CHAPTER III : RESEARCH METHODOLOGY

3.1 Introduction

This section describes the methodology of the research. The data was examined for outliers and subjected to time series tests to ensure it was suitable for beta analysis. Furthermore, the return was then filtered to capture only returns below zero threshold. The downside beta values using the HV, EWMA and GARCH was computed. In establishing whether the results are in check, a variant of beta was introduced. This analysis of downside beta involves dividing the covariance of the market with the individual returns against the variance of the market. Finally, the Sortino ratio was sought from using the established GARCH (1,1) beta scores of the two portfolio. Similarly, in ensuring robustness of the Sortino results, the EWMA beta scores was used as a complimentary method.

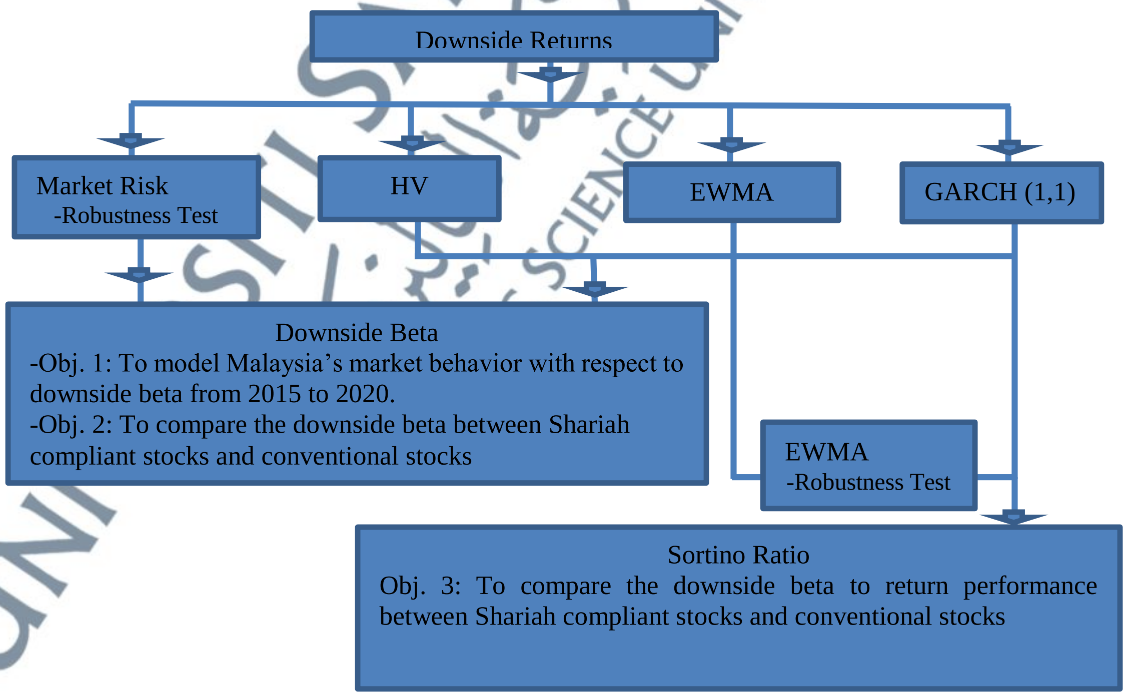

Figure 3.1 : Schematic Design Of The Research

3.2 Research Design

The randomly selected companies are highlighted in the table below, composed of 50 Shariah-compliant companies and 50 conventional companies. The stocks were all selected from the main market of FTSE Bursa Malaysia. As a result, each stock has equal probability to be selected. Moreover, the vast number of stocks considered in each pool (50 Shariah-compliant stocks and 50 conventional stocks) allows for reasonable downside beta measures.

