



'Pricing under Rough Volatility Models' Lab Report

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Abstract

In the present paper we investigate the roughness of the Russian stock market in the context of the rough stochastic volatility model. We obtain the estimation of the Hurst parameter for the major Russian corporations. In the end we form the conclusion that the rough volatility model is a working model for the Russian stock market and formulate the future research horizon.

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Introduction

The first revolutionary model of Mathematical Finance was introduced by F. Black and M. Sholes in 1973's article [BS73], and a similar model introduced in 1976 by F. Black in [Bla76] (the only fundamental difference was the use of the forward prices instead of spot prices, which is proven to be useful for some markets). Later there were created some local volatility models (like Dupire's LVM), and first stochastic volatility models (Heston SVM), but they still were not a perfect fit for pricing, even when first LSVMs were introduced.

Fractional Brownian motions were first employed in volatility modelling by F. Comte and E. Renault [CR98]. Their model (called FSV) used a fractional Brownian motion with Hurst parameter $H > 0.5$ to model volatility as a long-memory process i.e. one where autocorrelation decays slowly, which was a widely accepted stylized fact. They thus introduced the class of fractional stochastic volatility models.

In 2014, J. Gatheral, T. Jaisson, and M. Rosenbaum showed in [GJR18] that for major American indices Hurst parameter estimations have the order of $1e - 1$ (i.e. $H < 0.5$, therefore, there is no long-memory in the FSV-based models), and called the corresponding model (FSV + $H < 0.5$) a rough fractional stochastic volatility model (RFSV) to emphasise that the volatility is indeed rough.

However, their approach requires the use of a model, therefore, it is not perfect still. In 2022, R. Cont and P. Das [CD22] proposed a method of estimating the roughness of an asset without the need of a model, which can be used to find statistical evidence that volatility is rough even without RFSV.

In the present paper I show that the Hurst parameters of the major Russia-originated assets (stocks and depositary receipts of Russian corporations) are less than 0.5 under RFSV, i.e. Comte and Renault's basic FSV model is not working well for the Russian stock markets, therefore, RFSV should be used instead.

Chapter 1

Basic Theoretical Aspects

1.1 Realized volatility

Consider a stochastic volatility model

$$dS_t = \mu_t S_t dt + \sigma_t S_t dW_t, \quad (1.1.1)$$

where S_t is an asset price process, and σ_t is a stochastic volatility process representing a so-called *spot volatility*. Spot volatility, in fact, is not observable in the market, therefore, we should estimate it somehow.

Definition 1.1.1. The *realized variance* of a price process S over time interval $[t, t + \delta]$ sampled along the time partition π^n is defined as

$$RVar_{t,t+\delta}(\pi^n) = \sum_{\pi^n \cap [t,t+\delta]} \left(\log S_{t_{i+1}^n} - \log S_{t_i^n} \right)^2 \quad (1.1.2)$$

and *realized volatility* is defined as

$$RV_{t,t+\delta}(\pi^n) = \sqrt{\sum_{\pi^n \cap [t,t+\delta]} \left(\log S_{t_{i+1}^n} - \log S_{t_i^n} \right)^2} \quad (1.1.3)$$

Definition 1.1.2. Let S satisfy (1.1.1). Then the integrated variance is defined as

$$IVar_t = \int_0^t \sigma_s^2 ds \quad (1.1.4)$$

It has been shown many times (e.g. [BS02]) and mentioned in [CD22] that the realized variance converges in probability to the integrated variance as sampling frequency increases for all assets satisfying the equation (3.1.1) (i.e. stochastic volatility models).

Proposition 1.1.1. As time partition scale of π^n tends to 0, $RV_{t,t+\delta}(\pi^n) \approx \sqrt{\delta} \sigma_t$, i.e. $RV_{t,t+\delta}/\sqrt{\delta}$ could be considered as a consistent estimator of the spot volatility.

Definition 1.1.3. The *fractional Brownian motion* $(W_t^H)_{t \in \mathbb{R}_+}$ with Hurst parameter $H \in (0, 1)$ is a Gaussian process with the following properties:

1.2. NORMALITY STATISTICAL TESTS

1. $W_0^H = 0$,
2. $\mathbb{E}[W_t^H] \equiv 0$,
3. $\mathbb{E}[W_s^H W_t^H] = \frac{1}{2} (t^{2H} + s^{2H} - |t-s|^{2H})$

Definition 1.1.4. A stationary fOU process X_t is defined as the stationary solution of the stochastic differential equation

$$dX_t = \nu dW_t^H - \alpha(X_t - m)dt, \quad (1.1.5)$$

where $m \in \mathbb{R}$ and ν and α are positive parameters, see [CKM03].

1.1.1 What is a long-memory process?

Definition 1.1.5. A process X_t is said to have a long memory, if

$$\sum_{k=0}^{\infty} \text{Cov}[X_1, X_k - X_{k-1}] = +\infty. \quad (1.1.6)$$

In particular, the fractional Brownian motion with $H > \frac{1}{2}$ is a long-memory process. Long-memory of the stochastic volatility process in stochastic volatility models framework used to be a widely-accepted stylized fact [BCD98; CR98; CR96; DGE93].

1.2 Normality Statistical Tests

In the following, x_i denotes a sample of n observations, g_1 and g_2 are the sample skewness and kurtosis, μ_j 's are the j -th sample central moments, and \bar{x} is the sample mean.

1.2.1 D'Agostino's K-squared test

The sample skewness and kurtosis are defined as

$$g_1 = \frac{m_3}{m_2^{3/2}} = \frac{\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^3}{\left(\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2\right)^{3/2}}, \quad (1.2.1)$$

$$g_2 = \frac{m_4}{m_2^2} - 3 = \frac{\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^4}{\left(\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2\right)^2} - 3. \quad (1.2.2)$$

Let

$$Z_1(g_1) = \delta \operatorname{asinh}\left(\frac{g_1}{\alpha \sqrt{\mu_2}}\right), \quad (1.2.3)$$

where constants α and δ are computed as

$$W^2 = \sqrt{2\gamma_2 + 4} - 1, \quad (1.2.4)$$

$$\delta = 1/\sqrt{\ln W}, \quad (1.2.5)$$

$$\alpha^2 = 2/(W^2 - 1), \quad (1.2.6)$$

1.2. NORMALITY STATISTICAL TESTS

and

$$Z_2(g_2) = \sqrt{\frac{9A}{2}} \left\{ 1 - \frac{2}{9A} - \left(\frac{1 - 2/A}{1 + \frac{g_2 - \mu_1}{\sqrt{\mu_2}} \sqrt{2/(A-4)}} \right)^{1/3} \right\}, \quad (1.2.7)$$

where

$$A = 6 + \frac{8}{\gamma_1} \left(\frac{2}{\gamma_1} + \sqrt{1 + 4/\gamma_1^2} \right), \quad (1.2.8)$$

$$\mu_1(g_2) = -\frac{6}{n+1}, \quad (1.2.9)$$

$$\mu_2(g_2) = \frac{24n(n-2)(n-3)}{(n+1)^2(n+3)(n+5)}, \quad (1.2.10)$$

$$\gamma_1(g_2) \equiv \frac{\mu_3(g_2)}{\mu_2(g_2)^{3/2}} = \frac{6(n^2 - 5n + 2)}{(n+7)(n+9)} \sqrt{\frac{6(n+3)(n+5)}{n(n-2)(n-3)}}, \quad (1.2.11)$$

$$\gamma_2(g_2) \equiv \frac{\mu_4(g_2)}{\mu_2(g_2)^2} - 3 = \frac{36(15n^6 - 36n^5 - 628n^4 + 982n^3 + 5777n^2 - 6402n + 900)}{n(n-3)(n-2)(n+7)(n+9)(n+11)(n+13)}. \quad (1.2.12)$$

The analytical expressions for skewness and kurtosis (1.2.11) - (1.2.12) were derived by E. Pearson in [Pea31].

Definition 1.2.1. The *D'Agostino-Pearson* statistic is defined as

$$K^2 = Z_1(g_1)^2 + Z_2(g_2)^2 \quad (1.2.13)$$

Null hypothesis: the sample is normally distributed.

NB. The K^2 statistic is able to detect deviations from both skewness and kurtosis. If the null hypothesis is true, then the test statistic has the χ^2 distribution with 2 degrees of freedom.

1.2.2 Shapiro-Wilk test

Definition 1.2.2. The Shapiro-Wilk test statistic is defined as

$$W = \frac{\left(\sum_{i=1}^n a_i x_{(i)} \right)^2}{\sum_{i=1}^n (x_i - \bar{x})^2}, \quad (1.2.14)$$

where

$$(a_1, \dots, a_n) = \frac{m^T V^{-1}}{C}, \quad C = \|V^{-1}m\| = (m^T V^{-1} V^{-1} m)^{1/2},$$

and $m = (m_1, \dots, m_n)^T$ is a mean of order statistic from a normally distributed sample, V is the covariance matrix of those normal order statistics. Null hypothesis: the sample is normally distributed.

NB. The W statistic has no distinguishable name, and the cutoff values are calculated numerically by Monte-Carlo simulation.

Chapter 2

Zumbach Effect Estimation

2.1 Empirical Effect

[El +18]

2.2 Monte-Carlo Simulation of Zumbach Effect

Chapter 3

Rough Fractional Stochastic Volatility Model Estimation

3.1 Model description

In [GJR18] the authors considered the following model, as did I. Let there be a riskless asset $B_t \equiv 1$, and a risky asset, whose price S_t is defined by the following equations:

$$dS_t = \alpha S_t dt + \sigma_t S_t dW_t, \quad (3.1.1)$$

$$d \log \sigma_t = \alpha(m - \log \sigma_t) dt + \nu dW_t^H, \quad (3.1.2)$$

The risky asset is being traded in the market in numeraire prices (in our case, $B_t = 1$ RUB for stocks and GBP for depositary receipts).

Definition 3.1.1. A model (3.1.1) – (3.1.2) is called a *Fractional Stochastic Volatility Model*¹ (FSV). For a special case $H < 0.5$ the model is called a *Rough Fractional Stochastic Volatility Model* (RFSV) to emphasise a so-called roughness of the trajectories of the fBm.

In [CKM03] an exact formula for the autocovariance function of the log-volatility in the RFSV model was derived:

$$\begin{aligned} \text{cov} [\log \sigma_t, \log \sigma_{t+\Delta}] &= \\ &= \frac{H(2H-1)\nu^2}{2\alpha^{2H}} \left(e^{-\alpha\Delta} \Gamma(2H-1) + e^{-\alpha\Delta} \int_0^{\alpha\Delta} \frac{e^u}{u^{2-2H}} du + e^{\alpha\Delta} \int_{\alpha\Delta}^{+\infty} \frac{e^u}{u^{2-2H}} du \right) \end{aligned} \quad (3.1.3)$$

Via the explicit formula for the covariance function of the log-volatility in the RFSV model (3.1.3), we can write a closed-form expression for a theoretical $m(q, \Delta)$:

$$m(q, \Delta) = 2 (\text{var} \log \sigma_t - \text{cov} [\log \sigma_t, \log \sigma_{t+\Delta}]), \quad ^2 \quad (3.1.4)$$

¹Despite the original [CR98] naming (Comte and Renault used a model with long memory of volatility as a stylized fact), we shall call our model FSV for any $H \in (0, 1)$

² $m(q, \Delta) = \mathbb{E} [(\log \sigma_{t+\Delta} - \log \sigma_t)^2]$

3.2. STATISTICAL ANALYSIS

3.2 Statistical Analysis

3.2.1 Data Preprocessing and Realized Volatility Estimation

In the present paper we used high-frequency data for three types of assets:

1. **Stocks:** Yandex, Sberbank, Gazprom, VTB, Moscow Exchange, Lukoil, and X5 Group
2. **Depositary receipts:** Sberbank, Gazprom, VTB, and Lukoil
3. **Funds:**

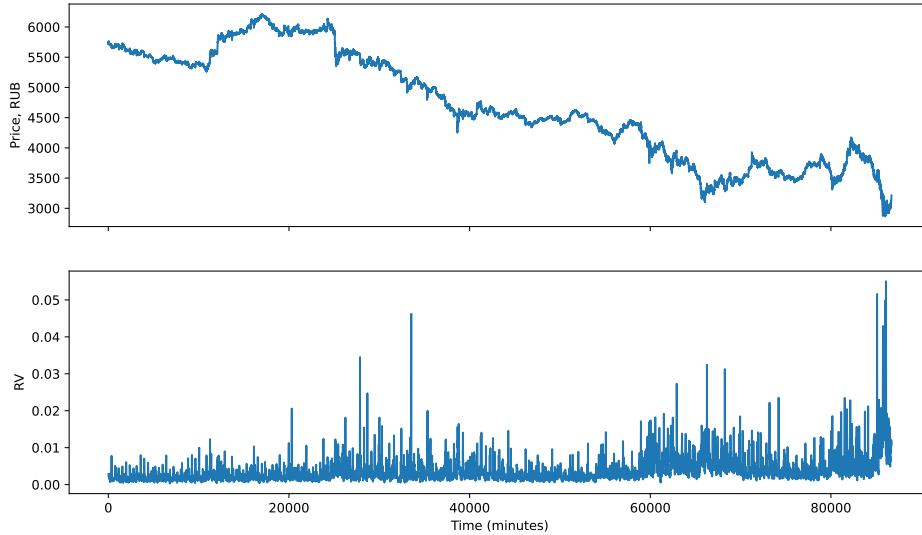


Figure 3.1: YNDX RX Equity. Price and Realized Volatility

Some text to be written

Using this approach to estimate the realized volatility we can be sure that our data is correlated in the least way possible.

3.2.2 Hurst Parameter Estimation

Let $m(q, \Delta, \pi^n)$ be a sample q -th absolute moment of $\log RV_{t+\Delta} - \log RV_t$ (under stationarity of increments assumptions):

$$m(q, \Delta, \pi^n) := \frac{1}{n} \sum_t |\log RV_{t+\Delta} - \log RV_t|^q, \quad (3.2.1)$$

i.e. $m(q, \Delta, \pi^n)$ is an empirical counterpart of $\mathbb{E} [|\log RV_\Delta - \log RV_0|^q]$. In my work we used the uniform partition with Δ -minutes increments, so we omit the π^n notation and use $m(q, \Delta)$.

Due to the similarities in the obtained results for all assets, we shall deeply analyze the Hurst parameter estimation only for the Yandex stocks (YNDX RX Equity). Plots for other equities

3.2. STATISTICAL ANALYSIS

could be found in the appendix, whereas the Hurst parameter estimations for them could be found in the table 3.1. Estimation parameters:

- Realized volatility is estimated by 15 minute disjoint windows
- $\Delta \in [0, 40]$ for ζ_q estimation and other plots

NB. We did not manage to obtain more HF data (only 5 months of 1m-tick data), therefore my estimations are not precise and could not be used for further application.

In the figure 3.2 we can see that for $q = 0.6, 0.8$, and 1.0 the dots are very discrepant for $\log \Delta > 2.0$. However, we get a pretty decent linear fit for $q = 0.2$ and $q = 0.4$, therefore, the estimation on these two point would be the best one we can manage to extract. On the other hand, on ζ_q plot we observe a perfect linear fit for all q -s, therefore, H is its slope indeed.

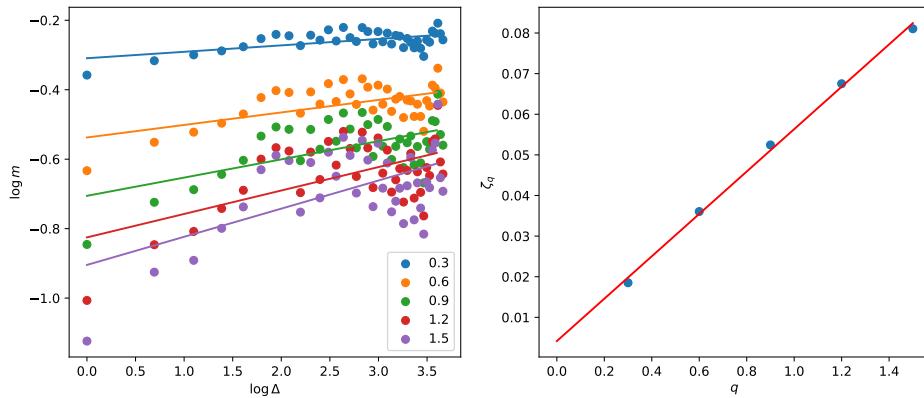


Figure 3.2: YNDX RX Equity. Plots for \hat{H}

We note that the graphs for ζ_q are slightly concave, which correlates with [GJR18] results. They conclude that this effect takes place due to the finite statistical population size.

3.2.3 Smoothing Effect Estimation

Smoothing effect is thoroughly discussed in the appendix of [GJR18].

We can clearly see that due to the positive slope of the plot 3.4, the hypothesis about increasing \hat{H} and decreasing $\hat{\alpha}$ as δ increases is to be accepted.

3.2.4 Tests for normality of volatility's log-increments

In order to test the normality of the log-increments of the realized volatility, we used the following tests:

1. Visual analysis of histograms: KDE vs normal fit vs empirical fit
2. Visual analysis of excessed kurtosis plot
3. D'Agostino's K Squared normality test

3.2. STATISTICAL ANALYSIS

Asset Type	Ticker	\hat{H}
Stock	YNDX	0.0521766
Stock	SBER	0.1551646
Stock	VTBR	0.0917236
Stock	MOEX	0.0853878
Stock	LKOH	0.0730521
Stock	GAZP	0.1309705
Stock	FIVE	0.0630289
Depositary receipt	OGZD	0.0523981
Depositary receipt	VTBR	0.0370185
Depositary receipt	SBER	0.0578053
Depositary receipt	LKOD	0.0352792
Index	.AEX	0.1271101
Index	.AORD	0.0731749
Index	.BFX	0.1340391
Index	.BVSP	0.1285106
Index	.DJI	0.1176993
Index	.FCHI	0.1300797
Index	.FTMIB	0.139092
Index	.FTSE	0.0958701
Index	.GDAXI	0.1130176
Index	.GSPTSE	0.0910194
Index	.HSI	0.0893922
Index	.IBEX	0.1028588
Index	.IXIC	0.1278909
Index	.KS11	0.1066547
Index	.KSE	0.1080452
Index	.MXX	0.0673153
Index	.N225	0.1063503
Index	.OMXC20	0.0997755
Index	.OMXHPI	0.0954135
Index	.OMXSPI	0.118664
Index	.OSEAX	0.0987837
Index	.RUT	0.1029421
Index	.SMSI	0.1319457
Index	.SPX	0.1328797
Index	.SSEC	0.1170868
Index	.SSMI	0.1469914

Table 3.1: Hurst parameter estimations

3.2. STATISTICAL ANALYSIS

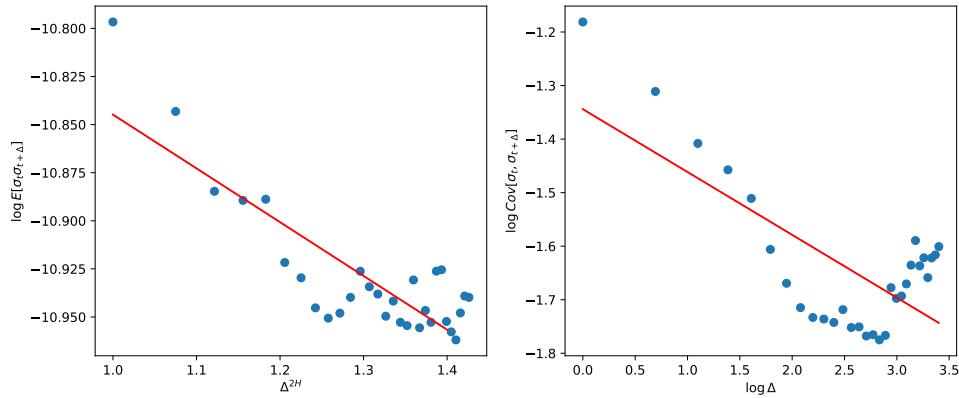


Figure 3.3: YNDX RX Equity. Empirical counterpart of $\log \mathbb{E} [\sigma_t \sigma_{t+\Delta}]$ as a function of Δ^{2H} (left) and Empirical counterpart of $\log \text{cov}[\sigma_t, \sigma_{t+\Delta}]$ as a function of $\log \Delta$ (right)

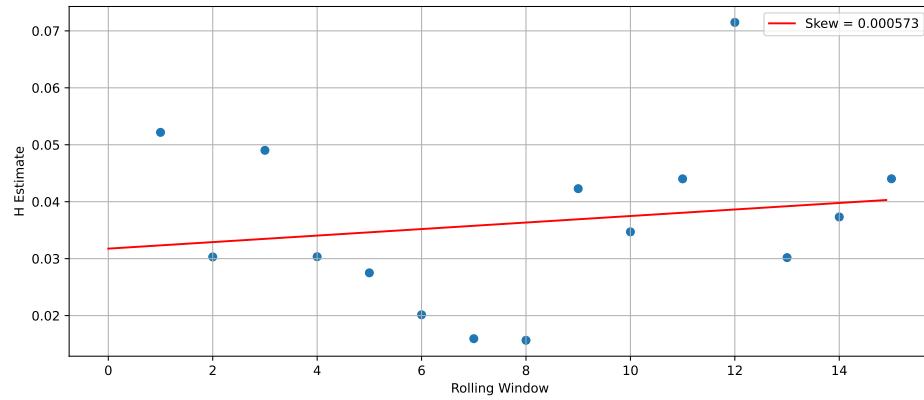


Figure 3.4: YNDX RX Equity. Smoothing Effect

3.2. STATISTICAL ANALYSIS

4. Shapiro-Wilk normality test

In [GJR18] the authors used **only** the visual analysis of the histograms, which, as we can now say, is not surprising due to the inadequacy of results for other numerical experiments.

Visual analysis of histograms and excessed kurtosis plot

1. KDE is the *kernel density estimator* of the data.
2. *Normal fit* $NF(\Delta)$ is the normal distribution fitted to the data with the same mean and variance.
3. *Empirical fit* $EF(\Delta)$ is the scaled normal distribution:
 - $EF(1)$ is said to be same as the $NF(1)$
 - $EF(\Delta)$ for $\Delta > 1$ is said to be a scaled $NF(1)$ by the factor of $\Delta^{\hat{H}}$ (by this we test the monofractal scaling property of normal distribution)

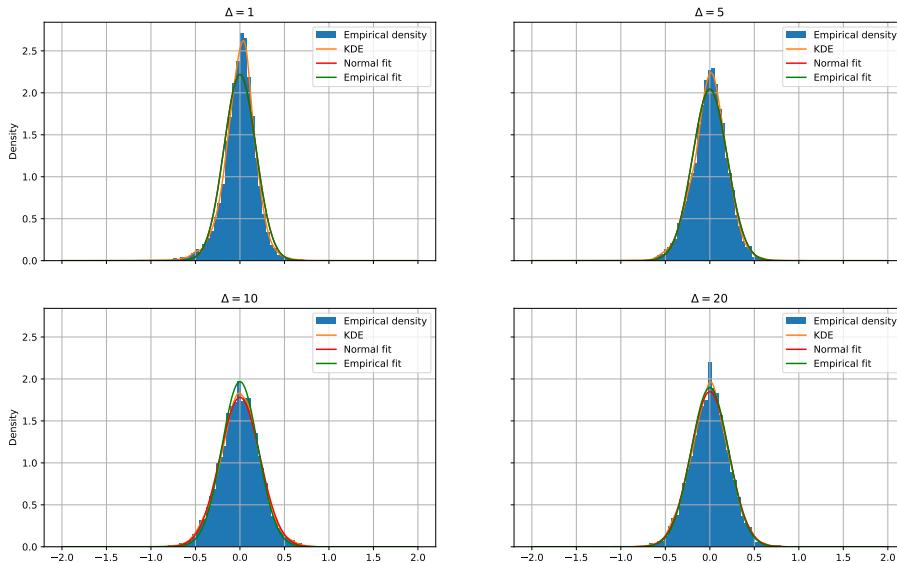


Figure 3.5: YNDX RX Equity. Empirical density of $\log \sigma_{t+\Delta} - \log \sigma_t$ for $\Delta = 1, 5, 10, 20$ days.

Looking at the figure 3.5, we may form a conclusion: *KDE* and *EF* are a decent normality approximations for $\Delta = 10, 20$. For others, we don't get a fancy picture: *KDE*(1) and *KDE*(5) have a large kurtosis (they are too 'peaky' for them to be normally distributed). Excessed kurtosis plot 3.6 confirms our visual conclusion for *KDE* and *EF* plots.

3.2. STATISTICAL ANALYSIS

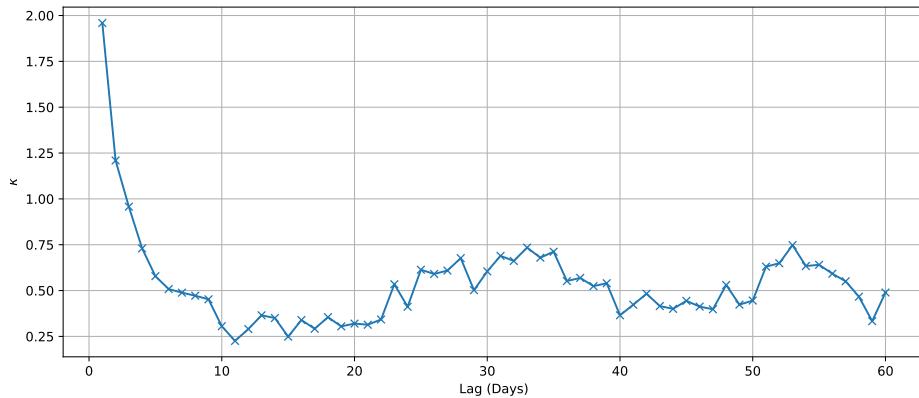


Figure 3.6: YNDX RX Equity. Excessed kurtosis κ as a function of Δ

Statistical tests for normality

We fix the confidence level to be $\alpha = 0.05$.

NB. Both of these tests require the data to be independent, but we cannot guarantee this due to the dependence of fBm's increments. We do our best to analyse the population, but these two tests give us weak proof of normality due to possible correlations.

Looking at the tables with the results of Shapiro-Wilk and D'Agostino's K-Squared tests (tables 3.2 – 3.12), we can see that for the majority of lags and for the majority of the considered assets, both tests showed the result "Not normal", i.e. both tests rejected the null hypothesis.

The three possible explanations are:

1. The tests are correct and the data is not normally distributed or is correlated strongly.
2. The visual analysis of the histograms show that for many lags the KDE plot, the normal fit and the empirical fit are very similar, therefore, the distribution is normal, but the data is correlated strongly. The excessed kurtosis plot shows that the data is distributed very close to the normal distribution for $\Delta > 5$, and at its closest distance for $\Delta \in [10, 22]$.
3. We get a population sampling error (not enough data).

Conclusion

Reproduced Hypotheses

We got aquainted with the fractional stochastic volatility models framework and studied the statistical properties of RFSV. We obtained roughness estimations for major Russian companies stocks and depositary receipts, and reproduced some effects described in [GJR18].

1. The Hurst exponent of the considered assets has the order of $1e - 1$ and is less than $\frac{1}{2}$.
2. The volatility of the considered assets **does not** have a property of long memory under fractional stochastic volatiltiy models.
3. Visual analysis and normality tests for the log-increments of volatility shows that for $\Delta \in [10, 25]$ the normality of log-inrements hypothesis holds.
4. The smoothing effect holds for the estimations of H and α (volatility of volatility under fOU). But **only** for VTBR LI Equity we got a negative slope of the smoothing effect. For other asset we got a nearly perfect linear fit and positive smoothing slopes.

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Appendix A. Results for Additional Assets

