

**FINAL REPORT OF THE
MINOR RESEARCH PROJECT**

**UNDER SCHEME OF XII PLAN PERIOD
(SCIENCE-STATISTICS)**

UNIVERSITY GRANTS COMMISSION

(MRP1893-/14-15/KLMG020/UGC-SWRO dtd 04 Feb-15-2015)

**Some contributions to
Concomitants of order statistics**

PROO/B

PRINCIPAL INVESTIGATOR

**Dr. Johny Scaria
Associate professor
Department of Statistics
Nirmala College Muvattupuzha
Kerala, 686 661**

MARCH 2017



ACKNOWLEDGEMENT

I express my heartfelt thanks to the University Grants Commission for providing financial support in the form of Minor Project grant for the successful completion of the project work.

I am grateful to the Principal, Nirmala College, Muvatupuzha and all the office staff for co-operation and assistance they extended to me during the tenure of the project.

I am grateful to my colleagues in the Department of Statistics at Nirmala college Muvatupuzha for their support and encouragement.

In the preparation of the report, I have received invaluable academic assistance from my teacher Prof. Unnikrishnan Nair and my Research scholars Sithara Mohan and Biju. I place on record my sincere thanks to each one.

Above all I thank the almighty for guiding, inspiring and strengthening me during the course of this project.

Johny Scaria

Contents

1. CONCOMITANTS OF ORDER STATISTICS: AN OVERVIEW	1-15
1.1 Introduction.....	1
1.2 Finite-Sample Distribution Theory.....	7
1.2.1 Concomitants with Simple Regression Models	7
1.2.2 General Results	9
1.2.3 Characterizations.....	12
1.2.4 Outline and Organization of the Thesis	14
2. THE CAMBANIS FAMILY OF BIVARIATE DISTRIBUTIONS: PROPERTIES AND APPLICATIONS.....	16-32
2.1 Introduction	16
2.2 Distributional Properties	18
2.2.1 Dependence	19
2.3 Application to Reliability Modelling	24
2.3.1 Hazard Rates	24
2.3.2 Mean Residual Life	25
2.3.3 The Exponential Case	27
2.3.4 Series and Parallel System	28
2.4 Modelling Survival Data.....	30
2.5 Conclusion	32
3. CONCOMITANTS OF ORDER STATISTICS FROM CAMBANIS TYPE BIVARIATE LOGISTIC DISTRIBUTION.....	33-45
3.1 Introduction.....	33
3.2 Distribution of the r^{th} Concomitant $Y_{[r:n]}^*$	35
3.3 Joint Distribution of $Y_{[r:n]}^*$ and $Y_{[s:n]}^*$ ($r < s$).....	37
3.4 Concomitants from Cambanis Type Bivariate Logistic Distribution	40
4. RECORD CONCOMITANTS FROM CAMBANIS TYPE BIVARIATE LOGISTIC DISTRIBUTION	46-55
4.1 Introduction.....	46
4.2 Distribution of n^{th} Record Concomitant $R_{[n]}$	48
4.3 Joint Distribution of $R_{[m]}$ and $R_{[n]}$ ($m < n$).....	49

4.4	Record concomitants from Cambanis Type Bivariate Logistic Distribution	52
5. CONCOMITANTS OF ORDER STATISTICS FROM THE CAMBANIS TYPE BIVARIATE EXPONENTIATED EXPONENTIAL DISTRIBUTION... ..56-64		
5.1	Introduction.....	56
5.2	Exponentiated exponential Distribution	57
5.3	Concomitants of Order Statistics from CTBEED.....	58
6. SECOND ORDER CONCOMITANTS FROM THE MORGENSTERN FAMILY OF DISTRIBUTIONS..... 65-83		
5.1	Introduction.....	65
5.2	Distribution of $Y_{\left(\frac{m+1}{2}, s, m\right); [p; k]}$	69
5.3	Applications	74
5.3.1	Estimation of Parameters	74
5.3.2	Application to the Selection Problem	78
5.4	Conclusions.....	79
7. SECOND ORDER CONCOMITANTS FROM MORGENSTERN TYPE BIVARIATE EXPONENTIAL DISTRIBUTION 84-89		
7.1	Introduction.....	84
7.2	Second Order Concomitant from MTBED	87
8. ON CHARACTERIZING GENERALIZED CAMBANIS FAMILY OF BIVARIATE DISTRIBUTIONS 90-98		
8.1	Introduction	90
8.2	Characterizations.....	91