

STANDARDS FOR PREPARING THESES AND DISSERTATIONS

Fifth Edition

2007

MISSISSIPPI STATE UNIVERSITY

PREFACE

The thesis or dissertation is a formal research paper presented by a graduate student to the Graduate Faculty at Mississippi State University, who certify that the presented work meets the standards of the academic discipline. The Graduate School of Mississippi State University would like to extend to you, the student, a special welcome as you undertake the development and writing of your thesis or dissertation, an exciting and critical part of your academic achievement.

Developed by a committee of the Mississippi State University Graduate Council, this manual is an update of an earlier version of the *Guidelines for the Preparation of Theses and Dissertations*. While there has been no basic change in philosophy concerning the purpose and presentation of the thesis or dissertation, significant changes in the formatting requirements have been made due to the use of word processing technology in document preparation.

Personnel in the Graduate School and the Library's Office of Thesis and Dissertation Format Review desire to make your research and writing a rewarding and enjoyable professional experience. The Graduate School is available to assist you in understanding the various policies and procedures necessary for completing your research project. For questions concerning format and appearance of your dissertation or thesis, contact the Library's Office of Thesis and Dissertation Format Review.

Office of the Graduate School E-Mail: grad@grad.msstate.edu Web: http://www.msstate.edu/dept/grad Telephone: 662-325-7400	Office of Thesis and Dissertation Format Review E-Mail: etd@library.msstate.edu Web: http://library.msstate.edu/etd Telephone: 662-325-2170
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TABLE OF CONTENTS

PREFACE	ii
CHAPTER	
I. INTRODUCTION	1
II. POLICY STATEMENT	2
III. LEGAL AND REGULATORY REQUIREMENTS	4
Previously Published Material	4
Copyrighted Material	4
Restricted Material	5
Microfilming the Graduate Degree Document	5
Research Protocols and Regulatory Compliance	5
IV. FORMAT AND APPEARANCE	7
Thesis or Dissertation General Format	7
Recommended Style	7
Type Fonts and Print Quality	8
Line Spacing	9
Margins	10
Pagination	11
Tables and Figures	12
Footnotes, Endnotes, and References	13
V. ARRANGEMENT OF CONTENTS	15
Preliminary Pages	15
Title Page	15
Copyright Page (Optional)	16
Approval Page	16
Abstract	17
Dedication (Optional)	18
Acknowledgements (Optional)	18
Table of Contents	18
List of Tables or Figures	18

List of Symbols, Abbreviations, and Special Nomenclature	19
Body or Text	19
Division into Chapters	19
Division of Chapters into Sections	20
Preface.....	20
Introduction.....	20
Other Chapters	21
Conclusion	21
The Reference Material.....	21
Bibliography, References, List of References, etc.....	21
Appendices.....	22
VI. SUBMISSION OF THE THESIS OR DISSERTATION.....	24
Submitting Electronic Theses and Dissertations (ETD) to the Library	25

APPENDIX

A. SAMPLE PRELIMINARY PAGES FOR THESES AND DISSERTATIONS.....	27
Instructions for Title Page.....	29
Instructions for Copyright Page	31
Instructions for Committee Approval Page	33
Instructions for Abstract Page(s)	35
Instructions for Dedication Page.....	38
Instructions for Acknowledgements Page	40
Instructions for Table of Contents	42
Instructions for List of Tables.....	46
Instructions for List of Figures	49
B. SAMPLE PAGES FOR THESES AND DISSERTATIONS	52
Instructions for First Page of Chapter.....	53
Instructions for Pages with Subheadings	55
Instructions for Pages with Equations.....	58
Instructions for Pages with Tables.....	60
Instructions for Pages with Figures.....	65
Instructions for Pages with Footnotes.....	69
Instructions for References Cited Pages	71
Instructions for Appendices	75

CHAPTER I
INTRODUCTION

Standards for Preparing Theses and Dissertations at Mississippi State University is intended to help graduate students organize and present the results of their research in the form of a scholarly document. This manual complements the current *Graduate School Bulletin* which provides uniform standards and contains general and program requirements for candidates pursuing advanced degrees as well as deadlines which candidates must meet. This updated fifth edition (2007) replaces all previous guidelines.

All candidates for advanced degrees must confer with their advisors and graduate coordinators to learn specific departmental requirements for preparation and presentation of graduate degree documents. Students should remember that these documents are checked by personnel in the Library's Office of Thesis and Dissertation Format Review to ensure conformity with this manual prior to final approval and publishing.

CHAPTER II

POLICY STATEMENT

Master's and educational specialist's theses and doctoral dissertations are formal written documents resulting from careful and extended research conducted by graduate students under the supervision of their major professors and with the advice of graduate advisory committees. Both documents must demonstrate the ability of the candidate to conduct scholarly research at an advanced level; however, a doctoral dissertation must demonstrate more fully the candidate's ability to plan and execute original research.

Writing and defending a thesis or dissertation is the culmination of a long period of sustained effort. The result should be a document in which the candidate, the advisor, the department, and the University can take pride. Theses and dissertations are representations of the standards of the degree-granting college and of Mississippi State University; these documents also reflect the standards of faculty members who sign the committee approval pages. Advisory committees are responsible for judging the technical and professional competency, writing quality, and professional appearance of these documents. All individuals involved in the preparation of theses and dissertations should ensure their work is of the highest quality possible.

The Graduate School and the Graduate Council understand that details and methods involved in thesis or dissertation preparation will vary among departments.

However, theses and dissertations must adhere to certain general standards and therefore must:

1. Be the result of concentrated effort to solve a well-defined problem. A graduate document must not consist of several studies related only in a general way but must focus on a coherent theme.
2. Furnish evidence that the candidate is familiar with the canons of scholarship in the discipline. Candidates must show familiarity with bibliographic literature and research methods and must present research results in a formal manner appropriate to the discipline.
3. Be readily comprehensible by other scholars in the field. Unless the candidate's program focuses on mastery of a foreign language, the graduate document must be written in standard English.

CHAPTER III
LEGAL AND REGULATORY REQUIREMENTS

Previously Published Material

Material previously published by the candidate while enrolled in the current degree program may be included in the document. Such material must be integrated into the body of the document.

Copyrighted Material

Mississippi State University sends all theses and dissertations to ProQuest Information and Learning to be microfilmed and made available to scholars. In compliance with ProQuest requirements, written permission of a copyright holder is required if substantial amounts of copyrighted materials are included. Requirements for gaining permission of a copyright holder are listed on the ProQuest website at <http://www.umi.com/umi/dissertations/copyright>. Failure to gain permission in advance of reproducing copyrighted material can delay the microfilming and may lead to charges of copyright infringement. Candidates are expected to read and abide by the copyright assurance and publication agreement in the ProQuest form they sign.

Copyrighting theses and dissertations is optional. Students desiring copyright protection should complete the application available from the Library's Office of Thesis and Dissertation Format Review (phone: 662-325-2170, email: etd@library.msstate.edu).

Students should give serious consideration to copyright protection, and it is recommended that students seek advice from their major professor before making this important decision. Copyright registration fees are charged to the student's University account and must be paid before final format approval of the thesis or dissertation.

Restricted Material

Thesis and dissertation documents should not include material restricted from publication by legal or proprietary considerations. Electronic submissions may have a publication delay of up to three years with the advisor's approval. Restrictions in perpetuity require forms from the student's dean and advisor.

Microfilming the Graduate Degree Document

For archival purposes, MSU requires microfilming of all theses and dissertations. The application form is available from the Library's Office of Thesis and Dissertation Format Review. Microfilming fees are charged to the student's University account and must be paid before final format approval of the thesis or dissertation.

Research Protocols and Regulatory Compliance

Students must secure prior approval of research protocols involving human subjects (including those protocols which utilize only surveys), animal subjects, radioactive substances, hazardous materials, recombinant DNA, or other regulated research. For more information see the Office of Regulatory Compliance website at www.msstate.edu/dept/compliance. Questions about human subjects research should be

directed to irb@research.msstate.edu. Questions regarding other types of research should be directed to compliance@research.msstate.edu.

CHAPTER IV

FORMAT AND APPEARANCE

Thesis or Dissertation General Format

Mississippi State University emphasizes the importance of conducting research to culminate in publication in the professional literature of the discipline. The thesis or dissertation may be written in a style acceptable to publication outlets in the candidate's discipline. If this format differs from the standards in this manual, a letter from the major advisor indicating the acceptability of the differences must be submitted at the time of initial submission to the Library.

The Graduate Council and the Library have developed precise standards to ensure that MSU theses and dissertations will have a consistently professional appearance. Close attention to these standards during document preparation will save time during the review process conducted by the Library's Office of Thesis and Dissertation Format Review.

