ANALYSIS OF THE ASYMMETRIC RELATIONSHIP BETWEEN PUBLIC EXPENDITURE AND TAX REVENUE IN KENYA

BY

WENDY M. NGUYU

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DECLARATION

I declare that this research paper is my original work and has not been presented for award of any degree in any other university or institution of higher learning.

Signature: ……. Date……

Student: Wendy Murugi Nguyu

Registration number: X50/74670/2014

This research paper has been submitted for examination with my approval as the supervisor.

Signature: ……. Date……

Dr. Owen Nyang'oro

School of Economics

University of Nairobi

DEDICATION

This research paper is devoted to my family. To my loving parents Dr. and Ms. Nguyu, whose unwavering encouragement and push for resilience have inspired me to pursue and complete this paper and my sister Barbara, for her prayers and eternal support.

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ABBREVIATIONS

ACF:	Autocorrelation Function
AECM:	Asymmetric Error Correction Model
AIC:	Akaike Information Criterion
ARDL:	Autoregressive Distributed Lag model
BIC:	Bayesian Information Criterion
BPS:	Budget Policy Statement
CBK:	Central Bank of Kenya
CLSE:	Conditional Least Squares Estimator
DF-GLS:	Dickey Fuller Generalized Least Squares
DOLS:	Dynamic Ordinary Least Squares
EAMU:	East African Monetary Union
ECM:	Error Correction Model
ECT:	Error Correction Term
GDP:	Gross Domestic Product
I. I. D	Independent and Identically Distributed random variables
JB:	Jarque-Bera
MTAR:	Momentum Threshold Autoregressive model
OECD:	Organization for Economic Cooperation and Development
PACF:	Partial Autocorrelation Function
PDF:	Probability Density Function
PFM:	Public Finance Management
SIC:	Schwarz Information Criterion
TAR:	Threshold Autoregressive model
VAR:	Vector Autoregressive model
VAT:	Value Added Tax

ABSTRACT

The concern over widening fiscal deficits has generated a host of debates in many countries globally, driven by literature on the topic of tax revenue and public expenditure termed as the revenue-expenditure nexus. In light of recent developments in time series analysis, the revenue-expenditure nexus is examined using an asymmetric approach. Therefore, this study adopts a non-linear framework to analyze the nexus thus departs from applying a standard cointegration model. The TAR and MTAR framework advanced by Enders & Granger (1998) and Enders & Siklos (2001) are employed in analysis. The purpose of the study is to investigate evidence of a causal link, long run equilibrium between the variables and check for existence of nonlinear behavior in the fiscal correction process in Kenya. This study analyses monthly time series secondary data collected from 2001:1 to 2018:8. The threshold cointegration technique is applied to estimate the asymmetric ECM. The empirical outcome supports evidence of nonlinear adjustment using the MTAR framework only. This study observes that adjustment to fiscal imbalances is more rapid when the fiscal position is favorable than when it is deteriorating. In the short run, bilateral causality between public outlays and tax revenue is detected in favor of the fiscal synchronization proposition and in the long run the causal nexus runs from tax revenue to state spending in support of the tax and spend premise. From the findings, the policy implications include; to trim the widening fiscal deficit it is imperative for the state to enhance revenue collection efforts. Secondly, to address asymmetries in adjustment to fiscal disequilibrium, it is crucial for the state to focus on public investments in critical sectors of the economy in the long term.

CHAPTER ONE

INTRODUCTION

1.1 Background

Fiscal policy is a significant policy instrument applied by the government to realize desired economic performance through deliberate decisions by the state on the general levels of public outlays and tax revenue in the country (Musgrave & Musgrave, 1984). The dynamic topic on the revenue-expenditure nexus has been researched and analyzed extensively for decades[1]. From the literature, there are at least two major reasons for this; the surge in expenditure in most nations from the time the second World War ended and persistent fiscal deficits in the government (Cameron, 1978; Dahlberg & Johansson, 1998). According to Cameron (1978) the surge in public expenditure can be attributed to provision of social services, public investments and management of the economy. The growth in fiscal deficits is mostly linked to implementation of expansionary fiscal policies by the state in order to boost economic recovery and rectify temporary fluctuations in aggregate demand during recessions (Keynes, 1936; Phiri, 2019).

The theoretical literature on the relationship reveals four directions for examining the 'revenue-expenditures nexus' (Payne, 2003). The hypotheses include; the tax-spend hypothesis, spend and tax hypothesis, fiscal synchronization hypothesis and institutional separation hypothesis. The first theory was developed by Friedman (1978) and says that tax revenue influences the states spending decisions where higher taxes increase public expenditure without correcting fiscal deficits. Therefore, the author advocates for reduced levels of expenditure because higher levels of tax revenue encourage additional inputs. The second hypothesis was advanced by Barro (1979) with emphasis on first managing expenditure then addressing the levels of tax revenue. From the author's argument, any supplementary expenditure by the public sector results in future tax liabilities. Peacock and Wiseman (1979) also weighed in on the theory using similar thoughts on the spend and tax hypothesis. They found that during times of economic hardship public expenditure would shift to a higher level occasioned by an expansion in taxes. Consequently, when

[1] The studies on the topic include: Ram (1988); Dahlberg & Johansson (1998); Narayan (2005); Ewing et al. (2006); Obioma & Ozughalu (2010); Saunoris & Payne (2010).

expenditure shifted to a higher level it would not revert thus uphold the new normal. This was identified as the displacement effect.

The third and fourth hypotheses indicate that either a mutually dependent or independent relationship exists between public spending and revenue respectively. Meltzer & Richard (1981) introduced the fiscal synchronization concept that states that the voter's choice determines the parallel adjustment in tax revenues and public expenditure. The proposition is in support of Musgrave (1966) who noted that, 'both public spending and tax-revenue must be decided jointly' in an effort to maximize the social welfare function. The institutional separation theory was endorsed by Wildavsky (1988) and Baghestani & McNown (1994). The authors specified that there exists no relationship between the variables because the statutory bodies charged with decisions on raising taxes and public spending are independent.

Recent developments in the analysis of the revenue-expenditure nexus have reignited a controversial debate on the existence of an asymmetric link between public revenue and expenditure and ensuing effects on the fiscal balance, globally [2]. Previous literature on the tax-spending nexus have generally been conducted under the assumption that tax revenue and public expenditure react to a linear fiscal disequilibrium[3]. Assuming, symmetric adjustment of tax revenue and public spending could result to spurious results and inaccurate conclusions regarding the relationship between the variables (Ewing, Payne, Thompson, & Al-Zoubi, 2006).

Ewing et al. (2006) highlights four main arguments on the possibility of nonlinear behavior between public revenue and expenditure. First, there is a tendency for policy makers to respond uniquely to adjustments in the fiscal balance. For instance, they respond more aggressively to fiscal deficits than surpluses. Secondly, the budgetary process and business cycles tend to be closely linked with the associated changes in both variables thus presenting asymmetric behavior. Thirdly, tax payers mostly react to changes in the tax framework which can generate nonlinear variations in the budget. Lastly, in certain circumstances changes in tax revenues are extremely susceptible

[2] The associated literature on nonlinear studies from developed and developing countries include: Ewing et al. (2006); Saunoris & Payne (2010); Apergis, Payne, & Saunoris (2012); Baharumshah, et al. (2016); Tiwari & Mutascu, (2016); Ndoricimpa, (2017); Phiri (2019).

[3] Empirical studies using a symmetric framework include: Bohn (1991); Hoover & Sheffrin (1992); Chang, Liu, & Caudill (2002); Wolde-Rufael (2008); Kiminyei (2018).

to domestic and extraneous factors. For instance, tax revenue on petroleum products in Kenya is vulnerable to the global economic situation such as asymmetric fluctuations in exchange rates and inflation levels (Republic of Kenya, 2019). Bearing in mind above concepts, examining the tax-spending nexus in Kenya using an asymmetric framework is expedient to inform fiscal policy as the state endeavors to attain a sustainable fiscal position.

1.1.1 Trends in Public Expenditure and Tax Revenue in Kenya

Kenya's fiscal policy is guided by the Constitution, short and long-term policies and strategies as prescribed in documents such as national budget, sessional papers, and Vision 2030 – Medium Term Plans (MTP) (Muthui, Kosimbei, Maingi, & Kiguru, 2013). Since independence, the budgetary process in the country has been evaluated to guarantee efficient allocation of state resources to priority programs and realization of fiscal policies (Khainga, Kiriga, Ouma, & Njeru, 2007). For instance, the Budget Policy Statement (BPS) for the fiscal year 2019/2020 is themed 'creating jobs, transforming lives and harnessing the 'big-four' plan'. The state has largely devoted spending to four main sectors[4] that were identified as the critical enablers for economic progress over the medium term (Republic of Kenya, 2019). In accordance with the projected programs, the government has made deliberate efforts to curb tax evasion and boost revenue mobilization through the Finance Act of 2018 and Finance Act of 2019. The documents have reviewed the tax structure and tax procedures in an effort to capitalize on revenue collection for ease of implementation of outlined development programs.

State spending can be categorized as either recurrent or development expenditure. Recurrent outlays comprise of domestic and foreign interest payments, compensation packages for public sector employees such as pensions, wages and salaries, operation and maintenance costs (Economic Survey, various years). Development expenditure mainly consists of public investments such as infrastructure managed by the state. Table 1.1 presents the two main classifications of expenditure as a percentage of total public outlays between 2014/15 and 2018/19. The table shows that the proportion of recurrent expenditure to aggregate state outlays continue to

[4] The four main pillars under the 'Big Four Agenda' include: enhanced manufacturing through value addition, increased food security, provision of quality healthcare for all under the Universal Health Coverage (UHC) and provision of affordable housing by strengthening the existing legal and policy framework in the sector (Republic of Kenya, 2019).

expand over time while the share allocated to development expenditure has declined in the last five fiscal years. On average, the proportion of recurrent expenditure and development expenditure to aggregate public spending is 75 per cent to 25 per cent respectively as a percentage of aggregate public outlays.

Table 1.1: Composition of Public Expenditure in Kenya

Fiscal Year (s)	Recurrent outlays as a (%) of total expenditure	Development outlays a (%) of total expenditure
2014/2015	67.8	32.2
2015/2016	73	27
2016/2017	72.5	27.4
2017/2018	77	23
2018/2019	78	22

Source of data: Compiled from CBK, Statistical Bulletin (various years)

The surge in recurrent expenditure from 2014/15 is mainly attributed to the rising wage bill owing to salary increments for teachers, police officers and public sector employees under the devolved system of governance (KIPPRA, 2016). Consequently, the spending allocated for public investments has reduced to below thirty per cent of aggregate state outlays. The present decline ceases to conform to the conditions set out under the PFM act that recommend the state's allocation for development expenditure should be above 30 per cent of total public outlays. Therefore, the government’s fiscal consolidation framework for 2019/2020 presents measures for rationalization of recurrent spending while guarding against decreasing development expenditure (Republic of Kenya, 2019).

Table 1.2 provides a comparative analysis of the composition of public revenue in Kenya. Tax revenue consists of taxes from foreign economic activities and businesses (import duty), income tax, taxes from manufactured goods (excise duty), VAT and other tax revenues (CBK, 2019). Non-tax revenue is collected by the state from sources other than tax for instance, grants, income from public property, fines, penalties and forfeits, and through provision of public services (OECD, 2018). The table indicates that total tax revenue has gone down from 92.2 per cent to 87.6 per cent between 2014/15 and 2018/19 respectively. Meanwhile, non-tax revenue has increased from 7.8 to 12.4 per cent respectively for the same period.

Table 1.2: Composition of Public Revenue in Kenya

Composition of taxes (as a percentage of total revenue)							
Fiscal Year	**Import duty**	**Excise duty**	**Income tax**	**VAT**	**Other tax revenue**	**Total tax revenue**	**Non tax revenue[5]**
2014/15	6.8	10.7	47.0	24.0	3.6	92.2	7.8
2015/16	6.5	11.4	46.2	23.7	3.2	91.0	9.0
2016/17	6.4	11.8	44.7	24.3	2.4	89.7	10.3
2017/18	6.7	10.9	43.1	24.0	3.5	88.2	11.8
2018/19	6.5	12.0	41.7	25.1	2.3	87.6	12.4

Source of data: Compiled from CBK, Statistical Bulletin (various years)

Income tax constitutes the largest share of public revenue at an average of 44.5 per cent as a ratio of total public revenue. Yet, income tax has recorded the highest decline owing to depressed performance in corporation tax and PAYE (Pay As You Earn) over time (Republic of Kenya, 2019). This is linked to increased job cuts in the formal sector and reduced profits for corporates. However, import duty, excise duty, VAT and other tax revenue have remained fairly stagnant for the last five years. Consequently, Kenya's public spending has increased gradually over the years accompanied by unmatched growth in tax revenue (Economic Survey, various years). Therefore, this has generated disparities in the state budget hence led to unstable fiscal balances (deficits) over the years.