BIBLIOGRAPHY

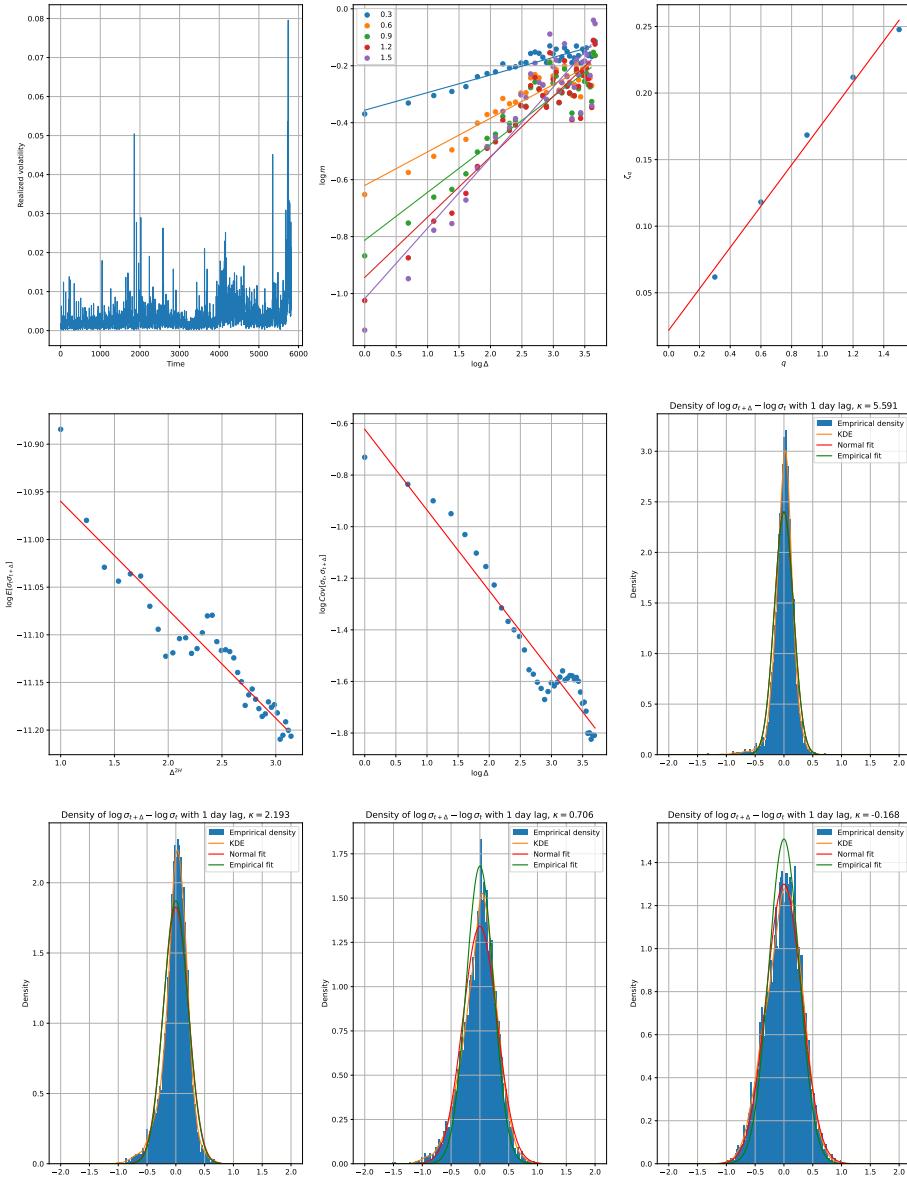


Figure 3.7: SBER RX Equity. \hat{H} plots

BIBLIOGRAPHY

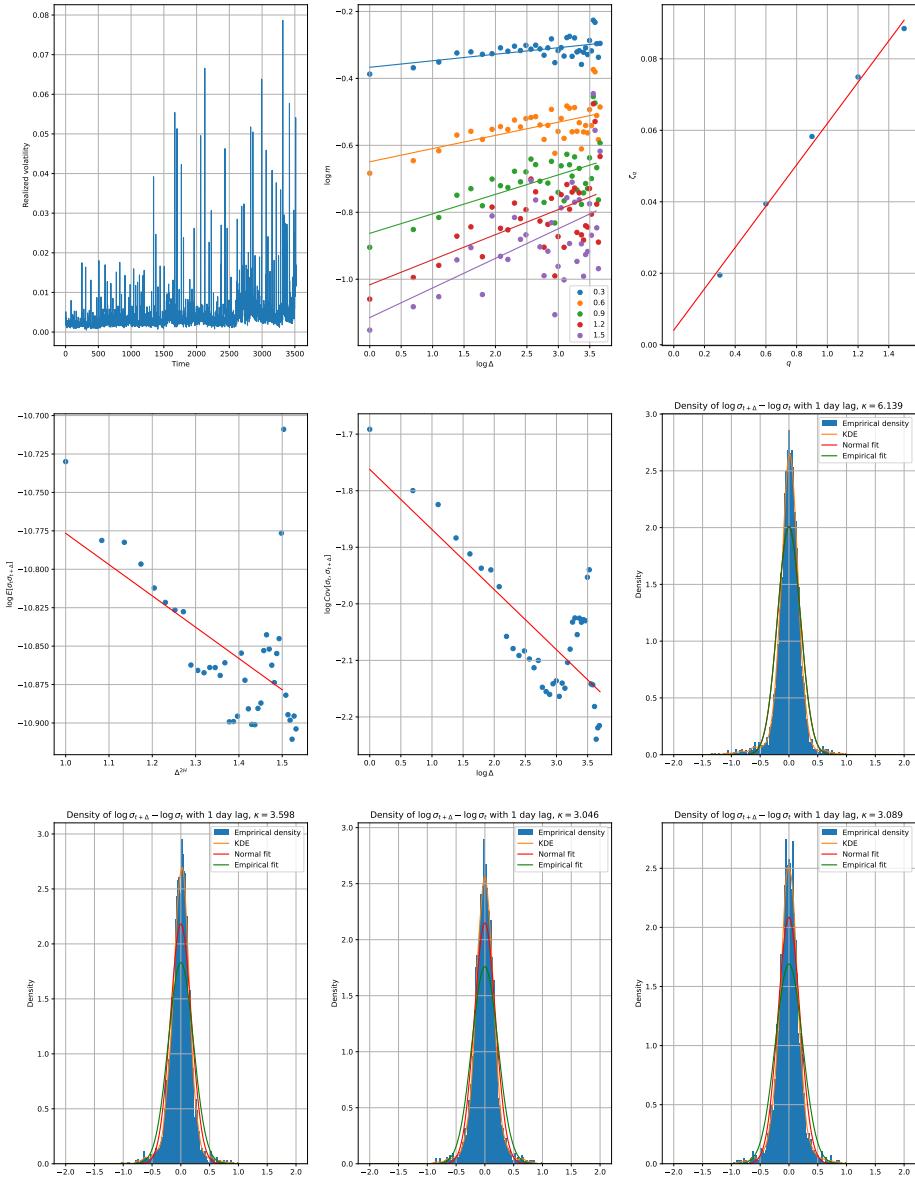


Figure 3.8: SBER LI Equity. \hat{H} plots

BIBLIOGRAPHY

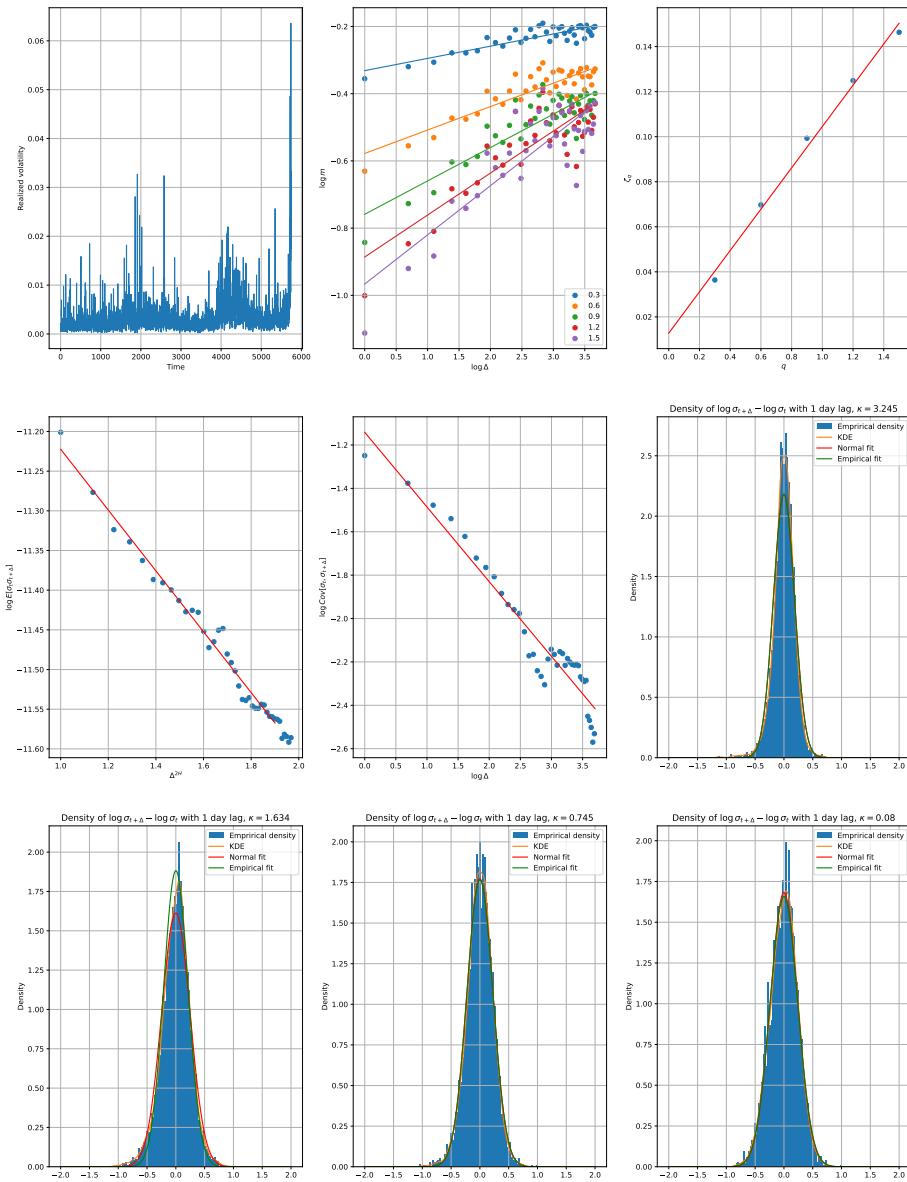


Figure 3.9: VTBR RX Equity. \hat{H} plots

BIBLIOGRAPHY

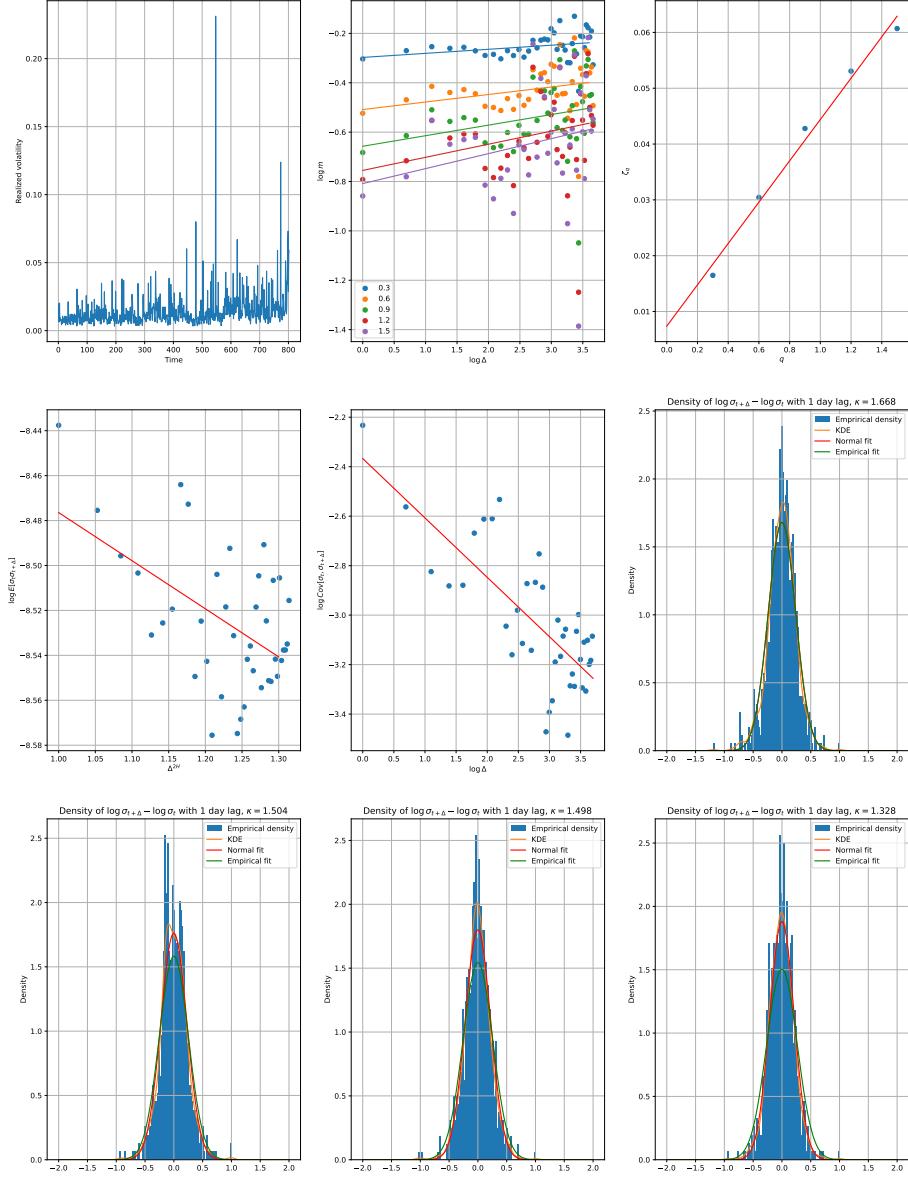


Figure 3.10: VTBR LI Equity. \hat{H} plots

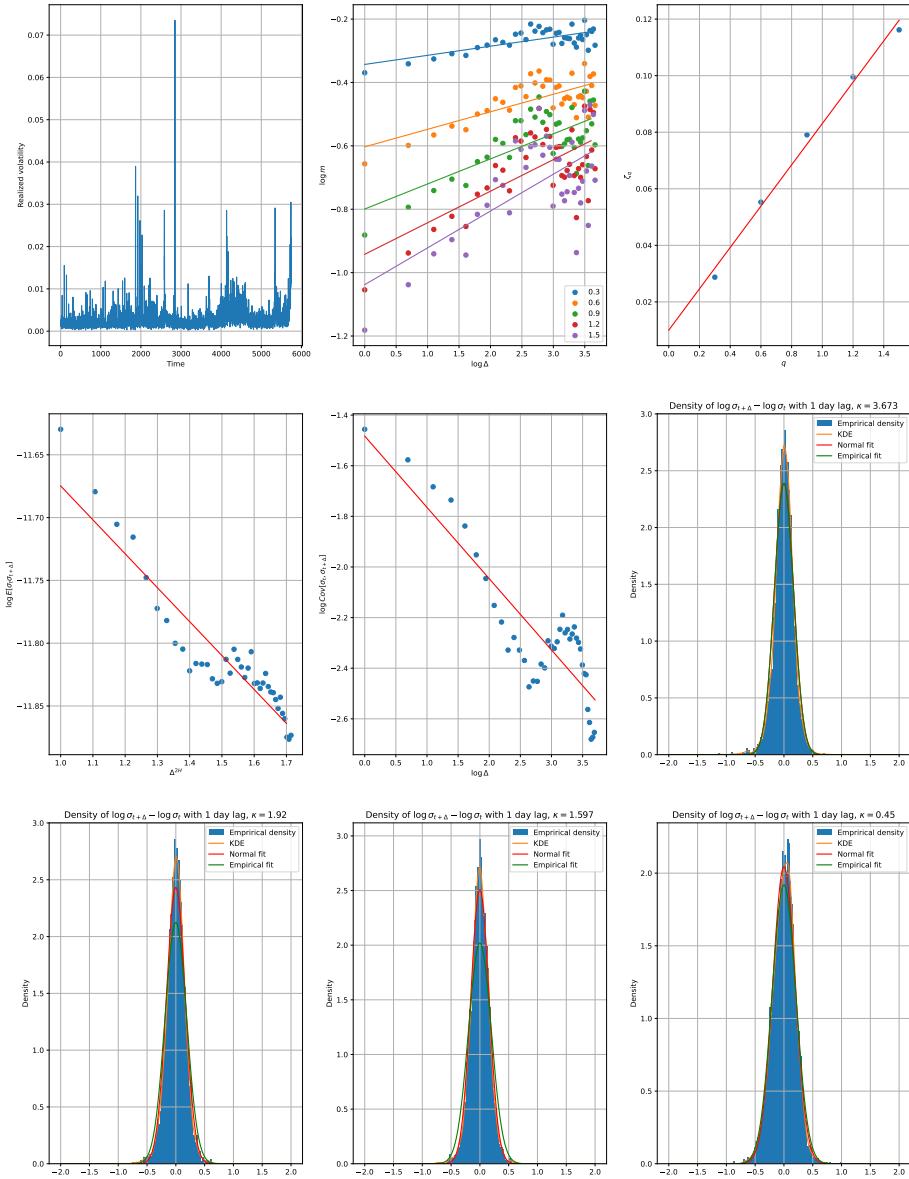


Figure 3.11: LKOH RX Equity. \hat{H} plots

BIBLIOGRAPHY

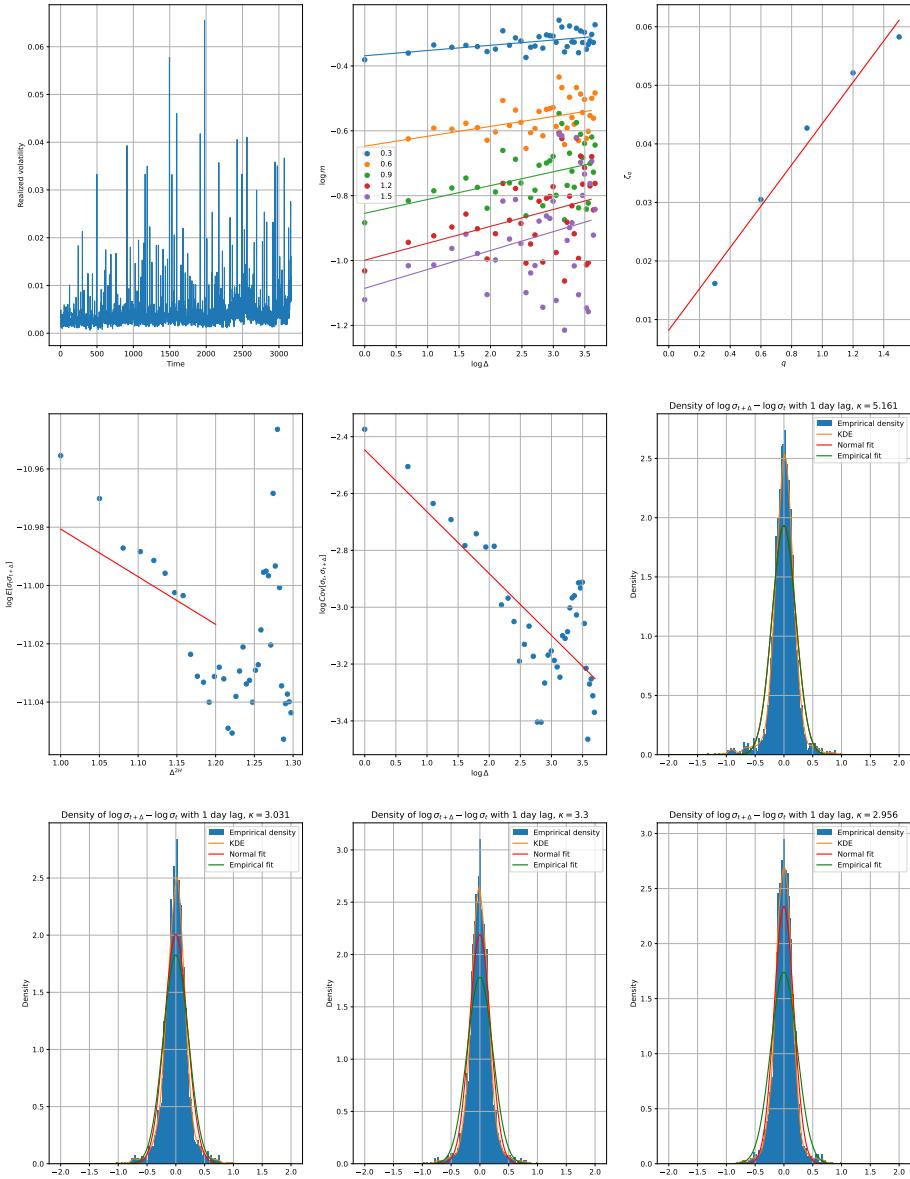


Figure 3.12: LKOD LI Equity. \hat{H} plots

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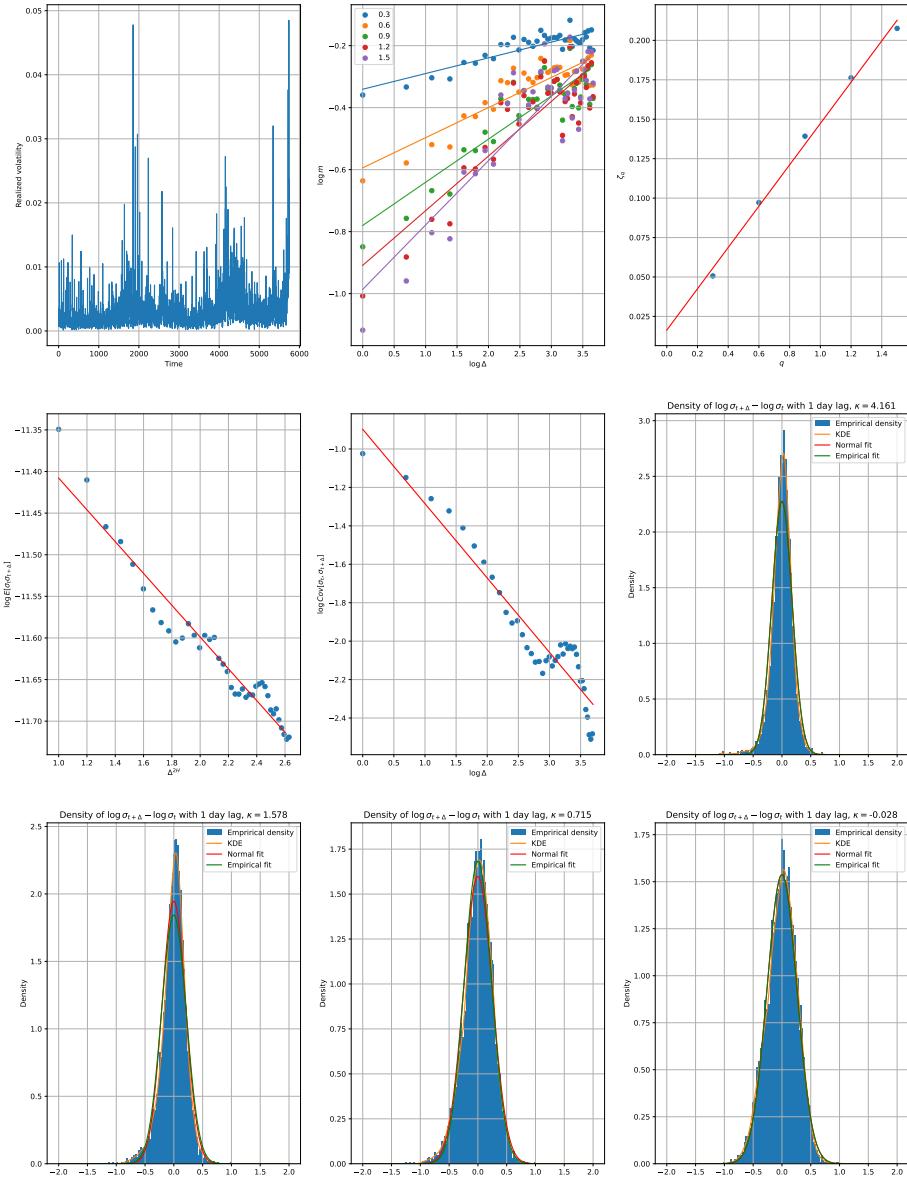


Figure 3.13: GAZP RX Equity. \hat{H} plots

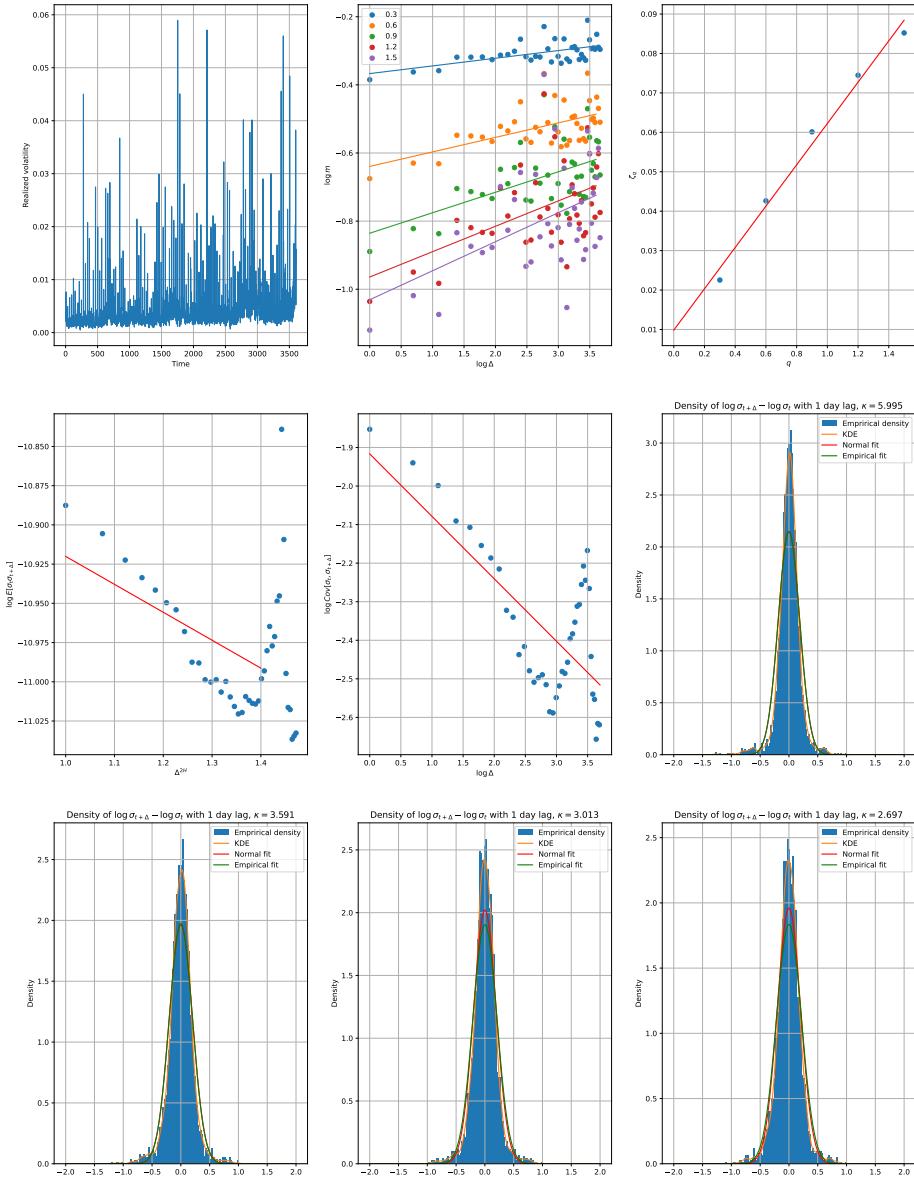


Figure 3.14: OGZD LI Equity. \hat{H} plots

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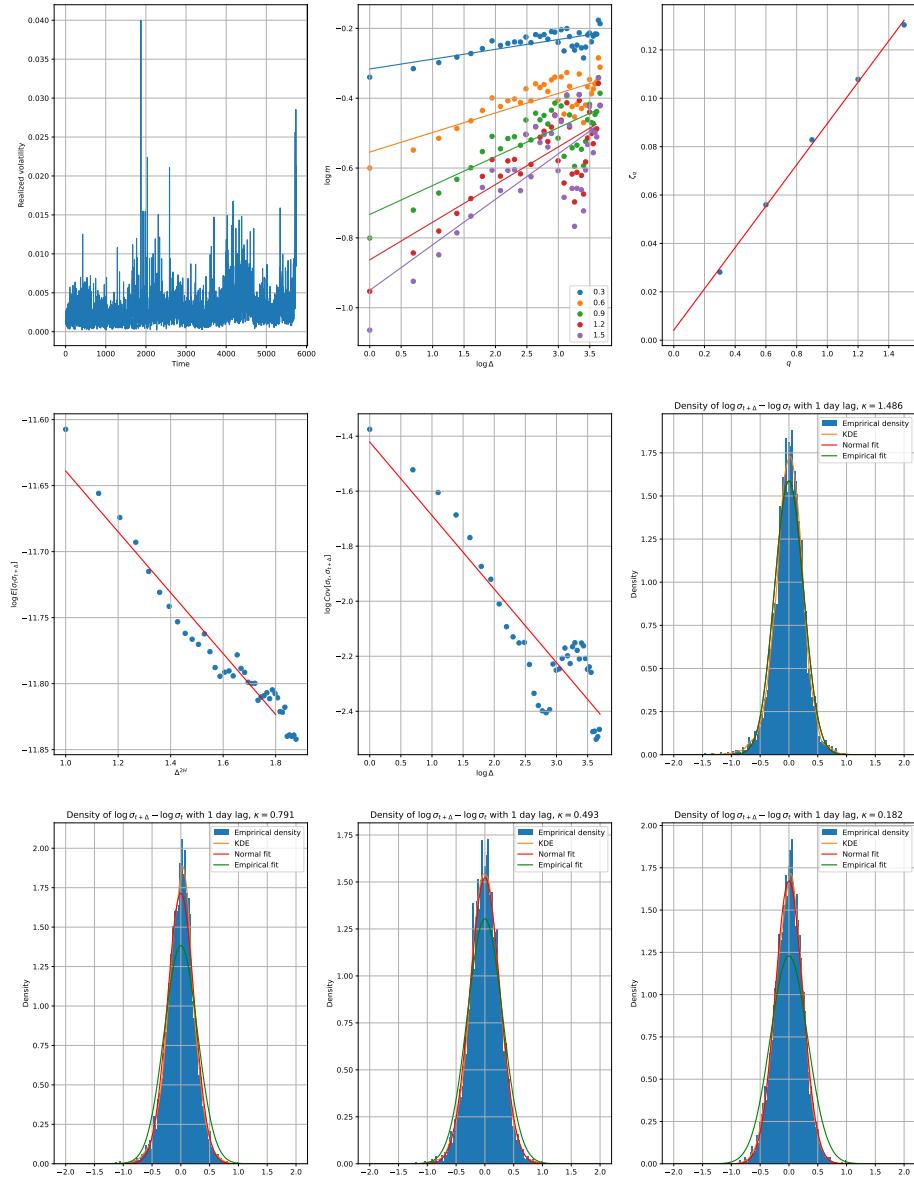


Figure 3.15: MOEX RX Equity. \hat{H} plots

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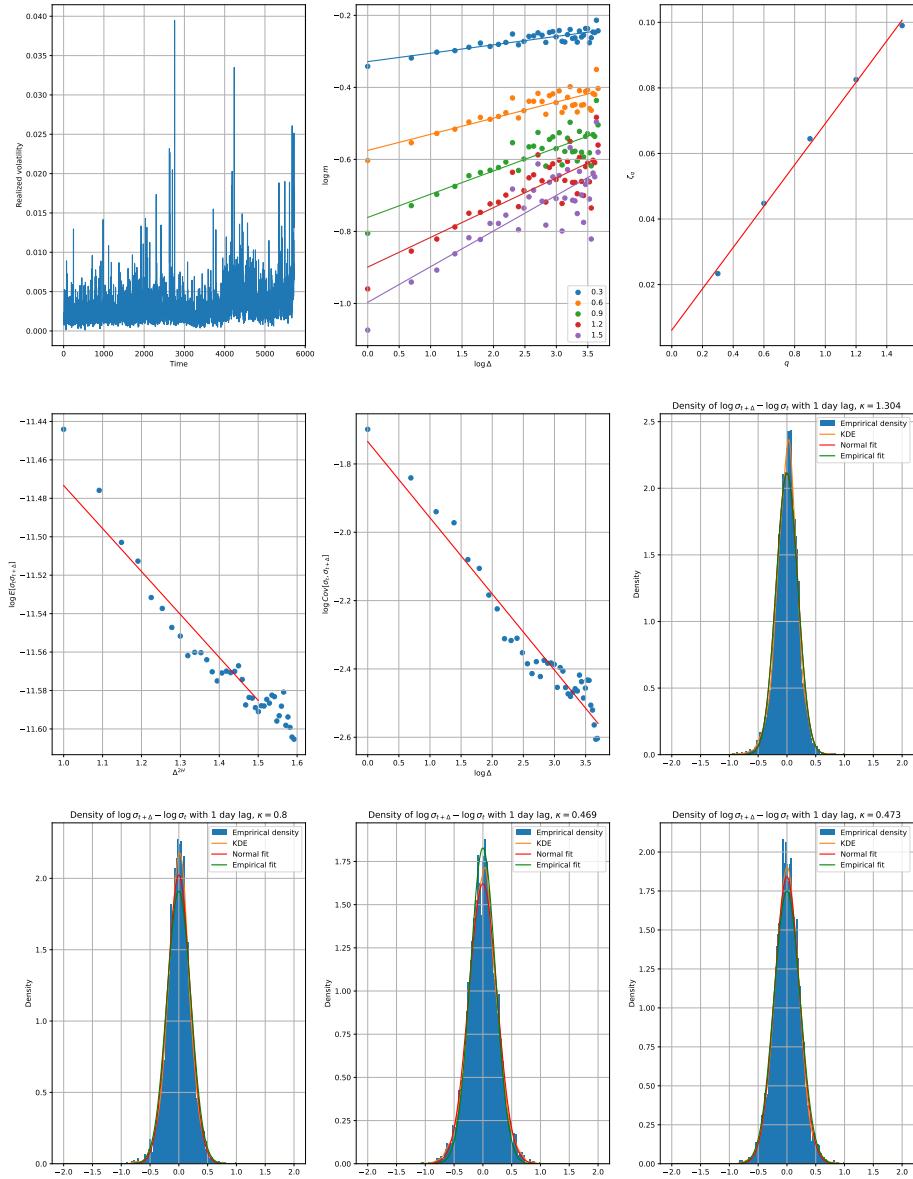


Figure 3.16: FIVE RX Equity. \hat{H} plots

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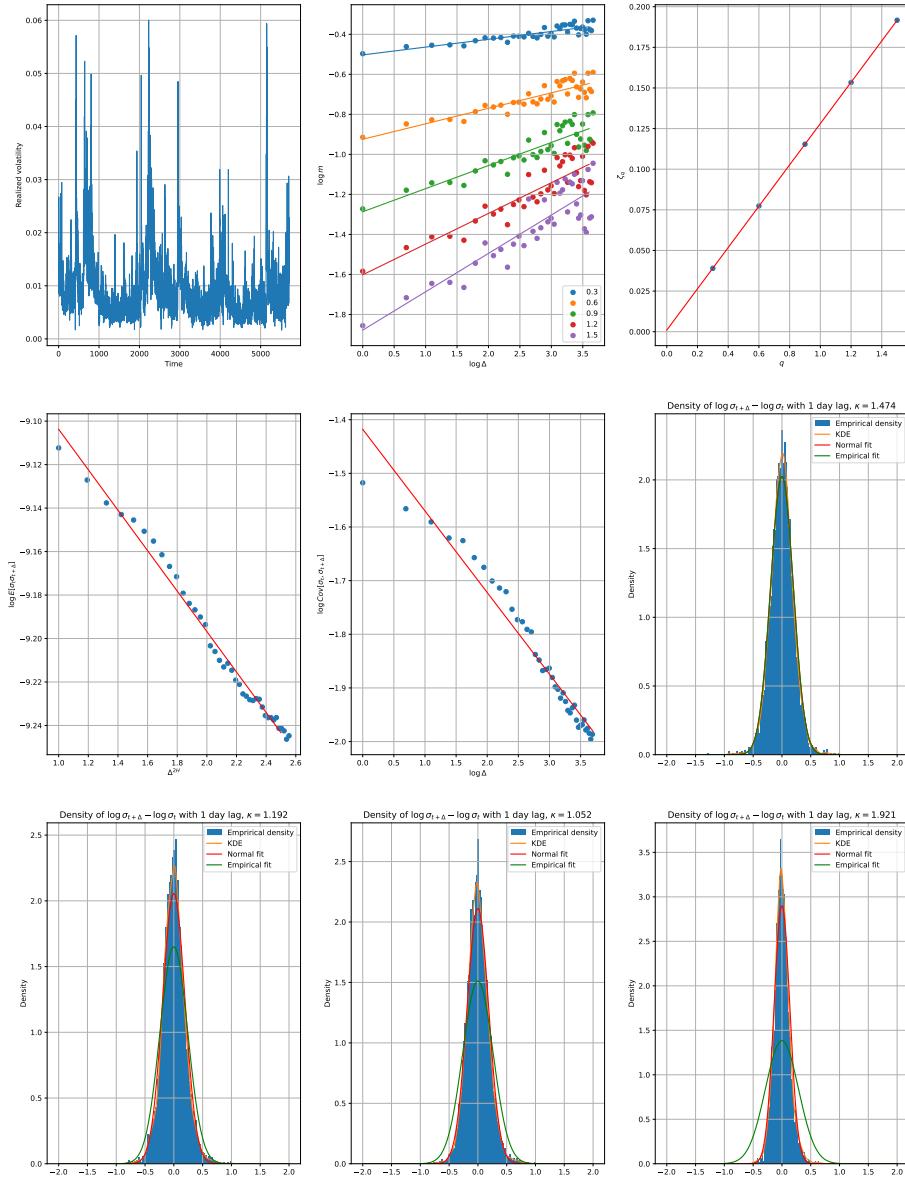


Figure 3.17: .AEX. \hat{H} plots

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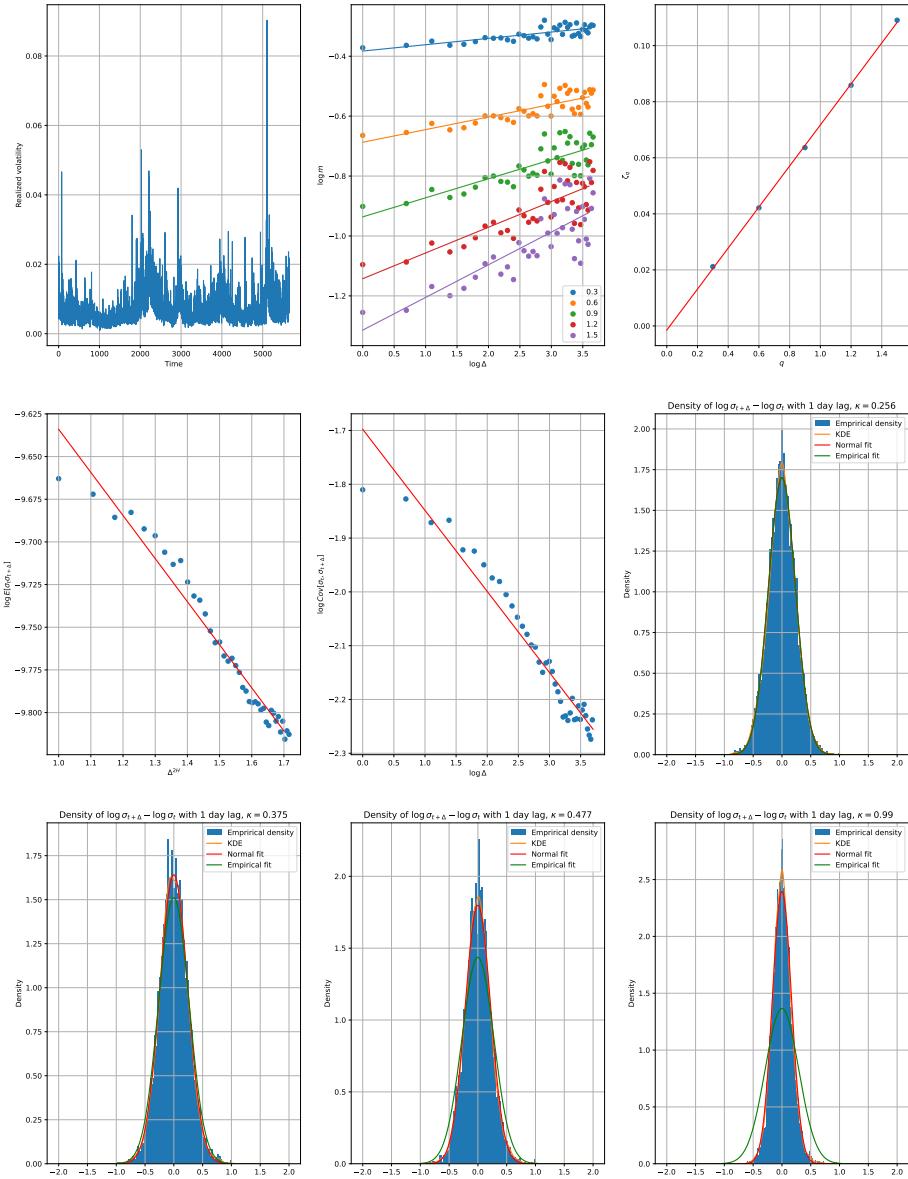


Figure 3.18: .AORD. \hat{H} plots

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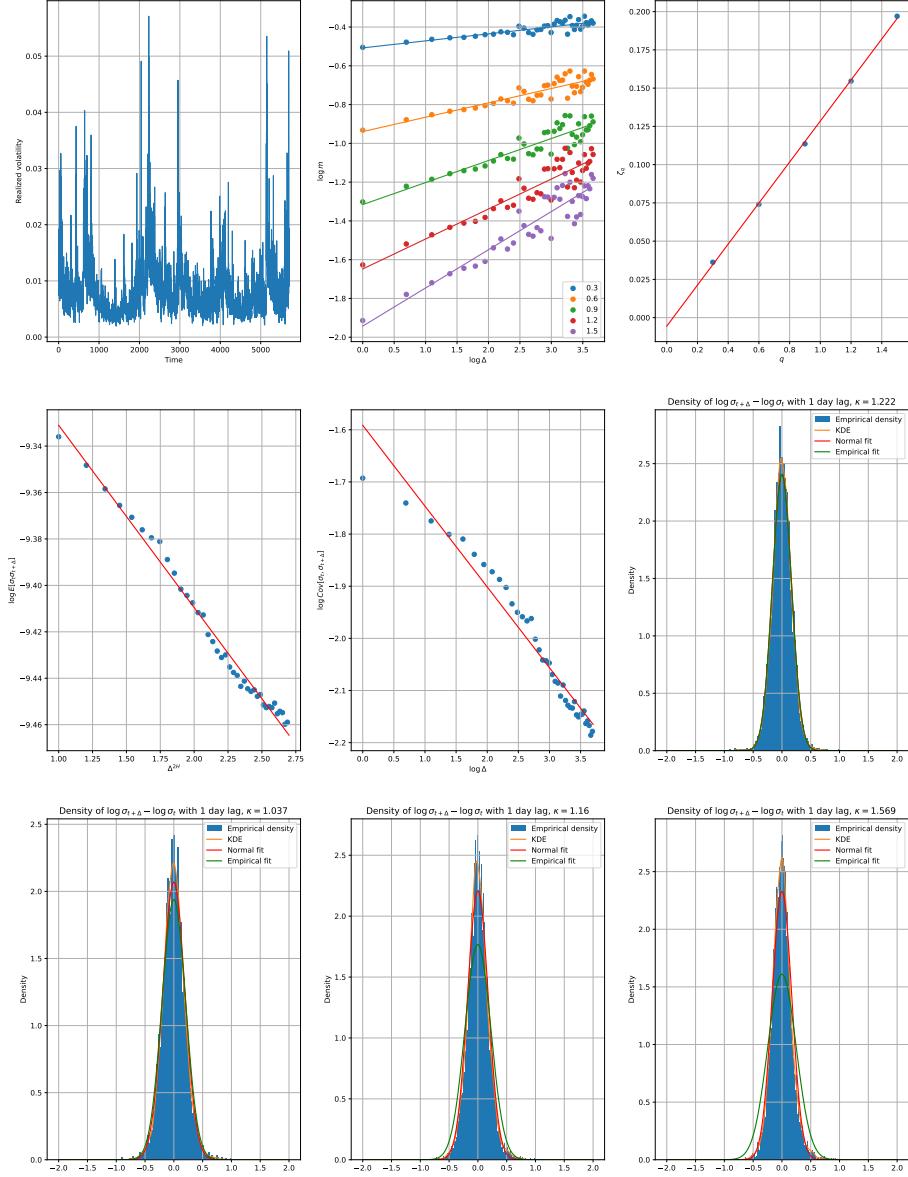