Recommended Style

Acceptable styles are selected by the candidate's degree-granting unit. Each candidate must consult with his or her major advisor or thesis/dissertation director on matters of style before beginning work. The degree-granting unit is responsible for ensuring that documents conform to the chosen style. If the style differs from the specific formatting set forth in these standards, a letter from the major advisor indicating the

acceptability of these differences should be submitted by the candidate at the time of the initial submission to the Library. Punctuation, spelling, and general format should be accurate and consistent.

Type Fonts and Print Quality

1. Type size may vary between ten and twelve points. Any standard font that produces clean, crisp type with no distracting marks is acceptable. Decorative or difficult-to-read fonts (such as script or shadowed) are unacceptable. The Office of Thesis and Dissertation Format Review in the Library will make the final decision on the acceptability of the font used. Once selected, the type font and size must be consistent throughout the document. Exceptions may be made for:
 - extensive tables, which may use a smaller point size provided it is easily readable;
 - formulas, which may use special fonts as required for such elements as mathematical, italics, or Greek symbols;
 - subscripts and superscripts, which may be smaller than the text font;
and
 - footnotes, which may be a smaller font if used consistently throughout the document.
2. Either italics or underlining may be used for non-English words and in the citation of titles. Such usage must be consistent throughout the document.

3. Boldface may be used for chapter numbers, chapter titles, subheadings, and tables and figures.
4. Special symbols or names such as mathematical symbols, variable names, scientific names or organisms, data names, and the names of computer program procedures may be printed using italics, boldface, or underlining. The use must be consistent throughout the document.

Line Spacing

1. Line-spacing terms used in this document are defined as follows:
 - Single space = no blank lines between lines of text.
 - Double space = 1 blank line between lines of text.
 - Triple space = 2 blank lines between lines of text.
2. Double spacing is required for the document with the exception of items noted below:
 - Single spacing is used within long quotations, long tables, footnotes, multi-line captions, and bibliographic entries. Double spacing should be used between footnotes and bibliographic entries. Examples of footnotes and bibliographical references are given on pages 70 and 72–74.
 - Lists may be single spaced with double spacing between items. Bullets may be used in lists as long as they are not oversized.
 - Tables or figures should be separated from the text above and below by 2 or 3 blank lines. Examples are given on pages 61–68.

- Headings should be separated from the text below by double spacing and from the text above by 2 or 3 blank lines. Examples are given on pages 56–57.

Margins

1. The left margin must be a minimum of 1 and 1-half inches wide; all other margins must be a minimum of 1 inch wide. Such margins will leave a 6 x 9 inch area on each sheet for the text or illustrative material. Page numbers must not be in the margins.
2. The following are the only exceptions to the above margin requirements:
 - The first page of each chapter of the document must leave 2 inches of white space between the top of the page and the title.
 - Tables and figures may be smaller and centered, thus leaving larger margins. Tables and figures may be photographically reduced to meet margin requirements.
3. Text may be left-justified or full-justified and must be consistent throughout the document.
4. All paragraphs must be indented 0.5” inches.
5. Leaving a single line of a paragraph or other subdivision (widow or orphan) at either the bottom or the top of a page is not permitted.
6. Photocopies should be made only from the original with margins on all copies accurate and consistent.

Pagination

1. Every page must have a page number except the title page, copyright page, approval page, and abstract pages.
2. Small Roman numerals are used for the preliminary pages, which should be arranged in the following order: dedication; acknowledgements; table of contents; and the lists of tables, figures, plates, symbols, abbreviations, and/or nomenclature. Although the title page is assigned Roman numeral i, that number does not appear on the page. Page numbers for other preliminary pages are centered, leaving 1 inch of white space from the page number to the bottom of the page. The copyright, approval, and abstract pages are neither counted nor numbered. See examples of preliminary pages in Appendix A.
3. Arabic numerals are used for paginating the remainder of the document, including the text and reference material. Pages are numbered consecutively beginning with 1 and continuing to the end of the document. No other numbering scheme is acceptable; the standard scheme may not be interrupted with insertions numbered 10a, 10b, 10c, etc.
4. All page numbers are placed at the bottom center position allowing 1 inch of white space from the numeral to the page bottom.

Tables and Figures

A table consists of columns of information, often in the form of numbers. A figure is any kind of graphic illustration other than a table, such as a graph, chart, drawing, diagram, map, or photograph.

1. Tables and figures must be numbered with Arabic numerals. Tables and figures may be numbered consecutively throughout the document (1, 2, 3, etc.) or consecutively within chapters (1.1, 1.2, 1.3, 2.1, 2.2, 2.3, etc.).
2. Table titles are placed 2 lines above the top line of the table. Depending on the style chosen, the table number may be placed to the left of the table title or centered 2 lines above the table title. Figure numbers and titles are placed 2 lines below the last line or bottom of the illustration. Table and figure titles must be single-spaced. The style chosen for title placement and capitalization conventions for tables and figures must be used consistently throughout the document.
3. A table that will not fit on 1 page may be continued onto subsequent pages with the appropriate notation placed 2 lines above the continuation of the table (e.g., Table 1 continued).
4. When the size or format of a table or figure requires horizontal placement, the examples in Appendix B should be followed.
5. As a general rule, a table or figure should be located as close as possible to the text describing it. Short tables or figures may appear on the same page with text, separated from the text above and below by triple spacing. A table or

figure longer than 1-half page should be placed on a separate page following the page where it is first referenced.

6. Text must not be "wrapped around" tables and figures. Table and figures must not be placed within paragraphs.
7. Two or more small tables or figures may be grouped together on a single page.
8. Color images do not reproduce consistently or microfilm well.
9. Photographs may be scanned, photocopied, or mounted on 8.5 x 11 inch paper. For mounted materials, an acid-free adhesive must be used.
10. Original questionnaires, letters, maps, data sheets, and similar materials to be included in appendices must conform to margin and page number specifications.
11. Important equations (typically those referred to in the text) should have numerical identification and should be numbered consecutively (e.g., 1, 2, 3, etc.; or within chapters, e.g., 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, etc.).
12. Overlays may be used in the document but must be placed in a clear plastic, acid-free page protector.

Footnotes, Endnotes, and References

Candidates should confer with their advisors regarding citation styles acceptable to their disciplines and use the designated style manuals.

1. References may be numbered consecutively throughout the entire document or consecutively within each chapter.

2. References may be placed at the end of a chapter or at the end of the document. The reference position must be consistent throughout the document.
3. A reference to information within tables should be placed directly below the pertinent table.
4. Regardless of the style used, references must be single-spaced with double spaces separating each item.

CHAPTER V
ARRANGEMENT OF CONTENTS

Preliminary Pages

The preliminary pages must appear in the following order: title page; copyright page; approval page; abstract; dedication; acknowledgements; table of contents; list of tables; list of figures; and list of symbols, abbreviations, and nomenclature. A sample of each preliminary page is included in Appendix A. Each element of the document is given in the order in which it should appear.

Title Page

The title page includes the elements listed below and is formatted as illustrated in Appendix A:

1. Full title, double-spaced, in inverted pyramid style
2. Author's full name preceded by the word "By"
3. Appropriate identification, i.e., "A Thesis (Dissertation) Submitted to the Faculty of Mississippi State University in Partial Fulfillment of the Requirements for the Degree of Master of Arts (Doctor of Philosophy, etc.) in English (Civil Engineering, etc.) in the Department (Program, etc.) of English (Civil Engineering, etc.)"
4. Location ("Mississippi State, Mississippi")

5. Month (May, August, or December) and year of the graduation at which the degree is awarded, with no comma between the month and year

The title is intended to provide a meaningful description of the scholarship being presented. Information retrieval systems consulted by scholars to locate theses and dissertations relating to their own work rely on the key words in the title and abstract. Consequently, oblique references and cryptic quotations should be avoided; therefore, if possible, word substitutes should be found for formulas, symbols, superscripts, and foreign alphabet letters.

Copyright Page (Optional)

For documents to be copyrighted, notice of copyright is centered in the following form on the sheet immediately after the title page:

Copyright by
John Quincy Student
1999

Approval Page

The committee approval page includes the manuscript title (double-spaced) in inverted-pyramid style, author's full name, and blank lines designated for the signatures of the thesis or dissertation director, the major professor (if different from the director), the graduate coordinator, members of the candidate's graduate committee, and the dean of the appropriate college. For individuals completing graduate degrees in interdisciplinary programs, the dean of the college of the dissertation director, if different from the dean where the program resides, must also sign the committee approval page. The names

(without degree designations) and academic titles of these individuals should be placed below their signature lines. A general format for the committee approval page may be seen in Appendix A. The dean of the degree-granting unit will not sign the committee approval page until the committee approved manuscript has all other required signatures.

Abstract

The abstract should state the problem being investigated and outline the method of investigation, the results obtained, and the conclusions reached. As a concise guide to the entire document, the abstract allows scholars surveying research publications to evaluate the usefulness of the thesis or dissertation to their own area of interest.