3.2.1 Selection Criteria for Firms

The firm selections were randomly done, however, a few criteria were maintained to ensure there is clear distinction between Shariah-compliant stocks against their conventional counterparts. The criteria are listed below:

Criteria for Shariah-compliant stocks

1. It is constituted from the main market of FTSE Bursa Malaysia.
2. Listed as Shariah-compliant under Bursa Market Place (2020).
3. Has a total number of 1239 trading days.
4. Firm listed under Yahoo Finance.
5. Traded currency in Malaysian Ringgit.

Criteria for conventional stocks

1. It is constituted from the main market of FTSE Bursa Malaysia.
2. Not listed as Shariah-compliant under Bursa Market Place (2020).
3. Has a total number of 1239 trading days.
4. Firm listed under Yahoo Finance.
5. Traded currency in Malaysian Ringgit.

Table 3.1: Shariah-Compliant And Conventional Companies

Shariah-Compliant Companies				***Conventional Companies***			
No	**Company**	**No**	**Company**	**No**	**Company**	**No.**	**Company**
1	Adventa	26	Pansar	51	Abmb	76	K-Star Sports
2	Ancom	27	Pantec	52	Aeon Credit Services	77	Hume Ind
3	Apm Automotive	28	Petra Energy	53	Am Bank	78	Lien Hoe Corp
4	Astino	29	Pan Malaysia Hldgs	54	British Ame Toba	79	Leader Stl Hldg
5	Bimb Hlds	30	Public Packages	55	Berjaya Asset	80	Maybank Bhd
6	Borneo Oil	31	Sapind	56	Berjaya Corp	81	Metrod Hld
7	Cb Ind Product Hld.	32	Sarawak Consolidated	57	Brem Holdings	82	Majuperak Hldgs
8	Cocoaland Hlds	33	Sbccorp	58	Bumi Armada	83	Pavilion Real Estate
9	Complete Logistic	34	Scanwolf Corp	59	Carlsberg Brew	84	Public Bank Bhd
10	Dutch Lady	35	Scgm	60	Cimb Grp Bhd	85	Pentamaster Corp
11	Emico	36	Shh Resources	61	Dolomite Corp	86	Plb Engineering
12	Fiamma Hlds	37	Sig Gases	62	Eco World Dev	87	Lbi Cap
13	Goodway Integrated	38	Sig Int	63	Luster Industries	88	Rhbank
14	Ijm Corp	39	Sime Darby Bhd	64	Eksons Corporations	89	Samchem
15	Ioicorp	40	Slp Resources	65	Facb Industries	90	Southern Steel
16	Ivory Properties	41	Spritzer	66	Warisan	91	Tasco Berhad
17	Kl Kepong	42	Success Transformer	67	Genting Bhd	92	Tan Chong Motor
18	Kretam Prop	43	Superlon Hldgs	68	Elk-Desa Resources	93	Tdm Berhad
19	Matrix Concepts	44	Taann	69	Hap Seng C. Bhd	94	Teck Guan P'dana
20	Mesb	45	Tasek	70	Maa Group	95	Texchem Res'rces
21	Misc	46	Teo Seng Capital	71	Hexza Corpn	96	Digistar
22	Mesiniaga	47	Time Dotcom	72	Hong Leong Bank	97	Yung Kong Galvan
23	Nestle	48	Tong Herr Resources	73	Igb Reit	98	Ytl Corporation
24	Notion	49	Tsh Resources	74	Ijm Plantations	99	Mphb Capital
25	Ntpm	50	Pestech	75	Johan Holdings	100	Pensonic Holdgs

3.2.2 Bursa Malaysia: Market Index

The market proxy is FTSE Bursa Malaysia Kuala Lumpur Stock Exchange Composite Index (FBM KLCI). FBM KLCI is a weight capitalized return series which is used to gauge the overall performance of the Malaysian market. The distinguishing criteria for selecting FBM KLCI returns as the ideal index for this research is centered on the fact that:

1. The scope of this research is limited to Malaysian firms
2. The FBM KLCI adopts the FTSE policies. It is run on international standards, normalizing it across different markets in the diaspora. This is

helpful for bases of future research where comparisons can be made quite easily with other international markets.