Figure 3.19: .BFX. \hat{H} plots

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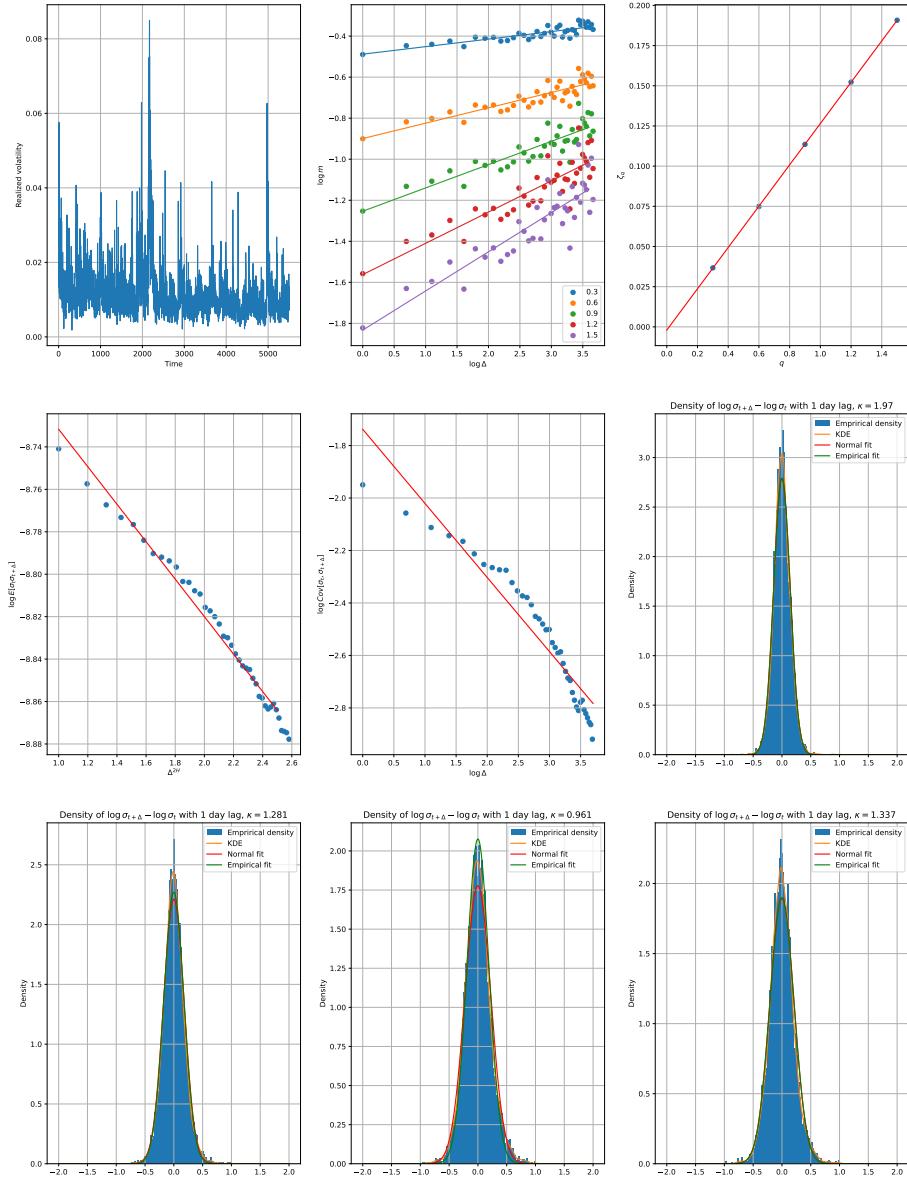


Figure 3.20: .BVSP. \hat{H} plots

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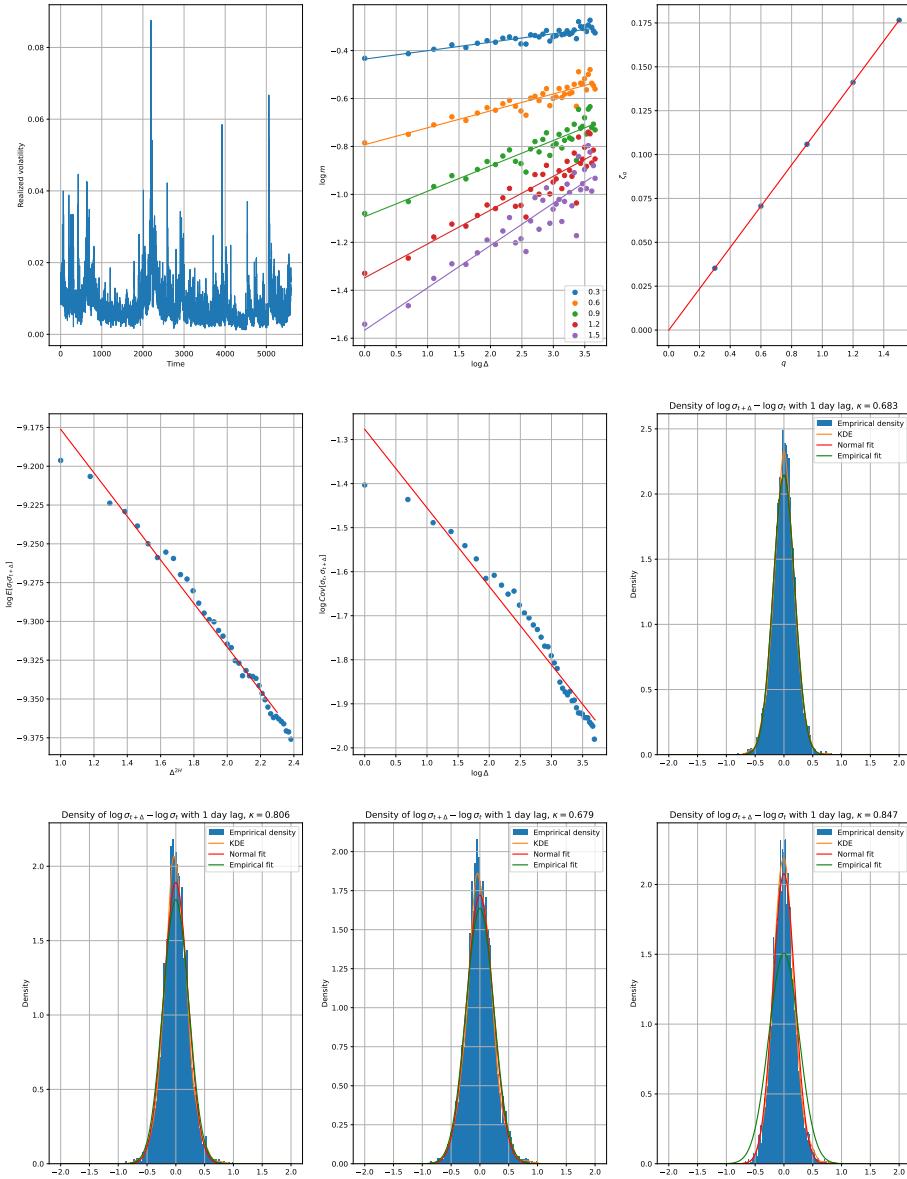


Figure 3.21: .DJI. \hat{H} plots

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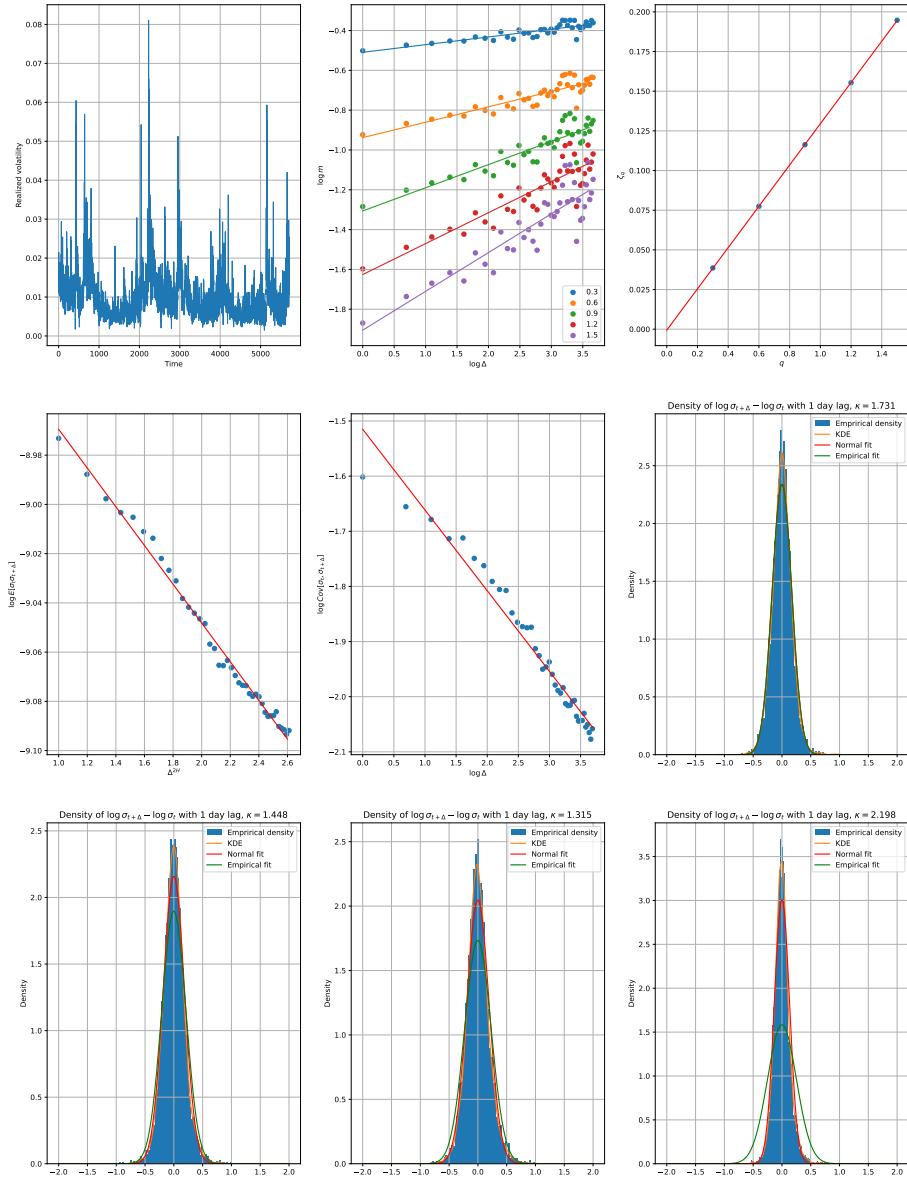


Figure 3.22: .FCHI. \hat{H} plots

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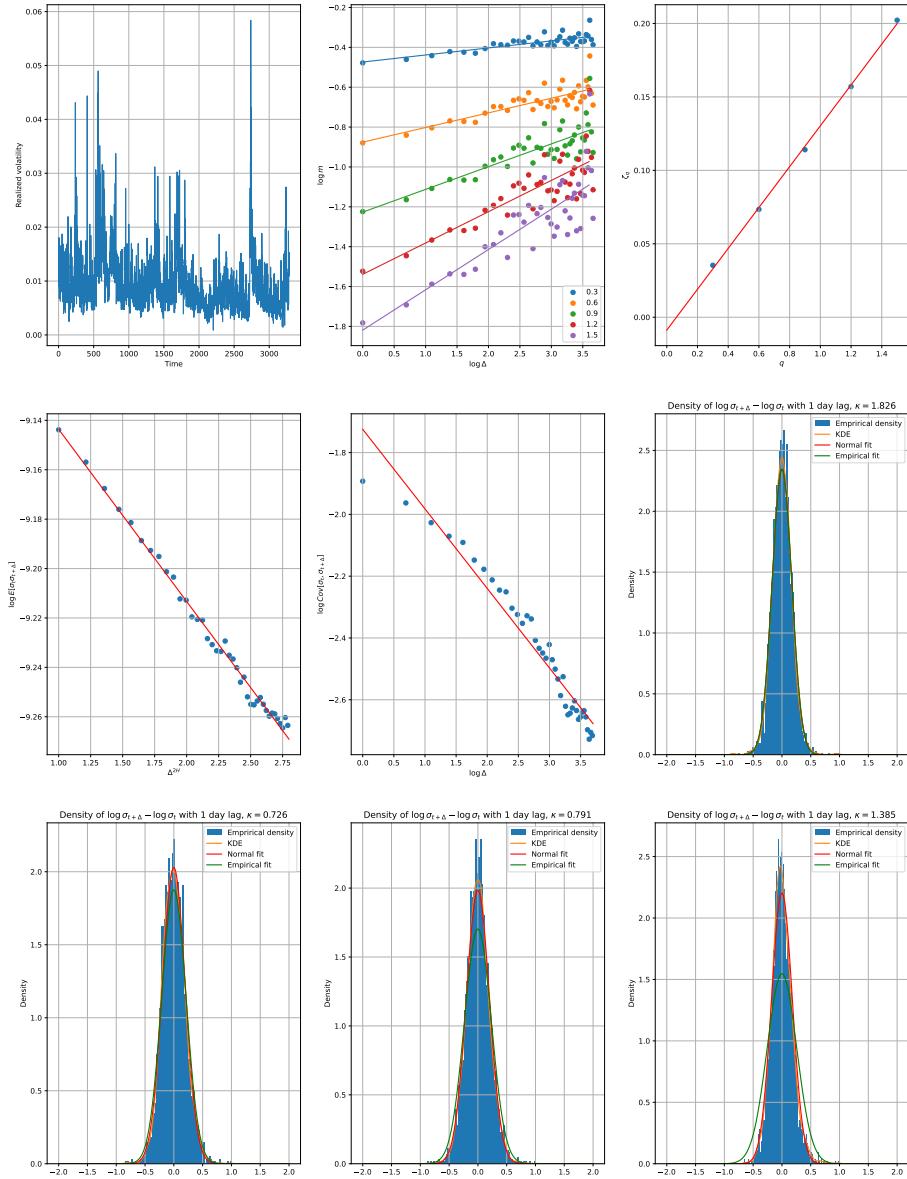


Figure 3.23: .FTMIB. \hat{H} plots

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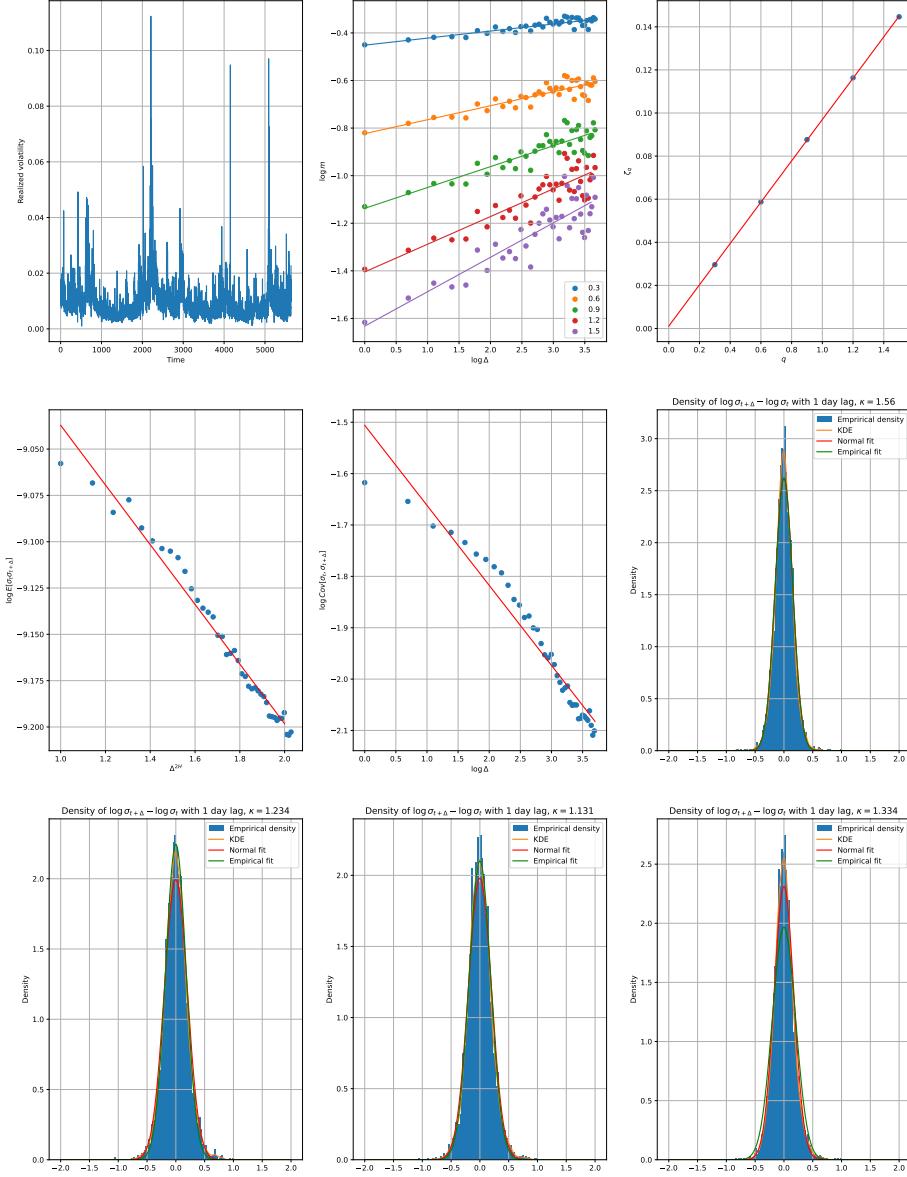


Figure 3.24: .FTSE. \hat{H} plots

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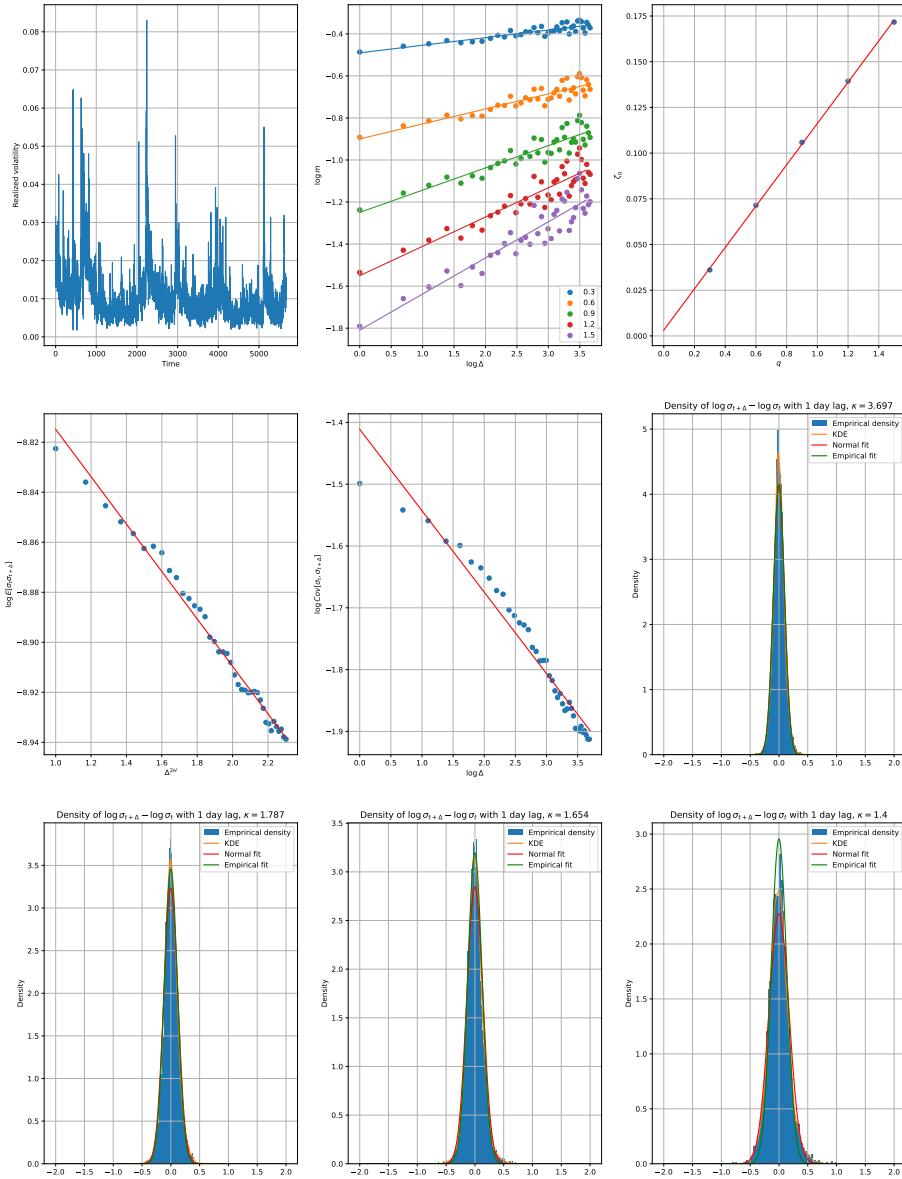


Figure 3.25: .GDAXI. \hat{H} plots

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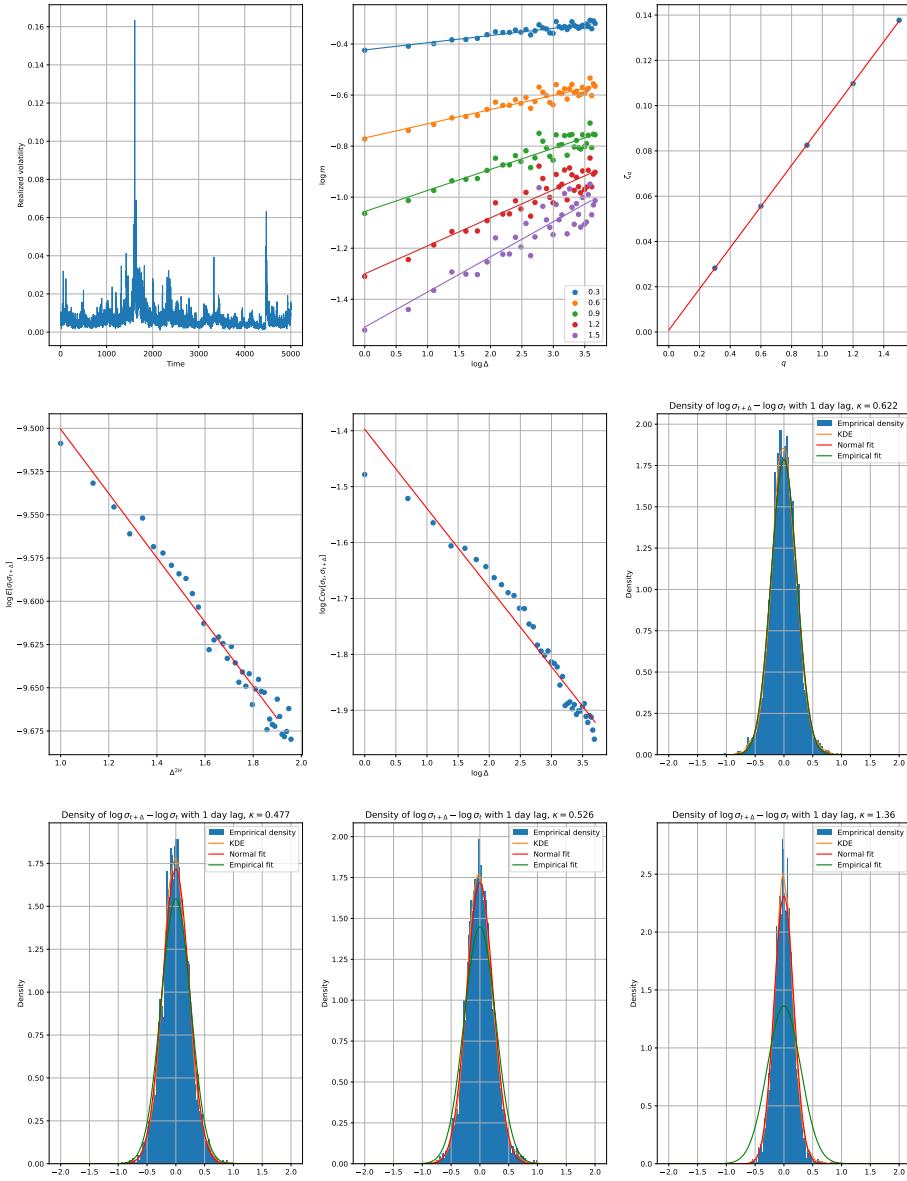


Figure 3.26: .GSPTSE. \hat{H} plots

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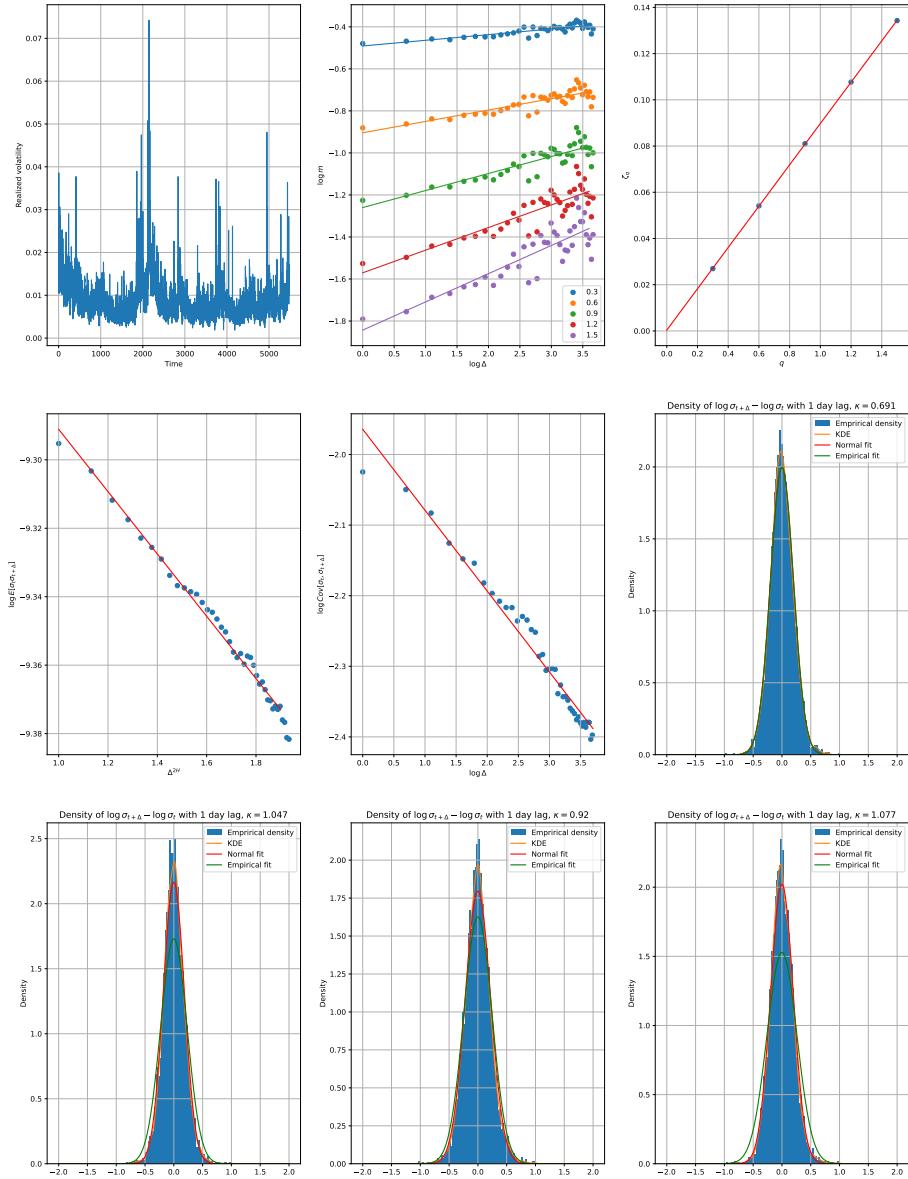


Figure 3.27: .HSI. \hat{H} plots

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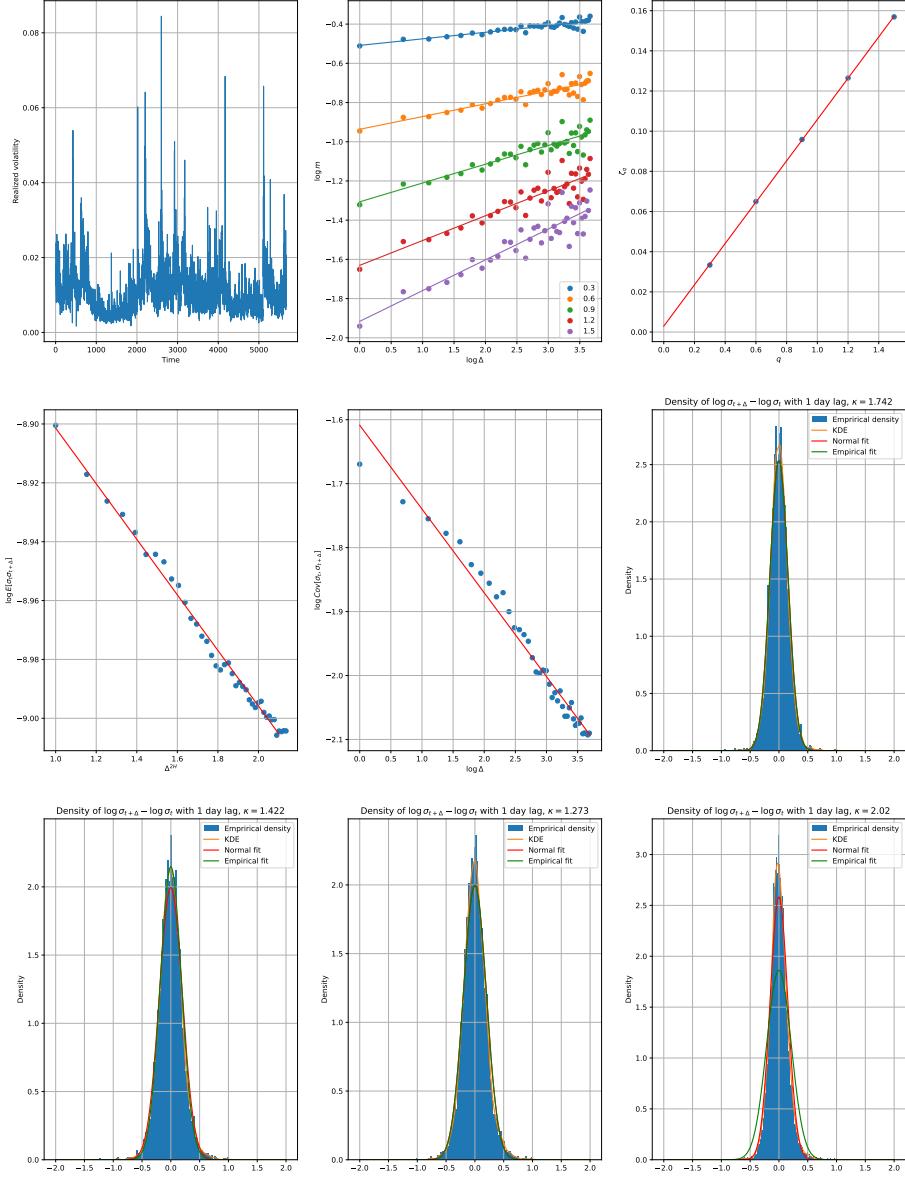


Figure 3.28: .IBEX. \hat{H} plots

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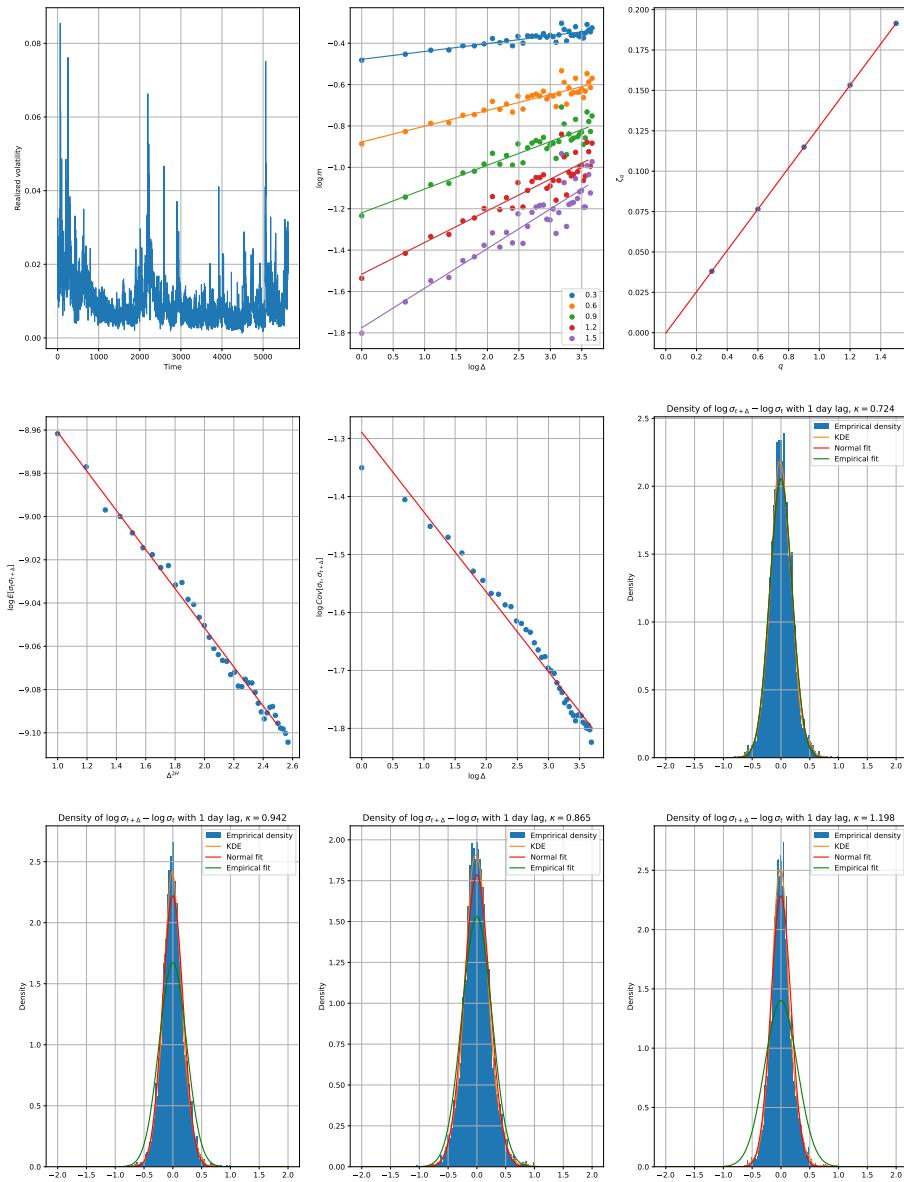


Figure 3.29: .IXIC. \hat{H} plots

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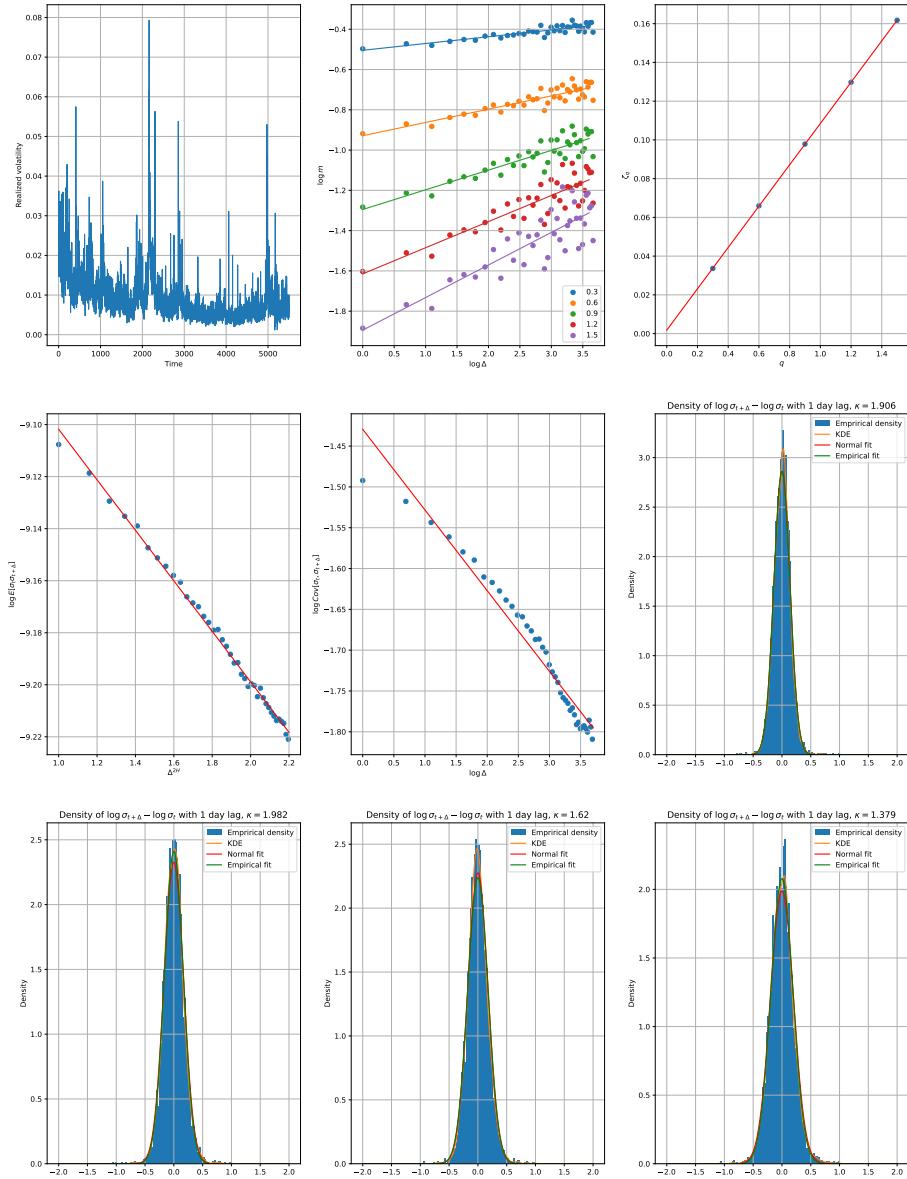


