OPEN ACCESS

Journal of Economics and International Finance

November 2018
ISSN 2006-9812
DOI 10.5897/JEIF
www.academicjournals.org

ACADEMIC JOURNALS
expand your knowledge

ABOUT JEIF

The **Journal of Economics and International Finance (JEIF)** is published monthly (one volume per year) by Academic Journals.

Journal of Economics and International Finance (JEIF) is an open access journal that provides rapid publication (monthly) of articles in all areas of the subject such as econometrics, trade balance, Mercantilism, Perfect competition etc. The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JEIF are peer-reviewed.

Contact Us

Editorial Office: jeif@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/JEIF

Submit manuscript online http://ms.academicjournals.me/

Editors

Prof. Nathalie Jeanne-Marie HILMI
Professor of Economics and Finance,
International University of Monaco,
Hedge Funds Research Institute,
98000 Monte-Carlo, Principality of, Monaco.
France

Prof. Osamah M. Al-Khazali
Professor of Finance,
School of Business and Management
American University of Sharjah,
P.O. Box 26666,
United Arab Emirates,

Dr. Guneratne B Wickremasinghe
School of Accounting
Faculty of Business and Law
Victoria University
Melbourne
Victoria, 8001.
Australia

Dr. Meltem Gürünlü
Department of Economics and Finance
University of Turin,
G.Prato,
Italy.

Prof. Yongrok Choi
Department of International Trade,
Inha university,
Incheon,
Korea.

Prof. Mohamed Osman Ahmed Bushara
Department of Agricultural Economics;
FAS; Gezira University; P. O. Box 20; Wad Medani;
Sudan.

Prof. Anyanwu John Chukwudi
Development Research Department
African Development Bank
15 Avenue du Ghana
BP 323, 1002 Tunis Belvedere
Tunis
Tunisia

Prof. S. E. Neaime
Department of Economics,
Institute of Financial Economics,
American University of Beirut,
Beirut,
Lebanon.

Dr. Adrei Vernikov
Banking Department,
Higher School of Economics
P.O. Box 43,
Moscow 125057,
Russia.

Prof. Keith Pilbeam
Department of Economics,
City University,
Northampton Square,
London EC1V OHB.
UK.

Editorial Board

Dr. Gbadebo Olusegun ODULARU
Regional Policies and Markets Analyst,
Forum for Agricultural Research in, Africa (FARA),
PMB CT 173 Cantonments, 2 Gowa Close, Roman Ridge,
Accra, Ghana.

Dr ilhan Ozturk
Çağ University, Faculty of Economics and Administrative,
Sciences, Adana - Mersin karayolu, uzeri, 33800,
Mersin ,Turkey.

Professor. Abdelkader BOUDRIGA
Professor of finance,
School of Economics and Commerce,
Tunis, Tunisia.

Dr. Shivakumar Deene
Dept. of Commerce and Management,
Karnataka State Open University,
Manasagangotri,
Mysore- 570 006,
Karnataka - India.

Mohammed Omran
The Egyptian Exchange, 4 (A) El, Sherifein St, Down, Town,
Postal Code 11513,
P.O. Box 358 Mohammed Farid,
Cairo, Egypt.

Dr. Kola Subair
Adjunct Professor, Business and, Financial Economics,
American Heritage University,
California, USA.

Dr. Bora Aktan
Assistant Professor of Finance,
Yasar University,
Faculty of Economics and, Administrative Sciences,
Department of Finance,
Selcuk Yasar Campus,
Universite Caddesi, No. 35-37,
35100 Bornova, Izmir,
Turkey.

Dr. Davide Furceri
Office of the Chief Economist,
Economics Department,
2, Rue André-Pascal,
75775 Paris Cedex 16,
France.

Dr. ABDUL JALIL
Wuhan University,
Economics and Management School,
Wuhan,Hubei,
PR China.

Prof. Silvia Ciotti
Dept of Social and Environmental Sciences,
St. John International University,
Della Rovere Castle - Rey Square,
10048 - Vinovo (Turin),
Italy.

