e-learning/e-teaching
An Implementation and Evaluation
of a Finance Introductory Course

A Master Thesis Presented

by

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to

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Declaration of Authorship

I hereby confirm that I have authored this master thesis independently and without use of others than the indicated resources. All passages which are literally or in general matter taken out of publications or other resources are marked as such.

Julius Mungo

Berlin, 17th May 2004

Abstract

In today's net-based technology culture, a new way of learning/teaching, accessing or preparing learning materials is finding root in Education. It is enabling individuals and institutions to play a more powerful and attractive role in the education process, referred to as e-learning. E-learning is internet-enabled learning that uses net work technology to design, deliver, select, administer and extend learning. Though there are observable increase for multimedia education in various subject fields, the e-learning/e-teaching of statistics and its application to some subject areas is lacking. Statistics as the science of obtaining, processing, and interpreting information from highly complex structural data is often difficult for learners. It requires skills in handling quantitative, graphical as well as mathematical ability. Developing e-learning/e-teaching tool to address these concerns is a powerful and attractive way in which statistics and its application will benefit from e-learning. This thesis is based on such a tool, the MD*Book. It constitute two sections,

- Chapters 1 to 4: Introduces e-learning/e-teaching concept, the MD*Book tool and the XploRe Quantlet Client (XQC) techniques. I exemplify the application of MD*Book: e-learning/e-teaching with an implementation to a Finance Introductory Course, FIC MD*Booklet. The implementation herein is a reflection of one of the several enhanced examples on statistical methods and analysis in course content using the XploRe quantlet technology.

- Chapters 5 to 6: Explores criteria for e-learning evaluation, investigates e-learning/e-teaching with FIC MD*Booklet through an evaluation study on its learning innovation and outline some suggestions and remarks on the findings.
  Chapter 7 presents a conclusion on the project in this thesis.

Keywords: e-learning, FIC MD*Booklet, Implementation, Evaluation.

Useful links:

☞ http://www.quantlet.com/mdstat/scripts/fic/index.html

☞ http://www.md-stat.com

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Chapter 1

Introduction

1.1   e-learning/e-teaching

E-learning is a term used in conveying a wide range of applications and processes such as virtual learning, computer learning, web-based learning and digital collaborations. It is a subset of the larger worlds of both information technology and education. It includes new ways to access, learn/teach, prepare learning materials and delivery of learning content through the internet or extranet. Through the use of multimedia tools, the responsibility for learning is shifting to the learner. The major shift in education is the transfer from teaching towards learning. In effect, it's a learner centered world.

As reported in a New York Times article

> "The next big killer application for the internet is going
> to be education. Education over the internet is going
> to be so big to make e-mail look like a rounding error"
>
> New York Times article 1999; COMDEX conference.

Figure 1.1: Education: The Killer Application

1.2   e-learning categories

From the basic to the more advanced, e-learning is categorized into knowledge database, online support, asynchronous and synchronous learning.

☞ **knowledge database**: Is the basic forms of e-learning that is usually moderately interactive, with step by step instructions for performing tasks. Learners can enter key words to search the database or select from an alphabetic list with index explanations.

☞ **online support**: It is much more interactive than knowledge database and function in the form of chat rooms, e-mail, online bulletin or live message support.

☞ **asynchronous learning**: This is the traditional form of e-learning that involve, Net-based technology, Intranet, Internet or CD-ROM based. It is usually self-paced with links to access learning or reference materials.

☞ **synchronous learning**: This is real-time learning that takes place through internet telephony, internet web site, video conferencing, usually with a live instructor facilitating the learning process.

In reference to this thesis, we deal with asynchronous learning; e-learning that is self-paced, an offering where the learner determines the pace and timing of content delivery. For such application there is much need to develop effective e-learning/e-teaching tools aiming at presenting learners easy and effective ways to access learning materials, often refer to as the e-book.

What is an e-book?
Promoters and developers of the e-book concept may have different definition and interpretation of what an e-book is. One thing we know for sure is that e-learning/e-teaching tools represent an alternative method for disseminating and reading information. It provides faster learning at reduced cost, increase access to learning and clear accountability for all who participate in the learning process. In the attempt to explaining what an e-book is, we consider the following definitions.

☞ The OEBF's (Open eBook forum) Digital Rights Management Strategy working group:
"Electronic Book (Sometimes ebook)

1. A Literary Work in the form of a Digital object consisting of one or more standard unique identifiers, Metadata, and a Monographic

body of contents intended to be published and accessed electronically. See also epublication.

2. May also refer to as hardware device created for the purpose of reading ebooks (vide RocketBookSoftBook, Franklin e-Bookman)."

☞ The Electronic Publication (epublication):
"A Literary Work disseminated in the form of a Digital Object and accessed electronically. These works can be multimedia, incorporating text, digitized images, animation, sound tracts, and functioning formulae. They may also be hypertext technology."

In practical term, an e-book is a digital object that is an electronic representation of a book. It is a versatile, portable and convenient tool that encompasses a variety of reading experiences and methods for packaging and preparing digital contents. The format may be plain text, PDF, HTML, SGML or any other encrypted format. E-learning can be CD-ROM, Network, Intranet or Extranet based and can include text, video, audio, animated, and virtual environments. Some e-books may be downloaded and read using e-book reader software, some can be read while connected to the web using that site reader software.
It may also be distributed by downloads, e-mail, ftp, on diskettes, CD-ROM, DVD except restrictive technology is applied. It may be printed and read in paper form. For an e-book to be readable, it's monographic body of contents must be transformed to a digital form to display correctly on the target reader. Most e-book pages take the normal book page form. It may be in full colored, include graphics and photos. The pages may be viewed in single or double-page or rotated as in the traditional format. There is often a navigation bar to allow access from one page to another.

1.3 An e-learning functional model
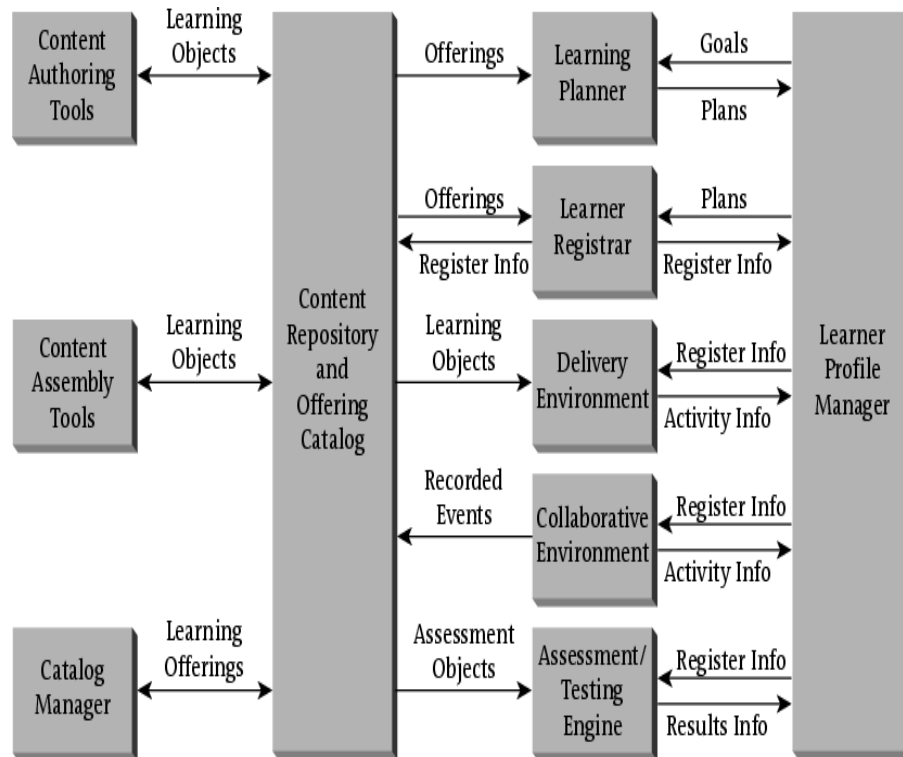
Figure 1.2: Education: An e-learning functional model

Figure (1.2) represents an e-learning model with inherent components that are important for managing the learning environment, provide a place where content is organized and presented to learners, learning plans are managed, and where learning activities and results are monitored.

What will it take to make e-learning of statistical applications, data analysis work easier, more fruitful, or in any sense better?

Chapter 2

e-learning/FIC MD*Booklet

2.1   The MD*Book tool

The MD*Book (Method and Data Book) is a flexible user interface tool for generating net based user interactive e-learning/e-teaching documents, MD*Booklet. This tool has been created at the institute of Statistics and Economics of the Humboldt University - Berlin. Unlike most e-learning/e-teaching tools, the text and graphical presentations are in LaTeX format with some structural information in its main LaTeX file that enables the MD*Book compilation in Postscript, Adobe PDF, HTML versions. The MD*Book tool constitute two main programs, the tex2sk and the mdbook programs, figure 2.1.

- **program tex2sk**: generates control file from latex that is used within the mdbook program to further generate all useful information such as the medium for which the e-book is to be created.

- **program mdbook**: generates the e-book in Postscript, PDF and HTML document options. The options
  -html creates HTML without using Java Script
  -java uses JavaScript functions

-xpl generates HTML documents that offer reproducibility as well as interactivity for XploRe Quantlets
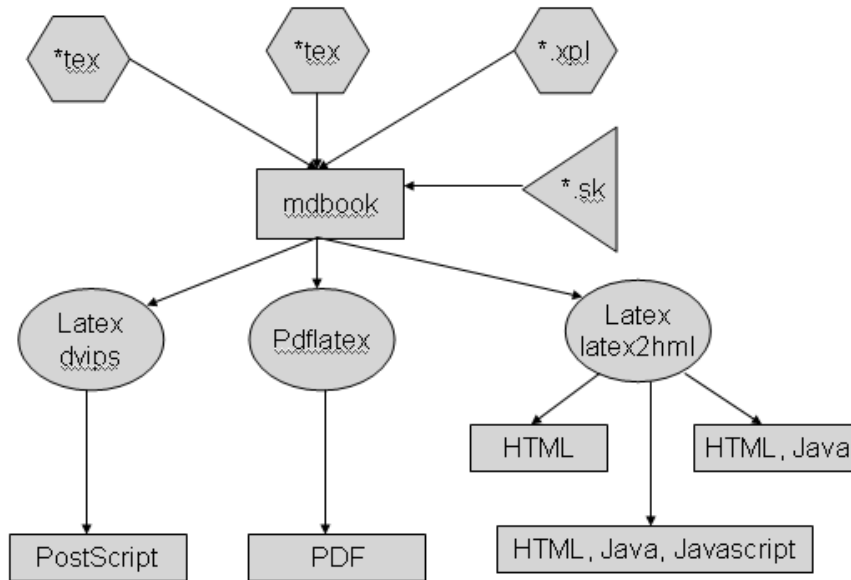
Figure 2.1: The MD*Book project

Figure 2.2: MD*Book

Figure 2.3: FIC MD*Booklet cover page.

2.2 The FIC MD*Booklet

The graphical user interface (GUI), (figure 2.5) is a simple design and shows the main features at first sight to consist of filing cards depicted by courses. The filing card format and the information structure is called an MD*Booklet. Each course unit presents a topic or lecture component that the learner can get through quickly. The information in each course unit is broken down into components (section 2.2.1) to give the leaner information in manageable pieces.
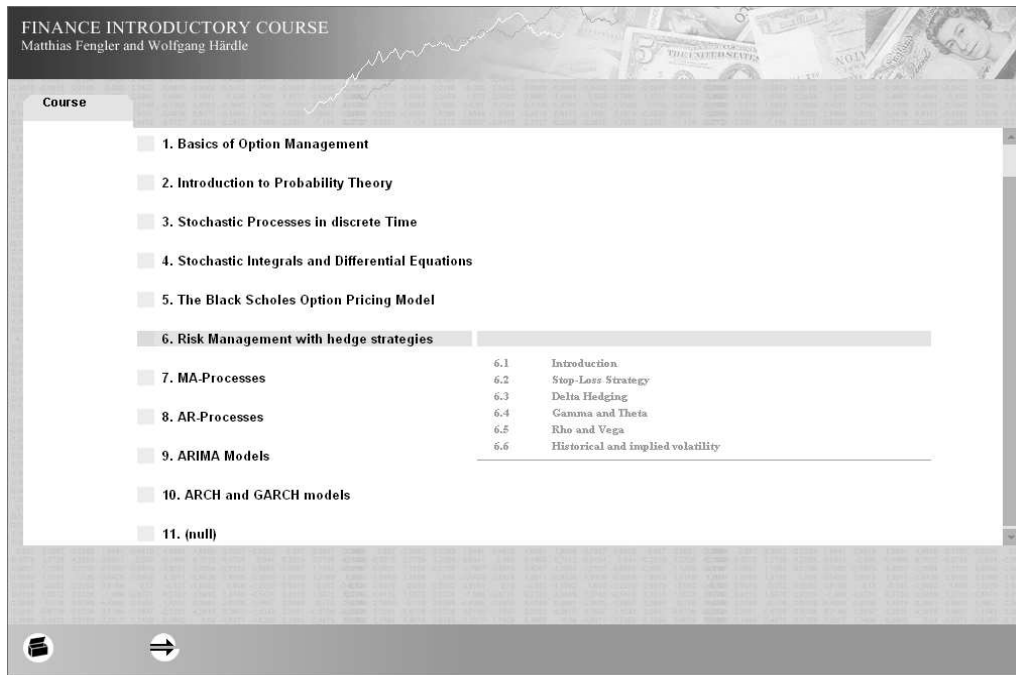
Figure 2.4: FIC MD*Booklet: a "course" content page.