Figure 3.30: .KS11. \hat{H} plots

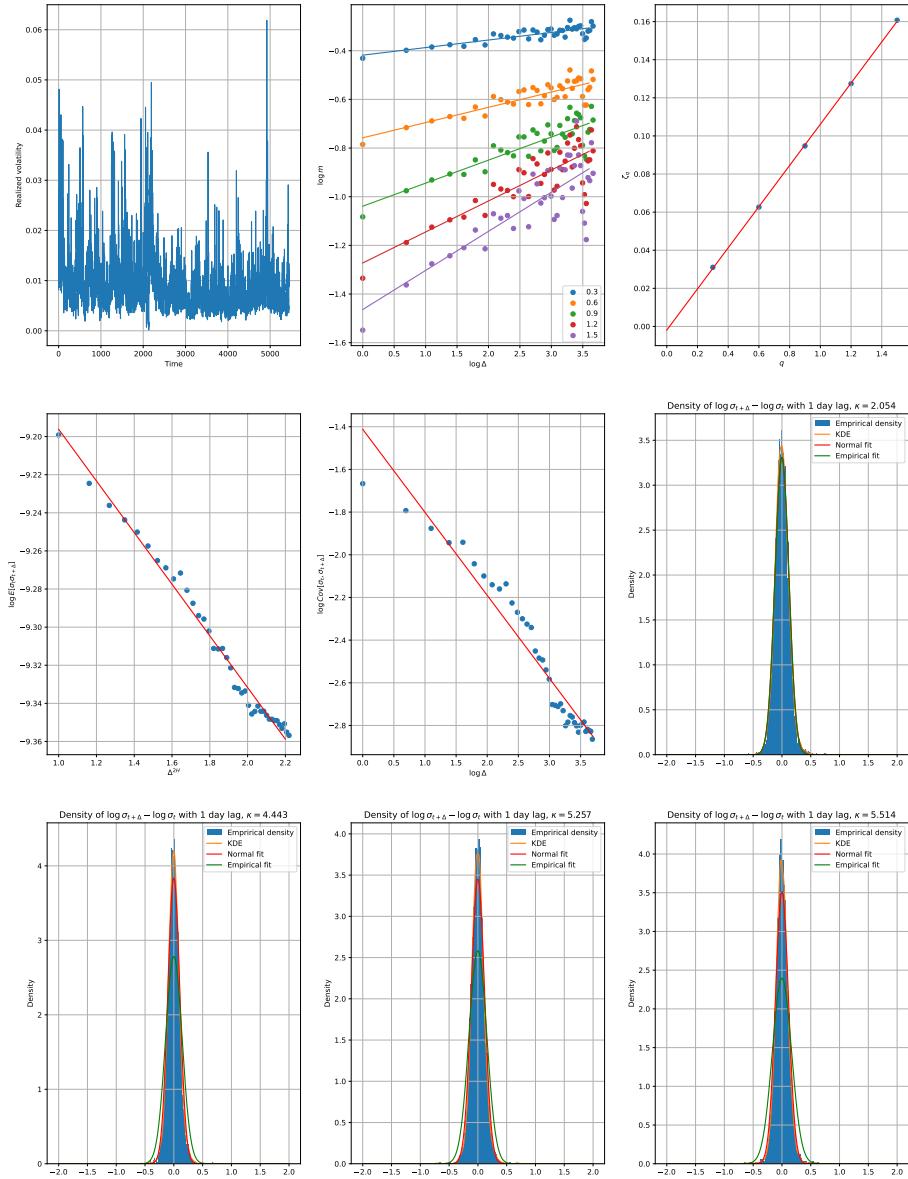


Figure 3.31: .KSE. \hat{H} plots

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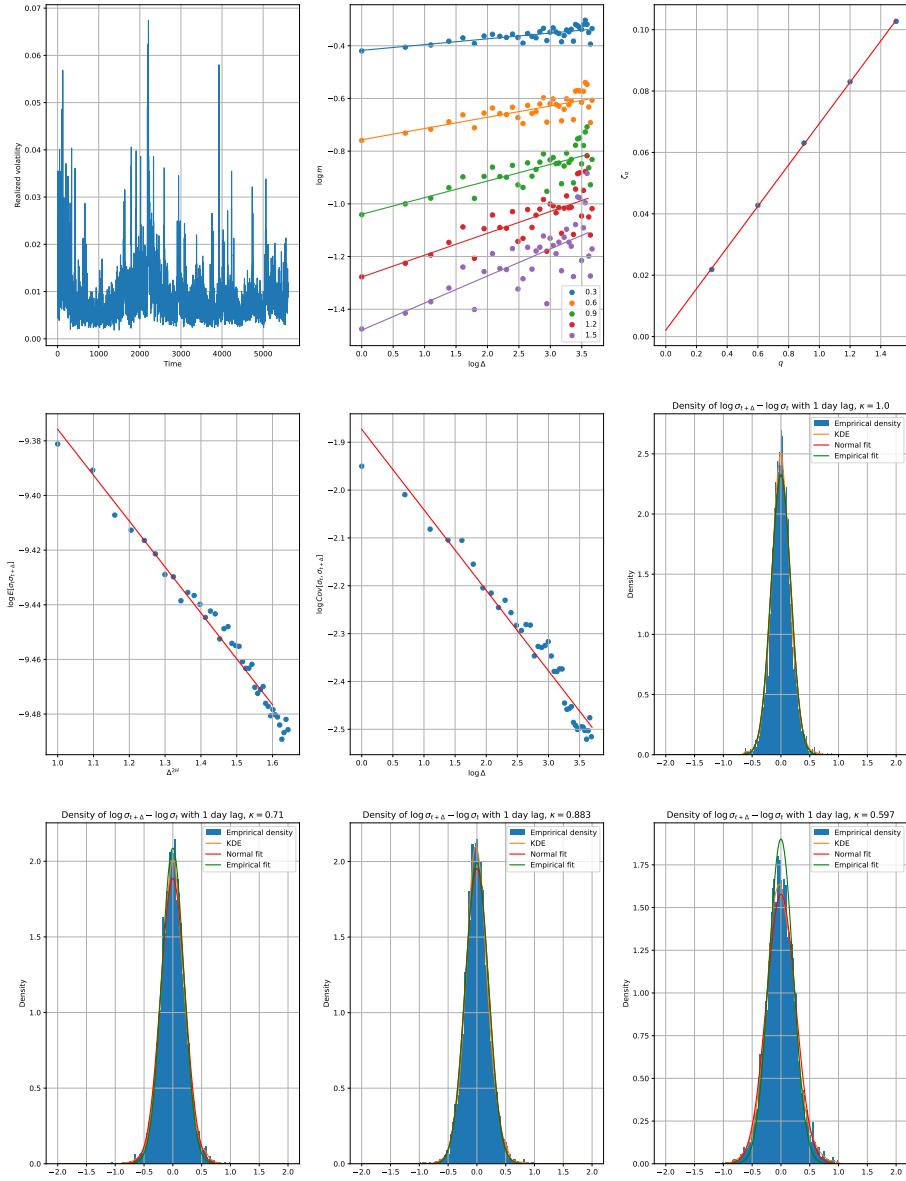


Figure 3.32: .MXX. \hat{H} plots

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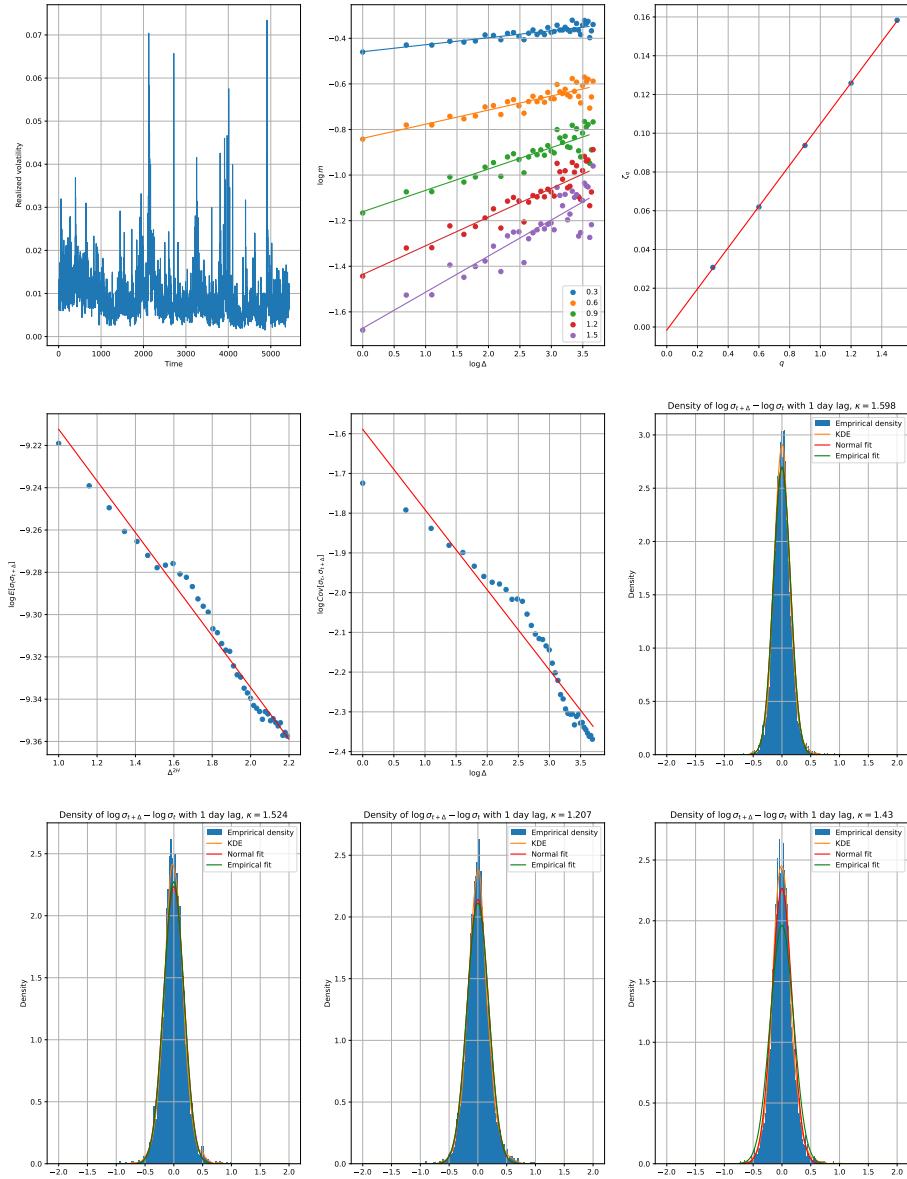


Figure 3.33: .N225. \hat{H} plots

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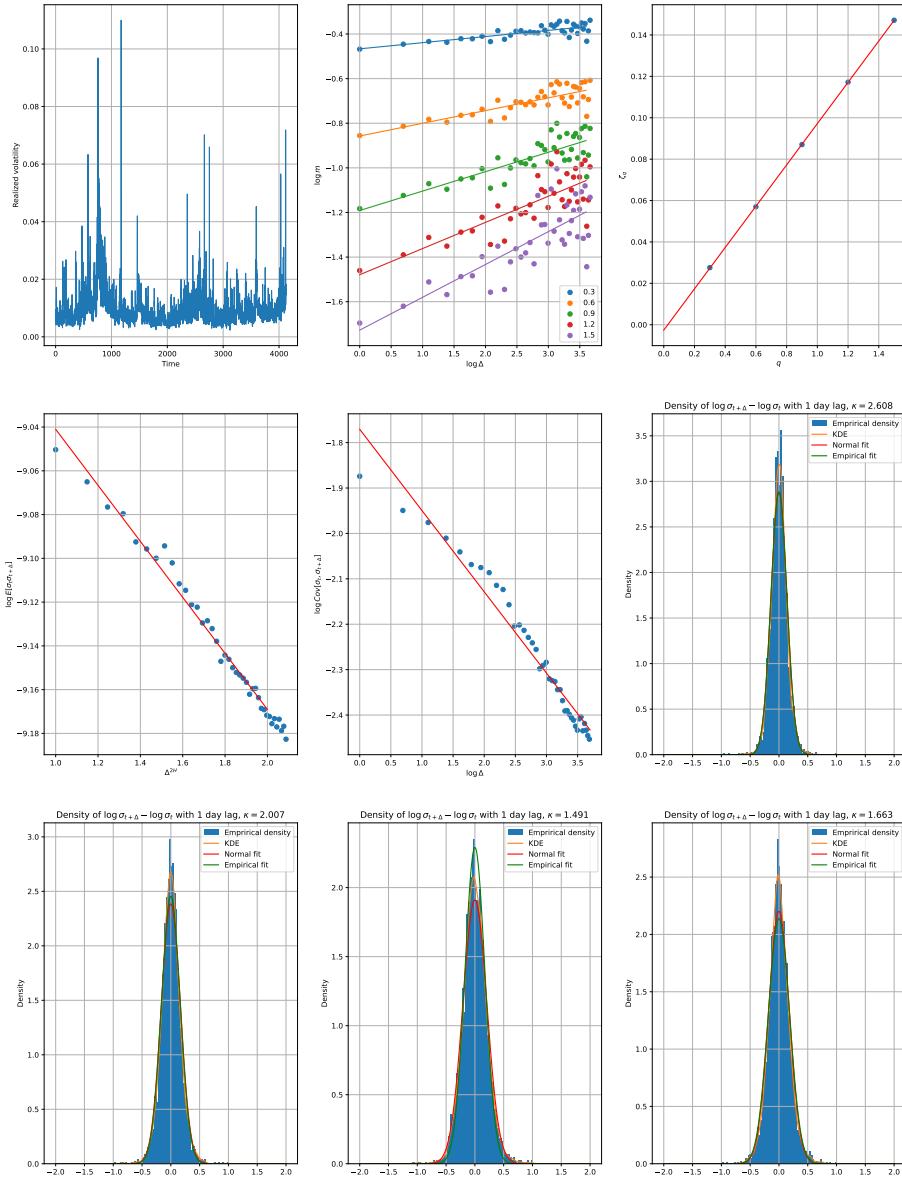


Figure 3.34: .OMXC20. \hat{H} plots

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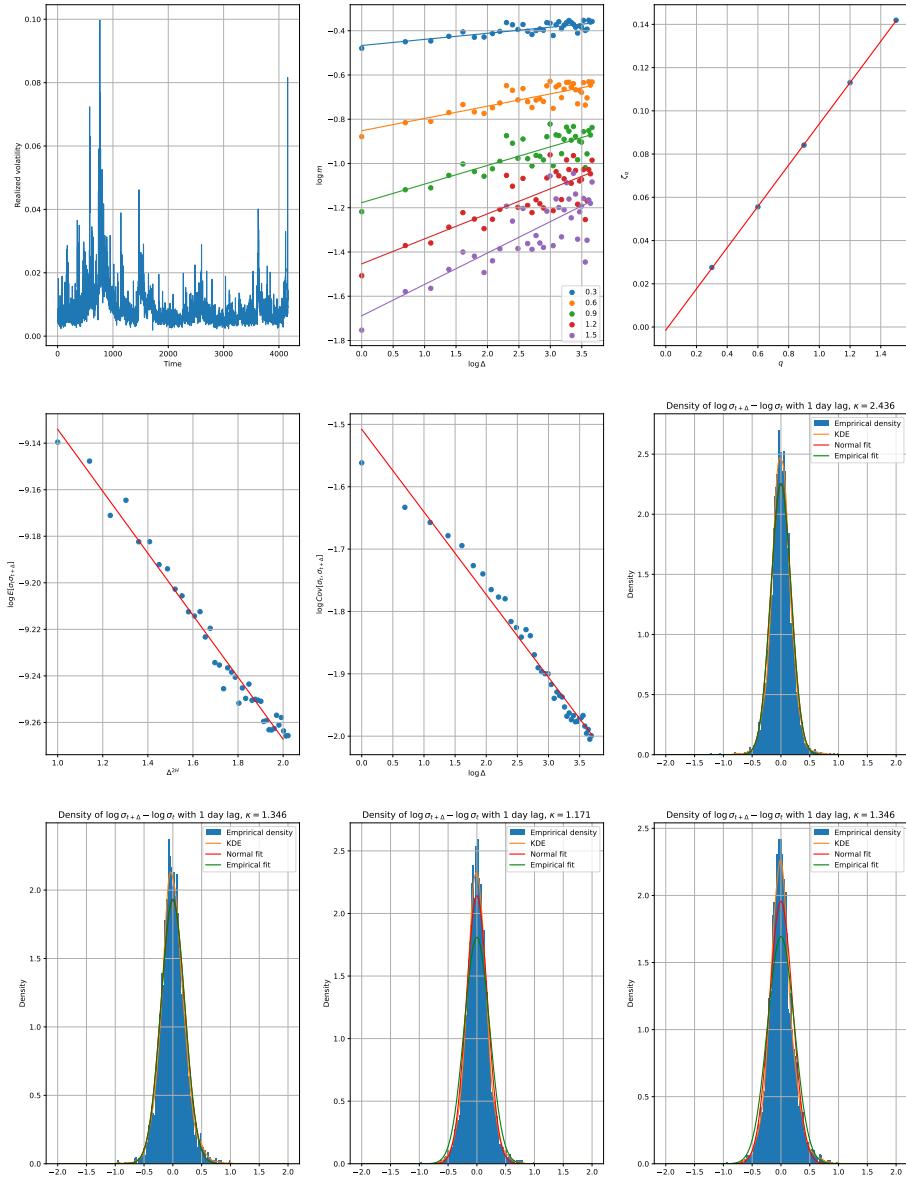


Figure 3.35: .OMXHPI. \hat{H} plots

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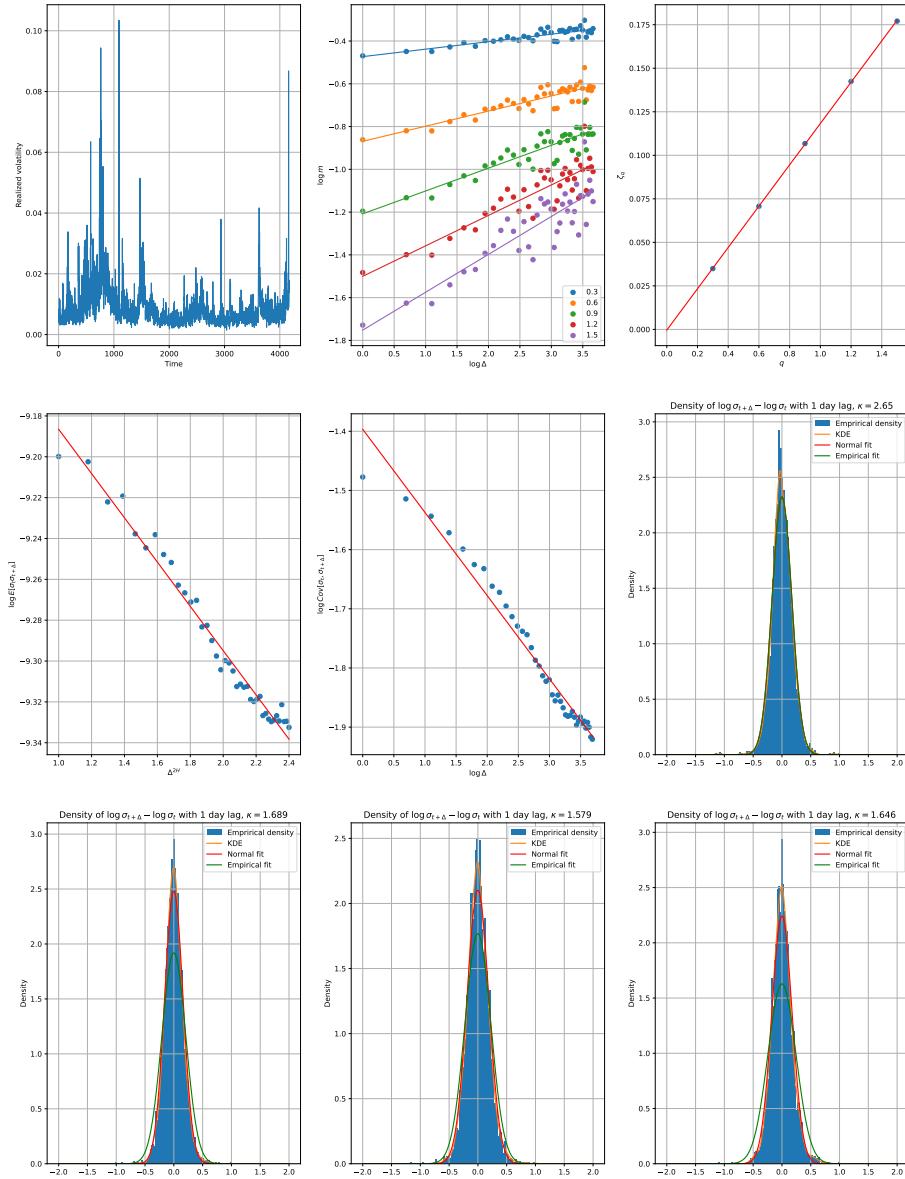


Figure 3.36: .OMXSPI. \hat{H} plots

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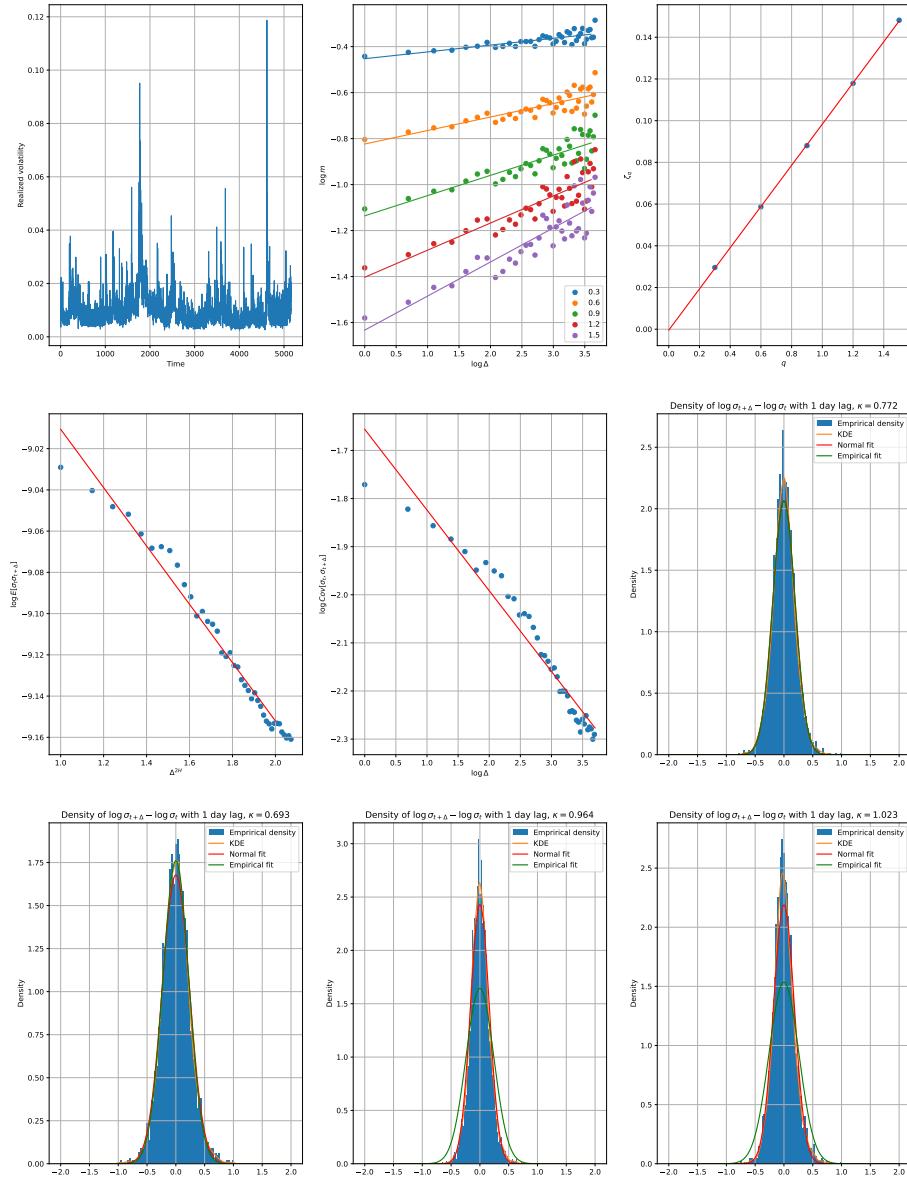


Figure 3.37: .OSEAX. \hat{H} plots

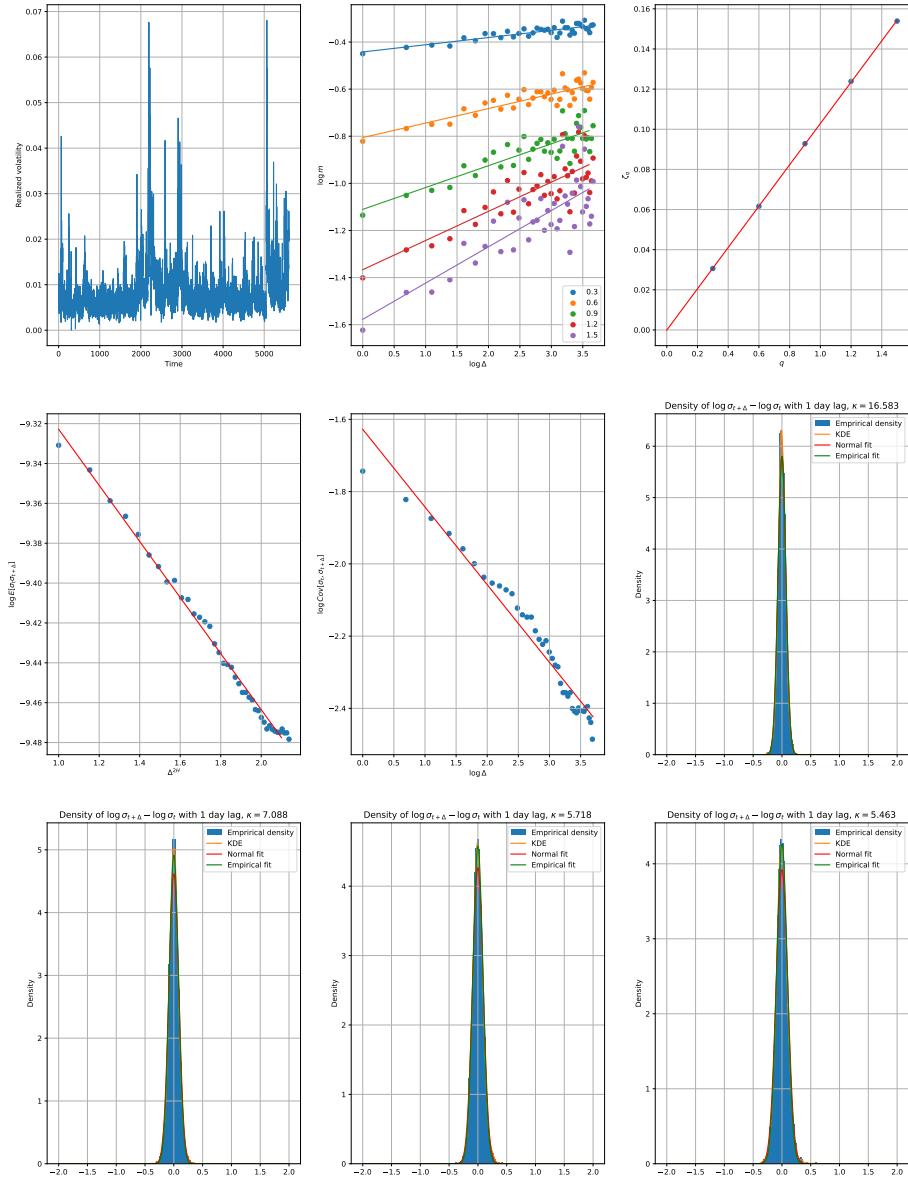


Figure 3.38: .RUT. \hat{H} plots

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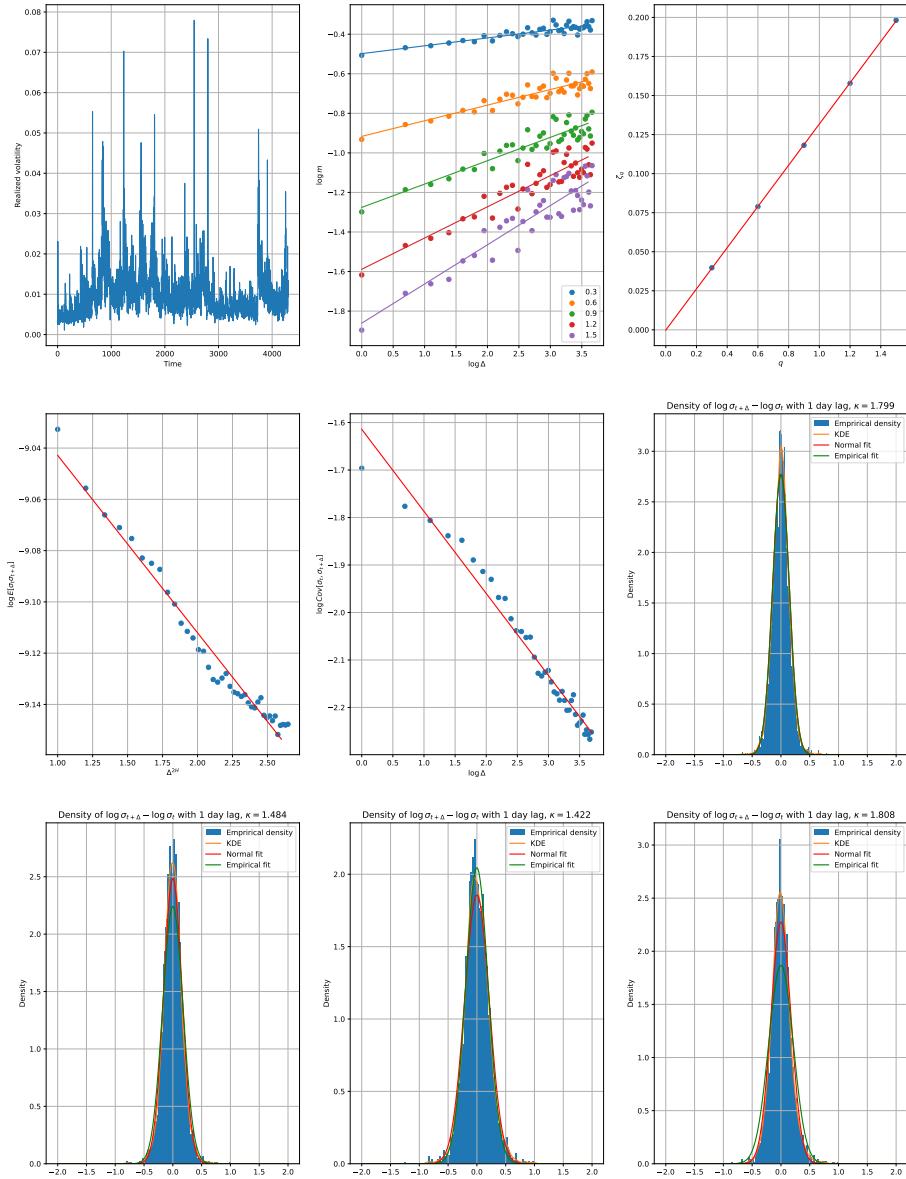


Figure 3.39: .SMSI. \hat{H} plots

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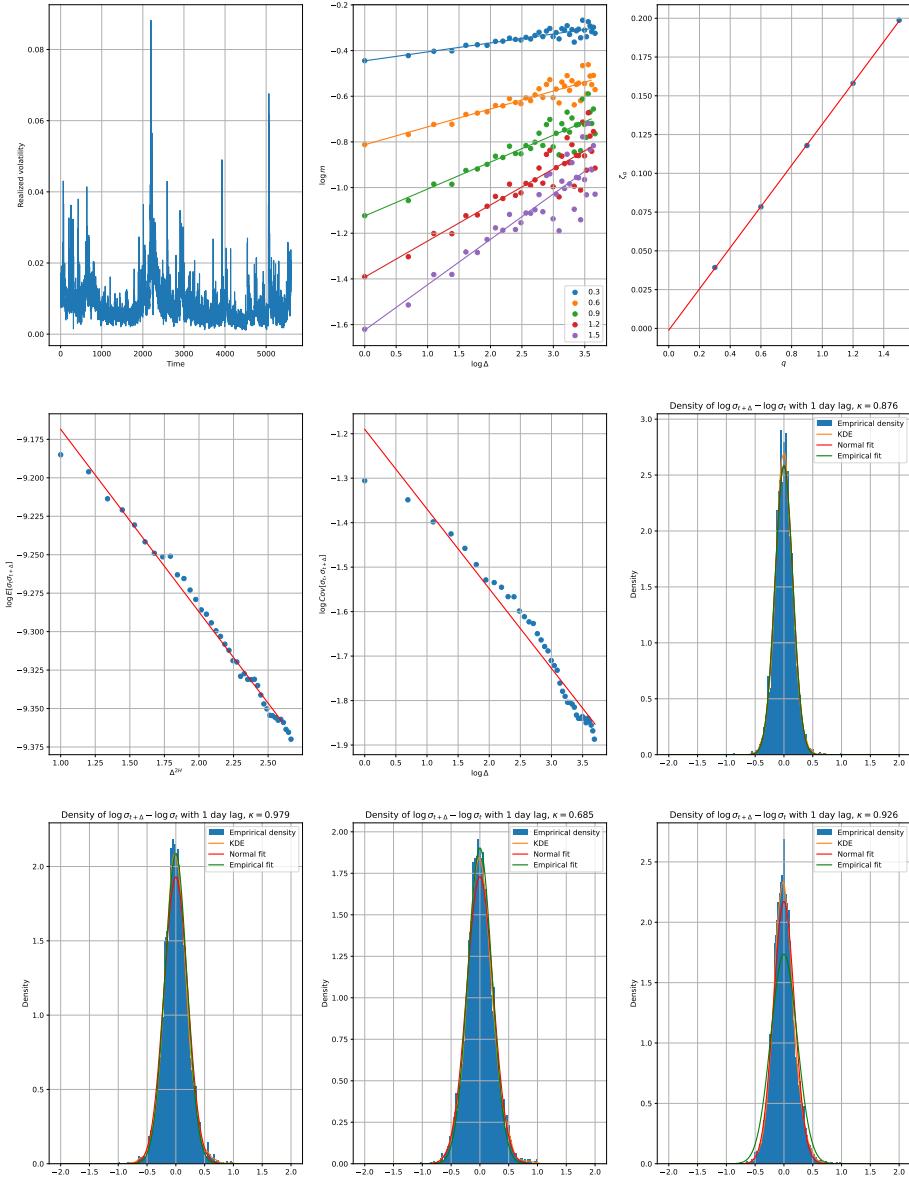


Figure 3.40: .SPX. \hat{H} plots

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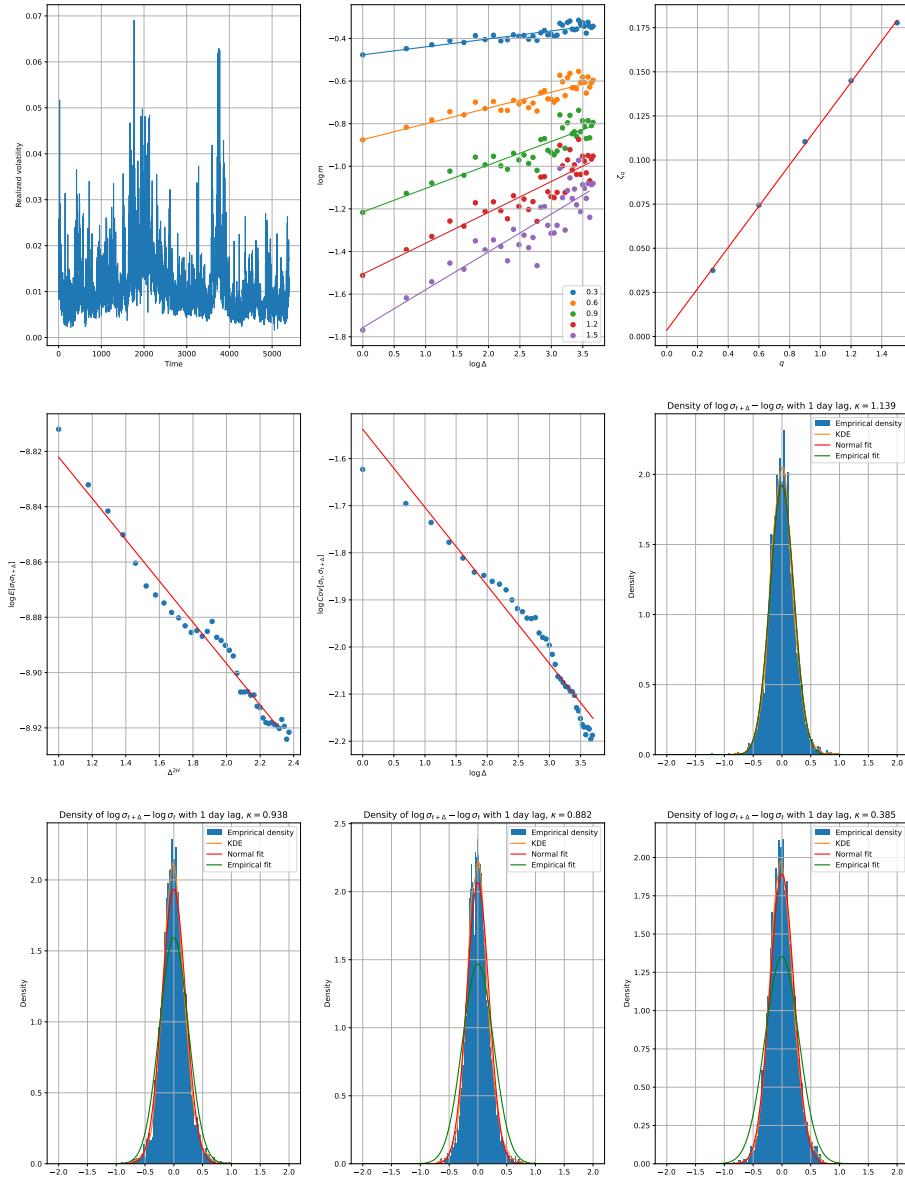