Prof. Tessaleno Devezas
Advanced Materials and Technological, Forecasting,
University of Beira Interior,
6200-001 Covilhã,
Portugal.

Dr. Nikolay Sukhomlin
Autonomous University,
Santo Domingo,
Dominican Republic.

Prof. Dev Tewari
Deputy Dean, Faculty of Management Studies
Professor, School of Economics and Finance,
Westville Campus, University of KwaZulu-Natal
Resource Economics, Durban, 4001.
South Africa.

Dr. Tarek Chebbi
Faculty of Law, Economics and Political Science
University of Sousse,
Erriadh City - 4023 Sousse,
Tunisia

Professor Hichri Walid
Gate & Uinversity of Lyon, LAREQUAD
Gate, 93 Chemin des mouilles, 69130 Ecully
France.

Dr.Sunderasan Srinivasan
Navillu Road 7th Cross, Kuvempunagar,
Mysore 570023,
India.

Dr. P. Malyadri
Government degree College,Osmania University
Tandur-501141,Rangareddy District
India.

Journal of Economics and International Finance

Table of Contents: Volume 10 Number 11 November 2018

ARTICLE

Vol. 10(11), pp. 134-155, November 2018
DOI: 10.5897/JEIF2018.0924
Article Number: 51F281F59416
ISSN: 2006-9812
Copyright ©2018
Author(s) retain the copyright of this article
http://www.academicjournals.org/JEIF

ACADEMIC JOURNALS
expand your knowledge

Journal of Economics and International Finance

Full Length Research

Determinants of tax revenue in East African countries: An application of multivariate panel data cointegration analysis

Kitessa Delessa Terefe[1*] and Jewaria Teera[2]

[1]Department of Economics, School of Business and Economics, Ambo University, Woliso Campus, Woliso, Ethiopia.
[2]Department of Economics, School of Economics, Makerere University, Kampala, Uganda.

Received 11 July, 2018; Accepted 30 August, 2018

Domestic revenue mobilization has received growing attention in recent years as it has crucial national and international dimensions for sub-Saharan African (SSA) and East African countries. In most countries, tax has not increased with increasing development expenditures. In place, the share of tax revenue to gross domestic product (GDP) is declining and countries constantly rely on foreign capital inflow as a major source of the government budget. Thus, equally tax revenue is key for economic development, the study thought to empirically examine the key determinants of tax revenue in East African countries using a novel dataset ranging from 1992 to 2015 by employing panel data cointegration approach. Panel unit root test of stationarity based on the LLC, IPS and ADF test of stationarity shows that all variables are cointegrated of order one, I(1), except the variable inflation which is stationary at level. The model estimation was done using the FGLS and the dynamic panel data GMM model. The long run estimated equation from the FGLS results indicates that per capita GDP, foreign aid, trade openness, share of agriculture, share of industry and share of services have positive contribution for tax revenue of East African countries over the study period. On the other hand, urbanization, official exchange rate and rate of inflation have negative impact on the tax revenue to GDP ratio of the region. From the short run, PVECM one period lagged tax revenue and urbanization has negative impact on the current period tax revenue while two period lagged urbanization and official exchange rate has positive impact. Thus, the robust result of the study calls for an indication that tax revenue increases under stable macroeconomic environment. Hence, East African countries should therefore better pursue economic policies that at least reveal low inflation rate and favorable trade policies. Moreover, the countries are required to set prudent macroeconomic policy environment which create economic integrations among different sectors, mobilizes domestic resource and improve external trade policies to make each country's growth sustainable on the basis of domestic resource mobilizations. The cumulative effects lead to improved tax revenue collection of the region.

Key words: Tax revenue, multivariate panel cointegration, East African countries.

INTRODUCTION

Sustainable economic development, a base for improvement of welfare and living standards, inherently depends on the real capital formation which is supposed to be generated from availabilityand mobilization of domestic resources at large.

