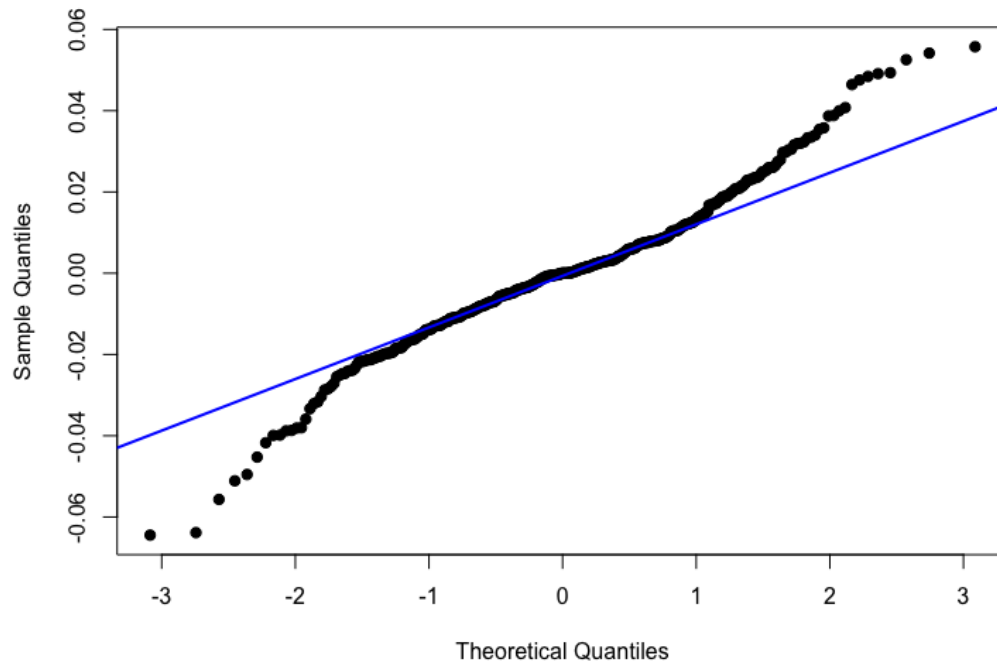


E.6.2 Spar Group

Number of Remaining Observations = 494



Normal Q-Q Plot for Spar Group

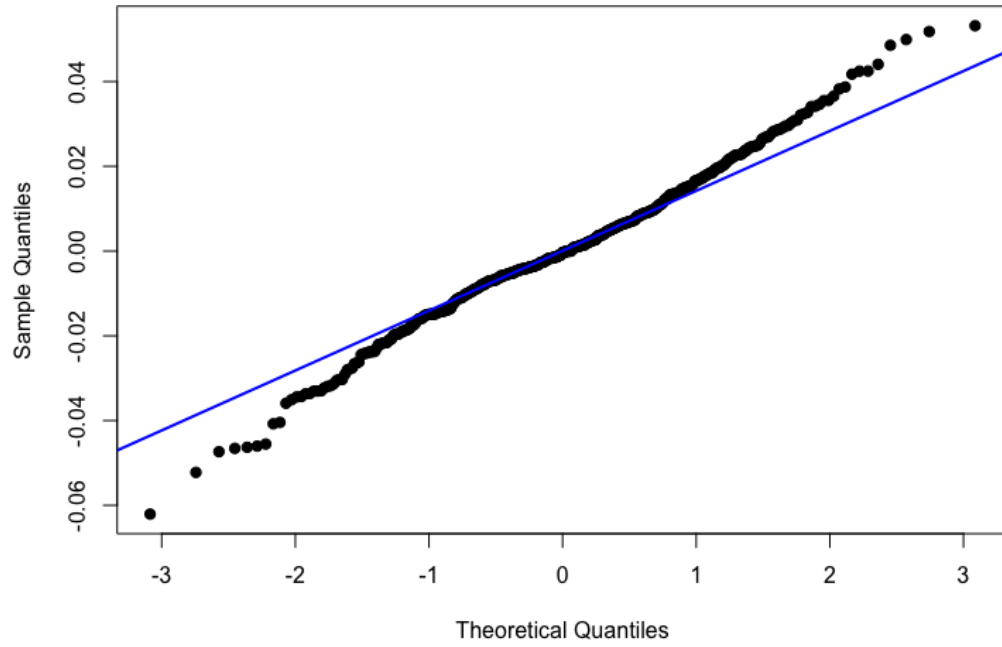


E.6.3 Pick 'n Pay Stores

Number of Remaining Observations = 494

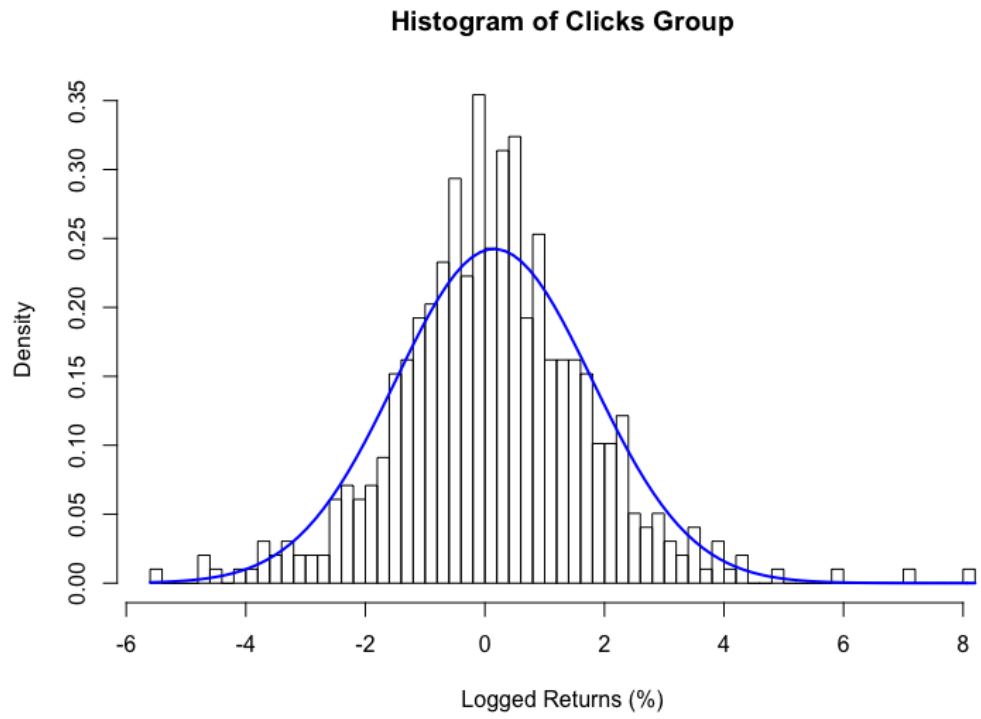


Normal Q-Q Plot for
Pick'n Pay Stores

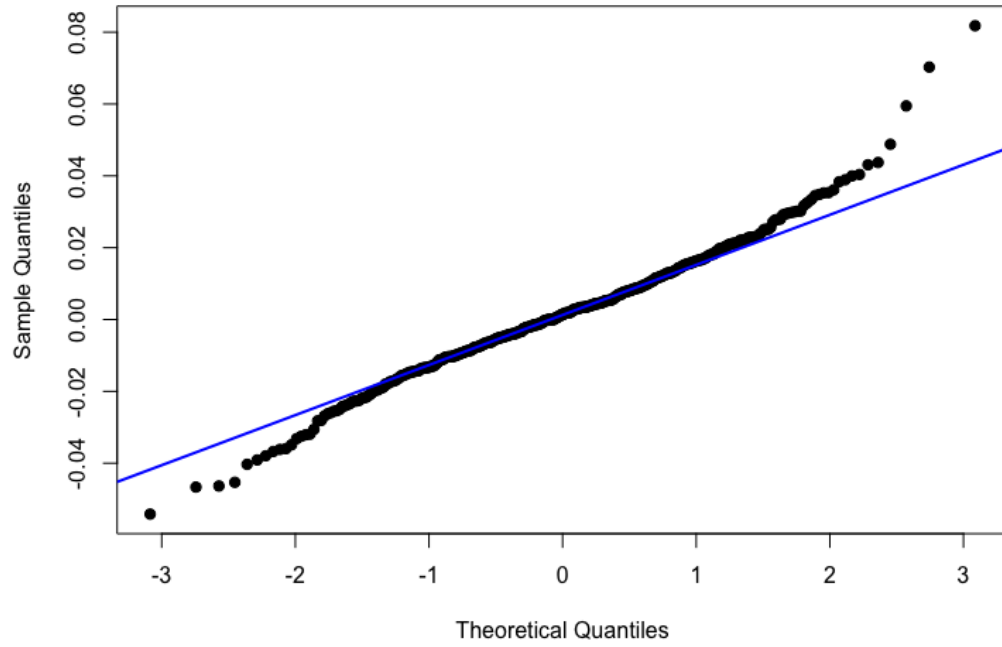


E.6.4 Clicks Group

Number of Remaining Observations = 494



Normal Q-Q Plot for Clicks Group



E.6.5 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Shoprite Holdings	1.5011***	0.053895***	0.98624***	46.849***	1.78480*
Spar Group	4.5057***	0.077617***	0.96964***	69.012***	0.234010
Pick 'n Pay Stores	1.5838***	0.049153***	0.99097***	10.948***	-0.142010
Clicks Group	1.8535***	0.049161***	0.97925***	90.766***	2.7482***