$$\text{Index} = \frac{Current\ aggregate\ market\ capitalization}{Base\ aggregate\ market\ capitaliztion} \times 100 \qquad (3.1)$$

3.2.3 Computing Rate of Return

Return is simply a measure of how much money an investor gains or losses on an investment. It is a fundamental index in our computation of downside beta, which ultimately discloses the level of beta. The daily stock returns (u_{n-i}) was generated by:

$$Return_t = u_{n-i} = Ln\left(\frac{Price_t}{Price_{t-1}}\right) \qquad (3.2)$$

Where

$Return_t$: u_{n-i} : Stock Return at time t,

Ln: Natural Logarithm,

$Price_t$: Stock price at time t,

$Price_{t-1}$: Stock price at time t – 1.

Then, the target return is set at 0. This becomes the mean ($\bar{u}$) return to differentiate the downside returns from upside returns. It is denoted by:

$$\bar{u}_i = 0 \qquad (3.3)$$

The methods for modelling downside beta using the HV, EWMA and GARCH (1,1) methods are then reflected in the subsequent section.

3.3 Historical Volatility Method

The Historical Volatility Method (HV Method) allowed for the realization of the first and second objectives as it is a measure of downside beta. It is obtained through computing the squared downward deviation from a benchmark (FTSE KLCI). In more analytical terms, it is expressed by Post, Vilet & Lansdorp (2012) as:

$$\beta_{sv,i} \equiv \frac{E\ [R_m R_i \mid R_m \leq 0]}{E\ [R_m^2 \mid R_m \leq 0]} = \frac{Covariance\ (R_{m,} R_i)}{Variance\ (R_m)} \tag{3.4}$$

The numerator details the covariance between the market and the stock returns while the denominator highlights the variance of the market returns. After sorting the returns for Shariah-compliant stocks and conventional stocks, the variance of each portfolio was computed. Firstly, the daily returns are each subtracted from the target return (0). Then, the values obtained were each squared and summed up. Finally, the result was divided by the total number of trading days in the sample size. In statistical terms, it is denoted by:

$$\sigma_n^2 = \frac{1}{m-1} \sum_{i=1}^{m} (u_{n-i} - \bar{u})^2 \tag{3.5}$$

Where

σ^2 : Variance,

m : Number of trading days,

u_{n-i} : Return on i^{th} asset,

$\bar{u}$: Return threshold that separates losses from gains.

The standard deviation is then given by taking the square root of the variance.

$$\sigma = \sqrt{\sigma^2} = \sqrt{\frac{1}{m-1} \sum_{i=1}^{m} (u_{n-i} - \bar{u})^2} \tag{3.6}$$

Where

M= 37 days.

NB: The beta for the 38^{th} day was calculated by using the returns of the first 37 days. Therefore, there is no recorded daily beta for the first 37 days because the returns were used as statistics to inform on the beta for the 38^{th} working day. This is not necessary for the HV but for the EWMA. Therefore, to maintain consistency, the HV was computed for the whole 5-year period, except the first 2 months of 2015.

3.4 EWMA Method

The EWMA is an instrument that detects smaller fluctuations in the mean of data points constrained by time. Similar to the HV method, the EWMA was also utilized to obtain both the first and second objectives of the study. By way of assumption, the EWMA is significant only when observations are normally distributed. In our computation of beta, the EWMA allows for flexibility in more recent weights having a higher influence on the beta as opposed to previous periods. The innovation of the EWMA over the HV method is the addition of weights which assign higher magnitude to more recent returns. Therefore, the 37 days' variance are such that the 37th day carries 94% of the total weight. This is called the smoothing parameter. The 36th day is assigned a weight of (94% of the weight of day 37). The 35th day is assigned a weight of (94% of the weight the 36th day), and so on. This implies that yesterday's return has a much higher influence in predicting today's returns as compared to the long run history. It is noteworthy to recognize that the introduced weights are allocated in an exponentially declining order. The analysis was done using Microsoft excel.