Tax revenue is the specified amount of money the

citizen of the country legally pays for the government of the country on the enforceable ways to support the economic and social developments of the country (Ehtisham and Nicholas, 1989), (Michael, 2015). Though, taxation is an important instrument for fiscal policy used for mobilizing resources leading to capital formation in the public sector, there is high mismatch between the ever increasing demand for government expenditure and the limited scope of tax revenue raised to finance such development scenarios showing that low income countries are facing the challenge of raising tax revenue (David, 2000; Saibu and Olasunbo, 2013; Joyce, 2014; Garner, 1999; OECD, 2008).

Subsequently, tax revenue mobilization in less developing countries is a subject of great concern and hence has received a lot of attention. The need to raise tax revenue is fundamental to lower unnecessary dependence on foreign aid, manage macroeconomic problems, limit the recourse of borrowing and achieve robust economic growth. Reflecting this, increasing tax to GDP ratio is an explicit aim of policy in developing countries (Nouriel, 1994; Zulal, 2005; Saibu and Olasunbo, 2013).

Regardless of copious tax reforms intended to increase tax to gross domestic product (GDP) ratio, to advance the socioeconomic conditions through increasing public goods by government, the sub-Saharan African (SSA) countries in general and East African countries in particular, remain among the poorest in the world with lowest revenue collections allied to large fiscal deficits triggering fiscal imbalances (Saeid, 200). Such persistent and broadening budget deficits forces the government to run unsustainable budget deficits, negative trade balance and decline in exports of goods and services incapable to achieve macroeconomic goals as the tax system is the victim of numerous economic crises (Kayaga, 2007). Moreover, failure to collect sufficient revenue and low capacity of tax administration exposed East African countries to suffer from tiny proportion of tax revenues further deteriorating the financial situations of the countries and baring them to external shocks. And, this remains a crucial problem in the taxing system of the countries (Bersley and Persson, 2014; IMF, 2015; Langford and Ohlenburg, 2016).

Therefore, as tax revenue collection is not optimal subject to a number of factors, it is essential to explore forces working behind it. To this point, the study thought to empirically examine the key determinants of tax revenue for nine East African countries (See Appendix A) using the broader data ranging from 1992 to 2015 by employing the multivariate panel cointegration approach which gives large number of data points, increases degree of freedom, reduces collinearity among explanatory variables and allows the control of omitted variables.

MATERIALS AND METHODS

Model specification

The conceptual framework of the model follows the explicit production function where set of explanatory variables, here the tax revenue determinants, are taken into account as potential factors explaining the specified dependent variable, tax revenue as a ratio of GDP. Thus, to investigate the dynamic relationship between the dependent and explanatory variables, the conceptual framework is as shown in Figure 1 was used:

Thus, the econometric model specification with panel data type starts with:

$$(T/Y)_{it} = f(X_{it}) = \beta_0 + \beta_{it}X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

Here, it is assumed that, $(T/Y)_{it}$, is the ratio of tax revenue to GDP for country *i* at time *t*, is explained by a set of vector of explanatory variables X that are taken in two dimensions, temporal and individual, X_{it} where *i* is for individual dimension and *t* is for time dimension. With X_{it} the set of explanatory variables measured on individuals at different dates, μi refers to the individual effects, and ε_{it} error terms.

Assuming the multiplicative augments among explanatory variables, the function is summarized as:

$$(T/Y) = f(GDPPC, AID, URB, OPEN, OER, AGR, IND, SERV, INF, \varepsilon) \quad (2)$$

The specific outfitted model in an estimable econometric form is given as: where T/Y here after represented

$$\ln(T/Y)_{it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 AID_{it} + \beta_3 lnURB_{it} + \beta_4 lnOPEN_{it} + \beta_5 lnOER_{it} + \beta_6 AGR_{it} + \beta_7 IND_{it} + \beta_8 SERV_{it} + \beta_9 INF_{it} + \varepsilon_{it}$$

as TR is the ratio of tax revenue of GDP; GDPPC is GDP per capita in constant US$; AID is net official development assistance (ODA) received (% of GNI); URB is percentage of urban population; OPEN is trade further deteriorating the financial situations of the countries and baring them to external shocks. And, this openness measured as sum of export plus import as a percentage of GDP; OER is the official exchange rate; AGR is the share of agriculture value added (% of GDP), IND is the share of industry value added (% of GDP), SERV is the share of service value added (% of GDP) and INF is inflation, GDP deflator (annual %).