Because thesis and dissertation abstracts are published in *ProQuest Dissertations & Theses (PQDT)*, specifications for their preparation are set by ProQuest:

1. Appendix A illustrates the correct format for all abstracts. Each abstract includes the author's name, date of degree (month, day and year), institution, major field, major professor (and director of thesis or dissertation if different from major professor), title of document, number of pages in document (i.e., last numbered page), and summary of the content of the document.
2. Doctoral dissertation abstracts cannot exceed 350 words; master's thesis abstracts cannot exceed 150 words. As a rule, 350 words consume fewer than 2 pages of double-spaced typing. Longer abstracts will not be accepted by the Library because they cause processing delays at ProQuest.
3. Charts, graphs, tables, or figures are not allowed in the abstract.
4. The abstract is not counted as a page within the document and is not numbered.

Dedication (Optional)

The heading DEDICATION appears centered without punctuation below 2 inches of white space at the top of the page; the text begins below the heading after 2 or 3 blank lines. If used, the dedication page is numbered with Roman numeral ii.

Acknowledgements (Optional)

The heading ACKNOWLEDGEMENTS appears centered without punctuation below 2 inches of white space at the top of the page; the text begins below the heading after 2 or 3 blank lines. The acknowledgement is a record of assistance provided by others and includes notice of permission to use previously-copyrighted materials that appear in the text.

Table of Contents

The heading TABLE OF CONTENTS appears centered below 2 inches of white space at the top of the page. The listing of actual contents begins at the left margin below the heading after 2 or 3 blank lines.

The titles and numbers of chapters and subsections listed in the table of contents must be worded, capitalized, and punctuated exactly as they appear in the body of the document. The table of contents indicates the page on which each heading and subheading appears.

List of Tables or Figures

A list of tables or a list of figures is required if any tables or figures appear in the document. The heading LIST OF TABLES or LIST OF FIGURES appears centered

without punctuation below 2 inches of white space at the top of the page; the listing begins at the left margin below the heading after 2 or 3 blank lines.

Tables and figures must be identified in their respective lists by the same numbers and titles used in the document. All titles in the list of tables and list of figures must be worded, capitalized, and punctuated exactly as they appear in the document.

Page designations of tables and figures should be those on which the titles appear. Examples are found on pages 47–48 and 50.

List of Symbols, Abbreviations, and Special Nomenclature

This list is required when symbols, abbreviations, and special nomenclature are essential to understanding the document. It follows the lists of tables and figures and may take any form acceptable in the candidate's field of study.

Body or Text

The text is divided into chapters including, at a minimum:

1. An introduction, which is considered the first chapter
2. Discussion of the research, which may be presented in 1 or more chapters
3. A conclusion, and
4. A list of references, which may be presented at the end of each chapter or at the end of the document

Division into Chapters

Each chapter must have a general title and a descriptive title. The general title is comprised of the word CHAPTER followed by either an Arabic or Roman numeral.

Whichever numeral style is chosen must be used consistently. The descriptive title indicates the subject content of the chapter. In developing these descriptive titles, the author should choose language that allows a reader to readily understand what is being presented.

Division of Chapters into Sections

Chapters may be divided with headings and subheadings. Each level of heading must be formatted differently and applied consistently throughout the document.

Preface

Normally, there is no need to include a preface to the document unless the genesis of the project is important in order to understand the work or unless the method of research is so unusual as to require some explanation.

Introduction

An overall introduction is required even if subsequent chapters have their own introductions. The overall introduction should not be a recapitulation of individual chapter introductions. Its function is to explain how the individual chapters work together to form the cohesive document described in the publications policy statement.

The introduction must be the first chapter. The general chapter title (such as CHAPTER 1) in all capitals must be at the top of the page and centered beneath 2 inches of white space; the word INTRODUCTION is placed 2 lines below. The text begins below the INTRODUCTION after 2 or 3 blank lines.

Other Chapters

The remaining chapters are numbered consecutively using either Arabic or Roman numerals. The general chapter title in all capitals must be at the top of the page and centered below 2 inches of white space; the descriptive title is placed 2 lines below. The text begins below the descriptive title after 2 or 3 blank lines.

Conclusion

The conclusion explains how the preceding chapters work together to solve the problem outlined in the introduction. The general chapter title in all capitals must be at the top of the page and centered beneath 2 inches of white space; the word CONCLUSION, or similar descriptive title, is placed 2 spaces below. The text begins 2 spaces below the word CONCLUSION.

The Reference Material

The reference material document consists of a required bibliography or list of references, and optional appendices.

Bibliography, References, List of References, etc.

Any document making use of other works either in direct quotation or by reference must contain a listing of these sources. The listing must be entitled as specified by the style used by the discipline. The listing may appear at the end of each individual chapter and/or as a general listing at the end of the document. The latter method is preferred if it does not conflict with discipline requirements.

A few sample bibliographic styles are illustrated in Appendix B. Additional format guidelines can be obtained from standard style guides. Bibliographic entries should be formatted in such a way as to be acceptable to both the department and the discipline.

The listing title is centered without punctuation below 2 inches of white space from the top of the page; the list begins 2 line spaces below. Each bibliographic entry must be single-spaced with a double space between each entry.

Appendices

Reference materials such as tables, charts, figures, illustrative documents, folklore, interview transcriptions, and other addenda that are not absolutely necessary to the text are often grouped in an appendix or in appendices. If used, an appendix generally follows immediately after the last chapter of the text. However, the bibliography or references may precede the appendix.

Each appendix is preceded by a divider sheet identifying the appendix by letter and including the title of the appendix. All text should be centered horizontally and vertically on the page. If the title requires more than 1 line, the title should appear in inverted-pyramid order.

If the information to be appended dictates more than 1 appendix, the multiple appendices are designated APPENDIX A, APPENDIX B, etc. Each appendix with its title must be listed separately in the table of contents as a subdivision under the heading APPENDIX or APPENDICES.

Any tables or figures appearing in an appendix are handled in the same manner as those in the text; i.e., they are identified as tables or figures, are numbered consecutively,

and appear in the list of tables or figures in the preliminary pages. Appendix tables or figures may be identified by the letter of the appendix and respective table or figure number. For example, a table in Appendix B may be identified as Table B.2.

CHAPTER VI

SUBMISSION OF THE THESIS OR DISSERTATION

The Graduate School establishes deadlines for the submission of documents to the Office of Thesis and Dissertation Format Review; these deadlines cannot be waived. The deadlines are posted in the Graduate Academic Calendar in the current issue of the *Graduate Studies Bulletin* and on the Graduate School's website at <http://www.msstate.edu/dept/grad/calendar.htm>. However, if the deadline falls on a weekend, the thesis or dissertation must be submitted no later than 5:00 p.m. on the following Monday. To meet the first submission deadline, the student must submit the complete document with all signatures on the committee approval page. To meet the final submission deadline, the student must have made all corrections, completed all forms, and paid all thesis or dissertation fees. The following steps are to be observed in the submission of theses and dissertations.

Microfilming of all theses and dissertations is required. If the thesis or dissertation is to be copyrighted, the student must complete a copyright agreement. The necessary form is available in the Office of Thesis and Dissertation Format Review and on the Thesis and Dissertation webpage at <http://library.msstate.edu/etd>.

All fees for microfilming and/or copyrighting must be paid at the cashier's window or online through the University's accounting system prior to format approval of the final document.

Submitting Electronic Theses and Dissertations (ETD) to the Library

As of the 5th Edition (2007) of the *Standards for Preparing Theses and Dissertations*, documents must be submitted electronically; print documents will no longer be published by the Library. Document submission must be in PDF (Portable Document Format) and uploaded through the ETD database. The Library's Instructional Media Center (IMC) can assist in formatting Microsoft documents and converting them to PDF files. Contact the Office of Thesis and Dissertation Format Review for instructions on multimedia files. The committee approval page, complete with required signatures, must be submitted in print to the Library before the thesis or dissertation will be reviewed. Signatures should not be scanned for the PDF document; for security reasons this page will remain absent of signatures for the electronic version. The Library will retain a copy of the committee approval page with the signatures for archival purposes.

To submit a PDF to the Office of Thesis and Dissertation Format Review for format approval, the student will access the MSU Library ETD database at <http://library.msstate.edu/etd> and follow these steps:

1. Select "Login to the ETD Server"
2. Enter the authentication information and create an account (or log in if an account has already been created). Remember the account information; the Library staff cannot retrieve user IDs and/or passwords.
3. Complete the online forms using the spelling, punctuation, and capitalization that will create the desired appearance in the Electronic Thesis and Dissertation database.

4. Choose “Browse” to locate the needed files, 1 at a time.
5. Choose “Upload Files” to copy the files onto the ETD server.

The ETD Rights and Permissions form, author contact form, and ProQuest Publication form must be submitted to the Library before the thesis or dissertation can be approved for format compliance. The forms are available in the Office of Thesis and Dissertation Format Review and on the Thesis and Dissertation webpage at <http://library.msstate.edu/etd>.

