

**IDENTIFICATION OF IMPACT OF PUBLIC DEBT ON  
ECONOMIC GROWTH OF SRI LANKA USING AUTO  
REGRESSIVE DISTRIBUTED LAG MODELLING  
APPROACH**

**Manamperi Mudiyansele Lochanie Ayanthika Kumari Bandara**

**158876A**

**Dissertation submitted in partial fulfillment of the requirements for  
the degree Master of Science in Business Statistics**

**Department of Mathematics**

**University of Moratuwa**

**Sri Lanka**

**October 2019**

## **DECLARATION**

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature:

Date:

The above candidate has carried out research for the Masters/MPhil/PhD thesis/ Dissertation under my supervision.

Name of the supervisor:

Signature of the supervisor:

Date:

## **Acknowledgement**

I would first like to thank my thesis advisor Dr. P.M.Edirisinghe, Senior Lecturer of Department of Mathematics at University of Moratuwa whose door of office was always open whenever I ran into a trouble spot or had a question about my research or writing. He consistently allowed this paper to be my own work, but steered me in the right the direction whenever he thought I needed it.

I would also like to thank Dr. Chandana Gunathilaka, Senior Lecturer of Department of Finance, Faculty of Management Studies and Commerce at University of Sri Jayawardanapure, who gave me the initial research idea.

I would also like to acknowledge Senior Prof. T.S.G.Peiris, Course Co-ordinator, M.Sc in Business Statistics, Department of Mathematics at University of Moratuwa for inspiring me to continue this research.

Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my parents, whose love and guidance are with me in whatever I pursue. They are the ultimate role models.

## **ABSTRACT**

Nowadays, in Sri Lanka, the emergent public debt and its servicing costs are an unadorned burden on the economy. The main aim of the present study is to develop a model which reflects the relationship between public debt and economic growth in Sri Lanka using Non-Linear Auto Regressive Distributed Lag model. Economic growth was reflected by the annual GDP growth. Data were acquired from Department of Census and Statistics abstract reports and annual reports of Central Bank of Sri Lanka. As the first step data were analyzed to invent that relationship between Public debt and annual GDP growth is linear, using Auto Regressive Distributed Lag model and it was confirmed that there was no any significant linear relationship among variables (GDP growth and Public Debt). Then Non-linear Auto Regressive Distributed Lag model was fitted using GDP growth and Public Debt as variables. The Bound's test and Wald's test indicated the presence co-integration among variables GDP growth and Public Debt. The estimated Auto Regressive Distributed Lag model affirms the presence of asymmetries in GDP Growth behavior in long run. In the short run, it can be concluded that, if one-point positive change of fourth lag in Gross Total Public Debt will lead to 1.17 increase in GDP Growth and one-point increase in first and third lags of first difference of Real GDP Growth will lead to 1.07 and 0.26 increase in GDP Growth when all the other variables are constant. Furthermore, in the long run, one-point positive change of first lag in Gross Total Public Debt will leads to 0.35 decrease in GDP Growth while one-point negative change in first lag in Gross Total Public Debt will lead to 1.1 increase in GDP Growth when all the other variables are constant. All the changes reflected significant influence on the GDP Growth behavior. The both dynamic and static forecast values estimated from the developed Non-Linear ARDL model for the period during 1970 to 2017 were almost the same with actuals. However, the dynamic forecasting is more superior than the static forecast. The errors from both dynamic and static models were found to be random.

**Keywords:** Auto Regressive Distributed Lag, Non-Linear Auto Regressive Distributed Lag, Real GDP Growth

## TABLE OF CONTENTS

Declaration of the candidate & Supervisor .....	i
Acknowledgements .....	ii
Abstract .....	iii
Table of content .....	iv
List of Figures .....	viii
List of Tables .....	ix
List of abbreviations .....	x
List of Appendices .....	xi
1. INTRODUCTION .....	1
1.1 Problem Identification .....	2
1.2 Problem Justification .....	2
1.3 Significance of the Study .....	3
1.4 Limitations of the Study .....	4
1.5 Objectives of the Study .....	4
1.6 Outline of the Dissertation .....	4
2. LITERATURE REVIEW .....	5
2.1 Terminologies and Concepts relate to Public Debt and GDP .....	5
2.1.1 Public Debt .....	5
2.1.2 Sovereign Debt .....	5
2.1.3 Classification of Public Debt .....	5
2.1.3.1 Internal and External .....	5
2.1.3.2 Productive and unproductive .....	6
2.1.3.3 Short term and Long term .....	6
2.1.3.4 Voluntary and Compulsory .....	7
2.1.3.5 Redeemable and Irredeemable .....	7
2.1.3.6 Funded and Unfunded .....	7
2.1.4 Component of Public Debt .....	7
2.1.5 Objectives of Public Debt .....	8