*Corresponding author. E-mail: kitebuze@gmail.com. Tel: +251913234698.

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

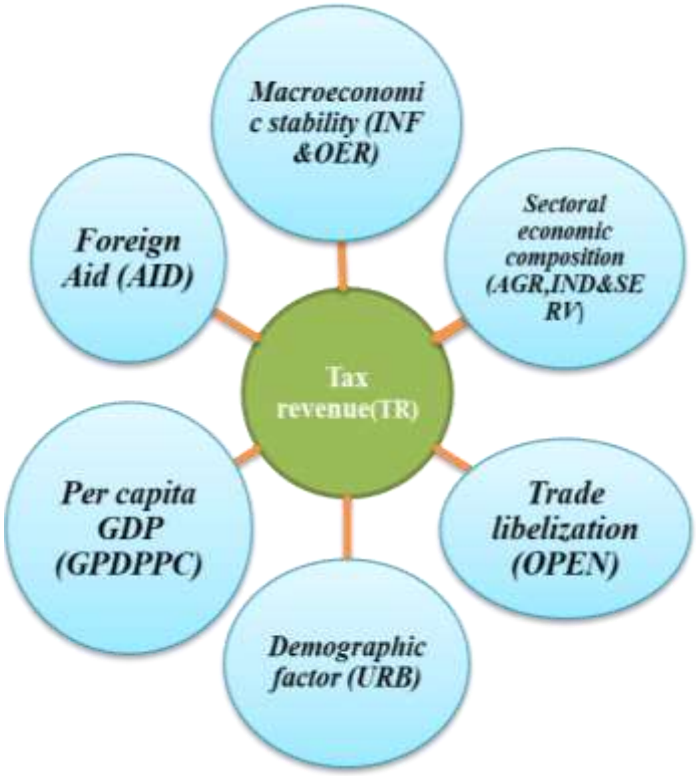


Figure 1. The diagrammatic illustration of set of variables.
Source: Own Conceptual Illustrations (2017).

Explanation of variables

Table 1 shows the explanation of variables.

GDP per capita (GDPPC)

Sustained increase in GDP will lead to increase in GDP per capita used to measure the relative economic performance of one country in relation to another. It is a tool for making comparison in standards of living between countries and over a period of time. Thus, higher income leads to increased GDP per capita which further leads to higher tax GDP ratio. As a result it is expected that there is a positive relationship between GDP per capita and tax revenue ($\beta_1>0$).

Foreign aid (AID)

For the economies of the less developing countries like SSA where there is clear resource gap due to low tax revenue collection the inflow of resources in the form of foreign aid is inevitable. But, the effect of foreign aid depends on the cumulative effects of the concessional loans and grants. Loans have positive effect on taxation because of the obligation to repay them back while grants have negative effects as the recipient countries can easily divert it to a nonproductive economic activity (aid fungibility). Thus, the overall effect of foreign aid on domestic resource mobilization will be negative if the negative effect from the grants outweighs the positive effect from loans and vice versa. Hence the expected sign for β_2 is conditional and inconclusive here.

Urbanization (URB)

Increase in urbanization leads to increase in demand for provision of goods and services accompanied by increase in public expenditure. This in turn entails increase in tax revenue to cover the spending. Thus, a positive relationship is expected between urbanization and tax revenue ($\beta_3>0$).

