

**IDENTIFYING FACTORS AFFECTING INFLATION RATE  
IN U.S.A UNDER FOUR PERIODS**

Illukkumbura Mudiyansele Gedara Anusha Sandamali Illukkumbura  
(168832V)

Degree of Master of Science in Business Statistics

Department of Mathematics

Faculty of Engineering

University of Moratuwa

Sri Lanka

December 2019

**IDENTIFYING FACTORS AFFECTING INFLATION RATE  
IN U.S.A UNDER FOUR PERIODS**

Illukkumbura Mudiyansele Gedara Anusha Sandamali Illukkumbura  
(168832V)

Dissertation submitted in partial fulfillment of the requirement for the  
Degree of Master of Science in Business Statistics

Department of Mathematics

Faculty of Engineering

University of Moratuwa

Sri Lanka

December 2019

## **Abstract**

Inflation rate is a crucial variable on an economy. It is defined as a rise in an economy's general price level across variety of sectors. There have been many economical theories on inflation. This paper examines influence of selected seven economical variables on inflation rate in U.S.A economy during four defined periods from first quarter of 1981 to fourth quarter of 2016. The four periods consists of two republican periods of 1981-1992 and 2001-2008 and two democratic periods of 1993-2008 and 2009-2016. Four vector error correction models are estimated and granger causality is tested to identify the short – run and long-run relationships between seven economical indicators and inflation. Foreign direct investment which has a negative influence on inflation rate which is contradictory to the relationship described in inflation theory. Other variables of exchange rate, gross domestic product, trade of balance, money supply, and government expenditure and unemployment rate have mixed influence on inflation rate in U.S.A economy. The study recommends that there are effects of selected economical variables on inflation rate in U.S.A and some aspects of the theories of inflation are applicable in U.S.A economy. Further scrutiny should be done to clear the ambivalent results of influence of other variables on inflation rate.

**Keywords:** U.S.A Economy, Inflation, Economical Indicators of U.S.A, Vector Error Correction Model.

## **ACKNOWLEDGEMENT**

Apart from the efforts of me, the success of this project depends largely on the encouragement and guidelines of many others. I take this opportunity to express my gratitude to the people who have been instrumental in the successful completion of this project.

First and foremost, I would like to thank to Prof. T.S.G. Peiris, Professor in Applied Statistics, the former Head of Department of Mathematics, Faculty of Engineering, University of Moratuwa and the Course Coordinator of M. Sc. / Post Graduate Diploma in Business Statistics (2016/2017) batch for the valuable guidance and advice. He inspired me greatly to work in this project. His willingness to motivate me contributed tremendously to this project.

## DECLARATION OF THE CANDIDATE

“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.

Signature:

Date:

I.M.G.A.S Illukkumbura

The above candidate has carried out research for the Masters Dissertation under my supervision.

Signature:

Date:

Prof. T.S.G Peiris

## Table of Contents

Abstract .....	iii
ACKNOWLEDGEMENT .....	iv
DECLARATION OF THE CANDIDATE .....	v
CHAPTER 1 .....	1
INTRODUCTION .....	1
1.1 Background to the Study .....	1
1.2 Research Question .....	2
1.3 Four Different Scenarios .....	3
1.4 Research Objective .....	3
1.5 Significance of the Study .....	3
1.6 Structure of the Dissertation .....	4
CHAPTER 2 .....	5
LITERATURE REVIEW .....	5
2.1 Inflation of Presidency Elected on Economy in the United States of America .....	5
2.2 Influence of Other Factors on U.S.A Economy .....	5
2.3 Influential factors of Inflation .....	6
2.4 Application of Vector Autoregressive Model (VAR) .....	9
2.5 Applications of Vector Error Correction Model (VECM) .....	10
2.6 Application of Autoregressive Distributed Lag Model (ARDL) .....	11
2.7 Summary of Chapter 2 .....	12
CHAPTER 3 .....	13
MATERIAL AND METHODOLOGY .....	13
3.1 Secondary Data .....	13
3.2 Basic Concepts of Economic Theory .....	13
3.2.1 Inflation .....	13
3.2.2 Inflation Gap .....	14
3.2.3 Keynesian Theory on Inflation .....	14
3.2.4 Multiplier Effect .....	15
3.2.5 Fiscal Policy .....	16
3.2.6 Monetary Policy: The quantity theory of money .....	16
3.2.7 Printing Money .....	17