Figure 3.41: .SSEC. \hat{H} plots

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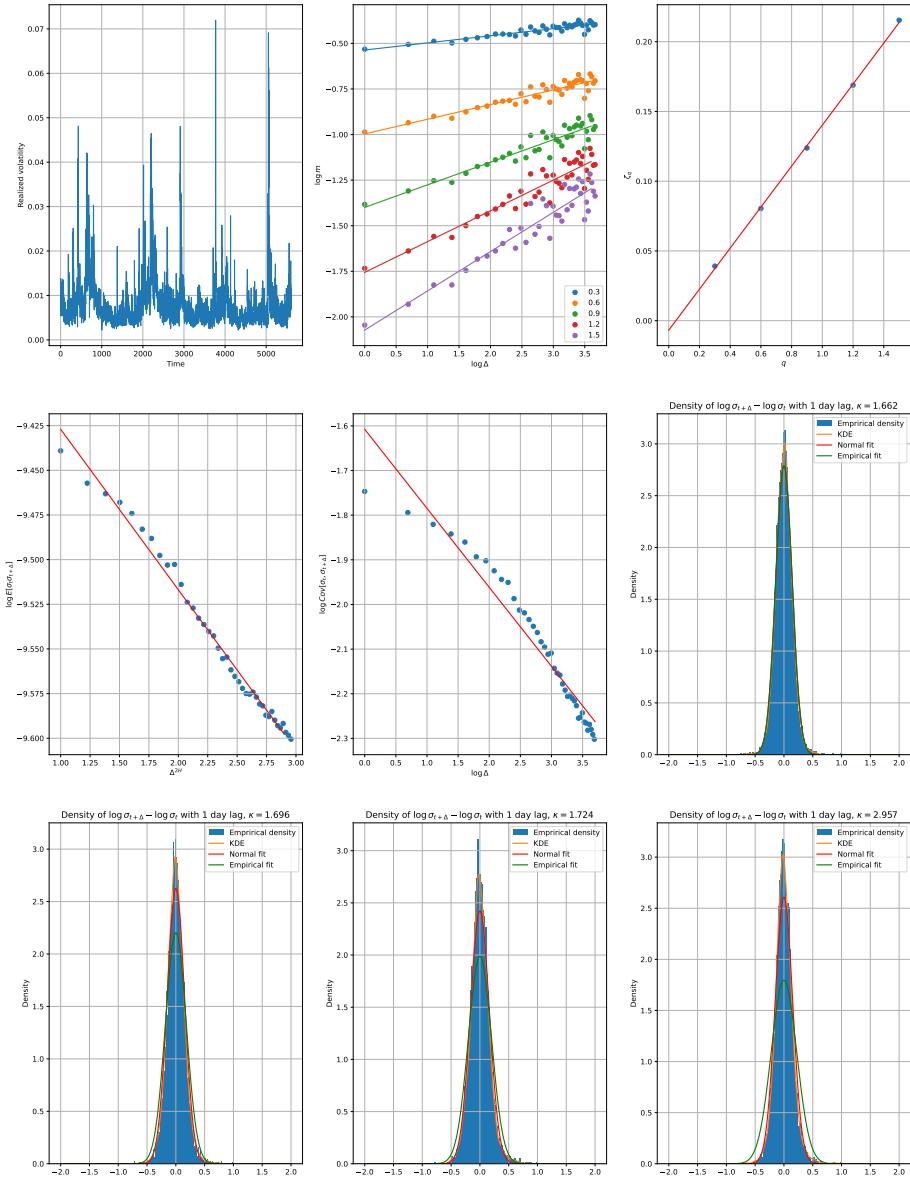


Figure 3.42: .SSMI. \hat{H} plots

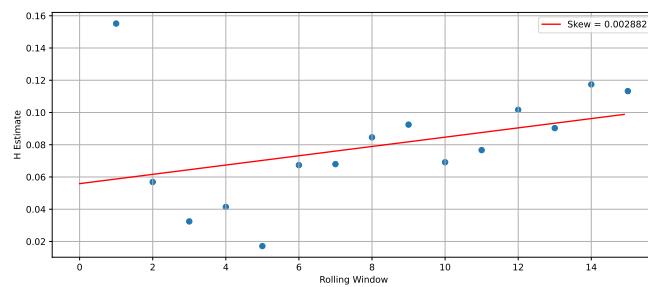


Figure 3.43: SBER RX Equity Smoothing Effect

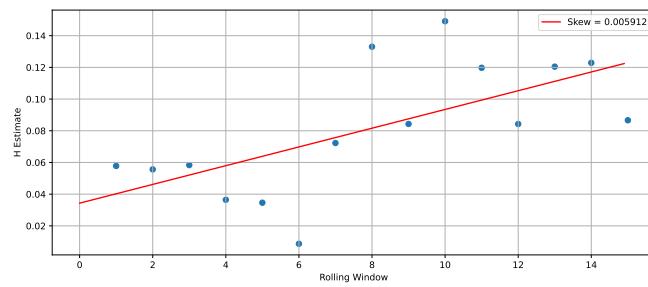


Figure 3.44: SBER LI Equity Smoothing Effect

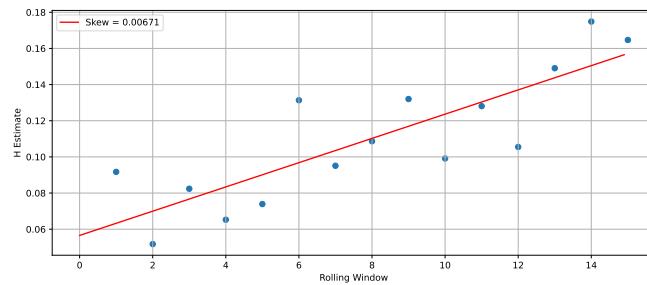


Figure 3.45: VTBR RX Equity Smoothing Effect

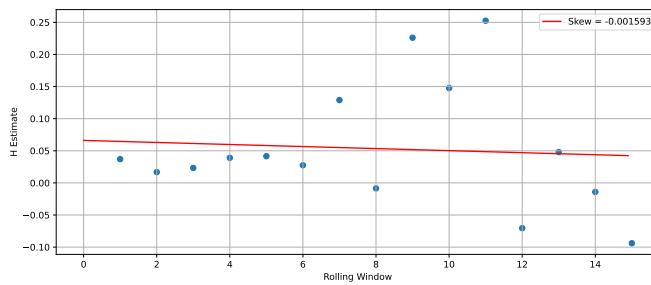


Figure 3.46: VTBR LI Equity Smoothing Effect

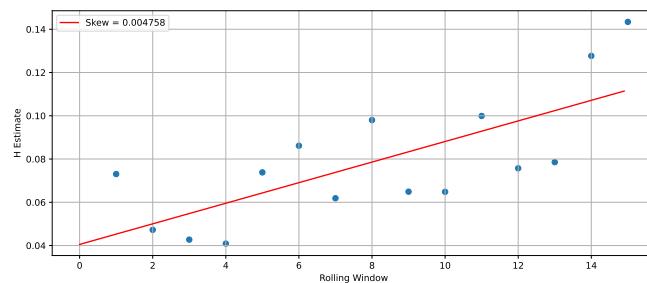


Figure 3.47: LKOH RX Equity Smoothing Effect

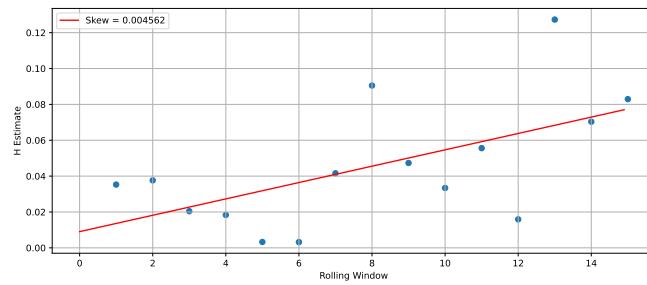


Figure 3.48: LKOD LI Equity Smoothing Effect

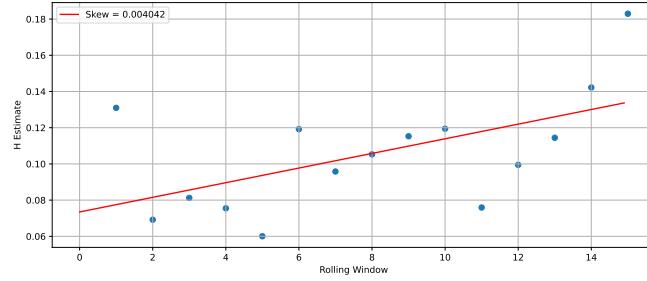


Figure 3.49: GAZP RX Equity Smoothing Effect

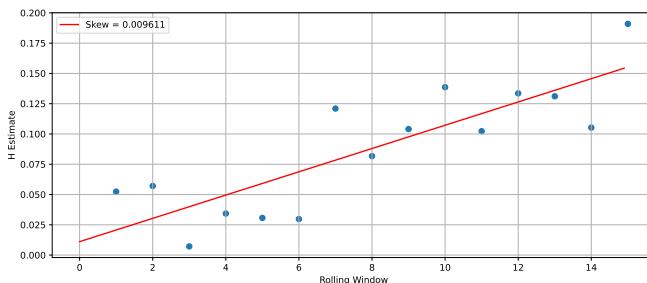


Figure 3.50: OGZD LI Equity Smoothing Effect

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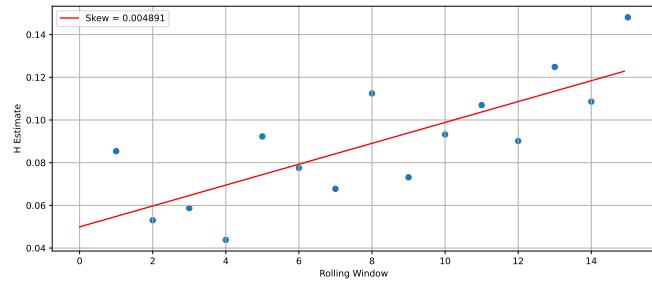


Figure 3.51: MOEX RX Equity Smoothing Effect

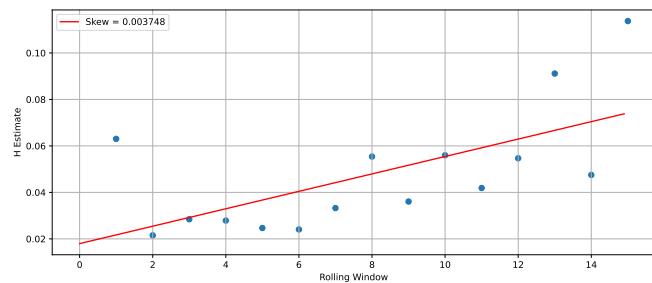


Figure 3.52: FIVE RX Equity Smoothing Effect

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.78331E-01	8.521E-29	4.21946E+02	2.374E-92	Not normal	
2	9.87221E-01	1.827E-22	2.44050E+02	1.012E-53	Not normal	
3	9.91074E-01	1.227E-18	1.66138E+02	8.388E-37	Not normal	
4	9.93357E-01	8.959E-16	1.15158E+02	9.857E-26	Not normal	
5	9.95637E-01	3.781E-12	7.34235E+01	1.138E-16	Not normal	
6	9.97077E-01	3.510E-09	6.01998E+01	8.468E-14	Not normal	
7	9.96985E-01	2.150E-09	4.91772E+01	2.096E-11	Not normal	
8	9.97603E-01	6.943E-08	4.51977E+01	1.533E-10	Not normal	
9	9.97847E-01	3.123E-07	3.43590E+01	3.460E-08	Not normal	
10	9.98919E-01	7.683E-04	1.79663E+01	1.255E-04	Not normal	
11	9.99302E-01	2.198E-02	1.02615E+01	5.912E-03	Not normal	
12	9.98813E-01	3.220E-04	1.98233E+01	4.959E-05	Not normal	
13	9.98313E-01	7.146E-06	2.80911E+01	7.945E-07	Not normal	
14	9.98520E-01	3.258E-05	2.51641E+01	3.433E-06	Not normal	
15	9.99092E-01	3.407E-03	1.24075E+01	2.022E-03	Not normal	
16	9.98578E-01	5.054E-05	2.20390E+01	1.638E-05	Not normal	
17	9.98762E-01	2.138E-04	1.73885E+01	1.675E-04	Not normal	
18	9.98328E-01	8.030E-06	2.25733E+01	1.254E-05	Not normal	
19	9.98844E-01	4.177E-04	1.91251E+01	7.031E-05	Not normal	
20	9.98932E-01	8.695E-04	1.94969E+01	5.838E-05	Not normal	
21	9.98787E-01	2.632E-04	2.03521E+01	3.807E-05	Not normal	
22	9.98509E-01	3.033E-05	2.39327E+01	6.355E-06	Not normal	
23	9.97368E-01	1.828E-08	4.51613E+01	1.561E-10	Not normal	
24	9.98072E-01	1.391E-06	3.02773E+01	2.663E-07	Not normal	
25	9.96688E-01	4.922E-10	5.77549E+01	2.875E-13	Not normal	
26	9.96639E-01	3.875E-10	6.13147E+01	4.849E-14	Not normal	
27	9.96502E-01	1.986E-10	6.18355E+01	3.738E-14	Not normal	
28	9.95934E-01	1.454E-11	6.61228E+01	4.381E-15	Not normal	
29	9.97702E-01	1.328E-07	4.04066E+01	1.682E-09	Not normal	
30	9.96864E-01	1.220E-09	5.63125E+01	5.914E-13	Not normal	
31	9.96448E-01	1.557E-10	6.58779E+01	4.952E-15	Not normal	
32	9.95876E-01	1.144E-11	6.24651E+01	2.728E-14	Not normal	
33	9.95495E-01	2.278E-12	7.60255E+01	3.099E-17	Not normal	
34	9.95883E-01	1.185E-11	6.93021E+01	8.938E-16	Not normal	
35	9.95461E-01	1.994E-12	7.52112E+01	4.657E-17	Not normal	
36	9.95680E-01	4.986E-12	6.24106E+01	2.804E-14	Not normal	
37	9.96425E-01	1.413E-10	5.74359E+01	3.372E-13	Not normal	
38	9.97254E-01	1.001E-08	4.73976E+01	5.102E-11	Not normal	
39	9.96900E-01	1.506E-09	5.13868E+01	6.942E-12	Not normal	
40	9.98060E-01	1.332E-06	2.81409E+01	7.750E-07	Not normal	
41	9.97998E-01	8.867E-07	3.33027E+01	5.867E-08	Not normal	
42	9.97776E-01	2.150E-07	4.06532E+01	1.487E-09	Not normal	
43	9.97970E-01	7.383E-07	3.31453E+01	6.347E-08	Not normal	
44	9.98152E-01	2.478E-06	3.04860E+01	2.399E-07	Not normal	
45	9.98049E-01	1.249E-06	3.81656E+01	5.158E-09	Not normal	
46	9.98417E-01	1.614E-05	2.91195E+01	4.751E-07	Not normal	
47	9.98447E-01	2.012E-05	2.85055E+01	6.458E-07	Not normal	
48	9.97762E-01	2.007E-07	4.48911E+01	1.787E-10	Not normal	
49	9.98279E-01	6.033E-06	59	3.10460E+01	1.813E-07	Not normal

Table 3.2: Normality tests for YNDX RX Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.35813E-01	1.541E-44	1.49244E+03	0.000E+00	Not normal	
2	9.46980E-01	1.658E-41	1.13069E+03	2.976E-246	Not normal	
3	9.52602E-01	8.675E-40	9.65907E+02	1.803E-210	Not normal	
4	9.57752E-01	4.594E-38	9.05537E+02	2.319E-197	Not normal	
5	9.64613E-01	1.734E-35	7.31001E+02	1.842E-159	Not normal	
6	9.69881E-01	3.170E-33	6.24109E+02	2.995E-136	Not normal	
7	9.76307E-01	5.283E-30	4.83693E+02	9.276E-106	Not normal	
8	9.79456E-01	3.603E-28	4.43458E+02	5.061E-97	Not normal	
9	9.84334E-01	7.460E-25	3.27528E+02	7.555E-72	Not normal	
10	9.88622E-01	3.169E-21	2.36699E+02	3.995E-52	Not normal	
11	9.90766E-01	5.081E-19	1.93139E+02	1.149E-42	Not normal	
12	9.91404E-01	2.708E-18	1.76024E+02	5.981E-39	Not normal	
13	9.92096E-01	1.841E-17	1.39965E+02	4.046E-31	Not normal	
14	9.94550E-01	4.942E-14	9.18491E+01	1.136E-20	Not normal	
15	9.95707E-01	4.778E-12	7.06854E+01	4.476E-16	Not normal	
16	9.97007E-01	2.289E-09	4.37143E+01	3.218E-10	Not normal	
17	9.96503E-01	1.787E-10	4.87933E+01	2.539E-11	Not normal	
18	9.97407E-01	2.100E-08	3.22999E+01	9.687E-08	Not normal	
19	9.97804E-01	2.276E-07	3.01283E+01	2.869E-07	Not normal	
20	9.97415E-01	2.206E-08	3.40207E+01	4.097E-08	Not normal	
21	9.97341E-01	1.446E-08	3.39454E+01	4.255E-08	Not normal	
22	9.97780E-01	1.969E-07	2.82951E+01	7.175E-07	Not normal	
23	9.97875E-01	3.600E-07	2.73240E+01	1.166E-06	Not normal	
24	9.97805E-01	2.313E-07	2.97587E+01	3.451E-07	Not normal	
25	9.97410E-01	2.166E-08	2.70730E+01	1.322E-06	Not normal	
26	9.97560E-01	5.209E-08	1.46167E+01	6.699E-04	Not normal	
27	9.97296E-01	1.140E-08	2.54806E+01	2.931E-06	Not normal	
28	9.97741E-01	1.569E-07	2.50250E+01	3.680E-06	Not normal	
29	9.97797E-01	2.221E-07	3.48181E+01	2.750E-08	Not normal	
30	9.96929E-01	1.579E-09	5.98787E+01	9.943E-14	Not normal	
31	9.96941E-01	1.683E-09	6.13445E+01	4.778E-14	Not normal	
32	9.97385E-01	1.913E-08	5.86757E+01	1.814E-13	Not normal	
33	9.97456E-01	2.877E-08	4.04238E+01	1.668E-09	Not normal	
34	9.97256E-01	9.293E-09	4.68076E+01	6.853E-11	Not normal	
35	9.97127E-01	4.582E-09	3.79309E+01	5.800E-09	Not normal	
36	9.97779E-01	2.028E-07	2.57000E+01	2.626E-06	Not normal	
37	9.96953E-01	1.821E-09	3.35454E+01	5.196E-08	Not normal	
38	9.96201E-01	4.557E-11	3.44499E+01	3.306E-08	Not normal	
39	9.95247E-01	7.724E-13	5.28028E+01	3.420E-12	Not normal	
40	9.94196E-01	1.519E-14	6.50607E+01	7.451E-15	Not normal	
41	9.93579E-01	1.882E-15	8.07111E+01	2.977E-18	Not normal	
42	9.92698E-01	1.193E-16	1.11106E+02	7.477E-25	Not normal	
43	9.92984E-01	2.862E-16	1.14048E+02	1.718E-25	Not normal	
44	9.92021E-01	1.673E-17	1.18711E+02	1.668E-26	Not normal	
45	9.91370E-01	2.811E-18	1.44601E+02	3.983E-32	Not normal	
46	9.91957E-01	1.410E-17	1.33967E+02	8.116E-30	Not normal	
47	9.92470E-01	6.180E-17	1.30649E+02	4.266E-29	Not normal	
48	9.90678E-01	4.710E-19	1.66767E+02	6.125E-37	Not normal	
49	9.91692E-01	6.837E-18	60	1.66856E+02	5.857E-37	Not normal

Table 3.3: Normality tests for SBER RX Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.65738E-01	7.232E-35	7.35050E+02	2.432E-160	Not normal	
2	9.71389E-01	2.284E-32	6.49920E+02	7.440E-142	Not normal	
3	9.79383E-01	4.481E-28	4.23467E+02	1.110E-92	Not normal	
4	9.84988E-01	3.171E-24	3.30597E+02	1.628E-72	Not normal	
5	9.85583E-01	9.374E-24	3.61521E+02	3.138E-79	Not normal	
6	9.89094E-01	1.194E-20	2.07574E+02	8.430E-46	Not normal	
7	9.88989E-01	9.445E-21	2.15389E+02	1.694E-47	Not normal	
8	9.92174E-01	2.928E-17	1.53824E+02	3.960E-34	Not normal	
9	9.93036E-01	3.810E-16	1.49945E+02	2.754E-33	Not normal	
10	9.94618E-01	7.853E-14	1.16543E+02	4.932E-26	Not normal	
11	9.97350E-01	1.758E-08	5.17100E+01	5.906E-12	Not normal	
12	9.95967E-01	1.801E-11	8.29198E+01	9.867E-19	Not normal	
13	9.96077E-01	2.950E-11	8.25761E+01	1.172E-18	Not normal	
14	9.96054E-01	2.665E-11	7.90164E+01	6.947E-18	Not normal	
15	9.97548E-01	5.559E-08	4.81896E+01	3.434E-11	Not normal	
16	9.97226E-01	8.895E-09	5.08659E+01	9.007E-12	Not normal	
17	9.98737E-01	1.866E-04	1.92402E+01	6.638E-05	Not normal	
18	9.98414E-01	1.600E-05	2.86373E+01	6.046E-07	Not normal	
19	9.99264E-01	1.642E-02	7.99361E+00	1.837E-02	Not normal	
20	9.98622E-01	7.653E-05	1.74282E+01	1.643E-04	Not normal	
21	9.98114E-01	1.984E-06	2.40289E+01	6.056E-06	Not normal	
22	9.98424E-01	1.737E-05	1.73494E+01	1.709E-04	Not normal	
23	9.99005E-01	1.703E-03	8.00492E+00	1.827E-02	Not normal	
24	9.99050E-01	2.512E-03	9.11081E+00	1.051E-02	Not normal	
25	9.98603E-01	6.657E-05	1.57325E+01	3.835E-04	Not normal	
26	9.98893E-01	6.675E-04	8.89888E+00	1.169E-02	Not normal	
27	9.99189E-01	8.530E-03	9.28383E+00	9.639E-03	Not normal	
28	9.99264E-01	1.658E-02	5.41437E+00	6.672E-02	Normal	
29	9.99255E-01	1.523E-02	5.62308E+00	6.011E-02	Normal	
30	9.99415E-01	6.361E-02	5.14056E+00	7.651E-02	Normal	
31	9.99631E-01	3.774E-01	2.60396E+00	2.720E-01	Normal	
32	9.99790E-01	8.805E-01	6.81491E-01	7.112E-01	Normal	
33	9.99692E-01	5.652E-01	3.60012E+00	1.653E-01	Normal	
34	9.99200E-01	9.473E-03	4.29943E+00	1.165E-01	Normal	
35	9.99333E-01	3.091E-02	2.46657E+00	2.913E-01	Normal	
36	9.98552E-01	4.608E-05	1.67350E+01	2.323E-04	Not normal	
37	9.98926E-01	8.949E-04	7.13522E+00	2.822E-02	Not normal	
38	9.98399E-01	1.496E-05	1.43961E+01	7.481E-04	Not normal	
39	9.98416E-01	1.696E-05	2.45176E+01	4.743E-06	Not normal	
40	9.98278E-01	6.341E-06	2.15475E+01	2.094E-05	Not normal	
41	9.97137E-01	5.840E-09	5.18449E+01	5.521E-12	Not normal	
42	9.97576E-01	6.999E-08	4.07611E+01	1.409E-09	Not normal	
43	9.98056E-01	1.409E-06	2.66872E+01	1.603E-06	Not normal	
44	9.97798E-01	2.705E-07	3.80213E+01	5.543E-09	Not normal	
45	9.95813E-01	1.015E-11	7.62067E+01	2.831E-17	Not normal	
46	9.95736E-01	7.323E-12	8.19944E+01	1.567E-18	Not normal	
47	9.95476E-01	2.481E-12	9.05709E+01	2.152E-20	Not normal	
48	9.95270E-01	1.079E-12	8.31723E+01	8.697E-19	Not normal	
49	9.95130E-01	6.226E-13	61	8.16565E+01	1.856E-18	Not normal

Table 3.4: Normality tests for VTBR RX Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.86253E-01	3.280E-23	2.96230E+02	4.727E-65	Not normal	
2	9.87673E-01	5.518E-22	2.53330E+02	9.773E-56	Not normal	
3	9.89920E-01	8.135E-20	2.08311E+02	5.833E-46	Not normal	
4	9.91729E-01	8.373E-18	1.65629E+02	1.082E-36	Not normal	
5	9.94132E-01	1.375E-14	1.14501E+02	1.369E-25	Not normal	
6	9.95203E-01	7.309E-13	9.26978E+01	7.429E-21	Not normal	
7	9.95254E-01	8.981E-13	9.56711E+01	1.680E-21	Not normal	
8	9.95090E-01	4.712E-13	1.09261E+02	1.880E-24	Not normal	
9	9.96455E-01	1.692E-10	7.12182E+01	3.429E-16	Not normal	
10	9.97602E-01	7.606E-08	4.66476E+01	7.423E-11	Not normal	
11	9.97015E-01	2.845E-09	5.45817E+01	1.405E-12	Not normal	
12	9.97146E-01	5.737E-09	6.12382E+01	5.038E-14	Not normal	
13	9.97251E-01	1.025E-08	5.76060E+01	3.098E-13	Not normal	
14	9.97845E-01	3.422E-07	4.35574E+01	3.480E-10	Not normal	
15	9.97003E-01	2.699E-09	5.72794E+01	3.647E-13	Not normal	
16	9.97793E-01	2.485E-07	4.14855E+01	9.807E-10	Not normal	
17	9.97878E-01	4.243E-07	3.81333E+01	5.242E-09	Not normal	
18	9.98191E-01	3.337E-06	3.21994E+01	1.019E-07	Not normal	
19	9.98892E-01	6.580E-04	1.61855E+01	3.057E-04	Not normal	
20	9.98923E-01	8.542E-04	1.16782E+01	2.911E-03	Not normal	
21	9.98554E-01	4.585E-05	1.98113E+01	4.989E-05	Not normal	
22	9.99001E-01	1.655E-03	1.57101E+01	3.878E-04	Not normal	
23	9.98733E-01	1.840E-04	1.98965E+01	4.781E-05	Not normal	
24	9.98817E-01	3.600E-04	1.92406E+01	6.637E-05	Not normal	
25	9.98035E-01	1.186E-06	3.38480E+01	4.467E-08	Not normal	
26	9.98353E-01	1.059E-05	2.56078E+01	2.750E-06	Not normal	
27	9.98983E-01	1.435E-03	1.35009E+01	1.170E-03	Not normal	
28	9.99120E-01	4.648E-03	1.53126E+01	4.731E-04	Not normal	
29	9.98133E-01	2.303E-06	3.41161E+01	3.906E-08	Not normal	
30	9.98871E-01	5.665E-04	1.91141E+01	7.070E-05	Not normal	
31	9.98862E-01	5.234E-04	2.15337E+01	2.109E-05	Not normal	
32	9.99436E-01	7.651E-02	9.07413E+00	1.070E-02	Normal	
33	9.99371E-01	4.320E-02	1.00014E+01	6.733E-03	Not normal	
34	9.99260E-01	1.615E-02	1.26737E+01	1.770E-03	Not normal	
35	9.99227E-01	1.199E-02	7.20330E+00	2.728E-02	Not normal	
36	9.98581E-01	5.747E-05	2.84615E+01	6.602E-07	Not normal	
37	9.97641E-01	1.025E-07	4.68187E+01	6.815E-11	Not normal	
38	9.96837E-01	1.209E-09	6.58118E+01	5.119E-15	Not normal	
39	9.98318E-01	8.449E-06	2.93353E+01	4.265E-07	Not normal	
40	9.97480E-01	4.005E-08	5.20385E+01	5.012E-12	Not normal	
41	9.98181E-01	3.278E-06	3.50333E+01	2.470E-08	Not normal	
42	9.98010E-01	1.050E-06	3.76342E+01	6.727E-09	Not normal	
43	9.98705E-01	1.522E-04	2.39758E+01	6.219E-06	Not normal	
44	9.98891E-01	6.788E-04	2.05627E+01	3.427E-05	Not normal	
45	9.97689E-01	1.401E-07	4.19281E+01	7.860E-10	Not normal	
46	9.98266E-01	5.947E-06	3.34811E+01	5.366E-08	Not normal	
47	9.98035E-01	1.243E-06	3.95202E+01	2.620E-09	Not normal	
48	9.97928E-01	6.234E-07	3.81473E+01	5.205E-09	Not normal	
49	9.98907E-01	7.801E-04	62	1.76200E+01	1.492E-04	Not normal

Table 3.5: Normality tests for MOEX RX Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.68911E-01	1.660E-33	7.20790E+02	3.037E-157	Not normal	
2	9.71463E-01	2.492E-32	5.90572E+02	5.739E-129	Not normal	
3	9.75711E-01	3.532E-30	4.26724E+02	2.178E-93	Not normal	
4	9.79322E-01	4.153E-28	4.19047E+02	1.012E-91	Not normal	
5	9.84734E-01	2.041E-24	3.13716E+02	7.542E-69	Not normal	
6	9.86408E-01	4.474E-23	2.89088E+02	1.680E-63	Not normal	
7	9.90080E-01	1.203E-19	2.01964E+02	1.393E-44	Not normal	
8	9.91266E-01	2.421E-18	2.06180E+02	1.693E-45	Not normal	
9	9.91447E-01	3.940E-18	1.84416E+02	9.009E-41	Not normal	
10	9.89510E-01	3.160E-20	2.35492E+02	7.305E-52	Not normal	
11	9.94163E-01	1.554E-14	1.24524E+02	9.121E-28	Not normal	
12	9.93787E-01	4.326E-15	1.46109E+02	1.875E-32	Not normal	
13	9.93911E-01	6.571E-15	1.38988E+02	6.595E-31	Not normal	
14	9.93950E-01	7.543E-15	1.46965E+02	1.222E-32	Not normal	
15	9.93708E-01	3.355E-15	1.37426E+02	1.440E-30	Not normal	
16	9.95751E-01	7.134E-12	9.03277E+01	2.430E-20	Not normal	
17	9.96952E-01	2.065E-09	5.74098E+01	3.417E-13	Not normal	
18	9.96794E-01	9.177E-10	6.44851E+01	9.937E-15	Not normal	
19	9.97277E-01	1.193E-08	4.13211E+01	1.065E-09	Not normal	
20	9.96615E-01	3.774E-10	5.59601E+01	7.054E-13	Not normal	
21	9.97329E-01	1.602E-08	3.70555E+01	8.985E-09	Not normal	
22	9.97721E-01	1.600E-07	3.96039E+01	2.513E-09	Not normal	
23	9.97719E-01	1.591E-07	3.68208E+01	1.010E-08	Not normal	
24	9.97401E-01	2.431E-08	3.82352E+01	4.981E-09	Not normal	
25	9.96982E-01	2.463E-09	5.46063E+01	1.388E-12	Not normal	
26	9.96995E-01	2.649E-09	5.77449E+01	2.890E-13	Not normal	
27	9.97392E-01	2.321E-08	4.11806E+01	1.142E-09	Not normal	
28	9.97077E-01	4.101E-09	5.16604E+01	6.055E-12	Not normal	
29	9.97912E-01	5.382E-07	3.21822E+01	1.027E-07	Not normal	
30	9.97734E-01	1.764E-07	3.65232E+01	1.172E-08	Not normal	
31	9.97191E-01	7.662E-09	4.69101E+01	6.510E-11	Not normal	
32	9.98501E-01	3.134E-05	2.15089E+01	2.135E-05	Not normal	
33	9.98792E-01	2.966E-04	1.40109E+01	9.069E-04	Not normal	
34	9.98960E-01	1.192E-03	1.15583E+01	3.091E-03	Not normal	
35	9.98922E-01	8.686E-04	1.34568E+01	1.196E-03	Not normal	
36	9.98049E-01	1.331E-06	3.33640E+01	5.690E-08	Not normal	
37	9.98014E-01	1.060E-06	3.78066E+01	6.172E-09	Not normal	
38	9.98013E-01	1.054E-06	3.41280E+01	3.883E-08	Not normal	
39	9.96742E-01	7.485E-10	6.64146E+01	3.787E-15	Not normal	
40	9.96384E-01	1.313E-10	6.64622E+01	3.698E-15	Not normal	
41	9.95934E-01	1.702E-11	8.70810E+01	1.232E-19	Not normal	
42	9.96809E-01	1.053E-09	6.08614E+01	6.083E-14	Not normal	
43	9.96112E-01	3.782E-11	7.46695E+01	6.106E-17	Not normal	
44	9.96157E-01	4.657E-11	7.53412E+01	4.364E-17	Not normal	
45	9.96278E-01	8.128E-11	7.58787E+01	3.335E-17	Not normal	
46	9.95567E-01	3.604E-12	8.10987E+01	2.453E-18	Not normal	
47	9.94378E-01	3.751E-14	1.08925E+02	2.224E-24	Not normal	
48	9.94402E-01	4.100E-14	1.13494E+02	2.265E-25	Not normal	
49	9.94118E-01	1.516E-14	63	1.08391E+02	2.905E-24	Not normal

Table 3.6: Normality tests for LKOH RX Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.56049E-01	1.783E-38	1.06426E+03	7.904E-232	Not normal	
2	9.61786E-01	2.017E-36	8.98275E+02	8.749E-196	Not normal	
3	9.67511E-01	4.101E-34	7.02403E+02	2.986E-153	Not normal	
4	9.73549E-01	2.647E-31	5.74303E+02	1.958E-125	Not normal	
5	9.76946E-01	1.705E-29	4.72138E+02	2.996E-103	Not normal	
6	9.81281E-01	7.299E-27	4.06361E+02	5.752E-89	Not normal	
7	9.84266E-01	9.098E-25	3.31414E+02	1.082E-72	Not normal	
8	9.86635E-01	7.001E-23	2.94586E+02	1.075E-64	Not normal	
9	9.89172E-01	1.447E-20	2.45921E+02	3.970E-54	Not normal	
10	9.91127E-01	1.692E-18	1.95091E+02	4.331E-43	Not normal	
11	9.92274E-01	3.957E-17	1.63712E+02	2.820E-36	Not normal	
12	9.92413E-01	5.935E-17	1.49801E+02	2.958E-33	Not normal	
13	9.94956E-01	2.831E-13	9.53055E+01	2.017E-21	Not normal	
14	9.95707E-01	5.883E-12	7.78854E+01	1.223E-17	Not normal	
15	9.96084E-01	3.067E-11	7.48638E+01	5.540E-17	Not normal	
16	9.97206E-01	8.010E-09	5.03216E+01	1.183E-11	Not normal	
17	9.97038E-01	3.244E-09	4.70147E+01	6.179E-11	Not normal	
18	9.97482E-01	3.829E-08	3.87159E+01	3.917E-09	Not normal	
19	9.97719E-01	1.574E-07	3.03331E+01	2.590E-07	Not normal	
20	9.97015E-01	2.888E-09	3.89996E+01	3.399E-09	Not normal	
21	9.97399E-01	2.382E-08	3.65644E+01	1.149E-08	Not normal	
22	9.96733E-01	6.830E-10	4.25579E+01	5.737E-10	Not normal	
23	9.97563E-01	6.210E-08	3.22277E+01	1.004E-07	Not normal	
24	9.97895E-01	4.771E-07	2.87768E+01	5.639E-07	Not normal	
25	9.97505E-01	4.447E-08	2.47545E+01	4.213E-06	Not normal	
26	9.97348E-01	1.804E-08	2.32894E+01	8.765E-06	Not normal	
27	9.97913E-01	5.397E-07	2.41669E+01	5.652E-06	Not normal	
28	9.98727E-01	1.754E-04	1.27265E+01	1.724E-03	Not normal	
29	9.98934E-01	9.485E-04	1.29167E+01	1.567E-03	Not normal	
30	9.98897E-01	6.994E-04	1.15337E+01	3.130E-03	Not normal	
31	9.99183E-01	8.091E-03	1.26717E+01	1.772E-03	Not normal	
32	9.99203E-01	9.687E-03	1.17127E+01	2.862E-03	Not normal	
33	9.99607E-01	3.172E-01	4.10760E+00	1.282E-01	Normal	
34	9.99541E-01	1.890E-01	2.43257E+00	2.963E-01	Normal	
35	9.99309E-01	2.490E-02	2.24129E+00	3.261E-01	Normal	
36	9.99159E-01	6.578E-03	5.40324E+00	6.710E-02	Normal	
37	9.98308E-01	7.785E-06	1.57270E+01	3.845E-04	Not normal	
38	9.97952E-01	7.093E-07	2.03002E+01	3.907E-05	Not normal	
39	9.97223E-01	9.310E-09	2.57321E+01	2.584E-06	Not normal	
40	9.95850E-01	1.177E-11	4.52170E+01	1.518E-10	Not normal	
41	9.95429E-01	2.014E-12	6.20961E+01	3.281E-14	Not normal	
42	9.95829E-01	1.081E-11	6.30434E+01	2.043E-14	Not normal	
43	9.96428E-01	1.636E-10	5.93910E+01	1.269E-13	Not normal	
44	9.95292E-01	1.168E-12	8.94902E+01	3.694E-20	Not normal	
45	9.94243E-01	2.314E-14	1.19861E+02	9.386E-27	Not normal	
46	9.94167E-01	1.776E-14	1.18459E+02	1.892E-26	Not normal	
47	9.94912E-01	2.678E-13	9.61789E+01	1.303E-21	Not normal	
48	9.93552E-01	2.264E-15	1.21170E+02	4.878E-27	Not normal	
49	9.94539E-01	6.744E-14	64	9.76440E+01	6.264E-22	Not normal

