National College of Ireland

Configuration Manual

MSc Research Project
MSC FINTECH

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MSc Project Submission Sheet

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Configuration Manual

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1 Introduction

This user configuration manual presents the process and product specifications to conduct the research undertaken titled, “Testing the degree of efficiency of Ireland Capital market with Efficient Market Hypothesis (EMH)”. A step by step guide to reproduce the results for comprehensive analysis are laid out in an orderly manner. Furthermore for effective analysis the the functionality of each code used for different models and tests are presented for effective analysis and guidance in order to replicate the research work.

2 Data Collection

Data was sourced from yahoo finance data base, spanning the period of January 2015 to December 2019(before the corona pandemic). ISEQ, FTSE, BFX, AEX stock information was collected to represent the Ireland, the UK, Belgium and the Netherlands Capital markets respectively.

3 System Setup

- **Hardware requirements**

The hardware system configuration is Intel Core i3-7020U
Device Name- HP LAPTOP 14S-DQ0XXX
Processor- Intel Premium ® CPU 5405U @2.30GHZ 2.30 GHZ
Installed RAM- 4.00 GB

- **Software requirements**

R STUDIO Version 1.3.959
R Version- R x64 4.0.2
Operating System Windows 10

4 Libraries Installed

The following libraries were imported to implement the proposed methodology. The Libraries included are Quantmod, moments, performanceAnalytics, tseries, tidyverse, entropy , entropyEstimation and the randtests.

4.1 Importing Libraries in R

```
library(quantmod)
library(moments)
library(PerformanceAnalytics)
library(tseries)
library(tidyverse)
library(entropy)
library(EntropyEstimation)
```

5 Loading the stock information Dataset into R from Yahoo finance database

5.1 Setting the coverage Period - Data is collected from Yahoo finance database for the period spanning from 01 Jan 2015 to 31 Dece 2019.

Code

```
startDate=as.Date("2015-01-01")
endDate=as.Date("2019-12-31")
```

5.2 Respective Stock Markets Index used to proxy the capital markets under analyses

- **Ireland Stock Market Index**

```
getSymbols("^ISEQ",from=startDate, to=endDate)
```

- **United Kingdom Stock Market Index**

```
getSymbols("^FTSE",from=startDate, to=endDate)
```

- **Belgium Stock Market Index**

```
getSymbols("^BFX",from=startDate, to=endDate)
```

- **Netherland Stock MArket Index**

```
getSymbols("^AEX",from=startDate, to=endDate)
```

6 Dataset Pre Processing

The dataset was checked for abnormalities such as missing value. This is necessary for easy implementation of R model and for the prevention of errors.

6.1 Checking for Missing Values

```
summary(ISEQ)
summary(FTSE)
summary(BFX)
summary(AEX)
```

6.2 Interpolation of Missing value

```
na.approx(ISEQ)-> ISEQ
na.approx(FTSE)-> FTSE
na.approx(BFX)-> BFX
```

6.3 Time plot of the closing price for the series

```
chartSeries(ISEQ)
chartSeries(FTSE)
chartSeries(BFX)
chartSeries(AEX)
```

7 Daily stock Returns for the stock index

- **ISEQ**

```
dr.iseq<-dailyReturn(ISEQ,type="log")
colnames(dr.iseq)<- "ISEQ"
```

- **FSTE**

```
dr.ftse<-dailyReturn(FTSE,type = "log")
colnames(dr.ftse)<-"FTSE"
```

- **BFX**

```
dr.bfx<-dailyReturn(BFX,type = "log")
colnames(dr.bfx)<-"BFX"
```

- **AEX**

```
dr.aex<-dailyReturn(AEX,type = "log")
colnames(dr.aex)<-"AEX"
```

7. 1 Volatility clustering: Time Plot of the daily Return Series

```
chartSeries(dr.iseq)
chartSeries(dr.ftse)
chartSeries(dr.bfx)
chartSeries(dr.aex)
```

8 Descriptive Summary of the daily returns

This is necessary to gives insight into the distribution of the returns such as Reward and risk inherent in the market, table.stats function helps in ascertaining the descriptive summary of the return series for all the markets.