If there are formatting errors a correction list will be sent to the student via email. The student must return to the original word processing document, correct errors, recreate the PDF file, and resubmit via the ETD database. An email will be sent to the student after all requirements have been satisfied and the thesis or dissertation has been accepted for format compliance.

APPENDIX A

SAMPLE PRELIMINARY PAGES FOR THESES AND DISSERTATIONS

The preliminary pages must conform to the format specified in the examples in this appendix, unless otherwise indicated. The preliminary pages include the following pages and must appear in the order listed below:

1. Title Page
2. Copyright page (optional)
3. Committee Approval page
4. Abstract
5. Dedication (optional)
6. Acknowledgements (optional)
7. Table of Contents
8. List of Tables (required if tables appear in the document)
9. List of Figures (required if figures appear in the document)
10. List of Symbols, Abbreviations, etc. (required if such identification is essential to understanding the document.)

Note: The title of each sample page listed in the appendices and the corresponding page number for this manual appear in the upper right-hand corner of each page, within a shaded rectangle.

Instructions for Title Page

1. The top margin should be between 3.5 and 4 inches. The left margin should be at least 1.5 inches. The right and bottom margins should be at least 1 inch.
2. A standard font must be used through the document.
3. All text on the title page is centered horizontally.
4. The full title is typed in all capital letters. If the title is longer than 1 line, double space (leave 1 blank line) between the lines of the title. The lines of the title are arranged in inverted-pyramid style.
5. The author's full name must be used. The author's name must match the name on the copyright, approval, and abstract pages.
6. All information elements must fit on the page in a visually appealing way. The actual distances between the elements will vary slightly depending on the length of the information. Distance requirements are listed below:
 - a. The distance from the top of the page to the first line of the title will vary from about 3.5 to 4 inches depending on the length of the title.
 - b. The distance from the last line of the title to the word "By" is about 1 inch.
 - c. There should be 1 blank line between the word "By" and the name.
 - d. The distance from the name to the next text line is about 1.5 inches.
 - e. Two or 3 blank lines are left between the name of the department and the place.
 - f. One blank line is left between the place and the date.
7. The degree statement must match the example, with the following exceptions:
 - a. Master's and Educational Specialist candidates should replace "Dissertation" with "Thesis."
 - b. The correct degree, major, and department are inserted.
8. The date is the month and year in which the degree is awarded. Acceptable months are May, August and December. There should be no comma between month and year.
9. No page number is printed on the title page.

THE USE OF NEURAL NETWORKS IN THE COMBINING OF TIME SERIES
FORECASTS WITH DIFFERENTIAL PENALTY COSTS

By

Morgan Beverly Wilder

A Dissertation
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
in Computer Science
in the Department of Computer Science

Mississippi State, Mississippi

December 1998

Instructions for Copyright Page

1. This page is optional.
2. The text should be page centered (vertically and horizontally).
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THE USE OF NEURAL NETWORKS IN THE COMBINING OF TIME SERIES
FORECASTS WITH DIFFERENTIAL PENALTY COSTS

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Title of Study: THE USE OF NEURAL NETWORKS IN THE COMBINING OF TIME
SERIES FORECASTS WITH DIFFERENTIAL PENALTY COSTS

Pages in Study: 187

Candidate for Degree of Doctor of Philosophy

The need for accurate forecasting and its potential benefits are well established in the literature. Virtually all individuals and organizations have at one time or another made decisions based on forecasts of future events. This widespread need for accurate predictions has resulted in considerable growth in the science of forecasting. To a large degree, practitioners are heavily dependent on academicians for generating new and improved forecasting techniques.

In response to an increasingly dynamic environment, more diverse and complex forecasting methods have been proposed to more accurately predict future events. These methods, which focus on the different characteristics of historical data, have ranged in complexity from simplistic to very sophisticated mathematical computations requiring a high level of expertise. By combining individual techniques in order to improve on the forecasting accuracy, researchers have taken advantage of the various strengths of these techniques. A number of combining methods have proven to yield better forecasts than individual methods, with the complexity of the various combining methods ranging from a simple average to quite complex weighting schemes.

The focus of this study is to examine the usefulness of neural networks in composite forecasting. Emphasis is placed on the effectiveness of two neural networks (*i.e.*, a back propagation neural network and a modular neural network) relative to 3 traditional composite models (*i.e.*, a simple average, a constrained mathematical programming model, and an unconstrained mathematical programming model) in the presence of four penalty cost functions for forecasting errors.

Specifically, the overall objective of this study is to compare the short-term predictive ability of each of the five composite forecasting techniques on various first-order autoregressive models, taking into account penalty cost functions representing four different situations. The results of this research suggest that in the vast majority of scenarios examined in this study, the neural network model clearly outperformed the other composite models.

Key words: neural networks, forecasting, autoregression

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DEDICATION

I would like to dedicate this research to my parents, Frederick and Hanna Wilder, and my brother Jason.

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ACKNOWLEDGEMENTS

The author expresses his sincere gratitude to the many people without whose selfless assistance this dissertation could not have materialized. First of all, sincere thanks are due to Dr. Peter F. Strauss, my committee chairman, for his magnanimity in expending time and effort to guide and assist me throughout the intricacies of the doctoral program and the dissertation process. Expressed appreciation is also due to the other members of my dissertation committee, namely, Dr. Bailey R. Keenan, Dr. Taylor M. O’Leary, Dr. Rong-Jen Lin, and Dr. Kelly C. Darden, for the invaluable aid and direction provided by them. Finally, the author would like to thank Dr. Herbert Hubbell of the University of North Carolina for making available the computer program for the computation of the BDS statistics used in this study.

Instructions for Table of Contents

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TABLE OF CONTENTS

DEDICATION ii

ACKNOWLEDGMENTS iii

LIST OF TABLESv

LIST OF FIGURES vi

CHAPTER

I. INTRODUCTION1

 Background2

 Time Series3

 Neural Networks4

 Statement of the Problem5

 Objectives of the Study8

 Justification and Usefulness of the Study12

 Scope and Limitations of the Study13

 Summary and Plan of Presentation14

II. LITERATURE REVIEW16

 Review of Traditional Composite Forecasting Models16

 A Brief History of Composite Forecasting Models17

 Comparison Among Traditional Composite Forecasting Models24

 Applications of Traditional Composite Forecasting Models30

 Review of Neural Networks31

 Evolution of Neural Networks31

 Neural Networks Background32

 Types of Neural Network Models33

 The Use of Neural Networks in Forecasting35

 Penalty Costs.....36

 Conclusion37

III. METHODOLOGY	38
Description of the Data Sets	39
Model Used to Simulate the Data	40
Data From the Simulated Model	42
Portfolio Return Data	45
Development of the Individual Forecasting Models	45
Development of the Composite Models	45
Procedure Used to Evaluate the Composite Forecast Results	49
Summary	59
 BIBLIOGRAPHY	 60
 APPENDIX	
A. FORTRAN PROGRAM FOR GENERATING AR(1) DATA SETS	68
B. FORTRAN PROGRAM FOR OPTIMIZING A MOVING AVERAGE FORECAST	69
C. FORTRAN PROGRAM FOR OPTIMIZING A SIMPLE EXPONENTIAL SMOOTHING FORECAST	70

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10. The page number is centered at the bottom leaving 1-inch of white space; small Roman numerals are used.

LIST OF TABLES

4.1	Parameters for Optimal Individual Forecasting Models For Simulated Data	68
4.2	Weights for Individual Forecasts for Case #1	80
4.3	Weights for Individual Forecasts for Case #2	81
4.4	Weights for Individual Forecasts for Case #3	82
4.5	Weights for Individual Forecasts for Case #4	83
4.6	Summary Statistics of Forecast Errors for Case #1	84
4.7	Summary Statistics of Forecast Errors for Case #2	84
4.8	Summary Statistics of Forecast Errors for Case #3	85
4.9	Summary Statistics of Forecast Errors for Case #4	85
4.10	Shapiro-Wilk Normality Test for Case #1 Forecasts	87
4.11	Shapiro-Wilk Normality Test for Case #2 Forecasts	87
4.12	Shapiro-Wilk Normality Test for Case #3 Forecasts	88
4.13	Shapiro-Wilk Normality Test for Case #4 Forecasts	88
4.14	Correlation Coefficients for Case #1	90
4.15	Correlation Coefficients for Case #2	91
4.16	Correlation Coefficients for Case #3	92
4.17	Correlation Coefficients for Case #4	93
4.18	Results for Friedman's Multiple Comparison Test for Case #1	97

4.19 Results for Friedman’s Multiple Comparison Test for Case #297

4.20 Results for Friedman’s Multiple Comparison Test for Case #398

Instructions for List of Figures

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10. The page number is centered at the bottom leaving 1-inch of white space; small Roman numerals are used.