3.4.1 The Smoothing Parameter

The EWMA introduces a controlling/smoothing parameter lambda (λ) which is levered on each squared periodic return. λ is a decay factor that lies between 0 and 1. It is typically assigned a value of 85% to 96%. The decay factor's effects on the model is such that lower λ values will suppress the influence of more distant squared returns.

A lambda of 94% is chosen in this research as it is mainstream in most financial risk management companies (Morgan Stanley Capital International, n.d.). The weight for the most recent return was (1-94%), the subsequent weight recorded (94% of the (1-94%)) and so on. This is represented as:

$$\sigma_{t-1}^2 = \lambda\sigma_t^2 + (1-\lambda)r_{t-1}^2 \tag{3.7}$$

Where

λ : smoothing parameter,

σ : Variance,

r : stock return.

The EWMA uses a refined method of calculating the variance. This is given as, Wahab (2009):

$$\sigma^2 = \frac{(1-\lambda)\sum_{i=1}^{m}(\lambda^{i-1})(u_{n-i}-\bar{u})^2}{m-1} \tag{3.8}$$

Where

$(\lambda \mid 0 < \lambda < 1)$,

λ : Smoothing parameter.

In summary,

1. We first obtain the daily log returns for the different portfolios in our study.
2. Next, we find the return threshold that separates loses from gains. This is subtracted from the monthly log returns.
3. Then, the log returns subtracted from the return threshold is squared. This is the variance of the portfolio and it is represented by:

$$\sigma_n^2 = \frac{1}{m-1}\sum_{i=1}^{m}(u_{n-i} - \bar{u} \mid (u_{n-i} < \bar{u})^2 \qquad (3.9)$$

Where

σ^2 : Variance,

u_{n-i} : Portfolio return,

m : Number of days,

$\bar{u}$: Return threshold that separates losses from gains.

4. Assign weights to the returns in descending order of proportions with the most recent return carrying the most weight. The weights are assigned as $(1-\lambda)\lambda^{i=0}$ to the i^{th} return.
5. The squared returns are multiplied with their corresponding weights and summed up.
6. Finally, the value is divided by the total number of trading days to give the total downside variance of the portfolio. The square root of the variance yields the standard deviation.

A t-test is done to register the statistical significance of the difference in mean values amongst the two portfolios. The t-test was computed with a 95% confidence level.

3.5 GARCH

The GARCH (1,1) model is done using E-Views. The GARCH process is an improvement over the ARCH process which estimates beta based only on past variances. This was utilized in achieving both the first and second objectives. The strength of the GARCH is dependent on the fact that it also factors the lagged conditional variances. However, before downside beta can be modelled using the GARCH process, it needs to satisfy conditions under the ARCH process.

3.5.1 The ARCH Process

Financial time series exhibit certain futures that warrants the consideration of using ARCH models instead of homoscedastic models to estimate beta. Firstly, the effects of volatility clustering are very common in time series data. This means that moments of high and low beta are prevalent in a recursive manner throughout the time period. This consequently leads to a time varying conditional mean. Moreover, financial time series normally exhibit a mean reversion in the data.

The Autoregressive Conditional Heteroscedasticity (ARCH) indicates unequal variance in the time series that are auto-correlated. The variance is dependent on the auto-correlations of the returns and the error term.

Considering the ARIMA model where the error term is normally distributed and the variance is a constant, the price returns are modelled as (Ghani & Rahim, 2019):

$$y_t = C + \sum_{i=1}^{m} \emptyset_i y_{t-i} + \sum_{j=1}^{n} \theta_j \varepsilon_{t-j} \tag{3.10}$$

Where

y_t : Daily prices

C: Constant term

$\emptyset_t$: Autoregressive parameters

θ_t: Moving average parameters

ε_t: Error term

And

$$\sigma_t^2 = b_0 \tag{3.11}$$

Where

b_0 : constant

Therefore, allowing for a time varying error variance σ_t^2 and a distribution of the error term be conditionally normal such that:

$$\mu_t | I_{t-1} \sim N(0, h_t) \tag{3.12}$$

This yields the equation of beta under the ARCH (1) model as:

$$\sigma_t = b_0 + b_1 u_{t-1}^2 \tag{3.13}$$

Where

u_{t-1}^2: lagged square error at t-1,

b_0 : $b_0 > 0$: Constant term,

b_1: $0 < b_1 < 1$: Constant term.