2.1.6 Good and Bad side of Public Debt .....	8
2.2 Burden of Public Debt .....	9
2.3 Management of Public Debt .....	10
2.3.1 Importance of Public Debt Management .....	11
2.3.2 Objectives of Public Debt Management .....	11
2.3.3 Principles of Public Debt Management .....	11
2.3.4 Debt Management Plan .....	12
2.4 Public Debt and Economic Growth .....	12
2.5 Current Situation in Sri Lanka .....	12
2.5.1 Economic Growth in Sri Lanka .....	12
2.5.2 Situation of Public Debt in Sri Lanka .....	13
2.6 Similar Studies and Findings .....	15
2.7 Summary of Literature Review .....	18
3. MATERIALS AND METHODS .....	19
3.1 Data Acquisition .....	19
3.2 Variables .....	19
3.3 Descriptions of Variables in the Study .....	19
3.3.1 Public Debt .....	19
3.3.2 GDP (Gross Domestic Production) .....	19
3.4 Statistical Methods for Analyzing .....	20
3.4.1 Auto Regressive Distributed Lag Model (ARDL) .....	20
3.4.1.1 Assumptions in the ARDL Model .....	21
3.4.1.2 Advantages in Applying the ARDL Model .....	22
3.5 Theoretical Framework in Auto Regressive Distributed Lag Model .....	23
3.5.1 Stationary and Non- Stationary Concept .....	23
3.5.2 Unit Root Test .....	24
3.5.3 Co-Integration Test .....	24
3.5.4 Re-parameterization .....	26
3.6 Model Formulation .....	25
3.6.1 Formation of Re- Parameterized Model .....	27
3.6.2 Formation of Non-Linear ARDL Model .....	27
3.7 Data Preprocessing Methodology .....	28

3.7.1 Data Preprocessing and Descriptive Statistics .....	28
3.7.2 Data Validation .....	28
3.7.3 Data Transformation .....	28
3.7.3.1 Natural Log Transformation .....	29
3.7.4 Unit Root Test for Checking Stationarity .....	29
3.7.4.1 Differencing .....	29
3.8 Data Analyzing .....	29
3.8.1 Estimate the ARDL Model .....	29
3.8.2 Determine the Evidence for Long Run Relationship .....	30
3.8.3 Determine Optimal Lag Structure .....	30
3.8.4 Determine the Short Run and Long Run Coefficients .....	30
3.8.5 Model Re- Parameterization .....	30
3.8.6 Model Validation and Stability Checking .....	31
3.9 Non – Linear ARDL Model .....	32
3.9.1 Asymmetric Co-integration Test .....	32
3.9.2 Presence of Asymmetric .....	33
3.10 Forecasting .....	34
4. RESULTS AND DISCUSSION .....	35
4.1 Descriptive Statistics .....	35
4.2 Data Validation .....	37
4.2.1 Normality Test .....	37
4.3 Data Transformation .....	38
4.3.1 Results of Normality Test after Natural Log Transformation .....	38
4.4 Unit Root Test .....	39
4.5 Determine Optimal (Profit Lag) Lag Structure .....	41
4.6 Selection of the ARDL Model .....	42
4.7 Determine the Evidence for Long Run Relationship .....	43
4.8 Determine the Short Run Relationship .....	43
4.8.1 Model Diagnostics and Stability Checking for Short Run Model .....	45
4.9 Determine the Long Run Coefficients .....	46
4.9.1 Model Diagnostics and Stability Checking for Long Run Model.....	48
4.10 Model Re-parameterization .....	48