LIST OF FIGURES

1.1	Procedure Followed in Achieving the Objective	11
2.1	Overall MAPE as a Function of Number of Methods	28
3.1	Description of the Data Generating Process	44
3.2	Neural Network for Combining Forecasts	53
3.3	Modular Neural Network	54
3.4	Graphic Description of Forecasted Data Sets	58
4.1	Case #1 Data Summary	64
4.2	Case #2 Data Summary	65
4.3	Case #3 Data Summary	66
4.4	Case #4 Data Summary	67
4.5	MNN Architecture	75
4.6	Modular Neural Network Training Procedure	77
4.7	Composite Model Comparison for Case #1	101
4.8	Composite Model Comparison for Case #2	102
4.9	Composite Model Comparison for Case #3	103
4.10	Composite Model Comparison for Case #4	104
5.1	Daily Portfolio Returns Information for Large Corporations Traded on the NYSE	116

5.2 Daily Portfolio Returns Information for Small Corporations
Traded on the NYSE117

5.3 Composite Model Comparison for Portfolio #1122

APPENDIX B

SAMPLE PAGES FOR THESES AND DISSERTATIONS

Instructions for First Page of Chapter

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4. One blank line is left between the chapter number and chapter title.
5. The chapter title is centered, and all capitals are used. If the title is longer than 1 line, 1 blank line is left between the lines of the title. The lines of the title are arranged in the inverted-pyramid style.
6. Chapter numbers and titles may be boldfaced.
7. Two blank lines are left after the chapter title.
8. The page number is centered at the bottom center. A 1-inch margin is left below the page number.

Note: The title of each sample page listed in the appendices and the corresponding page number for this manual appear in the upper right-hand corner of each page, within a shaded rectangle.

CHAPTER I

INTRODUCTION

Accurate predictions of the future can yield significant advantages and outstanding opportunities. However, these benefits will not be realized unless one anticipates and evaluates possible future events and makes appropriate strategic decisions today. Because of this need to generate information today that reflects expected outcomes in the future, forecasting has developed into an extremely important and useful activity which, in recent years, has taken on an additional dimension of complexity. Furthermore, since virtually all individuals and organizations have at one time or another made a decision based on a forecast of future events, forecasting has diverse strategic uses. Business executives, government policy-makers, and individuals all face an uncertain future, which, if ignored or ineffectively evaluated, will lead to inevitable failures. From this widespread need for accurate prediction, the science of forecasting has grown considerably, particularly in the past thirty years. Numerous articles are published each year on various aspects of forecasting. These studies appear in journals such as the following: *Journal of Forecasting*, *International Journal of Forecasting*, *Management Science*, *Operational Research Quarterly*, *Decision Sciences*, and *Interfaces*, among others. To a large degree, practitioners are heavily dependent on academicians for generating new and improved forecasting techniques

Instructions for Pages with Subheadings

1. Chapters may be divided into sections with descriptive headings.
2. Two blank lines are used before each heading.
3. The student should follow department style guidelines in selecting heading formats. The sample pages show some acceptable methods of formatting headings. Other formats are acceptable if applied consistently.
4. Detailed outline numbering may be used as a method of varying the format of each heading. In detailed outline numbering, a section number is formed by an Arabic chapter numeral, a period, higher-level section numbers separated by periods, and finally the current subsection number. For example 2.3.4 denotes Chapter II, the 3rd section within Chapter II, and the 4th subsection within section 2.3.
5. Each level of heading must have a different format. Heading and subheading formats must be applied consistently throughout the document
 - a. All 1st level headings must match, all 2nd level headings must be different from 1st level headings, but match all other 2nd level headings.
 - b. Headings may be centered or aligned with the left margin. They may be plain text, boldfaced, italicized, underlined, or any combination of those 3 options. They may not be in a different font or font size or all CAPS.
6. If the style guide requires it, headings may begin the first line of a paragraph instead of being on a separate line. Headings on the first line of a paragraph must be boldfaced, italicized, underlined, or some combination of the 3 in order to differentiate from the beginning of the paragraph.
7. Three levels of heading are shown on the sample pages. Each level has a different format:
 - a. First level heading – Dendrochronology
 - b. Second level headings – Field Collection, Lab Analysis, Data Analysis
 - c. Third level heading – Standardized Ring Index

comparison between low-sun seasons showing interannual fluctuations and trends in precipitation (Figure 8).

Dendrochronology

The use of dendrochronological techniques provides a way to assess the impact of El Niño on vegetation and also provides a comparison between the dendro and instrumental records. Tree cores were obtained using an increment borer from several different locations on the Alabama Coast.

Field Collection

At locations in Mobile and Baldwin Counties, cores were collected from 28 large trees. Using an increment borer, cores were taken from each tree at 180 degrees apart to better gauge variation in growth across the entire trunk. This provided a total of 56 cores. Upon removal, cores were placed in labeled plastic straws, and the location of each tree was noted using a GPS unit. Collection of tree cores occurred on October 26th, November 21st, and December 23rd 2002.

Lab Analysis

Cores were extracted and brought to the Dendroclimatology lab at MSU (A small table in room 213). Each core was mounted and glued onto narrow wooden core mounts. The cores were then sanded using a belt sander with a grade of 120 to make the rings more clearly visible and to remove debris such as mold. After sanding, the growth ring

widths of each year for each core were measured to the nearest 0.001 mm using a Velmex measuring system. The Velmex system is an electronically controlled microscope stage that moves precisely between individual growth rings within a field of view. Velmex automatically keeps track of the distance that the stage has moved, which is used to calculate ring widths and number of rings.

Data Analysis

Standardized Ring Index

The study hinged on the creation of a standardized ring index for each year for all the trees. Using the computer program ARSTAN (Cook and Holmes, 1985) is standard procedure in dendrochronology to produce a standardized ring index. ARSTAN standardized the ring widths while crossdating the years 2 years above and below the sampled year. For example, if the year 1990 was being analyzed from one tree, the program tests to see if years from the other trees' 1988, 1989, 1991, and 1992 values correspond better to the 1990 value. If they match better, the program sequences the years to match the correct rings together and eliminate the biases of possible false rings. Trees frequently have false rings that do not completely encircle the diameter of the cross section. In addition to this, the trees sometimes grow faster on one side versus the other side. Also, the width of growth rings naturally lessens as the tree ages so any comparison of ring widths cannot be substantiated without standardization. ARSTAN removed the natural variations in ring width with age by overlaying cubic splines onto the raw data (Cook and Holmes, 1985).

Instructions for Pages with Equations

1. Equal line spacing is maintained on pages with equations or symbols.
2. An equation editor should be used for more complex equations.
3. Equal signs should be vertically aligned when several equations appear on the page.
4. Important equations should be numbered consecutively throughout the document. Equation numbers should be right-justified.

A brief description of the development of the BDS statistic and the concept of the Grassberger and Procaccia correlation dimension, a useful tool, follows.

An efficient way to test for chaos is to consider a measure called the correlation integral examined by Grassberger and Procaccia [1983], which is defined as the fraction of pairs (x_t^m, x_s^m) which are close to each other in the sense that $\max_{i=0, \dots, m-1} \{ |x_{s-i} - x_{t-i}| \} < \varepsilon$. For finite sequences such as $\{x_t\}$, a scalar sequence of T observations, the Grassberger and Procaccia correlation integral may be computed as:

$$C_{m,T}(\varepsilon) = \frac{2}{T_m(T_m-1)} \sum_{t < s} I_{\varepsilon}(x_t^m, x_s^m) \quad (3-5)$$

where:

$$\begin{aligned} T_m &= T - (m-1), \\ x_t^m &= \text{Dimensional vector of } m \text{ histories, i.e., } (x_t, x_{t+1}, \dots, x_{t+m-1}), \\ I_{\varepsilon}(x_t^m, x_s^m) &= \text{an indicator function that equals 1 when } \|x_t^m - x_s^m\| < \varepsilon \text{ and 0 otherwise.} \\ \| \| &= \text{the sup-norm.} \end{aligned}$$

Brock, *et al.* [1987] provide a statistical test for nonlinearity using the correlation integral. They demonstrate that, under the null hypothesis that $\{x_{\varepsilon}\}$ is independently and identically distributed (IID), with nondegenerate cumulative distribution F , for a fixed m and ε ,

$$C_{m,T}(\varepsilon) \rightarrow C(\varepsilon)^m \text{ with probability equal to 1 as } T \rightarrow \infty, \quad (3-6)$$

where: $C(\varepsilon) = \int [F(z + \varepsilon) - F(z - \varepsilon)] dF(z)$.

Also, $[C_{m,T}(\varepsilon) - C(\varepsilon)^m]$ has an asymptotic normal distribution with mean zero and a known variance $\sigma_m^2(\varepsilon)$. A consistent estimate of $C(\varepsilon)^m$ is provided by $C_{1,T}(\varepsilon)^m$.