Figure 1.1 illustrates the trend of tax revenue and public outlays from 1980 to 2018. The growth in public outlays has generally been in response to major disturbances in the economy or the need for the government to mitigate financial crisis or natural disasters (Economic Survey, various years). In some instances, the higher level of public spending is attributed specifically to increased state activities. For instance, years that coincided with general elections such as: 1987, 1992, 1997, 2002, 2007, 2013 and 2017 and the launch of economic policies such as the Economic Recovery Strategy (ERS) from 2003 to 2007 (Economic Survey, various years). However, the growth in public expenditure has not been accompanied by higher levels of tax revenue. Despite this, the government has made concerted efforts to improve domestic revenue mobilization, though the annual revenue collection targets have not been realized (Republic of Kenya, 2019). Consequently, the country's fiscal balance (deficit) has widened thus limiting the country's fiscal space.

[5] Non- tax revenue is reported as a share of overall state revenue in the table.

Figure 1.1: Trend of total public expenditure and tax revenue as a percentage of real GDP

Source of data: Compiled from Economic Survey (various years)

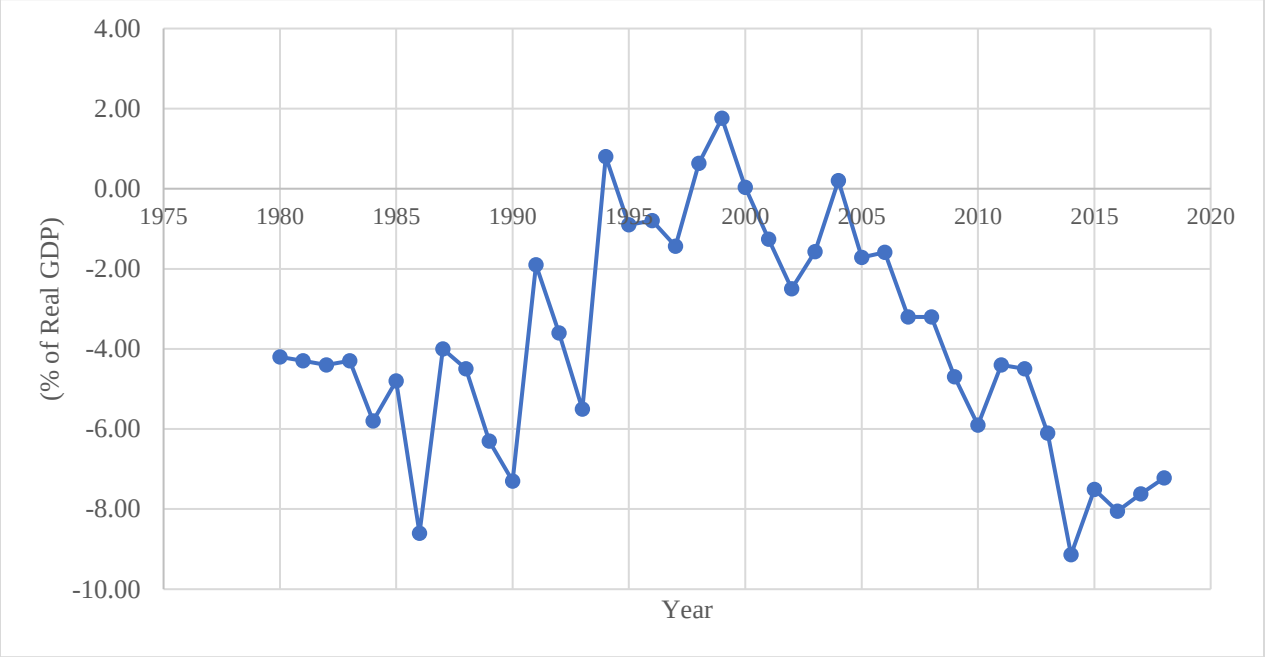
1.1.2 Trends in Kenya's Fiscal Balance

Recent policies by the state contained in the BPS (2019) specify the country's commitment to maintain a steady reduction in the fiscal deficit to 3.1 percent of real GDP by 2022/23 (Republic of Kenya, 2019). The deliberate fiscal framework by the government is also aligned to EAMU's intended threshold of 3.0 per cent fiscal deficit as a ratio of GDP. This is tailored to the needs of the country to guarantee a sustainable fiscal position (Republic of Kenya, 2019). Figure 1.2 reveals that the country has endured fluctuating fiscal balances at an average of fiscal balance (deficit) to real GDP of 4.4 per cent over the last four decades.

The fluctuations in the fiscal deficit can be linked to elevated levels of state outlays each time Kenya has endured shocks which sometimes called for state intervention. For instance, internal shocks such as 1984 drought and famine, the political strife that ensued after the 2007/2008 elections and the 2017 repeat election after the initial general elections were annulled by the supreme court of Kenya. (Republic of Kenya, various years). Instances of external shocks include; the Gulf crisis of 1990/91 which triggered a surge in oil prices and exchange rate instability, and the global financial crisis of 2007/08 that resulted in high costs of oil prices and food (Republic of Kenya, various years). Therefore, the shocks have had adverse effects on the levels of public

expenditure and revenue and resulted in elevated levels in the fiscal deficit (Economic Survey, various years).

Figure 1.2: Trend of fiscal balance as a percentage of real GDP



Source of data: Compiled from Economic Survey (various years)

1.2 Statement of the Problem

The country's fiscal balance has been varying owing to disproportionate growth in public expenditure relative to tax revenue. Available statistics on the fiscal balance over GDP indicate persistent deficits for several years. Analysis of the trend of fiscal deficit to real GDP for the last five years displayed relatively elevated levels of between 7 per cent and 9 per cent. For instance, for the fiscal years 2016/17 and 2017/18 the fiscal deficit was 9.1 and 7.2 per cent of real GDP respectively against a target of 3.1 per cent of real GDP for the medium term (Republic of Kenya, 2019). Fiscal deficits in a country indicate that tax revenue collections are not at par with public expenditure (Phiri, 2009). This corresponds to the scenario in Kenya where the government's fiscal consolidation plan has been pegged on higher domestic revenue collection which has yet to materialize in the country (Republic of Kenya, 2019).

The existing empirical literature on the revenue-expenditure nexus in Kenya has been conducted under the assumption that the variables demonstrate linear behavior in response to adjustments in the budget process (Wolde-Rufael, 2008; Ghartey, 2010; Kiminyei, 2018). The findings from the

studies present conflicting results using different linear cointegration techniques[6]. For instance, Yemane (2008) and Ghartey (2010) found evidence of one-way causality between the variables in favor of the tax and spend proposition. However, Kiminyei's (2018) findings contradict the tax-spend hypothesis and note that public outlays granger cause tax revenue in line with the spend and tax theory. Hence, the state begins by formulating spending decisions then pays for public outlays later by raising taxes. Consequently, premised on the inconsistent results it was expedient to re-examine the revenue-expenditure nexus in Kenya.

Significant developments in modern time series literary works support analysis of asymmetric relationships and nonlinear correction mechanisms between economic variables (Chan, 1993; Enders & Granger, 1998; Enders & Siklos, 2001). Assuming symmetric adjustment between economic variables in analysis when in fact it is asymmetric could result in misspecification in analysis and inappropriate policy prescriptions (Enders & Granger, 1998). This study addresses this by re-examining the tax-spend nexus in Kenya against a background of an asymmetric adjustment approach thus departs from estimating a linear framework. Similarly, limited evidence[7] exists on the non-linear link between state outlays and tax revenue. Therefore, this study complements existing empirical literature by examining existence of asymmetric adjustment between the respective variables in response to imbalances in the budget and contributes to the fiscal policy debate albeit intellectually.

1.3 Research Questions

i. What is the relationship between public expenditure and tax revenue in Kenya?
ii. Do asymmetries exist in the budgetary adjustment process in Kenya?

1.4 Research Objectives

The general objective of this study is to analyze the relationship between tax revenue and public expenditure in Kenya. The specific objectives of this study are:

[6] Wolde-Rufael (2008) and Ghartey (2010) conducted a cross country analysis using the VAR model and ARDL methodology respectively. Whereas, Kiminyei (2018) undertook a country specific analysis and applied the Johansen and Juselius cointegration technique.

[7] The statement is made to the best knowledge of the author.

i. To establish the direction of causality between tax revenue and public expenditure in Kenya using a non-linear framework.
ii. To examine the existence of asymmetries in the budgetary adjustment process in Kenya.
iii. To derive policy implications based on (i) and (ii) and give appropriate recommendations.

1.5 Justification of the Study

This study focuses on the revenue-expenditure nexus in Kenya thus contributes to empirical literary works in various ways. First, by re-examining the relationship based on a non-linear framework. In analysing an asymmetric link between the two variables, this study addresses an existing gap in empirical literature in view of differing results by previous studies on the topic by various authors (Wolde-Rufael, 2008; Ghartey, 2010; Kiminyei, 2018). A plausible explanation for the contradictions in the empirical results is the use of linear econometric frameworks in the studies. According to Enders & Granger (1998) numerous significant economic variables display asymmetric adjustment paths. Therefore, testing for relationships using linear cointegration procedures could produce spurious results and incorrect policy prescriptions. Secondly, this study seeks to establish whether tax revenue and public expenditure variables react to changes in the budgetary process owing to asymmetric adjustments when the fiscal position either improves or worsens. Consequently, the outcome of this study endeavors to provide appropriate evidence for policy makers on whether the government should adopt austerity measures or increase tax revenue to reduce the fiscal deficit, or a combination of both actions.

1.6 Organization of the Study

The subsequent sections are arranged in four chapters. Chapter two presents the literature that is; theoretical and empirical. Chapter three is centered on; the conceptual framework, econometric model, model specification and diagnostic tests. The fourth chapter reports the outcome of empirical analysis. The fifth chapter presents the summary, conclusions and policy implications.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, both theoretical and empirical literature are reviewed. From the theoretical literature, different propositions have been put forward to describe the revenue-expenditure nexus. The specific hypotheses are; tax and spend, expenditure dominance, fiscal synchronization and institutional separation (Buchanan & Wagner, 1977; Friedman, 1978; Barro, 1979; Peacock & Wiseman, 1979; Meltzer & Richard, 1981; Baghestani & McNown, 1994). The first three theories indicate interdependence of the variables. While, the fourth theory points toward an autonomous link between public outlays and tax revenue. The final section provides a brief account of the literary works.

2.2 Theoretical Literature Review

2.2.1 Tax and Spend Hypothesis

Friedman (1978) noted that a decline in tax revenue lowered public expenditure and ultimately reduced the fiscal deficit. On the flip side, a growth in tax revenue was often accompanied by a surge in public outlays followed by unstable fiscal balances. Correspondingly, Buchanan & Wagner (1977) found that a cut in taxes could trigger a fiscal illusion where the citizens assumed that spending on government ventures had diminished. In response, the public would compel the state to boost spending which if implemented would spur higher expenditure and ensuing fiscal imbalances. Therefore, the authors advocated for indirect taxation as a suitable means of funding expenditure in this case, since the tax payers would perceive the system as cheaper compared to other measures. Thus, the antidote for budget deficits by the state was indirect taxes even though the approach tended to outweigh any benefits and resulted in higher interest rates and inflation, and also suppressed private sector spending. The causal nexus ran from tax revenue to state outlays where, Buchanan & Wagner (1977) observed an adverse relation while Friedman (1978) discovered a favorable outcome.

2.2.2 Spend and Tax Hypothesis

The theory also known as the expenditure dominance proposition was developed by Barro (1979). He noted that policies on expenditure were undertaken by the state and thereafter adjustments on tax revenue would be effected to cater for any supplementary expenditure. Against the framework

of the Ricardian equivalence premise, Barro (1979) pointed out that the presence of any debt today is repaid by a higher tax in the future. Therefore, fiscal deficit reduction was mainly achieved through reduced expenditure. The authors' view is consistent with Ricardo's (1951) assumption that indicates the state faces a similar budget constraint as consumers where the government cannot run on a budget deficit forever since public spending should equal revenue. Peacock and Wiseman (1979) provided an alternate interpretation of the thesis dubbed the displacement effect. The authors observed that during the course of a crisis the government raises the level of spending temporarily as a form of a fiscal stimulus package (Phiri, 2019). However, the short-term growth in state outlays results in a permanent growth in tax revenue over the long haul.

2.2.3 Fiscal Synchronization Hypothesis

Musgrave (1966) and Meltzer & Richard (1981) observed that the electorate appraised state programs based on the marginal benefits versus marginal costs when determining optimum levels of returns and public outlays. Therefore, under this condition, the appropriate solutions for the fiscal deficit required either increasing revenue which would affect spending decisions or altered levels of expenditure that would affect revenue decisions. The authors advocated that revenues and expenditures should be decided simultaneously. By effect, the causal relation between public expenditure and revenue is two-way.

2.2.4 Institutional Separation Hypothesis

The institutional separation premise is also referred to as the fiscal neutrality hypothesis. The theory suggests an independent relationship between the variables. According to Wildavsky, (1988) and Baghestani & McNown, (1994) the theory holds in a federal system where decisions regarding tax revenue and public expenditure are made by separate institutions tasked with the responsibility of raising and spending taxes. Thus, a surge in public outlays is not related to variations in tax revenue. However, Payne (2003) found that in a couple of systems the phenomenon is linked to political reasons such as lack of loyalty within the public sector that breeds a lack of accountability for state operations.