4.10.1 Model Diagnostics and Stability Checking for Reparametrized Model .....	49
4.11 Estimation of Non-Linear ARDL Model .....	50
4.12 Determine the Evidence for Long Run Relationship of NARDL Model .....	50
4.13 Determine the Short Run Coefficients for NARDL Model .....	51
4.14 Determine the Long Run Coefficients for NARDL Model .....	52
4.14.1 Model Diagnostics and Stability Checking for NARDL Model .....	53
4.15 Checking for Long Run Asymmetry .....	55
4.16 Testing the Presence of Short Run Asymmetry .....	55
4.17 Forecasting .....	57
4.18 Summary of Results and Discussion .....	59
5. CONCLUSION AND RECOMMENDATIONS .....	60
5.1 Conclusion .....	60
5.2 Recommendations .....	60
REFERENCES .....	62
APPENDIX I .....	67
APPENDIX II .....	70



## LIST OF FIGURES

		<b>Page</b>
Figure 2.1	Types of Public Debt	6
Figure 2.2	Relationship of Public debt, capital and Economic growth	10
Figure 2.3	Sri Lanka Government Debts	14
Figure 2.4	Sri Lanka Government Debts	15
Figure 3.1	Sri Lanka's Public debt composition	20
Figure 4.1	Gross Total Public Debt Series	36
Figure 4.2	Real GDP Growth Series	36
Figure 4.3	Jarque & Bera Test Results for Original Gross Total Public Debt Series	37
Figure 4.4	Jarque & Bera Test Results for Original Real GDP Growth Series	38
Figure 4.5	Jarque & Bera Test Results for Log values of Gross Total Public Debt	38
Figure 4.6	Jarque & Bera Test Results for Log values of Real GDP	39
Figure 4.7	Graph of AIC values of Tested Models	42
Figure 4.8	Results of Normality Test for Short Run Model	45
Figure 4.9	Results of the Normality Test for NARDL Model	54
Figure 4.10	Results of Cusum Test for NARDL Model	55
Figure 4.11	Graph of Dynamic forecasting	58
Figure 4.12	Graph of Static forecasting	58

## LIST OF TABLES

		<b>Page</b>
Table 4.1	Descriptive Statistics	35
Table 4.2	Results of Augmented Dickey-Fuller Test in Original Level of Normalized Data	40
Table 4.3	Results of Augmented Dickey-Fuller Test in First Difference Level of Normalized Data	40
Table 4.4	Results of Optimal Lag Length for Real GDP Variable	41
Table 4.5	Results of Optimal Lag Length for Gross Total Public Debt Variable	41
Table 4.6	Results of ARDL Model Selection	42
Table 4.7	Results of Bounds Co-Integration Test	43
Table 4.8	Results of Short Run Coefficients	43
Table 4.9	Results of the Breusch-Godfrey LM Test for Short Run Model	45
Table 4.10	Results of Heteroscedasticity Test for Short Run Model	45
Table 4.11	Results of Ramsey Reset Test for Short Run Model	46
Table 4.12	Results of Long Run Coefficients	46
Table 4.13	Results of ECM Model Coefficients	48
Table 4.14	Results of Bounds Co-Integration Test for NARDL	50
Table 4.15	Results of short run coefficients for NARDL	51
Table 4.16	Long Run Coefficients for NARDL Model	52
Table 4.17	Results of the Breusch-Godfrey LM Test for NARDL Model	53
Table 4.18	Results of the Breusch-Pagan-Godfrey Heteroscedasticity Test for NARDL Model	54
Table 4.19	Results of the Ramsey Reset Test for NARDL Model	54
Table 4.20	Results of Wald's Test for Short Run Asymmetries	56
Table 4.21	Results of Wald's Test for Presence of Long Run Asymmetries	56
Table 4.22	Forecasting Models' Error results	58

## LIST OF ABBREVIATIONS

<b>Abbreviation</b>	<b>Description</b>
ARDL	Auto Regressive Distributed Lag Model
DW	Durbin Watson
ECM	Error Correction Model
Ex	Example
GNP	Gross National Production
NARDL	Non- Linear Auto Regressive Distributed Lag Model
OLS	Ordinary Least Squares
RWM	Random Walk Model
TIPS	Treasury Inflation Protected Securities
VECM	Vector Error Correction Model

## **LIST OF APPENDICES**

<b>Appendix</b>	<b>Description</b>	<b>Page</b>
Appendix I	Program Codes in E-Views	67
Appendix II	Forecasted Values	70