The hyper-linked (forward and backward arrows) at bottom left enhance navigation, allowing the users to navigate (back and forth) to find items of interest quickly and easily. The user can enter the courses topics via a list of contents (figure 2.4) and may navigate back and forth to any desired topic or course chapter. By hovering the mouse pointer over a selected course file for a few seconds, a tag will appear to identify the course topic.
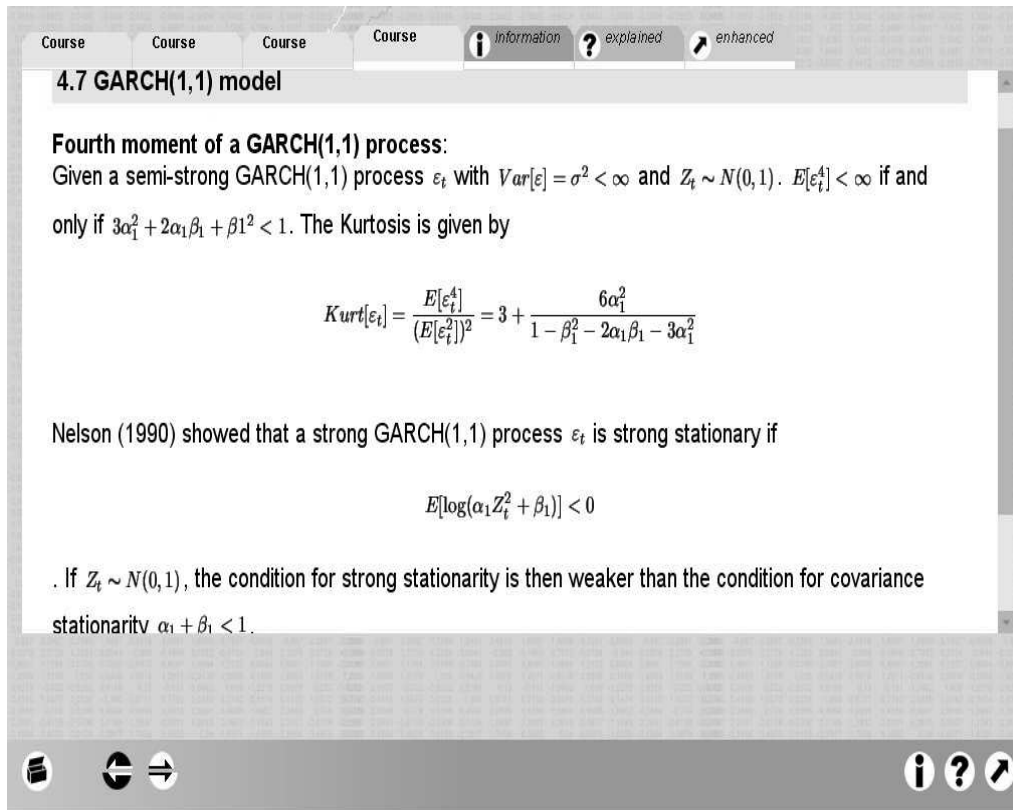
Figure 2.5: GUI of FIC MD*Booklet with course "GARCH(1,1) Model".

The Finance Introductory Course, FIC MD*Booklet has three components structures; the information, explained and enhanced (bottom right). This structural format for presenting content materials is maintained consistently throughout and aim at separating the basics from the more complicated statistical applications that is encountered within each course topic, (http://www.quantlet.com/mdstat/scripts/fic/index.html)
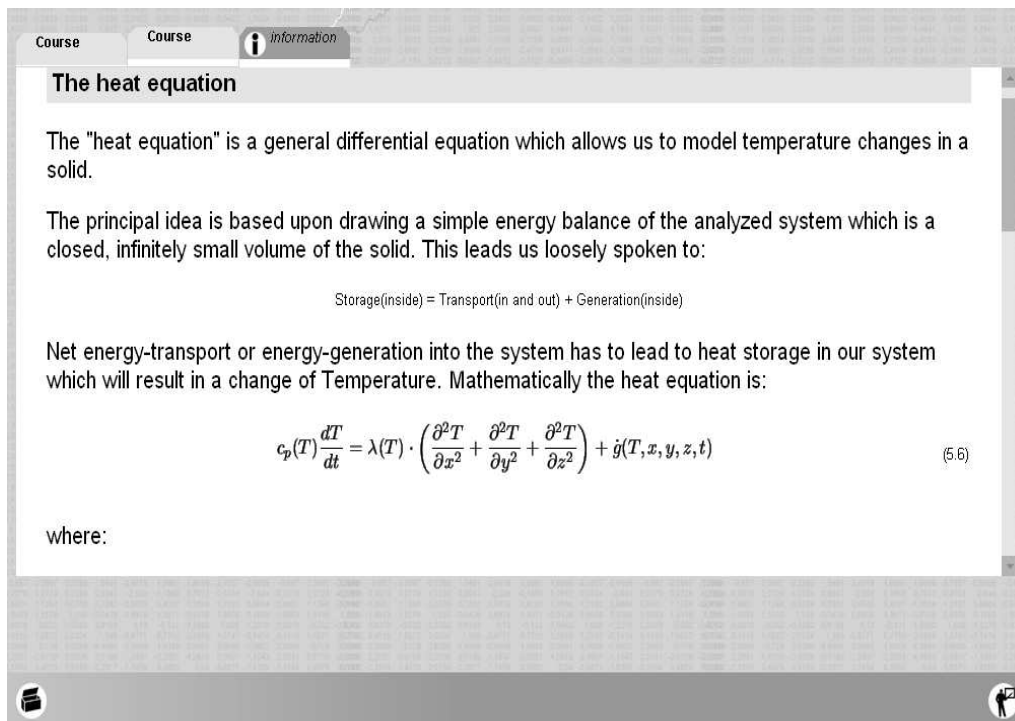
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2.2.1 Component Description: FIC MD*Booklet

The Information (ⓘ) component

It gives information on the general statistical theory, definitions, formulae, mathematical proofs or some history of the statistics associated with the topic of that particular course content. This is necessary especially for the broader and deeper understanding of the statistics involved. Figure 2.6 exemplifies implementation of the "information" component presented in chapter 5 on Black-Scholes option pricing model. The information invokes the principal idea which was the major performance of Black and Scholes to show that prices for Derivatives might be explained with models like the one existing for the Heat equation in physics.

The heat equation

The "heat equation" is a general differential equation which allows us to model temperature changes in a solid.

The principal idea is based upon drawing a simple energy balance of the analyzed system which is a closed, infinitely small volume of the solid. This leads us loosely spoken to:

$$Storage(inside) = Transport(in\ and\ out) + Generation(inside)$$

Net energy-transport or energy-generation into the system has to lead to heat storage in our system which will result in a change of Temperature. Mathematically the heat equation is:

$$c_p(T)\frac{dT}{dt} = \lambda(T) \cdot \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2}\right) + \dot{g}(T, x, y, z, t) \qquad (5.6)$$

where:

Figure 2.6: FIC MD*Booklet: an "information" component

The explained (?) component

This component usually consist of statistical applications, graphical illustrations or tables with interactive XploRe quantlet technology to assure some degree of user participation in the learning process. An example, figure 2.7 explains (chapter 5, Black-Scholes option pricing model) why the value of a call option can be interpreted as the discounted expected value of the final payoff of the Call, with conditions for the distribution of the payoff!.

Course   Course   **?** *explained*

Expected value

The following should just be a motivation why the value of a call can be interpreted as the discounted expected value of the final payoff of the Call Option

The expected value of a Function $g(x)$ is:

$$E(g(x)) = \int_{-\infty}^{\infty} g(x) f(x) dx$$

with $f(x) = \dfrac{1}{\sigma \sqrt{\tau} y \sqrt{2\pi}} e^{-\frac{[\ln y - (\ln S + (b - \frac{\sigma^2}{2})\tau)]^2}{2\sigma^2 \tau}}$
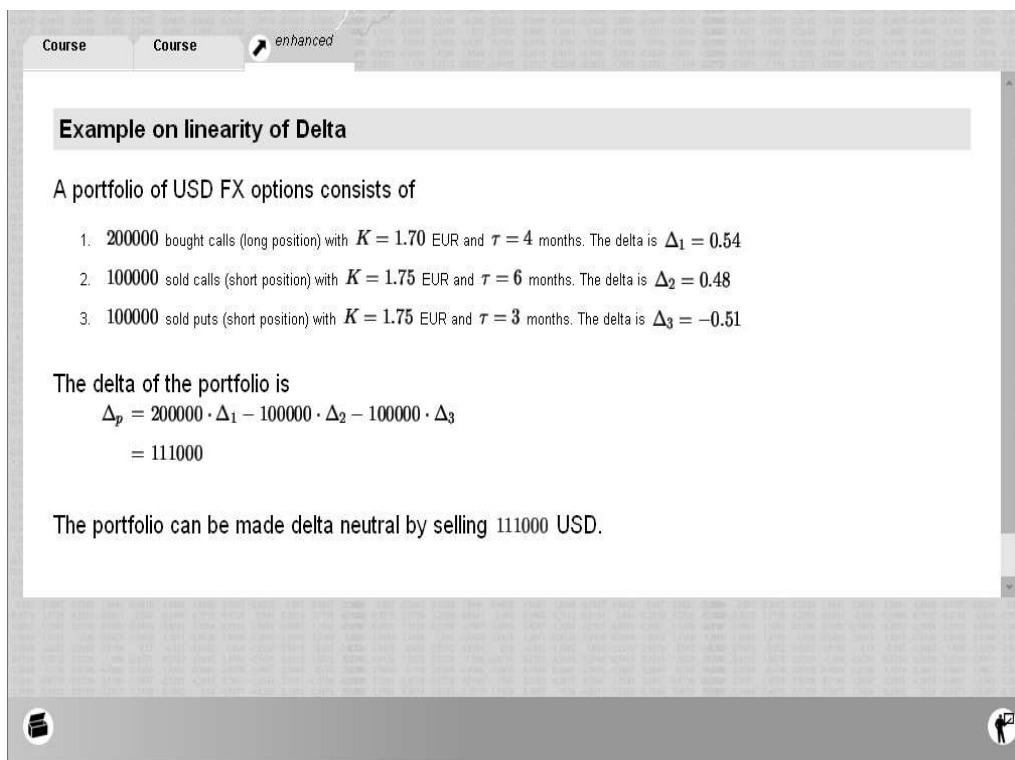
and $g(x) = max(0; S - K)$

Where the expected value is calculated for a rv. $\ln Y \sim N(\tilde{\mu}, \tilde{\sigma}^2)$

Figure 2.7: FIC MD*Booklet: an "explained" component

The enhanced (⬈) component

In this component, applied statistical procedure on some empirical example from a real world data is implemented. The enhanced component makes clear the relevance and structural complexity of the statistics in daily life and to demonstrate the interplay of various statistical methods. A succinct implementation example of an enhanced component is presented in section 4.2, using the Xplore quantlet technology.

Figure 2.8: FIC MD*Booklet: an "enhanced" component

2.2.2 The interactive statistical Computing Environment

The quality of any e-learning material lies in its content and delivery. The beauty of e-learning with FIC MD*Booklet is that the inherent XploRe software allows for the creation of a very effective learning environment that can engulf the learner in the material presented with much opportunity for interaction.

It also include some menu driven interface with dialogues and menu options so that the naive user is able to interact, create graphics and perform sophisticated statistical analysis. Some examples include, menu driven interface for calculating Option pricing (figure 2.9), for analyzing an MA(q) process and to compare two MA(q) processes (figure 2.10).
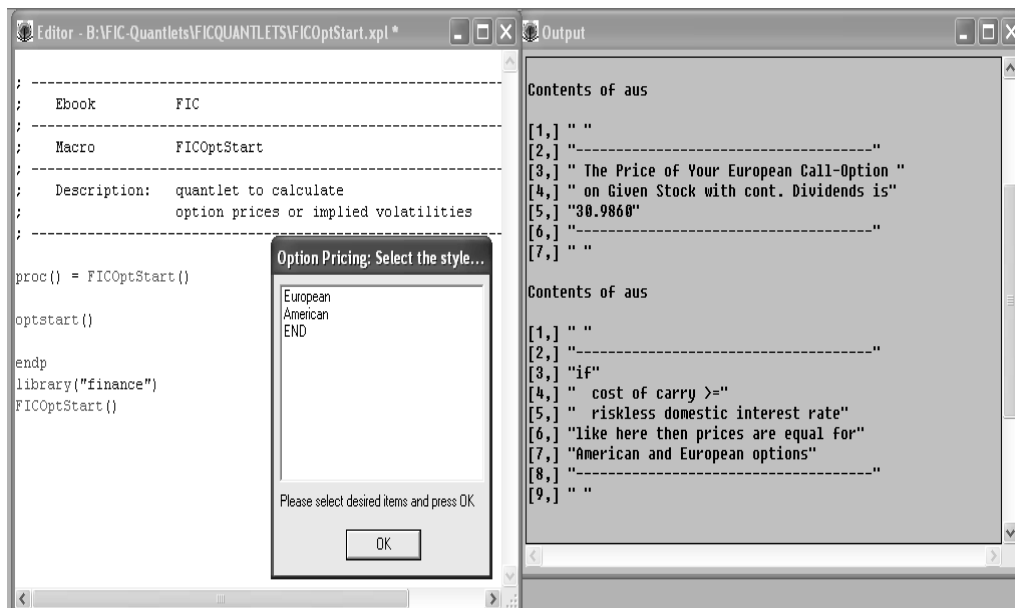
Figure 2.9: FIC MD*Booklet: menu driven interface for calculating Option pricing. **Q** FICOptStart.xpl
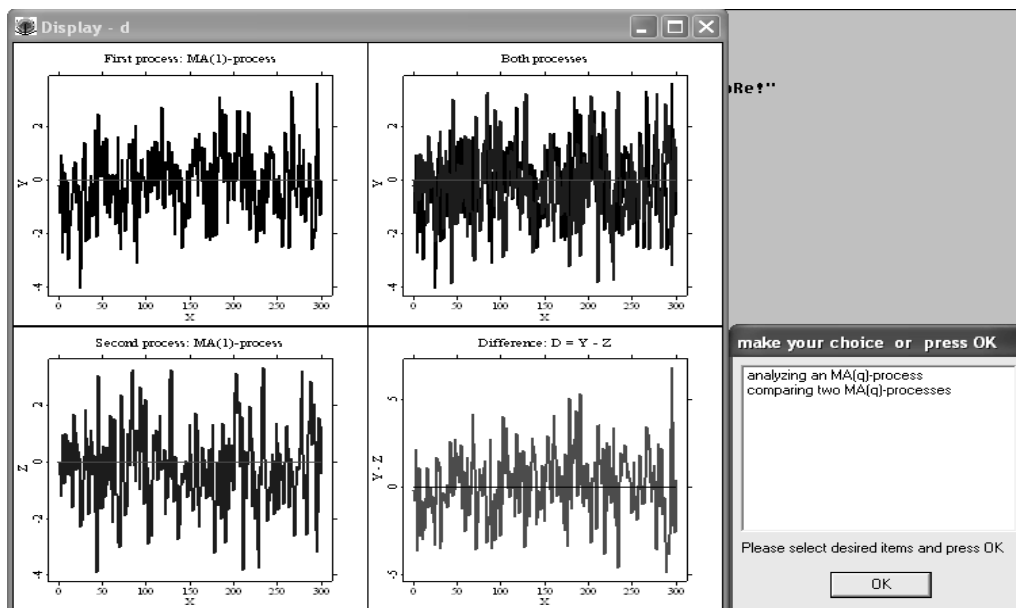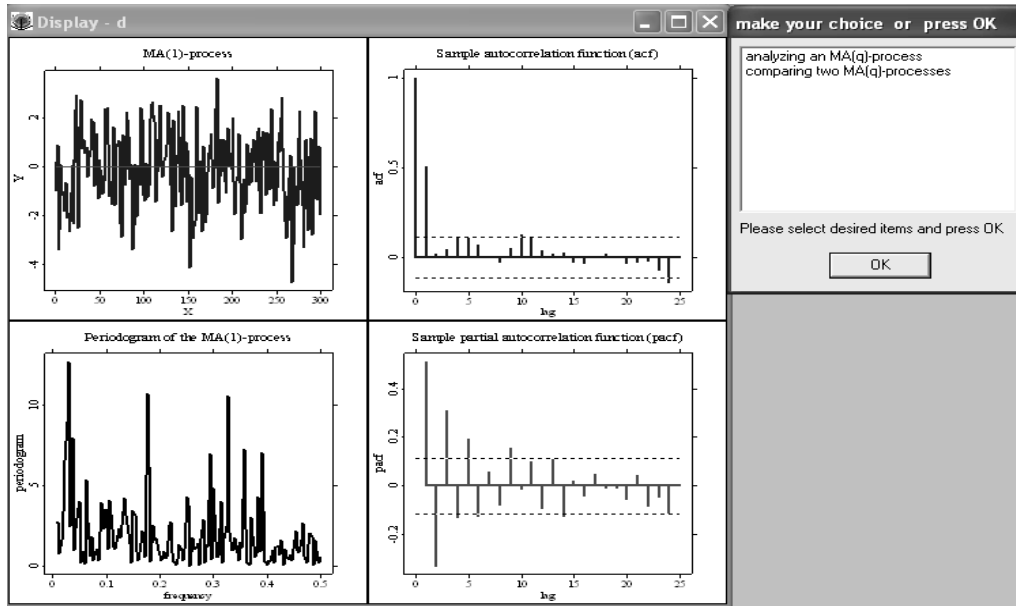
Figure 2.10: FIC MD*Booklet: menu driven interface for analyzing MA(q) process and comparing two MA(q) processes. **Q** FICMA02.xpl