2.3 Empirical Literature Review

Empirical research on the topic sought to ascertain whether the findings from either a single economy or a group of nations are listed in favor of the highlighted theoretical hypotheses. For ease of review, the empirical literature is categorized into two main themes they are; analysis using

either linear cointegration models or asymmetric frameworks. The first theme looks at initial empirical studies from developed and developing nations using symmetric frameworks for analysis. The empirical review is further broken down into three key categories of literature. The first cluster presents seminal works conducted on the US economy that reveal a unilateral causal nexus from state revenue to public outlays using linear frameworks. For example, Ram (1988) applied the Granger causality technique on yearly time series data from 1929 to 1983. The findings confirmed support for the expenditure dominance theory in USA. Bohn (1991) used an Unrestricted Distibutive Lag model (UDL) to analyze data from 1954 to 1979 whereas, Hoover & Sheffrin (1992) used an Error Correction Model (ECM) to examine data from 1972 to 1988 with similar findings as Ram (1988).

The second cluster of empirical studies on the topic provide cross country analysis from advanced and emerging nations using different linear frameworks. Kollias & Makrydakis (2000) studied four advanced nations between 1960 and 1995 using an ECM framework. From the findings, Portugal revealed evidence of a one sided causal nexus from spending to revenue while, Spain displayed a causal relation that ran from tax revenue to state outlays. Greece and Ireland showed presence of two-way causality between the variables. Chang, Liu, & Caudill (2002), analysed annual time series data for 10 developed and developing countries using an ECM framework for the period between 1951 and 1996. The results of the study reveal that in USA, Taiwan, UK, Tunisia and South Korea the causal nexus ran from tax revenue to state expenses. Whereas, in Australia and South Africa the causal relation was from public outlays to revenue. For the case of Canada, there was evidence of two-way causality in the variables however, there was no presence of a causal link in New Zealand and Thailand. Narayan (2005) explored the revenue-expenditure nexus for nine Asian countries using yearly time series data from 1960 to 2000. The author applied a conditional ECM for analysis and confirmed evidence of an autonomous link between the variables in India, Malaysia, Pakistan, Thailand and Phillipines. However, one way causality was present and ran from tax revenue to public outlays in Indonesia, Nepal, Singapore and Srilanka.

Existing literature on the subject across the developing world provides compelling evidence in support of different theoretical hypotheses for respective countries. A cross country analysis by Wolde-Rufael (2008) used a multivariate framework to analyse yearly time series data between

1964 and 2003 for 13 African countries[8]. From the findings, a two-way causal nexus between the variables was confirmed for Zimbabwe, Mauritius and Swaziland. For Botswana, Burundi and Rwanda there was no proof of a causal link in the variables. In the case of Ethiopia, Nigeria, Mali, Ghana, Kenya, and Zambia, one-way causality was evident from tax revenue to state outlays while in Burkina Faso the causal link ran from state outlays to revenue. Ghartey (2010) investigated presence of a causal relationship in the two variables between 1960 and 2007 using yearly time series data for three African states. The author applied an ARDL model for analysis. The findings revealed one-sided causality from tax revenue to state outlays for Kenya. However, in Nigeria and South Africa bidirectional causality was established in the variables.

The third cluster of studies explored the tax and spend nexus in specific countries thus provided a more inclusive approach to the revenue expenditure debate. For instance, Obioma & Ozughalu (2010) studied the topic in Nigeria from 1970 to 2007 using annual time series data. The authors utilized three standard ECM frameworks for analysis namely, Granger causality, the Engel-Granger technique and cointegration methodology by Johansen. From the results, a one way causal link from public revenue to expenditure was established. The findings contradicts Ghartey's (2010) study that established presence of bidirectional causality in Nigeria. A similar scenario was noted for Kenya by Kiminyei (2018) who examined the revenue-expenditure nexus between 1960 and 2011. The author applied the Johansen and Juselius cointegration technique on annual time series data. The findings confirmed one-way causality from public expenditure to tax revenue thus, differed from the results by Wolde-Rufael (2008) and Ghartey (2010).

The second theme examines evidence of non-linear relationships between public revenue and expenditure using an econometric model (that is; TAR and M-TAR) proceeded by the estimation of asymmetric error correction models. The main rationale behind these group of studies is current developments in time series literature that suggest that the budgetary process undergoes some form of non-linear adjustment depending on whether the economy is above or below some threshold (Chan, 1993; Enders & Granger, 1998; Enders & Siklos, 2001). The econometric framework contradicts the standard cointegration theorems that are anchored on the assumption that relationships are linear and react to changes in disequilibrium symmetrically (Enders & Siklos,

[8] The countries include: Burkina Faso, Ethiopia, Ghana, Kenya, Nigeria, Mali, Zambia, Mauritius, Swaziland, Zimbabwe, Botswana, Burundi and Rwanda.

2001). For instance, using Dynamic Ordinary Least Squares (DOLS) estimation procedure, Engle & Granger (1987) advanced a two-stage approach to check for stationarity on the residual series. The model assumed that linear adjustments occur transiently at each period which can result in misspecification in the analysis if there is evidence of constant costs in adjustments (Bulke & Fomby, 1997). Recent advancements have since been adopted for analysing asymmetries in economic variables (Sun, 2015). Granger & Lee (1989) were the first to extend model specification to include asymmetric adjustments where, the ECT and first differences of the parameters are decomposed into positive and negative factors. According to the authors study, this permited for a more comprehensive analysis of the behaviour of prices in response to non-linear effects owing to positive and negative variations in prices. This was followed by development of threshold cointegration by Enders & Granger (1998) and Enders & Siklos (2001) that applied a two-regime system with nonlinear modification for analysis.

Based on above evidence, several empirical works are anchored on the premise that non-linear cointegration exists in the tax and spend nexus. The studies are categorized into two approaches for easier review. The first approach lists empirical works on the topic that established asymmetric cointegration between the variables. Ewing, et al. (2006) analysed quartely data for the period between 1958 and 2003 in USA. Employing the TAR and M-TAR framework, the authors found presence of non linear cointegration where the budgetary system reacted to a deteriorating fiscal position but not to a favourable one. Public revenue and expenditure indicated no causal link through the short term. However, two way causality was established over the long term. Using quarterly data for UK from 1955 to 2009, Saunoris & Payne (2010) confirmed existence of asymmetric cointegration between the variables. From the findings, one way causality ran from state outlays to tax revenue in the long run.

Modelling the fiscal deficit in Romania between 1999 and 2012 as a TAR and M-TAR process, Tiwari & Mutascu (2016) established asymmetric cointegration using quarterly time series data. Evidence of fiscal adjustments in the budgetary process revealed fiscal balances respond to declining budgets compared to one that is improving. A one way causal nexus was found from public expenditure to revenue. Ndoricimpa (2017) found evidence of asymmetric adjustment in Burundi where, spending responded to imbalances in the budgetary process only if the fiscal position was declining. The author applied the TAR and MTAR model to analyse high frequency

data (monthly data) for the period between 1997 and 2013. The variables used in analysis were external grants, government expenditure and revenue. The evaluation of external grants in the paper was supported by the fact that grants account for atleast 36.4 per cent of total revenue in the state. However, the results revealed that tax revenue and public expenditure did not affect grants thus, grants were independent of fiscal behaviour in Burundi.

Several studies have examined the tax and spend nexus by accounting for structural breaks in the economy such as changes in national policies that result in fluctuations in tax revenue and expenditure levels in the country (Gregory & Hansen, 1996). For instance, in Greece, yearly time series data was analyzed from 1957 to 2019 by Apergis, et al. (2012). The author confirmed evidence of non-linear threshold cointegration between tax revenue and public expenditure in the long term[9] and unidirectional causality from public revenue to expenditure was identified over the short term while, in the long haul the causal nexus ran from revenue to public spending. A cross country study by Paleologou (2013) for the period between 1965 and 2009 in Greece obtained similar results with structural breaks in analysis.

Phiri (2019) analyzed the revenue-expenditure nexus in South Africa from 1960 to 2016. The author employed the M-TAR model to examine quarterly time series data with structural breaks for three regime changes. The outcome of the study established two-way causality between tax revenue and public outlays thus, indicating a weakly sustainable budget. The author found that the MTAR model was statistically significant with evidence of asymmetric cointegration thus major corrections to the fiscal framework occured when the fiscal position was improving instead of when it was declining. Baharumshah et al. (2016) also used endogenous breaks in analysis though the paper differed to some extent from the study by Phiri (2019) based on the modelling approach. This is mainly because the authors applied an asymmetric framework (TAR and M-TAR) for analysis but reverted to a linear ECM model when they found no evidence of asymmetric cointegration.

The second approach considers empirical studies that detected no evidence of asymmetric cointegration between tax revenue and spending using non-linear models. Paleologou (2013)

[9] The results on asymmetric cointegration indicate that government revenue responds to an improving budget however, government expenditure responds to a deteriorating budget than a recovering one.

applied a non linear framework using the TAR and MTAR model with structural breaks for three EU countries namely; Sweden, Greece and Germany for the period between 1965 and 2009. However, evidence of symmetric cointegration was observed in Germany and Sweden. The presence of two-way causality was established between the variables for the two nations. Similar findings of symmetric adjustment between the variables were observed in South Africa by Baharumshah et al. (2016) using yearly time series data between 1960 and 2013. Payne et al. (2008) studied the phenomenon in Turkey data from 1968 to 2004. Using the econometric model, the findings found no evidence of asymmetric cointegration between public outlays and tax revenue using yearly time series. The results of causality showed presence of a one way causal nexus that ran from tax revenue to public spending.

2.4 Overview of the Literature

The revenue-expenditure nexus has been explained using four theoretical approaches that illustrate how the two variables relate to each other. Buchanan & Wagner (1977) note that the causal nexus from revenue to spending is negative however, the proposition by Friedman (1978) infers positive causality. The expenditure dominance theory is characterized by a favorable causal relationship from spending to revenue (Barro, 1979; Peacock & Wiseman, 1979). The fiscal synchronization premise reinforced by Meltzer & Richard (1981) is represented by a two-way causal link between the two variables. Finally, the absence of a causal nexus in the variables is upheld by the fiscal neutrality proposition (Wildavsky, 1988; Baghestani & McNown, 1994).

Studies on the topic reveal contradictory results for different countries hence, this creates a solid basis for re-examining the revenue-expenditure nexus. Payne (2003) attributes the disparities in findings to varying modelling methods, time periods analyzed, degree of temporal aggregation and specification of frameworks. For instance, previous studies in Kenya have examined the topic using different symmetric cointegration models with conflicting results (Yemane, 2008; Ghartey, 2010; Kiminyei, 2018). The absence of a consensus in the literature is also linked to use of yearly data which does not effectively demonstrate long run and short run dynamic effects (Phiri, 2019). For instance, Baharumshah et al. (2016) study transformed annual time series data to natural logs thus, lessened the likelihoood of understanding significant non-linear effects in the framework. According to Phiri (2019) inorder to capture the effects of asymmetric budgetary adjustment the use of high frequency data is the more viable option in analysis.

This study sought to address two main gaps identified in the literature. First, limited evidence exists on the tax-spending nexus in Kenya. Therefore, this study re-examines the revenue expenditure nexus using a nonlinear framework with high frequency data (monthly time series data). Secondly, the study investigates whether the behavior in the variables is altered by budgetary disequilibrium in Kenya. Specifically, whether the variables respond to the correction mechanisms and if the response is limited to a declining budget position or a favorable one. Consequently, the study sought to provide evidence to researchers and inform fiscal policy on whether to increase taxes or reduce expenditure or a blend of both measures to trim the fiscal deficit.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the conceptual framework, econometric and empirical model specification, definition of variables, diagnostic tests and sources of data.

3.2 Conceptual Framework

The theoretical literature on the topic presents four approaches that describe the revenue-expenditure nexus (Payne, 2003). The tax and spend theory states that tax revenue influences the government's public expenditure decisions hence, causality runs from tax revenue to expenditure (Buchanan and Wagner, 1977; Friedman, 1978). The expenditure dominance proposition developed by Barro (1979) finds that governments typically spend first then proceed to tax later. Hence, the causal link runs from public outlays to tax revenue. The fiscal synchronization hypothesis states that to attain optimal levels of spending and tax revenue, decisions on public expenditure and tax revenue should be made simultaneously thus the causal nexus is two-way (Musgrave, 1966; Meltzer and Richard, 1981). The fourth theory postulates that the link between the variables is autonomous consequently there is no causal link between the variables (Wildavsky, 1988; Baghestani & McNown, 1994). The relationships can be modelled in functional form as:

$$\text{TR} \rightarrow \text{PE} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (1)$$

$$\text{PE} \rightarrow \text{TR} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. (2)$$

$$\text{TR} \leftrightarrow \text{PE} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. (3)$$

$$\text{TR} \neq \text{PE} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. (4)$$

Where, TR represents tax revenue and PE denotes public expenditure.

Equation (1) indicates that tax revenue granger causes public expenditure while equation (2) shows that public expenditure granger causes tax revenue. Equation (3) specifies a two-way causal nexus between tax revenue and public expenditure whereas, equation (4) indicates no relationship between both variables. The equations are anchored on the theoretical hypotheses and provide the conceptual framework for the study.

