UNIVERSITI PUTRA MALAYSIA

GEOMETRIC APPROACH TO STATIC AND DYNAMIC MEASUREMENTS OF RISK, BANKRUPTCY AND MARKET RANKING

ALIREZA BAHIRAIE

IPM 2010 20

GEOMETRIC APPROACH TO STATIC AND DYNAMIC MEASUREMENTS OF RISK, BANKRUPTCY AND MARKET RANKING

By

ALIREZA BAHIRAIE

Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

March 2010

DEDICATIONS

To my beloved parents, for their support and encouragement throughout this study and who have always wish me the best

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

GEOMETRIC APPROACH TO STATIC AND DYNAMIC MEASUREMENTS OF RISK, BANKRUPTCY AND MARKET RANKING

By

ALIREZA BAHIRAIE

March 2010

Chair : Noor Akma Ibrahim, PhD

Institute: Institute for Mathematical Research

This thesis presents two new geometric techniques for empirical analysis of financial data with empirical application on bankruptcy risk prediction. Within these frameworks, we propose the use of new ratio representations (index), the Risk Box measure (RB) and the Dynamic Risk Space (DRS). We also demonstrate the application of these geometric approaches for variable transformation and data visualization at different stages of corporate bankruptcy prediction models based on financial balance sheet. The different stages involved are the selection of variables (predictors), accuracy of each estimation model and the representation of each model for the transformed and common ratios.

We provide evidence of the extent to which changes in values of this index are associated with changes in each axis values and how this may alter our economic interpretation of the patterns and direction of risk components. Results of Multiple Discriminant Analysis (MDA), Logistic Analysis (LA) and Genetic Programming (GP) and Logistic Robust statistics are obtained and compared as different classification models. Empirical results show that these classifiers with common ratio are outperformed by the transformed ratios. The Risk Box (RB) and Dynamic Risk Space (DRS) methodologies would be a general methodological guideline associated with financial data, including solving some methodological problems concerning financial ratios such as non-proportion, non-symmetric, non-scaled as illustrated in this thesis for bankruptcy prediction. In this research, the first geometric methodology for financial risk measurement is developed for financial concepts, focusing on theoretical bases rather than isolated facts of financial risk management. Subsequently, this study provides the first graphical financial risk ranking software, named as Dynamic Geometric Risk Space Software (DGRSS). This software provides visualization of risk factors and market ranking. It is ideal for public and private investors, banks, market analysts, companies and stock markets and compatible with any country/sector dataset based on DRS method. Lastly in this research, the Logistic Robust Regression is applied to bankruptcy data for the first time to handle outliers and to obtain more accurate predictions.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENDEKATAN GEOMETRIK KEPADA UKURAN RISIKO DINAMIK DAN STATIK, KEMUFLISAN DAN KEDUDUKAN PASARAN

Oleh

ALIREZA BAHIRAIE

Mac 2010

Pengerusi: Noor Akma Ibrahim, PhD

Institut : Institut Penyelidikan Matematik

Tesis ini menyajikan dua teknik geometrik baharu khusus untuk analisis empirikal keatas data kewangan dan ramalan risiko kemuflisan. Di dalam kerangka ini, kami mencadangkan penggunaan perwakilan nisbah yang baharu , iaitu Kotak Ukuran Risiko (RB) dan Ruang Dinamik Risiko (DRS). Kami juga mempamerkan teknik pendekatan geometrik ini bagi transformasi pembolehubah dan gambaran data diperingkat berbeza bagi model ramalan kemuflisan korporat berdasarkan kepada kunci kira-kira kewangan. Pembinaan dan applikasi kedua-dua teknik pendekatan geometrik ini kepada data utama kira-kira kewangan melibatkan transformasi pembolehubah beserta gambaran data di peringkat yang berbeza bagi model ramalan kemuflisan korporat. Peringkat yang berbeza ini merangkumi pemilihan pembolehubah (peramal), ketepatan setiap model anggaran, dan gambaran setiap model dangan nisbah yang biasa dan diubah. Kajian ini juga mempamerkan pembinaan dan penggunaan kaedah geometrik buat

pertama kali bagi membantu pembinaan ukuran risiko kewangan dimana kaedah geometri ini dibina berteraskan kepada teori dan bukan kepada rumusan mudah indeks pengukuran risiko kewangan. Antara beberapa kelebihan penggunaan nisbah kaedah RB dan DRS sapertimana yang dinyatakan dan dibuktikan dalam tesis ini jika dibandingkan dengan penggunaan nisbah biasa data kewangan ialah bebas dari ciri tak berkadaran, tak simetri dan tak berskalar untuk ramalan kemuflisan.