The parameter for $b_1$is constrained otherwise the model will yield large values.

b_1> 0 indicates the squared errors contain positive serial correlation.

b_1< 0 indicates the squared errors contain negative serial correlation.

b_1= 0 indicates no serial correlation, ergo no time varying beta.

The ARCH (2) Model is given by:

$$\sigma_t = b_0 + b_1 u_{t-1}^2 + b_2 u_{t-2}^2 \tag{3.14}$$

ARCH (q):

$$\sigma_t = b_0 + b_1 u_{t-1}^2 + b_2 u_{t-2}^2 + \cdots + b_q u_{t-q}^2 \tag{3.15}$$

3.5.2 Testing for ARCH Effects

It is important to test for ARCH effects before estimating with ARCH models. Therefore, a general diagnostic was done on each time series. This is to ensure the returns satisfy the requirements for the methods. These included the ARCH Effect test and testing for stationarity tests.

a. The implored ARCH Effect test is the LM Test.

b. The implored stationarity test is the visual test.

The presence of ARCH effects gives the permission for the use of ARCH methods over the OLS. To test for ARCH effects, a visual plot is done to see the presence of volatility clustering.

The squared residuals are represented with the AR Model given below:

$$\hat{\mu}_t^2 = b_0 + b_1\hat{\mu}_{t-1}^2 + b_2\hat{\mu}_{t-2}^2 + \cdots + b_q\hat{\mu}_{t-q}^2 + e_t \quad (3.16)$$

Where

b_0: Intercept,

b_i: Parameters.

This is followed by hypothesis testing. The hypothesis proposes that the parameters have no effect on the squared residuals. While the alternative hypothesis suggests that the parameters do have an influence on the squared residuals. Therefore:

$H_0 : b_1 = 0$ [No ARCH effects present]

$H_A : b_1 \neq 0$ [ARCH effects present]

The significance of the parameters (b_i) means there is ARCH effect present. Therefore, testing for ARCH (1) effects gives:

$$\hat{\mu}_t^2 = b_0 + b_1\hat{\mu}_{t-1}^2 + e_t \quad (3.17)$$

Where

b_0: Intercept,

b_i: Parameters,

$\hat{\mu}_t^2$: Squared residual at time t,

e_t: White noise.

Consequently, failing to reject the null hypothesis means that the model is homoscedastic while rejecting the null indicates the model is heteroskedastic.

ARCH Effect Process using E-Views

The data for all the stocks used in this research passed the ARCH effect test and can therefore be modelled using the GARCH (1,1) process. The method for ARCH effect test is the Lagrange multiplier (LM). The test detects the presence of ARCH effects. If there exist ARCH effects, R-squared records relatively high compared to the GARCH term (b_1). Furthermore, the results show that the Obs*R-squared > Prob. Chi-Square (1). Therefore, the null is rejected and there is presence of ARCH effects. Therefore, the ARCH modelling techniques is used to calculate the beta. This is replicated to examine all the stock returns used in the research. The modelling software employed for the testing of ARCH effects is E-views. The steps are as follows:

1. The data for the returns is loaded
2. An estimation of the equation is done using OLS
3. A H-test is selected under residual diagnostics
4. ARCH effect test is selected

3.6 GARCH (1,1)

In addition to the standard deviation method of estimating downside beta for the selected portfolios in Malaysia, this paper also intends to use GARCH as a comparative measure of downside beta. The GARCH model is a variation of the ARCH model. The GARCH Model involves modelling the mean return series and also the conditional variance of the residuals (Emenike, 2010). It was first modeled by Engle (1982).