Then the BDS statistic, which can be denoted as

$$W_{m,T}(\varepsilon) = \sqrt{T} [C_{m,T}(\varepsilon) - C_{1,T}(\varepsilon)^m] \div \sigma_{m,T}(\varepsilon) \quad (3-7)$$

has a limiting standard normal distribution under the null hypothesis of IID.

Instructions for Pages with Tables

1. A standard font must be used throughout the document. Smaller fonts may be used within tables if needed. Boldface and italics may be used in tables (examples on page 64).
2. Tables may be numbered consecutively throughout the document (1, 2, 3, etc.) or consecutively within chapters (1.1, 1.2, 1.3, 2.1, 2.2, 2.3, etc.).
3. Table numbers and titles appear above tables. Table numbers and titles may be centered (examples on pages 64, 65 and 67) or left-aligned and blocked (example on page 66). Table numbers and titles may not be boldfaced. All table titles must be formatted consistently throughout the document.
4. Tables more than ½ page long may be placed on a separate page (example on page 5).
5. Tables less than ½ page long may be placed on the same page as text. Two blank lines are left between the table number and text above. Two blank lines are left between the table and text below (example on page 65).
6. Two or more short tables should appear on the same page to avoid unnecessary white space (example on page 66).
7. Tables may be placed in landscape orientation. The page number must be placed at the bottom center as though the page is in portrait orientation (example on page 67).
8. The page number is centered at the bottom. A 1-inch margin is left below the page number.

Table 3

Risk/Return Characteristics of Country Stock Market Indices and Selected Portfolios:
January 1990 - December 1994

Country Index and Type of Portfolio:	*Mean Return: \bar{x}	Standard Deviation σ	Coeff. of Var.: σ/\bar{x}	Proportions in Portfolio:				
				Equally Weighted	Overall Optimum	Equally Weighted	Optim. Portfolio	Equally Weighted
Australia	.1007	2.3246	23.08	.06				
Belgium	.0627	2.2018	35.14	.06				
Canada	-.0386	1.7540	-45.49	.06				
Denmark	.0688	2.7323	39.73	.06				
France	.0704	2.5251	35.85	.06				
Germany	.0871	2.5892	29.72	.06				
Hong Kong	.4410	3.4983	7.93	.06	.35	.20	.43	.33
Italy	-.0204	3.7920	-185.67	.06				
Japan	-.0019	3.6002	-187.59	.06				
Netherlands	.1775	1.8625	10.49	.06	.20	.20	.27	.33
Norway	.0868	3.3162	38.19	.06				
Singapore/Malaysia	.2810	2.7200	9.68	.06	.11	.20		
Spain	-.0033	3.3540	-100.73	.06				
Sweden	.1143	3.4814	30.47	.06				
Switzerland	.2518	2.3952	9.51	.06	.21	.20	.30	.33
U. K.	.1213	2.3962	19.76	.06				
U. S.	.1274	1.7087	13.41	.06	.14	.20		
Portfolio #1	.1103	‡1.7926	16.26	1.00				
Portfolio #2	.2887	1.9986	6.92		1.00			
Portfolio #3	.2549	1.8068	7.09			1.00		
Portfolio #4	.3125	2.1938	7.02				1.00	
Portfolio #5	.2898	2.0521	7.08					1.00

* Represents the mean weekly percentage rate of return.

‡ To the extent that returns on individual country indices are less than perfectly positively correlated with the returns on the portfolio, the standard deviation of a portfolio is less than the weighted average of the individual standard deviations of country indices in a portfolio.

NOTE: **Portfolio #1** consists of each one of the 17 country indices, all equally weighted in the portfolio.

Portfolio #2 represents the overall optimum portfolio, defined as the one which minimizes the absolute value of the coefficient of variation for the portfolio.

Portfolio #3 consists of the five country indices which make up the optimum portfolio, in this case, however, each index received equal weight in the portfolio.

Portfolio #4 is an optimum portfolio based on the optimum three country indices.

Portfolio #5 consists of the above 3-country index, but equally weighted.

Process Employed to Optimize the Individual Forecasting Models

FORTTRAN programs (Appendix B.1-B.4) are used to optimize the four individual forecasting models (*i.e.*, MAVG, SES, Holt's, and Winter's). In this study a model is considered optimal when its parameters yield a minimum mean square error (MSE) for the training data. The resulting parameters of the forecasting models are summarized in Table 4.1.

Table 4.1

PARAMETERS FOR OPTIMAL INDIVIDUAL FORECASTING MODELS FOR SIMULATED DATA

Composite Models:	Individual Forecasting Parameters	Case #1	Case #2	Case #3	Case #4
		Positive correl. Low variance	Positive correl. High variance	Negative correl. Low variance	Negative correl. High variance
MAVG	$n =$	6	6	6	6
SES	$\alpha =$	0.37	0.37	0.05	0.03
Holt's	$\alpha =$	0.40	0.40	0.05	0.05
	$\gamma =$	0.05	0.05	0.05	0.05
Winter's	$\alpha =$	0.05	0.05	0.05	0.05
	$\beta =$	0.05	0.05	0.05	0.05
	$\gamma =$	0.40	0.40	0.05	0.05

It should be pointed out that while these four models may not be the best models to fit an AR(1) process, the purpose of this research is to compare how well various composite models perform in combining the same four individual forecasts. Therefore, as long as each of the composite models receives the same information, the specific four individual forecasting models employed should not have a significant impact on the overall comparison between the composite models.

Table 4 Testing for Differences in Rates of Return in Three Market Indices by the Day-of-the-Week and Business Cycles: Results of ANOVA and Kruskal-Wallis

$H_0: R_i(\text{Monday}) = R_i(\text{Tuesday}) = R_i(\text{Wednesday}) = R_i(\text{Thursday}) = R_i(\text{Friday})$

Index:	ANOVA:		No. of Observ.	Kruskal-Wallis:	
	F-value:	*P-value:		F-value:	*P-value:
Junk Bonds (overall)	4.08	.0027	1,886	67.56	.0000
Expansion:	3.44	.0082	1,719	57.17	.0000
Contraction:	1.15	.3347	167	7.97	.0926
Investment-Grade Bonds	0.16	.9588	1,891	1.30	.8615
Expansion:	0.16	.9572	1,724	1.65	.7998
Contraction:	0.13	.9729	167	1.02	.9061
CRSP Equally-Weighted					
Equity (overall)	5.83	.0001	1,770	38.81	.0000
Expansion:	6.36	.0000	1,603	39.81	.0000
Contraction:	0.82	.5129	167	4.68	.3219

*The reported F-values and associated P-values correspond to the null hypothesis of equal mean return by the day of the week.

Table 5 Duncan's Test Statistics for Pairwise Comparisons in the Daily Returns in the Three Market Indices by Business Cycles

Index:	Comparison of Days With Significantly Different Returns at the .05 Level:
Junk Bonds (overall) -----	Friday > Monday, Tuesday, Wednesday, Thurs.
Expansions: -----	Friday > Monday, Tuesday, Wednesday, Thurs.
Contractions: -----	(none)
Investment-Grade Bonds (overall) (none)	
Expansions: -----	(none)
Contractions: -----	(none)
CRSP Equally-Weighted	
Equity (overall) -----	Monday < Wednesday, Thursday, Friday Tuesday < Wednesday
Expansions: -----	Monday < Tuesday, Wednesday, Thurs., Friday Tuesday < Wednesday
Contractions: -----	(none)

Table 2

Weekly Rates of Return of Selected International Stock Markets by Year

Year	Australia	France	Germany	Hong Kong	Japan	Sing./Mal.	Spain	Sweden	U.K.	U.S.	World
*1978	5.264	11.610	2.846	3.047	8.024	8.046	1.822	1.901	3.790	2.037	3.606
1979	5.654	4.234	-1.632	9.616	-3.115	4.308	-1.471	-0.763	2.589	1.472	1.229
1980	7.252	-1.536	-2.897	10.409	4.210	9.099	-1.631	2.247	5.092	3.961	3.633
1981	-5.163	-8.218	-2.730	-3.396	3.109	2.825	0.450	5.673	-2.961	-1.835	-1.413
1982	-5.887	-1.716	1.200	-12.351	-0.309	-4.019	-9.351	3.389	0.628	2.691	1.109
1983	7.507	43468	3.569	-1.698	3.806	4.788	-3.201	7.440	2.009	2.960	3.230
1984	-3.073	0.451	-1.531	5.823	2.763	-6.230	4.393	-5.221	-0.091	0.086	0239
1985	2-565	10.348	15.480	7.345	6.514	-5.956	6.380	7.763	7.006	4.445	5.794
1986	6.244	12.115	5.939	7.720	13.196	7.242	14.437	9.636	3.824	3.093	6.706
1987	0.972	-3.504	-5.576	-1.006	6.596	0.203	5.930	0.250	6.02	-0.155	2.459
1988	5.880	5.542	3.292	4.022	5.986	5.300	1.708	7.442	0.014	2.169	3.762
1989	1.120	5.896	7.122	1.032	0.391	6.583	1.544	4.984	2.958	4.324	2.625
1990	-4.778	-3.453	-2.292	0.589	-8.838	-2.962	-4.159	-5.219	1.193	-1.047	-4.044

NOTE: All weekly returns are converted in U.S. dollars and, for improved readability, are multiplied by 1,000.