Chapter 3

XploRe Quantlet Client/Server (XQC/XQS)
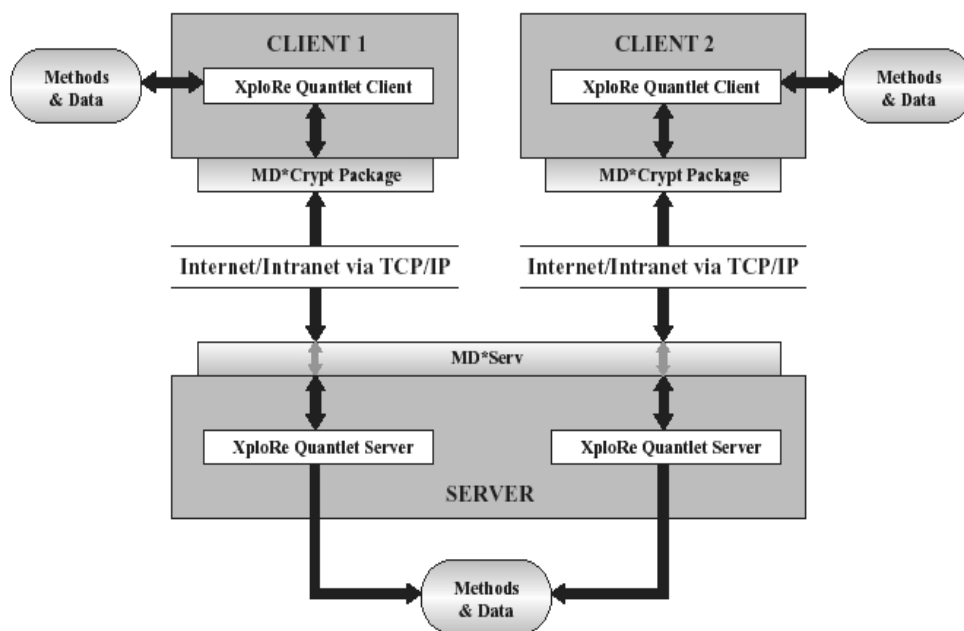
Figure 3.1: The Xplore Quantlet Client/Server (QC/QS) architecture

The Xplore Quantlet Client/Server (QC/XQ) model figure 3.1 comprise of Quantlet Sever (QS), Quantlet middleware (MD*Serv) and Quantlet Client(QC), responsible for reproductivity and interactivity regarding

data and statistical program.

- **Quantlet Sever (QS)**: is the computing engine, based on the XploRe computing language and provides services to clients.

- **Quantlet middleware (MD*Serv)**: is responsible for handling data from QS, transform the data in a QC readable form and transmitting the data to the QC and vice versa. Transmitting data from MD*Serv to QS is via a protocol based on TCP/IP. The MD*Serv and the protocol connect different clients with different severs.

- **Quantlet Client (QC)**: is the user interface of the XploRe Quantlet Client/Server (QC/QS) architecture responsible for presenting statistical results. Programmed in Java to run as an application as well as an appalet within a web browser, the XQC does not depend on a particular platform to run. Running of XQC as an application does not require programming skills. With the ability for customization through property files, XQC is able to integrate into HTML and PDF contents. The XQC uses simple ASCII file containing commands that allow starting XQC with

  - executing a command "ExecuteCommand"
  - executing an XploRe Quantlet "ExecuteProgram"
  - opening a data set "OpenData"
  - opening an XploRe Quantlet "OpenInEditor"

  The XQC works with three different configuration files

  - xqc.ini: contains basic set up information of XQC such as server and port information for client connection and size, width, height of the client, figure 3.7.
  - xqc-language.ini: contains all the texts that is used within the XQC

– xqc- methodtree.ini: contains information on the method tree- a
tool to access statistical methods

3.1 XQC Technique
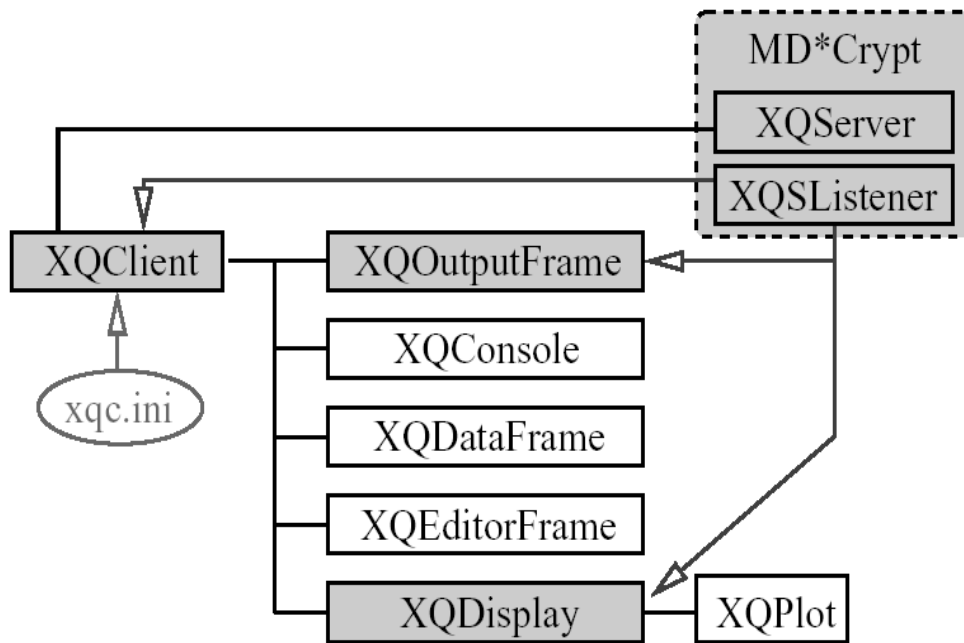
Figure 3.2: The Xplore Quantlet Client (XQC) architecture

The technical structure of XQC is based on the GUI in figure 3.2. The
XQClient represents the desktop. Through the XQClient, the XQConsole,
XQDataFrame and XQEditorFrame send their contents to the XQServer
of the MD*Crypt package. Depending on information from XQServer, the
MD*Crypt package send results as objects such as XQCOtputObject,
XQCGraphicsObjects etc. The XQSLListener is implemented to obtain data
and information from XQServer.

3.1.1 XQC Starting

The XQC executes the inherent XploRe Quantlet using the OpenInEditor with the possibility to explore, edit (program and data) and execute the program. The user is not limited to the program and data but is able to use own data and extend the program. The XQC offers a Graphical user interface (Graphical- UI) functionality realized by the combination of data- and method window. The data-and method window has two parts: a table (excel-type) for data editing and a tree with methods to apply on the data. This functionality allows the user to explore data and available method without much ado about the XploRe know-how. From the configuration file, the XQC is able to access, read information and connect to the corresponding XploRe server. The server status at bottom right of the XQC window (figure 3.3) indicates

- a green light for successful connection to the server, ready to function

- a yellow light for a busy sever; busy in computing the code received

- a red light for no connection between XQC and server.

At bottom left is a status line with status message "XploRe- The Interactive Statistical Environment". In execution of XploRe Quantlet, the status line indicates the quantlet the server is working with. The XQC opens with two additional windows; the console and output/result window.
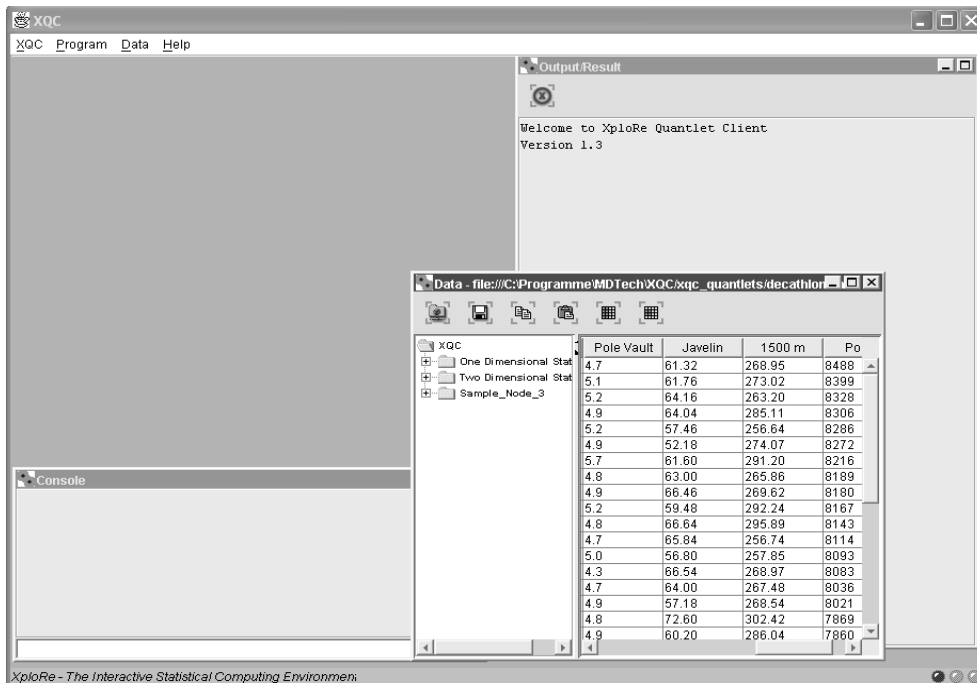
Figure 3.3: The Xplore Quantlet Client window

The console window:

This component represents one part of XQC's Character User Interface (CUI) which is primarily useful for users familiar with XploRe programming. It allows for on the spot execution of single-line commands and also offer a history of the last 20 commands that is sent to the server. By highlighting a command, it is copied on the command line and pressing the "return" on the keyboard, executes the code.

Figure 3.4: The Console window

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The output/result window:

As the name suggest, this window shows the output or result displayed on the screen. The displayed output can be selected and copied. Clearing of the output window is a click on the Icon.
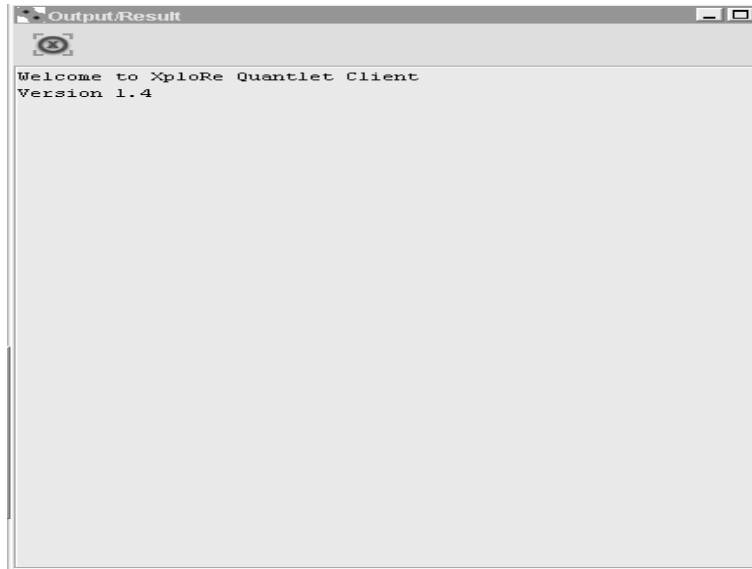
Figure 3.5: The Output window

The XQC menu bar

The menu bar (top left) of the XQC window offers additional menu functions: **XQC**, **Program**, **Data** and **Help**. **XQC menu**: with four features

- *Connect*- allows the user to connect to server and port number through a popup menu (figure?)

- *Disconnect*- closes the server process, disconnect client and server.

- *Reconnect*- disconnect from server and make a new connection.

- *Quit*- Closes the server process and quits the Quantlet Client.
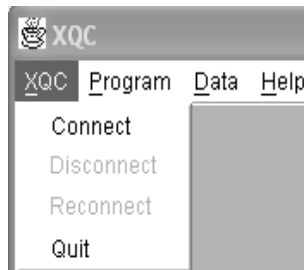
Figure 3.6: The "XQC" menu
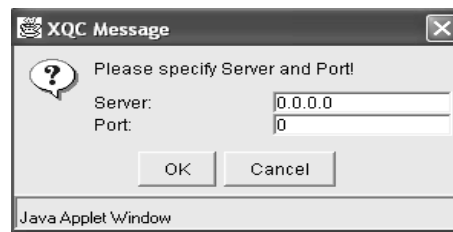
Figure 3.7: The server and port number input

Program menu:
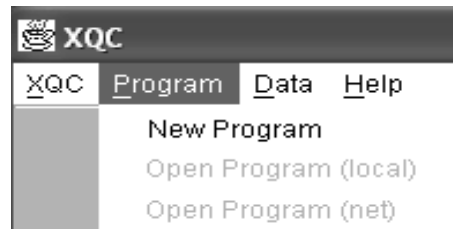
Figure 3.8: The "Program" menu

Data menu:
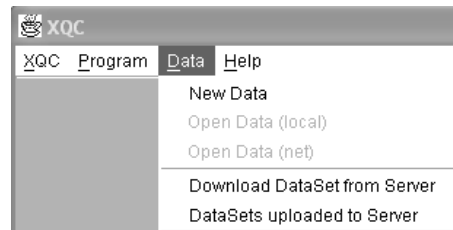
Figure 3.9: The "Data" menu

Help menu:

- *OnlineHelp*: provides direct access to XploRe - Auto pilot Support System (APSS), providing an XploRe tutorial and library on the net.