In a GARCH (a,b) model, the first letter (a) denotes how many autoregressive lags or ARCH terms appear in the equation and the second letter (b) refers to how many moving average lags are specified, as denoted by Engle (2001).

The Generalized Autoregressive Conditioned Heteroscedasticity GARCH (1,1) is a stochastic means of estimating a portfolio's beta, and in our specific case, downside beta. This involves first modelling the stock returns using a best-fitting Autoregressive (AR) model. Autoregressive simply means having enough statistical knowledge about the past that allows the efficient use of information to predict the future with sufficient accuracy. The error term refers to the sum of deviations within the regression line. It is generally calculated by accounting for all the points that fall outside the trend line. Lamoureux & Lastrapes (1990) claim persistent shocks of volatility are overrated using the standard GARCH model. The GARCH formula is given by taking the square root of the conditional variance, as denoted by Hamid & Hasan (2016):

$$\sigma_t^2 = \hat{h}_t = \omega + \theta_1 \hat{h}_{t-1} + b_1 \hat{u}^2{}_{n-1} \quad (3.18)$$

Where

$\hat{h}_{t-1}$: Conditional variance,

ω : Mean beta level,

$\hat{u}^2{}_{n-1}$: Squared error,

b_1: ARCH parameter,

θ_1: GARCH parameter.

The more distinct representation decomposes the ω term into two parts, defining it as the product of a weight and a long run variance:

$$\omega = \gamma V_L \tag{3.19}$$

Where,

γ : Weight assigned to long run variance

V_L : Long Run variance/conditional variance

The stability condition of the GARCH (1,1) model is such that:

$0 < \theta_1 < 1$, $0 < b_1 < 1$ and $\theta_1 + b_1 < 1$.

The GARCH (1,1) downside beta values are also subjected to a t-test to establish whether there is statistical significance of the difference in mean values between Shariah-compliant stocks and conventional stocks. The hypothesis proposes that there is no statistical difference in the mean downside beta value between the two portfolios. The t-test was done with a 95% confidence level.

The major differences between the three models used in this research is highlighted below.

Table 3.2: Major differences between the three model

Differences	HV Model	EWMA Model	GARCH Model
Number of weights	1	2	3
Greater weight to more recent returns	No	Yes	Yes
Mean reversion	No	No	Yes
Formula	$\sigma_n^2 = \frac{1}{m}\sum_{i=1}^{m}(u_{n-i} - \bar{u})^2$	$\sigma_n^2 = (1-\lambda){\mu^2}_{n-1} + \lambda{\sigma^2}_{n-1}$	$\hat{h}_t = \gamma V_L + \theta_1 \hat{h}_{t-1} + b_1 {\hat{u}^2}_{n-1}$

3.7 The Sortino Ratio

When doing a comparative study between beta and return premium, the commonly utilized method is the Sharpe ratio. The ratio basically subtracts the risk free or target return rate from a security's return and then divides the result with the security's standard deviation. However, for downside beta to return ratio, the Sortino ratio is utilized. The slight variation between the Sharpe and the Sortino ratio is the exclusion of upside beta in the Sortino Ratio. The Sortino ratio subtracts the target return or minimum acceptable return from the average returns and divides that value with the downside beta scores. This was implemented in achieving the third objective of the study. The minimum acceptable return score used in this research is 0. Moreover, a higher Sortino ratio indicates a more efficient portfolio with a higher beta to reward ratio. The average Sortino ratio for the 5-year period is calculated for both Sharia-compliant stocks and conventional stocks. The Sortino ratio does exhibit a good level of accuracy, edging over the Sharpe method for computing performance of excess returns which are skewed (Chaudhry & Johnson, 2008). This is represented by:

$$Sortino\ Ratio = \frac{u_{n-i} - \bar{u}}{\sigma} \tag{3.20}$$

Where

u_{n-i} : Portfolio return,

$\bar{u}$: Return threshold that separates losses from gains,

σ : Downside deviation.