** Weekly return based on February – December 1978.

Instructions for Pages with Figures

1. A standard font must be used throughout the document. Boldface and smaller fonts may be used within figures if needed (example on page 69).
2. Figures may be numbered consecutively throughout the document (1, 2, 3, etc.) or consecutively within chapters (1.1, 1.2, 1.3, 2.1, 2.2, 2.3, etc.)
3. Figure numbers and titles appear below figures. Figure numbers and titles may be centered (examples on pages 64, 65 and 67) or left-aligned and blocked (example on page 66). Figure numbers and titles may not be boldfaced.
4. Figures less than $\frac{1}{2}$ page long may be placed on the same page as text. Two blank lines are left between the figure and text above. Two blank lines are left between the figure title and text below (example on page 69).
5. Figures more than $\frac{1}{2}$ page long may be placed on a separate page (example on page 70).
6. Two or more small figures should appear on the same page to avoid unnecessary white space.
7. Figures may be placed in landscape orientation. The page number must be placed at the bottom center as though the page is in portrait orientation (example on page 71).
8. The page number is centered at the bottom. A 1-inch margin is left below the page number.

The use of mathematical programming helped to identify Portfolio #2, the one with the smallest coefficient of variation. This portfolio resulted in a remarkable reduction in the coefficient of variation relative to Portfolio #1 (i.e., 6.92 versus 16.26, respectively). In addition, the risk/return characteristics of this portfolio are significantly better than those of any individual country index. It is also of interest to note that the overall optimum portfolio required only 5 of the 17 country indices.

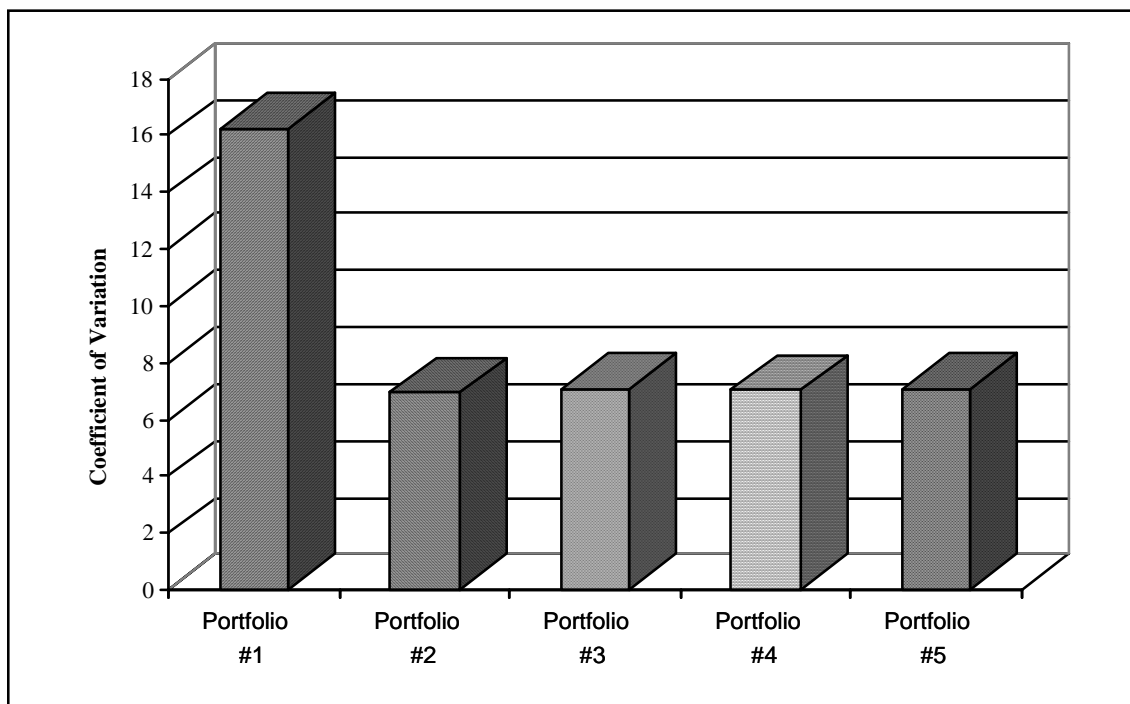


Figure 4.1 Risk/Return Characteristics of Selected International Portfolios: January 1990-December 1994

Relying on more relaxed assumptions, Portfolio #3's results are quite close to those obtained for the overall optimum portfolio (coefficient of variation of 7.09 versus 6.92, respectively). Recall that Portfolio #3 relies on the same country indices as the optimum portfolio, except they are all equally weighted. So, comparing the coefficient .