Table 3.7: Normality tests for GAZP RX Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.89149E-01	1.440E-20	2.11558E+02	1.150E-46	Not normal	
2	9.92807E-01	1.980E-16	1.25557E+02	5.442E-28	Not normal	
3	9.92463E-01	7.149E-17	1.47435E+02	9.660E-33	Not normal	
4	9.95311E-01	1.180E-12	8.39926E+01	5.771E-19	Not normal	
5	9.95284E-01	1.064E-12	8.65874E+01	1.577E-19	Not normal	
6	9.95607E-01	3.998E-12	7.66845E+01	2.229E-17	Not normal	
7	9.96999E-01	2.698E-09	6.16007E+01	4.203E-14	Not normal	
8	9.95491E-01	2.485E-12	8.42088E+01	5.180E-19	Not normal	
9	9.95874E-01	1.259E-11	8.27650E+01	1.066E-18	Not normal	
10	9.97820E-01	3.007E-07	3.71969E+01	8.372E-09	Not normal	
11	9.96943E-01	2.040E-09	5.36498E+01	2.239E-12	Not normal	
12	9.94875E-01	2.207E-13	1.13773E+02	1.970E-25	Not normal	
13	9.96081E-01	3.181E-11	7.88351E+01	7.606E-18	Not normal	
14	9.97788E-01	2.485E-07	3.97882E+01	2.291E-09	Not normal	
15	9.98412E-01	1.635E-05	2.80273E+01	8.202E-07	Not normal	
16	9.97516E-01	4.849E-08	4.67270E+01	7.134E-11	Not normal	
17	9.97296E-01	1.386E-08	5.18974E+01	5.378E-12	Not normal	
18	9.96388E-01	1.326E-10	6.67637E+01	3.180E-15	Not normal	
19	9.96317E-01	9.543E-11	6.57686E+01	5.230E-15	Not normal	
20	9.97940E-01	6.557E-07	3.65087E+01	1.181E-08	Not normal	
21	9.95803E-01	9.605E-12	7.94880E+01	5.488E-18	Not normal	
22	9.96592E-01	3.566E-10	6.51825E+01	7.011E-15	Not normal	
23	9.96155E-01	4.586E-11	7.60146E+01	3.116E-17	Not normal	
24	9.95771E-01	8.460E-12	8.05830E+01	3.174E-18	Not normal	
25	9.96496E-01	2.265E-10	5.87647E+01	1.735E-13	Not normal	
26	9.96724E-01	6.948E-10	5.75120E+01	3.247E-13	Not normal	
27	9.96707E-01	6.378E-10	5.98148E+01	1.027E-13	Not normal	
28	9.96399E-01	1.442E-10	7.34665E+01	1.114E-16	Not normal	
29	9.94702E-01	1.220E-13	9.69006E+01	9.085E-22	Not normal	
30	9.93983E-01	9.534E-15	1.19606E+02	1.066E-26	Not normal	
31	9.96809E-01	1.077E-09	6.16684E+01	4.063E-14	Not normal	
32	9.96604E-01	3.894E-10	6.34852E+01	1.638E-14	Not normal	
33	9.96763E-01	8.611E-10	6.11305E+01	5.317E-14	Not normal	
34	9.96101E-01	3.707E-11	7.31724E+01	1.291E-16	Not normal	
35	9.96325E-01	1.039E-10	6.76906E+01	2.001E-15	Not normal	
36	9.97920E-01	6.006E-07	3.86586E+01	4.031E-09	Not normal	
37	9.97329E-01	1.753E-08	4.89143E+01	2.390E-11	Not normal	
38	9.97673E-01	1.300E-07	4.14242E+01	1.011E-09	Not normal	
39	9.97700E-01	1.532E-07	4.00133E+01	2.048E-09	Not normal	
40	9.96417E-01	1.619E-10	6.67443E+01	3.211E-15	Not normal	
41	9.96531E-01	2.807E-10	6.14349E+01	4.566E-14	Not normal	
42	9.97150E-01	6.624E-09	4.48000E+01	1.870E-10	Not normal	
43	9.97340E-01	1.893E-08	4.47499E+01	1.917E-10	Not normal	
44	9.97456E-01	3.674E-08	4.76599E+01	4.475E-11	Not normal	
45	9.96870E-01	1.527E-09	5.75197E+01	3.234E-13	Not normal	
46	9.96453E-01	1.953E-10	6.51374E+01	7.171E-15	Not normal	
47	9.97887E-01	4.966E-07	4.02643E+01	1.806E-09	Not normal	
48	9.97498E-01	4.722E-08	4.53862E+01	1.395E-10	Not normal	
49	9.97173E-01	7.634E-09	65	4.59928E+01	1.030E-10	Not normal

Table 3.8: Normality tests for FIVE RX Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.16093E-01	7.966E-41	7.45140E+02	1.566E-162	Not normal	
2	9.44144E-01	6.515E-35	4.41209E+02	1.558E-96	Not normal	
3	9.52090E-01	8.336E-33	3.22623E+02	8.774E-71	Not normal	
4	9.49936E-01	2.135E-33	3.69807E+02	4.983E-81	Not normal	
5	9.53330E-01	1.911E-32	3.32630E+02	5.892E-73	Not normal	
6	9.65898E-01	2.221E-28	2.34592E+02	1.146E-51	Not normal	
7	9.62768E-01	1.747E-29	2.55825E+02	2.807E-56	Not normal	
8	9.59215E-01	1.182E-30	2.73767E+02	3.567E-60	Not normal	
9	9.57407E-01	3.231E-31	2.77472E+02	5.595E-61	Not normal	
10	9.61492E-01	6.643E-30	2.62974E+02	7.868E-58	Not normal	
11	9.57214E-01	2.868E-31	2.80485E+02	1.240E-61	Not normal	
12	9.61110E-01	5.047E-30	2.67378E+02	8.703E-59	Not normal	
13	9.56193E-01	1.427E-31	2.87605E+02	3.526E-63	Not normal	
14	9.59917E-01	2.092E-30	2.60580E+02	2.605E-57	Not normal	
15	9.61243E-01	5.731E-30	2.62390E+02	1.054E-57	Not normal	
16	9.64922E-01	1.070E-28	2.44020E+02	1.027E-53	Not normal	
17	9.63944E-01	4.858E-29	2.46135E+02	3.568E-54	Not normal	
18	9.63785E-01	4.311E-29	2.47039E+02	2.271E-54	Not normal	
19	9.69194E-01	4.432E-27	2.33854E+02	1.657E-51	Not normal	
20	9.67114E-01	7.046E-28	2.36390E+02	4.663E-52	Not normal	
21	9.66581E-01	4.490E-28	2.33284E+02	2.203E-51	Not normal	
22	9.69864E-01	8.399E-27	2.27362E+02	4.257E-50	Not normal	
23	9.67283E-01	8.365E-28	2.39343E+02	1.065E-52	Not normal	
24	9.71067E-01	2.645E-26	2.06032E+02	1.823E-45	Not normal	
25	9.68260E-01	2.009E-27	2.31279E+02	6.005E-51	Not normal	
26	9.70900E-01	2.292E-26	2.06869E+02	1.200E-45	Not normal	
27	9.73732E-01	3.783E-25	1.98302E+02	8.695E-44	Not normal	
28	9.74143E-01	5.830E-25	1.94709E+02	5.242E-43	Not normal	
29	9.71793E-01	5.539E-26	2.29552E+02	1.424E-50	Not normal	
30	9.72140E-01	7.835E-26	2.14537E+02	2.593E-47	Not normal	
31	9.73693E-01	3.750E-25	2.03344E+02	6.990E-45	Not normal	
32	9.73670E-01	3.691E-25	2.19927E+02	1.751E-48	Not normal	
33	9.77717E-01	3.054E-23	1.93543E+02	9.389E-43	Not normal	
34	9.73527E-01	3.239E-25	2.45564E+02	4.749E-54	Not normal	
35	9.75398E-01	2.322E-24	2.07112E+02	1.062E-45	Not normal	
36	9.73753E-01	4.148E-25	2.09353E+02	3.464E-46	Not normal	
37	9.72966E-01	1.880E-25	2.10007E+02	2.498E-46	Not normal	
38	9.71097E-01	3.042E-26	2.15054E+02	2.002E-47	Not normal	
39	9.72950E-01	1.879E-25	2.04092E+02	4.809E-45	Not normal	
40	9.73475E-01	3.219E-25	2.04878E+02	3.246E-45	Not normal	
41	9.73955E-01	5.309E-25	1.94008E+02	7.442E-43	Not normal	
42	9.68037E-01	1.894E-27	2.22260E+02	5.456E-49	Not normal	
43	9.71054E-01	3.040E-26	2.08359E+02	5.693E-46	Not normal	
44	9.71082E-01	3.146E-26	2.15078E+02	1.979E-47	Not normal	
45	9.68133E-01	2.114E-27	2.10301E+02	2.156E-46	Not normal	
46	9.73918E-01	5.313E-25	1.87425E+02	2.000E-41	Not normal	
47	9.66248E-01	4.199E-28	2.36185E+02	5.164E-52	Not normal	
48	9.68876E-01	4.206E-27	2.16760E+02	8.533E-48	Not normal	
49	9.65666E-01	2.616E-28	66	2.37476E+02	2.709E-52	Not normal

Table 3.9: Normality tests for OGZD LI Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.82993E-01	5.006E-08	4.57060E+01	1.189E-10	Not normal	
2	9.85074E-01	2.820E-07	3.16814E+01	1.320E-07	Not normal	
3	9.85636E-01	4.649E-07	3.80277E+01	5.526E-09	Not normal	
4	9.88654E-01	7.649E-06	2.70348E+01	1.347E-06	Not normal	
5	9.86365E-01	9.119E-07	3.01748E+01	2.803E-07	Not normal	
6	9.82377E-01	3.363E-08	3.88751E+01	3.617E-09	Not normal	
7	9.88597E-01	7.538E-06	3.06923E+01	2.164E-07	Not normal	
8	9.89462E-01	1.806E-05	2.69168E+01	1.429E-06	Not normal	
9	9.91369E-01	1.372E-04	1.80303E+01	1.216E-04	Not normal	
10	9.88297E-01	5.881E-06	2.92982E+01	4.345E-07	Not normal	
11	9.92087E-01	3.139E-04	1.84233E+01	9.987E-05	Not normal	
12	9.90715E-01	6.992E-05	2.12548E+01	2.424E-05	Not normal	
13	9.87502E-01	2.893E-06	3.01331E+01	2.862E-07	Not normal	
14	9.93198E-01	1.186E-03	1.36409E+01	1.091E-03	Not normal	
15	9.93235E-01	1.251E-03	1.44308E+01	7.352E-04	Not normal	
16	9.93077E-01	1.047E-03	1.50232E+01	5.467E-04	Not normal	
17	9.94136E-01	3.834E-03	1.55500E+01	4.201E-04	Not normal	
18	9.89858E-01	3.079E-05	2.98982E+01	3.219E-07	Not normal	
19	9.81866E-01	2.848E-08	4.67719E+01	6.976E-11	Not normal	
20	9.90493E-01	6.103E-05	2.44317E+01	4.951E-06	Not normal	
21	9.90315E-01	5.131E-05	2.31470E+01	9.412E-06	Not normal	
22	9.92037E-01	3.350E-04	1.65608E+01	2.534E-04	Not normal	
23	9.91606E-01	2.097E-04	2.35676E+01	7.627E-06	Not normal	
24	9.94293E-01	4.954E-03	1.27558E+01	1.699E-03	Not normal	
25	9.87393E-01	3.116E-06	3.49143E+01	2.621E-08	Not normal	
26	9.94398E-01	5.741E-03	1.29231E+01	1.562E-03	Not normal	
27	9.94787E-01	9.431E-03	9.67430E+00	7.930E-03	Not normal	
28	9.93294E-01	1.528E-03	1.07536E+01	4.623E-03	Not normal	
29	9.92209E-01	4.395E-04	1.71344E+01	1.902E-04	Not normal	
30	9.95644E-01	2.878E-02	7.87842E+00	1.946E-02	Not normal	
31	9.93164E-01	1.349E-03	1.81142E+01	1.166E-04	Not normal	
32	9.96560E-01	9.429E-02	6.62962E+00	3.634E-02	Normal	
33	9.91827E-01	3.001E-04	1.83914E+01	1.015E-04	Not normal	
34	9.94971E-01	1.258E-02	1.24906E+01	1.940E-03	Not normal	
35	9.92499E-01	6.518E-04	1.61940E+01	3.045E-04	Not normal	
36	9.92463E-01	6.325E-04	1.59004E+01	3.526E-04	Not normal	
37	9.91986E-01	3.742E-04	1.89193E+01	7.793E-05	Not normal	
38	9.93833E-01	3.199E-03	1.40878E+01	8.727E-04	Not normal	
39	9.92985E-01	1.188E-03	1.49684E+01	5.619E-04	Not normal	
40	9.95383E-01	2.213E-02	1.17387E+01	2.825E-03	Not normal	
41	9.92732E-01	9.054E-04	1.97880E+01	5.048E-05	Not normal	
42	9.94233E-01	5.388E-03	1.27901E+01	1.670E-03	Not normal	
43	9.91526E-01	2.422E-04	1.82732E+01	1.077E-04	Not normal	
44	9.95652E-01	3.199E-02	9.87608E+00	7.169E-03	Not normal	
45	9.96290E-01	7.197E-02	7.09833E+00	2.875E-02	Normal	
46	9.94307E-01	6.106E-03	1.46661E+01	6.536E-04	Not normal	
47	9.95911E-01	4.522E-02	8.25592E+00	1.612E-02	Not normal	
48	9.93541E-01	2.484E-03	1.15884E+01	3.045E-03	Not normal	
49	9.94234E-01	5.736E-03	67	1.41470E+01	8.473E-04	Not normal

Table 3.10: Normality tests for VTBR LI Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion
1	9.13318E-01	6.311E-41	7.95465E+02	1.849E-173	Not normal
2	9.37291E-01	3.524E-36	4.62610E+02	3.513E-101	Not normal
3	9.52292E-01	2.084E-32	3.44665E+02	1.435E-75	Not normal
4	9.50895E-01	8.619E-33	3.76979E+02	1.381E-82	Not normal
5	9.54370E-01	8.315E-32	3.15510E+02	3.075E-69	Not normal
6	9.59861E-01	3.971E-30	2.76277E+02	1.017E-60	Not normal
7	9.59492E-01	3.054E-30	2.71379E+02	1.177E-59	Not normal
8	9.57224E-01	6.044E-31	2.98988E+02	1.190E-65	Not normal
9	9.56950E-01	5.032E-31	3.02204E+02	2.383E-66	Not normal
10	9.63086E-01	4.812E-29	2.56106E+02	2.439E-56	Not normal
11	9.59285E-01	2.720E-30	2.76762E+02	7.978E-61	Not normal
12	9.58918E-01	2.100E-30	2.77372E+02	5.880E-61	Not normal
13	9.54142E-01	7.681E-32	2.90227E+02	9.505E-64	Not normal
14	9.55976E-01	2.680E-31	2.89217E+02	1.575E-63	Not normal
15	9.60515E-01	6.992E-30	2.65751E+02	1.962E-58	Not normal
16	9.57320E-01	6.947E-31	2.73249E+02	4.620E-60	Not normal
17	9.58247E-01	1.354E-30	2.73619E+02	3.841E-60	Not normal
18	9.58431E-01	1.559E-30	2.66388E+02	1.428E-58	Not normal
19	9.63958E-01	1.041E-28	2.54757E+02	4.789E-56	Not normal
20	9.62549E-01	3.446E-29	2.59575E+02	4.305E-57	Not normal
21	9.61678E-01	1.775E-29	2.68759E+02	4.363E-59	Not normal
22	9.58310E-01	1.481E-30	2.79888E+02	1.672E-61	Not normal
23	9.59798E-01	4.405E-30	2.82275E+02	5.068E-62	Not normal
24	9.58887E-01	2.285E-30	2.68742E+02	4.399E-59	Not normal
25	9.56327E-01	3.771E-31	2.82561E+02	4.392E-62	Not normal
26	9.62401E-01	3.238E-29	2.61570E+02	1.588E-57	Not normal
27	9.62269E-01	2.949E-29	2.56963E+02	1.589E-56	Not normal
28	9.62077E-01	2.564E-29	2.61847E+02	1.382E-57	Not normal
29	9.60691E-01	9.019E-30	2.58613E+02	6.964E-57	Not normal
30	9.60910E-01	1.073E-29	2.78557E+02	3.252E-61	Not normal
31	9.65352E-01	3.587E-28	2.57907E+02	9.913E-57	Not normal
32	9.58076E-01	1.371E-30	2.82094E+02	5.548E-62	Not normal
33	9.68252E-01	4.335E-27	2.51904E+02	1.994E-55	Not normal
34	9.73801E-01	8.420E-25	2.37478E+02	2.705E-52	Not normal
35	9.64556E-01	1.934E-28	2.74991E+02	1.934E-60	Not normal
36	9.67196E-01	1.771E-27	2.44979E+02	6.361E-54	Not normal
37	9.67553E-01	2.432E-27	2.45831E+02	4.155E-54	Not normal
38	9.65055E-01	2.982E-28	2.43595E+02	1.270E-53	Not normal
39	9.66544E-01	1.041E-27	2.24342E+02	1.927E-49	Not normal
40	9.64460E-01	1.868E-28	2.37591E+02	2.557E-52	Not normal
41	9.63931E-01	1.231E-28	2.55954E+02	2.633E-56	Not normal
42	9.63702E-01	1.034E-28	2.61902E+02	1.345E-57	Not normal
43	9.62457E-01	3.922E-29	2.49304E+02	7.317E-55	Not normal
44	9.68194E-01	4.515E-27	2.17806E+02	5.058E-48	Not normal
45	9.64438E-01	1.915E-28	2.41953E+02	2.888E-53	Not normal
46	9.68942E-01	8.930E-27	2.23177E+02	3.449E-49	Not normal
47	9.62946E-01	5.945E-29	2.54493E+02	5.464E-56	Not normal
48	9.63642E-01	1.039E-28	2.48004E+02	1.402E-54	Not normal
49	9.63720E-01	1.115E-28	2.56524E+02	1.980E-56	Not normal

Table 3.11: Normality tests for SBER LI Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.22917E-01	1.578E-37	6.03530E+02	8.814E-132	Not normal	
2	9.47011E-01	2.497E-32	3.72757E+02	1.140E-81	Not normal	
3	9.55016E-01	3.503E-30	2.73125E+02	4.917E-60	Not normal	
4	9.59160E-01	5.979E-29	2.86229E+02	7.017E-63	Not normal	
5	9.61506E-01	3.304E-28	2.30324E+02	9.676E-51	Not normal	
6	9.60629E-01	1.750E-28	2.54314E+02	5.977E-56	Not normal	
7	9.62217E-01	5.725E-28	2.43058E+02	1.662E-53	Not normal	
8	9.60513E-01	1.640E-28	2.56242E+02	2.279E-56	Not normal	
9	9.61739E-01	4.081E-28	2.31569E+02	5.193E-51	Not normal	
10	9.59838E-01	1.027E-28	2.48689E+02	9.953E-55	Not normal	
11	9.58708E-01	4.650E-29	2.60906E+02	2.213E-57	Not normal	
12	9.54799E-01	3.319E-30	2.62076E+02	1.233E-57	Not normal	
13	9.57787E-01	2.496E-29	2.61489E+02	1.654E-57	Not normal	
14	9.60536E-01	1.765E-28	2.44145E+02	9.650E-54	Not normal	
15	9.60787E-01	2.140E-28	2.44950E+02	6.452E-54	Not normal	
16	9.60725E-01	2.065E-28	2.43798E+02	1.148E-53	Not normal	
17	9.59810E-01	1.076E-28	2.47222E+02	2.072E-54	Not normal	
18	9.63692E-01	1.955E-27	2.33689E+02	1.799E-51	Not normal	
19	9.65593E-01	8.868E-27	2.24182E+02	2.087E-49	Not normal	
20	9.65983E-01	1.228E-26	2.25490E+02	1.085E-49	Not normal	
21	9.61448E-01	3.683E-28	2.43066E+02	1.656E-53	Not normal	
22	9.69253E-01	1.982E-25	2.13533E+02	4.284E-47	Not normal	
23	9.63723E-01	2.099E-27	2.58004E+02	9.444E-57	Not normal	
24	9.67500E-01	4.472E-26	2.14095E+02	3.235E-47	Not normal	
25	9.64601E-01	4.250E-27	2.29184E+02	1.712E-50	Not normal	
26	9.68346E-01	9.348E-26	2.06644E+02	1.342E-45	Not normal	
27	9.65983E-01	1.309E-26	2.16035E+02	1.226E-47	Not normal	
28	9.71561E-01	1.685E-24	1.88328E+02	1.274E-41	Not normal	
29	9.67594E-01	5.064E-26	2.21779E+02	6.939E-49	Not normal	
30	9.71936E-01	2.436E-24	1.97484E+02	1.309E-43	Not normal	
31	9.72137E-01	2.971E-24	1.95657E+02	3.262E-43	Not normal	
32	9.68553E-01	1.179E-25	2.14293E+02	2.930E-47	Not normal	
33	9.72306E-01	3.548E-24	2.15521E+02	1.586E-47	Not normal	
34	9.65388E-01	8.634E-27	2.38475E+02	1.644E-52	Not normal	
35	9.68796E-01	1.495E-25	2.15422E+02	1.666E-47	Not normal	
36	9.71819E-01	2.300E-24	1.96128E+02	2.578E-43	Not normal	
37	9.76920E-01	3.958E-22	1.70350E+02	1.021E-37	Not normal	
38	9.74885E-01	4.682E-23	1.67726E+02	3.791E-37	Not normal	
39	9.73697E-01	1.435E-23	1.89028E+02	8.978E-42	Not normal	
40	9.71235E-01	1.384E-24	1.95857E+02	2.952E-43	Not normal	
41	9.68144E-01	9.007E-26	2.02675E+02	9.764E-45	Not normal	
42	9.66667E-01	2.631E-26	2.23404E+02	3.079E-49	Not normal	
43	9.65514E-01	1.038E-26	2.19697E+02	1.965E-48	Not normal	
44	9.63365E-01	1.939E-27	2.21510E+02	7.938E-49	Not normal	
45	9.69969E-01	4.587E-25	1.92617E+02	1.492E-42	Not normal	
46	9.67135E-01	4.024E-26	2.07285E+02	9.742E-46	Not normal	
47	9.67062E-01	3.819E-26	2.12947E+02	5.742E-47	Not normal	
48	9.67005E-01	3.677E-26	2.16337E+02	1.054E-47	Not normal	
49	9.68509E-01	1.323E-25	69	2.07479E+02	8.842E-46	Not normal

Table 3.12: Normality tests for LKOD LI Equity

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.90202E-01	1.855E-19	1.86418E+02	3.311E-41	Not normal	
2	9.94499E-01	5.681E-14	9.96687E+01	2.276E-22	Not normal	
3	9.94084E-01	1.316E-14	1.12694E+02	3.378E-25	Not normal	
4	9.93355E-01	1.178E-15	1.12991E+02	2.913E-25	Not normal	
5	9.90784E-01	8.021E-19	1.70201E+02	1.100E-37	Not normal	
6	9.91880E-01	1.480E-17	1.49514E+02	3.415E-33	Not normal	
7	9.91907E-01	1.603E-17	1.58916E+02	3.103E-35	Not normal	
8	9.91873E-01	1.462E-17	1.61149E+02	1.016E-35	Not normal	
9	9.90669E-01	6.089E-19	1.85968E+02	4.146E-41	Not normal	
10	9.91230E-01	2.590E-18	1.85293E+02	5.811E-41	Not normal	
11	9.89622E-01	4.853E-20	2.09487E+02	3.239E-46	Not normal	
12	9.88590E-01	4.746E-21	2.66901E+02	1.105E-58	Not normal	
13	9.88939E-01	1.029E-20	2.75574E+02	1.445E-60	Not normal	
14	9.87698E-01	7.215E-22	2.65468E+02	2.261E-58	Not normal	
15	9.86686E-01	9.538E-23	3.07919E+02	1.368E-67	Not normal	
16	9.87254E-01	2.945E-22	2.86299E+02	6.774E-63	Not normal	
17	9.85852E-01	1.963E-23	3.17743E+02	1.007E-69	Not normal	
18	9.83714E-01	4.522E-25	3.71877E+02	1.769E-81	Not normal	
19	9.82907E-01	1.202E-25	3.84488E+02	3.232E-84	Not normal	
20	9.82262E-01	4.313E-26	4.19605E+02	7.653E-92	Not normal	
21	9.87902E-01	1.139E-21	2.76438E+02	9.382E-61	Not normal	
22	9.86187E-01	3.776E-23	3.14465E+02	5.186E-69	Not normal	
23	9.85270E-01	6.947E-24	3.31840E+02	8.747E-73	Not normal	
24	9.86436E-01	6.128E-23	2.99727E+02	8.225E-66	Not normal	
25	9.84903E-01	3.635E-24	3.33008E+02	4.878E-73	Not normal	
26	9.86480E-01	6.727E-23	3.13244E+02	9.548E-69	Not normal	
27	9.87777E-01	9.001E-22	2.66508E+02	1.344E-58	Not normal	
28	9.86489E-01	6.907E-23	2.90669E+02	7.621E-64	Not normal	
29	9.86045E-01	2.981E-23	2.97721E+02	2.242E-65	Not normal	
30	9.86006E-01	2.782E-23	2.94853E+02	9.408E-65	Not normal	
31	9.88025E-01	1.539E-21	2.53168E+02	1.060E-55	Not normal	
32	9.87942E-01	1.299E-21	2.53500E+02	8.979E-56	Not normal	
33	9.88157E-01	2.053E-21	2.48629E+02	1.025E-54	Not normal	
34	9.87221E-01	2.990E-22	2.57400E+02	1.277E-56	Not normal	
35	9.88147E-01	2.028E-21	2.60973E+02	2.140E-57	Not normal	
36	9.87021E-01	2.025E-22	2.73766E+02	3.569E-60	Not normal	
37	9.87906E-01	1.231E-21	2.68926E+02	4.012E-59	Not normal	
38	9.88341E-01	3.104E-21	2.65733E+02	1.981E-58	Not normal	
39	9.88064E-01	1.732E-21	2.64452E+02	3.758E-58	Not normal	
40	9.87837E-01	1.080E-21	2.80976E+02	9.701E-62	Not normal	
41	9.86896E-01	1.618E-22	3.18919E+02	5.593E-70	Not normal	
42	9.86544E-01	8.185E-23	3.12262E+02	1.560E-68	Not normal	
43	9.85813E-01	2.061E-23	3.23940E+02	4.542E-71	Not normal	
44	9.85681E-01	1.622E-23	3.34305E+02	2.551E-73	Not normal	
45	9.87609E-01	6.910E-22	2.96060E+02	5.146E-65	Not normal	
46	9.89403E-01	3.393E-20	2.49713E+02	5.965E-55	Not normal	
47	9.89437E-01	3.682E-20	2.45674E+02	4.493E-54	Not normal	
48	9.88892E-01	1.080E-20	2.54864E+02	4.539E-56	Not normal	
49	9.89298E-01	2.702E-20	70	2.41948E+02	2.895E-53	Not normal

Table 3.13: Normality tests for .AEX

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.99126E-01	5.307E-03	1.29897E+01	1.511E-03	Not normal	
2	9.98213E-01	4.551E-06	3.51858E+01	2.288E-08	Not normal	
3	9.98464E-01	2.703E-05	2.69139E+01	1.431E-06	Not normal	
4	9.98501E-01	3.535E-05	2.78900E+01	8.785E-07	Not normal	
5	9.98437E-01	2.214E-05	2.80826E+01	7.979E-07	Not normal	
6	9.97915E-01	6.452E-07	3.99192E+01	2.146E-09	Not normal	
7	9.96107E-01	4.417E-11	7.55207E+01	3.989E-17	Not normal	
8	9.97223E-01	1.098E-08	5.59112E+01	7.228E-13	Not normal	
9	9.98102E-01	2.179E-06	3.53322E+01	2.127E-08	Not normal	
10	9.97643E-01	1.215E-07	4.53535E+01	1.418E-10	Not normal	
11	9.97067E-01	4.779E-09	5.70427E+01	4.105E-13	Not normal	
12	9.97246E-01	1.259E-08	5.59629E+01	7.044E-13	Not normal	
13	9.96890E-01	1.910E-09	6.13778E+01	4.699E-14	Not normal	
14	9.97048E-01	4.371E-09	5.82299E+01	2.267E-13	Not normal	
15	9.94774E-01	1.969E-13	1.04906E+02	1.659E-23	Not normal	
16	9.93143E-01	7.786E-16	1.45771E+02	2.219E-32	Not normal	
17	9.94068E-01	1.596E-14	1.35455E+02	3.858E-30	Not normal	
18	9.94346E-01	4.212E-14	1.25100E+02	6.837E-28	Not normal	
19	9.93965E-01	1.132E-14	1.26897E+02	2.784E-28	Not normal	
20	9.93348E-01	1.507E-15	1.54722E+02	2.527E-34	Not normal	
21	9.92887E-01	3.617E-16	1.67209E+02	4.910E-37	Not normal	
22	9.93162E-01	8.450E-16	1.56929E+02	8.382E-35	Not normal	
23	9.91255E-01	3.669E-18	1.98941E+02	6.318E-44	Not normal	
24	9.92227E-01	5.260E-17	1.72334E+02	3.786E-38	Not normal	
25	9.92060E-01	3.290E-17	1.83992E+02	1.113E-40	Not normal	
26	9.93825E-01	7.263E-15	1.39994E+02	3.988E-31	Not normal	
27	9.92133E-01	4.077E-17	1.65816E+02	9.850E-37	Not normal	
28	9.91625E-01	1.004E-17	1.80816E+02	5.447E-40	Not normal	
29	9.91801E-01	1.627E-17	1.73569E+02	2.042E-38	Not normal	
30	9.93420E-01	1.960E-15	1.37671E+02	1.274E-30	Not normal	
31	9.92657E-01	1.885E-16	1.61814E+02	7.288E-36	Not normal	
32	9.92681E-01	2.034E-16	1.55057E+02	2.137E-34	Not normal	
33	9.93900E-01	9.561E-15	1.31096E+02	3.411E-29	Not normal	
34	9.94092E-01	1.842E-14	1.34103E+02	7.583E-30	Not normal	
35	9.94421E-01	5.835E-14	1.17495E+02	3.063E-26	Not normal	
36	9.93712E-01	5.178E-15	1.43153E+02	8.216E-32	Not normal	
37	9.93480E-01	2.438E-15	1.51426E+02	1.313E-33	Not normal	
38	9.93351E-01	1.623E-15	1.41075E+02	2.322E-31	Not normal	
39	9.93809E-01	7.193E-15	1.33273E+02	1.148E-29	Not normal	
40	9.93039E-01	6.175E-16	1.46600E+02	1.467E-32	Not normal	
41	9.93651E-01	4.309E-15	1.44502E+02	4.186E-32	Not normal	
42	9.92510E-01	1.277E-16	1.65487E+02	1.161E-36	Not normal	
43	9.94315E-01	4.122E-14	1.22127E+02	3.023E-27	Not normal	
44	9.94086E-01	1.870E-14	1.26571E+02	3.277E-28	Not normal	
45	9.94385E-01	5.309E-14	1.08379E+02	2.923E-24	Not normal	
46	9.95373E-01	2.217E-12	9.10627E+01	1.683E-20	Not normal	
47	9.95523E-01	4.091E-12	9.23331E+01	8.915E-21	Not normal	
48	9.96526E-01	3.469E-10	7.20295E+01	2.286E-16	Not normal	
49	9.95221E-01	1.220E-12	71	9.73076E+01	7.412E-22	Not normal

Table 3.14: Normality tests for .AORD

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.92768E-01	1.905E-16	1.46580E+02	1.481E-32	Not normal	
2	9.95405E-01	1.838E-12	8.50781E+01	3.354E-19	Not normal	
3	9.95000E-01	3.710E-13	8.87278E+01	5.408E-20	Not normal	
4	9.93437E-01	1.544E-15	1.23080E+02	1.877E-27	Not normal	
5	9.93169E-01	6.611E-16	1.32787E+02	1.464E-29	Not normal	
6	9.92793E-01	2.091E-16	1.36658E+02	2.114E-30	Not normal	
7	9.92329E-01	5.337E-17	1.46412E+02	1.611E-32	Not normal	
8	9.91956E-01	1.856E-17	1.61696E+02	7.731E-36	Not normal	
9	9.90757E-01	7.679E-19	1.72305E+02	3.841E-38	Not normal	
10	9.90760E-01	7.756E-19	1.88092E+02	1.433E-41	Not normal	
11	9.90887E-01	1.078E-18	1.70364E+02	1.014E-37	Not normal	
12	9.91082E-01	1.789E-18	1.67157E+02	5.038E-37	Not normal	
13	9.89789E-01	7.299E-20	2.15265E+02	1.802E-47	Not normal	
14	9.87821E-01	9.399E-22	2.33574E+02	1.906E-51	Not normal	
15	9.87751E-01	8.165E-22	2.58956E+02	5.868E-57	Not normal	
16	9.89536E-01	4.087E-20	2.25201E+02	1.254E-49	Not normal	
17	9.87469E-01	4.613E-22	2.52594E+02	1.412E-55	Not normal	
18	9.84394E-01	1.455E-24	3.31535E+02	1.019E-72	Not normal	
19	9.83939E-01	6.701E-25	3.41345E+02	7.547E-75	Not normal	
20	9.84288E-01	1.223E-24	3.54802E+02	9.029E-78	Not normal	
21	9.88320E-01	2.779E-21	2.60668E+02	2.493E-57	Not normal	
22	9.89256E-01	2.204E-20	2.46020E+02	3.779E-54	Not normal	
23	9.88285E-01	2.602E-21	2.64729E+02	3.273E-58	Not normal	
24	9.89226E-01	2.077E-20	2.48664E+02	1.008E-54	Not normal	
25	9.87138E-01	2.454E-22	2.82310E+02	4.980E-62	Not normal	
26	9.86848E-01	1.387E-22	2.93894E+02	1.520E-64	Not normal	
27	9.86416E-01	6.031E-23	2.87988E+02	2.912E-63	Not normal	
28	9.86358E-01	5.422E-23	2.91964E+02	3.988E-64	Not normal	
29	9.86086E-01	3.249E-23	2.69058E+02	3.756E-59	Not normal	
30	9.87444E-01	4.649E-22	2.62743E+02	8.834E-58	Not normal	
31	9.88912E-01	1.056E-20	2.44843E+02	6.809E-54	Not normal	
32	9.87995E-01	1.463E-21	2.37547E+02	2.614E-52	Not normal	
33	9.88508E-01	4.392E-21	2.44271E+02	9.060E-54	Not normal	
34	9.87829E-01	1.043E-21	2.53491E+02	9.020E-56	Not normal	
35	9.88122E-01	1.937E-21	2.39478E+02	9.956E-53	Not normal	
36	9.87864E-01	1.134E-21	2.64281E+02	4.093E-58	Not normal	
37	9.87809E-01	1.016E-21	2.59103E+02	5.451E-57	Not normal	
38	9.87351E-01	3.991E-22	2.80632E+02	1.152E-61	Not normal	
39	9.88367E-01	3.324E-21	2.52925E+02	1.197E-55	Not normal	
40	9.88612E-01	5.673E-21	2.66174E+02	1.589E-58	Not normal	
41	9.87581E-01	6.467E-22	2.90899E+02	6.793E-64	Not normal	
42	9.87109E-01	2.500E-22	3.10824E+02	3.202E-68	Not normal	
43	9.85639E-01	1.510E-23	3.30474E+02	1.732E-72	Not normal	
44	9.86386E-01	6.158E-23	3.04652E+02	7.009E-67	Not normal	
45	9.87102E-01	2.499E-22	2.97473E+02	2.539E-65	Not normal	
46	9.87639E-01	7.443E-22	2.81843E+02	6.290E-62	Not normal	
47	9.88209E-01	2.459E-21	2.74521E+02	2.446E-60	Not normal	
48	9.88886E-01	1.073E-20	2.59031E+02	5.652E-57	Not normal	
49	9.87947E-01	1.428E-21	72	2.64305E+02	4.045E-58	Not normal