Openness (OPEN)

OPEN measured as the ratio of the sum of exports and imports of goods and services over GDP, as named, measures the degree of openness of countries to international trade. Greater trade openness may be beneficial in two ways: exporters experience a decrease in the costs, while imported goods and services increase. This increase in the traded goods widens the tax base and makes the government more likely to move from cross-border taxation to internal taxation. On top of that based on the implicit assumption that trade creates jobs, expands markets, facilitates competition; disseminates knowledge and raises income in less developing countries including the economy of East African countries trade as a principal engine for growth. Thus, a positive relationship is expected between Openness and tax revenue ($\beta_4>0$).

Official exchange rate (OER)

According to Tanzi (1989) there is inverse relationship between official exchange rate and tax revenue. Currency appreciation has the direct effect of destroying of import and export of goods and

Table 1. Summary of variables, their hypothesized signs and explanations.

Variable	Definition of variables	Source	Hypothesized sign
Tax revenue	Tax revenue (% of GDP)	WDI	Dependent variable
Per capita GDP	Gross domestic product divided by midyear population.	WDI	+
Foreign Aid	Net ODA received (% of GNI).	WDI	?
Urbanization	People living in urban areas defined as % of total population	WDI	+
Trade Openness	Openness measured as the sum of exports and imports of goods and services a ratio of GDP	WDI	+
Official Exchange Rate	Official exchange rate (LCU per US$, period average) calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar)	WDI	-
Share of Agriculture as % of GDP	Agriculture, value added (% of GDP)	WDI	?
Share of Industry as % of GDP	Industry, value added (% of GDP)	WDI	+
Share of Services as % of GDP	Services, etc., value added (% of GDP)		+
Inflation	Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole.	IMF	-

Source: WDI and IMF (2017), Refer to Appendix (B)

services measured in domestic currency units which further deteriorate international trade tax. Overvaluation also has indirect effects by reducing the incentive to produce goods for export, encouraging capital flight and currency substitution, weakening the balance of payments, encouraging black markets, and encouraging trade restrictions. Hence, negative relationship is expected between official exchange rate and tax revenue ($\beta_5>0$).

Share of agriculture value added (AGR)

According to Matsuyama (1992) agriculture is always dubbed as "the hardest sector to tax" as it is characterized by voluminous informal sector and underground economies dominated by a large number of subsistence farmers. Inefficiency in tax administration puts pressure on fiscal authorities so that the probability of escaping from paying tax is common for the sector and it exacerbates loss in tax revenue. This led to the conclusion that negative relationship is expected. The divergent view is that there is a *revenue generation effect*, in that higher agricultural productivity raises agricultural output, which increases tax revenues and public spending on infrastructures (Jing et al., 2006). Hence, the expected sign for β_6 is questionable.

Share of industry value added (IND)

The sector is pillar for economic development of the nation. Industry is viewed as leading sector to economic development. It helps to have economies of scale where production and employment will increase rapidly. This will bring economic growth and capital formation. Industrial development helps in the rapid growth of the national and per capita income. A country cannot produce goods and services of high quality in order to attain decent living standard without the progress of industrial sector. And so the cumulative effect is increase in tax revenue. Consequently, positive relationship is expected between shares of industry value added and tax revenue ($\beta_7>0$).

Share of services value added (SERV)

These days service sector has emerged as the dominant and vibrant sector of the economy and its share in GDP has been rising from time to time. On top of this the sector is contributing to the growth in employment, international trade and foreign direct investment. The economy moves towards an increasingly services-dominant economy. Therefore, positive relationship is expected between shares of service value added and tax revenue ($\beta_8>0$).

Inflation (INF)

Measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. This is all about how government revenue responds for increase in price levels over a period of time. Its effect commonly known as the

Table 1. Summary of Panel Unit Root Tests.

Test	Null (H_0)	Alternative (H_a)	Possible deterministic component	Autocorrelation correction method
LLC	Unit root	No unit root	None, F, T	Lags
IPS	Unit root	Some cross-sections without unit root	None, F, T	Lags
Fisher-ADF	Unit root	Some cross-sections without unit root	None, F, T	Lags

None=no exogenous variable; F=fixed effect and T= individual effect and individual trend.
Source: Summary Compilation (2017).