- *About*: provides on the current client/server and Java Runtime Environment the XQC is running in.
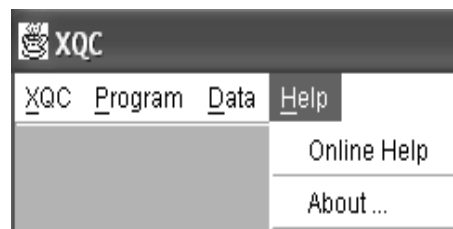
Figure 3.10: The "Help" menu

3.2   FIC MD*Booklet: The Golden Solution

Working with Data and Program in FIC MD*Booklet does not require XploRe programming skills. Reproductivity and interactivity involves some clicks. An "information" example on Risk management with hedge strategy (FIC MD*Booklet chapter 6), Delta Hedging is presented in figure 3.11.

http://www.quantlet.com/mdstat/scripts/fic/index.html
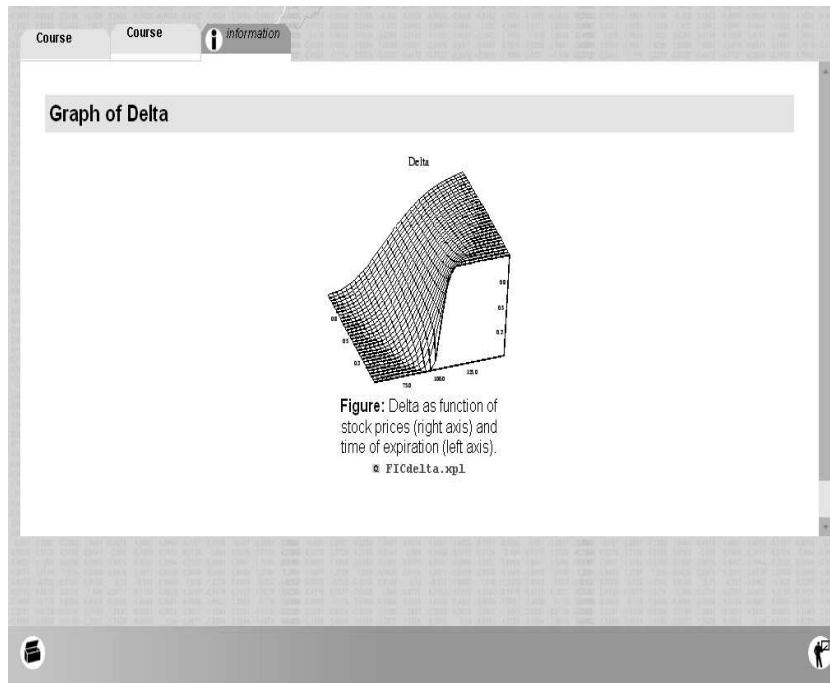
Figure 3.11: Delta as a function of stock prices and time of expiration

A click on   Q FICdelta.xpl starts the XQC which causes the client to run in a limited functionality mode that work with the started XploRe Quantlet.The XQC window provides a home, execute, edit and help menu. This limitation mode is called the "the Golden Solution".

Execute: Starting the XQC and with **execute**, the XploRe quantlet starts automatically without showing coding. For graphical presentation, the generated graph is identical to that in the document. Using **readvalue** for the Quantlet, the user can adjust parameters to influence the computation of graphical results. Results of graphical presentation also indicates Coordinates of data, with possible rotation for 3-dimensional plots.

Figure 3.12: The Starting XQC window

Edit: With edit, the XQC offers interactivity with regard to data and program. The interested user can verify results, explore, edit and execute the program. The user has the possibility to change the program and data within the quantlet. The XQC functionality requires no Java programming skills for adjusting the client. New data can be uploaded in the server to be used within the quantlet.
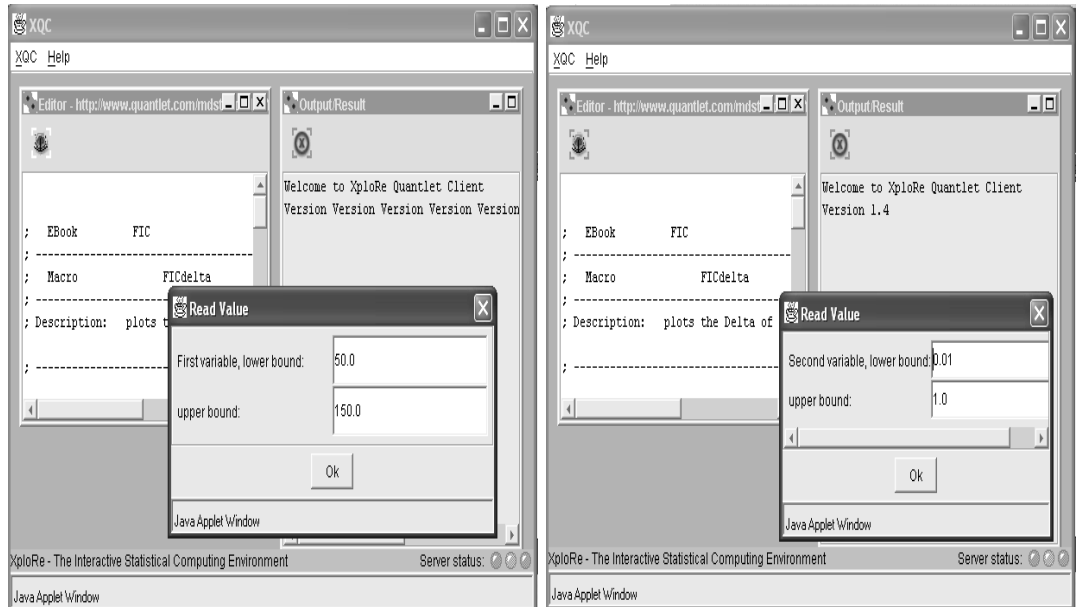
Figure 3.13: The Execute window

Figure 3.14: An XQC working example: plotting the delta of a call option
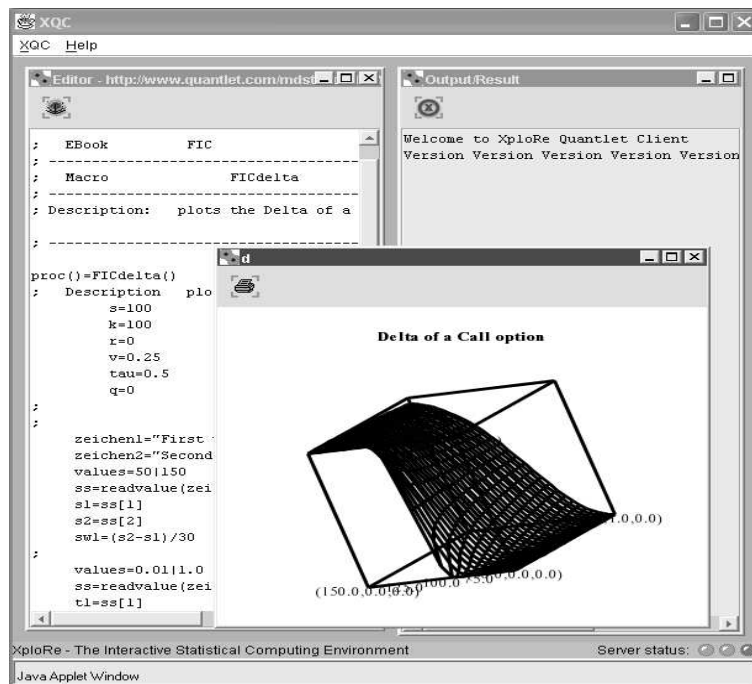
Chapter 4

FIC MD*Booklet Implementation

4.1 Time Series Implementation

In this section, some definitions and statistical properties for describing time series models that are capable of reproducing nonstationarity behavior is presented. The focus is on the ARIMA model, obtained by assuming that it can be represented by an ARMA stationary model after differencing.

4.1.1 Definition and Statistical Properties

Definition: White noise(WN)

$$\mu_t = 0 \text{ and } \gamma_\tau = \begin{cases} \sigma^2 & \text{if } \tau = 0 \\ 0 & \text{if } \tau \neq 0 \end{cases} \tag{4.1}$$

It therefore satisfies the conditions that:

$$\begin{aligned} E(\varepsilon_t) &= 0 \\ E(\varepsilon_t^2) &= \sigma^2 \\ E(\varepsilon_t \varepsilon_s) &= 0 \quad for \quad t \neq s \end{aligned}$$

In other words, a white noise process has mean zero, variance σ^2 and is uncorrelated over time. Though economic time series rarely follow white noise pattern, it is very important for formulating more complex models.

Definition: Integrated process

The process X_t is integrated of order d, I(d) if:

- $(1-L)^{d-1}X_t$ is non stationary

- $(1-L)^d X_t$ is stationary

with $(1-L)X_t = X_t - X_{t-1}$. Random walk is an example of such a class of non stationary processes known as integrated processes. In general, if X_t is integrated of order d, it can be represented by the model

$$\phi(L)(1-L)^d X_t = \mu + \Theta(L)\varepsilon_t \tag{4.2}$$

Definition: ARIMA(p,d,q)

A process X_t is an ARIMA(p,d,q) if it satisfy

$$\phi(L)(1-L)^d X_t = \Theta(L)\varepsilon_t$$

for $t \geq 0$ where,

- $\phi(L) = 1 + \phi 1L + ...\phi p L^p$, with $\phi p \neq 0$
  $\phi(L) = 1 + \phi 1L + ...\phi q L^q$, with $\phi q \neq 0$
  are polynomials with roots greater than 1 in modus.

- the initial values of X_t are uncorrelated with the future values of the noise, $\varepsilon_0, \varepsilon_1, ..., \varepsilon_t, ...$ and

- ε_t is white noise with variance σ^2.

The basic requirements for defining an $ARIMA$ model include:

- Covariance stationarity

- The autocovariance for a time series X_t at lag k

- An autoregressive model for a stationary time series X_t

- A moving average model for a stationary time series X_t

- An autoregressive moving average model, $ARMA(p,q)$

- A lag operator (or back) operator L, where $LX_t = X_{t-1}$

- A delta operator,

$$
\begin{aligned}
\Delta X_t &= X_t - X_{t-1} \\
&= (1-L)X_t
\end{aligned}
$$

ARIMA model as a difference equation

The ARIMA(p,d,q) model is represented by

$$\varepsilon_t = c + X\varepsilon_{t-1} + ... + \theta_q\varepsilon_{t-q} + w_t - \phi_1 w_{t-1} - ... - \phi_p w_{t-p}.$$

It may also be written as,

$$\phi(L)\Delta^d X_t = c + \theta(L)\varepsilon_t,$$

where c is a drift term and $\Delta^d X_t$ is the dth difference. This form of representation is the time domain method for dealing with non stationarity. It assumes that

$$\Delta^d X_t = (1-L)^d X_t,$$

is a stationary ARIMA(p,d,q) process.

Denoting

$$\Delta^d X_t = (1 - L)^d X_t,$$

it is of interest to find a process X_t that satisfy,

$$\phi(L)\Delta^d X_t = \Theta(L)\varepsilon_t. \tag{4.3}$$

The parameters are chosen so that the zeros of both polynomials, $\phi(L)$ and $\Theta(L)$ lie outside the unit circle in order to avoid generating unbounded processes.

ARIMA as a random chock model

Equation (3.3) can be represented as

$$\gamma(L)X_t = \Theta(L)\varepsilon_t$$

where $\gamma(L)$ a non-stationary AR operator with d roots equal one; all other roots lie outside the unit circle. Express in terms of ψ weights and the white noise components,

$$X_t = \frac{\Theta(L)}{\gamma(L)}\varepsilon_t \equiv \psi(L)\varepsilon_t. \tag{4.4}$$

We can write,

$$\gamma(L)\psi(L) = \Theta(L)$$

$$(1 - \sum_{i=1}^{p+d}\gamma_i L^i)(1 - \sum_{i=1}^{\infty}\psi_i L^i) = (1 - \sum_{i=1}^{q}\Theta_i L^i)$$

If m is the maximum of (p+d-1,q),

$$p + d - 1 \geq q \quad =: m > p + d - 1$$

$$p + d - 1 < q \quad =: m > q$$

It shows that the ψ weights satisfy

$$\psi(L)\psi_m = \phi(L)\Delta^d \psi_m = 0$$

This indicates that large lagged ψ weights comprise of polynomials, exponentials and sinusoids with respect to the index, m.

Autocorrelation Function ACF

For a covariance stationary stochastic process the ACF is

$$\rho_\tau = \frac{\gamma_\tau}{\gamma_0}.$$

It represents the standardized covariance between X_t and its lag, or the correlation between X_t and X_{t-k}. In practice, estimation of ρ_τ involves ordinary sample correlation r_k between X_t and X_{t-k}.

Partial Autocorrelation Function($PACF$)

The Partial autocorrelation of $k - th$ order

$$
\begin{aligned}
\phi_{kk} &= Corr(X_t - \mathcal{P}(X_t \mid X_{t+1}, \ldots, X_{t+k-1}), \\
&\quad X_{t+k} - \mathcal{P}(X_{t+k} \mid X_{t+1}, \ldots, X_{t+k-1}))
\end{aligned}
\tag{4.5}
$$

where $\mathcal{P}(W \mid Z)$ is the best linear projection of W on Z:

$$\mathcal{P}(W \mid Z) = \Sigma_{WZ}\Sigma_{ZZ}^{-1}Z$$

with $\Sigma_{ZZ} = Var(Z)$ the covariance matrix of the regressors and $\Sigma_{WZ} = Cov(W, Z)$ the matrix of the covariances between W and Z.

An equivalent definition is the solution of the

Yule-Walker equation

$$P_k\phi_k = \rho_{(k)}$$

$$
P_k = \begin{pmatrix}
1 & \rho_1 & \cdots & \rho_{k-1} \\
\rho_1 & 1 & \cdots & \rho_{k-2} \\
\vdots & \vdots & \ddots & \vdots \\
\rho_{k-1} & \rho_{k-2} & \cdots & 1
\end{pmatrix}
$$

$$\phi_k = (\phi_{k1}, \ldots, \phi_{kk})^T$$

and

$$\rho_{(k)} = (\rho_1, \rho_2, \ldots, \rho_k)^T.$$

The last coefficient ϕ_{kk} is the partial autocorrelation of order k. Using Cramer's rule, the coefficient ϕ_{kk} can be solved as

$$\phi_{kk} = \frac{|P_k^*|}{|P_k|} \qquad \forall \quad k = 1, 2, \ldots$$

where P_k^* is obtained by replacing the last column of matrix P_k by vector $\rho_{(k)} = (\rho_1, \rho_2 \ldots, \rho_k)^T$.