3.3 Econometric Model

The standard cointegration frameworks were built on the premise that economic relationships are symmetric and display linear adjustment patterns (Enders & Siklos, 2001). For instance, Engle & Granger's (1987) cointegration framework used a residual based technique that entailed testing for stationarity in the residual series. The DOLS model by Stock & Watson (1993) was applied to estimate the long run equation specified as:

$$\mathrm{TR_t} = \propto + \lambda \mathrm{PE_t} + \mu_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (5)$$

Where $\propto$ and λ are cointegrating parameters with μ_t residuals that represent the fiscal imbalance between $\mathrm{TR_t}$ and $\mathrm{PE_t}$. The linear cointegration equation is built on the augumented Dickey-Fuller test and specified as follows:

$$\Delta\gamma_t = \rho\gamma_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta\gamma_{t-i} + \mu_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (6)$$

Where $\mu_t \sim \mathrm{I.I.D}\ (0, \sigma^2)$, the lagged variables of $\Delta\gamma$ inhibit correlated residuals where (k) sum of lags are selected to avoid autocorrelation.

While using the Engle-Granger technique, the null hypothesis is anchored on the assumption that ρ = 0 however, the alternate hypothesis subtly assumes imbalances in the budget process are corrected symmetrically. In addition, the ECM assumes that any temporary changes in revenues and expenditure are due to a fiscal disequilibrium which is strictly linear (Ewing et al., 2006). If however, tax revenue and public expenditure display asymmetric behaviour to fiscal disequilibrium the application of a linear adjustment process and corresponding ECM leads to a misspecification. Therefore this study employs the TAR and M-TAR frameworks by Enders & Granger (1998) and Enders & Siklos (2001) to test for cointegration while accounting for existence of asymmetric adjustment in the fiscal system. The model utilizes a generalized Dickey Fuller as follows:

$$\Delta\varepsilon_t = \varphi_1 I_t \varepsilon_{t-1} + \varphi_2 (1 - I_t)\varepsilon_{t-1} + \sum_{j=1}^{k} \alpha_i \Delta\varepsilon_{t-1} + \omega_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots (7)$$

Where $\omega_t \sim \mathrm{I.I.D}\ (0, \delta^2)$ and ε_t lagged values should not generate correlated residuals.

I_t is the Heaviside indicator function denoted as:

$$I_t = \begin{cases} 1 & if \quad \varepsilon_{t-1} \geq \lambda \\ 0 & if \quad \varepsilon_{t-1} < \lambda \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$I_t = \begin{cases} 1 & if \quad \Delta\varepsilon_{t-1} \geq \lambda \\ 0 & if \quad \Delta\varepsilon_{t-1} < \lambda \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where (λ) presents the threshold parameter. The value is determined endogenously as advanced by Chan's (1993) framework that specifies a consistent estimate of the parameter. The author developed a technique that ranks the values of (ε_t) and $(\Delta\varepsilon_t)$ for the TAR and MTAR model respectively. The approach ranks the values upwards while the minimum and maximum 15 per cent are eliminated. The other values that is; 70 per cent, provide the consistent estimate of the threshold derived from the consistent least square estimator (CLSE). Therefore, the threshold value is determined from the middle 70 per cent values of the variables denoted as (ε_{t-1}) and $(\Delta\varepsilon_{t-1})$ for TAR and MTAR framework respectively.

Equations (7) and (8) denote the TAR model where, equation (8) is hinged on the fiscal disequilibirum in the prior period (ε_{t-1}). Hence, the TAR framework captures the response to disequilibrium in the fiscal system as either positive or negative movements from the threshold. Inorder to conclude the budgetary process is in a positive stage, the former imbalance (ε_{t-1}) is above the threshold in this case the adjustment is $\varphi_1\varepsilon_{t-1}$. However, if the budgetary disequilibrium is in a negative phase the adjustment is $\varphi_2\varepsilon_{t-1}$. Thus, the model is applied to understand imbalances in the fiscal process owing to positive and negative diversions from the threshold. The hypothesis is tested as follows:

H_0: $\varphi 1 = \varphi_2 = 0$ (This means there is no presence of threshold cointegration)

H_1: $\varphi_1 = \varphi_2$ (This means there is presence of threshold cointegration)

If the null hypothesis is rejected, evidence of threshold cointegration is established subsequently, the study checks for non linear correction mechanisms towards long term balance in the model.

Equation (7) and (9) represent the M-TAR model where deviations in adjustment are linked to the former period's variation in $(\Delta\varepsilon_{t-1})$. Thus, the indicator variable in equation (9) is anchored on the

earlier phase's fiscal disequilibrium. Hence, the model is necessary for checking if the budgetary correction mechanisms display more momentum to one path than another. The M-TAR model demonstrates the behavior of both variables to different stages of fiscal adjustments. The hypothesis is tested as follows:

H_0: $\varphi_1 = \varphi_2 = 0$ (This means the correction mechanism is symmetric in the long run)

H_1: $\varphi_1 = \varphi_2$ (This means the correction mechanism process is asymmetric in the long run)

The null hypothesis is rejected when asymmetric adjustment is established. The alternate hypothesis indicates that either $\varphi_1 \; or \; \varphi_2$ is higher than zero using the F critical values denoted as Φ for the TAR model and Φ^* for the MTAR model by Enders & Siklos (2001). Therefore, both hypotheses are tested against the normal F-test statistic. The results of the two sets of hypotheses present the main results of non-linear alterations within the context of cointegration (Sun, 2015). The TAR and M-TAR framework are ideal for this study because the models test for non-linear cointegration and asymmetric causality using a non linear error correction modelling approach for empirical analysis. Once existence of non-linear adjustment is detected, the next step of this study involves estimating an asymmetric ECM. However, if there is no evidence of asymmetric adjustment the study estimates a standard ECM.

3.4 Empirical Model Specification

3.4.1 Estimation of Asymmetric Error Correction Model

This study departs from the standard methods of testing for symmetric adjustment using linear cointegration techniques by applying the threshold cointegration method for empirical analysis. As stated earlier in the study, the conventional cointegration approaches are primarily anchored on Engle & Granger (1987) econometric theorem. The underlying assumption of the approach is that fiscal imbalances between variables are corrected symmetrically. This can result in spurious results if the adjustment is asymmetric. Inorder to cater for nonlinear modification between public expenditure and tax revenue in the analysis, the econometric framwework by Enders & Granger (1998) and Enders & Siklos (2001) is employed in the study. Therefore, to establish threshold cointegration between public expenditure and tax revenue, this study principally borrows from the empirical model by Ndoricimpa (2017). The model specification in operational form is as follows:

$$\Delta PE_t = c_{PE} + \sum_{i=1}^{k} \acute{\alpha}_i \, \Delta TR_{t-i} + \sum_{i=1}^{k} \hat{z}_i \, \Delta PE_{t-i} + I_t \acute{p}_1 \gamma_{t-1} + (1 - I_t) \acute{p}_2 \gamma_{t-1} + \omega_{1t} \dots \dots \dots (10)$$

$$\Delta TR_t = c_{TR} + \sum_{i=1}^{k} \alpha_i \, \Delta TR_{t-i} + \sum_{i=1}^{k} z_i \, \Delta PE_{t-i} + I_t \rho_1 \gamma_{t-1} + (1 - I_t) \rho_2 \gamma_{t-1} + \omega_{2t} \dots \dots \dots (11)$$

Where, c is the constant, PE = Public Expenditure and TR = Tax Revenue, $\omega_{1,2t} \sim I.I.D\ (0, \sigma^2)$ and $\gamma_{t-1} = TR_{t-1} - \acute{\alpha} - \hat{z}PE_{t-1}$. The limits on the lagged differences for tax revenue and public expenditure represent short-term changes while the constants on the lagged non linear ECT denote the correction mechanisms to long term equilibrium.

If evidence of threshold cointegration is confirmed from equation (10) and (11), the error correction terms are modified further to estimate the AECM framework using the nonlinear threshold cointegration method by Sun (2015). The asymmetric ECM equation is modified as follows:

$$\Delta PE_t = c_{PE} + \sum_{i=1}^{k} \acute{\alpha}_i \, \Delta TR_{t-i} + \sum_{i=1}^{k} \hat{z}_i \, \Delta PE_{t-i} + I_t \acute{p}_1 \gamma_{t-1} + (1 - I_t) \acute{p}_2 \gamma_{t-1} + \sigma_{PE}^{+} e_{t-1}^{+} + \sigma_{PE}^{-} e_{t-1}^{-} + \omega_{1t} \dots \dots \dots \dots \dots \dots (12)$$

$$\Delta TR_t = c_{TR} + \sum_{i=1}^{k} \alpha_i \, \Delta TR_{t-i} + \sum_{i=1}^{k} z_i \, \Delta PE_{t-i} + I_t \rho_1 \gamma_{t-1} + (1 - I_t) \rho_2 \gamma_{t-1} + \sigma_{TR}^{+} e_{t-1}^{+} + \sigma_{TR}^{-} e_{t-1}^{-} + \omega_{2t} \dots \dots \dots \dots \dots \dots . (13)$$

Where, c is the constant, PE is public expenditure and TR is Tax Revenue, $\omega_{1,2t} \sim I.I.D\ (0, \sigma^2)$ and $(\sigma^{+} e_{t-1}^{+}), (\sigma^{-} e_{t-1}^{-})$ represent the error correction terms. From equation (12) and (13), σ^{+} and σ^{-} demonstrate how public expenditure and tax revenue asymmetrically react to positive and negative shifts from long run equilibrium. Specifically, σ^{+} denotes how public outlays and tax revenue respond to a budget position that is improving while, σ^{-} illustrates how public expenditure and tax revenue react to a declining budget position.

3.4.2 Test for Granger Causality

The Granger causality methodology measures precedence and data content; not cause and effect. The regression analysis checks for the dependence of one variable to another variable, however,

this does not necessarily infer causation. The rationale behind the test is that time moves forward not backwards (Granger, 1969). Therefore, if an event Y occurs before event Z, then there is a chance Y causes Z (Gujarati, 2004). Though, this does not infer that Z causes Y. Therefore, the test measures to what extent the present Y can be used to explain previous values of Y and lagged values of Z. The method is chosen for the study because it provides accurate estimates and results when testing for causality. To examine the first objective of this study the following hypotheses are tested:

H_0: Public expenditure does not granger causes tax revenue

H_1: Tax revenue does not granger causes public expenditure

The resulting pair of regressors are estimated as follows:

$$PE_t = \sum_{i=0}^{n} \propto_i TR_{t-i} + \sum_{j=1}^{n} \beta_j PE_{t-j} + U_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

$$TR_t = \sum_{i=0}^{n} \omega_i TR_{t-i} + \sum_{j=1}^{n} \delta_j PE_{t-j} + U_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Where, PE is public expenditure and TR is tax revenue and the disturbances U_{1t} and U_{2t} are uncorrelated. Consequently, this study tests for either bilateral or one-way causality. The short run causal effects are observed through the F-statistic and t-value. The long run causal effects are detected through the error correction term from the t-value, though this is only applicable to an ECM.

3.5 Diagnostic Tests

This study conducts pre-estimation and post-estimation tests to determine statistical and time series characteristics of the variables. For estimated models to be robust, it is necessary to perform diagnostic tests so that any problems in the data can be identified and resolved. The tests include; normality, multicollinearity, seasonality, stationarity and autocorrelation analysis of the time series.

3.5.1 Normality Test

The test for normality was initially introduced by Fisher (1948) and later developed by Jarque-Bera (1980). The Jarque-Bera (JB) test has been adopted widely as the main test for normality (Goksu & Ergun, 2013). When using the test, the method first calculates the coefficients of skewness of the probability density function (PDF) and kurtosis (Gujarati & Porter, 2010). Skewness refers to the degree of non-linearity of a PDF. Kurtosis assesses how far the PDF deviates relative to the normal distribution. When a variable is normally distributed, the skewness is zero, the kurtosis is equivalent to three and the JB statistic is zero. However, when the variable is non-linear, the JB statistic presents a progressively high value.

3.5.2 Test for Multicollinearity

Multicollinearity is one of the tests applied to check for whether variables are highly correlated. If the parameters exhibit high correlation, then multicollinearity is confirmed (Gujarati, 2004). When analyzing numerous applications using economic data two or more variables might not be linearly interrelated but exhibit near multicollinearity which is not necessarily perfect (Gujarati & Porter, 2010). However, multicollinearity is a serious problem if it is perfect since the estimates cannot be determined. In order to determine multicollinearity, the pairwise correlations matrix is adopted for this study.