3.3	Monetarism: Friedman’s Modern Quantity Theory of Money .....	17
3.3.1	Equation of Modern Quantitative Theory of Money .....	18
3.3.2	Monetarist View on Aggregate Demand (AD) and Supply Curve .....	19
3.4	Phillips Curve.....	20
3.5	Vector Auto-Regression Model .....	20
3.5.1	Johansen –Juselius (1990) Co-integration Test .....	21
3.6	Error Correction Model.....	22
CHAPTER 4 .....		23
BEHAVIOUR OF INFLATION RATE AND OTHER ECONOMIC VARIABLES .....		23
4.1	Grouping of Data in U.S.A .....	23
4.2	Temporal Variability of Inflation Rate (INF) during Four Periods .....	23
4.2.1	Basic Statistics for Inflation Rate .....	25
4.2.2	Comparison of Inflation Rate between four periods.....	26
4.3	Temporal Variability of Gross Domestic Product (GDP) during Four Periods....	27
4.3.1	Basic Statistics for Gross Domestic Product .....	28
4.3.2	Comparison of Gross Domestic Product between four periods.....	28
4.4	Temporal Variability of Trade of Balance during Four Periods.....	29
4.4.1	Basic Statistics for Trade of Balance .....	32
4.4.2	Comparison of Trade of Balance between four periods .....	32
4.5	Temporal Variability of Exchange Rate (EXC) during Four Periods.....	33
4.5.1	Basic Statistics for Exchange Rate .....	34
4.5.2	Comparison of Exchange rate between four periods.....	35
4.6	Temporal Variability of Money Supply (MS) during Four Periods .....	36
4.6.1	Basic Statistics for Money Supply .....	38
4.6.2	Comparison of Money Supply between four periods. ....	39
4.7	Temporal Variability of Foreign Direct Investment (FDI) for Four Periods.....	40
4.7.1	Basic Statistics for Foreign Direct Investment .....	41
4.7.2	Comparison of Foreign Direct Investment between four periods.....	41
4.8	Temporal Variable of Government Expenditure (GE) for Four Periods .....	42
4.8.1	Basic Statistics for Government Expenditure .....	44
4.8.2	Comparison of Government Expenditure between four periods .....	44
4.9	Temporal Variable of Unemployment Rate (UMP) for Four Periods .....	45

4.9.1	Basic Statistics for Unemployment Rate .....	46
4.9.2	Comparison of Unemployment Rate between Four Periods.....	47
4.10	Summary of Chapter 4.....	48
CHAPTER 5 .....		49
APPLICATION OF VAR MODEL.....		49
5.1	Association among variables .....	49
5.2	VAR Model for the Period 1 (1981-1992).....	52
5.2.1	Stationary of time series for Period 1 .....	52
5.2.2	Lag Length Criteria for Period 1.....	52
5.2.3	Co-integration of the Time Series for Period 1.....	53
5.2.4	VEC Model for period 1 .....	54
5.2.5	Residual Tests for VEC Model 1 .....	57
5.2.6	Granger Causality for Period 1 .....	60
5.2.7	Impulse Responses Function for Period 1 .....	61
5.3	VAR Model for the Period 2 (1993-2000).....	61
5.3.1	Stationary of Time Series for Period 2 .....	61
5.3.2	Lag Length Criteria for Period 2.....	62
5.3.3	Co-integration of the Time Series for Period 2.....	63
5.3.4	VEC Model for Period 2.....	63
5.3.5	Residual Tests for VEC Model 2.....	67
5.3.6	Granger Causality for Period 2 .....	70
5.3.7	Impulse Responses Functions for Period 2.....	71
5.4	VAR Model for the Period 3.....	72
5.4.1	Stationary of Time Series for Period 3 .....	72
5.4.2	Lag Length Criteria for Period 3.....	73
5.4.3	Co-integration of the Time Series for Period 3.....	74
5.4.4	VEC Model for period 3 .....	74
5.4.5	Residual Tests for VEC Model 3 .....	78
5.4.6	Granger Causality for Period 3 .....	81
5.4.7	Impulse Responses Functions for Period 3.....	82
5.5	VAR Model for the Period 4.....	83
5.5.1	Stationary of Time Series Period 4 .....	83