PACF tries to measure the dependence between X_t and $X_{t+\tau}$ by first correcting X_t and $X_{t+\tau}$ for the linear influence of the variables $X_{t+1}, ..., X_{t+\tau-1}$ and then to measure the correlation. This quantity may intuitively be thought as the sample autocorrelation of the times series observations separated by a lag of k time units with the effects of the intervening observations eliminated. The partial autocorrelation ϕ_{kk} is interpreted as the degree of variation of X_{t-1} not explained by this regression.

The PACF is useful for identifying the nature of time series process. To determine the order of an AR process, its significant partials are examine with

$$\phi_{kk} = 0 \qquad \forall k > p,$$

where p is the order of the process.

4.1.2 Estimating Moment Functions

Consider a stationary series X_t, ($t = 1, 2, ..., T$) with $E[X_t] = \mu$ and $Cov(X_t, X_{t+\tau}) = \gamma_\tau$.

Mean:
$$\bar{X} = \frac{1}{T} \sum_{i=1}^{T} X_t$$
$$E[\bar{X}] = \mu$$

Variance:

$$
\begin{aligned}
Var(\bar{X}) &= Var(\frac{1}{T}\sum_{i=1}^{T}X_t) \\
&= \frac{1}{T^2}\sum_{t=1}^{T}\sum_{s=1}^{T}Cov(X_t, X_s) \\
&= \frac{1}{T^2}\sum_{t=1}^{T}\sum_{s=1}^{T}\gamma_{t-s} \\
&= \frac{1}{T}\sum_{\tau=-(T-1)}^{T-1}\frac{T-|\tau|}{T}\gamma_\tau
\end{aligned}
$$

Assuming absolute summation of γ_τ, then

- $Var(\bar{X}) < \infty$ and $lim_{T\to\infty} = 0$.

- The asymptotic variance

$$
\begin{aligned}
lim_{T\to\infty}TVar(\bar{X}) &= \gamma_0 + 2\sum_{\tau=1}^{\infty}\gamma_\tau \\
&= f(0)
\end{aligned}
$$

  represents the spectra density at 0.

- The asymptotic distribution $\sqrt{T}(\bar{X}-\mu) \xrightarrow{\mathcal{L}} N(0, f(0))$.

Covariance Function

A possible estimator of the covariance function, γ_τ is

$$
\hat{\gamma}_{\tau,T} = \frac{1}{T}\sum_{t=1}^{T-\tau}(X_t - \bar{X}_T)(X_{t+\tau} - \bar{X}_T)
$$

with

$$
\begin{aligned}
E[\hat{\gamma}_{\tau,T}] &= E[\frac{1}{T}\sum_{t=1}^{T-\tau}(X_t - \bar{X}_T)(X_{t+\tau} - \bar{X}_T)] \\
&= (1 - \frac{\tau}{T})\gamma_\tau - (1 - \frac{\tau}{T})Var(\bar{X}) + O(\frac{1}{T^2})
\end{aligned}
$$

Hence $\hat{\gamma}_{\tau,T}$ is a bias estimator of γ_τ.

However, $lim_{T \longrightarrow \infty} E[\hat{\gamma}_{\tau,T}] = \gamma_\tau$, the bias vanish asymptotically.

The variance may be approximated by,

$$Var(\hat{\gamma}_{\tau,T}) \approx \frac{1}{T} \sum_{j=-\infty}^{\infty} (\gamma_j^2 + \gamma_{j-\tau}\gamma_{j+\tau})$$

$$= \frac{1}{T} Var(\hat{\gamma}_{\tau,\infty})$$

Since $lim_{T \longrightarrow \infty} Var(\hat{\gamma}_{\tau,T}) = 0$ exist, $\hat{\gamma}_{\tau,T}$ is a consistent estimator of γ_τ with $T^{\frac{1}{2}}(\hat{\gamma}_{\tau,T} - \gamma_\tau)(\bar{X} - \mu) \xrightarrow{\mathcal{L}} N(0, Var(\hat{\gamma}_{\tau,\infty}))$.

Unit Roots and Stationarity Tests

From equation(4.2), the properties of a non-stationary time series (with respect to the mean) depends on the order, d of integration or the presence of unit roots. There are d unit roots if $\phi(L)$ is stationary and $\Theta(L)$ is invertible. In other words, if $\Delta^d X_t$ is stationary, X_t has d unit roots.

Unit root test

Consider an AR(1) process

$$X_t = c + \alpha X_{t-1} + \epsilon_t \tag{4.6}$$

If $|\alpha| < 1$ then X_t is stationary.

If $\alpha = 1$ then X_t is a non stationary random walk. We are interested in testing $\alpha = 1$. Such tests are known as unit root tests.

Dickey-Fuller(DF)Tests

Unit root test, $H_0 : \alpha = 1$ vs $H_1 : \alpha \neq 1$. The basic idea is the regression

$$\Delta X_t = c + (\alpha - 1)X_{t-1} + \epsilon_t, \tag{4.7}$$

Under H_0 the coefficient of X_{t-1} equals zero. Under H_1 this coefficient is negative. A standard $t-$statistics are developed as

$$\hat{t}_n = \frac{\hat{\alpha} - 1}{\sqrt{\hat{\sigma}^2 \sum_{t=2}^{n} X_{t-1}^2}}, \tag{4.8}$$

where $(\hat{\alpha}; \hat{\sigma}^2)$ are the LS-estimators of (α, σ^2). As n increases, this statistic does not converge to the standard normal distribution, but to a distribution function of a Wiener process.

$$\hat{t}_n \xrightarrow{\mathcal{L}} \frac{1 - W^2(1)}{2\left\{\int_0^1 W^2(u)du\right\}^{1/2}}$$

where W is a standard Wiener process.

The problem of DF Test is that the level e.g. $\alpha = 5\%$) is strongly affected if ϵ_t are autocorrelated. To avoid this negative effect, Dickey and Fuller augmented by suggesting one regression with the past differences.

The augmented test(ADF): Reject H_0 if $\tau = \hat{t}_n$ (constructed with $\hat{\alpha}$) is smaller than the critical value.

Stationarity Test

The KPSS Test of Kwiatkowski, Philipps, Schmidt and Shin tests the stationarity, i.e. the alternative H_1 is the unit root. In contrast to the ADF test the hypotheses are exchanged. The regression model with trend is of the form:

$$X_t = c + \mu t + k \sum_{i=1}^{t} \xi_i + \epsilon_t,$$

with stationary ϵ_t and ξ_t i.i.d.(0,1).

The two hypothesis are:

- $H_0 : k = 0$,trend stationary.

- $H_1 : k \neq 0$, unit root (non stationary).

In order to construct the KPSS Statistic, the following procedure can be followed:

1. calculate LS residuals $\hat{\epsilon}_t$ under H_0

2. construct partial sums: $S_t = \sum_{i=1}^{t} \hat{\epsilon}_i$, (under H_0 the variance increases with t)

3. the statistic

$$KPSS_T = \frac{\sum_{t=1}^{n} S_t^2}{n^2 \hat{\omega}_T^2},$$ (4.9)

with

$$\hat{\omega}_T^2 = \hat{\sigma}_\epsilon^2 + 2 \sum_{\tau=1}^{T} (1 - \frac{\tau}{T-1}) \hat{\gamma}_\tau$$

being an estimator of the spectral density at zero; $\hat{\sigma}_\epsilon^2$ is the estimated variance of ϵ_t and $\hat{\gamma}_\tau = 1/n \sum_{t=\tau+1}^{n} \hat{\epsilon}_t \hat{\epsilon}_{t-\tau}$ is the estimator of covariance.
A problem here is the choice of the cutoff point T for the spectral density estimator. For small T the test is biased if there is autocorrelation; for large T the test loses power.

Order Selection Criteria

For the general AR order selection criteria, consider the following form:

$$Cr(n) = \log \hat{\sigma}_\varepsilon{}^n(n) + C_T \varphi_{(n)}$$

where $\hat{\sigma}_\varepsilon{}^2(n) = T^{-1} \sum_{t=1}^{T} \hat{\sigma}_\varepsilon{}^2(n)$ is the error variance estimator based on the OLS residuals, $\hat{\sigma}_\varepsilon(n)$ from the AR model of order n, C_T is a term related to the sample size and $\varphi(n)$ is a penal function for large AR orders. In the criteria below, $\varphi(n)$ is of order n, which fits the process.
The idea is to choose an order $\hat{p}$ which minimizes this criterion.
The frequently used criteria include:

- Akaike Information Criterion: $AIC(n) = \log \hat{\sigma}_\varepsilon{}^2(n) + \frac{2}{T}n$

- Honnan & Quinn: $HQ(n) = \log \hat{\sigma}_\varepsilon{}^2(n) + \frac{2 \log \log T}{T}n$

- Schwarz Information Criterion: $AIC(n) = \log \hat{\sigma}_\varepsilon{}^2(n) + \frac{\log T}{T}n$

AIC asymptotically overestimates the order, HQ estimates the order consistently ($plim\hat{p} = p$) and SIC estimates strongly consistently ($\hat{p} \to p \quad a.s.$).

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ACF estimation

An estimation for ACF

$$\hat{\rho}_{\tau,n} = \frac{\hat{\gamma}_{\tau,n}}{\hat{\gamma}_{0,n}}$$

- mean

$$E(\hat{\rho}_{\tau,n}) = \rho_\tau - O(\frac{1}{n})$$

- Variance

$$Var(\hat{\rho}_{\tau,n}) = \frac{1}{n} \sum_{\rho,\tau\tau} + \frac{1}{n^2}$$

The estimator is consistent.

Defining

$$\hat{\rho}_{(k),n} = (\hat{\rho}_{1,n},\,,\,,\hat{\rho}_{k,n})^T$$

with asymptotic distribution $n^{\frac{1}{2}}(\hat{\rho}_{(k),n} - \rho_{(k)}) \xrightarrow{\mathcal{L}} N(0, \sum_p)$.

Diagnostic checking

If X_t is white noise

$$E(\hat{\rho}_{\tau,n}) = -\frac{1}{n} + O(\frac{1}{n^2})$$

$$Var(\hat{\rho}_{\tau,n}) = \frac{1}{n} + O(\frac{1}{n^2})$$

The asymptotic covariance matrix of $n^{\frac{1}{2}}(\hat{\rho}_{(k),n} - \rho_{(k)})$ is an identity matrix. Hence, a 95% confidence interval can be constructed for all sample ACF within $\pm 2\sqrt{n}$ limits.

Portmanteau Statistics

Using the asymptotic distribution of $\hat{\rho}_\tau$, testing the hypothesis of white noise can be done on the original series or on the residuals of an ARMA(p,q) process.

$H_0:$ $\qquad \rho_1 = 0,,,,\rho_m = 0$ for all m, assuming $n^{\frac{1}{2}}(\hat{\rho}_{\tau,n} - 0) \xrightarrow{\mathcal{L}} N(0,1)$.

$H_1:$ $\qquad$ at least one $\rho_i \neq 0$

Test statistic (Q_m):

$$Q_m = n \sum_{j=1}^{m} \hat{\rho}_{j,n}^2 \xrightarrow{\mathcal{L}} \chi_{m-k}^2$$

where $k = 0$ for $\hat{\rho}$ calculated from X_t

$k = p + q$ for $\hat{\rho}$ calculated from residuals of an ARMA(p,q).

Reject H_0 if:

$$Q_m > \chi_{m-k;\alpha}^2.$$

The Portmanteau statistics (Q_m^*):

For the asymptotic equivalent statistic with better small sample properties,

$$Q_m^* = n(n+2) \sum_{j=1}^{m} \frac{1}{n-j} \hat{\rho}_{j,m}^2$$

4.2 An Enhanced Example with XploRe Quantlet Technology

In exemplifying e-learning of statistical applications in the FIC MD*Booklet, an enhanced example involving modelling a time series data is presented. The data represents sales (in units of 1000) for a manufacturer producing and marketing Super Tech. Videocassette Tape, over a period of 161 weeks. (http://www.quantlet.com/mdstat/scripts/fic/index.html)
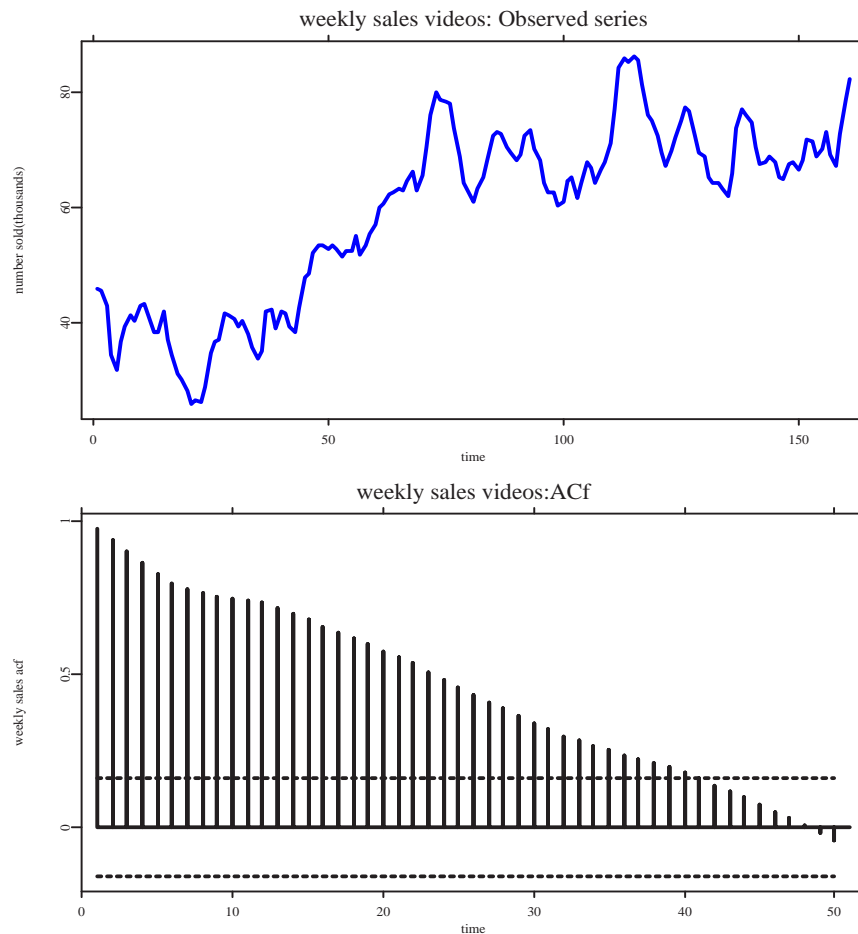
Figure 4.1: Time plot and ACF original sales data. ⓠ FICArimaf01.xpl