*p < 0.1

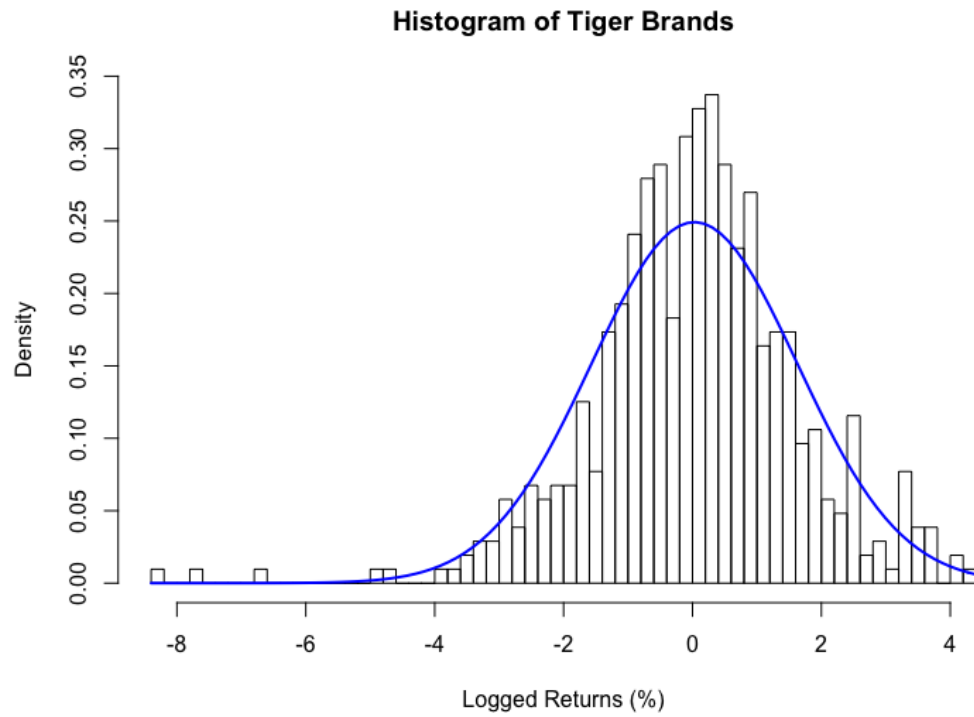
** p < 0.05

*** p < 0.01

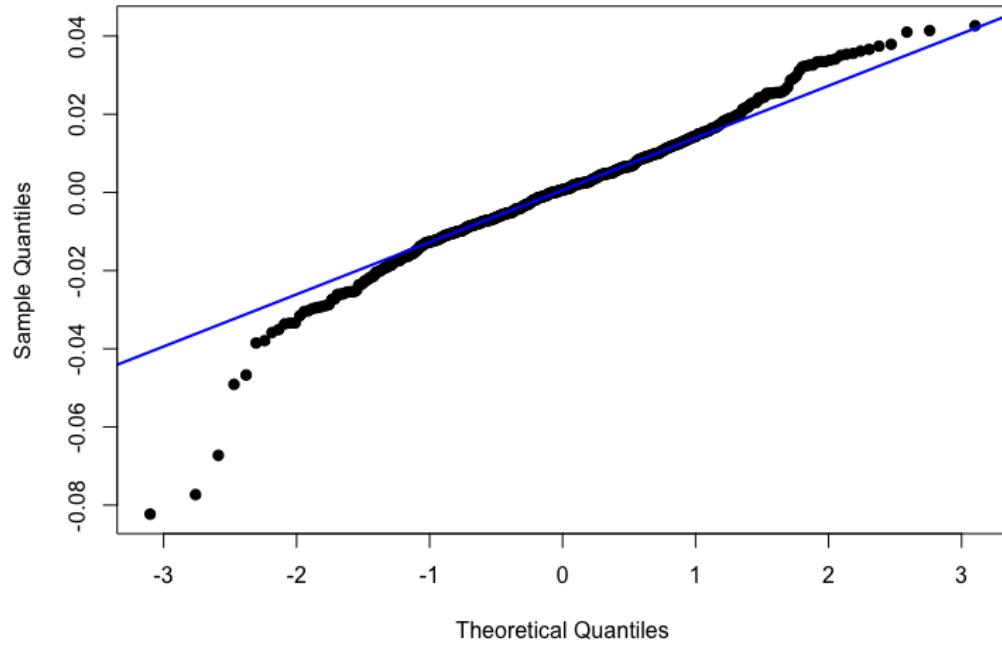
E.7 Food Producers

E.7.1 Tiger Brands

Number of Remaining Observations = 519

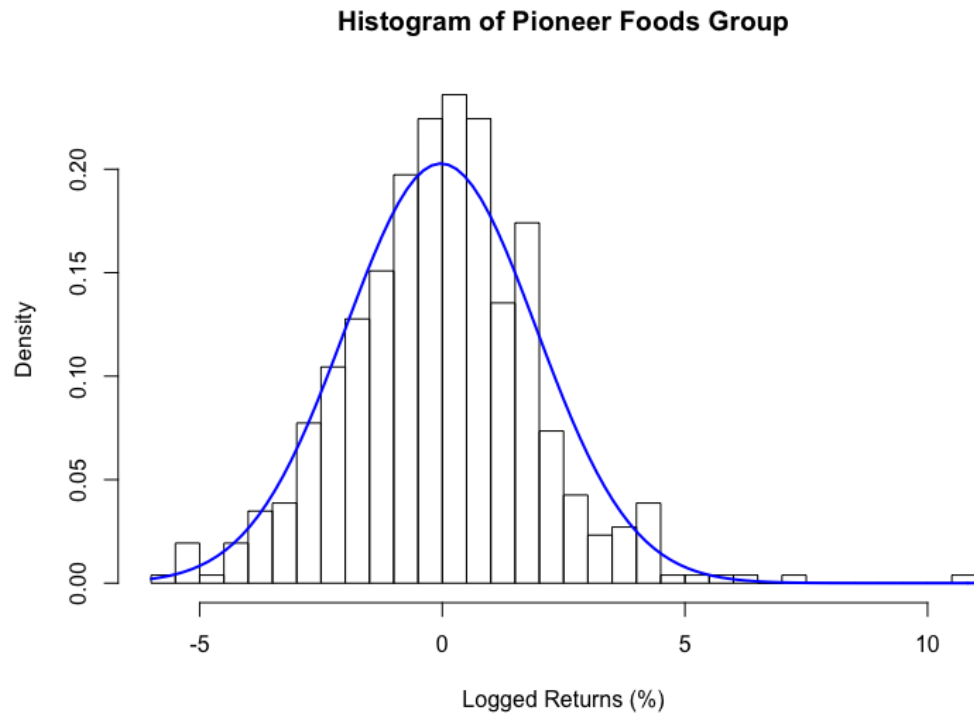


Normal Q-Q Plot for Tiger Brands

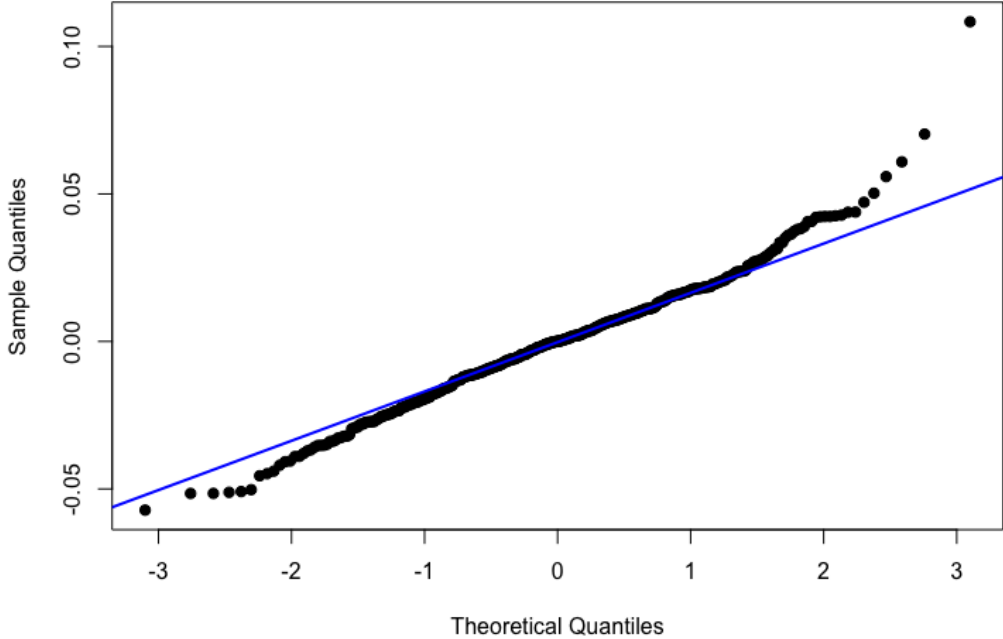


E.7.2 Pioneer Foods Group

Number of Remaining Observations = 517

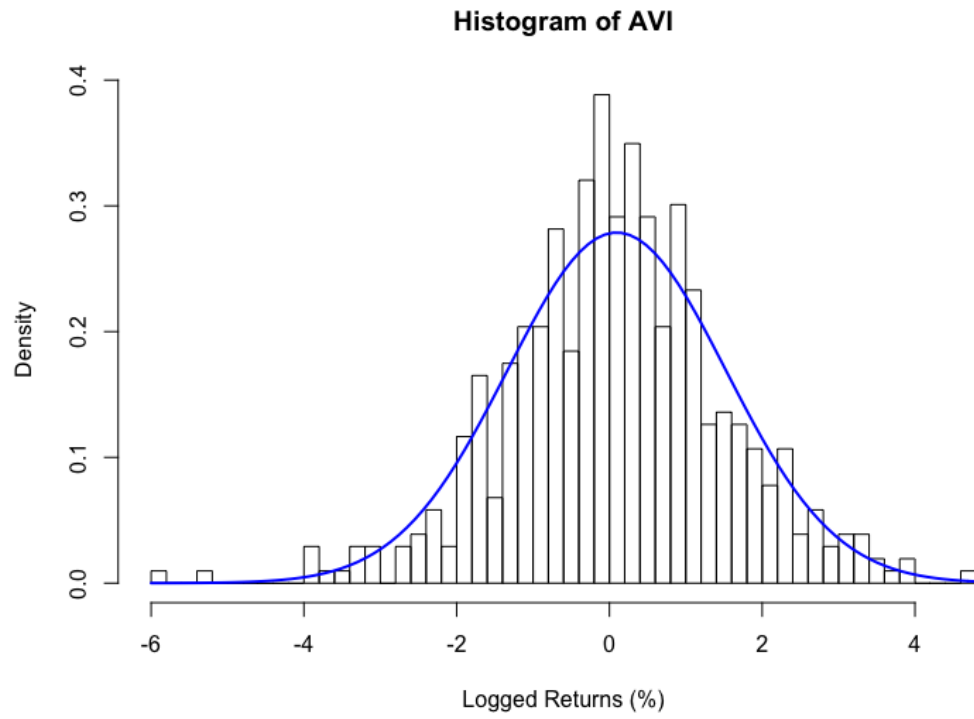


Normal Q-Q Plot for Pioneer Foods Group

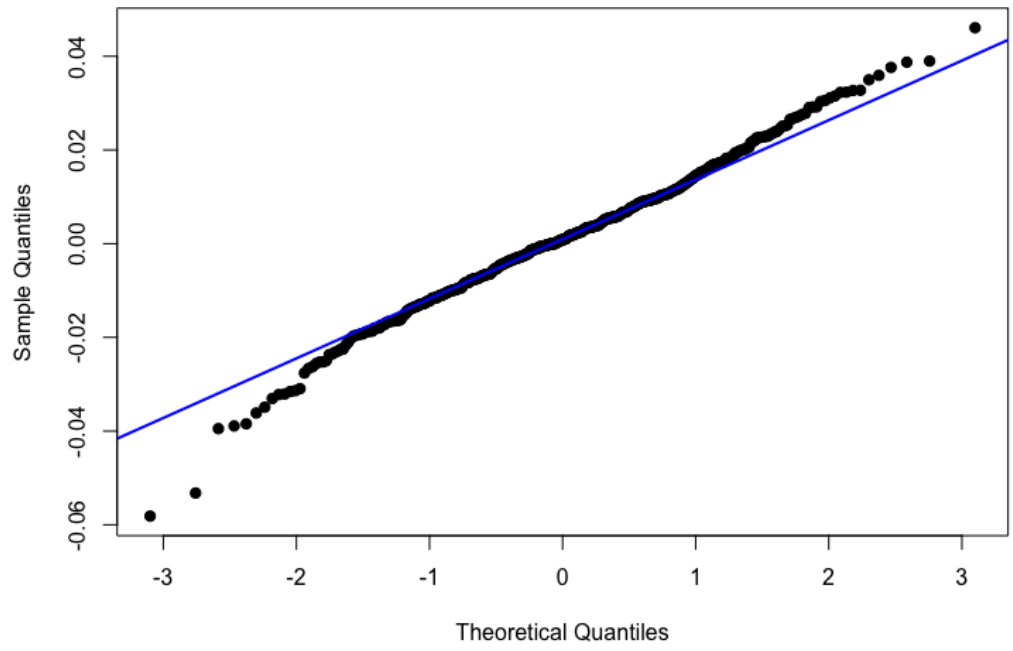


E.7.3 AVI

Number of Remaining Observations = 515

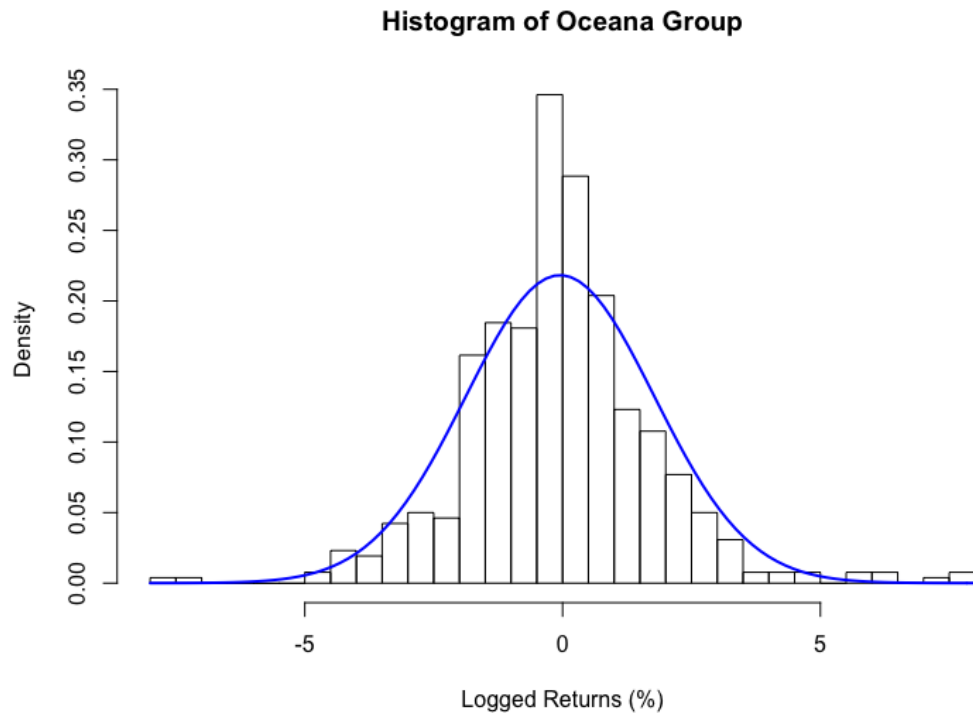


Normal Q-Q Plot for AVI

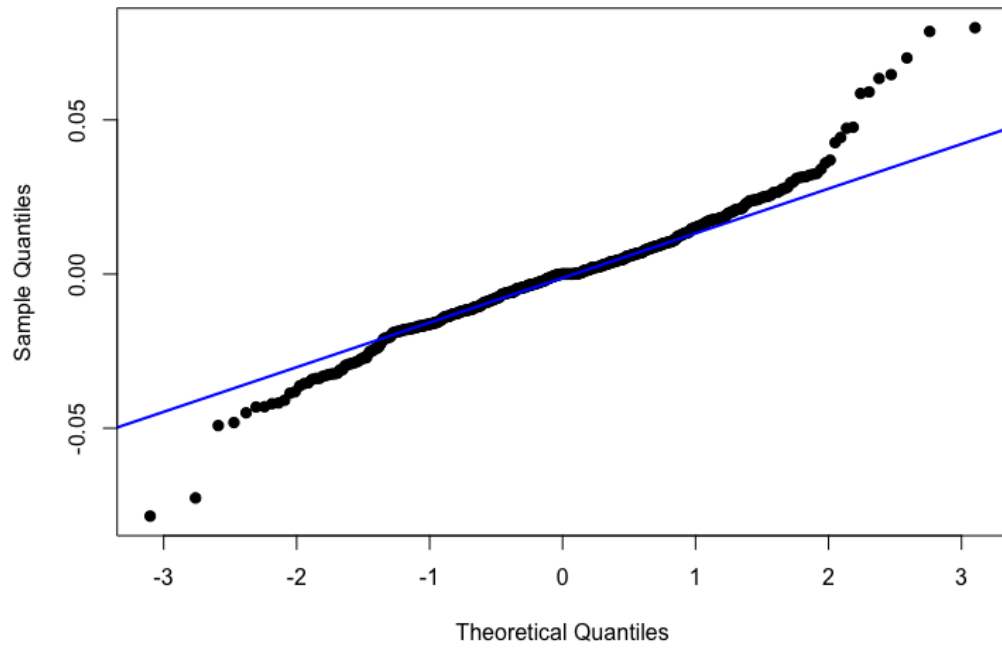


E.7.4 Oceana Group

Number of Remaining Observations = 520

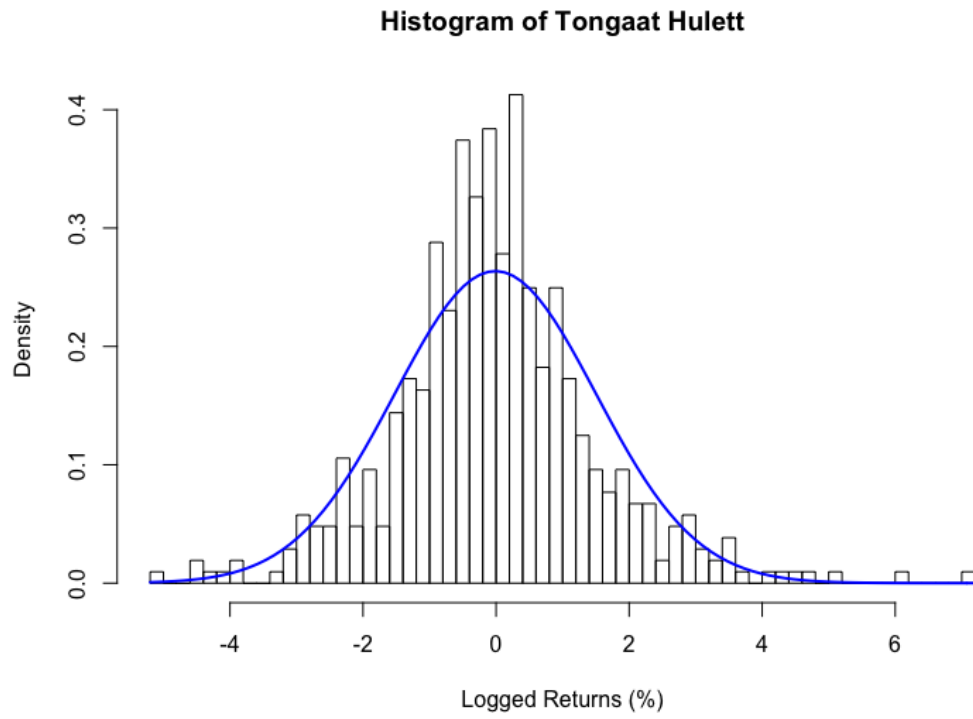


Normal Q-Q Plot for Oceana Group

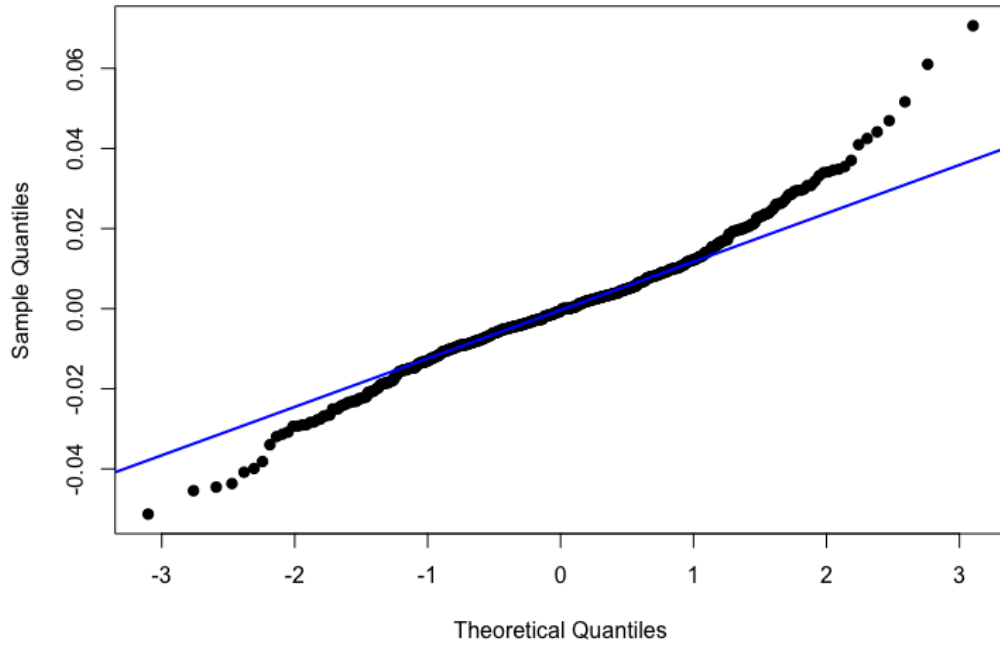


E.7.5 Tongaat Hulett

Number of Remaining Observations = 521



Normal Q-Q Plot for Tongaat Hulett



E.7.6 Results from Goodness-of-Fit Tests

		Normality Test Statistics				
		AD	LF	SW	JB	DP
Tiger Brands		2.2708***	0.054518***	0.96869***	90.766***	-4.88510***
Pioneer Foods Group		1.3029***	0.044532**	0.98168***	93.145***	3.21630***
AVI		0.97071**	0.036149	0.99122***	20.678***	-1.58830
Oceana Group		4.3318***	0.067323***	0.95975***	196.52***	3.06290***
Tongaat Hulett		3.6354***	0.068195***	0.97401***	95.445***	3.39930***

*p <0.1

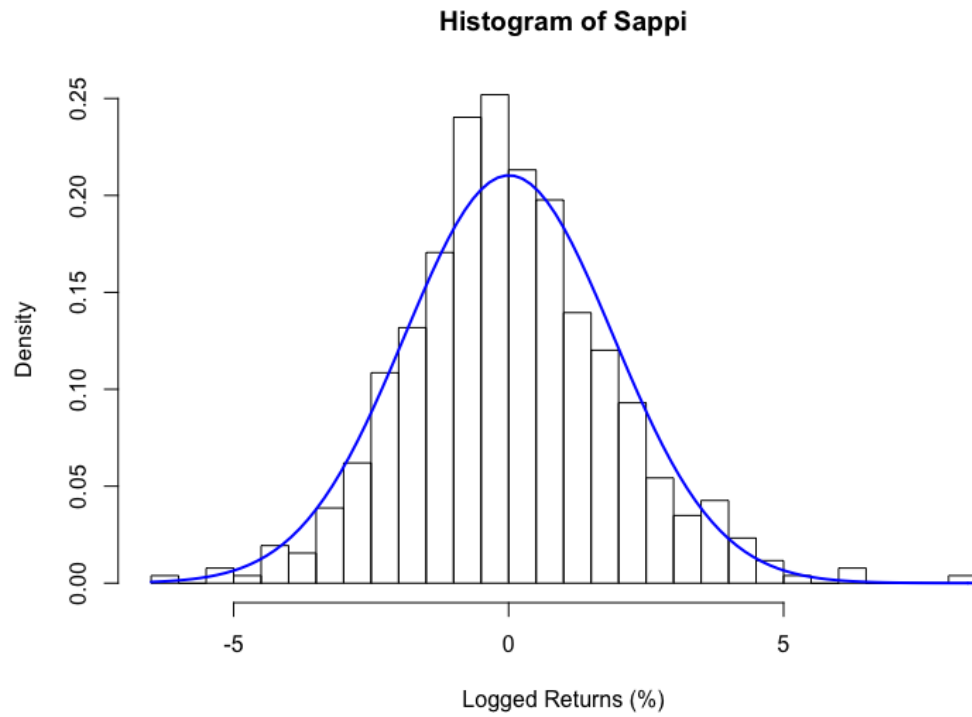
** p <0.05

*** p <0.01

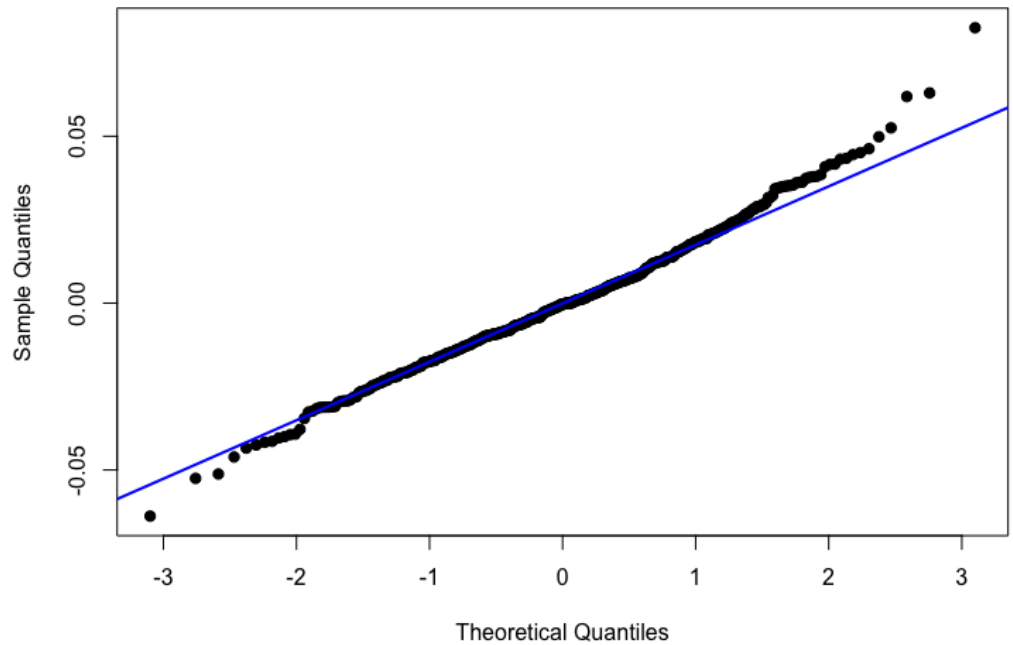
E.8 Forestry and Paper

E.8.1 Sappi

Number of Remaining Observations = 516



Normal Q-Q Plot for Sappi



E.8.2 Results from Goodness-of-Fit Tests

609

Normality Test Statistics					
	AD	LF	SW	JB	DP
Sappi	1.2651***	0.048137***	0.99011***	26.769***	2.92510***

*p < 0.1

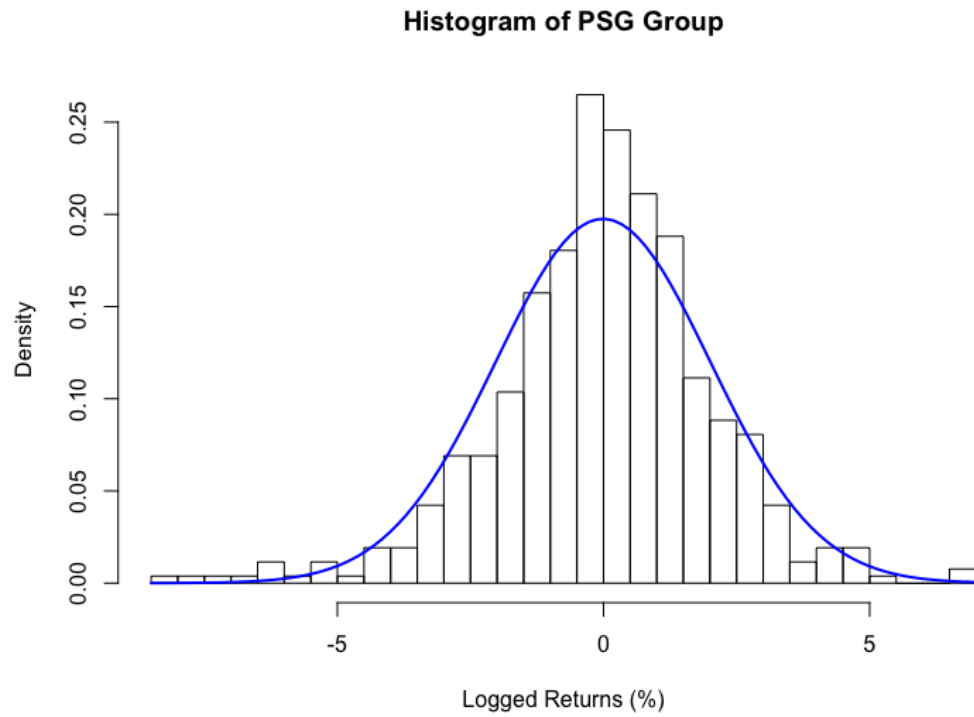
** p < 0.05

*** p < 0.01

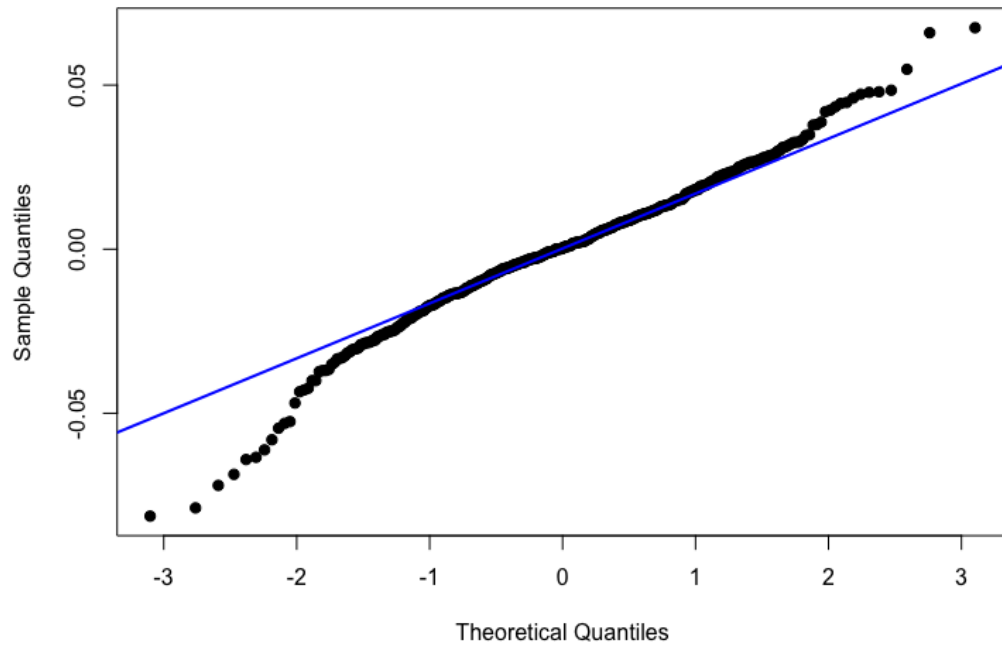
E.9 General Financials

E.9.1 PSG Group

Number of Remaining Observations = 521

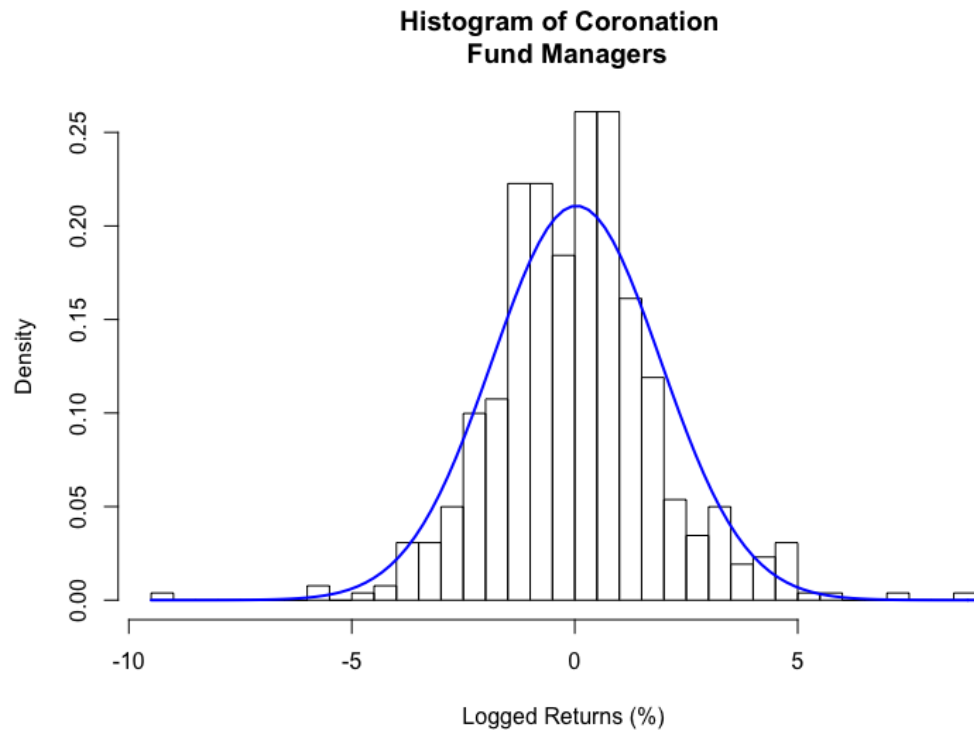


Normal Q-Q Plot for PSG Group

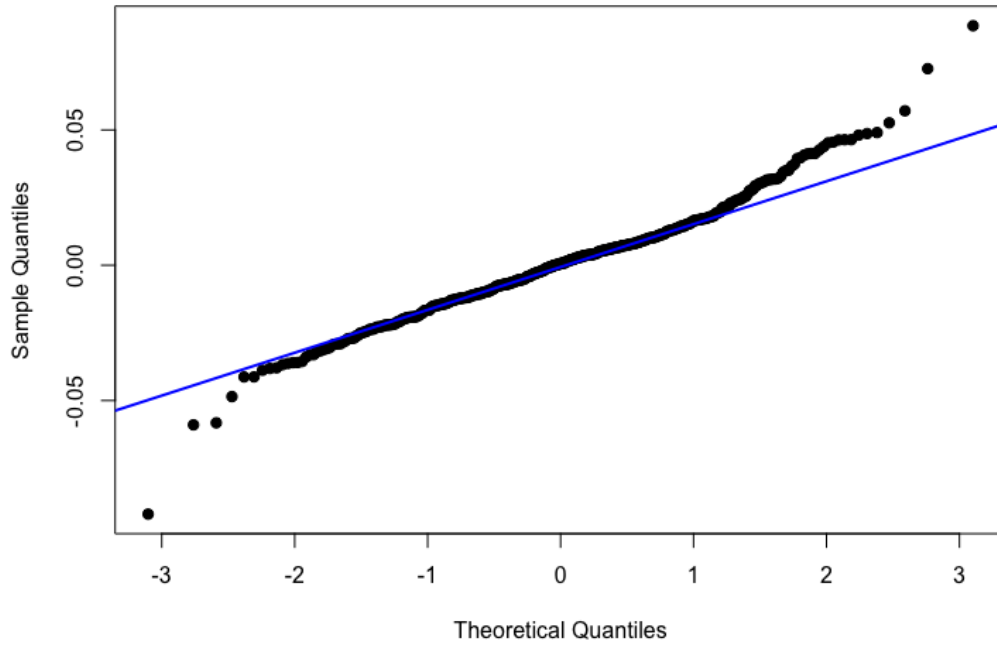


E.9.2 Coronation Fund Managers

Number of Remaining Observations = 521

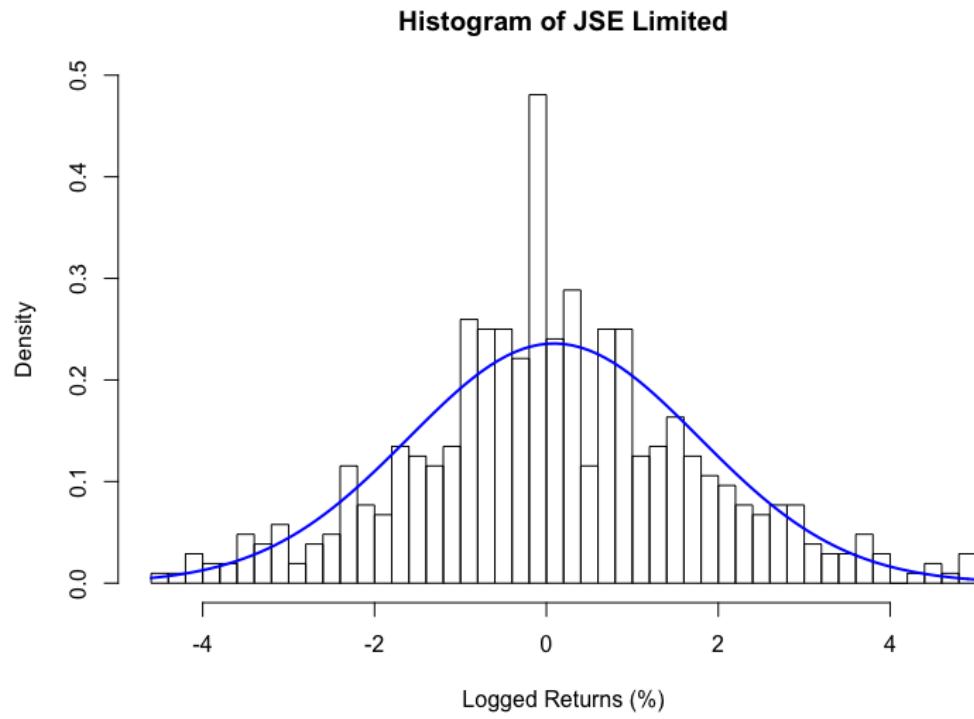


Normal Q-Q Plot for
Coronation Fund Managers

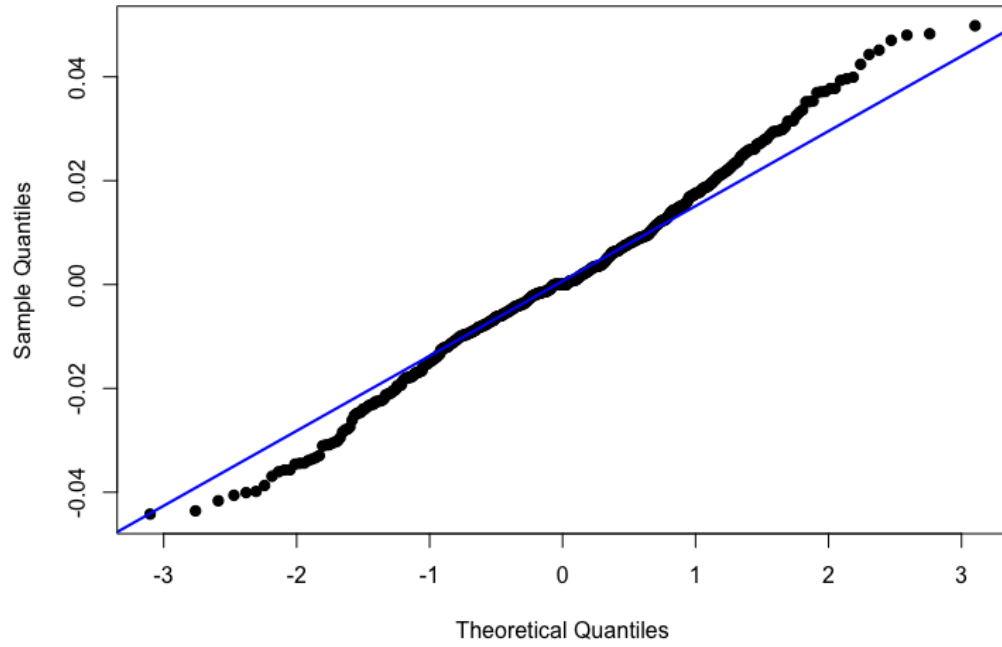


E.9.3 JSE Limited

Number of Remaining Observations = 520



Normal Q-Q Plot for
JSE Limited



E.9.4 Results from Goodness-of-Fit Tests

		Normality Test Statistics				
		AD	LF	SW	JB	DP
PSG Group		2.6203***	0.059389***	0.97651***	77.345***	-3.74760***
Coronation Managers	Fund	2.5521***	0.060948***	0.97527***	113.72***	2.12230**
JSE		1.4107***	0.048337***	0.9925**	2.348	1.00500