The t-test is iterated over the scores of each company's Sortino ratio score to establish any fundamental difference in mean values among the two portfolios. The hypothesis proposes that there is no statistical difference in the Sortino ratio values between Shariah-compliant stocks and conventional stocks. The alternative hypothesis suggests that there is a difference.

3.8 Robustness Test

The coexistence of both Shariah-compliant and conventional stocks creates an appetizing need to establish the downside beta and performance of Shariah-compliant and conventional stocks. While this is done using sufficient methods, it is important to perform robustness tests for downside beta as well as performance of the two portfolios. The robustness check for downside beta is done using the market beta as a benchmark for the two portfolios whilst for performance measure, results of the EWMA beta scores were used.

3.8.1 Downside Beta

The downside beta values (with 0 as threshold) were obtained from computing the covariance between the market downside returns and the individual company returns divided by the variance of the market return. This is a complimentary method to ensure robustness of the first and second objectives. The formulation for the mathematical representation of the methodology adopted is given by Estrada (2007):

$$\beta_i^- = \frac{Cov(r_i r_m \,|r_m < \, u_m)}{Var(r_m \,|r_m < \, u_m)} \tag{3.21}$$

Where

r_i : The return on the i^{th} asset,

r_m : Return on the market,

U_m : The average market excess return.

The downside beta values obtained in each portfolio was subjected to the t-test to observe whether the results corroborated the findings of the GARCH (1,1) downside beta scores for the two portfolios. As highlighted earlier, the t-test is computed to establish any fundamental difference in mean values among the two portfolios. The hypothesis proposes that there is no statistical difference in the downside beta values between Shariah-compliant stocks and conventional stocks. The alternative hypothesis suggests that there is a difference.

3.8.2 Performance

The downside beta scores obtained from the EWMA method is used to establish the performance of the two portfolios as a complimentary method to the GARCH (1,1) Sortino results. This model was instrumental in achieving the third objective of the study. The data was compared with the result for the performance using the GARCH (1,1) beta scores. The EMWA is subjected as a robustness test because it does not suffer severe penalty when used in estimating returns that experience medium shocks (Ding & Meade, 2010). The performance scores were subjected to a t-test to analyse whether the two portfolios will yield statistically different mean values. Similarly, the hypothesis proposes that there is no statistical difference in the mean downside beta value between Shariah-compliant stocks and conventional stocks. The alternative hypothesis suggests that there is a difference.

3.9 Hypothesis Testing

After achieving results for each objective, tests are done between the two portfolios to establish whether the results displayed similar and statistically significant mean scores. Hence the necessity for hypothesis testing. All hypothesis testing was done at 95% confidence level.

The general format of the hypothesis proposes that there is no statistical difference in the measured mean values between Shariah-compliant stocks and conventional stocks. The alternative hypothesis suggests that there is a difference. Therefore:

$$H_0 : \mu_d = 0 \tag{3.22}$$

$$H_A : \mu_{\mathrm{d}} \neq 0 \tag{3.23}$$

Where

H_0: The null hypothesis,

H_A: The alternative hypothesis,

μ_{d} : The difference in mean values between the two portfolios.

3.9.1 Two Sample T-Test for Equal Mean

The t-test is a measure of significance in comparing two sets of data. First published anonymously by William Sealy Gosset as Student (1908), the t-test parameterizes the degree of freedom, the t-statistic and t-distribution values to calculate the statistical significance of mean values for two sets of variables. The t-test analysis data from the EWMA method, the GARCH (1,1) method, the Sortino ratio scores where EWMA and GARCH (1,1) downside beta were used. As a method based off of hypothesis testing, the null hypothesis of the t-test assumes the mean values for both portfolios are equal.