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Model Identification The sales series shows increasing trend in the mean. The ACF decays slowly, decreasing in numerical values with increasing lags. This indicates non-stationarity in mean. Hence, differencing is recommended to obtain stationarity.
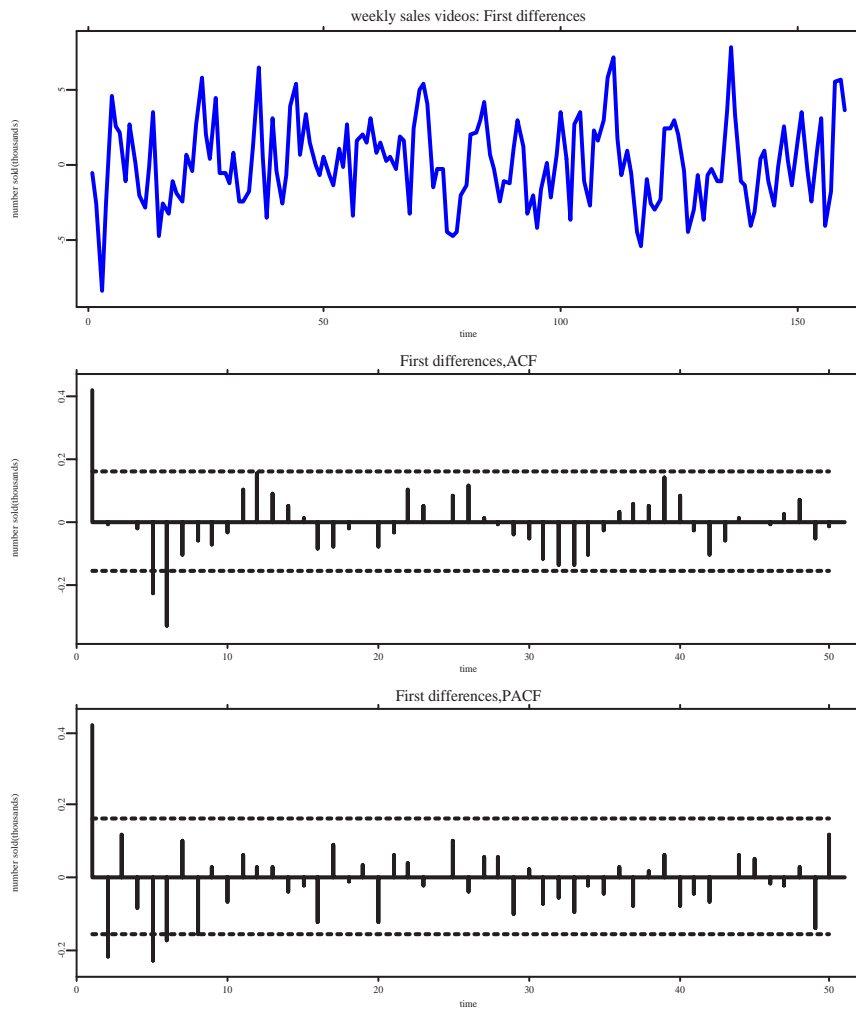
Figure 4.2: First difference sales plot,ACF and PACF.
Q FICArimaf02.xpl

Parameter estimation

The ACF dies slowly indicating an AR-process and the PACF cuts-off at lags 1, 2, and 5. Considering the cut at lag two, and a tentative AR(2) Model

$$X_t = \upsilon + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \varepsilon_t.$$

to describe the first differences of sales values. We obtain the estimated parameters for the model as $\nu = 0.18043$, $\alpha_1 = 0.5079$, $\alpha_2 = -0.21743$.

$$
\begin{aligned}
AIC &= 1.8737 \\
SIC &= 1.9125
\end{aligned}
$$

Investigating stationarity conditions we obtain

- The stationarity triangle, $\alpha_1 + \alpha_2 < 1$, $\alpha_2 - \alpha_1 < 1$, $|\alpha_2| < 1$

- The ADF test statistic for a unit root, $\tau = -8.2862$

- The KPSS test,

Order	Test	Statistic	Crit. Value		
			0.1	0.05	0.01
2	const	0.051	0.347	0.463	0.739
2	trend	0.053	0.119	0.146	0.216

Table 4.1: The KPSS test: confirm stationarity. Q FICArimaf03.xpl

Diagnostic checking

The series of residuals and its ACF is consistent with white noise with almost all sample ACF within the $\pm 2/\sqrt{n}$ limits. The Box-Ljung statistic for the first five lags confirms statistical significance in residual autocorrelation. The model is therefore adequate for forecasting future sales.
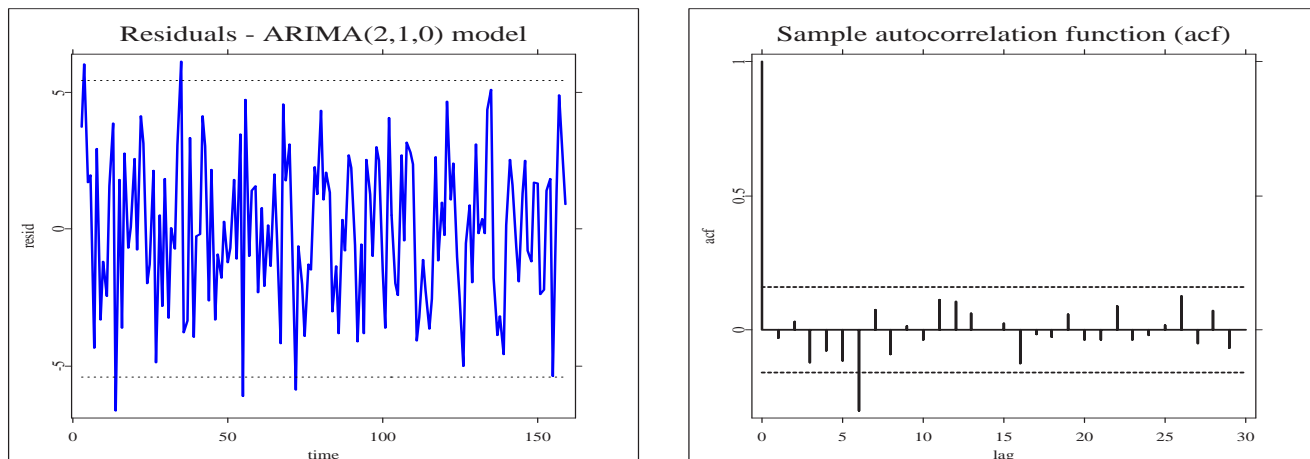
Figure 4.3: Residual plot and residual acf of model. 🂠 FICArimaf04.xpl

| Box-Lung values | 0.0013508 | 0.84667 | 1.8755 | 2.3576 | 4.9654 |
| P-values | 0.97068 | 0.65486 | 0.59864 | 0.6703 | 0.42011 |

Table 4.2: Box-Lung statistics for residuals.

| time lag | 41 | 42 | 43 | 44 | 45 | 46 | 47 |
| forecast value | 82.967 | 82.513 | 82.137 | 82.042 | 82.074 | 82.111 | 82.123 |

Table 4.3: L=7 step ahead Sales forecast values.
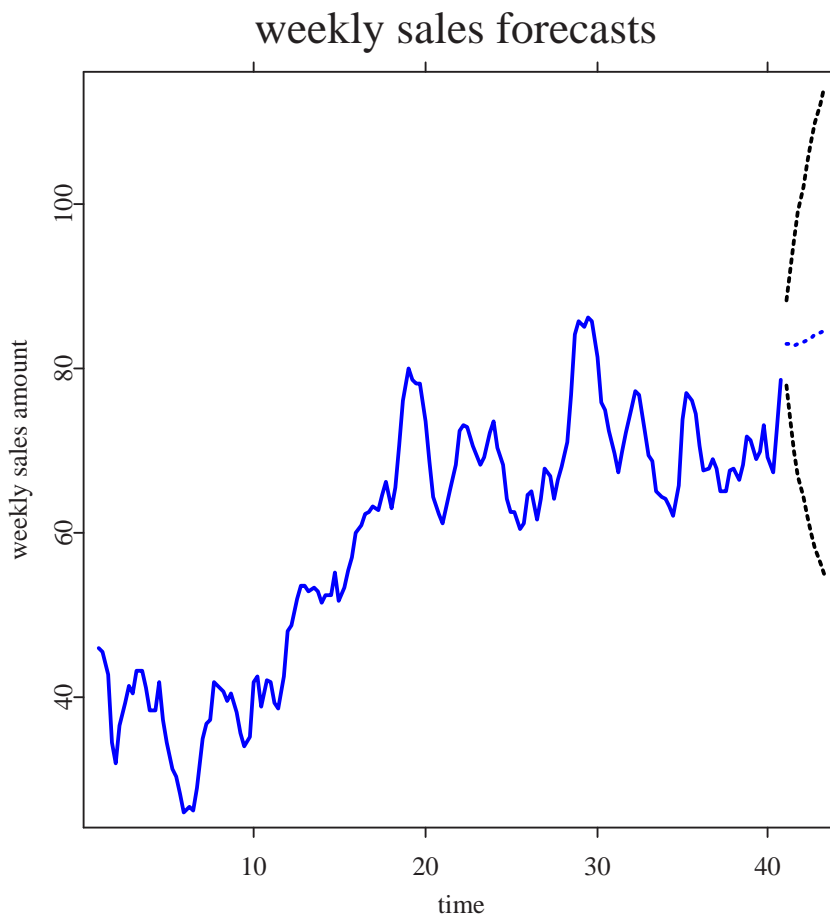
Figure 4.4: Sales forecast for Model from $t = 40$. FICArimaf05.xpl
The doted bowl-shaped lines represents the 95% tolerance interval for the
L-step ahead forecast from $t = 40$.

Chapter 5

e-learning Evaluation

5.1 Evaluation Criteria

With increasing growth in size and complexity in e-learning implementations, the demand on the underlying technology is becoming more rigorous. This involves new ways to access, learn/teach and prepare learning materials. For an e-learning/e-teaching tool to be appreciated, there is need to find out whether the technology infrastructure has the capacity to support the users and network load, or scalable enough to support growth. It must also be stable to ensure high availability to learners and support connectivity between components. A good guide to evaluating any e-learning material is to have a clear description of the learning needs. With this in mind, one can assess the ability of the inherent technology to address these needs. Some useful e-learning evaluation criteria include

- **Navigation**

  The ease with which learners reach, and the ability to find way within the learning package. This take into account the progress indication within course material, the necessary forward, backward option

choices such as to skip ahead and go backwards to previously covered material, Bookmark functionalities, menu or modules of course progress completion.

- **Screen Design (format, layout, appearance)**
  This include full screen presentation, good use of different fonts and colored text with few colors that work well. The availability of graphics and visual style that enhance learning, sounds and animation options as well as simple and clear images and objects where necessary.

- **Instructional Structure**
  e-learning materials must relate to the reading level, depth and experience of the target learner. It should include an introduction on the subject to be learned and its importance in the learning process.

- **content/ substance**
  Evaluating content involve address how the learning information is uniquely created, accurate, meaningful, comprehensive, current, easy to edit, update and maintain.

- **Interactivity**
  This criteria focus on user participation in the learning process through interactive examples. Interaction is based on the knowledge and skill of the learner. The type of interaction may include simulations, free response, executing inherent software applications, drag and drop, etc.

- **Applicability**
  Applicability for e-learning evaluation involves how applicable the instructional content is to the specific need and situation the learner faces. It looks for a strong connection between the course content and the benefit of learners from the learning process.

Chapter 6

FIC MD*Booklet Evaluation

6.1   Introduction

This section does not focus on the technicalities behind MD*Book design and development but rather on the evaluation of its implementation in the eyes and minds of the learner. As such, the evaluation study herein centers on its pedagogic influence; the theoretical underpinning of the learning process with the learner on focus. On this thought, this evaluation study examines pedagogic variables underlying e-learning with respect to FIC MD*Booklet, its robustness and usefulness. In terms of these variables, the evaluation carried out seeks to

- Establishing whether FIC MD*Booklet meet specific e-learning criteria (the level and nature of e-learning, accessibility issues, FIC MD*Booklet e-learning methodology, Navigability, interactive capability and flexibility, self-assessment components) for the learner.

- Identifying problems that occur in learning with FIC MD*Booklet so as to provide improved solutions.

These variables have been categorized in terms of Navigability and Usability.

Navigability:

- Ease of navigation: How easy is it for the learner to get to the learning site and navigate between course components.

- The clarity in units and course headings that will enable the user to refer easily to them.

- The linearity (chronological and consistency) in course components design.

Usability:

Learners are most likely to remember well organized information, nice illustrations and interactive examples. Therefore the evaluation process has in most part reflected the views of the learner on:

- Content/substance: The quality of learning information.

- Layout/format and appearance: How consistent course components are laid out, the placement of hyperlinks forward and backwards between course components.

- How good the linkage to all pertinent learning components is; the "Information", "Explained" and "Enhanced" components.

- Applicability: The innovative and interactive effect of XploRe application software in the learning process.

6.2 The Evaluation Methodology

The common aim of any evaluation study is to provide data to justify the
results obtained or evidence to support the feeling that the material is help-
ing the learner to learn more effectively. The process of evaluating FIC
MD*Booklet is an observational study. Respondents were students study-
ing statistics of Finance and its related subjects. The evaluation methodol-
ogy was based on a questionnaire designed and tested on learners. It cov-
ers information for navigability, accessibility and usability. Respondents
attitude towards FIC MD*Booklet was measured using a seven-item scale
comprising statements to which they agreed or disagreed, using a five-point
Likert response format such that:

- 1=strongly disagree

- 2=disagree

- 3=undecided

- 4=agree

- 5=strongly agree.

A general comment box is also available.

6.2.1 The Evaluation Questionnaire

In order to continuously improve the concept behind MD*Booklet: FINANCE INTRODUCTORY COURSE, we would like to have your feedback and comments on this questionnaire. Please, cross out your response.