*p < 0.1

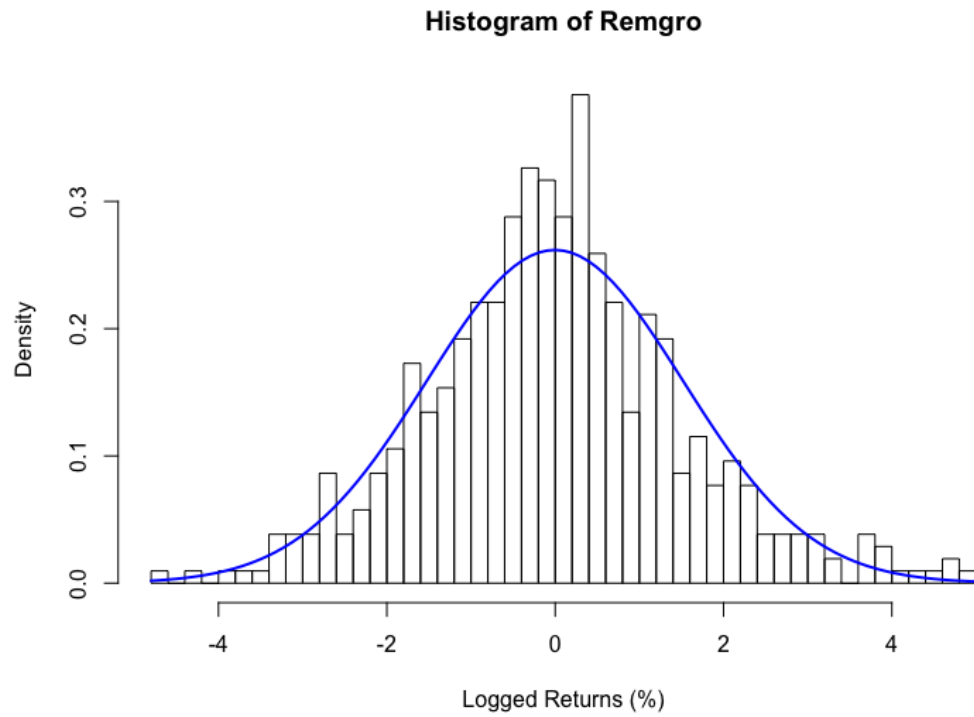
** p < 0.05

*** p < 0.01

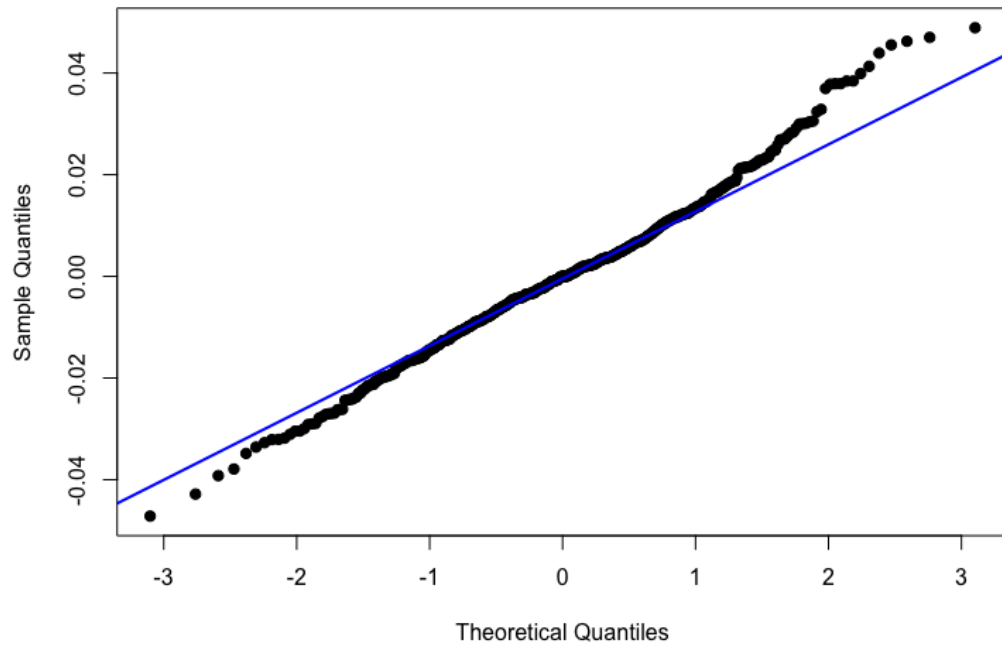
E.10 General Industrials

E.10.1 Remgro

Number of Remaining Observations = 521

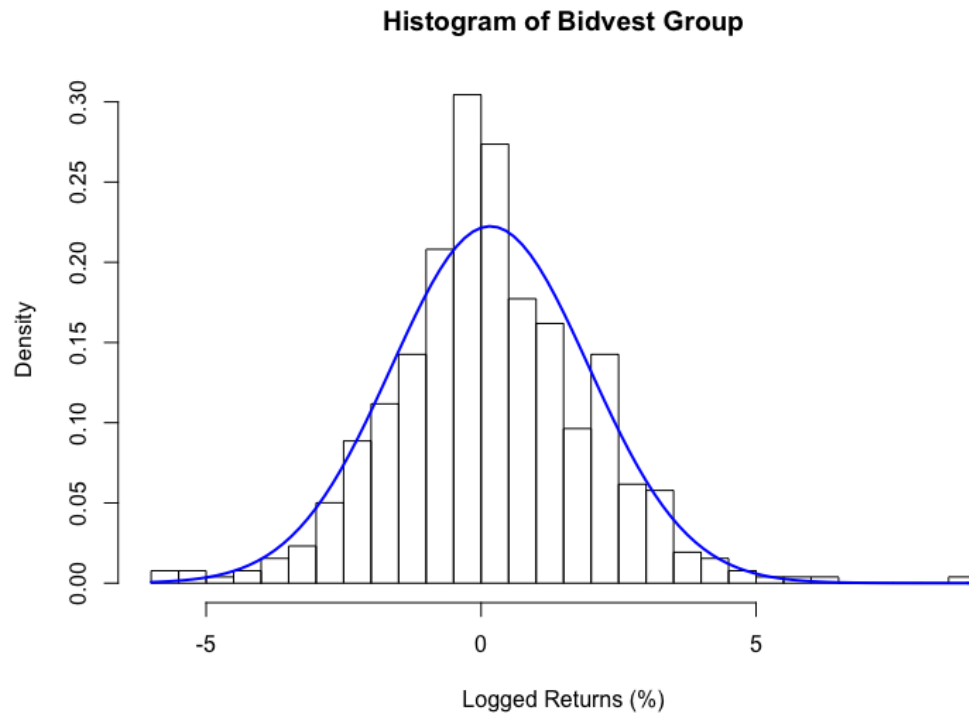


Normal Q-Q Plot for Remgro

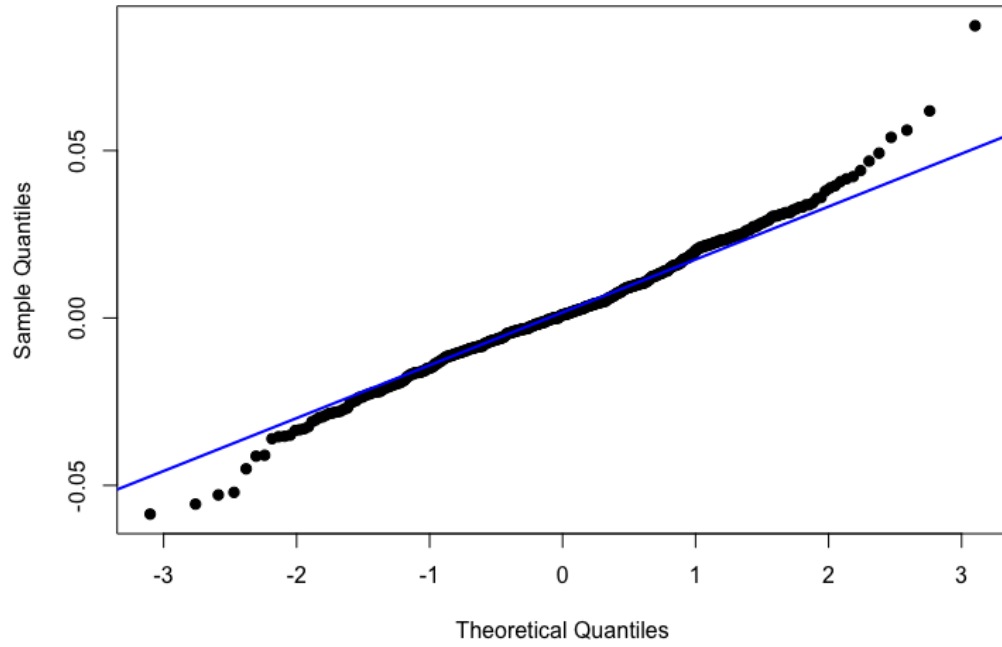


E.10.2 Bidvest Group

Number of Remaining Observations = 519

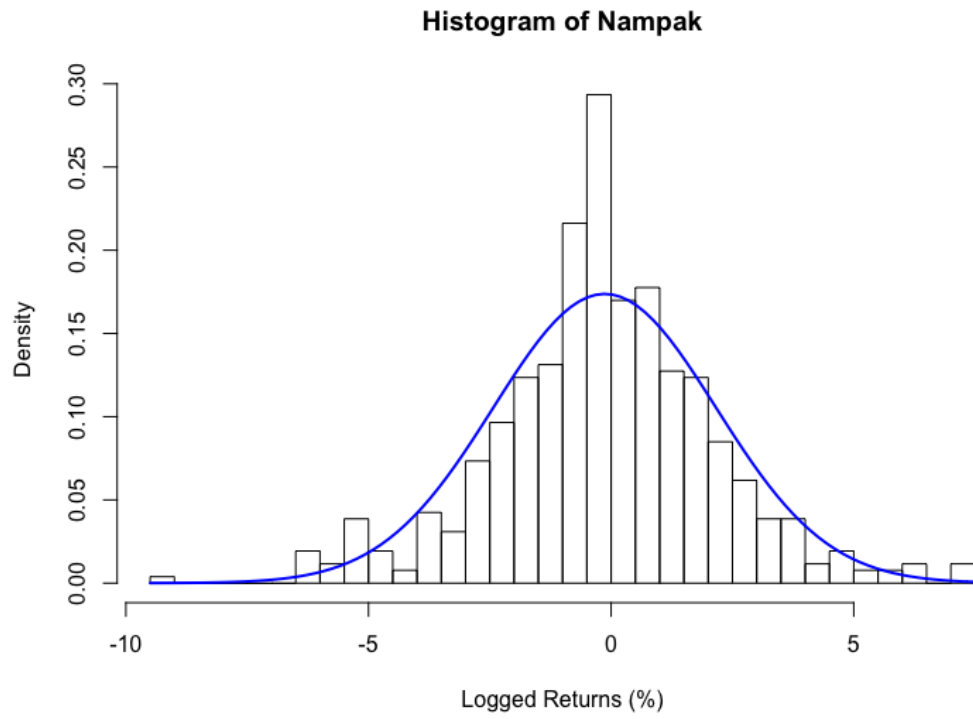


Normal Q-Q Plot for Bidvest Group

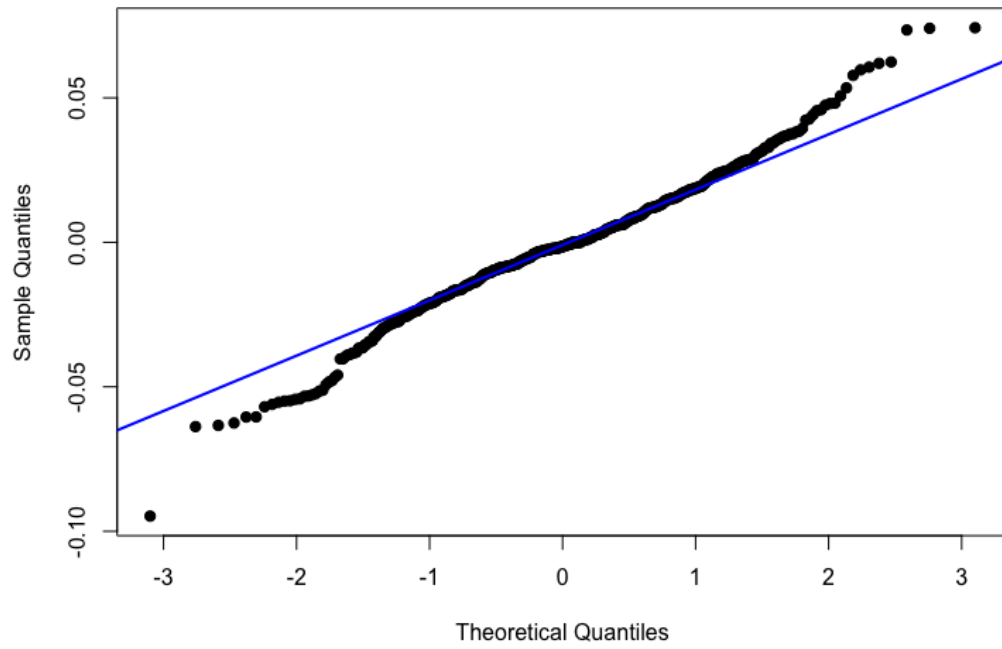


E.10.3 Nampak

Number of Remaining Observations = 518

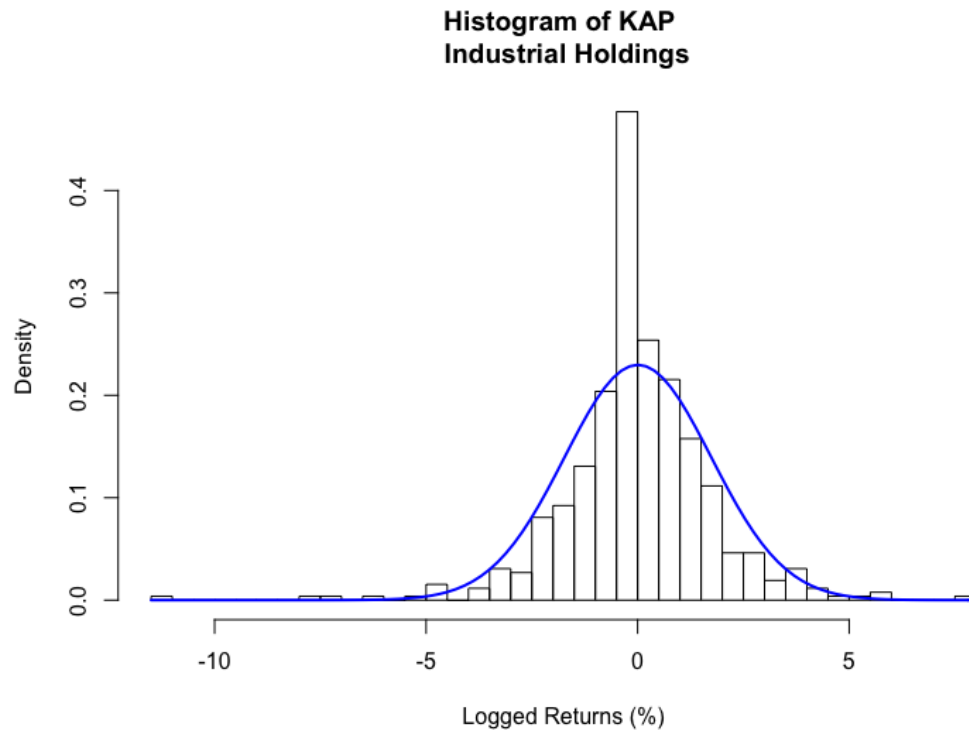


Normal Q-Q Plot for Nampak

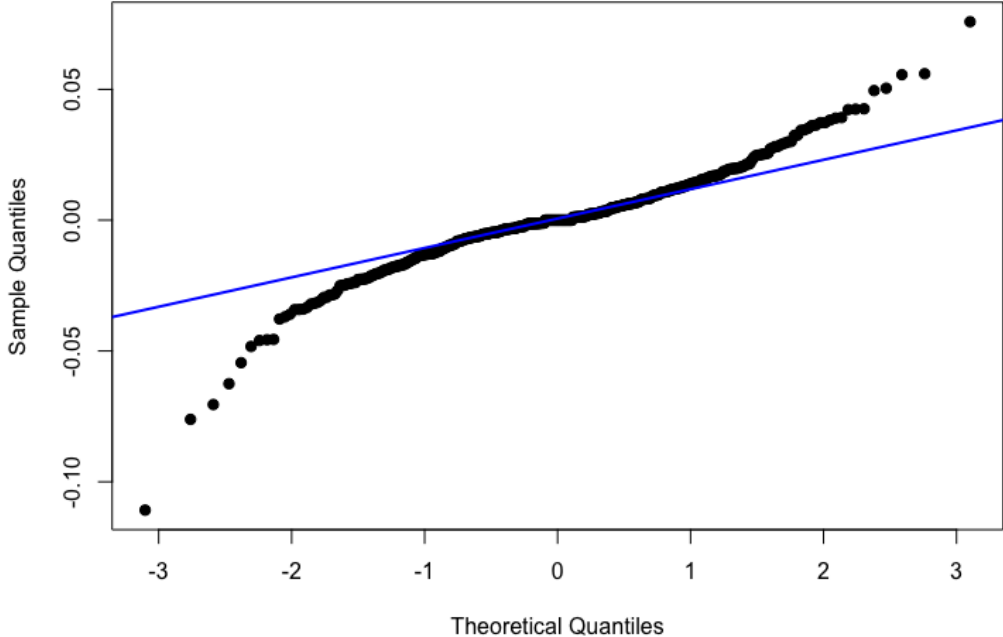


E.10.4 KAP Industrial Holdings

Number of Remaining Observations = 520

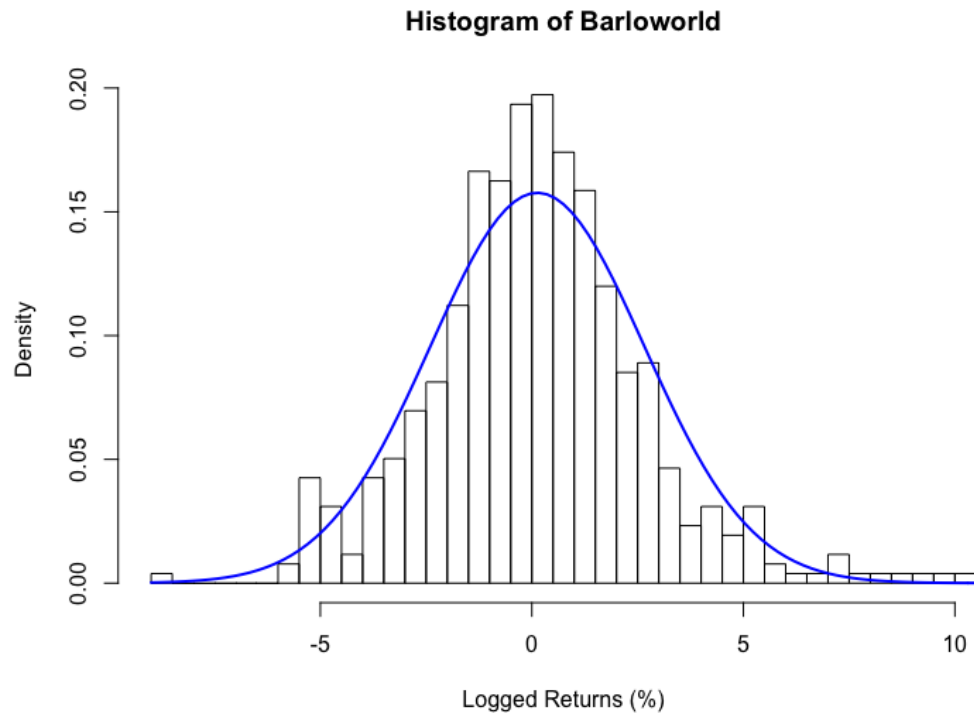


Normal Q-Q Plot for
KAP Industrial Holdings

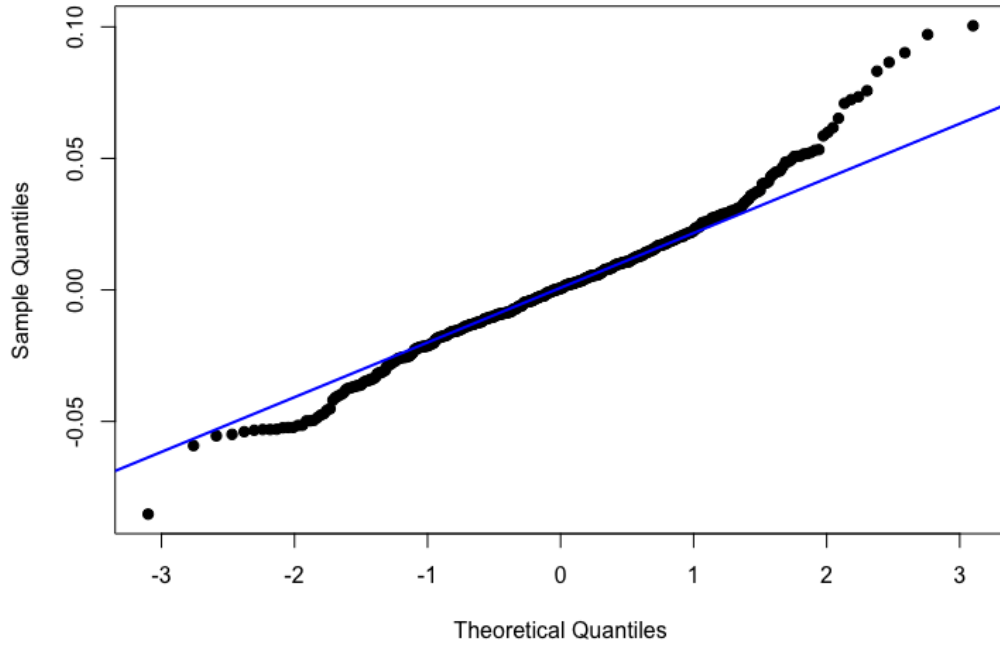


E.10.5 Barloworld

Number of Remaining Observations = 517



Normal Q-Q Plot for Barloworld



E.10.6 Results from Goodness-of-Fit Tests

		Normality Test Statistics				
		AD	LF	SW	JB	DP
Remgro		1.4113***	0.047191***	0.9906***	12.511***	2.19270**
Bidvest Group		1.4062***	0.052578***	0.98735***	43.297***	1.9857**
Nampak		2.8026***	0.058502***	0.98283***	31.065***	-0.599590
KAP Industrial Holdings		7.9674***	0.096213***	0.93362***	635.29***	-4.9771***
Barloworld		2.5482***	0.052497***	0.97807***	58.607***	3.78720***