3.5.3 Seasonality Test

The study uses monthly time series data for analysis. Since the data is high frequency, it is prudent to test for seasonality before conducting any comprehensive analysis (Ndoricimpa, 2017). This is because several economic phenomenon's exhibit some form of seasonality (Enders, 2004). For instance, the agricultural and tourism sectors manifest seasonal patterns owing to their reliance on the weather. Seasonal variations refers to a periodic high and low pattern that recurs annually due to the effect of seasons on the variable (Harper, 1998). Enders (2004) states that ignoring seasonality in analysis caters for preeminence of its variance thus, the series has a high variance. If there is evidence of seasonality, the data is seasonally adjusted. The procedures applied for seasonal adjustment entail two main processes that is; to remove the seasonality then estimate the autoregressive and moving average coefficients (Bell & Hilmer, 1984). This study uses a correlogram to check for seasonality in the series. This hypothesis for seasonality is tested as follows:

H_0: No evidence of seasonality

H_1: Evidence of seasonality

3.5.4 Stationarity Test

This study employs the Dickey Fuller Generalized Least Square (DF-GLS) proposed by Eliott, Rothenberg, & Stock (1996) as the principal unit root test. The Dickey Fuller test with GLS detrending is a basic revision of the standard ADF test. Using the technique, the data is detrended so that the regressors are omitted from the data before running the test regression (EViews, 2019). The unit root equation takes the following form:

$$y_t = \delta + y_{t-1} + \mu_t \quad \ldots \ldots \ldots \ldots \ldots \ldots (16)$$

Equation (16) presents a random walk with drift. Where, $\mu_t \sim$ white noise is $(0, \sigma^2)$. This study tests the hypothesis to check for presence of unit roots as follows:

H_0: $\mu_t = 0$ The differenced series are non-stationary or presence of unit root

H_1: $\mu_t < 0$ The differenced series are stationary or absence of unit root

To infer that variables are stationary there should be no presence of unit root. Therefore, the null hypothesis is rejected.

This study also applies the break point unit root test to examine stationarity with structural breaks in the variables. According to Perron (1989) structural breaks and unit roots are inextricably connected therefore, the author emphasized the significance of making provisions for structural breaks in unit root analysis. The author observed that standard tests for stationarity were biased where the series was trend stationary with a structural break (EViews, 2019). The stationarity test with a single break is anchored on research by Perron (1989) that specifies a fixed break date in advance. The development was followed by research by Zivot & Andrews (1992) and Vogelsang & Perron (1998) that focused on single breaks that are intrinsically identified from the data. This study tests the hypothesis to check for presence of unit roots with structural break as follows:

H_0: The data follows a unit root process with a breakpoint hence non stationary.

H_1: The data fails to follow a unit root process with a breakpoint thus stationary.

3.5.5 Test for Autocorrelation

Autocorrelation is a major challenge encountered when analyzing time series data. Autocorrelation refers to a situation where the errors are correlated to each other (Gujarati, 2004). This means if there exist similarities between the time series and lagged variables, the series is affected by its previous values. For instance, the present year's budget is generally linked to some degree to the previous period's budget. The existing tests for autocorrelation are built on the premise that if the true disturbances are serially correlated, then this attribute can be detected through autocorrelation in the least square residuals (Greene, 2008). This study uses the Durbin-Watson d statistic to check for serial correlation. A great advantage of applying the method in analysis is its ease in use and the test is usually computed in most statistical packages. The decision criteria for the calculated d value is, when the computed d value approaches zero there is presence of positive autocorrelation in the series (Gujarati & Porter, 2010). However, when the d value nears 2, evidence points to no autocorrelation.

3.6 Definition of variables and a priori expectations.

The following table defines the variables used in the study.

Table 3.1: Definition of variables

Variable name	Definition
Public Expenditure (PE)	This refers to aggregate public expenditure on government operations and maintenance and public investments. Specifically, wages, salaries and pension, domestic and foreign interests, transfer payments and development expenditure.
Tax Revenue (TR)	This refers to total tax revenue earned by the state from levies on goods and services, income of individuals and companies annually.

The table presents the expected outcome of the causality test.

Table 3.2: A priori expectations

A priori expectation	Type of causality	Source
TR → PE	Denotes unilateral causality from tax revenue to public expenditure.	(Ghartey, 2010; Wolde-Rufael, 2008)
PE → TR	Represents unidirectional causation from public expenditure to tax revenue.	(Saunoris & Payne, 2010; Apergis, Payne, & Saunoris, 2012; Tiwari & Mutascu, 2016; Kiminyei, 2018)
TR ↔ PE	Represents bidirectional causality between tax revenue and state outlays.	(Paleologou, 2013; Phiri, 2019)
TR ≠ PE	Specifies that there is no evidence of causality between the variables.	(Ewing et. al, 2006)

3.7 Data and sources of data

This study uses monthly time series data from 2001:1 to 2018:8. Kenya's fiscal year is an annual decision-making process however; this study examines monthly data because the collection of taxes and disbursement of public outlays happens through the year. In order to analyze the revenue-spending nexus for Kenya, this study adopts two variables represented by tax revenue (TR) and public expenditure (PE). Both variables are transformed to natural logs in the analysis. The data is compiled from the government financial statistics from Central Bank of Kenya (CBK).

CHAPTER FOUR

EMPIRICAL ESTIMATION AND RESULTS

4.1 Introduction

This chapter outlines; the descriptive statistics, pre-estimation tests, model estimation techniques with the objective of analyzing the relationship between public expenditure and tax revenue in Kenya.

4.2 Descriptive statistics

Descriptive statistics help to provide an overall feel about the data and better appreciation of the basic characteristics of the series and is reported as follows:

Table 4.1: Descriptive statistics for the variables used in the study

Variables	Observations	Mean	Std Deviation	Minimum	Maximum
Public expenditure	212	12.455	1.076	9.534	14.606
Tax revenue	212	12.133	1.025	9.213	14.047

Note: The variables used have been transformed to natural logarithms.

From table 4.1, public expenditure has a mean value of 12.455 with a maximum of 14.606 and a minimum of 9.534 for the period of study under consideration. The standard deviation is 1.076 which indicates that the variable has a high variation from the mean value. For the case of tax revenue, the mean value is 12.13 with a maximum of 14.047 and records a minimum of 9.213 over the study period and the standard deviation is 1.025. The full summary of statistics is provided in Appendix A1.

4.3 Diagnostic tests

In this study, the main diagnostic tests performed comprise tests for; normality, multicollinearity, seasonality, stationarity and autocorrelation. The results are reported in the sections that follow.

4.3.1 Test for normality of data

Table 4.2 provides the Jarque-Bera (JB) statistic, probability values and kurtosis for each variable used in the study. From the table, public expenditure has a JB statistic of 3.605 with a kurtosis value of 2.616. Tax revenue has a JB statistic of 6.449 with a kurtosis value of 2.856. From the results, the variables are not normally distributed thus this provides justification for conducting an asymmetric analysis of the variables.

Table 4.2: Test for normality for log-transformed variables

Variables	Jarque-Bera Statistic	Probability value	Kurtosis
Public expenditure	3.605	0.165	2.616
Tax revenue	6.449	0.040	2.856

Note: The variables used have been transformed to natural logarithms.

4.3.2 Test for Multicollinearity

To examine evidence of multicollinearity the pairwise correlations was used. The findings are reported as follows.

Table 4.3: Pairwise correlation between explanatory variables

Variables	Public expenditure	Tax revenue
Public expenditure	1	0.992
Tax revenue	0.992	1

Note: The variables used have been transformed to natural logarithms.

From the table, the pairwise correlations between the variables is greater than 0.8, thus the results indicate high collinearity at 0.992 between the variables. The presence of imperfect multicollinearity between the two variables is expected because expenditure is a function of tax revenue. Furthermore, multicollinearity tends to be a data problem rather than a statistical problem (Gujarati, 2004). For these reasons, multicollinearity is tolerated in the time series.

4.3.3 Test for Seasonality

The test for seasonality was carried out after generating the correlograms for both variables. The correlograms are provided in Appendix A2 and A3 for public expenditure and tax revenue respectively. From the appendix, the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) present evidence of outliers with highs and lows in the data. Specifically, the ACF plot displays distinct characteristics in the series such as presence of outliers, seasonality, residuals and evidence of non-stationarity (for instance, if the time series converges to zero geometrically if the data is stationary). Whereas, the PACF provides the partial correlation of the series using its own lagged values where the values are regressed at shorter lag lengths (Enders, 2004). This study used the Census X12 seasonal adjustment program to manage seasonal variations in the time series. The selected technique is the multiplicative seasonal adjustment that allows for the interaction of the ARMA and seasonal effects in the series (Enders, 2004). The results from the seasonality test are provided in table 4.4.

Table 4.4: Test for Seasonality

Variables	F-test	Kruskal-Wallis Test	Moving Seasonality Test
Public expenditure	3586.934***	209.422***	4.993**
Tax revenue	3372.002***	208.986***	11.532**

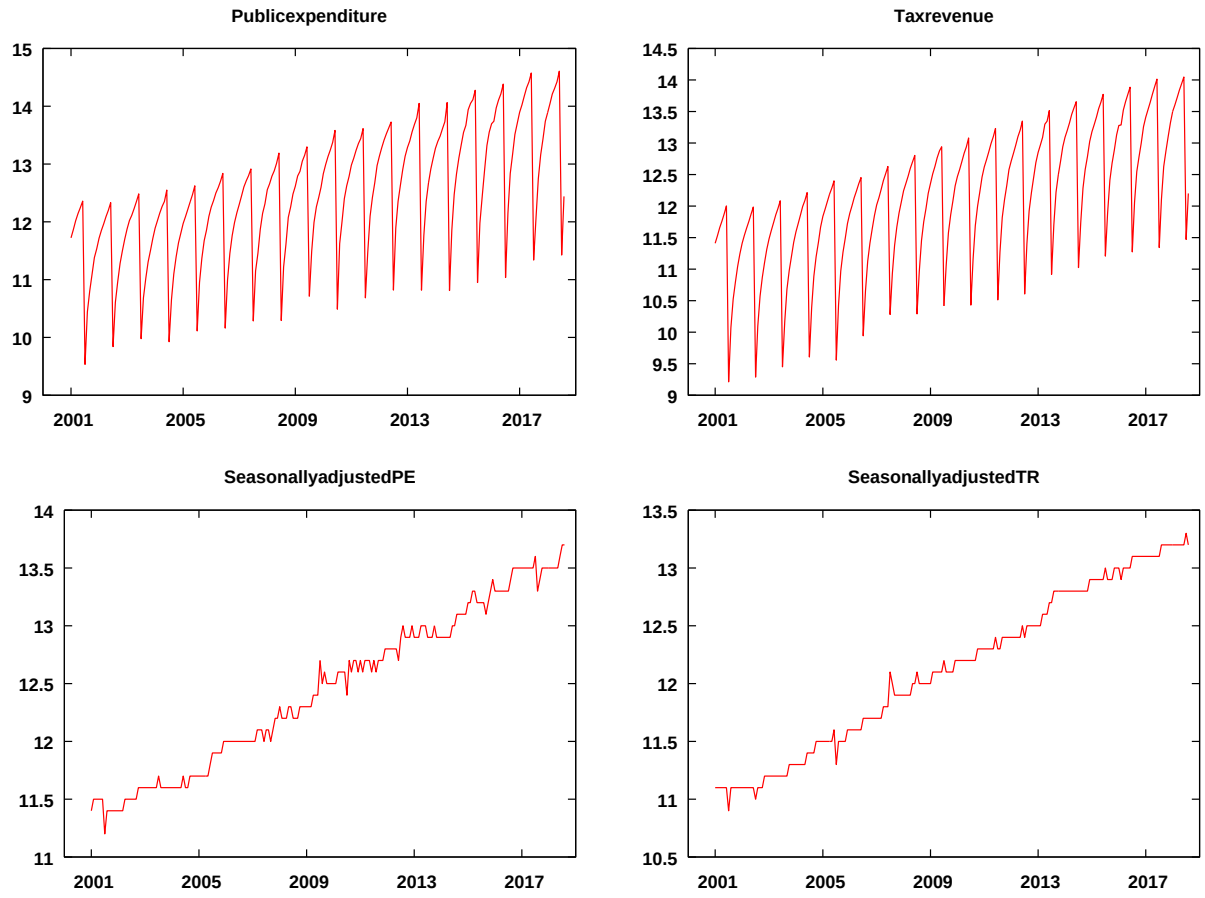
Note: ** and *** denote 5% and 1% significance level respectively.

Following the test of seasonality, both public expenditure and tax revenue present evidence of seasonality at one per cent level for F test, and at one per cent level when using a non-parametric test (Kruskal-Wallis statistic). There is also evidence of seasonality in both variables at the 5% significance level for the moving seasonality test. From the results, there is presence of seasonal variations in the series thus the data is seasonally adjusted. Therefore, deseasonalized data is adopted for subsequent analysis in the study.

4.3.4 Test for Stationarity

This study plots the variables against time to determine the trends. Figure 4.1 presents the line plot graphs of log transformed values and log transformed seasonally adjusted variables. From the figure, the line plot graphs specify that both variables are non-stationary in nature and with some form of trend. The line plots for the variables also specify an upward trend with evidence of a positive slope.

Figure 4.1: Line plot graphs



This study applies the DF-GLS and break point unit root test to check for stationarity. Table 4.5 reports the results of the DF-GLS unit root test.

Table 4.5: Test for stationarity using DF-GLS method

Variable	Include in test equation	Level	1st Difference	Remarks
PE	Intercept	2.438	-21.216**	Stationarity at 1st difference
	Trend and intercept	-3.397***	-21.221**	Stationarity at level and 1st difference
TR	Intercept	3.950	-21.380**	Stationarity at 1st difference
	Trend and intercept	-2.195**	-14.521**	Stationarity at level and 1st difference

Note: PE is public expenditure and TR is tax revenue. The automatic lag selection is based on SIC. ** and *** denote 5% and 1% significance level respectively. The critical values are obtained from Elliott-Rothenberg-Stock (1996, Table 1). The critical values at intercept are: 1% = -2.576, 5% = -1.942 and 10% = -1.616. At trend and intercept the critical values are: 1% = -3.461, 5% = -2.928 and 10% = -2.637.