Table 3.15: Normality tests for .BFX

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.86950E-01	3.805E-22	2.82787E+02	3.923E-62	Not normal	
2	9.91222E-01	5.591E-18	1.66933E+02	5.635E-37	Not normal	
3	9.90727E-01	1.587E-18	1.71758E+02	5.049E-38	Not normal	
4	9.91337E-01	7.612E-18	1.63283E+02	3.496E-36	Not normal	
5	9.89930E-01	2.309E-19	2.11151E+02	1.410E-46	Not normal	
6	9.92132E-01	6.626E-17	1.36806E+02	1.963E-30	Not normal	
7	9.91848E-01	3.034E-17	1.50111E+02	2.534E-33	Not normal	
8	9.93054E-01	9.912E-16	1.29544E+02	7.412E-29	Not normal	
9	9.92207E-01	8.285E-17	1.39797E+02	4.400E-31	Not normal	
10	9.91497E-01	1.191E-17	1.48495E+02	5.684E-33	Not normal	
11	9.91958E-01	4.170E-17	1.48297E+02	6.277E-33	Not normal	
12	9.91454E-01	1.070E-17	1.60438E+02	1.450E-35	Not normal	
13	9.91073E-01	3.980E-18	1.75143E+02	9.292E-39	Not normal	
14	9.91833E-01	2.992E-17	1.65974E+02	9.106E-37	Not normal	
15	9.91506E-01	1.244E-17	1.65060E+02	1.438E-36	Not normal	
16	9.92191E-01	8.133E-17	1.53647E+02	4.326E-34	Not normal	
17	9.90802E-01	2.033E-18	1.80878E+02	5.283E-40	Not normal	
18	9.90361E-01	6.863E-19	1.81278E+02	4.325E-40	Not normal	
19	9.90298E-01	5.912E-19	1.87421E+02	2.005E-41	Not normal	
20	9.88282E-01	6.231E-21	2.12188E+02	8.394E-47	Not normal	
21	9.90130E-01	3.974E-19	1.93292E+02	1.065E-42	Not normal	
22	9.90138E-01	4.069E-19	1.89957E+02	5.641E-42	Not normal	
23	9.89509E-01	9.390E-20	2.07080E+02	1.079E-45	Not normal	
24	9.89954E-01	2.656E-19	1.78393E+02	1.830E-39	Not normal	
25	9.88224E-01	5.642E-21	2.26786E+02	5.677E-50	Not normal	
26	9.90195E-01	4.747E-19	1.74517E+02	1.271E-38	Not normal	
27	9.89915E-01	2.449E-19	1.74256E+02	1.448E-38	Not normal	
28	9.90796E-01	2.094E-18	1.65830E+02	9.785E-37	Not normal	
29	9.91166E-01	5.404E-18	1.65081E+02	1.422E-36	Not normal	
30	9.92203E-01	8.903E-17	1.37934E+02	1.117E-30	Not normal	
31	9.91060E-01	4.143E-18	1.58975E+02	3.013E-35	Not normal	
32	9.91761E-01	2.641E-17	1.57917E+02	5.113E-35	Not normal	
33	9.91121E-01	4.886E-18	1.74162E+02	1.518E-38	Not normal	
34	9.92600E-01	2.825E-16	1.54269E+02	3.168E-34	Not normal	
35	9.93041E-01	1.056E-15	1.47973E+02	7.381E-33	Not normal	
36	9.92812E-01	5.315E-16	1.51601E+02	1.203E-33	Not normal	
37	9.92355E-01	1.411E-16	1.51618E+02	1.193E-33	Not normal	
38	9.92453E-01	1.871E-16	1.54978E+02	2.224E-34	Not normal	
39	9.92132E-01	7.555E-17	1.66951E+02	5.585E-37	Not normal	
40	9.91169E-01	5.700E-18	1.76270E+02	5.290E-39	Not normal	
41	9.90214E-01	5.305E-19	2.10451E+02	2.001E-46	Not normal	
42	9.91603E-01	1.800E-17	1.65791E+02	9.973E-37	Not normal	
43	9.90732E-01	1.901E-18	1.71135E+02	6.895E-38	Not normal	
44	9.91652E-01	2.067E-17	1.53061E+02	5.796E-34	Not normal	
45	9.92534E-01	2.436E-16	1.39589E+02	4.882E-31	Not normal	
46	9.92982E-01	9.211E-16	1.39177E+02	5.999E-31	Not normal	
47	9.92884E-01	6.894E-16	1.26752E+02	2.993E-28	Not normal	
48	9.93268E-01	2.230E-15	1.23895E+02	1.249E-27	Not normal	
49	9.91432E-01	1.174E-17	73	1.60460E+02	1.434E-35	Not normal

Table 3.16: Normality tests for .BVSP

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.96461E-01	2.533E-10	6.30263E+01	2.061E-14	Not normal	
2	9.96314E-01	1.276E-10	7.44985E+01	6.651E-17	Not normal	
3	9.95443E-01	2.956E-12	8.87895E+01	5.243E-20	Not normal	
4	9.93971E-01	1.287E-14	1.16981E+02	3.963E-26	Not normal	
5	9.94516E-01	8.630E-14	9.83838E+01	4.327E-22	Not normal	
6	9.94283E-01	3.791E-14	1.05824E+02	1.048E-23	Not normal	
7	9.94905E-01	3.646E-13	9.73146E+01	7.386E-22	Not normal	
8	9.95079E-01	7.110E-13	9.35833E+01	4.771E-21	Not normal	
9	9.96127E-01	5.574E-11	7.25940E+01	1.724E-16	Not normal	
10	9.94961E-01	4.553E-13	9.09069E+01	1.819E-20	Not normal	
11	9.95199E-01	1.147E-12	9.30055E+01	6.370E-21	Not normal	
12	9.94250E-01	3.447E-14	1.15810E+02	7.115E-26	Not normal	
13	9.93738E-01	6.099E-15	1.33425E+02	1.065E-29	Not normal	
14	9.92840E-01	3.621E-16	1.51247E+02	1.436E-33	Not normal	
15	9.93033E-01	6.525E-16	1.52761E+02	6.737E-34	Not normal	
16	9.92273E-01	6.916E-17	1.61680E+02	7.792E-36	Not normal	
17	9.90922E-01	1.816E-18	1.98857E+02	6.588E-44	Not normal	
18	9.92286E-01	7.229E-17	1.67853E+02	3.558E-37	Not normal	
19	9.92071E-01	3.950E-17	1.73745E+02	1.870E-38	Not normal	
20	9.92871E-01	4.062E-16	1.57959E+02	5.009E-35	Not normal	
21	9.93129E-01	8.973E-16	1.46154E+02	1.833E-32	Not normal	
22	9.90996E-01	2.241E-18	2.07011E+02	1.117E-45	Not normal	
23	9.91686E-01	1.387E-17	1.83248E+02	1.615E-40	Not normal	
24	9.92136E-01	4.840E-17	1.71351E+02	6.189E-38	Not normal	
25	9.92209E-01	5.980E-17	1.73386E+02	2.238E-38	Not normal	
26	9.92136E-01	4.882E-17	1.71219E+02	6.610E-38	Not normal	
27	9.91617E-01	1.171E-17	1.86650E+02	2.948E-41	Not normal	
28	9.91513E-01	8.874E-18	1.66338E+02	7.590E-37	Not normal	
29	9.92030E-01	3.662E-17	1.71209E+02	6.644E-38	Not normal	
30	9.92718E-01	2.670E-16	1.42404E+02	1.195E-31	Not normal	
31	9.93783E-01	7.552E-15	1.21778E+02	3.600E-27	Not normal	
32	9.93300E-01	1.597E-15	1.34297E+02	6.883E-30	Not normal	
33	9.94121E-01	2.377E-14	1.24171E+02	1.088E-27	Not normal	
34	9.93663E-01	5.135E-15	1.29321E+02	8.284E-29	Not normal	
35	9.93360E-01	1.950E-15	1.36951E+02	1.826E-30	Not normal	
36	9.92569E-01	1.758E-16	1.57734E+02	5.605E-35	Not normal	
37	9.93883E-01	1.074E-14	1.36347E+02	2.470E-30	Not normal	
38	9.93145E-01	1.004E-15	1.42795E+02	9.830E-32	Not normal	
39	9.93162E-01	1.063E-15	1.45085E+02	3.128E-32	Not normal	
40	9.93747E-01	6.929E-15	1.39424E+02	5.303E-31	Not normal	
41	9.93281E-01	1.552E-15	1.47240E+02	1.065E-32	Not normal	
42	9.92548E-01	1.692E-16	1.68976E+02	2.029E-37	Not normal	
43	9.91253E-01	4.745E-18	1.94624E+02	5.470E-43	Not normal	
44	9.90841E-01	1.650E-18	2.03378E+02	6.870E-45	Not normal	
45	9.91257E-01	4.834E-18	2.03951E+02	5.160E-45	Not normal	
46	9.90682E-01	1.115E-18	2.00258E+02	3.271E-44	Not normal	
47	9.92469E-01	1.372E-16	1.63511E+02	3.119E-36	Not normal	
48	9.91319E-01	5.764E-18	1.94068E+02	7.221E-43	Not normal	
49	9.91712E-01	1.652E-17	74	1.89895E+02	5.817E-42	Not normal

Table 3.17: Normality tests for .DJI

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion
1	9.87673E-01	6.408E-22	2.42019E+02	2.794E-53	Not normal
2	9.91937E-01	1.695E-17	1.39881E+02	4.219E-31	Not normal
3	9.90652E-01	5.652E-19	1.73344E+02	2.285E-38	Not normal
4	9.90246E-01	2.074E-19	1.63806E+02	2.692E-36	Not normal
5	9.88682E-01	5.586E-21	2.07113E+02	1.062E-45	Not normal
6	9.88836E-01	7.874E-21	2.04731E+02	3.492E-45	Not normal
7	9.89901E-01	9.137E-20	1.81546E+02	3.782E-40	Not normal
8	9.89082E-01	1.376E-20	2.07911E+02	7.124E-46	Not normal
9	9.88602E-01	4.773E-21	2.01863E+02	1.465E-44	Not normal
10	9.88091E-01	1.599E-21	2.27043E+02	4.993E-50	Not normal
11	9.88320E-01	2.614E-21	2.12406E+02	7.528E-47	Not normal
12	9.86225E-01	3.839E-23	2.79271E+02	2.275E-61	Not normal
13	9.86718E-01	9.967E-23	3.15456E+02	3.159E-69	Not normal
14	9.84814E-01	2.919E-24	2.91778E+02	4.377E-64	Not normal
15	9.84648E-01	2.188E-24	3.10881E+02	3.112E-68	Not normal
16	9.84717E-01	2.484E-24	3.24545E+02	3.356E-71	Not normal
17	9.83532E-01	3.287E-25	3.42870E+02	3.521E-75	Not normal
18	9.80318E-01	2.238E-27	4.09998E+02	9.332E-90	Not normal
19	9.79526E-01	7.227E-28	4.46363E+02	1.185E-97	Not normal
20	9.79068E-01	3.830E-28	4.93251E+02	7.798E-108	Not normal
21	9.84296E-01	1.222E-24	3.58981E+02	1.118E-78	Not normal
22	9.83680E-01	4.306E-25	3.78860E+02	5.391E-83	Not normal
23	9.83241E-01	2.092E-25	3.63867E+02	9.710E-80	Not normal
24	9.84322E-01	1.296E-24	3.58964E+02	1.127E-78	Not normal
25	9.83028E-01	1.492E-25	3.69544E+02	5.684E-81	Not normal
26	9.86713E-01	1.046E-22	3.07694E+02	1.531E-67	Not normal
27	9.85704E-01	1.549E-23	3.25354E+02	2.240E-71	Not normal
28	9.85085E-01	5.050E-24	3.34919E+02	1.876E-73	Not normal
29	9.84687E-01	2.506E-24	3.35911E+02	1.142E-73	Not normal
30	9.84861E-01	3.419E-24	3.14298E+02	5.638E-69	Not normal
31	9.87999E-01	1.444E-21	2.57421E+02	1.264E-56	Not normal
32	9.85889E-01	2.237E-23	2.81097E+02	9.130E-62	Not normal
33	9.86773E-01	1.214E-22	2.65460E+02	2.270E-58	Not normal
34	9.85682E-01	1.537E-23	2.86585E+02	5.872E-63	Not normal
35	9.85816E-01	1.977E-23	2.91169E+02	5.936E-64	Not normal
36	9.84623E-01	2.317E-24	3.11068E+02	2.835E-68	Not normal
37	9.86019E-01	2.921E-23	2.97680E+02	2.289E-65	Not normal
38	9.86764E-01	1.222E-22	2.94620E+02	1.057E-64	Not normal
39	9.86751E-01	1.197E-22	2.77274E+02	6.176E-61	Not normal
40	9.86474E-01	7.026E-23	3.06835E+02	2.353E-67	Not normal
41	9.85837E-01	2.116E-23	3.33793E+02	3.295E-73	Not normal
42	9.85028E-01	4.872E-24	3.36215E+02	9.814E-74	Not normal
43	9.83674E-01	4.721E-25	3.70894E+02	2.893E-81	Not normal
44	9.84003E-01	8.270E-25	3.59264E+02	9.702E-79	Not normal
45	9.85352E-01	8.848E-24	3.50988E+02	6.080E-77	Not normal
46	9.86291E-01	5.088E-23	3.31865E+02	8.637E-73	Not normal
47	9.84772E-01	3.169E-24	3.54642E+02	9.785E-78	Not normal
48	9.85939E-01	2.646E-23	3.10603E+02	3.577E-68	Not normal
49	9.86172E-01	4.117E-23	2.89529E+02	1.348E-63	Not normal

Table 3.18: Normality tests for .FCHI

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.87264E-01	1.324E-16	1.43680E+02	6.315E-32	Not normal	
2	9.93744E-01	1.093E-10	7.55781E+01	3.876E-17	Not normal	
3	9.93743E-01	1.098E-10	7.75290E+01	1.461E-17	Not normal	
4	9.94669E-01	1.496E-09	6.56812E+01	5.464E-15	Not normal	
5	9.94585E-01	1.174E-09	6.30537E+01	2.033E-14	Not normal	
6	9.92550E-01	5.354E-12	9.91767E+01	2.911E-22	Not normal	
7	9.94615E-01	1.296E-09	6.36178E+01	1.533E-14	Not normal	
8	9.96124E-01	1.666E-07	4.85299E+01	2.896E-11	Not normal	
9	9.94096E-01	2.965E-10	8.04938E+01	3.319E-18	Not normal	
10	9.95438E-01	1.656E-08	5.45946E+01	1.396E-12	Not normal	
11	9.93915E-01	1.818E-10	6.85188E+01	1.322E-15	Not normal	
12	9.93920E-01	1.852E-10	7.71476E+01	1.769E-17	Not normal	
13	9.93987E-01	2.239E-10	6.99245E+01	6.548E-16	Not normal	
14	9.92394E-01	3.858E-12	8.24904E+01	1.223E-18	Not normal	
15	9.90855E-01	1.239E-13	9.72616E+01	7.584E-22	Not normal	
16	9.91142E-01	2.299E-13	1.05869E+02	1.025E-23	Not normal	
17	9.89451E-01	7.471E-15	1.19342E+02	1.217E-26	Not normal	
18	9.89757E-01	1.359E-14	1.30822E+02	3.912E-29	Not normal	
19	9.87670E-01	2.980E-16	1.65625E+02	1.084E-36	Not normal	
20	9.86365E-01	3.420E-17	1.93521E+02	9.493E-43	Not normal	
21	9.90282E-01	3.934E-14	1.32155E+02	2.009E-29	Not normal	
22	9.90866E-01	1.322E-13	1.22537E+02	2.462E-27	Not normal	
23	9.91183E-01	2.613E-13	1.21288E+02	4.598E-27	Not normal	
24	9.90412E-01	5.212E-14	1.26135E+02	4.076E-28	Not normal	
25	9.89573E-01	9.933E-15	1.38806E+02	7.222E-31	Not normal	
26	9.90012E-01	2.358E-14	1.22245E+02	2.850E-27	Not normal	
27	9.91661E-01	7.655E-13	1.06976E+02	5.896E-24	Not normal	
28	9.90645E-01	8.629E-14	1.15539E+02	8.146E-26	Not normal	
29	9.91999E-01	1.663E-12	9.29430E+01	6.572E-21	Not normal	
30	9.92013E-01	1.728E-12	9.59112E+01	1.490E-21	Not normal	
31	9.91783E-01	1.030E-12	9.75036E+01	6.720E-22	Not normal	
32	9.92579E-01	6.612E-12	8.47238E+01	4.004E-19	Not normal	
33	9.91254E-01	3.235E-13	1.02687E+02	5.033E-23	Not normal	
34	9.90028E-01	2.560E-14	1.28851E+02	1.048E-28	Not normal	
35	9.86990E-01	1.050E-16	1.62972E+02	4.084E-36	Not normal	
36	9.87458E-01	2.319E-16	1.62067E+02	6.420E-36	Not normal	
37	9.87816E-01	4.313E-16	1.63417E+02	3.270E-36	Not normal	
38	9.87023E-01	1.131E-16	1.71473E+02	5.822E-38	Not normal	
39	9.85225E-01	6.581E-18	1.96708E+02	1.930E-43	Not normal	
40	9.84500E-01	2.252E-18	2.11637E+02	1.105E-46	Not normal	
41	9.85136E-01	5.839E-18	2.02625E+02	1.001E-44	Not normal	
42	9.83966E-01	1.053E-18	2.19558E+02	2.107E-48	Not normal	
43	9.84806E-01	3.613E-18	2.00535E+02	2.846E-44	Not normal	
44	9.84015E-01	1.147E-18	2.24480E+02	1.798E-49	Not normal	
45	9.81606E-01	4.347E-20	2.58855E+02	6.171E-57	Not normal	
46	9.85654E-01	1.333E-17	1.93847E+02	8.065E-43	Not normal	
47	9.84792E-01	3.641E-18	1.96868E+02	1.781E-43	Not normal	
48	9.83752E-01	8.114E-19	2.08948E+02	4.241E-46	Not normal	
49	9.82088E-01	8.415E-20	76	2.40721E+02	5.346E-53	Not normal

Table 3.19: Normality tests for .FTMIB

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.89667E-01	6.808E-20	2.04238E+02	4.470E-45	Not normal	
2	9.91270E-01	3.622E-18	1.79176E+02	1.237E-39	Not normal	
3	9.90719E-01	8.800E-19	1.73536E+02	2.075E-38	Not normal	
4	9.91029E-01	1.947E-18	1.57013E+02	8.034E-35	Not normal	
5	9.90566E-01	6.051E-19	1.74454E+02	1.311E-38	Not normal	
6	9.88828E-01	1.035E-20	2.02481E+02	1.076E-44	Not normal	
7	9.92006E-01	2.719E-17	1.59983E+02	1.821E-35	Not normal	
8	9.92058E-01	3.155E-17	1.51042E+02	1.591E-33	Not normal	
9	9.90259E-01	2.884E-19	1.82045E+02	2.948E-40	Not normal	
10	9.91735E-01	1.301E-17	1.56790E+02	8.986E-35	Not normal	
11	9.88629E-01	6.835E-21	2.36840E+02	3.722E-52	Not normal	
12	9.87703E-01	9.672E-22	2.64573E+02	3.538E-58	Not normal	
13	9.90435E-01	4.516E-19	1.84288E+02	9.605E-41	Not normal	
14	9.92297E-01	6.365E-17	1.45504E+02	2.536E-32	Not normal	
15	9.91041E-01	2.099E-18	1.83049E+02	1.785E-40	Not normal	
16	9.90272E-01	3.063E-19	2.13358E+02	4.677E-47	Not normal	
17	9.90154E-01	2.315E-19	1.86191E+02	3.707E-41	Not normal	
18	9.89313E-01	3.234E-20	2.26556E+02	6.367E-50	Not normal	
19	9.87967E-01	1.725E-21	2.49225E+02	7.610E-55	Not normal	
20	9.89394E-01	3.921E-20	2.22022E+02	6.146E-49	Not normal	
21	9.89136E-01	2.195E-20	2.35227E+02	8.338E-52	Not normal	
22	9.90434E-01	4.680E-19	1.98178E+02	9.251E-44	Not normal	
23	9.90769E-01	1.084E-18	1.98652E+02	7.299E-44	Not normal	
24	9.90655E-01	8.166E-19	1.98139E+02	9.434E-44	Not normal	
25	9.90266E-01	3.137E-19	2.01068E+02	2.180E-44	Not normal	
26	9.89510E-01	5.257E-20	2.19046E+02	2.722E-48	Not normal	
27	9.88073E-01	2.229E-21	2.44102E+02	9.862E-54	Not normal	
28	9.88419E-01	4.678E-21	2.40506E+02	5.953E-53	Not normal	
29	9.91570E-01	8.974E-18	1.72953E+02	2.777E-38	Not normal	
30	9.90243E-01	3.027E-19	1.94161E+02	6.894E-43	Not normal	
31	9.89447E-01	4.648E-20	2.03713E+02	5.812E-45	Not normal	
32	9.87892E-01	1.563E-21	2.42452E+02	2.250E-53	Not normal	
33	9.89682E-01	8.069E-20	2.25041E+02	1.358E-49	Not normal	
34	9.90881E-01	1.507E-18	1.70768E+02	8.283E-38	Not normal	
35	9.88672E-01	8.336E-21	2.29509E+02	1.454E-50	Not normal	
36	9.88947E-01	1.533E-20	2.29261E+02	1.647E-50	Not normal	
37	9.89167E-01	2.521E-20	2.42031E+02	2.778E-53	Not normal	
38	9.90540E-01	6.497E-19	1.96814E+02	1.830E-43	Not normal	
39	9.88681E-01	8.651E-21	2.41922E+02	2.933E-53	Not normal	
40	9.88687E-01	8.816E-21	2.40251E+02	6.762E-53	Not normal	
41	9.89516E-01	5.686E-20	2.29989E+02	1.144E-50	Not normal	
42	9.87528E-01	7.737E-22	2.72098E+02	8.217E-60	Not normal	
43	9.87165E-01	3.743E-22	2.73077E+02	5.036E-60	Not normal	
44	9.87828E-01	1.443E-21	2.52186E+02	1.731E-55	Not normal	
45	9.88262E-01	3.605E-21	2.49428E+02	6.877E-55	Not normal	
46	9.87573E-01	8.635E-22	2.49174E+02	7.808E-55	Not normal	
47	9.89388E-01	4.344E-20	2.15686E+02	1.460E-47	Not normal	
48	9.90005E-01	1.842E-19	2.11943E+02	9.488E-47	Not normal	
49	9.90102E-01	2.332E-19	77	2.03091E+02	7.932E-45	Not normal

Table 3.20: Normality tests for .FTSE

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion
1	9.81416E-01	1.271E-26	5.22543E+02	3.397E-114	Not normal
2	9.86837E-01	1.421E-22	3.57621E+02	2.206E-78	Not normal
3	9.89081E-01	1.582E-20	2.29696E+02	1.325E-50	Not normal
4	9.89965E-01	1.232E-19	2.06256E+02	1.630E-45	Not normal
5	9.88142E-01	2.057E-21	2.99966E+02	7.299E-66	Not normal
6	9.89422E-01	3.481E-20	2.34333E+02	1.304E-51	Not normal
7	9.89352E-01	2.979E-20	2.24037E+02	2.244E-49	Not normal
8	9.88984E-01	1.301E-20	2.47613E+02	1.704E-54	Not normal
9	9.86757E-01	1.256E-22	3.30070E+02	2.120E-72	Not normal
10	9.86540E-01	8.281E-23	3.03218E+02	1.435E-66	Not normal
11	9.90071E-01	1.637E-19	2.03394E+02	6.816E-45	Not normal
12	9.90201E-01	2.249E-19	2.02690E+02	9.694E-45	Not normal
13	9.91167E-01	2.570E-18	1.78739E+02	1.539E-39	Not normal
14	9.88167E-01	2.259E-21	2.36772E+02	3.851E-52	Not normal
15	9.90272E-01	2.707E-19	2.03562E+02	6.266E-45	Not normal
16	9.88308E-01	3.077E-21	2.25406E+02	1.132E-49	Not normal
17	9.87498E-01	5.708E-22	2.62296E+02	1.104E-57	Not normal
18	9.88251E-01	2.746E-21	2.52946E+02	1.184E-55	Not normal
19	9.84779E-01	3.363E-24	3.40777E+02	1.003E-74	Not normal
20	9.86303E-01	5.497E-23	3.02062E+02	2.559E-66	Not normal
21	9.87345E-01	4.258E-22	2.84647E+02	1.548E-62	Not normal
22	9.88134E-01	2.183E-21	2.73078E+02	5.033E-60	Not normal
23	9.87924E-01	1.411E-21	2.59756E+02	3.934E-57	Not normal
24	9.86901E-01	1.781E-22	2.94189E+02	1.311E-64	Not normal
25	9.85665E-01	1.706E-23	3.21333E+02	1.673E-70	Not normal
26	9.86677E-01	1.161E-22	3.06051E+02	3.482E-67	Not normal
27	9.86499E-01	8.267E-23	3.07083E+02	2.078E-67	Not normal
28	9.86904E-01	1.825E-22	2.88171E+02	2.658E-63	Not normal
29	9.88006E-01	1.718E-21	2.64248E+02	4.161E-58	Not normal
30	9.88432E-01	4.270E-21	2.42376E+02	2.338E-53	Not normal
31	9.90087E-01	1.846E-19	2.13965E+02	3.451E-47	Not normal
32	9.89083E-01	1.801E-20	2.21556E+02	7.757E-49	Not normal
33	9.89059E-01	1.713E-20	2.15499E+02	1.603E-47	Not normal
34	9.89202E-01	2.378E-20	2.25975E+02	8.515E-50	Not normal
35	9.88185E-01	2.573E-21	2.31017E+02	6.844E-51	Not normal
36	9.87648E-01	8.441E-22	2.56692E+02	1.820E-56	Not normal
37	9.89871E-01	1.133E-19	2.18829E+02	3.033E-48	Not normal
38	9.90055E-01	1.761E-19	2.34238E+02	1.367E-51	Not normal
39	9.89345E-01	3.362E-20	2.39193E+02	1.148E-52	Not normal
40	9.89129E-01	2.067E-20	2.43005E+02	1.707E-53	Not normal
41	9.88710E-01	8.198E-21	2.57003E+02	1.557E-56	Not normal
42	9.88868E-01	1.165E-20	2.45022E+02	6.226E-54	Not normal
43	9.89857E-01	1.124E-19	2.18070E+02	4.432E-48	Not normal
44	9.88144E-01	2.456E-21	2.59165E+02	5.284E-57	Not normal
45	9.88716E-01	8.440E-21	2.63001E+02	7.762E-58	Not normal
46	9.89911E-01	1.293E-19	2.25775E+02	9.408E-50	Not normal
47	9.91055E-01	2.205E-18	2.03300E+02	7.144E-45	Not normal
48	9.89955E-01	1.446E-19	2.15750E+02	1.414E-47	Not normal
49	9.89342E-01	3.483E-20	2.19031E+02	2.742E-48	Not normal

Table 3.21: Normality tests for .GDAXI

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.96720E-01	4.892E-09	5.08612E+01	9.029E-12	Not normal	
2	9.96671E-01	3.909E-09	5.06565E+01	1.000E-11	Not normal	
3	9.98123E-01	9.859E-06	2.07089E+01	3.185E-05	Not normal	
4	9.95408E-01	1.855E-11	6.61001E+01	4.431E-15	Not normal	
5	9.97649E-01	5.905E-07	3.79756E+01	5.671E-09	Not normal	
6	9.96992E-01	1.848E-08	5.12260E+01	7.524E-12	Not normal	
7	9.96762E-01	6.083E-09	5.80382E+01	2.496E-13	Not normal	
8	9.96507E-01	1.867E-09	6.59980E+01	4.664E-15	Not normal	
9	9.95909E-01	1.394E-10	7.67340E+01	2.175E-17	Not normal	
10	9.96423E-01	1.284E-09	6.42326E+01	1.127E-14	Not normal	
11	9.94507E-01	7.101E-13	1.08321E+02	3.008E-24	Not normal	
12	9.95587E-01	3.836E-11	8.49263E+01	3.618E-19	Not normal	
13	9.92830E-01	3.629E-15	1.46484E+02	1.554E-32	Not normal	
14	9.91503E-01	9.756E-17	1.79076E+02	1.301E-39	Not normal	
15	9.91750E-01	1.864E-16	1.65445E+02	1.186E-36	Not normal	
16	9.91323E-01	6.205E-17	1.78034E+02	2.189E-39	Not normal	
17	9.91614E-01	1.316E-16	1.72005E+02	4.462E-38	Not normal	
18	9.90654E-01	1.198E-17	1.94474E+02	5.895E-43	Not normal	
19	9.89456E-01	7.558E-19	2.18938E+02	2.872E-48	Not normal	
20	9.88758E-01	1.678E-19	2.37391E+02	2.826E-52	Not normal	
21	9.88878E-01	2.176E-19	2.34364E+02	1.284E-51	Not normal	
22	9.89030E-01	3.028E-19	2.25905E+02	8.818E-50	Not normal	
23	9.87690E-01	1.910E-20	2.60513E+02	2.694E-57	Not normal	
24	9.88369E-01	7.589E-20	2.37275E+02	2.996E-52	Not normal	
25	9.89615E-01	1.107E-18	2.03438E+02	6.668E-45	Not normal	
26	9.88759E-01	1.728E-19	2.22815E+02	4.133E-49	Not normal	
27	9.88474E-01	9.554E-20	2.30814E+02	7.573E-51	Not normal	
28	9.88049E-01	4.020E-20	2.28542E+02	2.359E-50	Not normal	
29	9.87170E-01	7.133E-21	2.47326E+02	1.967E-54	Not normal	
30	9.86343E-01	1.516E-21	2.63139E+02	7.247E-58	Not normal	
31	9.87560E-01	1.537E-20	2.39142E+02	1.178E-52	Not normal	
32	9.87736E-01	2.187E-20	2.26877E+02	5.424E-50	Not normal	
33	9.87830E-01	2.654E-20	2.45367E+02	5.238E-54	Not normal	
34	9.85545E-01	3.678E-22	2.96290E+02	4.585E-65	Not normal	
35	9.87742E-01	2.248E-20	2.34853E+02	1.005E-51	Not normal	
36	9.86842E-01	3.952E-21	2.54403E+02	5.715E-56	Not normal	
37	9.86994E-01	5.302E-21	2.74314E+02	2.713E-60	Not normal	
38	9.85124E-01	1.802E-22	2.99972E+02	7.276E-66	Not normal	
39	9.85157E-01	1.918E-22	3.02681E+02	1.878E-66	Not normal	
40	9.86014E-01	8.757E-22	2.78834E+02	2.832E-61	Not normal	
41	9.83066E-01	6.225E-24	3.50459E+02	7.920E-77	Not normal	
42	9.84406E-01	5.451E-23	3.03414E+02	1.302E-66	Not normal	
43	9.85521E-01	3.695E-22	2.89824E+02	1.163E-63	Not normal	
44	9.86343E-01	1.626E-21	2.71516E+02	1.099E-59	Not normal	
45	9.87017E-01	5.766E-21	2.49981E+02	5.216E-55	Not normal	
46	9.86621E-01	2.749E-21	2.78177E+02	3.932E-61	Not normal	
47	9.85811E-01	6.305E-22	2.90576E+02	7.986E-64	Not normal	
48	9.89184E-01	4.776E-19	2.07191E+02	1.021E-45	Not normal	
49	9.87704E-01	2.232E-20	79	2.36178E+02	5.182E-52	Not normal

Table 3.22: Normality tests for .GSPTSE

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.95656E-01	1.045E-11	8.83604E+01	6.498E-20	Not normal	
2	9.94949E-01	6.444E-13	1.13287E+02	2.512E-25	Not normal	
3	9.95141E-01	1.346E-12	9.69966E+01	8.659E-22	Not normal	
4	9.95388E-01	3.555E-12	8.44038E+01	4.698E-19	Not normal	
5	9.93428E-01	3.434E-15	1.25341E+02	6.062E-28	Not normal	
6	9.92096E-01	6.598E-17	1.59273E+02	2.596E-35	Not normal	
7	9.92823E-01	5.401E-16	1.38678E+02	7.698E-31	Not normal	
8	9.92169E-01	8.158E-17	1.55935E+02	1.378E-34	Not normal	
9	9.92423E-01	1.687E-16	1.43862E+02	5.764E-32	Not normal	
10	9.93798E-01	1.156E-14	1.11529E+02	6.052E-25	Not normal	
11	9.95672E-01	1.155E-11	8.83428E+01	6.556E-20	Not normal	
12	9.95693E-01	1.264E-11	8.43630E+01	4.795E-19	Not normal	
13	9.95351E-01	3.157E-12	9.69059E+01	9.060E-22	Not normal	
14	9.94678E-01	2.460E-13	1.00307E+02	1.655E-22	Not normal	
15	9.94924E-01	6.133E-13	1.01092E+02	1.117E-22	Not normal	
16	9.93077E-01	1.202E-15	1.27041E+02	2.590E-28	Not normal	
17	9.94958E-01	7.010E-13	1.03525E+02	3.311E-23	Not normal	
18	9.92420E-01	1.732E-16	1.52310E+02	8.437E-34	Not normal	
19	9.93108E-01	1.336E-15	1.29715E+02	6.802E-29	Not normal	
20	9.92087E-01	6.800E-17	1.61139E+02	1.021E-35	Not normal	
21	9.91137E-01	5.350E-18	1.66994E+02	5.468E-37	Not normal	
22	9.92946E-01	8.253E-16	1.47134E+02	1.122E-32	Not normal	
23	9.94426E-01	1.028E-13	1.13154E+02	2.685E-25	Not normal	
24	9.94357E-01	8.111E-14	1.09780E+02	1.451E-24	Not normal	
25	9.95084E-01	1.162E-12	9.72971E+01	7.451E-22	Not normal	
26	9.95112E-01	1.297E-12	8.36603E+01	6.814E-19	Not normal	
27	9.94960E-01	7.308E-13	8.63822E+01	1.747E-19	Not normal	
28	9.95760E-01	1.757E-11	7.39430E+01	8.780E-17	Not normal	
29	9.94752E-01	3.393E-13	1.03214E+02	3.867E-23	Not normal	
30	9.96108E-01	7.938E-11	6.59196E+01	4.850E-15	Not normal	
31	9.93447E-01	4.023E-15	1.48949E+02	4.531E-33	Not normal	
32	9.92648E-01	3.539E-16	1.42378E+02	1.211E-31	Not normal	
33	9.92428E-01	1.877E-16	1.52540E+02	7.522E-34	Not normal	
34	9.92456E-01	2.046E-16	1.52224E+02	8.810E-34	Not normal	
35	9.93814E-01	1.334E-14	1.21989E+02	3.240E-27	Not normal	
36	9.94262E-01	6.069E-14	1.06038E+02	9.420E-24	Not normal	
37	9.93838E-01	1.455E-14	1.22613E+02	2.371E-27	Not normal	
38	9.94389E-01	9.510E-14	1.13199E+02	2.624E-25	Not normal	
39	9.94078E-01	3.275E-14	1.04813E+02	1.738E-23	Not normal	
40	9.95092E-01	1.258E-12	9.75927E+01	6.427E-22	Not normal	
41	9.94575E-01	1.862E-13	1.01179E+02	1.070E-22	Not normal	
42	9.93689E-01	9.096E-15	1.27202E+02	2.391E-28	Not normal	
43	9.92277E-01	1.271E-16	1.57072E+02	7.802E-35	Not normal	
44	9.94019E-01	2.733E-14	1.19711E+02	1.012E-26	Not normal	
45	9.94622E-01	2.237E-13	1.17391E+02	3.228E-26	Not normal	
46	9.93244E-01	2.252E-15	1.37692E+02	1.261E-30	Not normal	
47	9.93500E-01	5.058E-15	1.32850E+02	1.419E-29	Not normal	
48	9.92877E-01	7.432E-16	1.36043E+02	2.875E-30	Not normal	
49	9.93742E-01	1.109E-14	80	1.25173E+02	6.593E-28	Not normal