*p <0.1

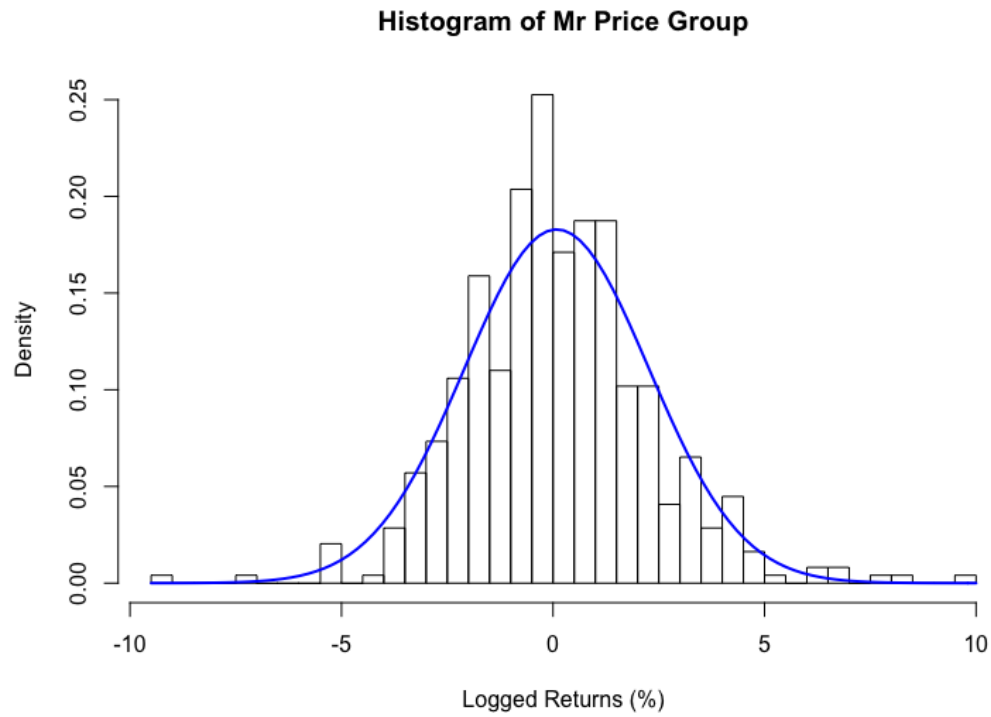
** p <0.05

*** p <0.01

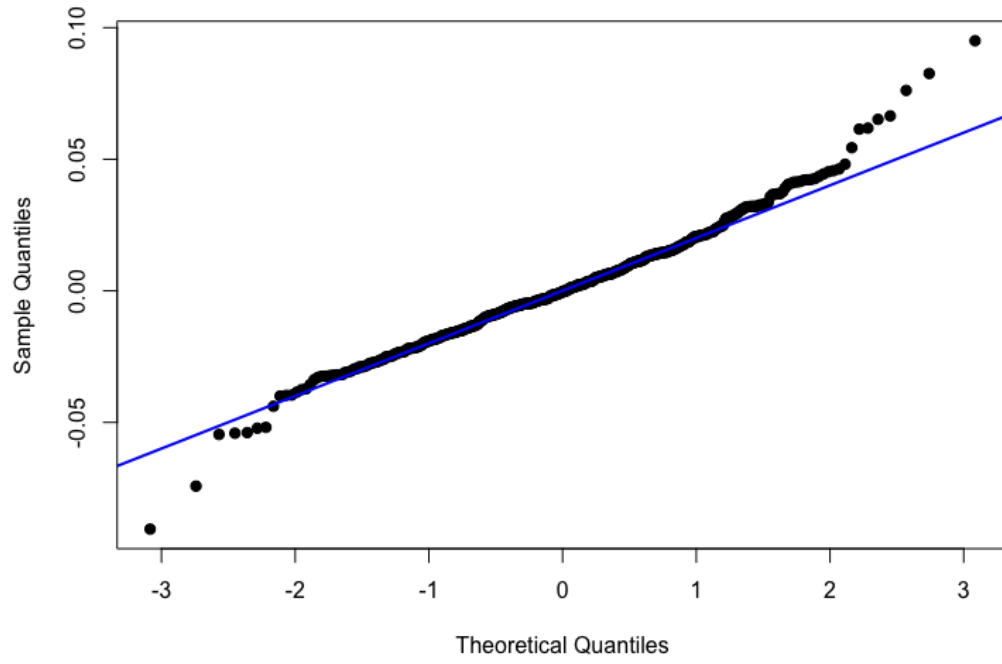
E.11 General Retailers

E.11.1 Mr Price Group

Number of Remaining Observations = 491

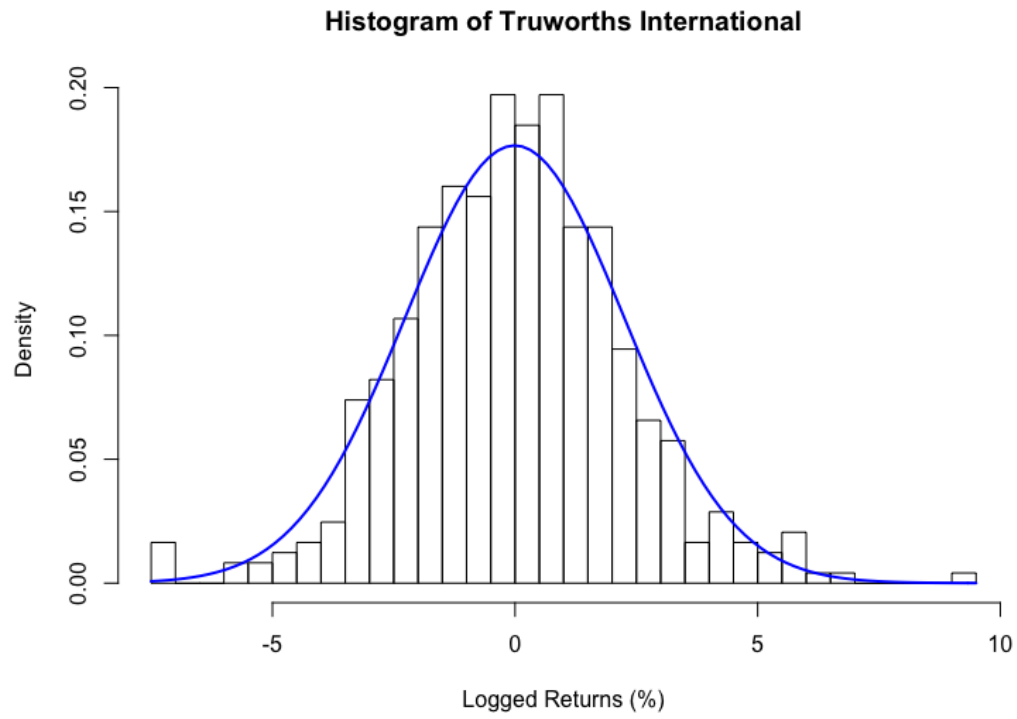


Normal Q-Q Plot for
Mr Price Group

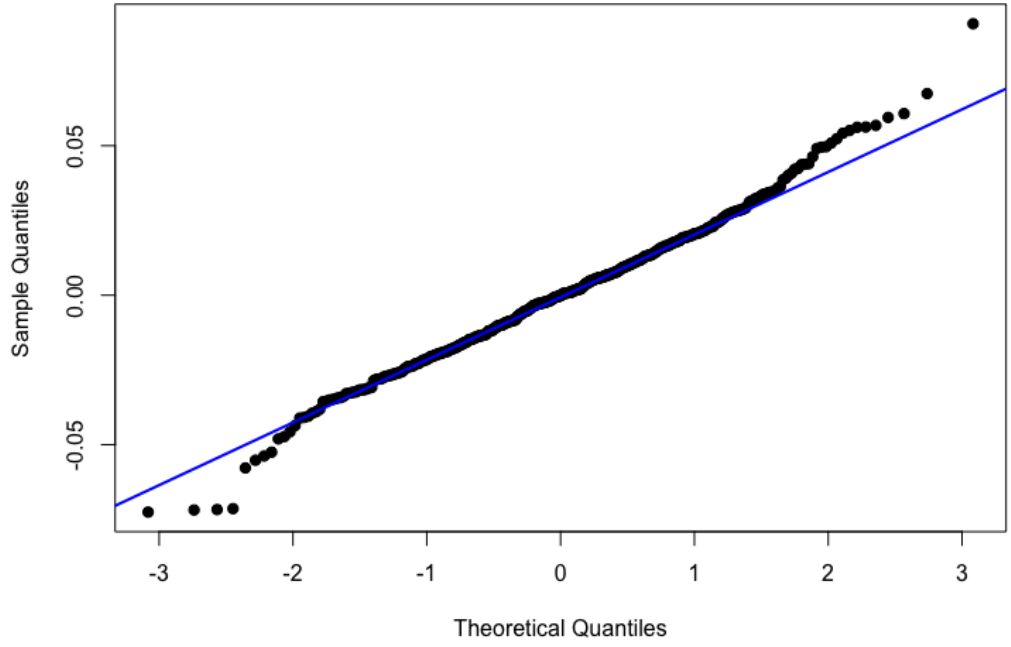


E.11.2 Truworths International

Number of Remaining Observations = 487

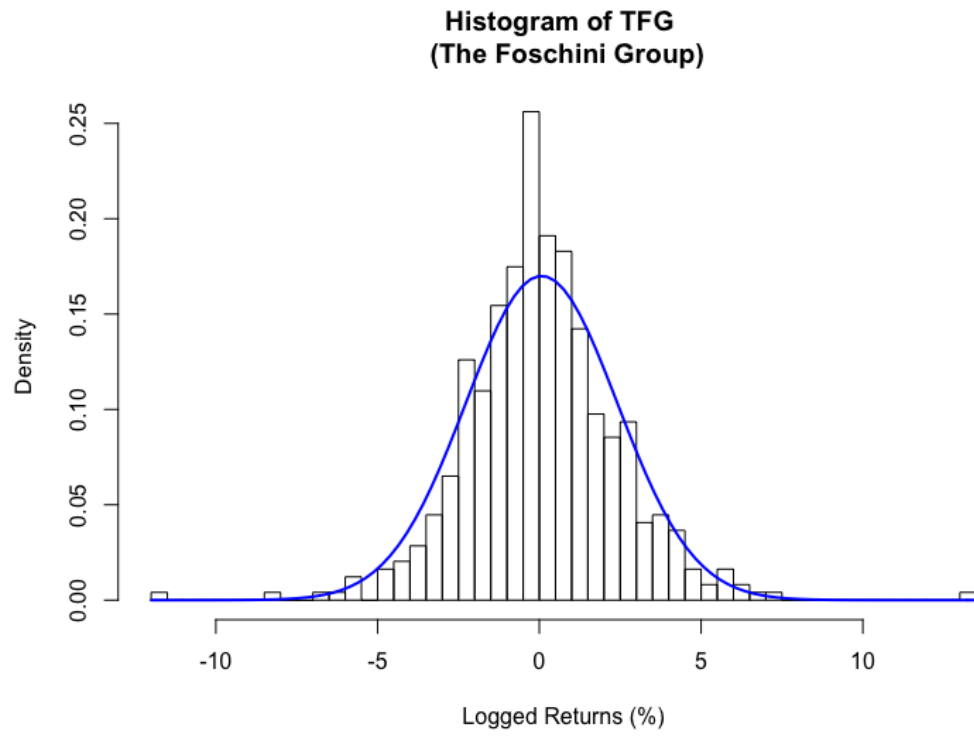


Normal Q-Q Plot for
Truworths International

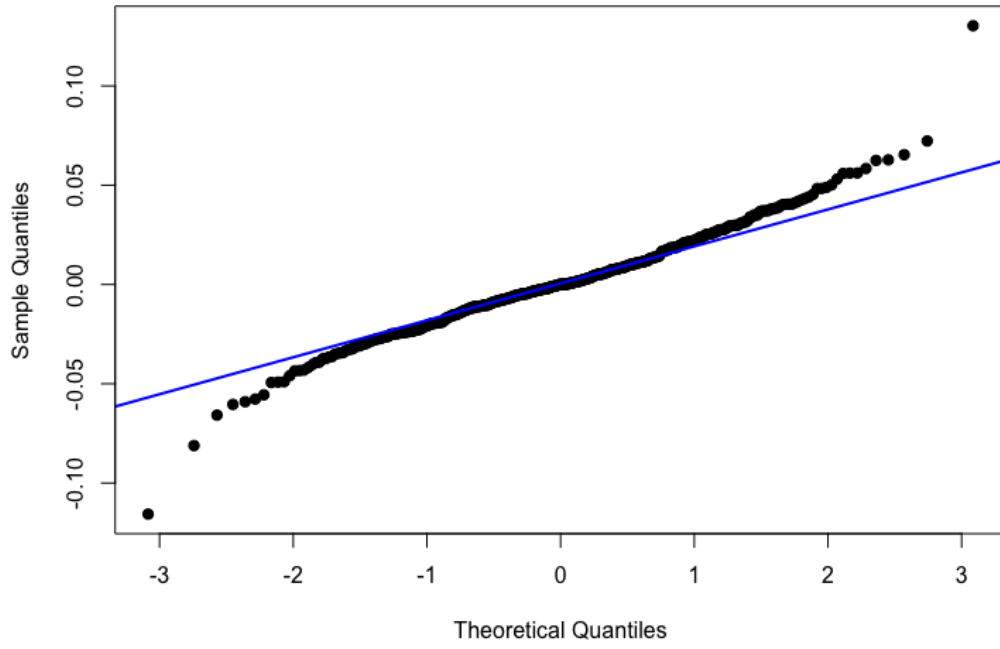


E.11.3 TFG

Number of Remaining Observations = 492

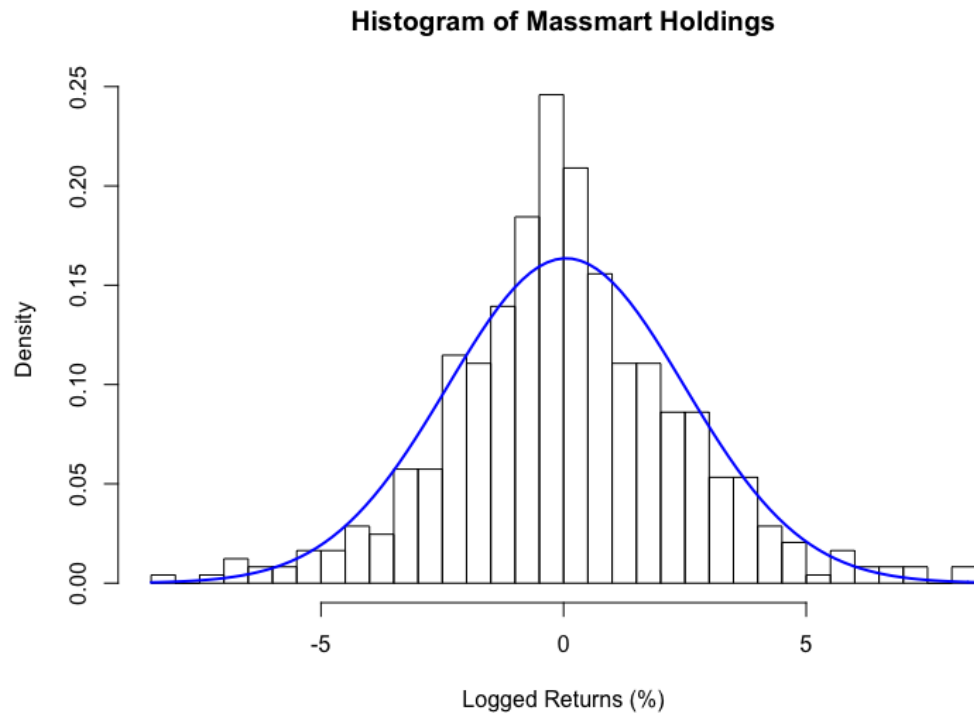


Normal Q-Q Plot for
TFG (The Foschini Group)