$$\mu_d = \mu_1 - \mu_2 \tag{3.24}$$

$H_0 : \mu_d = 0$

$H_A : \mu_{\mathrm{d}} \neq 0$

Where,

μ_{d} : The difference in mean values between the two portfolios

H_0: The null hypothesis

H_A: The alternative hypothesis

The equation for the t-test is given as:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad (3.25)$$

Where,

μ_{d} : The difference in mean values between the two portfolios

$\bar{x}_1 - \bar{x}_2$: Sample mean from Shariah-compliant and conventional stocks

μ_1: Mean return of Shariah-compliant portfolio

μ_2: Mean return of conventional portfolio

n_1, n_2: Number of sample size for Shariah-compliant and conventional stocks

s_p: Pooled standard deviation

H_A: The alternative hypothesis

The research looked into scores of downside beta for both portfolios and to draw conclusions on whether the difference in mean values are statistically significant or not, the t-test was explored. Similar tests were done for the Sortino ratio scores. The t-test was computed for variables with equal variances or for variables with unequal variances. To determine which set of results from the study should be subjected to the t-test with equal variance, or its counterpart, an F-test was conducted.

3.9.2 F-Test

The F-test allows for clarity as to whether the two sets of data have equal variances or not. This is achieved through comparing the standard deviations of the two samples for variability. The null proposes the standard deviations between the two samples are equal while the alternate hypothesis suggests the opposite.

$$H_0 : \sigma_1^2 = \sigma_2^2 \tag{3.26}$$

$$H_A : \sigma_1^2 \neq \sigma_2^2 \tag{3.27}$$

Where

σ_1: Standard deviation of first sample,

σ_2: Standard deviation of second sample.

The F-statistics is then computed as the ratio of the variance of the sample means divided by the mean of the respective group specific variance. Also, the F-critical values were obtained through dividing the square of the highest variance amongst the two samples with the lowest. The degrees of freedom were gained through subtracting one (1) away from the sample size.

Microsoft excel was used to analyze the sets of data under the F-test. The flow diagram simulates how the F-test and t-test informs the output of the research.

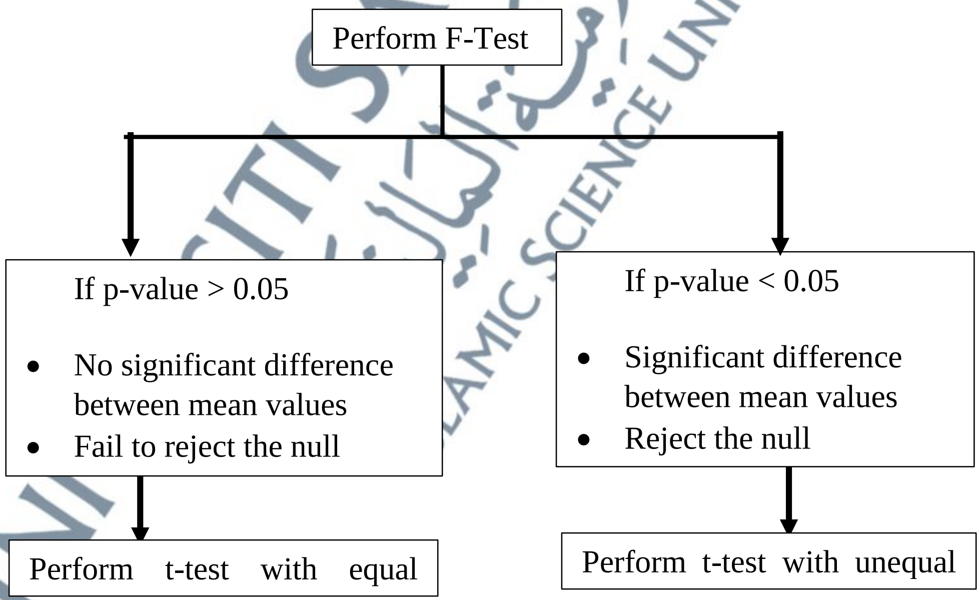

Figure 3.2 : F-Test Flow Diagram