Oliveira-Tanzi effect[1] stipulates that inflation impacts negatively the tax revenue due to lags in the tax collection. In fact, inflation causes the real value of the collected taxes to decrease between the time of implementation and the time that the tax is effectively levied. Hence, negative relationship is expected between inflation and tax revenue ($\beta_9>0$).

Panel unit root tests

A variety of procedures have been developed for the analysis of unit roots in a panel context. Among many panel unit root tests, the most common tests used in practice are the Levin-Lin Chu (Levin et al., 2002), the Im-Pesaran-Shin (Im et al., 2003) and Fisher type tests using Augmented Dickey Fuller (Maddala and Wu, 1999).

Table 2 shows the basic characteristics of the panel unit root tests.

Panel cointegration test

Pedironi panel cointegration test

Panel cointegration is the test for the existence of a long-run relationship among tax revenue as a ratio of GDP and the independent variables using panel cointegration tests suggested by (Pedroni, 1999, 2004). The test applies seven panel cointegrations (Pedironi, 1999) to determine the appropriateness of the tests to be applied to estimated residuals from a cointegration regression.

Kao panel cointegration test

Kao (1999) proposes the Dickey Fuller and Augmented Dickey-Fuller (ADF). If $\hat{e}_{it}$ is the estimated residual from the following regression equation:

$$\boldsymbol{y_{it} = \alpha_i + \beta x_{it} + e_{it}} \quad (8)$$

The Kao DF test is applied to the estimated residuals:

$$\boldsymbol{\hat{e}_{it} = \gamma \hat{e}_{it-1} + \hat{v}_{it}} \quad (9)$$

The null hypothesis of no cointegration, H_0:γ=1 is tested against the alternative of cointegration for all i=1…..n.

[1]The Oliveira-Tanzi effect is an economic situation involving a period of high inflation in a country which results in a decline in the volume of tax collection and a deterioration of real tax proceeds being collected by the government of that country. This is due to the time elapsed between the moment the taxable event occurs and the collection of the tax becomes effective (Tanzi, 1977).

Panel vector error correction model (PVECM)

The PVECM for tax revenue model ($lnTR_{it}$) on the cross-sectional unit at time t is given as:

$$\Delta \boldsymbol{lnTR_{it} = \mu_i \Delta X_{it-1} + \varphi_1 (lnTR_{it-1} - \beta_i X_{it-1}) + u_{it}} \quad (10)$$

where Δ represents the first difference, μ_i, φ_1, *and* β_i are unknown parameters, X_{it-1} is vector of explanatory variables and μ_{it} is the white noise error term.

Test for cointegration using the PVECM framework tests, the null hypothesis of (H_0:φ_1=0) against the alternative hypothesis of (H_0:$\varphi_1\neq$0) (Kremers et al., 1992).

The dynamic panel data models

There might be cases where the dependent variable is explained by its own lag. Thus, in order not to lose the dynamic information the autoregressive one (AR (1)) is incorporated. Thus, the dynamic model based on the previously specified model is set as follows:

$$\ln TR_{it} = \varphi_0 + \varphi_1 lnGDPPC_{it} + \varphi_2 AID_{it} + \varphi_3 lnURB_{it} + \varphi_4 lnOPEN_{it} + \varphi_9 lnOER_{it} + \varphi_6 AGR_{it} + \varphi_7 lnIND_{it} + \varphi_8 SERV_{it} + \varphi_9 INF_{it} + \varepsilon_{it} \quad (17)$$

where i denotes East African countries used in the sample and t denotes the time dimension.

$$\boldsymbol{ln\,TR_{it} - ln\,TR_{it-1} = \delta_t + \gamma\, ln\,TR_{it-1} + \beta_i x_{it} + u_{it} + \varepsilon_{it} - -} \quad (18)$$

Where $lnTR_{it}$ is the natural log of tax to GDP ratio is, $lnTR_{it}$ - $lnTR_{it-1}$ is the rate of tax to GDP ratio growth, $lnTR_{it-1}$ is the initial level of log of tax to GDP ratio, x_{it} is vector of explanatory variables, u_{it} is an unobserved country specific and time invariant effect, ε_{it} is the error term. δ_t refers to the specific intercept terms to capture changes common to all countries.