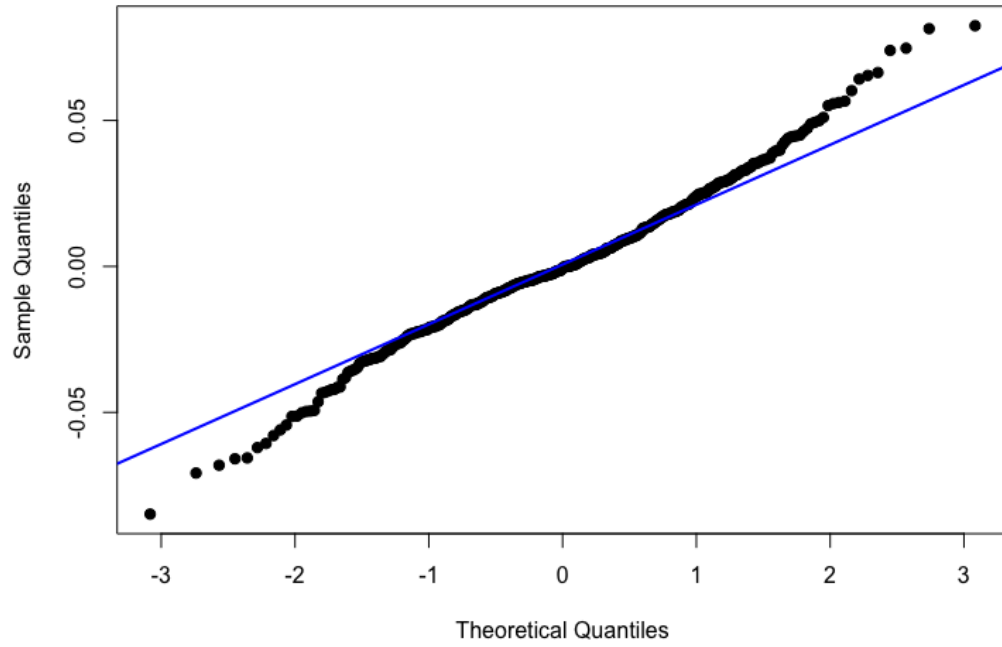


E.11.4 Massmart Holdings

Number of Remaining Observations = 488

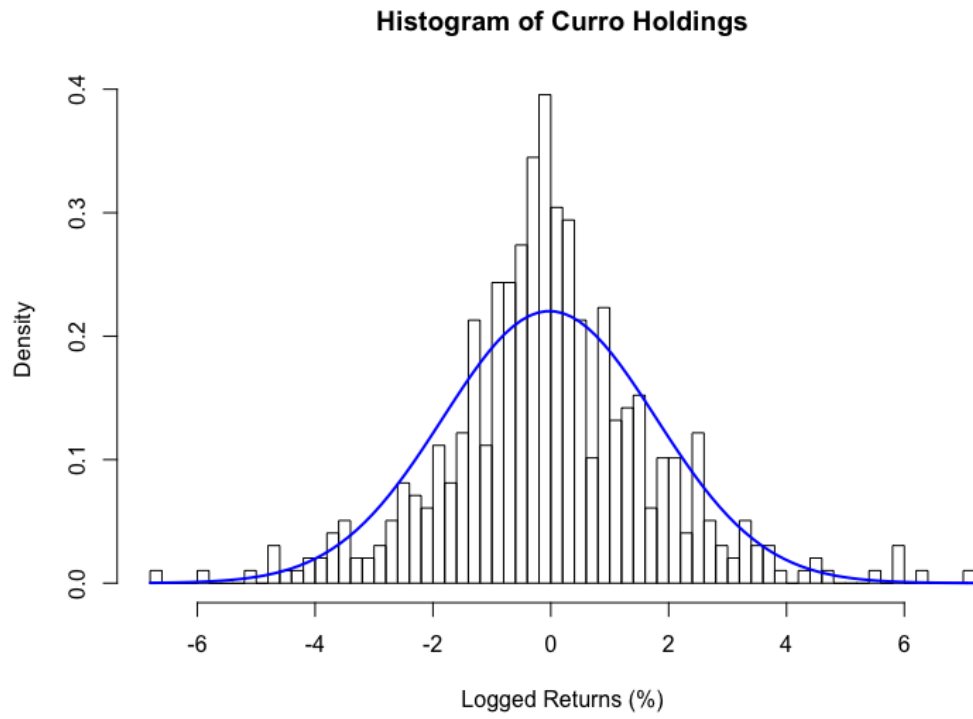


Normal Q-Q Plot for
Massmart Holdings

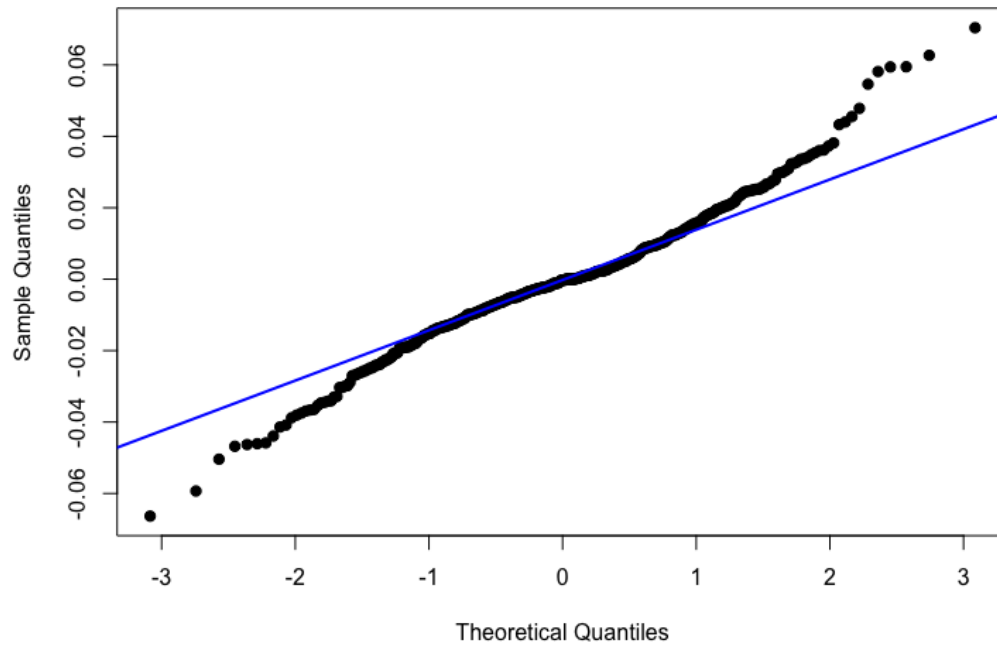


E.11.5 Curro Holdings

Number of Remaining Observations = 493

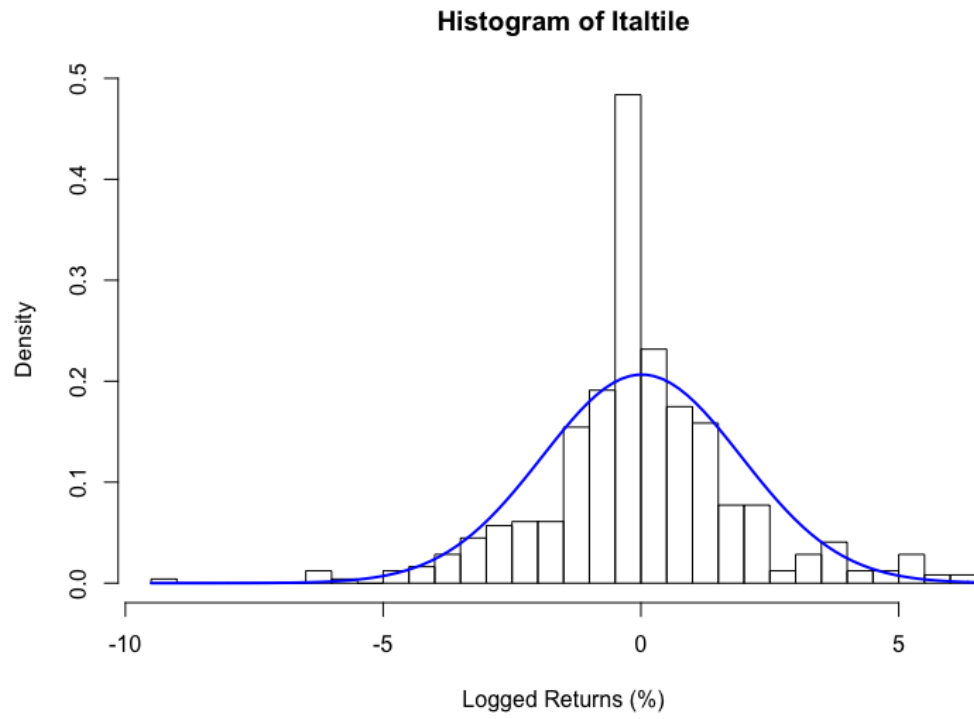


Normal Q-Q Plot for Curro Holdings

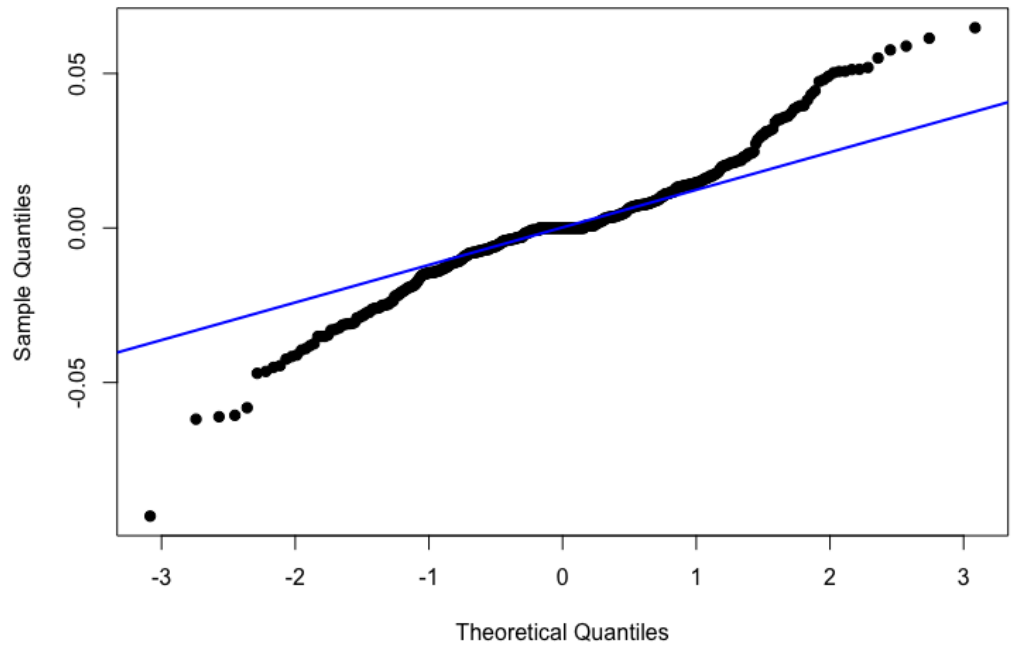


E.11.6 Italtile

Number of Remaining Observations = 492



Normal Q-Q Plot for Italtile



E.11.7 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Mr Price Group	1.7269***	0.046904**	0.98055***	68.573***	2.66480***
Truworths International	0.76449**	0.028376	0.99125***	16.937***	1.01480
TFG	2.2526***	0.058873***	0.97212***	189.42***	1.52540
Massmart Holdings	1.9268***	0.050813***	0.98779***	19.352***	0.95751
Curro Holdings	3.6829***	0.068934***	0.97654***	54.779***	1.76580*
Italtile	8.3887***	0.091034***	0.95322***	110.05***	-0.248390

*p < 0.1

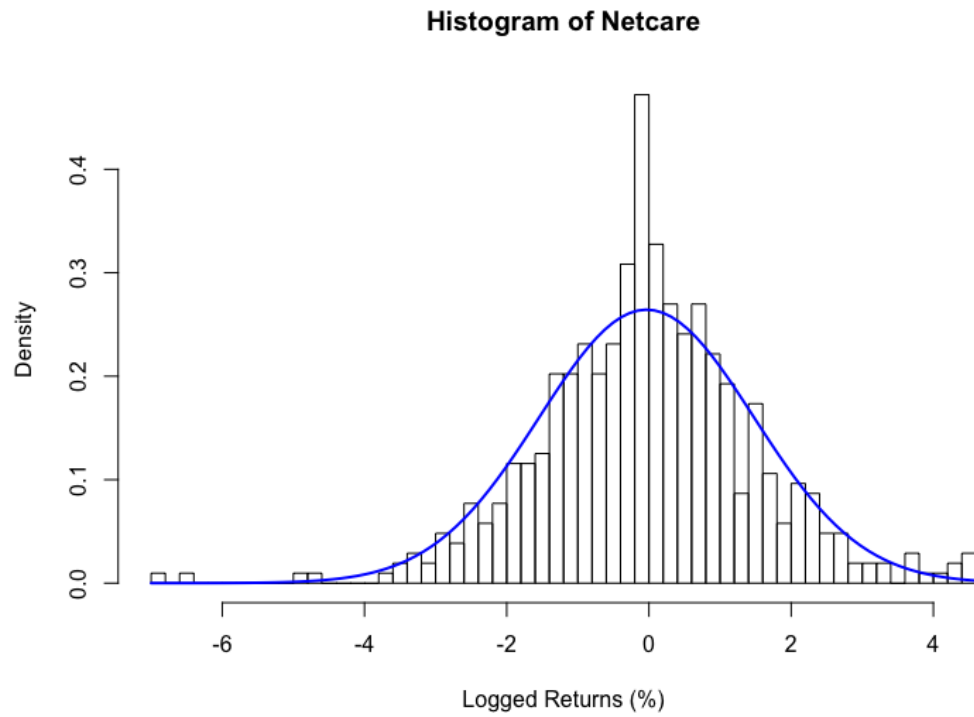
** p < 0.05

*** p < 0.01

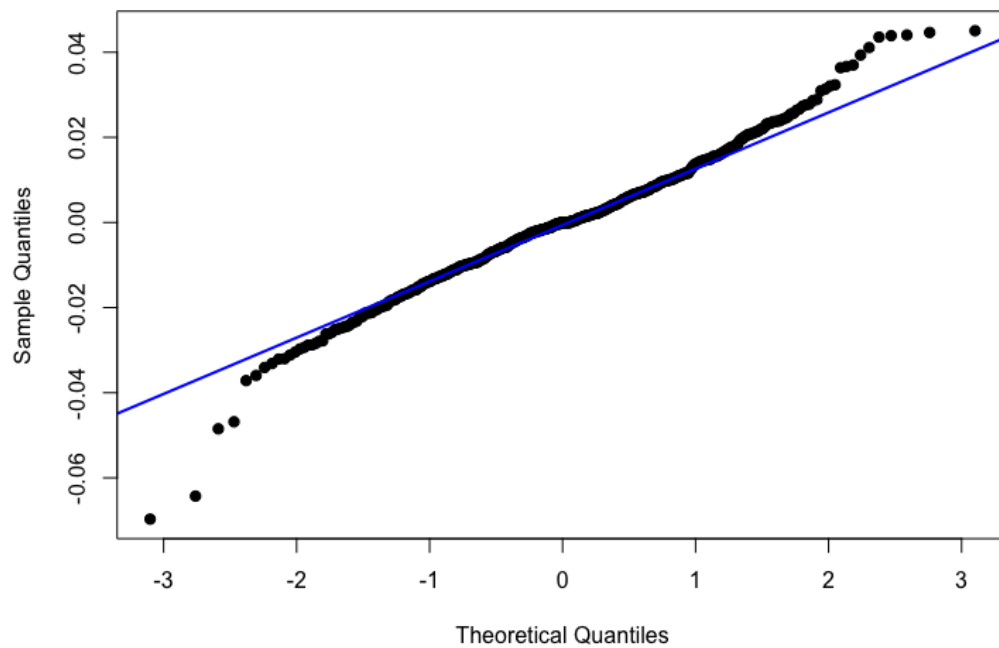
E.12 Healthcare Equipment and Services

E.12.1 Netcare

Number of Remaining Observations = 519

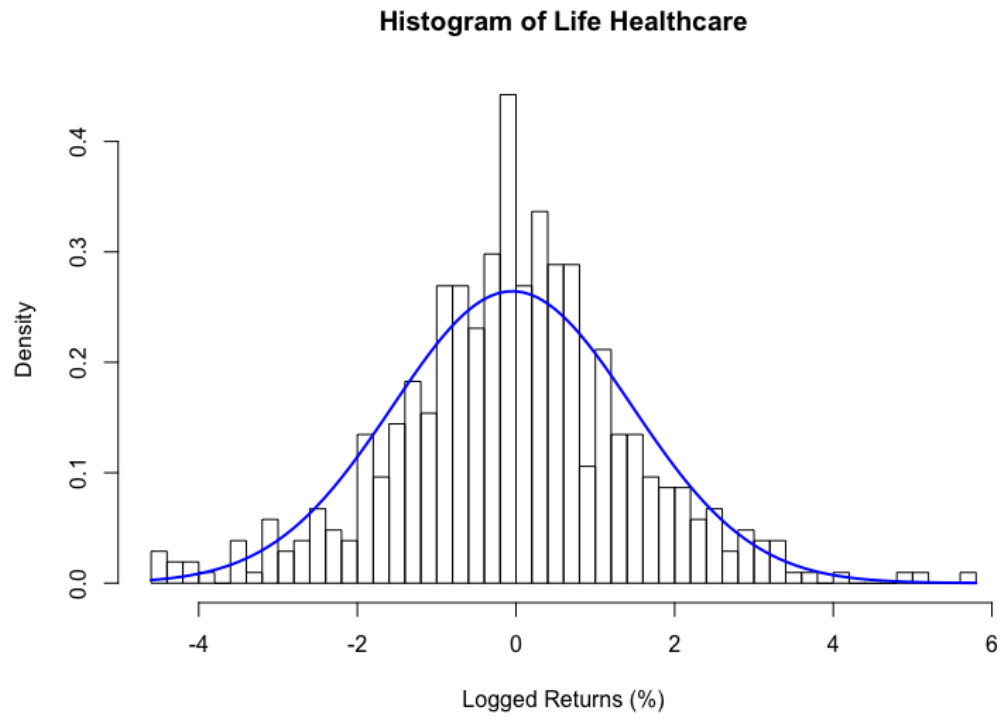


Normal Q-Q Plot for Netcare

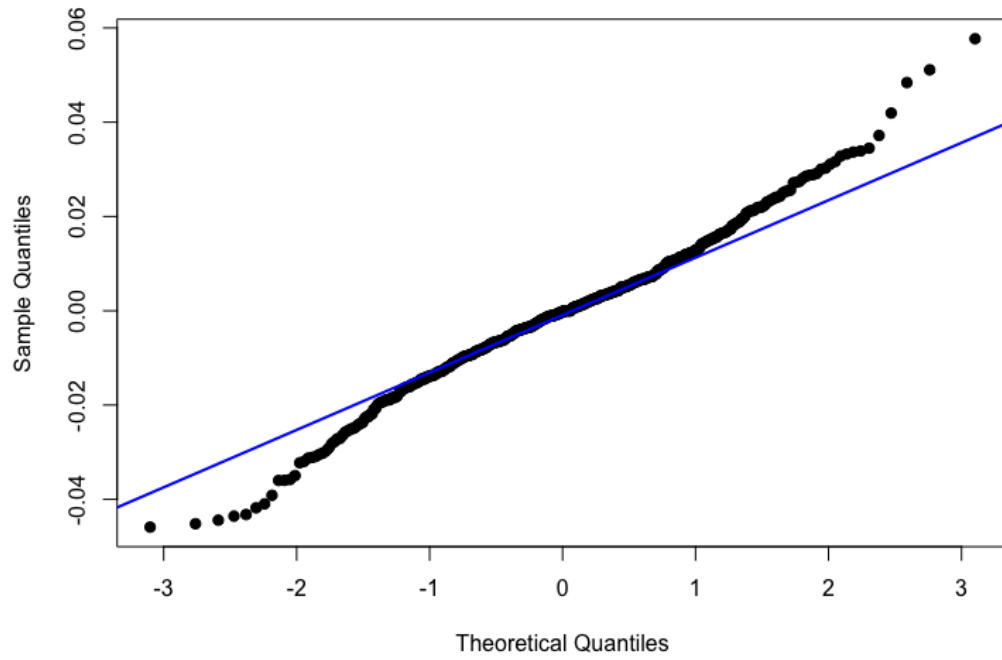


E.12.2 Life Healthcare

Number of Remaining Observations = 520



Normal Q-Q Plot for Life Healthcare



E.12.3 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Netcare	1.8128***	0.043422**	0.98192***	60.671***	-1.34940
Life Healthcare	1.9815***	0.055023***	0.98727***	22.123***	0.15234

*p <0.1

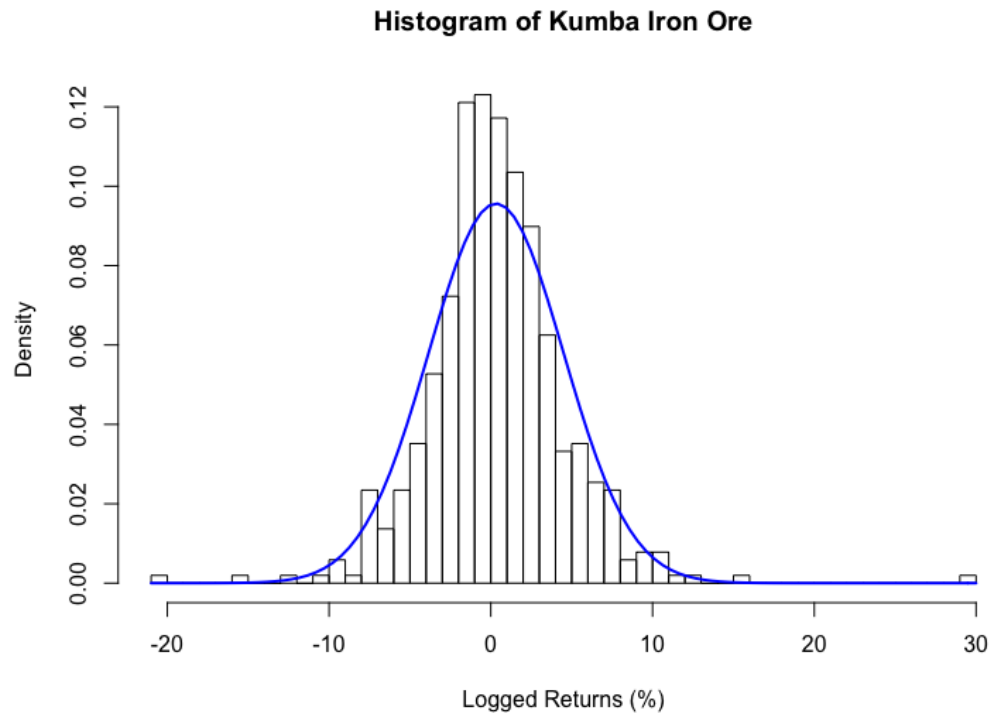
** p <0.05

*** p <0.01

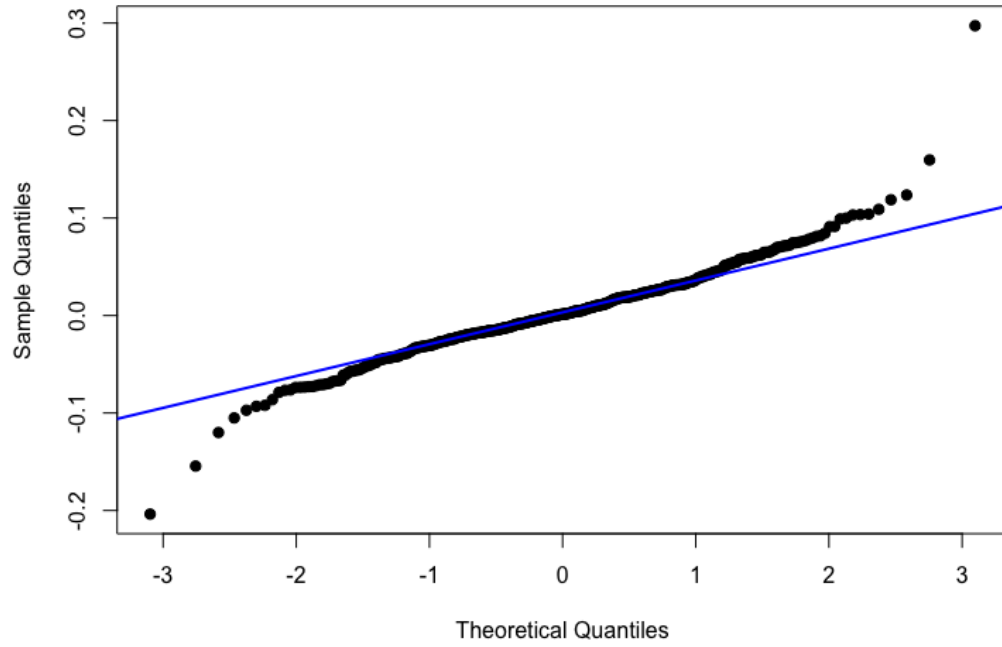
E.13 Industrial Metals

E.13.1 Kumba Iron Ore

Number of Remaining Observations = 512



Normal Q-Q Plot for
Kumba Iron Ore



E.13.2 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Kumba Iron Ore	3.6622***	0.064371***	0.94722***	818.53***	4.68740***

639

*p < 0.1

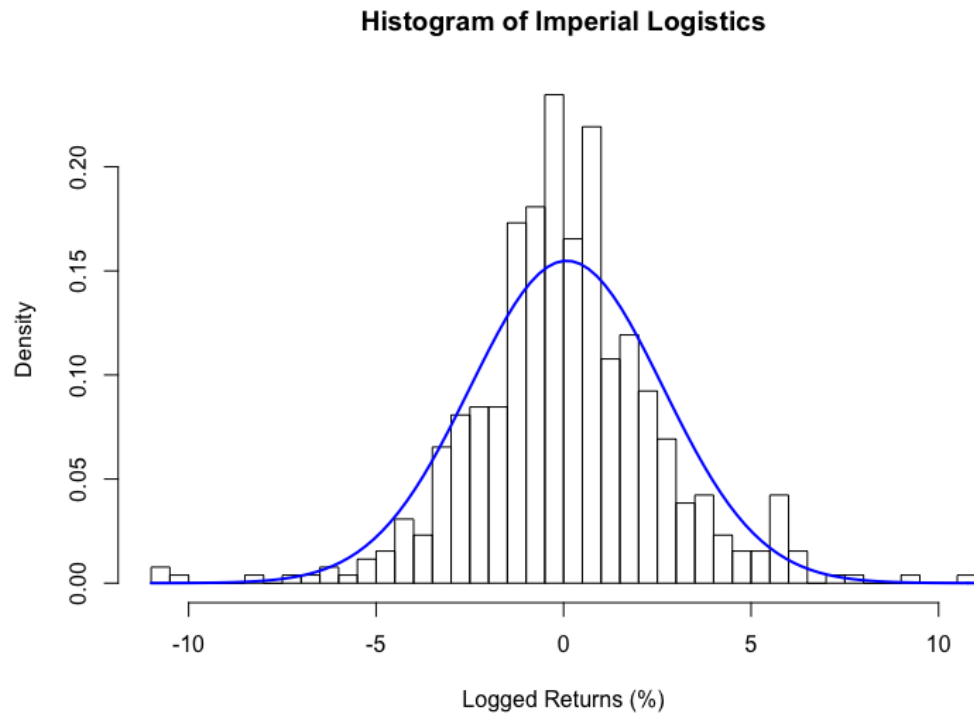
** p < 0.05

*** p < 0.01

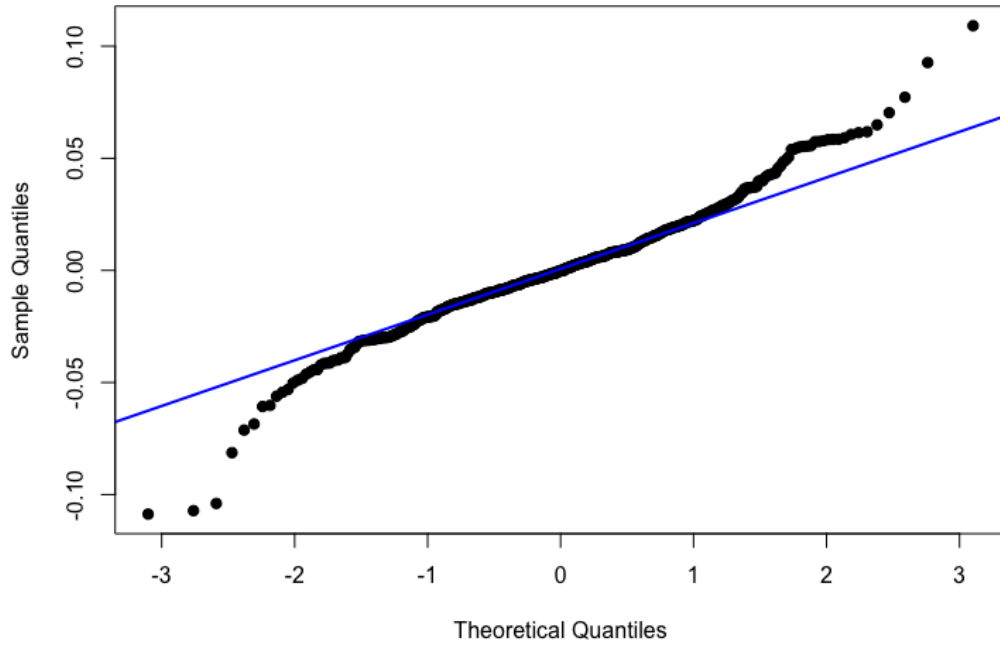
E.14 Industrial Transportation

E.14.1 Imperial Logistics

Number of Remaining Observations = 520

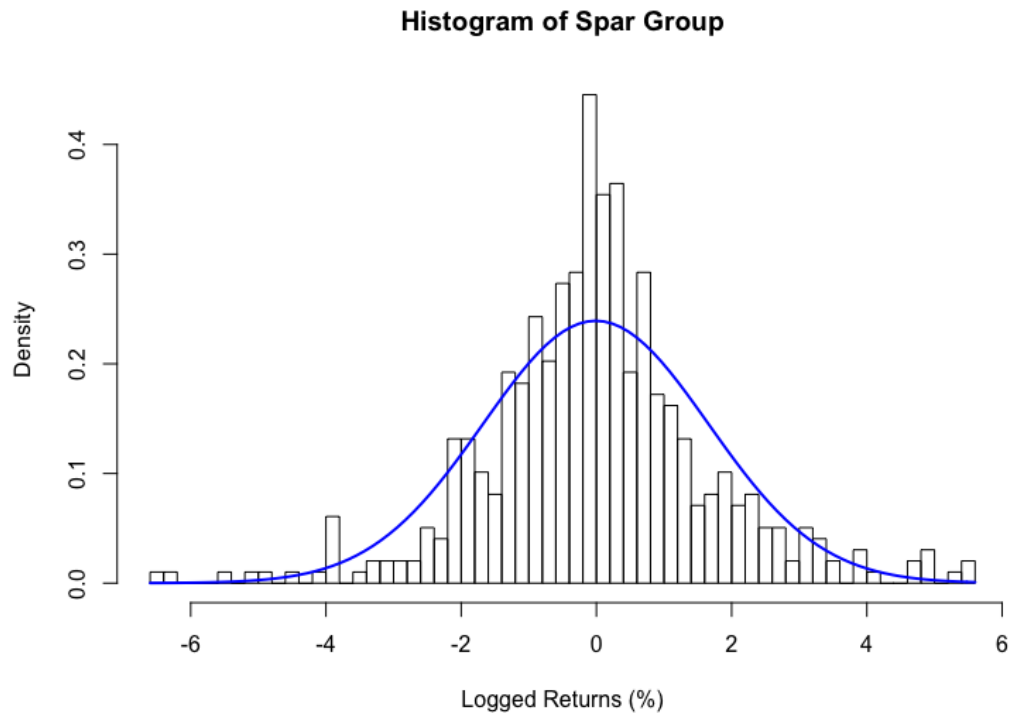


Normal Q-Q Plot for Imperial Logistics

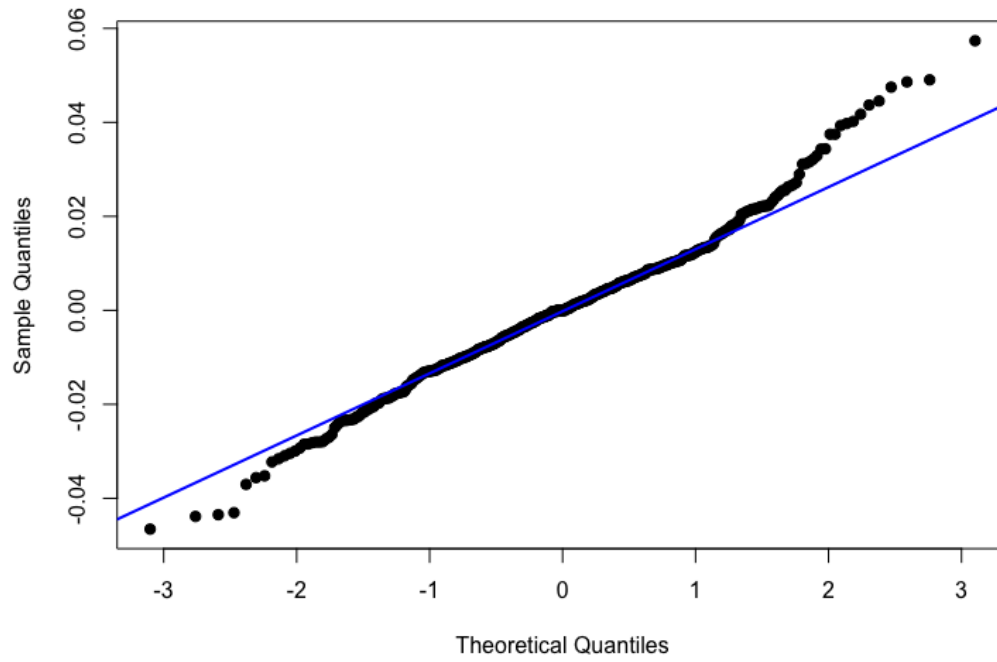


E.14.2 Super Group

Number of Remaining Observations = 520



Normal Q-Q Plot for Super Group



E.14.3 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Imperial Logistics	3.6162***	0.065949***	0.96961***	117.11***	-0.30085
Super Group	2.0282***	0.057394***	0.98449***	32.938***	2.40660**