From the table, the calculated ERS test statistic of public expenditure is 2.438 and lies to the right of the critical values meaning we fail to reject the null hypothesis that the variable is non stationary at level. The calculated ERS value of public expenditure is -21.216 and -21.221 and lies to the left of the critical values thus, we reject the null hypothesis that the variable has a unit root. The computed ERS test statistic of tax revenue is 3.950 and lies to the right of the critical values which denotes that we fail to reject the null hypothesis that the variable has a unit root at level. The calculated ERS test statistic of tax revenue is -21.380 and -14.521 and lies to the left of the critical values thus we reject the null hypothesis that the variable has a unit root. Thus, public expenditure and tax revenue are observed to be stationary when differenced once when both intercept, trend and intercept are included in the test equation.

This study also applies the breakpoint unit root test to check for stationarity in the time series. The procedure accomodates structural breaks in unit root analysis. There are two major models applied in the treatment of breaks namely; the innovational outlier (IO) model and additive outlier (AO) model (EViews, 2019). The IO signifies that breaks takes place progressively and follow a similar route as innovations. The AO presumes that the break is swift. The outcome of the breakpoint unit root test is reported in table 4.6. From the table, the breaks are detected in 2003 M7, 2008 M8, 2008 M9 and 2009 M7 for public expenditure and 2005 M6, 2005 M8, 2006 M8, 2006 M12, 2007 M5, 2007 M7 and 2007 M9 for tax revenue respectively.

From the results, while accounting for breaks, both variables are found to be non-stationary at level when the trend specification is intercept only, with a p-value of 0.99 that is greater than 0.05 at 5% level of significance. Both variables indicate presence of unit root with the innovational and additive outlier. However, when the series is differenced once, the null hypothesis is rejected at 1% level when both intercept, trend and intercept are considered in the trend specification. The DF-GLS test and breakpoint unit root test confirm that public expenditure and tax revenue are stationary processes when differenced once.

Table 4.6: Test for stationarity using breakpoint unit root test (with structural break)

Innovational Outlier							
		Level			1st Difference		
Variable	Trend Specification	t-statistic	P value	Break date	t-statistic	P value	Break date
PE	Intercept only	-0.938	> 0.99	2008 M9	-22.002**	< 0.01	2009 M7
	Trend & Intercept	-5.809**	< 0.01	2003 M7	-22.036**	< 0.01	2009 M7
TR	Intercept only	-1.454	> 0.99	2005 M8	-4.666**	0.027	2006 M8
	Trend & Intercept	-5.6988**	< 0.01	2007 M5	-17.1826**	< 0.01	2007 M7
Additive Outlier							
		Level			1st Difference		
Variable	Trend Specification	t-statistic	P value	Break date	t-statistic	P value	Break date
PE	Intercept only	-1.008	> 0.99	2008 M8	-22.098**	< 0.01	2009 M7
	Trend & Intercept	-7.860**	< 0.01	2003 M7	-22.157**	< 0.01	2009 M7
TR	Intercept only	-1.435	> 0.99	2005 M6	-22.618**	< 0.01	2007 M9
	Trend & Intercept	-7.498**	< 0.01	2006 M12	-22.710**	< 0.01	2007 M9

Note: PE is public expenditure and TR is tax revenue. The break selection method chosen is the one that minimizes the Dickey Fuller t-statistic. ** represents significance at 5% level. The optimal lag is automatically selected based on SIC. The critical values at intercept are: 1% = -4.949, 5% = -4.444 and 10% = -4.194. At trend and intercept the critical values are: 1% = -5.348, 5% = -4.860 and 10% = -4.607.

4.4 Threshold cointegration analysis

The aim of this study is to analyze the revenue-expenditure nexus in Kenya. The TAR and MTAR econometric model are applied to investigate existence of asymmetries between the two variables. The time series are integrated of a similar order, order one, therefore, the cointegration link between the variables is analyzed[10]. The study begins by testing for evidence of a threshold between public expenditure and tax revenue using the econometric framework. The threshold value (λ) for the TAR and MTAR framework is specified as zero or estimated using Chan's (1993) framework. Four models are estimated they are; TAR with $\lambda = 0$, the consistent TAR with λ computed, MTAR with $\lambda = 0$, and consistent MTAR with λ calculated. The lags (k) are chosen to safeguard against autocorrelation of the residuals (ω_t). Prior to testing for the presence of the threshold value, the study first selects the appropriate order of lags. The results of lag selection are presented as follows:

[10] The study employs the test based on the R statistical package, "apt" (version 2.5) created by Sun (2015) to conduct threshold cointegration analysis. Where 'apt' denotes asymmetric price transmission.

Table 4.7: Lag Selection: Test for presence of threshold

Model	Threshold value	ESS	Optimal Lag	AIC	BIC
TAR	0	1.200	1	-455.004	-441.830
c-TAR	-0.119	1.200	1	-456.549	-443.376
MTAR	0	1.174	1	-455.389	-442.216
c-MTAR	0.002	1.174	1	-458.106	-444.932

Note: ESS represents the sum of squared errors in the model.

From the table, out of a maximum of 12 lags, both AIC and BIC indicate that the suitable lag selection order is 1. The sum of squared errors for TAR model is 1.200 and for MTAR model is 1.174. From the results, the AIC and BIC values for the consistent MTAR model are the lowest. According to Sun (2011) the most relevant model is the one with the least AIC thus, the MTAR model has the most effective threshold value. Appendix A4 provides the models for c-TAR and c-MTAR with threshold values of $\lambda = -0.119$ and of $\lambda = 0.002$ correspondingly. Since evidence of threshold has been established using the econometric framework, the study proceeds to test for evidence of threshold cointegration. We first select the most suitable lag before conducting the threshold cointegration analysis as shown in table 4.8. From the table, the models are selected at a lag of 3, out of a maximum of 12 lags using AIC. The results of the AIC and BIC values for the consistent MTAR model are the lowest.

Table 4.8: Lag selection: Threshold cointegration analysis

Model	Threshold value	Optimal lag	AIC	BIC
TAR	0	3	-479.542	-459.516
c-TAR	-0.119	3	-481.063	-461.038
MTAR	0	3	-479.768	-459.743
c-MTAR	0.002	3	-482.753	-462.728

The threshold value (λ) and selected lag lengths are applied in the threshold cointegration analysis. The threshold cointegration and asymmetry analysis results are reported in table 4.9. The Ljung Box Q statistics test indicates that we fail to reject the null hypothesis of no autocorrelation for order 4, 8 and 12. From the results, the F statistic for TAR is 9.419 and the F statistic for consistent TAR is 10.233 thus exceeds the F critical value (Φ), 9.18. The F value for MTAR is 9.540 and for consistent MTAR is 11.145 which is higher than the F critical value (Φ*), 8.84. Therefore, the models are statistically significant thus indicate presence of threshold cointegration. Threshold

cointegration is also evident at the first lag at one per cent level for TAR, c-TAR, MTAR and c-MTAR model.

Table 4.9: Results of threshold cointegration and symmetry

Model	**TAR**	**c-TAR**	**MTAR**	**c-MTAR**
Threshold (λ)	0	-0.119	0	0.002
Estimates				
$\boldsymbol{\varphi_1}$	-0.329***	-0.360***	-0.298***	-0.444***
	(-3.583)	(-4.185)	(-4.339)	(-4.148)
$\boldsymbol{\varphi_2}$	-0.243***	-0.204***	-0.182*	-0.218***
	(-3.119)	(-2.494)	(-1.505)	(-3.070)
Lag 1	-0.231***	-0.222***	-0.260***	-0.203***
	(-2.867)	(-2.745)	(-3.109)	(-2.494)
Lag 2	0.028	0.032	0.013	0.039
	(0.346)	(0.408)	(0.154)	(0.497)
Lag 3	0.018	0.021	0.010	0.018
	(0.260)	(0.300)	(0.140)	(0.257)
Q_{LB} (4)	0.999	1.000	0.998	0.999
Q_{LB} (8)	0.996	0.995	0.993	0.990
Q_{LB} (12)	0.869	0.900	0.874	0.921
Hypothesis Testing				
Null Hypothesis: No cointegration	9.419***	10.233***	9.540***	11.145***
Φ (H_0: $\boldsymbol{\varphi 1 = \varphi_2}$ = 0)	(0.000)	(0.000)	(0.000)	(0.000)
Null Hypothesis: Symmetry	0.639	2.134	0.860	3.807**
F (H_0: $\boldsymbol{\varphi 1 = \varphi_2 = 0}$)	(0.425)	(0.146)	(0.355)	(0.050)

Note: c-TAR refers to consistent TAR and c-MTAR refers to consistent MTAR. Q_{LB} refers to Ljung box test statistic presented in p-values. Below the estimated coefficients, are the parenteses (.) that provide t-values. Significance levels: *, ** and *** denote the 10%, 5% and 1% levels respectively. The F critical values (Φ) for TAR model are: 1% = 9.18, 5% = 6.93 and 10% = 5.92 and F critical value (Φ*) for MTAR are: 1% = 8.84, 5% = 6.93 and 10% = 5.92. The values are obtained from Enders and Siklos (2001, Table 5, p. 172).

Since there is evidence of threshold cointegration in the framework, the study proceeds to check for existence of asymmetries in adjustment between public expenditure and tax revenue. From the table, the p values for the TAR, c-TAR and MTAR are not statistically significant thus we fail to reject the null hypothesis of presence of symmetry($\varphi 1 = \varphi_2 = 0$) in the models. However, the c-MTAR model is statistically significant at 5% level hence the null hypothesis is rejected. Therefore, the MTAR framework offers support for non-linear fiscal adjustment in Kenya. From the results, the absolute values of the coefficients are $\varphi 1 > \varphi_2$ for the M-TAR model. This

indicates that correction mechanisms during fiscal imbalances are faster when the fiscal position is favorable than when deteriorating. Therefore, budget surpluses are easier to correct than budget deficits in Kenya.

Given that the study has established cointegration between public expenditure and tax revenue, as well as non-linear adjustment in budgetary disequilibrium using the consistent M-TAR framework, this provides adequate justification to estimate an asymmetric ECM. It is worth noting that for model estimation and all other subsequent procedures in the study, only the consistent MTAR framework is considered because the TAR model is observed to be linear. Also, the MTAR model displays lower values for the BIC and AIC lag selection statistics than the TAR model, thus the MTAR model is selected as the most appropriate for analysis. This study primarily borrows from the empirical framework of Ndoricimpa (2017) that estimates an AECM. Thus, to address the objectives of the study the asymmetric ECM will be analyzed.

4.5 Estimation of the AECM using threshold cointegration

The results from the asymmetric ECM using threshold cointegration are reported in Table 4.10. The table provides estimates of the long run regression coefficients between public expenditure and tax revenue and threshold ECT coefficient estimates. The coefficients are divided into positive and negative parts that represent two regime shifts, as specified by the superscripts + and – (Sun, 2015). Where, $\alpha^{+}\Delta TR_{t-1}$ is equivalent to TR_{t-1} - TR_{t-2} if $TR_{t-1} > TR_{t-2}$ and equal to zero otherwise, and $\alpha^{-}\Delta TR_{t-1}$ is equal to TR_{t-1} - TR_{t-2} if $TR_{t-1} < TR_{t-2}$ and equal to zero otherwise, and the same applies for the public expenditure equation. The signs of the estimated coefficients confirm evidence of asymmetric behaviour between both variables and capture the behavior of corresponding variables to fiscal imbalances from previous periods. The error correction terms are a critical component of the AECM and are denoted as ($\sigma^{+}e_{t-1}^{-}$ and $\sigma^{-}e_{t-1}^{-}$) in the table.

The maximum sum of lags (k) is selected using the AIC and Ljung-Box Q test to ensure regression residuals are not serially correlated. From table 4.10, out of a maximum lag of 12, the AIC is used to select an optimal lag of 4 to estimate the AECM. The Ljung-Box p-values indicate that we fail to reject the null hypothesis of no serial correlation for order 4, 8 and 12 in the AECM. From the table, the Durbin-Watson test is reported where the null hypothesis of presence of autocorrelation of order 1, is rejected for the AECM. From the analysis, the F value of the public expenditure equation is 4.074 and the F value for the tax revenue equation is 3.954. The model is statistically

significant thus there is evidence of asymmetric error correction effects within the model and estimated regression.