Bukti sejauh mana perubahan di dalam nilai indeks ini berkaitan dengan perubahan di dalam setiap nilai paksi telah juga diperlihatkan, dan bagaimana ini boleh mengubah tafsiran kewangan bagi pola dan arah komponen risiko. Keputusan daripada Analisis Diskriminan Berganda (MDA), Analisis Logistik (LA), Pengaturcaraan Genetik (GP), dan Statistik Teguh Logistik (LR) diperolehi dan dibandingkan sebagai model pengkelasan berbeza. Hasil analisis empirikal tesis ini ke atas data kewangan membuktikan bahawa prestasi pengkelasan kemuflisan dengan penggunaan nisbah yang diubah berteraskan kerangka teoretikal geometri yang dibina mengatasi prestasi penggunaan nisbah biasa. Seterusnya pengkelasan kemuflisan dengan penggunaan nisbah kaedah RB dan DRS disyorkan untuk dijadikan sebagai salah satu kaedah umum yang boleh digunapakai oleh institusi kewangan. Selanjutnya, kajian ini juga telah menyediakan perisian grafik pertama kedudukan risiko kewangan yang dinamakan Perisian Ruang Risiko Geometrik Dinamik (DGRSS). Perisian ini menyediakan gambaran tentang faktor risiko dan kedudukan pasaran. Ia sangat sesuai untuk digunakan oleh pelabur awam dan swasta, bank, penganalisis pasaran, syarikat dan pasaran saham. Perisian ini juga sesuai untuk set data sektor/negara yang berdasarkan Ruang Dinamik Risiko (DRS). Akhir sekali dalam kajian ini, Regresi Logistik Teguh (LR) diterapkan kepada data kemuflisan untuk pertama kali bagi menangani cerapan terpencil dan untuk mendapatkan ramalan yang lebih tepat.

ACKNOWLEDGEMENTS

All praises to the Almighty Allah, the Most Gracious and Merciful, who is omnipresent, for giving me the strength and determination to complete this study. No words can express adequately my sense of indebtedness yet I feel I shall be failing in my obligation if I do not put on record my gratitude to the following persons:

I am deeply indebted to Associate Prof. Dr. Noor Akma bt Ibrahim, Institute for Mathematical Research, Universiti Putra Malaysia, as the chairman of supervisory committee who has provided valuable guidance in all aspects of the research process. Special thanks are also due to my supervisory committee members; Associate Prof. Dr. Mohamad Azhar Abdul Karim and Prof. Dr. Ismail bin Mohd for sharing their time and ideas, comments and advice on developing and reporting this research and for serving as members of my committee. Special thanks to all my friends for countless hours spent discussing fruitful ideas at the University Putra Malaysia. My special thanks go to Prof. Dr. Dato Kamel Ariffin Mohd Atan, director and all lecturers and staffs in Institute for Mathematical Research in University Putra Malaysia, for the warm hospitality and supports throughout my study**.** Last but not least, I would like to thank my parents for their endless love and encouragement throughout this entire journey without whom I would have struggled to find the inspiration and motivation needed to complete this dissertation.

I certify that a Thesis Examination Committee has met on 4th March 2010 to conduct the final examination of Alireza Bahiraie on his thesis entitled "GEOMETRIC APPROACH TO STATIC AND DYNAMIC MEASUREMENTS OF RISK, BANKRUPTCY AND MARKET RANKING" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Isa Daud, PhD
Associate Professor
Faculty of Science, Department of Mathematics
University Putra Malaysia
(Chairman)

Mohd Rizam Abu Bakar, PhD
Associate Professor
Faculty of Science, Department of Mathematics
University Putra Malaysia
(Internal Examiner)

Kassim Haron, PhD
Associate Professor
Faculty of Science, Department of Mathematics
University Putra Malaysia
(Internal Examiner)

Abu Hassan Shaari Md. Nor, PhD
Professor
Faculty of Economics, Department of Applied Statistics
University Kebangsaan Malaysia
(External Examiner)

_____

BUJANG BIN KIM HUAT, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of Doctor of Philosophy.

The members of the Supervisory Committee were as follows:

Noor Akma bt Ibrahim, PhD
Associate Professor
Institute for Mathematical Research
Universiti Putra Malaysia
(Chairman)

Mohamed Azhar Abdul Karim, PhD
Associate Professor
Graduate School of Management
Universiti Putra Malaysia
(Member)

Ismail bin Mohd, PhD
Professor
Faculty of Computer and Mathematics
Universiti Malaysia in Terengganu
(Member)

_____

HASANAH MOHD GHAZALI, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 13 May 2010

DECLARATION

I hereby declare that this thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

ALIREZA BAHIRAIE

Date: 3 March 2010

TABLE OF CONTENTS