Rating is on a 1 to 5 scale. 1 equals "strongly disagree" and 5 equals "strongly agree". 1 represents the lowest and most negative impression on the scale, 3 represents an undecided impression and 5 represents the highest and most positive impression.Cross out your response to each item. (1=Strongly disagree 2=Disagree 3=Undecided 4=Agree 5=Strongly agree)

1. **The FIC MD*Booklet is readily accessible online**.
   ☐ strongly disagree ☐ disagree ☐ undecided ☐ agree ☐ strongly agree

2. **Navigation to course units and components is quick and easy**.
   ☐ strongly disagree ☐ disagree ☐ undecided ☐ agree ☐ strongly agree

3. **The "information", "Explained" and "Enhanced" component is very useful in learning course content**.
   ☐ strongly disagree ☐ disagree ☐ undecided ☐ agree ☐ strongly agree

4. **The learning material presented in each course unit (the information, explained and enhanced components) are clear and consistent**.
   ☐ strongly disagree ☐ disagree ☐ undecided ☐ agree ☐ strongly agree

5. **The design (format and layout) makes learning with FIC MD*Booklet attractive**.
   ☐ strongly disagree ☐ disagree ☐ undecided ☐ agree ☐ strongly agree

6. **The executable XploRe programs provides better understanding of the statistical methods implemented in this MD*Booklet**.

☐ strongly disagree ☐ disagree ☐ undecided ☐ agree ☐ strongly agree

7. **Rate how you would recommend FIC MD*Booklet as a convenient material for easy and quality online learning**.

☐ strongly disagree ☐ disagree ☐ undecided ☐ agree ☐ strongly agree

To promote validity of response, the aim of this FIC project was presented to perspective respondents in a course, statistics of Financial markets. Respondents affirmed to provide sincere response to the best of their ability. A draft questionnaire was put on web to enable respondents reflect on their responses and comments.

The survey sample data for all 79 questionnaire respondents is presented in tables (6.1, 6.2 and 6.3)

Respondent No.	Quest1	Quest2	Quest3	Quest4	Quest5	Quest6	Quest7
1	4	4	4	4	2	4	4
2	4	4	3	4	4	2	4
3	5	4	4	5	4	4	3
4	4	4	3	4	4	4	4
5	5	5	4	2	4	5	5
6	3	4	3	4	2	5	4
7	4	2	4	5	3	4	4
8	4	5	1	1	3	3	4
9	3	4	5	4	4	1	4
10	4	2	4	4	2	4	4
11	4	4	4	4	4	4	3
12	3	4	4	4	4	3	5
13	4	4	4	4	4	1	4
14	4	4	4	4	4	4	4
15	3	4	3	2	4	3	5

Table 6.1: Respondents (1-15) Sample data

Respondent No.	Quest1	Quest2	Quest3	Quest4	Quest5	Quest6	Quest7
16	4	4	2	1	4	3	2
17	3	4	4	1	4	3	4
18	1	2	4	4	1	4	3
19	4	1	4	5	4	4	4
20	3	5	4	5	4	5	4
21	4	4	4	2	1	4	2
22	4	4	2	2	2	4	2
23	3	5	4	4	4	4	4
24	5	2	5	4	4	5	4
25	4	4	4	4	2	3	4
26	4	4	4	4	4	3	4
27	4	2	4	4	4	2	4
28	4	4	4	4	4	4	3
29	4	4	2	5	4	4	5
30	4	4	4	5	2	4	4
31	4	5	4	4	4	2	4
32	4	4	4	4	2	4	3
33	4	4	4	4	4	4	3
34	2	1	4	4	5	3	3
35	5	4	4	3	2	4	5
36	3	4	4	4	3	2	4
37	4	4	4	4	4	4	3
38	4	4	3	4	3	4	4
39	3	1	3	4	5	4	5
40	4	4	3	4	4	4	5
41	4	4	4	4	4	4	4
42	5	5	4	4	5	4	1
43	4	4	5	5	2	3	4
44	4	3	4	4	4	3	4
45	3	4	4	4	5	4	3
46	4	4	4	4	4	3	5
47	4	4	5	4	4	2	5
48	4	4	4	4	3	4	3

Table 6.2: Respondents (16-48) Sample data

Respondent No.	Quest1	Quest2	Quest3	Quest4	Quest5	Quest6	Quest7
49	4	4	4	4	4	4	4
50	2	4	4	4	4	3	4
51	4	4	4	4	1	4	4
52	3	4	4	4	4	3	2
53	4	4	4	5	4	4	4
54	3	4	4	4	4	4	5
55	4	4	4	4	5	5	3
56	4	4	5	5	4	4	4
57	4	5	5	4	4	2	3
58	2	4	5	5	4	4	4
59	4	4	2	4	4	4	4
60	2	2	3	4	4	4	4
61	4	4	2	4	3	3	4
62	3	5	4	5	2	4	4
63	4	5	5	5	4	3	4
64	4	4	3	3	2	2	4
65	4	2	4	4	5	4	4
66	4	4	3	4	4	4	3
67	4	5	2	4	5	4	4
68	3	4	3	4	4	4	4
69	4	4	4	4	4	4	3
70	4	4	3	4	2	3	4
71	4	4	4	4	4	4	4
72	4	4	4	4	4	4	4
73	5	4	5	5	4	4	3
74	5	4	5	5	4	4	4
75	4	4	4	4	4	5	4
76	5	4	5	4	5	2	4
77	4	4	3	4	4	4	3
78	4	4	4	4	4	4	4
79	4	4	4	4	4	4	4

Table 6.3: Respondents (49-79) Sample data

6.3 The Evaluation Results

Response		strongly disagree	disagre	undecided	agree	strongly agree	total
Quest1	frequency	1	4	14	52	8	79
	Percentage	1.3	5.1	1.7	65.8	10.1	100
Quest2	frequency	3	7	1	58	10	79
	Percentage	3.8	8.9	1.3	73.4	12.7	100
Quest3	frequency	1	6	13	48	11	79
	Percentage	1.3	7.6	16.5	60.8	13.9	100
Quest4	frequency	3	4	2	56	14	79
	Percentage	3.8	5.1	2.5	70.9	17.7	100
Quest5	frequency	3	12	8	49	7	79
	Percentage	3.8	15.2	10.1	62.0	8.9	100
Quest6	frequency	2	8	16	47	6	79
	Percentage	2.5	10.1	20.3	59.5	7.6	100
Quest7	frequency	1	4	16	48	10	79
	Percentage	1.3	5.1	20.3	60.8	12.7	100

Table 6.4: Questionnaire response evaluation result

The average percentage representation of the response score "agree" for each questionnaire section (Navigability: Questions 1, 2 ; Usability: Questions 3, 4, 5, 6) is as follows:

- 69.6% of respondents agree to the quick access to, and easy navigation within MD*Book: FIC

- 63.3% of respondents agree on its usability in learning course topics.

In addition, 60.8%would recommend the use of FIC MD*Book as a convenient material for providing easy and quality e-learning.

Bar charts for categorical responses pertaining to each question, have
been summarized.
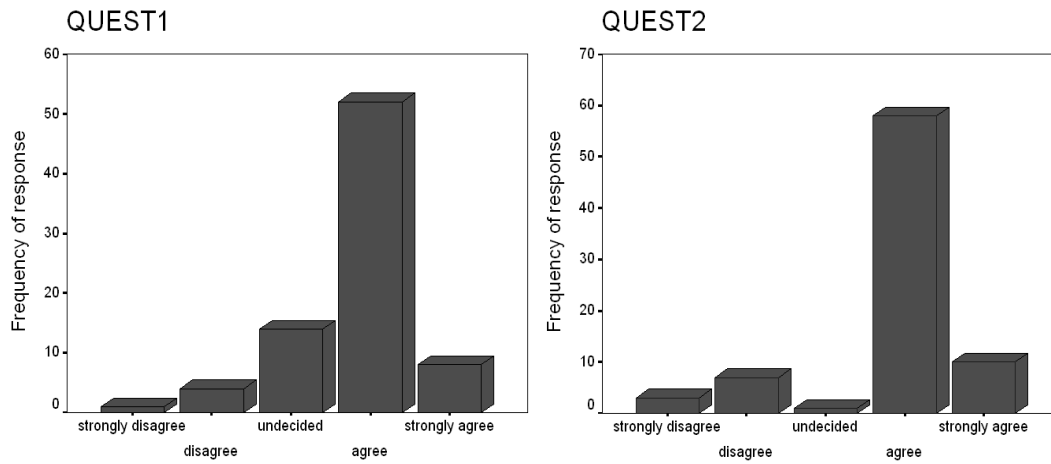
Figure 6.1: Bar chart: rated response for questions 1 and 2 (left to right)
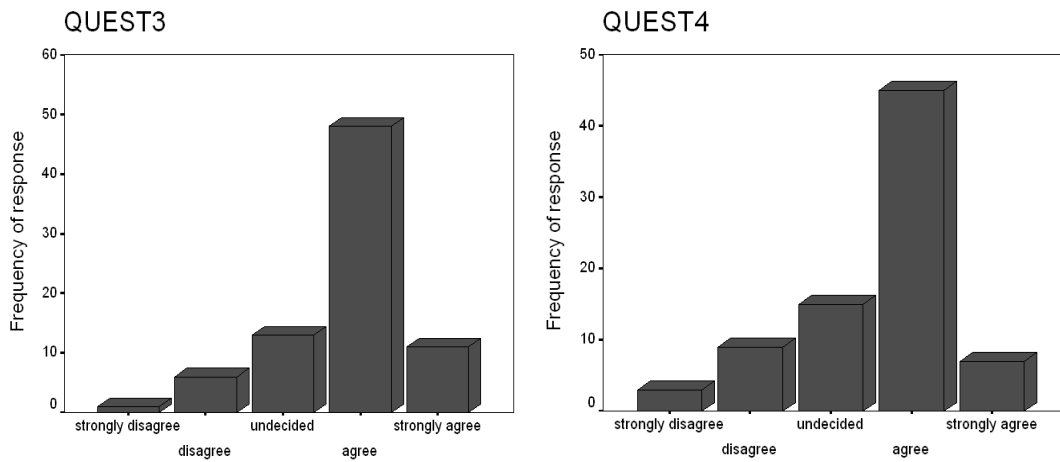
Figure 6.2: Bar chart: rated response for questions 3 and 4 (left to right)
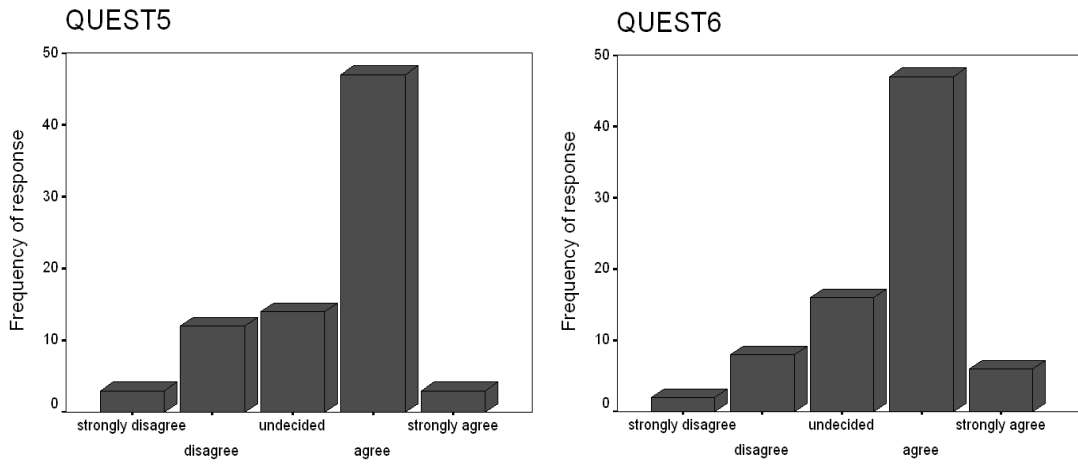
Figure 6.3: Bar chart: rated response for questions 5 and 6 (left to right)
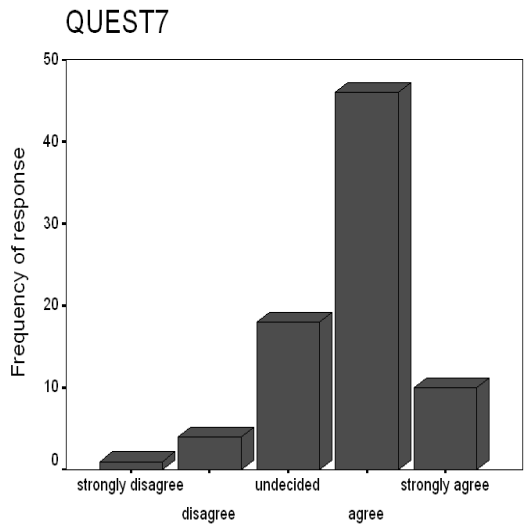
Figure 6.4: Bar chart: rated response for question 7

6.4 Summary of Comments and Suggestions

In summarizing this evaluation result, substantial advantages of FIC MD*Booklet from users responses include:

- a user friendly GUI with attractive course design and clear screen readability.

- an effective course browsability and Organization; course components are organized logically and chronologically.

- an easy Connectivity: FIC MD*Book can be accessed reliably online and is not overloaded.

- Interactivity: The interactive statistical applications of the XploRe software adds more value to e-learning with FIC MD*Booklet. The user can edit and run the existing programs for investigative purpose.

Navigability: Respondents indicated satisfaction in the navigational system in place which facilitates the movement between course contents as well as convenience in searching within specific course units.
Usability: Respondents indicated that they learn and retain more information through the explained, information and enhanced components.
Accessibility: The FIC MD*Booklet allows the learner to print off specific sections and view course pages in a variety of font sizes, which is an excellent option for the vision impaired

Some comments from respondents include,

> "The quantlets are the best way to understand many aspects of the Option topic: just exploring the quantlets gives good feeling on how changes affects the results".

"This introductory course is good with the interactive idea with Quantlets; It will be good to extend the this way of learning to include more advanced courses in Finance"

Despite the overall satisfaction, important concern was on the need for thorough preparation in XploRe know how, to fully benefit from the innovations underpinning e-learning with FIC MD*Booklet.

On the other hand the limitations of this project has been how to handle the number of variables that potentially affect the evaluation of an e-learning process, and is therefor particularly difficult to evaluate whether an e-learning material fulfills the need of every learner. An attempt to addressing this difficulty could be continuous evaluation with the help of an in built authoring tool to monitor the behavior of learners along with course content and description. The usefulness of such an authoring tool is to detect possible design errors, deficiency and or chances for improving on course content in a semi-automatic way. Further evaluation study on FIC MD*Booklet may have to consider emerging variables such as individual learning variable, learning environment variables, contextual as well as technology variables. These variables have a chain-effect and link each benefit level to the other.

Chapter 7

Conclusion

This thesis has dwelled on realizing an e-learning applications of statistics in a Finance Introductory Course project (FIC) through implementation of the MD*Book: e-learning/e-teaching tool and an evaluation of its learning process. My work is oriented towards the "padagogy innovation" layer of the e-learning/e-teaching concept with a functional overview of how statistics and its applications can benefit from e-learning.