*p <0.1

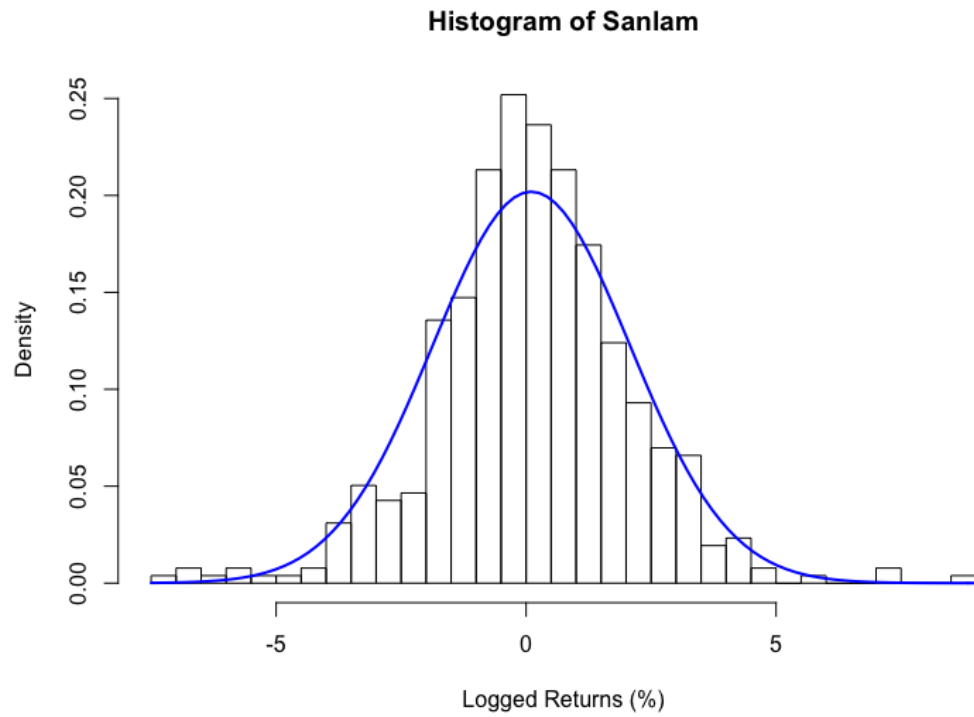
** p <0.05

*** p <0.01

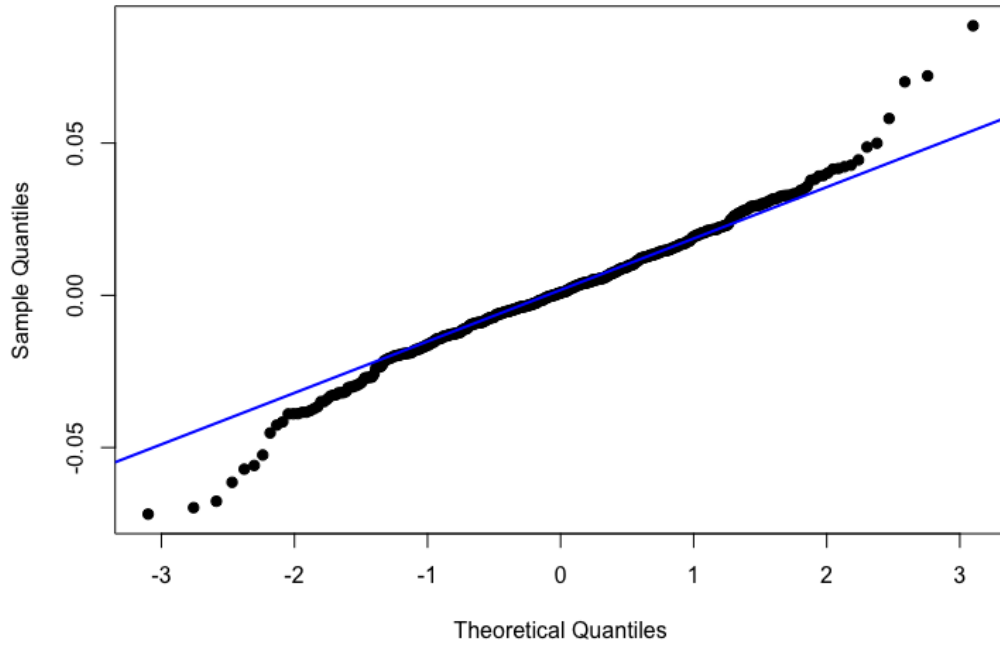
E.15 Life Insurance/Assurance

E.15.1 Sanlam

Number of Remaining Observations = 516

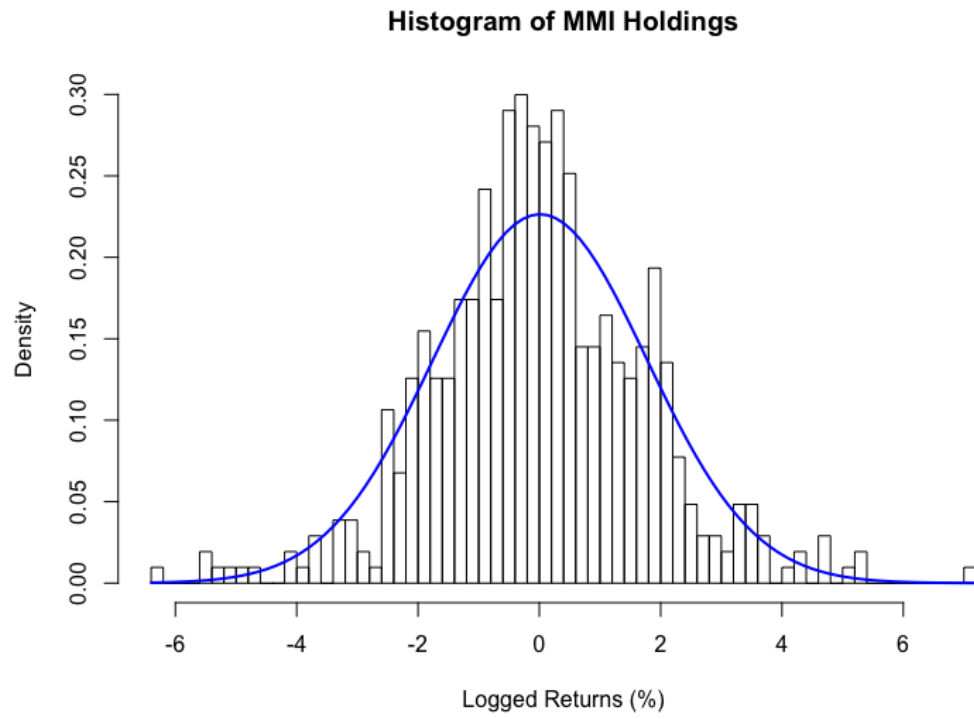


Normal Q-Q Plot for Sanlam

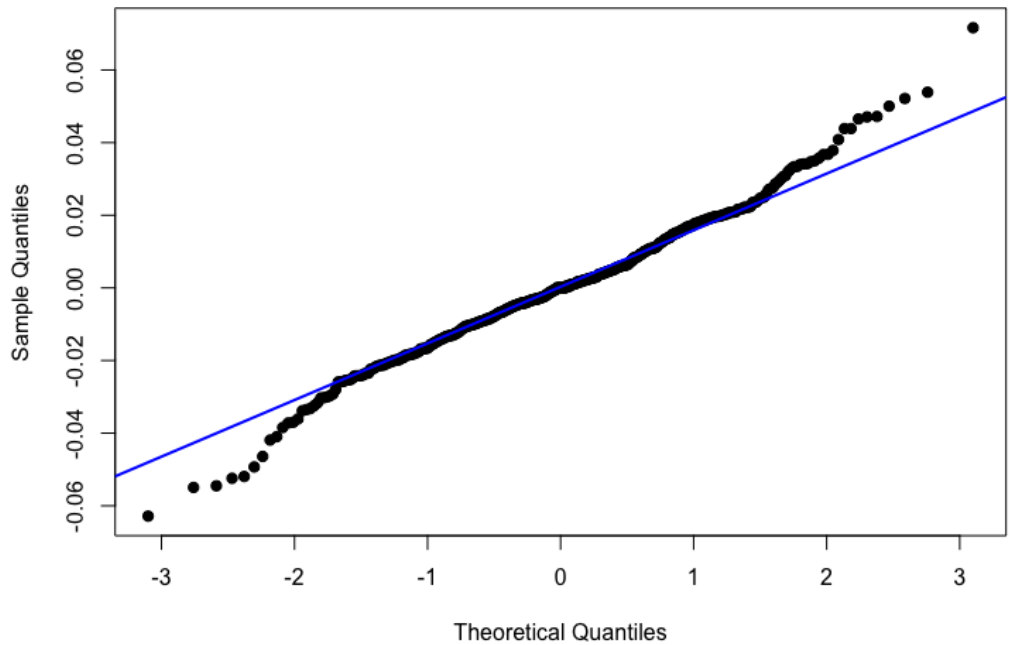


E.15.2 MMI Holdings

Number of Remaining Observations = 517

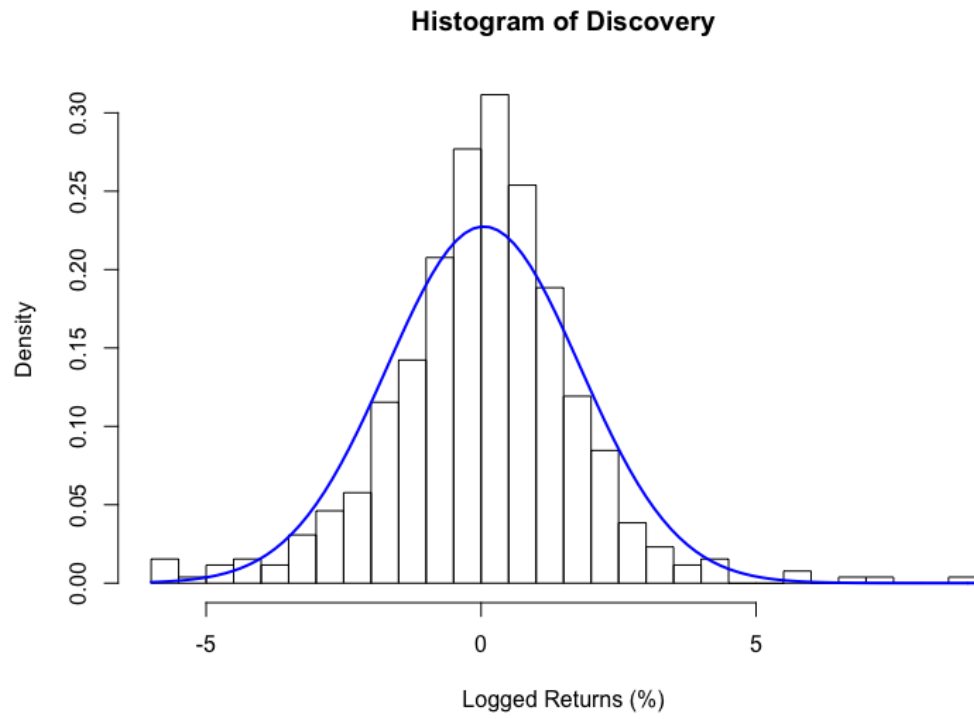


Normal Q-Q Plot for MMI Holdings

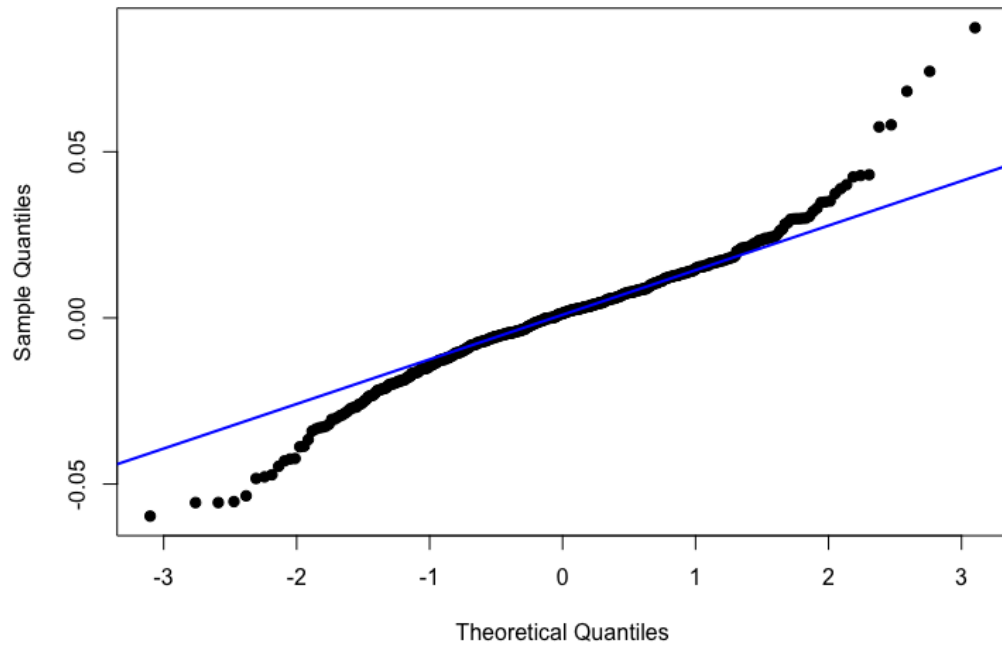


E.15.3 Discovery

Number of Remaining Observations = 520

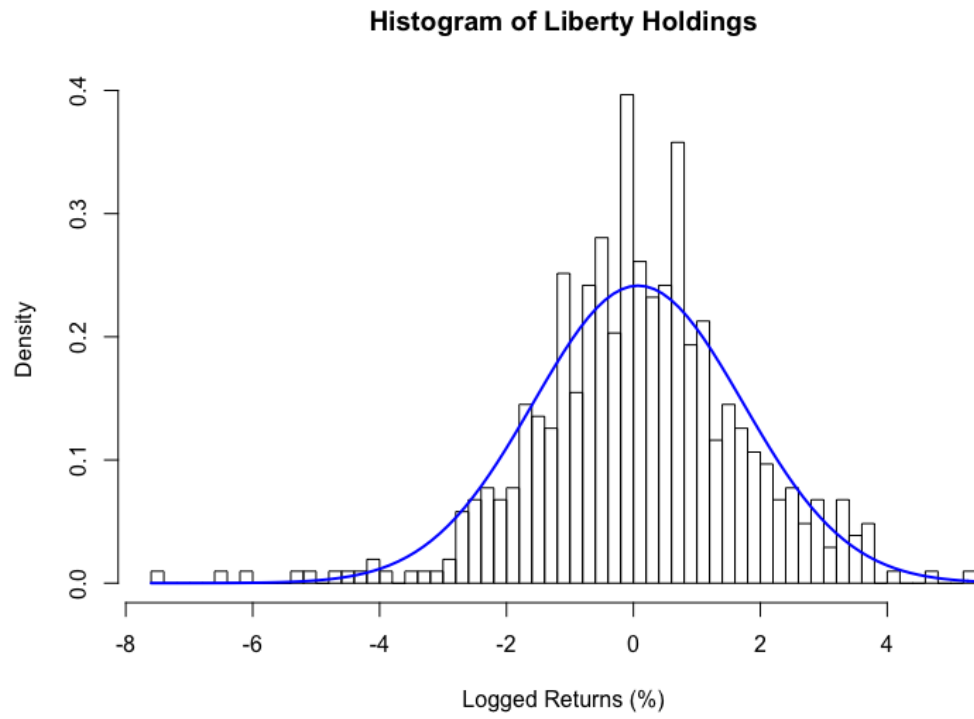


Normal Q-Q Plot for Discovery

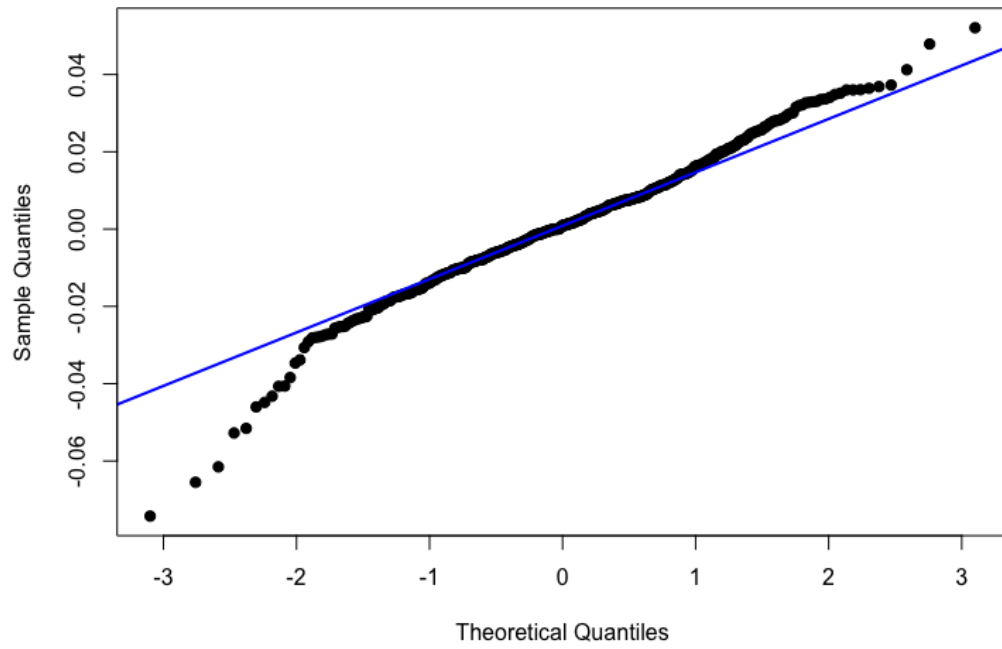


E.15.4 Liberty Holdings

Number of Remaining Observations = 517



Normal Q-Q Plot for Liberty Holdings



E.15.5 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Sanlam	1.8255***	0.045195**	0.9811***	67.422***	-0.266740
MMI Holdings	1.562***	0.053793***	0.98753***	29.507***	0.692010
Discovery	4.2022***	0.06466***	0.96239***	165.87***	1.09360
Liberty Holdings	1.804***	0.045944**	0.97947***	71.695***	-3.43980***