5.5.2	Lag Length Criteria for Period 4.....	84
5.5.3	Co-integration of the Time Series for Period 4.....	85
5.5.4	VEC Model for Period 4.....	85
5.5.5	Residual Tests for VEC model 4.....	88
5.5.6	Granger Causality Test for period 4.....	91
5.5.7	Impulse Responses Functions for Period 4.....	92
5.6	Summary of Chapter 5.....	93
CHAPTER 6.....		95
CONCLUSION AND RECOMMENDATION.....		95
6.1	Conclusion.....	95
6.2	Recommendations.....	95
6.3	Future Studies.....	95
Reference.....		97
Appendix 1.....		100
Results of Dicky Fuller and Phillips Perron Test for the Period 1.....		100
Appendix 1.1: Results for LNEXC.....		100
Appendix 1.2: Results for D(LNEXC).....		100
Appendix 1.3: Results for LNFDI.....		101
Appendix 1.4: Results for D(LNFDI).....		101
Appendix 1.5: Results for LNGDP.....		102
Appendix 1.6: Results for D(LNGDP).....		102
Appendix 1.7: Results for LNGE.....		103
Appendix 1.8: Results for D(LNGE).....		103
Appendix 1.9: Results for LNINF.....		104
Appendix 1.10: Results for D(LNINF).....		104
Appendix 1.11: Results for LNMS.....		105
Appendix 1.12: Results for D(LNMS).....		105
Appendix 1.13: Results for LNTOB.....		106
Appendix 1.14: Results for D(LNTOB).....		106
Appendix 1.15: Results for LNUMP.....		107
Appendix 1.16: Results for D(LNUMP).....		107
Appendix 2.....		108

Statistical Tests for the Period 2 .....	108
Appendix 2.1: Results for LNEXC .....	108
Appendix 2.2: Results for D(LNEXC).....	108
Appendix 2.3: Results for LNFDI.....	109
Appendix 2.4: Results for D(LNFDI) .....	109
Appendix 2.5 : Results for LNGDP .....	110
Appendix 2.6: Results for D(LNGDP).....	110
Appendix 2.7: Results for LNGE.....	111
Appendix 2.8: Results for D(LNGE) .....	111
Appendix 2.9: Results for LNINF.....	112
Appendix 2.10: Results for D(LNINF) .....	112
Appendix 2.11: Results for LNMS .....	113
Appendix 2.12: Results for D(LNMS).....	113
Appendix 2.13: Results for LNTOB .....	114
Appendix 2.14 : Results for D(LNTOB).....	114
Appendix 2.15: Results for LNUMP.....	115
Appendix 2.16: Results for D(LNUMP).....	115
Appendix 3.....	116
Statistical Tests for the Period 3 .....	116
Appendix 3.1: Results for LNEXC .....	116
Appendix 3.2: Results for D(LNEXC).....	116
Appendix 3.3 : Results for LNFDI.....	117
Appendix 3.4 : Results for D(LNFDI) .....	117
Appendix 3.5 : Results for LNGDP .....	118
Appendix 3.6: Results for D(LNGDP).....	118
Appendix 3.7 : Results for LNGE.....	119
Appendix 3.8 : Results for D(LNGE) .....	119
Appendix 3.9 : Results for LNINF.....	120
Appendix 3.10: Results for D(LNINF) .....	120
Appendix 3.11: Results for LNMS .....	121
Appendix 3.12 : Results for D(LNMS).....	121
Appendix 3.13 :Results for LNTOB .....	122