Table 3.23: Normality tests for .HSI

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.88168E-01	2.130E-21	2.45698E+02	4.440E-54	Not normal	
2	9.91887E-01	1.702E-17	1.71887E+02	4.734E-38	Not normal	
3	9.89101E-01	1.649E-20	2.26334E+02	7.114E-50	Not normal	
4	9.90822E-01	1.015E-18	1.78336E+02	1.883E-39	Not normal	
5	9.89608E-01	5.310E-20	1.93348E+02	1.035E-42	Not normal	
6	9.87070E-01	2.284E-22	2.23389E+02	3.103E-49	Not normal	
7	9.88785E-01	8.291E-21	2.13857E+02	3.644E-47	Not normal	
8	9.90637E-01	6.454E-19	1.77147E+02	3.412E-39	Not normal	
9	9.88649E-01	6.206E-21	2.07285E+02	9.740E-46	Not normal	
10	9.89278E-01	2.534E-20	2.09593E+02	3.073E-46	Not normal	
11	9.89371E-01	3.148E-20	2.03252E+02	7.317E-45	Not normal	
12	9.87039E-01	2.206E-22	2.70861E+02	1.525E-59	Not normal	
13	9.87825E-01	1.093E-21	2.91077E+02	6.216E-64	Not normal	
14	9.86701E-01	1.146E-22	2.49073E+02	8.214E-55	Not normal	
15	9.84821E-01	3.536E-24	2.95259E+02	7.679E-65	Not normal	
16	9.86818E-01	1.455E-22	2.88143E+02	2.695E-63	Not normal	
17	9.85649E-01	1.587E-23	2.84071E+02	2.064E-62	Not normal	
18	9.84019E-01	8.947E-25	3.48971E+02	1.667E-76	Not normal	
19	9.84293E-01	1.436E-24	3.82597E+02	8.320E-84	Not normal	
20	9.81081E-01	8.407E-27	4.48403E+02	4.271E-98	Not normal	
21	9.86051E-01	3.413E-23	3.17344E+02	1.229E-69	Not normal	
22	9.87080E-01	2.505E-22	3.07319E+02	1.847E-67	Not normal	
23	9.86841E-01	1.570E-22	2.94711E+02	1.010E-64	Not normal	
24	9.87695E-01	8.776E-22	2.81551E+02	7.278E-62	Not normal	
25	9.82871E-01	1.387E-25	3.73902E+02	6.429E-82	Not normal	
26	9.86451E-01	7.475E-23	2.96341E+02	4.471E-65	Not normal	
27	9.85474E-01	1.207E-23	3.10431E+02	3.897E-68	Not normal	
28	9.83971E-01	8.659E-25	3.30279E+02	1.909E-72	Not normal	
29	9.86373E-01	6.519E-23	2.86713E+02	5.509E-63	Not normal	
30	9.88085E-01	2.030E-21	2.35614E+02	6.873E-52	Not normal	
31	9.90002E-01	1.500E-19	1.98505E+02	7.855E-44	Not normal	
32	9.87663E-01	8.510E-22	2.35169E+02	8.583E-52	Not normal	
33	9.88245E-01	2.888E-21	2.28403E+02	2.529E-50	Not normal	
34	9.87933E-01	1.501E-21	2.45747E+02	4.333E-54	Not normal	
35	9.87275E-01	3.922E-22	2.67948E+02	6.543E-59	Not normal	
36	9.85338E-01	9.836E-24	2.90972E+02	6.551E-64	Not normal	
37	9.86357E-01	6.564E-23	2.73056E+02	5.088E-60	Not normal	
38	9.86478E-01	8.320E-23	2.98894E+02	1.247E-65	Not normal	
39	9.86425E-01	7.545E-23	2.94042E+02	1.412E-64	Not normal	
40	9.88344E-01	3.678E-21	2.60696E+02	2.458E-57	Not normal	
41	9.88043E-01	1.949E-21	2.61784E+02	1.426E-57	Not normal	
42	9.87354E-01	4.744E-22	2.76219E+02	1.047E-60	Not normal	
43	9.85252E-01	8.711E-24	3.05583E+02	4.401E-67	Not normal	
44	9.86077E-01	3.993E-23	3.01445E+02	3.483E-66	Not normal	
45	9.86617E-01	1.123E-22	2.94466E+02	1.141E-64	Not normal	
46	9.88740E-01	8.901E-21	2.38005E+02	2.079E-52	Not normal	
47	9.88222E-01	2.927E-21	2.48548E+02	1.068E-54	Not normal	
48	9.89365E-01	3.637E-20	2.20820E+02	1.121E-48	Not normal	
49	9.89450E-01	4.446E-20	81	2.11557E+02	1.151E-46	Not normal

Table 3.24: Normality tests for .IBEX

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.95644E-01	6.566E-12	8.03768E+01	3.519E-18	Not normal	
2	9.95946E-01	2.390E-11	7.01689E+01	5.795E-16	Not normal	
3	9.95346E-01	1.956E-12	9.51109E+01	2.223E-21	Not normal	
4	9.93843E-01	8.148E-15	1.20561E+02	6.616E-27	Not normal	
5	9.93711E-01	5.282E-15	1.30692E+02	4.174E-29	Not normal	
6	9.94095E-01	1.926E-14	1.10833E+02	8.570E-25	Not normal	
7	9.95181E-01	1.030E-12	9.14213E+01	1.406E-20	Not normal	
8	9.94920E-01	3.783E-13	1.00353E+02	1.617E-22	Not normal	
9	9.93684E-01	4.901E-15	1.25876E+02	4.639E-28	Not normal	
10	9.93583E-01	3.540E-15	1.20899E+02	5.585E-27	Not normal	
11	9.93388E-01	1.902E-15	1.29781E+02	6.584E-29	Not normal	
12	9.93579E-01	3.517E-15	1.14550E+02	1.336E-25	Not normal	
13	9.91801E-01	1.773E-17	1.60318E+02	1.539E-35	Not normal	
14	9.92162E-01	4.878E-17	1.42704E+02	1.029E-31	Not normal	
15	9.92932E-01	4.671E-16	1.40955E+02	2.466E-31	Not normal	
16	9.90357E-01	4.281E-19	2.15505E+02	1.599E-47	Not normal	
17	9.90875E-01	1.565E-18	2.04378E+02	4.167E-45	Not normal	
18	9.90581E-01	7.487E-19	2.12671E+02	6.593E-47	Not normal	
19	9.90694E-01	9.988E-19	2.00431E+02	2.999E-44	Not normal	
20	9.89338E-01	3.927E-20	2.35828E+02	6.174E-52	Not normal	
21	9.90582E-01	7.608E-19	2.18003E+02	4.585E-48	Not normal	
22	9.89335E-01	3.935E-20	2.41961E+02	2.876E-53	Not normal	
23	9.88248E-01	3.626E-21	2.57471E+02	1.233E-56	Not normal	
24	9.88549E-01	6.936E-21	2.44250E+02	9.158E-54	Not normal	
25	9.88826E-01	1.275E-20	2.39327E+02	1.073E-52	Not normal	
26	9.89412E-01	4.770E-20	2.26957E+02	5.210E-50	Not normal	
27	9.87812E-01	1.482E-21	2.55804E+02	2.837E-56	Not normal	
28	9.87839E-01	1.572E-21	2.34187E+02	1.402E-51	Not normal	
29	9.86998E-01	2.894E-22	2.50389E+02	4.254E-55	Not normal	
30	9.88783E-01	1.186E-20	2.10727E+02	1.743E-46	Not normal	
31	9.89860E-01	1.381E-19	2.04414E+02	4.094E-45	Not normal	
32	9.89923E-01	1.608E-19	2.08619E+02	5.000E-46	Not normal	
33	9.90607E-01	8.502E-19	1.91309E+02	2.869E-42	Not normal	
34	9.91449E-01	7.459E-18	1.73201E+02	2.454E-38	Not normal	
35	9.91717E-01	1.541E-17	1.71012E+02	7.333E-38	Not normal	
36	9.91824E-01	2.072E-17	1.74560E+02	1.244E-38	Not normal	
37	9.91692E-01	1.450E-17	1.73642E+02	1.969E-38	Not normal	
38	9.89835E-01	1.339E-19	2.17576E+02	5.676E-48	Not normal	
39	9.89821E-01	1.304E-19	2.16238E+02	1.108E-47	Not normal	
40	9.90322E-01	4.339E-19	1.97248E+02	1.473E-43	Not normal	
41	9.90331E-01	4.453E-19	2.12245E+02	8.157E-47	Not normal	
42	9.89446E-01	5.526E-20	2.36413E+02	4.608E-52	Not normal	
43	9.88975E-01	1.919E-20	2.49414E+02	6.925E-55	Not normal	
44	9.90168E-01	3.041E-19	2.15949E+02	1.280E-47	Not normal	
45	9.90200E-01	3.297E-19	2.10547E+02	1.907E-46	Not normal	
46	9.90348E-01	4.741E-19	2.08255E+02	5.997E-46	Not normal	
47	9.90549E-01	7.811E-19	2.00747E+02	2.560E-44	Not normal	
48	9.89399E-01	5.097E-20	2.25125E+02	1.303E-49	Not normal	
49	9.89692E-01	1.006E-19	82	2.18733E+02	3.182E-48	Not normal

Table 3.25: Normality tests for .IXIC

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.87550E-01	1.246E-21	2.55660E+02	3.048E-56	Not normal	
2	9.87807E-01	2.112E-21	2.62966E+02	7.901E-58	Not normal	
3	9.86494E-01	1.576E-22	2.85009E+02	1.292E-62	Not normal	
4	9.87294E-01	7.550E-22	2.41641E+02	3.376E-53	Not normal	
5	9.85579E-01	2.896E-23	2.68243E+02	5.645E-59	Not normal	
6	9.88692E-01	1.398E-20	2.42945E+02	1.759E-53	Not normal	
7	9.86803E-01	2.911E-22	2.63641E+02	5.637E-58	Not normal	
8	9.84426E-01	3.829E-24	3.41511E+02	6.948E-75	Not normal	
9	9.85952E-01	5.854E-23	3.12050E+02	1.734E-68	Not normal	
10	9.87720E-01	1.835E-21	2.57995E+02	9.485E-57	Not normal	
11	9.88069E-01	3.789E-21	2.40364E+02	6.391E-53	Not normal	
12	9.85625E-01	3.254E-23	3.50576E+02	7.472E-77	Not normal	
13	9.88452E-01	8.586E-21	2.54031E+02	6.886E-56	Not normal	
14	9.89087E-01	3.451E-20	2.14950E+02	2.110E-47	Not normal	
15	9.89849E-01	1.978E-19	1.81239E+02	4.410E-40	Not normal	
16	9.90437E-01	8.118E-19	1.81291E+02	4.297E-40	Not normal	
17	9.90875E-01	2.423E-18	1.77948E+02	2.287E-39	Not normal	
18	9.91767E-01	2.522E-17	1.49588E+02	3.292E-33	Not normal	
19	9.90618E-01	1.284E-18	1.89536E+02	6.963E-42	Not normal	
20	9.90049E-01	3.241E-19	1.79869E+02	8.747E-40	Not normal	
21	9.90725E-01	1.691E-18	1.77501E+02	2.859E-39	Not normal	
22	9.89559E-01	1.040E-19	1.90957E+02	3.421E-42	Not normal	
23	9.90312E-01	6.169E-19	1.78434E+02	1.793E-39	Not normal	
24	9.90025E-01	3.114E-19	2.00009E+02	3.703E-44	Not normal	
25	9.90424E-01	8.162E-19	1.98640E+02	7.341E-44	Not normal	
26	9.90202E-01	4.790E-19	1.95875E+02	2.926E-43	Not normal	
27	9.91732E-01	2.375E-17	1.74345E+02	1.385E-38	Not normal	
28	9.90274E-01	5.747E-19	1.82972E+02	1.854E-40	Not normal	
29	9.91189E-01	5.685E-18	1.65905E+02	9.424E-37	Not normal	
30	9.93591E-01	5.765E-15	1.23259E+02	1.716E-27	Not normal	
31	9.92406E-01	1.582E-16	1.37685E+02	1.265E-30	Not normal	
32	9.92741E-01	4.214E-16	1.19990E+02	8.800E-27	Not normal	
33	9.91914E-01	3.995E-17	1.38552E+02	8.200E-31	Not normal	
34	9.91455E-01	1.164E-17	1.44734E+02	3.728E-32	Not normal	
35	9.91810E-01	3.030E-17	1.37991E+02	1.086E-30	Not normal	
36	9.91447E-01	1.148E-17	1.41355E+02	2.019E-31	Not normal	
37	9.91112E-01	4.822E-18	1.58011E+02	4.879E-35	Not normal	
38	9.91647E-01	1.977E-17	1.45345E+02	2.747E-32	Not normal	
39	9.91193E-01	5.990E-18	1.62591E+02	4.941E-36	Not normal	
40	9.89957E-01	2.839E-19	1.73157E+02	2.509E-38	Not normal	
41	9.90571E-01	1.253E-18	1.57146E+02	7.519E-35	Not normal	
42	9.89056E-01	3.645E-20	1.94457E+02	5.947E-43	Not normal	
43	9.90077E-01	3.820E-19	1.68763E+02	2.258E-37	Not normal	
44	9.90959E-01	3.354E-18	1.61598E+02	8.119E-36	Not normal	
45	9.90920E-01	3.052E-18	1.63432E+02	3.245E-36	Not normal	
46	9.89798E-01	2.007E-19	1.83463E+02	1.451E-40	Not normal	
47	9.90089E-01	4.002E-19	1.85424E+02	5.440E-41	Not normal	
48	9.91085E-01	4.702E-18	1.62530E+02	5.095E-36	Not normal	
49	9.91684E-01	2.282E-17	83	1.53190E+02	5.434E-34	Not normal

Table 3.26: Normality tests for .KS11

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.86440E-01	1.825E-22	3.84634E+02	3.004E-84	Not normal	
2	9.90211E-01	5.580E-19	2.26815E+02	5.593E-50	Not normal	
3	9.83329E-01	7.829E-25	5.38173E+02	1.371E-117	Not normal	
4	9.78152E-01	3.972E-28	6.48400E+02	1.592E-141	Not normal	
5	9.72849E-01	6.227E-31	6.80409E+02	1.782E-148	Not normal	
6	9.70908E-01	7.505E-32	6.68335E+02	7.462E-146	Not normal	
7	9.69248E-01	1.339E-32	6.55716E+02	4.103E-143	Not normal	
8	9.67446E-01	2.236E-33	7.01645E+02	4.362E-153	Not normal	
9	9.63853E-01	7.814E-35	6.98098E+02	2.570E-152	Not normal	
10	9.62603E-01	2.598E-35	6.73533E+02	5.549E-147	Not normal	
11	9.69219E-01	1.331E-32	5.76579E+02	6.273E-126	Not normal	
12	9.73563E-01	1.457E-30	5.42676E+02	1.444E-118	Not normal	
13	9.75367E-01	1.226E-29	5.61295E+02	1.307E-122	Not normal	
14	9.75760E-01	1.989E-29	4.85258E+02	4.241E-106	Not normal	
15	9.74028E-01	2.533E-30	5.09268E+02	2.594E-111	Not normal	
16	9.71599E-01	1.671E-31	5.56599E+02	1.368E-121	Not normal	
17	9.65757E-01	4.702E-34	6.06756E+02	1.757E-132	Not normal	
18	9.62404E-01	2.296E-35	6.46633E+02	3.850E-141	Not normal	
19	9.61020E-01	7.048E-36	6.58655E+02	9.438E-144	Not normal	
20	9.60130E-01	3.365E-36	6.52671E+02	1.881E-142	Not normal	
21	9.62278E-01	2.096E-35	6.00010E+02	5.123E-131	Not normal	
22	9.62078E-01	1.773E-35	6.08433E+02	7.595E-133	Not normal	
23	9.60132E-01	3.435E-36	6.57663E+02	1.550E-143	Not normal	
24	9.59747E-01	2.513E-36	6.71493E+02	1.539E-146	Not normal	
25	9.61251E-01	8.903E-36	6.44110E+02	1.359E-140	Not normal	
26	9.65693E-01	4.676E-34	5.74196E+02	2.065E-125	Not normal	
27	9.64548E-01	1.636E-34	5.87192E+02	3.111E-128	Not normal	
28	9.65936E-01	5.945E-34	5.61331E+02	1.284E-122	Not normal	
29	9.64363E-01	1.401E-34	5.80363E+02	9.457E-127	Not normal	
30	9.62605E-01	2.946E-35	6.12730E+02	8.858E-134	Not normal	
31	9.64647E-01	1.835E-34	5.98167E+02	1.288E-130	Not normal	
32	9.64927E-01	2.385E-34	6.07082E+02	1.492E-132	Not normal	
33	9.66910E-01	1.548E-33	5.72683E+02	4.401E-125	Not normal	
34	9.69576E-01	2.199E-32	5.19555E+02	1.514E-113	Not normal	
35	9.70502E-01	5.784E-32	5.31430E+02	3.994E-116	Not normal	
36	9.72828E-01	7.262E-31	5.03801E+02	3.991E-110	Not normal	
37	9.73889E-01	2.444E-30	4.93091E+02	8.447E-108	Not normal	
38	9.72206E-01	3.683E-31	5.29884E+02	8.653E-116	Not normal	
39	9.72716E-01	6.516E-31	5.09752E+02	2.036E-111	Not normal	
40	9.75113E-01	1.050E-29	4.85616E+02	3.547E-106	Not normal	
41	9.75421E-01	1.530E-29	4.73337E+02	1.645E-103	Not normal	
42	9.77717E-01	2.754E-28	4.30834E+02	2.791E-94	Not normal	
43	9.77158E-01	1.344E-28	4.51231E+02	1.038E-98	Not normal	
44	9.75391E-01	1.501E-29	5.02352E+02	8.235E-110	Not normal	
45	9.77437E-01	1.947E-28	4.56307E+02	8.206E-100	Not normal	
46	9.80914E-01	2.340E-26	3.88156E+02	5.164E-85	Not normal	
47	9.78484E-01	7.801E-28	4.51983E+02	7.130E-99	Not normal	
48	9.78487E-01	7.873E-28	4.60343E+02	1.091E-100	Not normal	
49	9.81108E-01	3.166E-26	84	4.01493E+02	6.562E-88	Not normal

Table 3.27: Normality tests for .KSE

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.93671E-01	4.600E-15	1.26177E+02	3.990E-28	Not normal	
2	9.95273E-01	1.465E-12	9.61756E+01	1.305E-21	Not normal	
3	9.95917E-01	2.132E-11	6.65455E+01	3.547E-15	Not normal	
4	9.95322E-01	1.792E-12	8.77559E+01	8.791E-20	Not normal	
5	9.96310E-01	1.244E-10	6.83271E+01	1.455E-15	Not normal	
6	9.93750E-01	6.067E-15	1.24236E+02	1.053E-27	Not normal	
7	9.95129E-01	8.449E-13	8.87720E+01	5.289E-20	Not normal	
8	9.95225E-01	1.235E-12	9.26779E+01	7.503E-21	Not normal	
9	9.96328E-01	1.373E-10	6.57977E+01	5.155E-15	Not normal	
10	9.94532E-01	9.146E-14	1.03688E+02	3.051E-23	Not normal	
11	9.95049E-01	6.307E-13	9.63935E+01	1.171E-21	Not normal	
12	9.94362E-01	5.028E-14	1.08776E+02	2.396E-24	Not normal	
13	9.94781E-01	2.298E-13	9.76851E+01	6.137E-22	Not normal	
14	9.92208E-01	5.590E-17	1.59781E+02	2.014E-35	Not normal	
15	9.94628E-01	1.318E-13	1.00105E+02	1.830E-22	Not normal	
16	9.94318E-01	4.357E-14	1.02856E+02	4.624E-23	Not normal	
17	9.92986E-01	5.595E-16	1.24568E+02	8.920E-28	Not normal	
18	9.96222E-01	8.660E-11	7.41322E+01	7.987E-17	Not normal	
19	9.95113E-01	8.281E-13	9.73738E+01	7.171E-22	Not normal	
20	9.95702E-01	8.951E-12	7.20741E+01	2.235E-16	Not normal	
21	9.96298E-01	1.237E-10	7.36937E+01	9.945E-17	Not normal	
22	9.96948E-01	2.940E-09	6.24549E+01	2.742E-14	Not normal	
23	9.95793E-01	1.329E-11	7.63296E+01	2.662E-17	Not normal	
24	9.92659E-01	2.150E-16	1.39536E+02	5.013E-31	Not normal	
25	9.94730E-01	1.985E-13	1.08189E+02	3.214E-24	Not normal	
26	9.95429E-01	2.963E-12	8.51408E+01	3.250E-19	Not normal	
27	9.93814E-01	8.106E-15	1.03366E+02	3.584E-23	Not normal	
28	9.94092E-01	2.078E-14	1.06638E+02	6.980E-24	Not normal	
29	9.94198E-01	3.004E-14	1.17021E+02	3.883E-26	Not normal	
30	9.94886E-01	3.611E-13	9.84239E+01	4.242E-22	Not normal	
31	9.95793E-01	1.362E-11	7.60747E+01	3.024E-17	Not normal	
32	9.95962E-01	2.833E-11	7.39995E+01	8.535E-17	Not normal	
33	9.95822E-01	1.548E-11	7.49470E+01	5.314E-17	Not normal	
34	9.95414E-01	2.852E-12	8.29591E+01	9.675E-19	Not normal	
35	9.95688E-01	8.849E-12	7.93634E+01	5.841E-18	Not normal	
36	9.94510E-01	9.237E-14	1.10142E+02	1.211E-24	Not normal	
37	9.94690E-01	1.779E-13	1.01442E+02	9.378E-23	Not normal	
38	9.95099E-01	8.354E-13	9.44645E+01	3.071E-21	Not normal	
39	9.95172E-01	1.112E-12	8.72155E+01	1.152E-19	Not normal	
40	9.94773E-01	2.445E-13	9.75135E+01	6.687E-22	Not normal	
41	9.95096E-01	8.323E-13	9.23228E+01	8.961E-21	Not normal	
42	9.94708E-01	1.934E-13	9.50134E+01	2.334E-21	Not normal	
43	9.95636E-01	7.286E-12	7.61256E+01	2.948E-17	Not normal	
44	9.95272E-01	1.675E-12	8.53532E+01	2.923E-19	Not normal	
45	9.94277E-01	4.179E-14	9.96395E+01	2.310E-22	Not normal	
46	9.95765E-01	1.266E-11	7.50262E+01	5.108E-17	Not normal	
47	9.96032E-01	4.026E-11	6.54330E+01	6.186E-15	Not normal	
48	9.96537E-01	4.109E-10	6.32349E+01	1.857E-14	Not normal	
49	9.96488E-01	3.256E-10	85	6.51290E+01	7.201E-15	Not normal

Table 3.28: Normality tests for .MXX

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.88215E-01	6.786E-21	2.74141E+02	2.959E-60	Not normal	
2	9.89674E-01	1.691E-19	1.98225E+02	9.035E-44	Not normal	
3	9.89443E-01	1.000E-19	1.93883E+02	7.923E-43	Not normal	
4	9.87396E-01	1.284E-21	2.14091E+02	3.242E-47	Not normal	
5	9.88613E-01	1.609E-20	2.03135E+02	7.760E-45	Not normal	
6	9.89426E-01	9.758E-20	1.86412E+02	3.320E-41	Not normal	
7	9.87495E-01	1.587E-21	2.32350E+02	3.514E-51	Not normal	
8	9.89578E-01	1.393E-19	1.92149E+02	1.886E-42	Not normal	
9	9.89860E-01	2.682E-19	1.71466E+02	5.843E-38	Not normal	
10	9.90798E-01	2.610E-18	1.70879E+02	7.835E-38	Not normal	
11	9.90979E-01	4.134E-18	1.73974E+02	1.667E-38	Not normal	
12	9.90499E-01	1.253E-18	1.81569E+02	3.740E-40	Not normal	
13	9.89522E-01	1.252E-19	1.86487E+02	3.198E-41	Not normal	
14	9.88889E-01	3.052E-20	1.87780E+02	1.675E-41	Not normal	
15	9.89658E-01	1.724E-19	1.93198E+02	1.116E-42	Not normal	
16	9.88694E-01	2.015E-20	2.17204E+02	6.837E-48	Not normal	
17	9.88266E-01	8.127E-21	2.10832E+02	1.654E-46	Not normal	
18	9.89604E-01	1.543E-19	1.78454E+02	1.775E-39	Not normal	
19	9.86511E-01	2.453E-22	2.37088E+02	3.288E-52	Not normal	
20	9.88157E-01	6.557E-21	2.37200E+02	3.109E-52	Not normal	
21	9.87001E-01	6.373E-22	2.43311E+02	1.464E-53	Not normal	
22	9.86879E-01	5.047E-22	2.54836E+02	4.603E-56	Not normal	
23	9.87487E-01	1.684E-21	2.45385E+02	5.192E-54	Not normal	
24	9.88403E-01	1.120E-20	2.25477E+02	1.092E-49	Not normal	
25	9.88222E-01	7.671E-21	2.28978E+02	1.897E-50	Not normal	
26	9.86518E-01	2.572E-22	2.57619E+02	1.145E-56	Not normal	
27	9.87619E-01	2.239E-21	2.38516E+02	1.610E-52	Not normal	
28	9.87186E-01	9.464E-22	2.21514E+02	7.922E-49	Not normal	
29	9.88638E-01	1.892E-20	1.88525E+02	1.154E-41	Not normal	
30	9.87814E-01	3.376E-21	1.94727E+02	5.194E-43	Not normal	
31	9.87019E-01	6.917E-22	2.14849E+02	2.219E-47	Not normal	
32	9.87835E-01	3.553E-21	2.05047E+02	2.983E-45	Not normal	
33	9.88446E-01	1.279E-20	2.06880E+02	1.193E-45	Not normal	
34	9.87721E-01	2.842E-21	2.25014E+02	1.377E-49	Not normal	
35	9.88429E-01	1.243E-20	2.17029E+02	7.459E-48	Not normal	
36	9.86666E-01	3.573E-22	2.15144E+02	1.915E-47	Not normal	
37	9.84379E-01	5.783E-24	2.93067E+02	2.298E-64	Not normal	
38	9.84276E-01	4.877E-24	3.11502E+02	2.282E-68	Not normal	
39	9.86129E-01	1.316E-22	2.65346E+02	2.403E-58	Not normal	
40	9.87464E-01	1.740E-21	2.41113E+02	4.395E-53	Not normal	
41	9.84993E-01	1.706E-23	2.88200E+02	2.620E-63	Not normal	
42	9.83237E-01	8.903E-25	3.22274E+02	1.045E-70	Not normal	
43	9.84616E-01	8.944E-24	2.92313E+02	3.350E-64	Not normal	
44	9.86829E-01	5.077E-22	2.42669E+02	2.019E-53	Not normal	
45	9.85234E-01	2.660E-23	2.83897E+02	2.252E-62	Not normal	
46	9.84861E-01	1.387E-23	2.81516E+02	7.406E-62	Not normal	
47	9.84861E-01	1.394E-23	3.02392E+02	2.169E-66	Not normal	
48	9.85650E-01	5.701E-23	2.92386E+02	3.230E-64	Not normal	
49	9.86966E-01	6.781E-22	86	2.49745E+02	5.870E-55	Not normal

Table 3.29: Normality tests for .N225

BIBLIOGRAPHY

Δ	Shapiro-Wilk (stat)	Shapiro-Wilk (p-value)	K^2 (stat)	K^2 (p-value)	Conclusion	
1	9.81830E-01	1.326E-22	2.57393E+02	1.282E-56	Not normal	
2	9.80569E-01	2.360E-23	2.86157E+02	7.273E-63	Not normal	
3	9.84890E-01	1.341E-20	2.18135E+02	4.290E-48	Not normal	
4	9.82573E-01	3.911E-22	2.26599E+02	6.233E-50	Not normal	
5	9.84809E-01	1.192E-20	1.95294E+02	3.912E-43	Not normal	
6	9.83299E-01	1.155E-21	2.10738E+02	1.733E-46	Not normal	
7	9.85130E-01	2.028E-20	2.04436E+02	4.049E-45	Not normal	
8	9.91799E-01	1.137E-14	1.10466E+02	1.029E-24	Not normal	
9	9.88919E-01	1.911E-17	1.66502E+02	6.992E-37	Not normal	
10	9.88661E-01	1.148E-17	1.46800E+02	1.327E-32	Not normal	
11	9.90146E-01	2.508E-16	1.37639E+02	1.295E-30	Not normal	
12	9.85579E-01	4.377E-20	1.95662E+02	3.254E-43	Not normal	
13	9.89369E-01	4.876E-17	1.43825E+02	5.871E-32	Not normal	
14	9.89160E-01	3.192E-17	1.44120E+02	5.067E-32	Not normal	
15	9.88866E-01	1.774E-17	1.37067E+02	1.723E-30	Not normal	
16	9.88035E-01	3.526E-18	1.53196E+02	5.419E-34	Not normal	
17	9.87314E-01	9.261E-19	1.56431E+02	1.075E-34	Not normal	
18	9.87140E-01	6.791E-19	1.63220E+02	3.608E-36	Not normal	
19	9.87622E-01	1.652E-18	1.59592E+02	2.213E-35	Not normal	
20	9.86218E-01	1.354E-19	1.81494E+02	3.883E-40	Not normal	
21	9.87328E-01	9.719E-19	1.59302E+02	2.558E-35	Not normal	
22	9.89962E-01	1.784E-16	1.18363E+02	1.985E-26	Not normal	
23	9.87937E-01	3.046E-18	1.59285E+02	2.581E-35	Not normal	
24	9.87858E-01	2.638E-18	1.65530E+02	1.137E-36	Not normal	
25	9.87879E-01	2.759E-18	1.48597E+02	5.402E-33	Not normal	
26	9.87807E-01	2.423E-18	1.62718E+02	4.638E-36	Not normal	
27	9.87901E-01	2.911E-18	1.46404E+02	1.617E-32	Not normal	
28	9.89613E-01	8.783E-17	1.34495E+02	6.234E-30	Not normal	
29	9.88263E-01	5.868E-18	1.68074E+02	3.186E-37	Not normal	
30	9.88271E-01	5.983E-18	1.43432E+02	7.146E-32	Not normal	
31	9.86313E-01	1.699E-19	1.61722E+02	7.631E-36	Not normal	
32	9.87928E-01	3.146E-18	1.49322E+02	3.760E-33	Not normal	
33	9.91075E-01	2.274E-15	1.14195E+02	1.596E-25	Not normal	
34	9.90375E-01	4.678E-16	1.24178E+02	1.084E-27	Not normal	
35	9.90390E-01	4.861E-16	1.34818E+02	5.305E-30	Not normal	
36	9.88521E-01	1.006E-17	1.63154E+02	3.730E-36	Not normal	
37	9.88808E-01	1.781E-17	1.57426E+02	6.537E-35	Not normal	
38	9.87275E-01	9.717E-19	1.61394E+02	8.989E-36	Not normal	
39	9.86950E-01	5.440E-19	1.74383E+02	1.359E-38	Not normal	
40	9.85678E-01	6.086E-20	1.82483E+02	2.367E-40	Not normal	
41	9.87940E-01	3.388E-18	1.62436E+02	5.338E-36	Not normal	
42	9.88603E-01	1.220E-17	1.59646E+02	2.154E-35	Not normal	
43	9.88309E-01	6.919E-18	1.76130E+02	5.675E-39	Not normal	
44	9.87748E-01	2.402E-18	1.81669E+02	3.557E-40	Not normal	
45	9.89386E-01	5.996E-17	1.54736E+02	2.509E-34	Not normal	
46	9.89375E-01	5.895E-17	1.49606E+02	3.262E-33	Not normal	
47	9.87570E-01	1.755E-18	1.73102E+02	2.578E-38	Not normal	
48	9.87297E-01	1.071E-18	1.77508E+02	2.849E-39	Not normal	
49	9.90288E-01	4.176E-16	87	1.33294E+02	1.136E-29	Not normal

Table 3.30: Normality tests for .OMXC20

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Appendix B. Estimation Code.

```

def rlz_vol_est(df: pd.DataFrame,
                 count: int,
                 rolling_window: int=1) -> np.ndarray:
    log_returns = np.zeros(int(df.shape[0]/rolling_window))
    for i in range(1, log_returns.size):
        log_returns[i] =
            math.log(df["Mean"][i*rolling_window]/
                     df["Mean"][(i-1)*rolling_window])

    rlz_vol = np.zeros(int(log_returns.size/count))

    for i in range(rlz_vol.size):
        lr_n = np.zeros(count)
        for n in range(count):
            lr_n[n] = log_returns[i*count+n]

        tmp = 0.0
        for j in range(1, lr_n.size):
            tmp += (lr_n[j] - lr_n[j-1])**2

        rlz_vol[i] = math.sqrt(tmp)

    return rlz_vol


def hurst_estimation(name: str,
                      mode: str = 'yf',
                      rolling_window: int = 1,
                      show_pics = True,
                      save_pics = False):
    if mode == 'yf':
        count = days_count
        df = yf.download(name, '2000-01-01', '2019-01-01')
        df["Mean"] = 0.5*(df["Open"]+df["Close"])

    elif mode == 'bb':
        count = minutes_count
        df = pd.read_csv('data_bloomberg/'+name+'.csv', sep="\t")
        df["Mean"] = 0.5*(df["High"]+df["Low"])

    volatility_array = rlz_vol_est(df = df,
                                    count = count,
                                    rolling_window = rolling_window)
    zetaq = np.zeros((2, num_of_q))

    for I in range(0, num_of_q):
        graph_data = np.zeros((2, pD-sD))
        q = step_of_q*(1+I)

```

```

line_start = math.log(sD)
line_stop = math.log(pD)

for Delta in range(sD, pD):
    graph_data[0, Delta-sD] = math.log(Delta)
    graph_data[1, Delta-sD] = math.log(m(q, Delta, volatility_array))

linear_model      = np.polyfit(graph_data[0],graph_data[1], 1)
linear_model_fn = np.poly1d(linear_model)
x_s              = np.arange(line_start, line_stop, 0.1)

skew_of_linear_model = skew(line_start,
                            line_stop,
                            linear_model_fn(line_start),
                            linear_model_fn(line_stop))

zetaq[0, I] = q
zetaq[1, I] = skew_of_linear_model

linear_model_H      = np.polyfit(zetaq[0], zetaq[1], 1)
linear_model_H_fn = np.poly1d(linear_model_H)
x_s                = np.arange(0, step_of_q*(num_of_q+1), step_of_q)

H_est = skew(0,
             step_of_q*(num_of_q)+1,
             linear_model_H_fn(0),
             linear_model_H_fn(step_of_q*(num_of_q)+1))

sz = 40
graph_data = np.zeros((2, sz))

for Delta in range(1, sz+1):
    graph_data[0, Delta-1] = Delta**(2*H_est)
    graph_data[1, Delta-1] = ACov(volatility_array, Delta)

linear_model      = np.polyfit(graph_data[0],graph_data[1], 1)
linear_model_fn = np.poly1d(linear_model)
x_s              = np.arange(1, (sz+1)**(2*H_est), 0.1)

for Delta in range(1, sz+1):
    graph_data[0, Delta-1] = math.log(Delta)

linear_model      = np.polyfit(graph_data[0],graph_data[1], 1)
linear_model_fn = np.poly1d(linear_model)
x_s              = np.arange(0, math.log(sz+1), 0.1)

def lag_array(Delta):
    retarr = np.zeros(volatility_array.size - Delta)
    if Delta >= 0:

```

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```

        for i in range(0, volatility_array.size-Delta):
            retarr[i] = np.log(volatility_array[i+Delta]) -
                        np.log(volatility_array[i])
        else:
            for i in range(0, volatility_array.size-math.abs(Delta)):
                retarr[i] = np.log(volatility_array[i]) -
                            np.log(volatility_array[i-Delta])

        retarr = retarr/retarr.max()
        return retarr

    return H_est

def f(theta):
    return (1/((2*H+1)*(2*H+2)*theta**2)*((1+theta)**(2*H+2) - 2
        - 2 * theta**(2*H+2) + (1-theta)**(2*H+2)))

def smoothing_theoretical(delta: float):
    num_of_Deltas = 200
    plot = np.zeros((2, num_of_Deltas))

    Delta = np.arange(1, num_of_Deltas+1, 1)
    plot[0] = np.log(Delta)
    plot[1] = np.log(Delta**(2*H) * f(delta/Delta))

    linear_model      = np.polyfit(plot[0],plot[1], 1)
    linear_model_fn = np.poly1d(linear_model)
    x_s              = np.arange(0, 5, 0.1)

    print(skew(0, 1, linear_model_fn(0), linear_model_fn(1))*0.5)
    print(skew(0, 1, linear_model_fn(0), linear_model_fn(1))*0.5/H - 1)

def smoothing_empirical(name: str, show_pics: bool=True):
    num_of_wind = 20
    graph_data = np.zeros((2, num_of_wind))
    for i in range(1, num_of_wind+1):
        graph_data[0, i-1] = i
        graph_data[1, i-1] = analyse_volatility(name=name,
                                                mode='bb',
                                                rolling_window=i,
                                                show_pics=False)

    return [np.mean(graph_data[1]),
           np.std(graph_data[1]),
           np.min(graph_data[1])]

```