I have demonstrated this implementation in a Finance Introductory Course (the FIC MD*Booklet) using the Xplore Quantlet Client (XQC) technique of the XploRe quantlet technology, as well as carried out an evaluation study that investigates its innovation in e-learning/e-teaching of Statistics and data analysis.

In conclusion, the evaluation result positively affirms that, the concise structural format, the inter-operability, interactivity between course content, flexibility, hypertext functionality as well as the combination of the full-fledged XploRe statistical computing language are the practical and innovative requirements for which users of FIC MD*Booklet can successfully learn and interact with statistical applications in the learning process.

http://www.md-stat.com

Chapter 8

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Appendix A

Appendix

A.1 XploRe Quantlet FICOptStart

```
Ebook           FIC
------------------------------------------------------------------
Macro           FICOptStart
-------------------------------------------------------------------
Description:    to calculate option prices or implied volatilities
-------------------------------------------------------------------
Author          Feldmann, Sperlich 970217
-------------------------------------------------------------------
proc() = FICOptStart()
optstart()
endp
library("finance")
FICOptStart()
-------------------------------------------------------------------
```

A.2 XploRe Quantlet FICMA02

```
Ebook           FIC
------------------------------------------------------------------
Macro           FICMA02
------------------------------------------------------------------
Description:    Analysis and make comparison of two MA(q) processes.
------------------------------------------------------------------
proc(k)=param(u)
  k=matrix(u,1)
  defaults=matrix(u,1)
  j=1
  ValueNames = string("value of beta %.0f",j)
  while(j<(u))
    j=j+1
    ValueNames=ValueNames~string("value of beta
    %.0f",j)
  endo
  ValueNames=ValueNames'
  k=readvalue(ValueNames,defaults)
endp


proc(a)=control(x,u,v,w)
  switch
  case(x==v) a=w break
  case(x<=u) a=x break
  case(x>u)  a=u break
  endsw
endp
```

```
proc(w)=preac(u,v)
  n=rows(u)
  aa=acf(u)[1:v]
  bb=matrix(v,2)*0
  cc=vec((aa[1:v]~bb)')
  c1=0:(v-1)
  c2=1:(v)
  dd=vec((c1~c1~c2)')
  w=dd~cc
endp

proc(w)=prepac(u,v)
  v=v-1
  n=rows(u)
  aa=pacf(u,v)
  bb=matrix(v,2)*0
  cc=vec((aa[1:v]~bb)')
  c1=1:(v)
  c2=2:(v+1)
  dd=vec((c1~c1~c2)')
  w=dd~cc
endp

proc(peri)=preperi(u)
  n = rows(u)
  u = u-mean(u)
  p = log(n) / log(2)
  p = rint(exp(log(2)*ceil(p)))
  if (n != p)
    u = u|(matrix(p-n)-1)
```

```
  endif
  u=u~(matrix(p).*0)
  ftr = fft(u)
  peri = (sum((ftr.*ftr)')/p)'
  ind=2:(floor(n/2))
  putglobal("ind")
  peri = peri[ind]
endp


proc(k)=param2(u,v)

  k=matrix(u,1)
  defaults=matrix(u,1)
  j=1
  ValueNames = string("process
  %.0f:  value of beta %.0f ",v,j)
  while(j<(u))
    j=j+1
    ValueNames=ValueNames~string("process
    %.0f:  value of beta %.0f ",v,j)
  endo
  ValueNames=ValueNames'
  k=readvalue(ValueNames,defaults)
endp
  proc()=start()
  con=1
  while(con<>0)
    stitle="make your choice  or  press OK"
    sitems="analyzing an MA(q)-process"|
    "comparing two MA(q)-processes"
    atitle="make ONE choice"
```

```
con=select0item(stitle,sitems,atitle)
 if(con==1)
  randomize(223667)
  ValueNames = "number of observation"|
  "number of lags"|
  "order of the MA(q) process"
  defaults = 300 | 25 | 1
  v = readvalue(ValueNames,defaults)
  en=v[1,]
  lag=v[2,]
  q=v[3,]
  qu=abs(q)
  qu=control(qu,20,0,1)
  k=param(qu)
  lag=abs(lag)
  en=abs(en)
  q=abs(q)
  en=control(en,500,0,30)
  lag=control(lag,30,0,1)
  y = genarma(0,k,normal(en));MA(1) Proz. erzeugt
  te=1:en
  ya=te~y
  peri=preperi(y)
  v=prepac(y,lag)
  w=preac(y,lag)
  s1=(0|lag)~((1|1)*2/sqrt(en))
  s2=(0|lag)~((1|1)*(-2)/sqrt(en))
  s1=setmask(s1,"line", "dashed")
  s2=setmask(s2,"line", "dashed")
  gy=gryline(0,te)
  ind=getglobal("ind")
```

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```
we=setmask((ind/en)~peri, "line", "solid")
v=setmask(v,"line", "large", "red")
w=setmask(w,"line", "solid", "blue")
gy=setmask(gy, "line", "thin", "red")
mag=setmask(ya,"line","solid", "blue")


d=createdisplay(2,2)
show(d,1,1,mag,gy)
show(d,1,2,w,s1,s2)
show(d,2,2,v,s1,s2)
show(d,2,1,we)
setgopt(d,1,1,"title",string("MA(%.0f)-process",qu))
setgopt(d,1,2,"xlabel","lag","ylabel","acf","title",
"Sample autocorrelation function (acf)")
setgopt(d,2,2,"xlabel","lag","ylabel","pacf","title",
"Sample partial autocorrelation function (pacf)")
setgopt(d,2,1,"xlabel","frequency","ylabel","periodogram",
"title",string("Periodogram of the MA(
%.0f)-process",qu),"dispsize",800|500,"disppos",190|25)
endif
if(con==2)
ValueNames = "number of observation" | "number of lags"
  |"order of the first MA(q) process ( Y )"
  |"order of the second MA(q) process ( Z )"
defaults = 300 | 25 | 1 | 1
v = readvalue(ValueNames, defaults)
en=v[1,]
lag=v[2,]
q1=abs(v[3,])
q2=abs(v[4,])
```

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```
q1=control(q1,20,0,1)
q2=control(q2,20,0,1)
k=param2(q1,1)
l=param2(q2,2)

lag=abs(lag)
en=abs(en)
en=control(en,500,0,30)
lag=control(lag,30,0,1)

randomize(0)
y1 = genarma(0,k,normal(en))
randomize(01)
y2 = genarma(0,l,normal(en))
y3=(y1)-(y2)
te=1:en
y1=te~y1
y2=te~y2
y3=te~y3

gy=gryline(0, te)
gy=setmask(gy, "line", "thin", "red")
gy2=setmask(gy, "line", "thin", "black")
my1=setmask(y1,"line","solid", "black")
my2=setmask(y2,"line","solid", "blue")
my3=setmask(y3,"line","solid", "red")

d=createdisplay(2,2)
show(d,1,1,my1,gy)
show(d,2,1,my2,gy)
show(d,1,2,my1,my2,gy)
```

```
    show(d,2,2,my3,gy2)

    setgopt(d,1,1,"title",string("First process: MA(

    %.0f)-process",q1))

    setgopt(d,2,1,"ylabel","Z","title",string("Second process:

    MA(%.0f)-process",q2),"dispsize",800|500,"disppos",190|25)

    setgopt(d,1,2,"title","Both processes")

    setgopt(d,2,2,"ylabel","Y - Z","title","Difference: D = Y - Z")


  endif


 endo


endp library("times") library("plot") library("glm") start()

-------------------------------------------------------------------
```

A.3 XploRe Quantlet FICArimaf01

```
Ebook           FIC

-------------------------------------------------------------------

Macro           FICArimaf01

-------------------------------------------------------------------

Description:    time plot of the weekly sales of super tech videos

-------------------------------------------------------------------

Author          Julius, Mungo  3739879

-------------------------------------------------------------------


proc() =FICArimaf01()


y=read("video.dat")
```

```
gserie=createdisplay(2,1)

origyear=1

len=161

tim=1:161

py=setmask(tim~y,"line","blue")

title="weekly sales videos:Observed series"

show(gserie,1,1,py)

setgopt(gserie,1,1,"border",0,"xlabel","time","ylabel","number

sold(thousands)","title",title)

bb=matrix(50,2)*0 dd=vec(((1:50)~(1:50)~(2:51))')

s1=(1|50)~((1|1)*2/sqrt(157)) s1=setmask(s1,"line", "dashed")

s2=setmask(s1[,1]~(-s1[,2]),"line", "dashed")

corr=acf(y)[2:51] ccor=vec((corr~bb)') wy=setmask(dd~ccor,"line",

"solid") title="weekly sales videos:ACf" show(gserie,2,1,wy,s1,s2)

setgopt(gserie,2,1,"border",0,"xlabel","time","ylabel","weekly

sales acf","title",title)
```

```
endp


library("times") ; loads the library times


FICArimaf01()
```

A.4 XploRe Quantlet FICArimaf02

```
Ebook           FIC

-----------------------------------------------------------------

Macro           FICArimaf02

-----------------------------------------------------------------

Description:    First differences and estimation of parameters
                by conditional least squares.Computed model
                selection criteria are AIC and BIC.

-----------------------------------------------------------------

Author          Julius, Mungo   3739879

-----------------------------------------------------------------

proc()=
FICArimaf02()
y=read("video.dat")
z=diff(y)
tim=1:161
gserie=createdisplay(3,1)


title="weekly sales videos: First differences"
pz=setmask(tim[1:160]~z,"line","blue")
```

```
show(gserie,1,1,pz)

setgopt(gserie,1,1,"border",0,"xlabel","time","ylabel",
        "number sold (thousands)","title",title)
bb=matrix(50,2)*0
dd=vec(((1:50)~(1:50)~(2:51))')
s1=(1|50)~((1|1)*2/sqrt(157))
s1=setmask(s1,"line", "dashed")
s2=setmask(s1[,1]~(-s1[,2]),"line", "dashed")
corr=acf(z)[2:51]
ccor=vec((corr~bb)')

wy=setmask(dd~ccor,"line", "solid")
show(gserie,2,1,wy,s1,s2)

title= "First differences,ACF"

setgopt(gserie,2,1,"border",0,"xlabel","time","ylabel",
        "number sold(thousands)","title",title)

corr=pacf(z,50)
ccor=vec((corr~bb)')
wy=setmask(dd~ccor,"line","solid")
show(gserie,3,1,wy,s1,s2)

title= "First differences,PACF"

setgopt(gserie,3,1,"border",0,"xlabel","time","ylabel",
        "number sold(thousands)","title",title)

ar2 = ariols(y,2,1,"constant","prcheck","rcheck","msc")
```

```
param=ar2.b ; estimated AR coefficients


ar2.wnv ; estimated variance of the innovations
stdDev=sqrt(ar2.wnv)  ; standard deviation
mean=mean(z)


ar2.ic ; AIC and BIC
endp
library("times")   ; loads the library times


FICArimaf02()
```

A.5   XploRe Quantlet FICArimaf03

```
Ebook              FIC
```

```
Macro              FICArimaf03
```

```
Description:       Stationarity Tests; unit root (Augmented
                   Dickey-Fuller) test, Box-Lung statistics and
                   KPSS test of Trend Stationarity.
```

```
Author             Julius, Mungo   3739879
```

```
proc()= FICArimaf03()
```

```
y=read("video.dat")

p=2                               ; order AR

d=1                               ; first difference

ar2 = ariols(y,p,d,"noconstant","0","pcheck","msc")

ar2.checkp.est        ; informs if the process is stationary by 0

z=diff(y)

{ADF,cv}=adf(z,1,"noconstant")  ; test statistic for a unit root

cv.critvalues                 ; nonstandard critical values for
                              ; tau(1%,5%,10%)

cv.tvalueslags         ; t- and probability-values for the

                   ;estimated coefficients of lagged differences

qlb = boxlj(cv.residuals,5)   ; calculates the acf and the

          ; Box-Lung statistics with probability-values

          ; for the first five lags of the residuals

z=diff(y)

k=kpss(z,2,1)      ;KPSS test of Trend Stationarity
```

```
endp


library("times")                         ; loads the library times


FICArimaf03()
```

A.6 XploRe Quantlet FICArimaf04


```
Ebook          FIC
------------------------------------------------------------------
Macro          FICArimaf04
------------------------------------------------------------------
Description:   Residuals diagnostics tests to include timeplot
               with two-standard error bounds,correlograms and
               Ljung-Box statistics with p-values.
------------------------------------------------------------------
Author         Julius, Mungo  3739879
------------------------------------------------------------------


library("times")     ; loads the library times


library("stats")     ; loads the library stat


library("xplore"); loads the library xplore


" Weekly sales: ADF test for unit root with no constant"
```

```
y=read("video.dat")


p=2                          ; order AR


d=1                          ;first difference


ar2 = ariols(y,p,d,"noconstant","rcheck","pcheck","msc")


qlb = boxlj(cv.residuals,5)     ;calculates the acf and the Box-Lung
                                 statistics with probability-values
                                 for the first five lags of the
                                 residuals


qlb                          ; renders the calculations of boxlj
-------------------------------------------------------------------
```

A.7   XploRe Quantlet FICArimaf05

```
Ebook           FIC
-------------------------------------------------------------------
Macro           FICArimaf05
-------------------------------------------------------------------
Description:    FORECASTING with the ARIMA(2,1,0) model for the
                sales data Forecast
-------------------------------------------------------------------
Author          Julius, Mungo  3739879
-------------------------------------------------------------------
proc() = FICArimaf05() startweek=1 lend=160
```

```
L=10

y=read("video.dat")

m2=ariols(y,2,1,"noconstant","rcheck","0","msc")

salesf=arimaf(y,0,m2,2,1,0,L,"noconstant")

salesf          ; forecast sales values

ar2=#(1+m2.b[2],-m2.b[2])

weight=matrix(L)

weight[1]=1

weight[2]=ar2[1]

i=2 while(i<L)

i=i+1

weight[i]=ar2[1]*weight[i-1]+ar2[2]*weight[i-2]

endo

weight=cumsum(weight.^2)

weight=(m2.wnv)*weight

b=2*sqrt(weight)
```

```
tim=0|cumsum(0.25*matrix(lend+L))

tim=startweek+tim

fore=createdisplay(1,1)

z1=setmask(tim[1:lend]~y[1:lend],"line","blue")

z2=setmask(tim[lend+1:lend+L]~salesf,"line","blue","dotted")

s1=setmask(tim[lend+1:lend+L]~(salesf[1:L]+b),"line","dashed")

s2=setmask(tim[lend+1:lend+L]~(salesf[1:L]-b),"line","dashed")

title="weekly sales forecasts " show(fore,1,1,z1,z2,s1,s2)

setgopt(fore,1,1,"border",0,"xlabel","time","ylabel","weekly sales

amount","title",title)

endp

library("times")     ; loads the library times

FICArimaf05()
```