*p <0.1

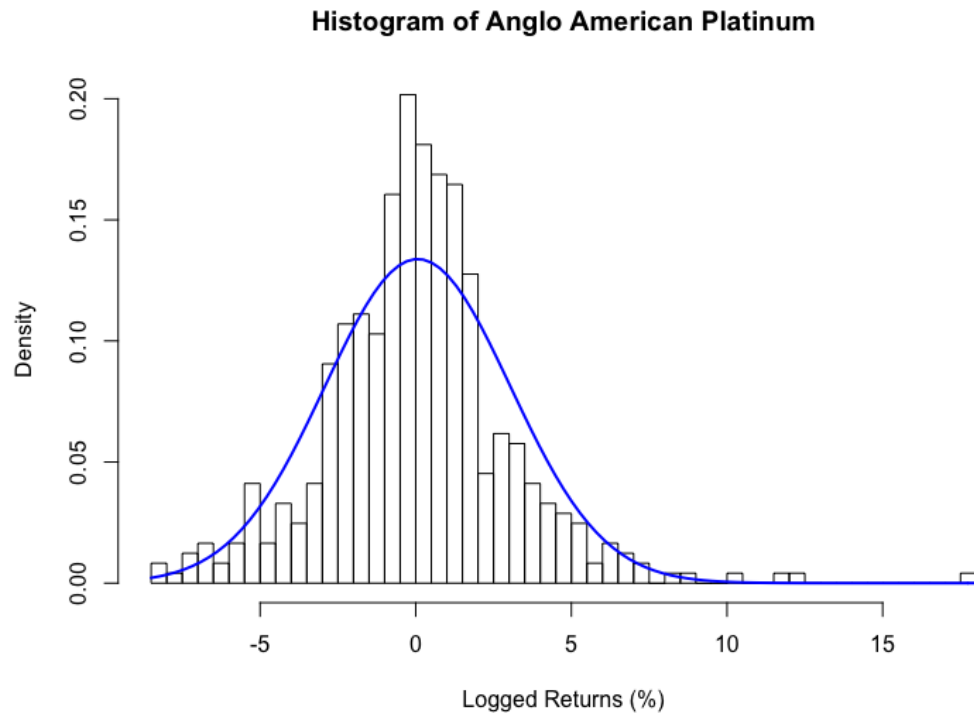
** p <0.05

*** p <0.01

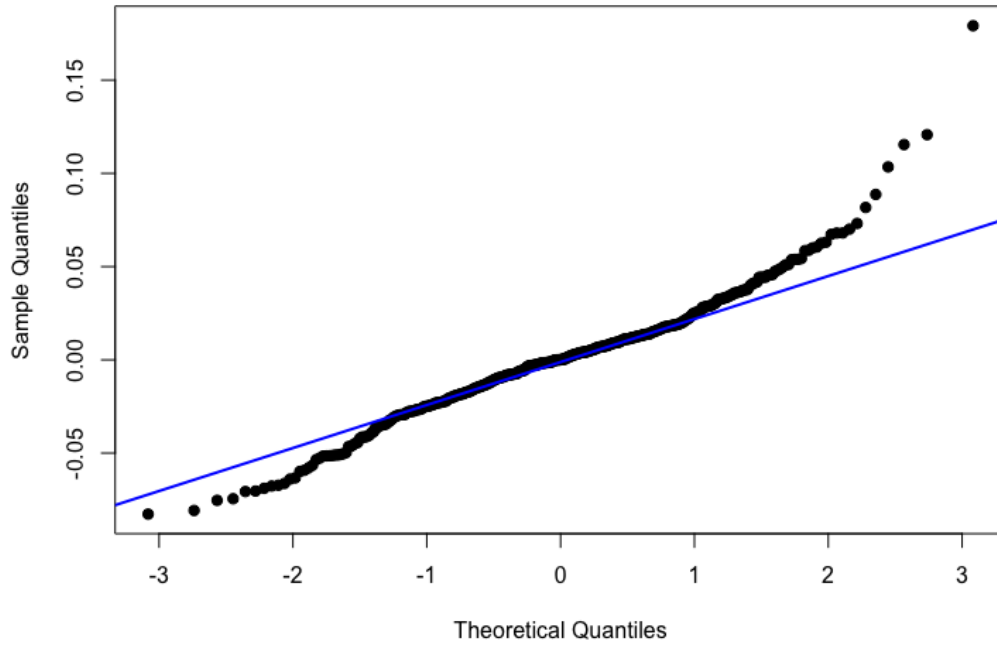
E.16 Mining

E.16.1 Anglo American Platinum

Number of Remaining Observations = 486

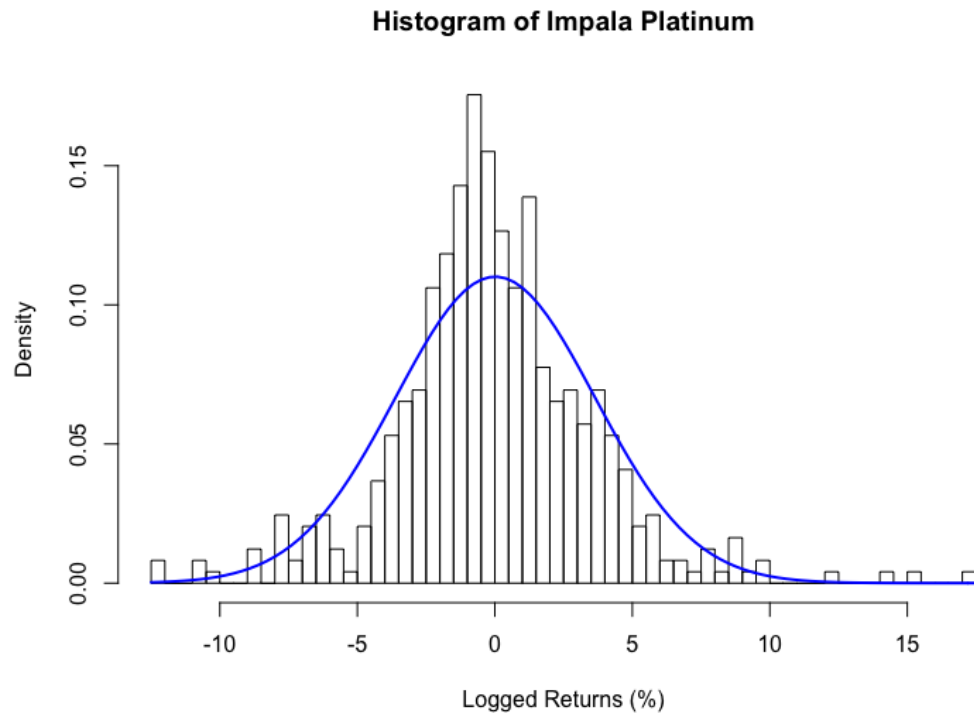


Normal Q-Q Plot for
Anglo American Platinum

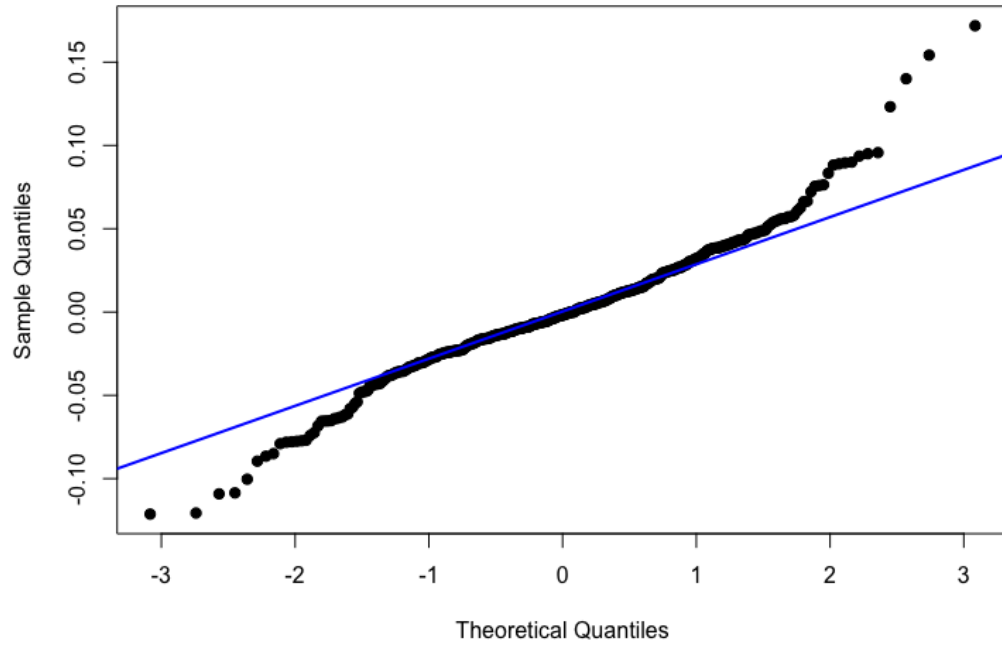


E.16.2 Impala Platinum

Number of Remaining Observations = 490

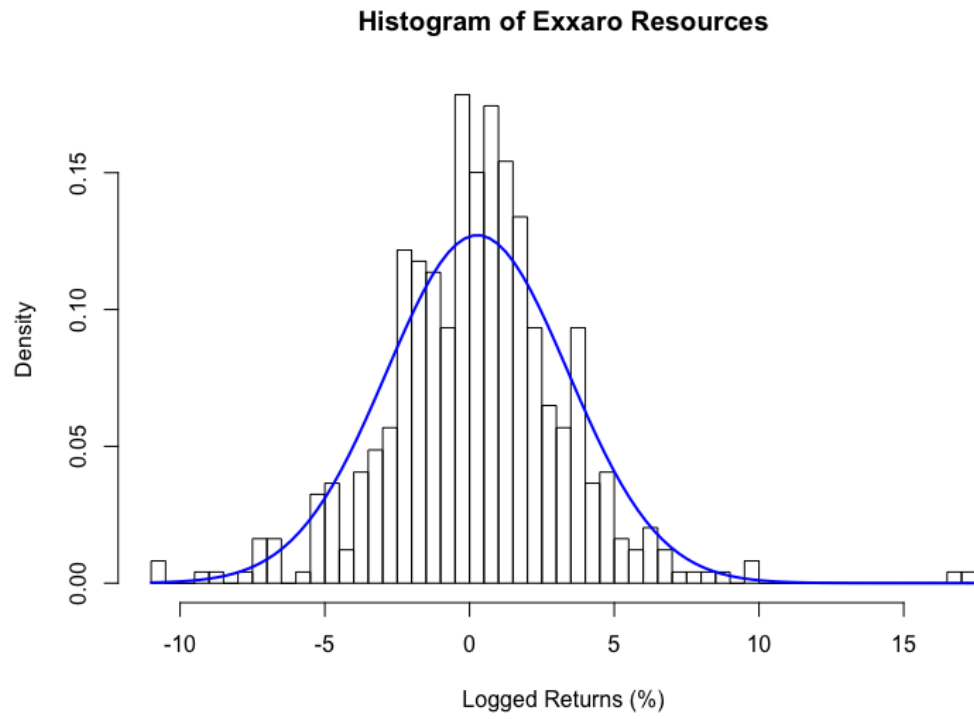


Normal Q-Q Plot for Impala Platinum

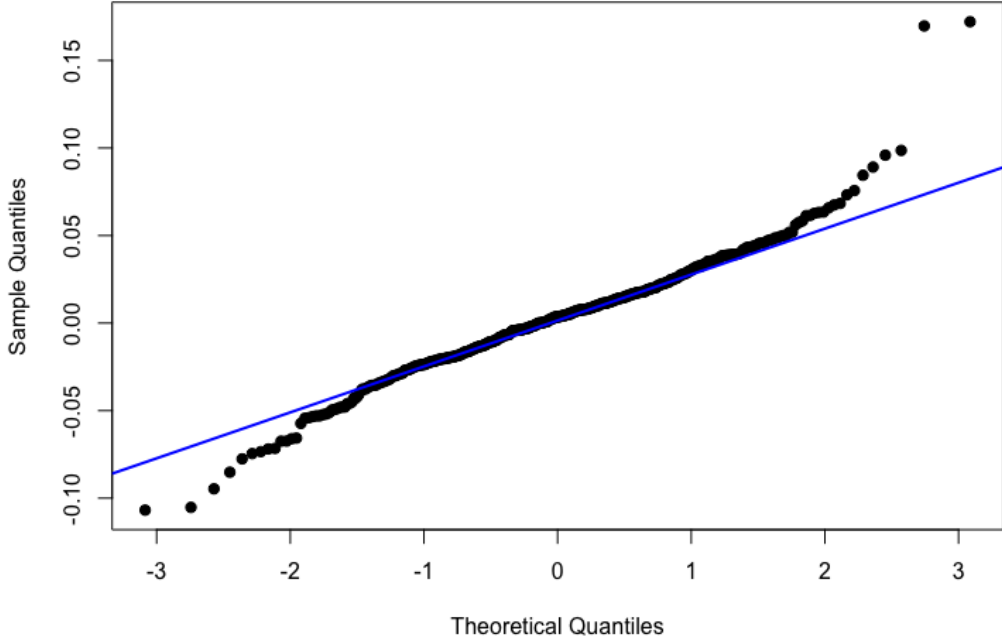


E.16.3 Exxaro Resources

Number of Remaining Observations = 493

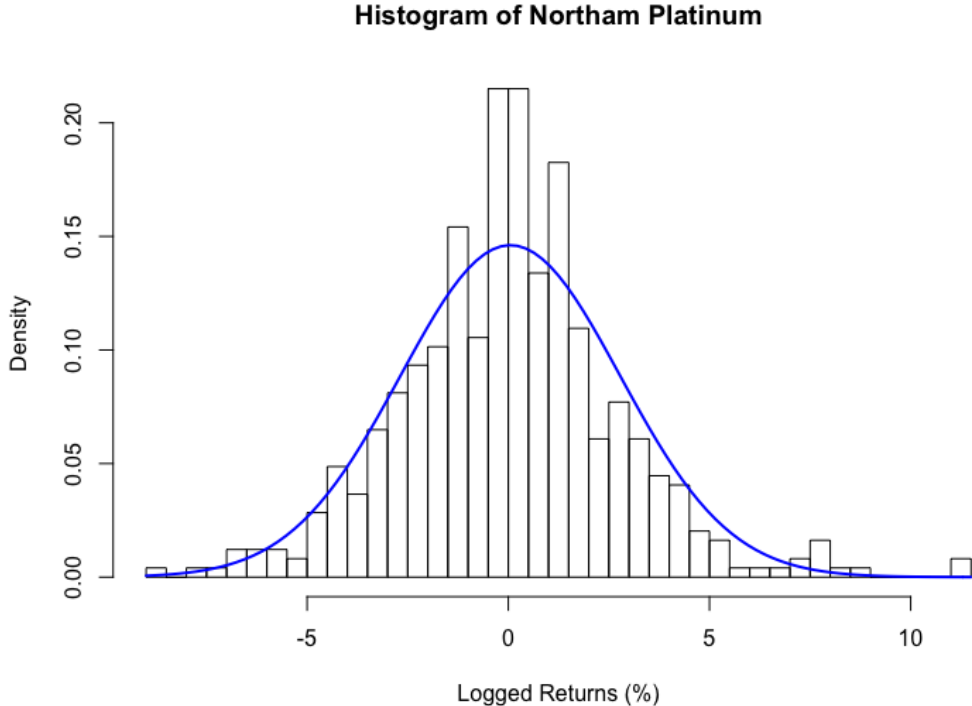


Normal Q-Q Plot for Exxaro Resources

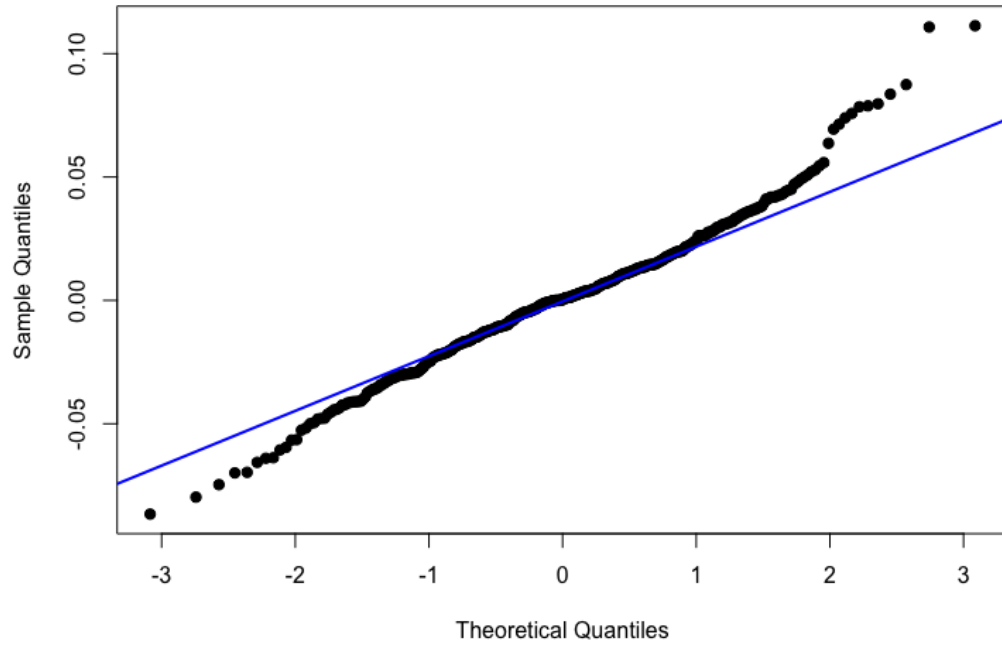


E.16.4 Northam Platinum

Number of Remaining Observations = 493



Normal Q-Q Plot for Northam Platinum



E.16.5 Results from Goodness-of-Fit Tests

		Normality Test Statistics				
		AD	LF	SW	JB	DP
Anglo American Platinum		3.8224***	0.079393***	0.95842***	290.03***	5.48750***
Impala Platinum		3.9905***	0.066083***	0.96488***	141.91***	3.12140***
Exxaro Resources		2.669***	0.057084***	0.96197***	276.29***	3.6282***
Northam Platinum		2.1655***	0.057571***	0.98072***	53.156***	2.72320***

*p <0.1

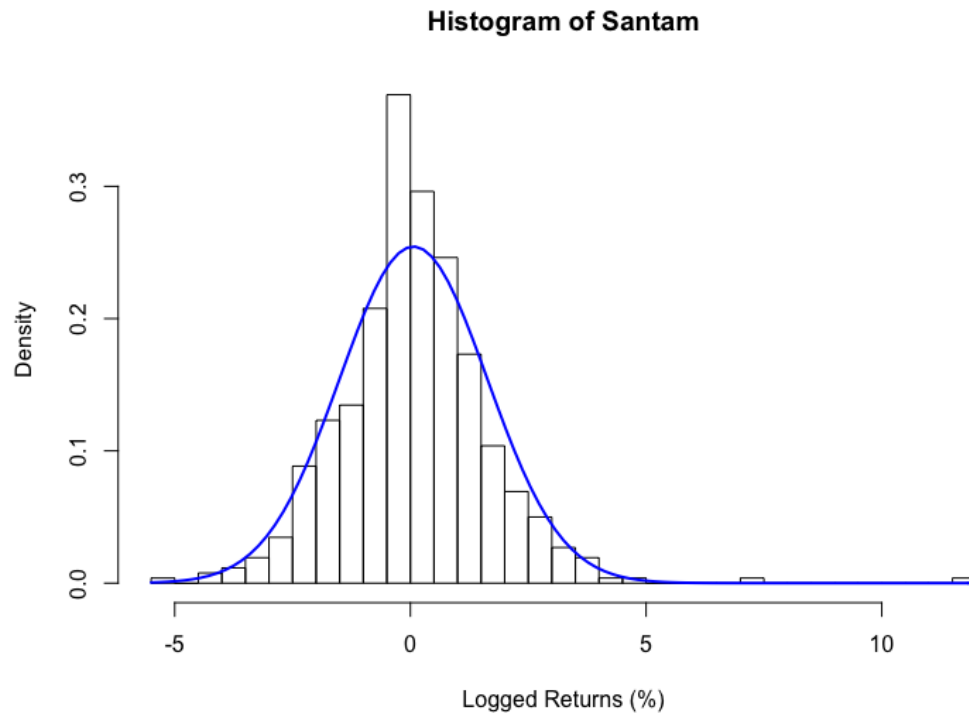
** p <0.05

*** p <0.01

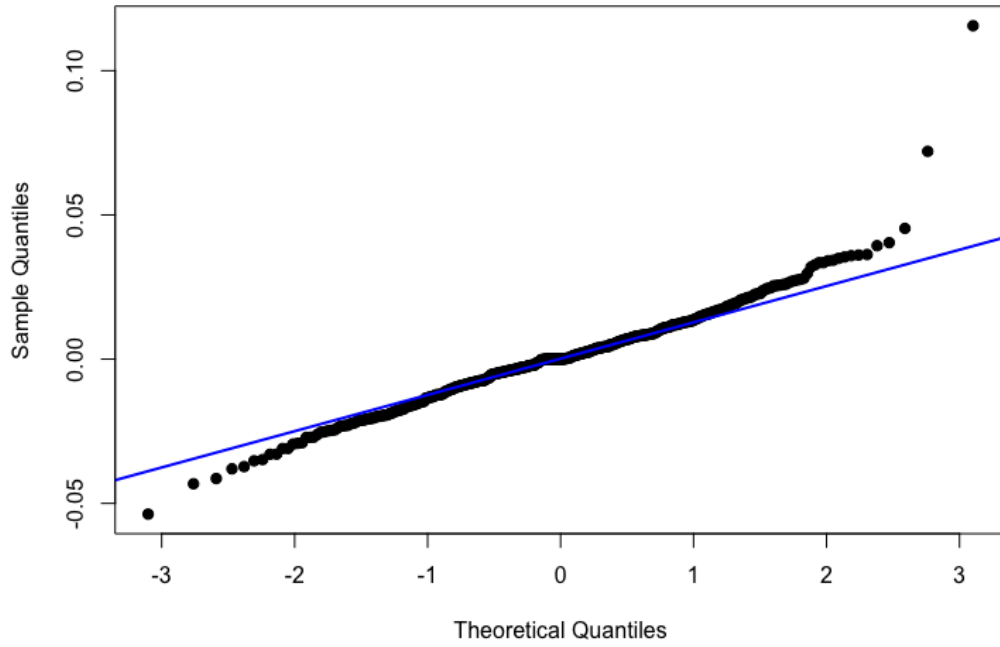
E.17 Non-Life Insurance

E.17.1 Santam

Number of Remaining Observations = 520



Normal Q-Q Plot for Santam



E.17.2 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Santam	2.5922***	0.058195***	0.95233***	843.6***	7.06380***

665

*p < 0.1

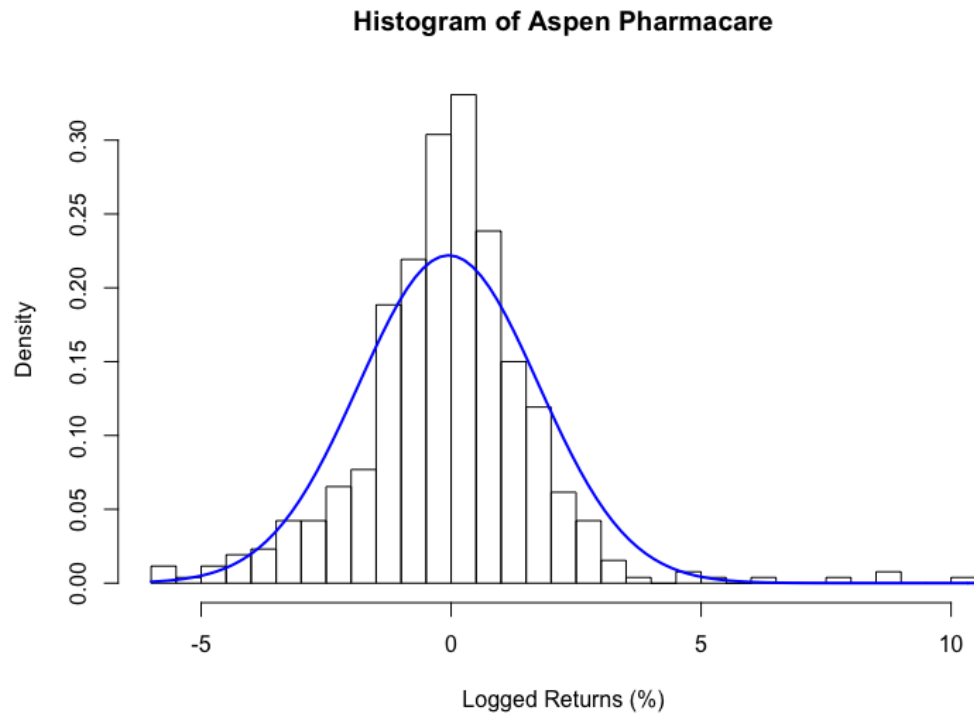
** p < 0.05

*** p < 0.01

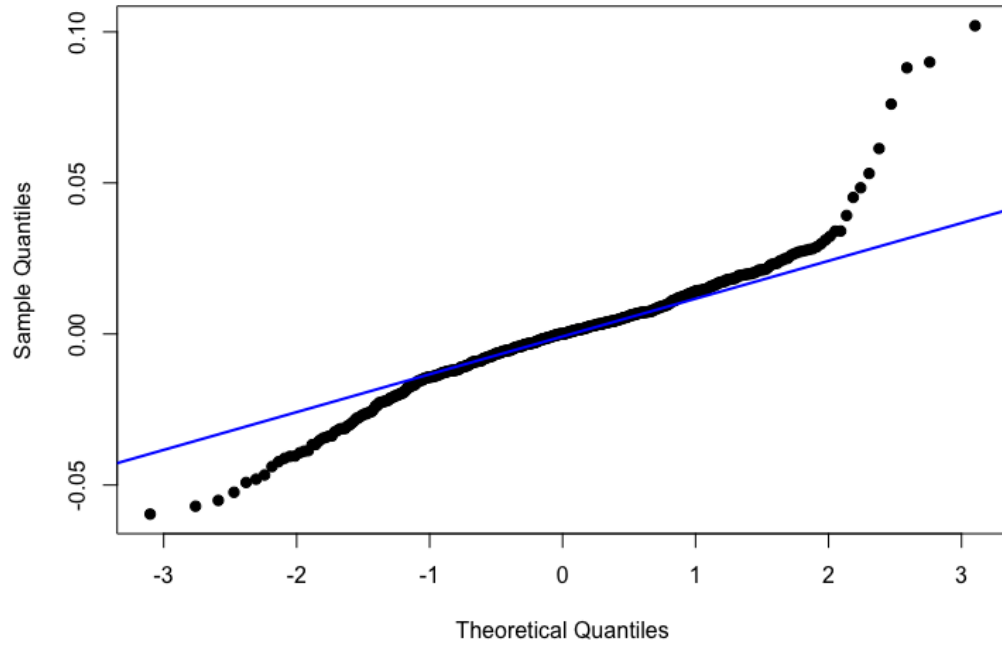
E.18 Pharmaceuticals and Biotechnology

E.18.1 Aspen Pharmacare

Number of Remaining Observations = 520



Normal Q-Q Plot for
Aspen Pharmacare



E.18.2 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
Aspen Pharmacare	6.2335***	0.076586***	0.93184***	583.74***	5.57900***