Table 4.10: Results of asymmetric ECM using threshold cointegration

Variable	Public Expenditure Equation		Tax Revenue Equation	
Coefficient	**Estimate**	**t-value**	**Estimate**	**t-value**
Constant	0.019***	2.580	0.018***	3.042
$\alpha^{+}\Delta TR_{t-1}$	-0.090	-0.715	-0.407***	-4.183
$\alpha^{+}\Delta TR_{t-2}$	-0.286**	-2.137	-0.164*	-1.576
$\alpha^{+}\Delta TR_{t-3}$	0.004	0.030	-0.077	-0.746
$\alpha^{+}\Delta TR_{t-4}$	0.090	0.753	0.059	0.632
$\alpha^{-}\Delta TR_{t-1}$	-0.206	-1.220	-0.391***	-2.982
$\alpha^{-}\Delta TR_{t-2}$	-0.038	-0.215	-0.186	-1.371
$\alpha^{-}\Delta TR_{t-3}$	-0.196	-1.144	-0.064	-0.483
$\alpha^{-}\Delta TR_{t-4}$	-0.161	-0.986	-0.065	-0.516
$z^{+}\Delta PE_{t-1}$	-0.209*	-1.735	-0.263***	-2.804
$z^{+}\Delta PE_{t-2}$	-0.156	-1.389	-1.007	0.315
$z^{+}\Delta PE_{t-3}$	-0.053	-0.468	-0.170	-1.944**
$z^{+}\Delta PE_{t-4}$	-0.292***	-2.867	-0.026	-0.330
$z^{-}\Delta PE_{t-1}$	-0.508***	-4.250	-0.115	0.218
$z^{-}\Delta PE_{t-2}$	-0.118	-0.923	-0.250***	-2.512
$z^{-}\Delta PE_{t-3}$	-0.231*	-1.829	-0.116	-1.180
$z^{-}\Delta PE_{t-4}$	0.102	0.861	-0.096	-1.039
$\sigma^{+}e_{t-1}^{-}$	-0.244**	-2.293	0.318***	3.843
$\sigma^{-}e_{t-1}^{-}$	-0.121*	-1.803	0.032	0.622
R^2	0.275		0.281	
F statistic	4.074 (0.000)		3.954 (0.000)	
AIC	-521.781		-626.192	
BIC	-455.127		-559.537	
Q_{LB} (4)	(0.987)		(0.959)	
Q_{LB} (8)	(0.991)		(0.948)	
Q_{LB} (12)	(0.067)		(0.170)	
DW (test statistic)	2.031 (0.814)		1.998 (0.962)	

Note: The parenteses (.) present p-values. The levels of significance is denoted as: ** and *** at 5% and 1% levels, respectively. Q_{LB} denotes the Ljung-Box Q test. DW stands for Durbin-Watson test for autocorrelation.

With reference to the coefficients results, $z^{+}\Delta PE_{t-4}$ and $z^{-}\Delta PE_{t-1}$ are statistically significant at 1% level for the expenditure equation. While, $\alpha^{+}\Delta TR_{t-1}$ and $\alpha^{-}\Delta TR_{t-1}$ are statistically significant at 1% level for the revenue equation. This suggests evidence of short run effects in the AECM where public expenditure and tax revenue respond to an improving and declining budget. For instance, $\alpha^{+}\Delta TR_{t-2}$ coefficient estimate is -0.286 and is statistically significant at 5% level in the

public expenditure equation therefore a positive change in tax revenue during the previous period is more than in the current time span. This provides evidence of asymmetric behaviour in tax revenue in response to the former periods disequilibrium due to a decline in public expenditure. The coefficient estimate of $z^{-}\Delta PE_{t-1}$ is -0.508 and is statistically significant at 1% level in the public expenditure equation. This shows that a negative change in expenditure through the present period is higher in comparison to the previous period. Consequently, public expenditure responds to fiscal disequilibrium in the preceding period.

Within the expenditure equation, the ECT, $\sigma^{+}e_{t-1}^{-}$ produces an adverse and statistically significant estimate of -0.244 at 5% significance level and the ECT, $\sigma^{-}e_{t-1}^{-}$ is statistically significant with an estimate of -0.121 at 10% level. While, under the revenue equation the ECT, $\sigma^{+}e_{t-1}^{-}$ produces a positive and statistically significant estimate of 0.318 at 1% level of significance while, the ECT $\sigma^{-}e_{t-1}^{-}$ is not statistically significant. Therefore, only the ECT in the expenditure equation indicates the relevant sign on the coefficients. Thus, the study concludes that only public expenditure responds to fiscal disequilibrium in the long run while, this is not the case for tax revenue in Kenya.

4.6 Granger causality test

The Granger causality methodology is adopted to address the first objective of this study. Although cointegration implies evidence of causality atleast in one direction, it hardly confirms the nature of causality between the variables. The granger causality results from the estimated AECM are provided in table 4.11.

Table 4.11: Results of Granger causality test from estimated AECM.

Variable	**Public Expenditure Equation**		**Tax Revenue Equation**	
H_0: No presence of Granger causality				
	F-statistic	P-value	F-statistic	P-value
PE → TR	3.532***	0.001	1.584	0.132
TR → PE	1.059	0.394	3.607***	0.001
Error Correction Term (adjustment path asymmetry)				
$\sigma^{+} = \sigma^{-}$	1.075	0.301	9.619***	0.002

Note: *** denotes significance at 1% level and σ^{+} and σ^{-} represent the error correction terms.

The first hypothesis states that public expenditure does not granger cause tax revenue with a probability of 0.001. Since the probability value is statistically significant, the null hypothesis is rejected. Therefore, the study establishes that public expenditure granger causes tax revenue within

the expenditure equation. The second hypothesis asserts that tax revenue granger causes public expenditure with a probability value of 0.001. Since the probability value is statistically significant, the null hypothesis is rejected. Thus, the study finds that tax revenue granger causes public expenditure within the tax revenue equation. By effect, the results indicate presence of bilateral causality between public expenditure and tax revenue in the short-run in Kenya.

The error correction terms specify deviation of public expenditure and tax revenue from their long-run values. The first hypothesis states that public expenditure does not granger cause tax revenue with a probability of 0.301. Since the probability value is not statistically significant, we fail to reject the null hypothesis. Therefore, the study concludes that public expenditure does not granger cause tax revenue for the expenditure equation. The second hypothesis states that tax revenue does not granger cause public expenditure with a probability of 0.002. Since the probability value is statistically significant the null hypothesis is rejected for the tax revenue equation. Hence, the study concludes unilateral causality from tax revenue to public expenditure over the long term in Kenya.

4.7 Discussion of empirical estimation and results

This section summarizes the outcome of empirical estimation and results. The TAR and MTAR framework validate presence of threshold cointegration between public expenditure and tax revenue. Previous empirical works are consistent with the results for instance; Ewing et al. (2006), Saunoris & Payne (2010), Apergis, et al. (2012), Tiwari & Mutascu (2016) and Ndoricimpa (2017). However, the findings differ from the results reported by Payne (2008) in Turkey and Paleologou (2013) for the case of Sweden and Germany. This study finds that the TAR model presents evidence of symmetric adjustment however, the MTAR model offers support for non linear adjustment towards long run equilibrium. Therefore, public expenditure and tax revenue in Kenya are cointegrated with asymmetric alteration in the long term. Specifically, the MTAR model has an estimated threshold parameter of 0.002. This means that Kenya has a general fiscal surplus of 0.002 or 0.2% fiscal surplus to GDP. The findings that adjustment is non-linear for consistent M-TAR model is in line with earlier empirical studies by Ewing et al. (2006), Apergis et al. (2012), Phiri (2017) and Ndoricimpa (2017).

The absolute values of the estimates ($\varphi 1$) and (φ_2) for the MTAR model indicate that $\varphi 1 > \varphi_2$. This implies that adjustment to equilibrium is faster resulting from a positive shock to the fiscal budget whereas the correction mechanism after an adverse shock to the budget is sluggish in Kenya

(Phiri, 2019). This means that phases of fiscal imbalances are easier to resolve with a fiscal surplus than with a fiscal deficit. The results are similar to findings observed by Apergis, et al. (2012) in Greece and Phiri (2017) in South Africa. However, the findings contradict the results observed by Ewing et al. (2006) in USA, Saunoris & Payne (2010) in UK, Tiwari & Mutascu (2016) in Romania and Ndoricimpa (2017) in Burundi. The AECM results confirm earlier findings on the MTAR model on asymmetric adjustment in Kenya. Specifically, the results indicate that public expenditure responds to both a favourable and declining budget, with 24.4% of budgetary disequilibrium being corrected by expenditure when the budget is improving. While, 12.1% of disequilibrium is corrected by expenditure when the fiscal space is deteriorating.

The causality results support that in the short-run there is evidence of two-way causality between public expenditure and tax revenue in support of the fiscal synchronization hypothesis by Musgrave (1966) and Meltzer & Richard (1981). Notably, preceding empirical works on the theme observed similar results of interdependence between the variables using a non-linear framework they include; Ewing et al. (2006) for USA, Phiri (2017) for South Africa and Ndoricimpa (2017) in Burundi. In the long run, the study establishes presence of one-way causality from tax revenue to public expenditure. This offers support for the tax and spend hypothesis by Friedman (1978) and Buchanan & Wagner (1978). Similar findings on long term causality were observed by Payne (2008) for the case of Turkey using a nonlinear framework. Previous empirical studies in Kenya have observed similar results using linear cointegration techniques for instance, research by Yemane (2008) and Ghartey (2010) found evidence of one-way causality between the variables in favor of the tax spend proposition. However, the outcome of this study contradicts Kiminyei's (2018) findings that detected public outlays granger cause tax revenue in Kenya in line with spend-tax theory.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction

The summary of the study, conclusions and policy implications observed from the findings are presented in this section.

5.2 Summary

The aim of this study is to analyze the relationship between public expenditure and tax revenue in Kenya using monthly time series data collected between 2001:1 and 2018:8. The specific objectives are to examine existence of asymmetries in the budget adjustment process and establish the direction of causality between tax revenue and public expenditure in Kenya. This study applies the TAR and MTAR econometric model developed by Enders & Granger (1998) and Enders & Siklos (2001) to test for threshold cointegration and asymmetric adjustment between the variables. The study confirms evidence of threshold cointegration in the TAR and MTAR model. However, only the MTAR model with an estimated threshold indicates existence of asymmetric adjustment towards long run equilibrium. By obtaining evidence in favor of asymmetric cointegration between tax revenue and public expenditure, the relationship between the variables is analyzed using an asymmetric ECM. The study finds evidence of short run nonlinear behaviour between public expenditure and tax revenue in response to disequilibrium from previous periods in the estimated model. The results from the analysed AECM also finds that the momentum in adjustment is faster when the fiscal position is improving than when the fiscal position is declining. A bilateral causal link is observed between the two variables in the short term. Over the long term, the causal relation runs from tax revenue to public expenditure.

5.3 Conclusions

This study concludes that the TAR and MTAR model provide support for threshold cointegration between public outlays and tax revenue in Kenya. The TAR model endorses symmetric adjustment while, the MTAR model provides evidence of nonlinear adjustment in the long run thus the MTAR is employed for analysis. From the MTAR cointegration model, the results support that public expenditure and tax revenue are cointegrated and the correction mechanism during fiscal disequilibrium is asymmetric in the long term. The findings from threshold cointegration analysis and estimated AECM strongly support that non-linear adjustment towards long run symmetry

between the variables. Where, there is more momentum when the fiscal position is improving than when it is declining. Therefore, this study concludes that public expenditure and tax revenue respond to long run requirements of the fiscal balance only when the budget position is improving. Using the asymmetric ECM, this study concludes that in the short run public expenditure and tax revenue exhibit two-way causality and in the long run tax revenue granger causes public expenditure.

5.4 Policy implications

In view of Kenya's widening fiscal deficit, this study sought to derive policy implications from the outcome of the empirical analysis. In light of evidence of asymmetries in the fiscal adjustment process in Kenya, this study confirms responsiveness to an improving budget relative to a declining one. Therefore, the government should prioritize public investments in critical sectors of the economy to address the fiscal imbalance. For instance, creation of employment and enhancing the ease of doing business in the country can augment economic activity and generate positive shocks in the economy. In the short run, there is presence of bidirectional causality between public expenditure and tax revenue. Therefore, the main policy implications over the short term are; reduced spending and improved revenue collection by the state to trim the fiscal deficit. First, the government needs to adopt austerity measures in the public sector to suppress recurrent expenditure and safeguard public investments using result-based frameworks for enhanced public expenditure outcomes. Secondly, the state needs to avoid increases in tax revenue and constant over projections of public revenue in the budget because the efforts only provide additional resources for the state without correcting the fiscal deficit. Over the long term, the findings of this study conclude that tax revenue granger causes public expenditure. This confirms the current scenario in the country where a growth in tax revenue mainly fosters as surge in public outlays without addressing the budget deficit. Thus, to reduce the fiscal deficit in the long run the state should curb tax evasion and criminalize revenue leakages, as these measures can increase tax revenue collection and consequently reduce the fiscal deficit.