Appendix 3.14 : Results for D(LNTOB).....	122
Appendix 3.15: Results for LNUMP.....	123
Appendix 3.16 : Results for D(LNUMP).....	123
Appendix 4.....	124
Statistical Tests for the Period 4 .....	124
Appendix 4.1: Results for LNEXC .....	124
Appendix 4.2 : Results for D(LNEXC).....	124
Appendix 4.3: Results for LNFDI.....	125
Appendix 4.4: Results for D(LNFDI) .....	125
Appendix 4.5 : Results for LNGDP .....	126
Appendix 4.6: Results for D(LNGDP).....	126
Appendix 4.7: Results for LNGE.....	127
Appendix 4.8 : Results for D(LNGE) .....	127
Appendix 4.9 : Results for LNINF.....	128
Appendix 4.10 : Results for D(LNINF) .....	128
Appendix 4.11: Results for LNMS .....	129
Appendix 4.12: Results for D(LNMS).....	129
Appendix 4.13: Results for LNTOB .....	130
Appendix 4.14 : Results for D(LNTOB).....	130
Appendix 4.15 :Results for LNUMP.....	131
Appendix 4.16: Results for D(LNUMP).....	131
Appendix 5.....	132
Vector Autoregressive Estimates for the Period 1 .....	132
Appendix 6.....	134
VAR Residual Portmanteau Tests for Autocorrelations for the Period 1 .....	134
Appendix 7.....	135
Vector Autoregression Estimates for period 2.....	135
Appendix 8.....	136
Vector Autoregression Estimates for Period 3.....	136
Appendix 9.....	137
Vector Autoregression Estimates for period 3.....	137

Table 3.1: List of the variables used for the study.....	13
Table 4.1: Descriptive Statistics of Inflation rate over different periods.....	25
Table 4.2: ANOVA output.....	26
Table 4.3: Descriptive Statistics of GDP of U.S.A over different periods. ....	28
Table 4.4: ANOVA output for GDP .....	29
Table 4.5 : Descriptive Statistics of Trade of Balance of U.S.A over different periods.....	32
Table 4.6: ANOVA Table for TOB .....	32
Table 4.7 : Descriptive Statistics of Exchange Rate of U.S.A over different periods. ....	35
Table 4.8: ANOVA Table for Exchange Rate .....	35
Table 4.9: Money Supply (As of December).....	37
Table 4.10: Descriptive Statistics of Money Supply of U.S.A over different periods. ....	38
Table 4.11: ANOVA Table for Money Supply .....	39
Table 4.12: Descriptive Statistics of Foreign Direct Investment of U.S.A.....	41
Table 4.13: ANOVA Table for Foreign Direct Investment.....	42
Table 4.14: Descriptive Statistics of Government Expenditure of U.S.A .....	44
Table 4.15: ANOVA table for Government Expenditure.....	44
Table 4.16: Descriptive Statistics of Unemployment Rate.....	47
Table 4.17: ANOVA table for unemployment rate .....	47
Table 4.18: Summary of the ranking order of means of variables during four periods.....	48
Table 5.1: Correlation Matrix of the selected 10 economical variables in U.S.A –Period 1 .....	49
Table 5.2: Correlation Matrix of the selected 10 economical variables in U.S.A –Period 2 .....	50
Table 5.3: Correlation Matrix of the selected 10 economical variables in U.S.A –Period 3 .....	50
Table 5.4: Correlation Matrix of the selected 10 economical variables in U.S.A – Period 4 .....	51
Table 5.5: Probability values of Root Test results of Sequence of Level.....	52
Table 5.6: Determine Lag Intervals with VAR Lag order Selection Criteria for 8 Economical Variables in U.S.A (Period 1).....	53

Table 5.7: Johansen Cointegration test for 8 economical variables in U.S.A (Period 1) ..	53
Table 5.8: VEC Model for selected economical variables in U.S.A (Period 1) .....	54
Table 5.9: Properties of the coefficient of the VEC Model 1 .....	56
Table 5.10: Portmanteau Test for Autocorrelation for VEC Model 1 .....	57
Table 5.11: Serial Correlation LM Test for VEC Model 1 .....	58
Table 5.12: Normality Tests VEC Model 1 .....	58
Table 5.13: Granger Causality test.....	60
Table 5.14: Probability Values of Unit Root Test results of Sequence of level for Period 1 .....	62
Table 5.15: Determine Lag Intervals with VAR Lag order selection criteria for 8 economical variables in U.S.A (Period 2) .....	62
Table 5.16: Johansen Co-integration test for 8 economical variables in U.S.A (Period 2)	63
Table 5.17: VEC Model for selected economical variables in U.S.A (Period 2) .....	63
Table 5.17: (Continued) .....	64
Table 5.17 (Continued) .....	65
Table 5.18: Properties of the coefficient of the VEC model 2.....	66
Table 5.19: Portmanteau Test for Autocorrelation for VEC Model 2 .....	67
Table 5.20: Serial Correlation LM Test for VEC Model 2.....	68
Table 5.21: Normality Tests for VEC Model 2 .....	68
Table 5.22: Granger Causality Test for Period 2 .....	70
Table 5.23 : Unit root Test Results of Sequence of level for Period 3 .....	72
Table 5.24 : Determine Lag Intervals with VAR Lag order selection criteria for 8 economical variables in U.S.A (Period 3) .....	73
Table 5.25: Johansen Co-integration test for 8 economical variables in U.S.A (Period 3)	74
Table 5.26 : VEC Model for selected economical variables in U.S.A (Period 3) .....	74
Table 5.26 : (Continued).....	75
Table 5.26: (Continued) .....	76
Table 5.27: Properties of the coefficient of the VEC model 3.....	77
Table 5.28: Portmanteau Test for Autocorrelation for VEC Model 3 .....	78