668

*p < 0.1

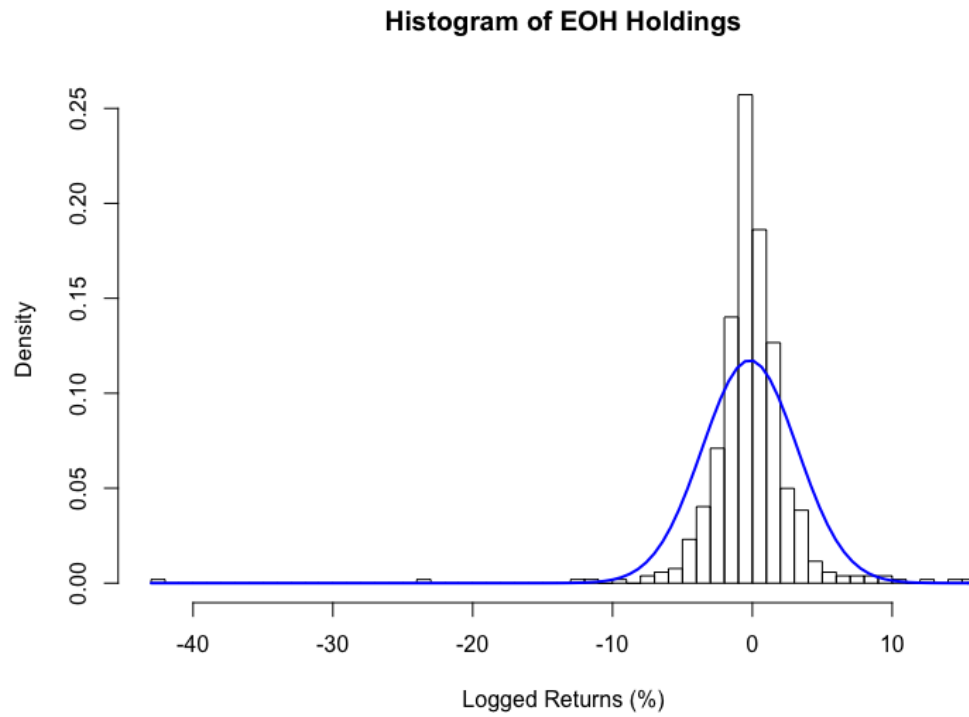
** p < 0.05

*** p < 0.01

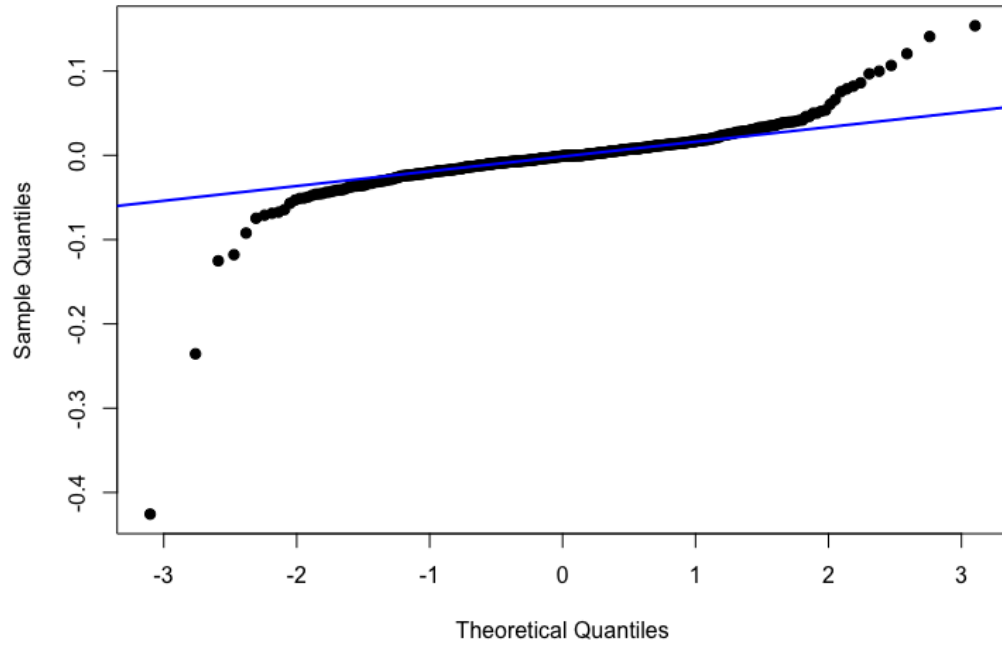
E.19 Software and Computer Services

E.19.1 EOH Holdings

Number of Remaining Observations = 521



Normal Q-Q Plot for EOH Holdings



E.19.2 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
EOH Holdings	25.653***	0.14097***	0.70136***	59358***	-17.7400***

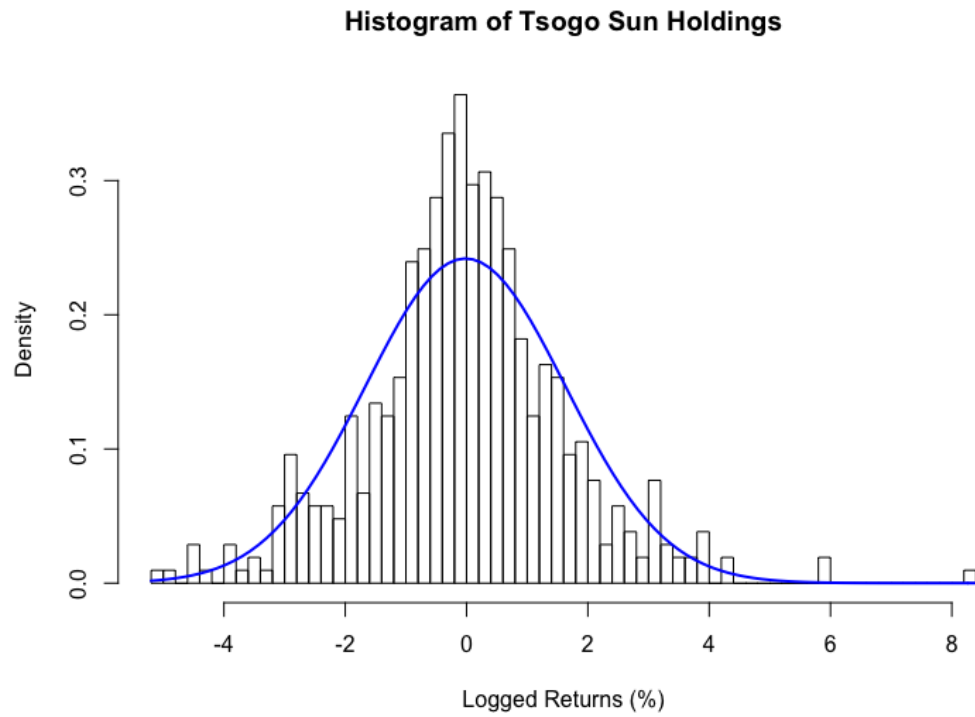
671

*p <0.1
 ** p <0.05
 *** p <0.01

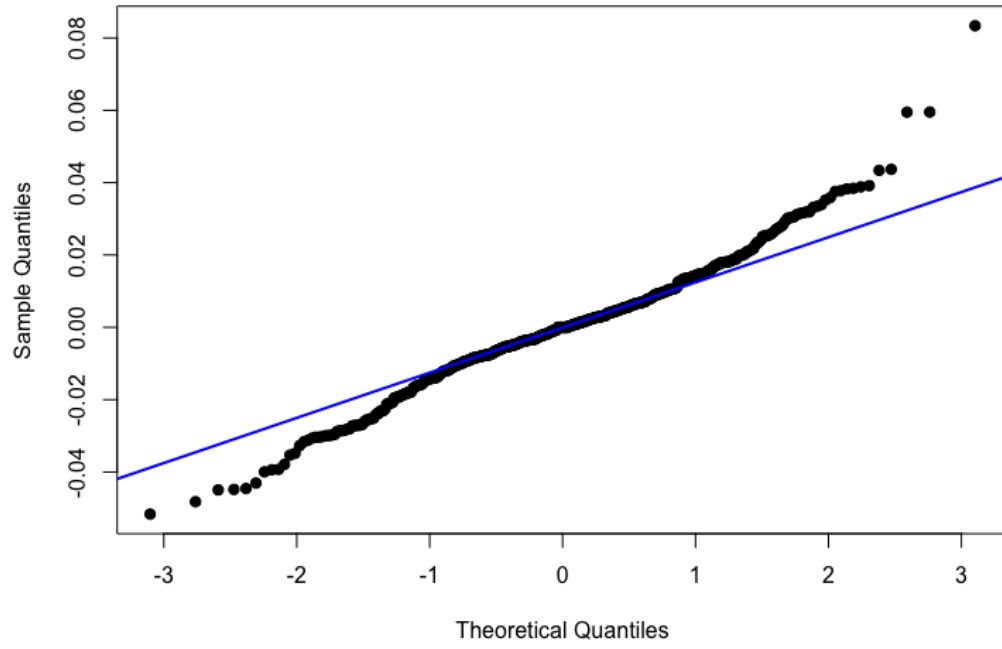
E.20 Travel and Leisure

E.20.1 Tsogo Sun Holdings

Number of Remaining Observations = 522

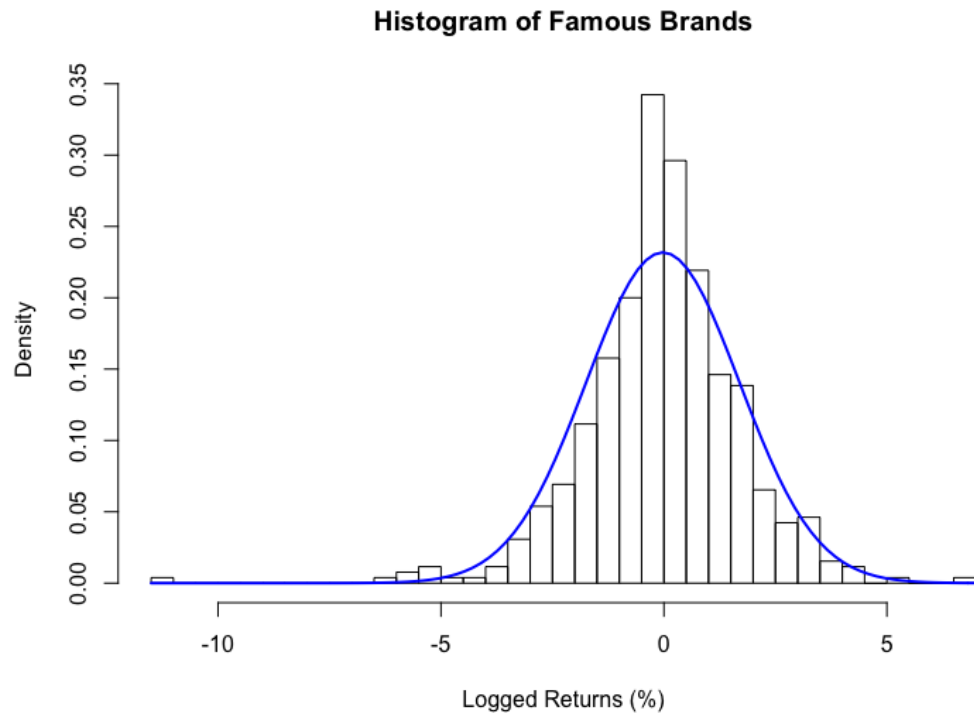


Normal Q-Q Plot for
Tsogo Sun Holdings

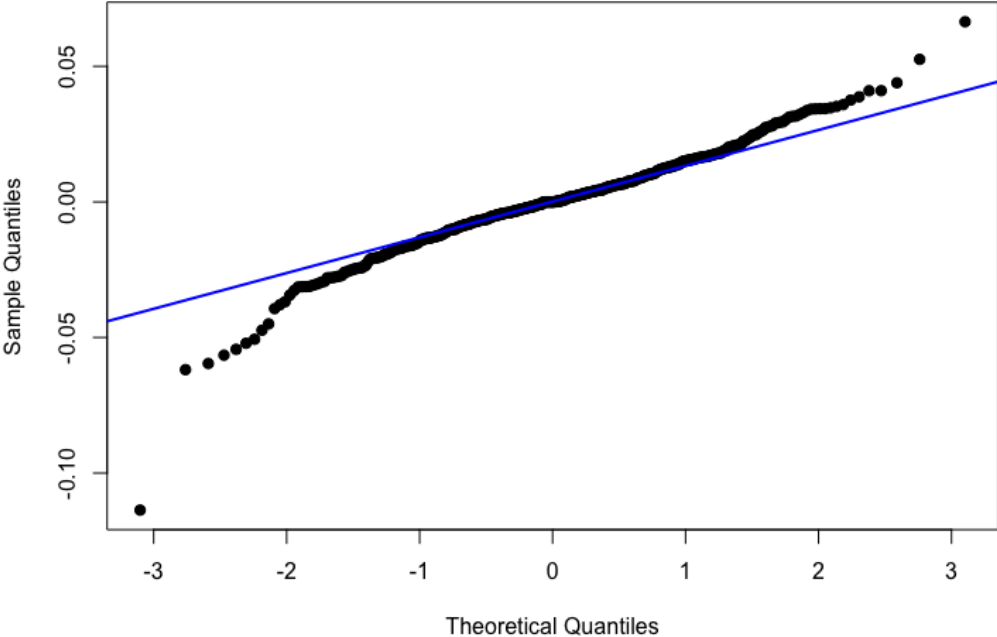


E.20.2 Famous Brands

Number of Remaining Observations = 518



Normal Q-Q Plot for Famous Brands



E.20.3 Results from Goodness-of-Fit Tests

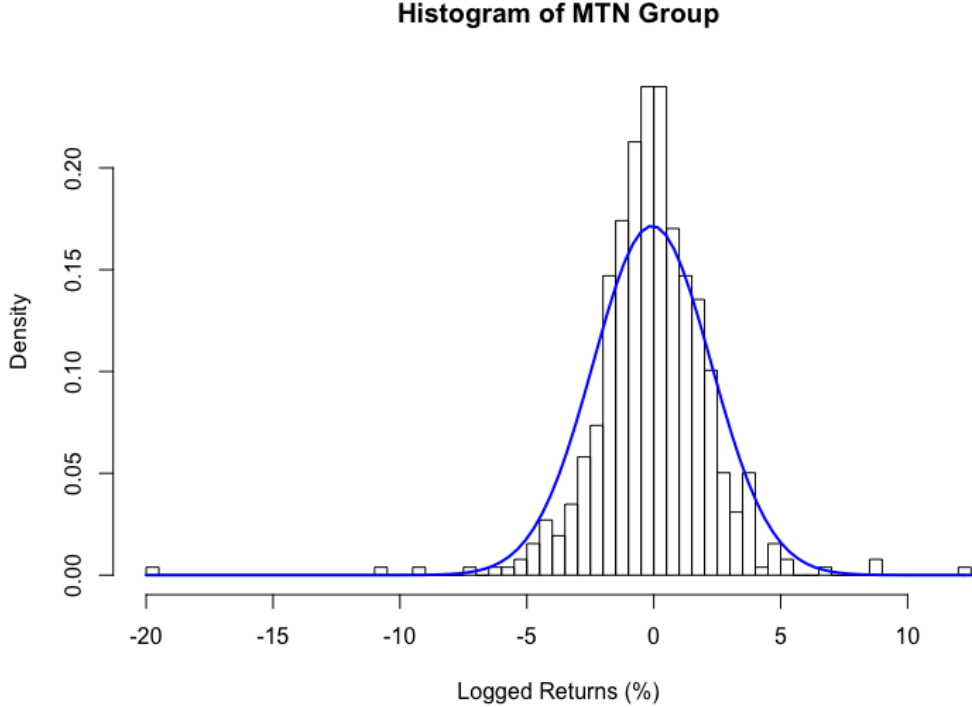
Normality Test Statistics					
	AD	LF	SW	JB	DP
Tsogo Sun Holdings	3.1432***	0.062437***	0.97716***	82.999***	2.56790**
Famous Brands	3.743***	0.065097***	0.95633***	468.61***	-5.84530***

*p <0.1
 ** p <0.05
 *** p <0.01

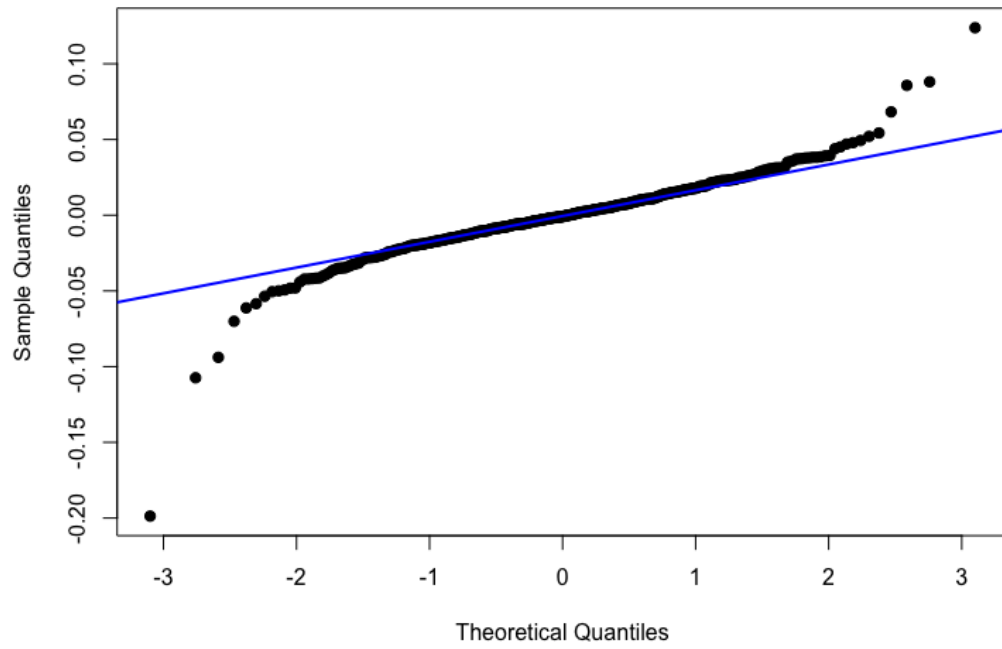
E.21 Wireless Telecom Services

E.21.1 MTN Group

Number of Remaining Observations = 517

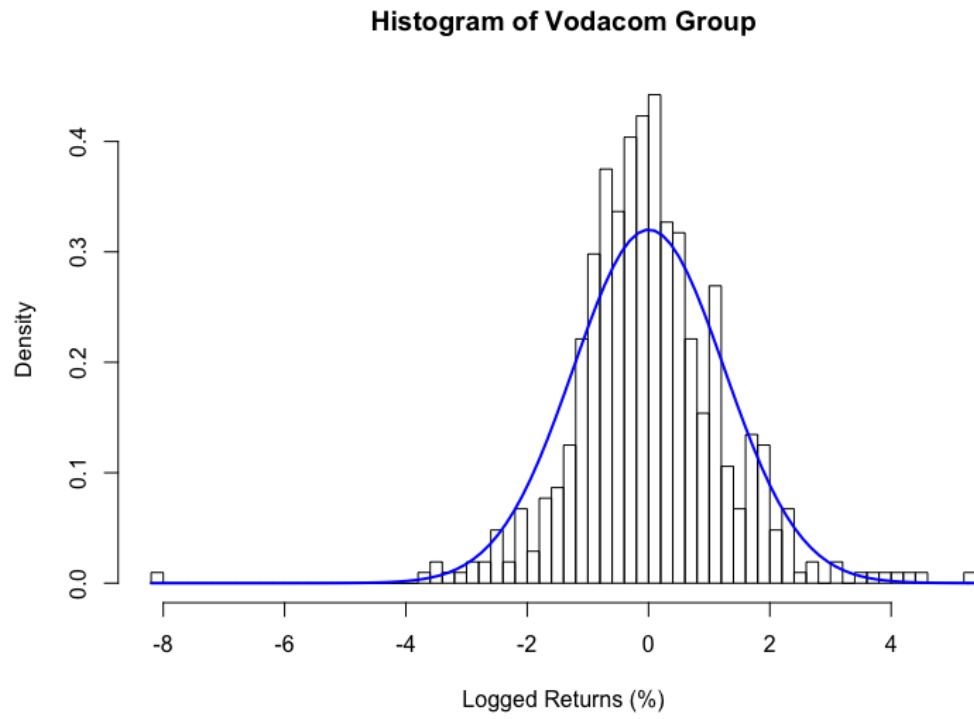


Normal Q-Q Plot for MTN Group

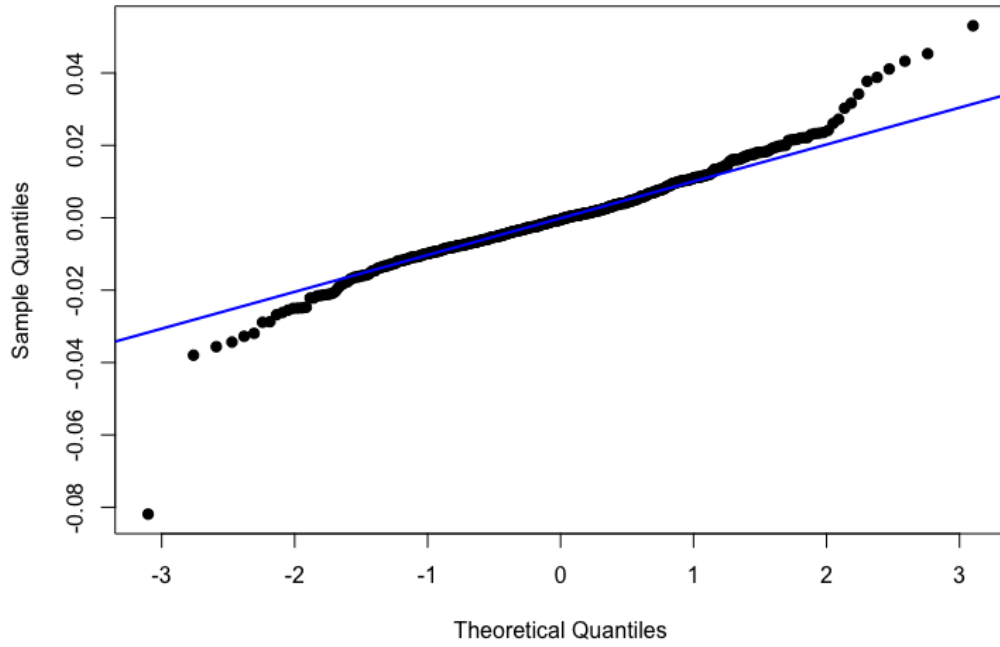


E.21.2 Vodacom Group

Number of Remaining Observations = 520



Normal Q-Q Plot for Vodacom Group



E.21.3 Results from Goodness-of-Fit Tests

Normality Test Statistics					
	AD	LF	SW	JB	DP
MTN Group	6.2563***	0.075503***	0.89742***	3559.2***	-8.2068***
Vodacom Group	3.7651***	0.06353***	0.95454***	468.23***	-1.49940

*p <0.1

** p <0.05

*** p <0.01