8.1 IESQ(Ireland Stock Index)

```
>table.Stats(dr.iseq,digits=7)
```

8.2 FTSE(UK Stock Market Index)

```
>table.Stats(dr.ftse,digits=7)
```

8.3 BFX(Belgium Stock Index)

```
>table.Stats(dr.bfx, digits = 7)
```

8.4 AEX(Netherland Stock Market)

```
> table.Stats(dr.aex,digits = 7)
```

8 Density Distribution graphical representation

Code

```
chart.Histogram(dr.iseq,methods = "add.density",main = "Density Plot for ISEQ")
chart.Histogram(dr.ftse,methods = "add.density",main = "Density Plot for FTSE")
chart.Histogram(dr.bfx,methods = "add.density",main = "Density Plot for BFX")
chart.Histogram(dr.aex,methods = "add.density",main = "Density Plot for AEX")
```

9 Test for normality and Correlation

9.1 Jarque Bera Normality Test code

- **IESQ**

>jarque.test(as.vector(dr.iseq))

- **FTSE**

>jarque.test(as.vector(dr.ftse))

- **BFX**

>jarque.test(as.vector(dr.bfx))

- **AEX**

>jarque.test(as.vector(dr.aex))

9.2 Correlation between the markets are computed

Code

```
table.Correlation(dr.iseq,dr.ftse)
table.Correlation(dr.iseq,dr.bfx)
table.Correlation(dr.iseq,dr.aex)
table.Correlation(dr.ftse,dr.bfx)
table.Correlation(dr.ftse,dr.aex)
table.Correlation(dr.bfx,dr.aex)
```

Binding into one dataframes

```
dr.all <- cbind(dr.iseq,dr.ftse,dr.bfx,dr.aex)
dr.all <- dr.all[-1,]
```

Correlation graph Code

```
chart.Correlation(dr.all)
```

10 Testing for the random walk hypothesis

The random walk hypothesis will be tested using the Unit Root, Serial correlation and Run test in order to test each of the markets for weak form of efficient market hypothesis.

10.1 Unit Root test

Augmented Dickey Fuller Test conducted to check the stationarity in the time series market returns data for all the four markets.

- **ISEQ**

```
adf.test(ISEQ$ISEQ.Close, alternative = "stationary",k=15)
```

- **FTSE**

```
adf.test(FTSE$FTSE.Close, alternative = "stationary",k=15)
```

- **BFX**

```
adf.test(BFX$BFX.Close, alternative = "stationary",k=15)
```

- **AEX**

```
adf.test(AEX$AEX.Close, alternative = "stationary",k=15)
```

10.2 Serial correlation test

Ljung Box test to analyze the data for serial correlation in time series to determine whether a series of observations over time are random and independent.

- **ISEQ**

```
Box.test(dr.iseq,lag=15,type=("Ljung-Box"))
chart.ACF(dr.iseq)
```

- **FTSE**

```
Box.test(dr.ftse,lag=15,type=("Ljung-Box"))
chart.ACF(dr.ftse)
```

- **BFX**

```
Box.test(dr.bfx,lag=15,type=("Ljung-Box"))
chart.ACF(dr.bfx)
```

- **AEX**

```
Box.test(dr.aex,lag=15,type=("Ljung-Box"))
chart.ACF(dr.aex)
```

10.3 Run test

Tests the sequence of changes in the return time series data, used to check randomness in the movement of the variables.

- Removing the t series package

```
detach("package:tseries", unload=TRUE)
library(randtests)
```

- **ISEQ**

```
runs.test(as.vector(dr.iseq),"two.sided")
```

- **FTSE**

```
runs.test(as.vector(dr.ftse),"two.sided")
```

- **BFX**

```
runs.test(as.vector(dr.bfx),"two.sided")
```

- **AEX**

```
runs.test(as.vector(dr.aex),"two.sided")
```

11 Shannon Information Test

The Shannon entropy use to rank information efficiency in the four markets. The countries with the highest entropy value is considered more informationally efficient.

Using the entropy package for calculating entropy and standardizing the results

- **ISEQ**

```
entropy(table(dr.iseq))/7.2
```

- **FTSE**

```
entropy(table(dr.ftse))/7.2
```

- **BFX**

```
entropy(table(dr.bfx))/7.2
```

- **AEX**

```
entropy(table(dr.aex))/7.2
```