Table 5.29: Serial Correlation LM Test for VEC Model 3.....	79
Table 5.30: Normality Tests for VEC Model 3 .....	79
Table 5.31: Granger Causality Test for Period 3 .....	81
Table 5.32 Unit Root Test Results of Sequence of level for Period 4 .....	83
Table 5.33: Determine Lag Intervals with VAR Lag order selection criteria for 8 economical variables in U.S.A (Period 4) .....	84
Table 5.34: Johansen Co-integration test for 8 Economical Variables in U.S.A (Period 4) .....	85
Table 5.35: VEC Model for selected economical variables in U.S.A (Period 4).....	85
Table 5.37: Properties of the coefficient of the VEC model 4.....	88
Table 5.38: Portmanteau Test for Autocorrelation for VEC model 4.....	89
Table 5.39: Serial Correlation LM Test VEC model 4.....	89
Table 5.40: Normality Tests for VEC model 4.....	90
Table 5.41: Granger Causality Test for period 4 .....	91
Table 5.42: Summary of Significant Variables (Long Term) during Four Periods.....	93
Table 5.43: Summary of Positively and Negatively Influenced Variables during Four Periods.....	93
Table 5.44: Summary of Significant Variables (Long Term) during Four Periods.....	94

Figure 3.1: Keynesian economy Demand and Supply Curve .....	14
Figure 3.2: Monetarist inflation in the Aggregate Demand (AD) and Aggregate Supply (AS) model.....	19
Figure 3.3: Phillips curve.....	20
Figure 4.1: Inflation rate from 1981 to 2016 according to four time periods.....	24
Figure 4.2: Plot of Mean of Inflation rate .....	26
Figure 4.3: GDP of United States of America for Four Periods.....	27
Figure 4.4: Mean Plot of GDP according to different time periods.....	29
Figure 4.5: Trade of Balance of United States of America for Four Periods .....	31
Figure 4.6: Mean Plot of TOB in U.S.A during different time periods .....	33
Figure 4.7: Exchange Rate of United States of America for Four Periods.....	34
Figure 4.8: Plot of mean of Exchange Rate during Four Periods in U.S.A .....	36
Figure 4.9 : Money Supply of United States of America for Four Periods .....	38
Figure 4.10: Plot of Mean of Money Supply during four periods in U.S.A .....	39
Figure 4.11: Foreign Direct Investment of United States of America for Four Periods.....	40
Figure 4.12: Plot of Mean of Foreign Direct Investment during four periods in U.S.A.....	42
Figure 4.13: Government Expenditure of United States of America for Four Periods .....	43
Figure 4.14: Plot of Mean of Government Expenditure during four periods in U.S.A .....	45
Figure 4.15: Unemployment of United States of America for Four Periods .....	46
Figure 4.16: Plot of Mean of Unemployment Rate during four periods in U.S.A.....	48
Figure 5.1: Inverse Roots of AR Stability of the VEC Model 1 .....	58
Figure 5.2: Impulse Responses Function for Period 1 .....	61
Figure 5.3: Inverse Roots of AR Stability of the VEC model 2 .....	69
Figure 5.4: Impulse Responses Functions for Period 2 .....	71
Figure 5.5: Inverse Roots of AR Stability of the VEC Model 3.....	80
Figure 5.6: Impulse Responses Functions for Period 3 .....	82
Figure 5.7 : Inverser Roots of AR Stability of the VEC model 4.....	90
Figure 5.8: Impulse Responses for periods 4.....	92