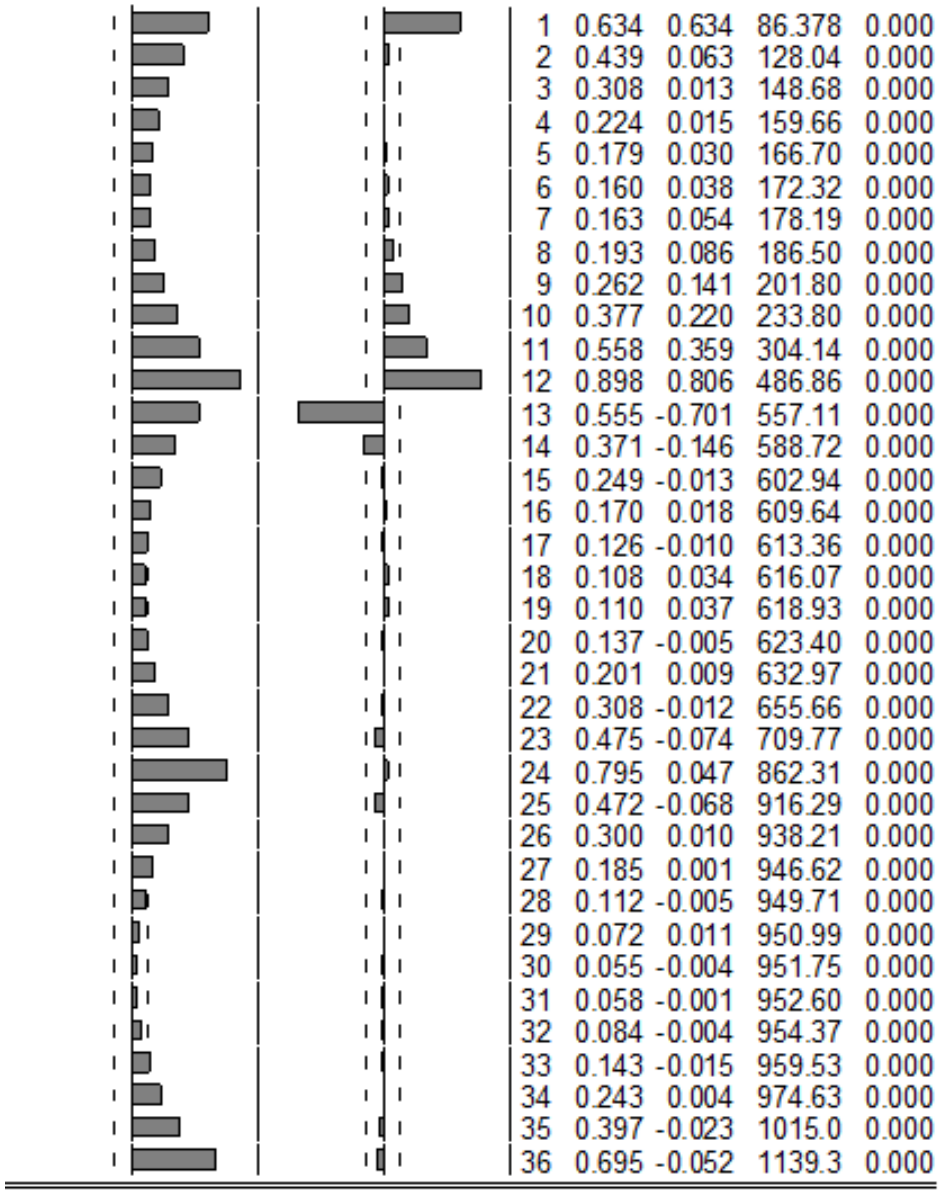
APPENDIX

Appendix A1: Summary Statistics

Descriptive Statistic	Public Expenditure (PE)	Tax Revenue (TR)
Mean	12.45531	12.13392
Median	12.44831	12.19517
Maximum	14.60675	14.04709
Minimum	9.534306	9.212937
Std. Dev.	1.076691	1.024587
Skewness	-0.255127	-0.421104
Kurtosis	2.615609	2.855746
Jarque-Bera	3.605020	6.449417
Probability	0.164885	0.039767
Sum	2640.525	2572.392
Sum Sq. Dev.	244.6044	221.5033
Observations	212	212

Appendix A2: Correlogram of public expenditure

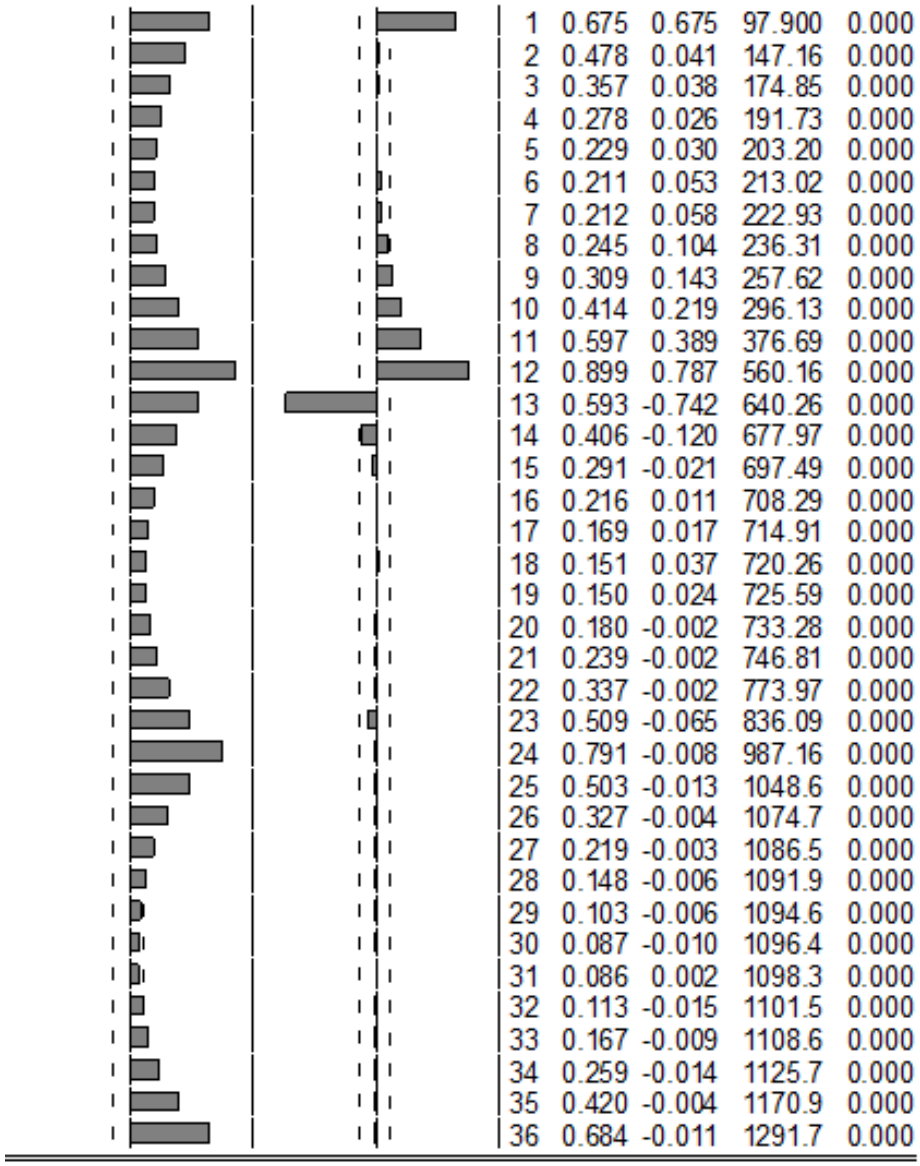
Date: 10/16/19 Time: 09:31
Sample: 2001M01 2018M08
Included observations: 212



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.634	0.634	86.378	0.000
		2	0.439	0.063	128.04	0.000
		3	0.308	0.013	148.68	0.000
		4	0.224	0.015	159.66	0.000
		5	0.179	0.030	166.70	0.000
		6	0.160	0.038	172.32	0.000
		7	0.163	0.054	178.19	0.000
		8	0.193	0.086	186.50	0.000
		9	0.262	0.141	201.80	0.000
		10	0.377	0.220	233.80	0.000
		11	0.558	0.359	304.14	0.000
		12	0.898	0.806	486.86	0.000
		13	0.555	-0.701	557.11	0.000
		14	0.371	-0.146	588.72	0.000
		15	0.249	-0.013	602.94	0.000
		16	0.170	0.018	609.64	0.000
		17	0.126	-0.010	613.36	0.000
		18	0.108	0.034	616.07	0.000
		19	0.110	0.037	618.93	0.000
		20	0.137	-0.005	623.40	0.000
		21	0.201	0.009	632.97	0.000
		22	0.308	-0.012	655.66	0.000
		23	0.475	-0.074	709.77	0.000
		24	0.795	0.047	862.31	0.000
		25	0.472	-0.068	916.29	0.000
		26	0.300	0.010	938.21	0.000
		27	0.185	0.001	946.62	0.000
		28	0.112	-0.005	949.71	0.000
		29	0.072	0.011	950.99	0.000
		30	0.055	-0.004	951.75	0.000
		31	0.058	-0.001	952.60	0.000
		32	0.084	-0.004	954.37	0.000
		33	0.143	-0.015	959.53	0.000
		34	0.243	0.004	974.63	0.000
		35	0.397	-0.023	1015.0	0.000
		36	0.695	-0.052	1139.3	0.000

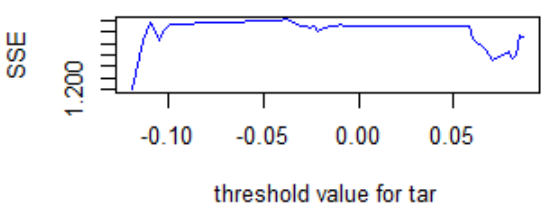
Appendix A3: Correlogram of tax revenue

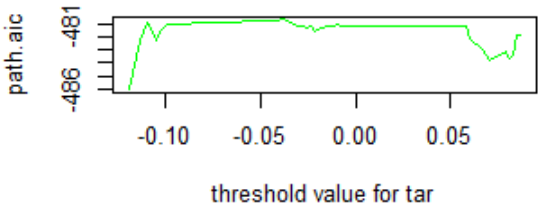
Date: 10/16/19 Time: 09:30
Sample: 2001M01 2018M08
Included observations: 212

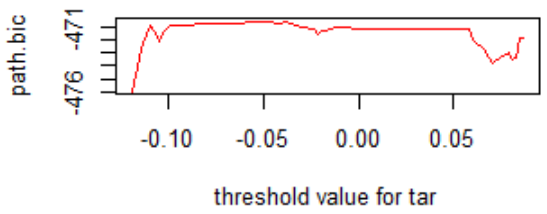


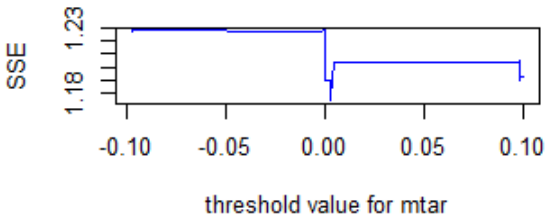
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.675	0.675	97.900	0.000
		2	0.478	0.041	147.16	0.000
		3	0.357	0.038	174.85	0.000
		4	0.278	0.026	191.73	0.000
		5	0.229	0.030	203.20	0.000
		6	0.211	0.053	213.02	0.000
		7	0.212	0.058	222.93	0.000
		8	0.245	0.104	236.31	0.000
		9	0.309	0.143	257.62	0.000
		10	0.414	0.219	296.13	0.000
		11	0.597	0.389	376.69	0.000
		12	0.899	0.787	560.16	0.000
		13	0.593	-0.742	640.26	0.000
		14	0.406	-0.120	677.97	0.000
		15	0.291	-0.021	697.49	0.000
		16	0.216	0.011	708.29	0.000
		17	0.169	0.017	714.91	0.000
		18	0.151	0.037	720.26	0.000
		19	0.150	0.024	725.59	0.000
		20	0.180	-0.002	733.28	0.000
		21	0.239	-0.002	746.81	0.000
		22	0.337	-0.002	773.97	0.000
		23	0.509	-0.065	836.09	0.000
		24	0.791	-0.008	987.16	0.000
		25	0.503	-0.013	1048.6	0.000
		26	0.327	-0.004	1074.7	0.000
		27	0.219	-0.003	1086.5	0.000
		28	0.148	-0.006	1091.9	0.000
		29	0.103	-0.006	1094.6	0.000
		30	0.087	-0.010	1096.4	0.000
		31	0.086	0.002	1098.3	0.000
		32	0.113	-0.015	1101.5	0.000
		33	0.167	-0.009	1108.6	0.000
		34	0.259	-0.014	1125.7	0.000
		35	0.420	-0.004	1170.9	0.000
		36	0.684	-0.011	1291.7	0.000

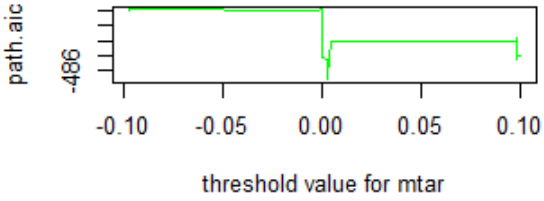
Appendix A4: Threshold values for consistent TAR and consistent MTAR model

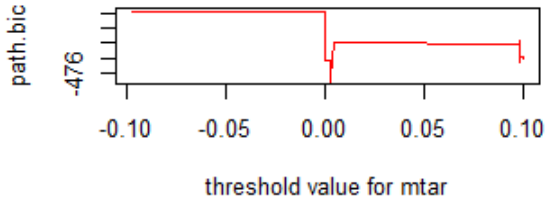












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