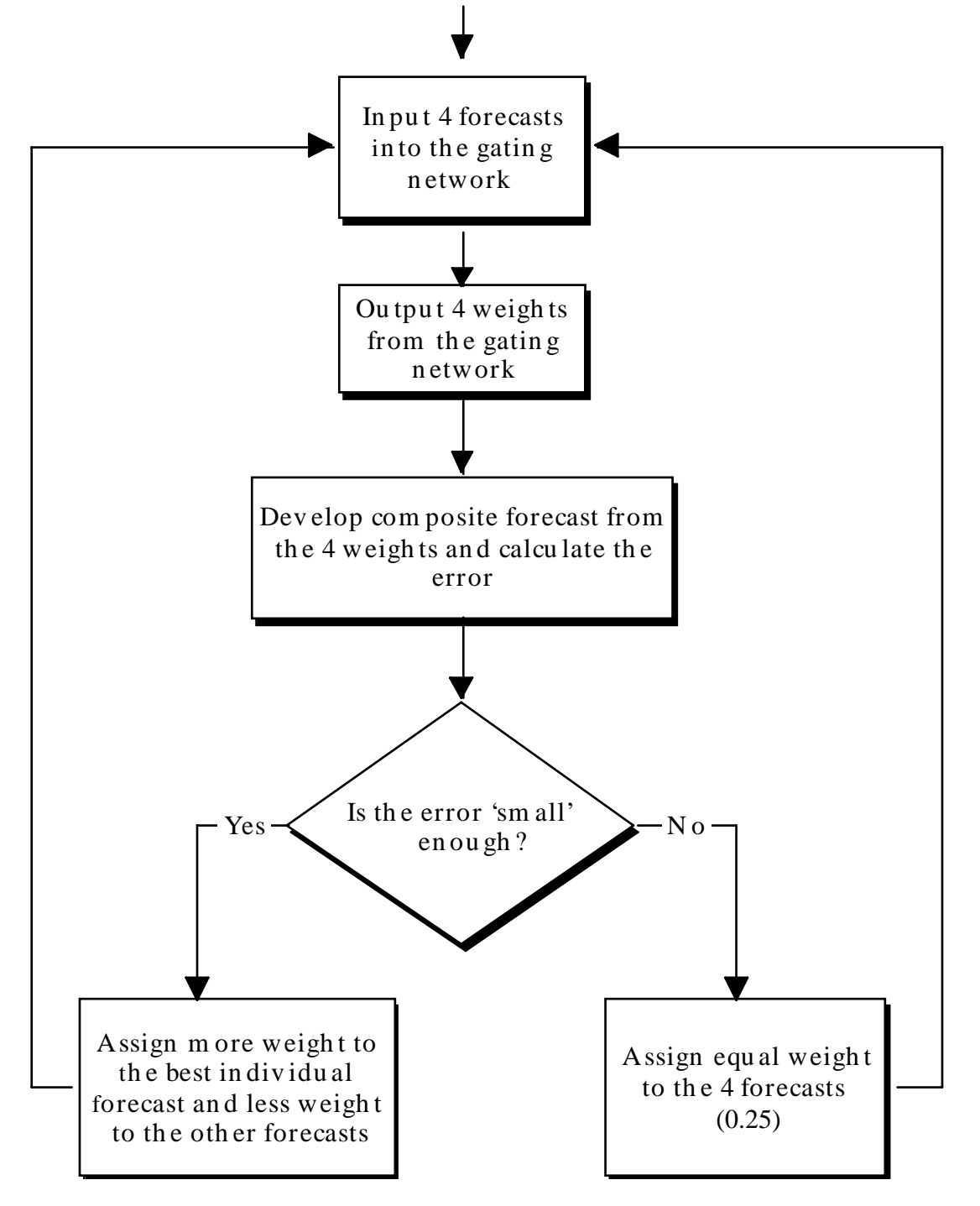


Figure 4.6

Modular Neural Network Training Procedure

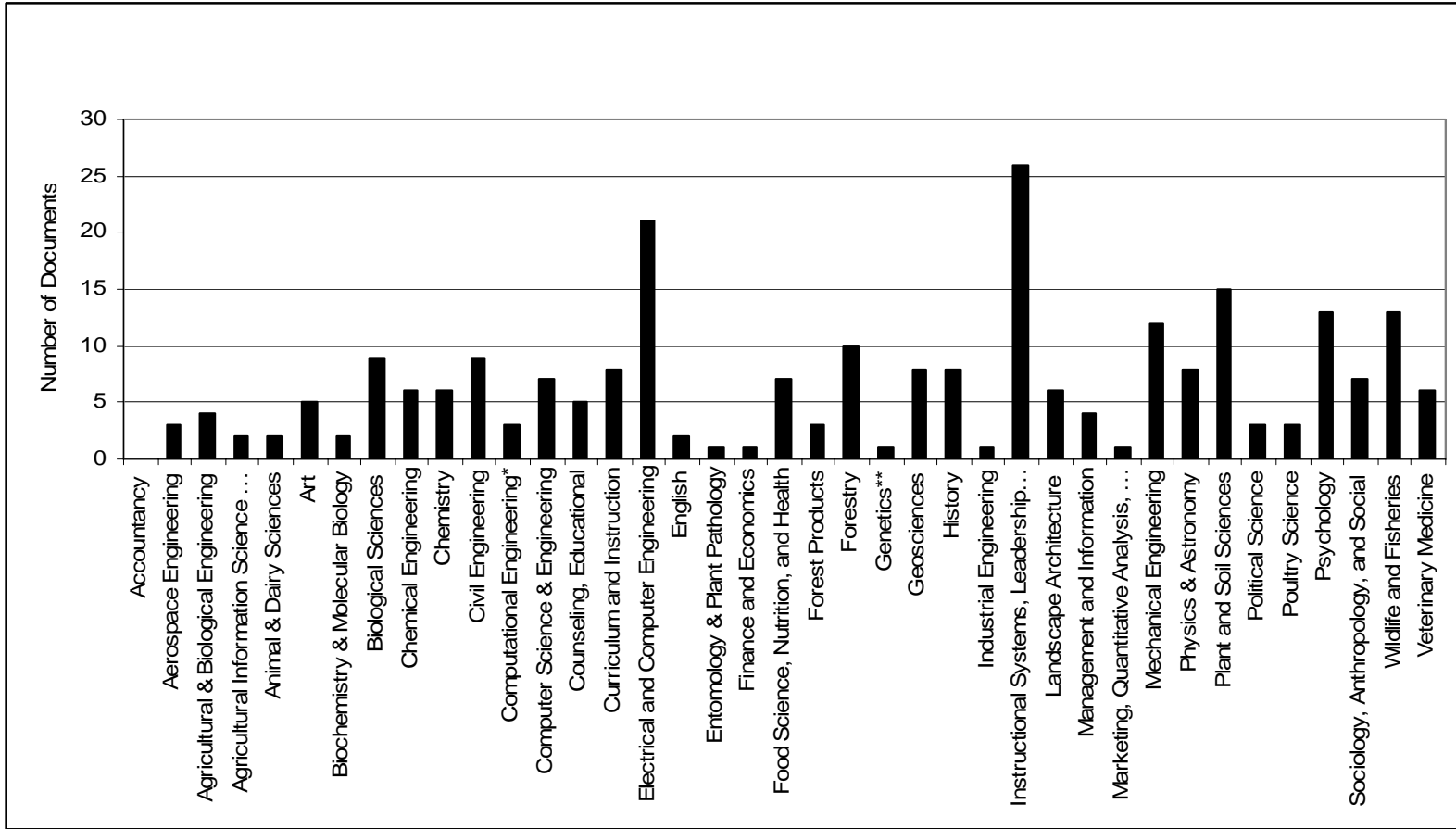


Figure 17 Number of theses and dissertations submitted by department, 2004-2005.

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2. To maintain equal line spacing, superscripts may be in a smaller font size.

In contrast, some studies suggest that sample size and/or error term adjustments render U.S. day-of-the-week effects statistically insignificant.⁵

In spite of the increasing evidence concerning seasonal anomalies in security rates of return, pronounced gaps in the research on this topic exist. For example, unlike the considerable body of investigations into seasonal regularities in equity markets, few studies have examined this phenomenon in fixed income markets. Specifically, investigating daily return patterns in T-bills, Gibbons and Hess found Wednesday's returns to be higher than those of any other day of the week, while Monday's returns were lower.⁶ Furthermore; several researchers have investigated the January effect in various bond markets and have reached different conclusions. For example, Smirlock was able to identify the existence of this anomaly in low-grade corporate bonds.⁷ In a recent paper, indications of significant year-end effects in junk bond prices were also provided by Cooper and Shulman.⁸

Virtually all of the existing research on seasonal anomalies in corporate bond returns has been confined to investment-grade bonds. As investment instruments, junk bonds became popular in the mid-1980s. Today many investors consider junk bonds to be part of a well-diversified portfolio primarily because of the hybrid nature of these

⁵For example, see B. Cornell, "Liquidity and the Pricing of Low-Grade Bonds," *Financial Analysts Journal*, January/February 1992; B. Cornell and K. Green, "The Investment Performance of Low-grade Bond Funds," *Journal of Finance*, 46, 1, March, 1991; and E. C. Chang, J. M. Pinegar and R. Ravichandran, "International Evidence on the Robustness of the Day-of-the-Week Effect," a paper presented at the 1992 Financial Management Association meeting in San Francisco, California.

⁶M. R. Gibbons and P. Hess, "Day-of-the-Week Effects and Asset Returns," *Journal of Business*, 54, 4, October 1981.

⁷M. Smirlock, "Seasonality and Bond Market Returns," *Journal of Portfolio Management*, 11, Spring 1985.

⁸R. A. Cooper and J. M. Shulman, "The Year-End Effect in Junk Bond Prices," *Financial Analysts Journal*, September/October 1994.

Instructions for Reference Material Pages

Reference lists may be placed at the end of each chapter or the end of the document. Select one method and follow the appropriate instructions.

Reference Lists at End of Document

1. The first page should have a 2-inch top margin, a 1.5-inch left margin, a 1-inch right margin, and 1-inch bottom margin. All other pages should have a 1.5-inch left margin and 1-inch top, right, and bottom margins.
2. The page heading must be in all capitals and centered. Two blank lines are left between the heading and the first entry. The wording of the heading (REFERENCES, WORKS CITED, etc) is determined by the style used by the department. Common examples are shown on the sample pages.
3. Citation formatting is determined by the style used by the department; the appropriate style guide should be consulted. Some common citation styles are shown on pages 75 – 78.
4. A blank line is left between each entry. Single-spacing is used within entries.
5. Page numbers are centered at the bottom with a 1-inch margin below the page number.

Reference Lists at End of Each Chapter

1. The first page should have a 2-inch top margin, a 1.5-inch left margin, a 1-inch right margin, and 1-inch bottom margin. All other pages should have a 1.5-inch left margin and 1-inch top, right, and bottom margins.
2. Start the reference materials on a new page rather than on the same pages as the last line of the chapter.
3. The format and wording of the heading is determined by the style used by the department.
4. Citation style is determined by the style used by the department. The appropriate style guide should be consulted.
5. A blank line is left between each entry. Single-spacing is used within entries.
6. Page numbers are centered at the bottom with a 1-inch margin below the page number.

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Each appendix must have an appendix divider (title) page formatted as follows:

1. All text on the appendix divider (title) page is page centered (both vertically and horizontally). The left margin should be 1.5 inches. The right margin should be 1 inch.
2. The word APPENDIX in all capital letters appears on the first line. If more than one appendix is used, they should be designated as APPENDIX A, APPENDIX B, etc.
3. One blank line is left between the word APPENDIX and the appendix title.
4. The appendix title is typed in all capital letters. If the title is longer than 1 line, 1 blank line is left between the lines of the title and the lines are arranged in inverted-pyramid style.
5. The page number is centered at the bottom with a 1-inch margin below.

The appendix contents are formatted as follows:

1. The page should have a 1.5-inch left margin and a 1-inch margin on top, right, and bottom.
2. Tables and figures must be numbered. Tables and figures must be included in the List of Tables and List of Figures.
3. Appendices frequently include material such as IRB letters, computer code, or surveys that cannot be reformatted. Such material may be single spaced and may use a different font than the rest of the document.
4. The page number is centered at the bottom with a 1-inch margin below.

APPENDIX A
DATA ON HURRICANES BEGINNING IN THE ATLANTIC BASIN AND
REACHING THE NORTH AMERICAN CONTINENT
FROM 1928 THROUGH 1933