Equation 18 can be rewritten as:

$$\boldsymbol{ln\,TR_{it} = \delta_t + \gamma\, ln\,TR_{it-1} + ln\,TR_{it-1} + \beta_i x_{it} + u_{it} + \varepsilon_{it}}$$

This is the same as to:

$$\boldsymbol{ln\,TR_{it} = \delta_t + (\gamma + 1)\, ln\,TR_{it-1} + \beta_i x_{it} + u_{it} + \varepsilon_{it}} \quad (19)$$

Thus, the dynamic panel data model used here with the realization of current tax to GDP ratio is influenced by past ones is set as:

$$\boldsymbol{ln\,TR_{it} = \delta_t + (\gamma + 1)\, ln\,TR_{it-1} + \beta_1 lnGDPPC_{it} + \beta_2 AID_{it} + \beta_3 lnURB_{it} + \beta_4 lnOPEN_{it} + \beta_9 lnOER_{it} + \beta_6 AGR_{it} + \beta_7 lnIND_{it} + \beta_8 SERV_{it} + \beta_9 INF_{it} + u_{it} + \varepsilon_{it}} \quad (20)$$

Table 3. Summary of descriptive statistics (1992-2015).

Variable		Mean	Std.Dev	Min	Max	Observations
	Overall		0.4019864	2.191598	4.045749	N = 216
lnTR	Between	2.911692	0.3786543	2.483708	3.743313	n = 9
	Within		0.1831726	2.371853	3.366194	T = 24
	Overall		1.114734	5.08657	9.513568	N = 216
lnGDPPC	Between	6.478885	1.157082	5.48384	9.21171	n = 9
	Within		0.2168363	5.849782	7.152251	T = 24
	Overall		10.69667	0.4992877	67.73533	N = 216
AID	Between	13.35963	7.461197	2.845311	25.67555	n = 9
	Within		7.043921	-4.241905	55.41941	T = 24
	Overall		0.485075	1.89266	3.986889	N = 216
lnURB	Between	3.247303	0.4977833	2.196919	3.93254	n = 9
	Within		0.113942	2.943043	3.540029	T = 24
	Overall		0.5039178	1.494733	4.723056	N = 216
lnOPEN	Between	3.3135509	0.43404	2.821176	4.206622	n = 9
	Within		0.2927386	1.98066	3.829942	T = 24
	Overall		2.493869	-1.75909	8.083528	N = 216
lnOER	Between	4.484798	2.50048	0.9760072	7.431177	n = 9
	Within		0.5664229	1.749772	5.664308	T = 24
	Overall		14.23664	2.350568	65.97296	N = 216
AGR	Between	29.68163	13.88746	3.550458	48.59281	n = 9
	Within		5.518348	19.59637	48.56973	T = 24
	Overall		7.132779	6.298477	48.96779	N = 216
IND	Between	20.04651	6.229826	11.75423	33.88358	n = 9
	Within		4.027115	9.017073	35.13073	T = 24
	Overall		13.87897	24.00501	104.3466	N = 216
SERV	Between	51.37961	13.5777	37.28413	83.27416	n = 9
	Within		5.290887	24.48162	72.45207	T = 24
	Overall		18.14033	-5.755335	165.534	N = 216
INF	Between	13.70688	6.813679	6.447881	30.58473	n = 9
	Within		16.95912	-11.43991	148.6561	T = 24

Source: Own Calculation (2017).

ESTIMATION AND DISCUSSION

Based on the specified econometric model to estimate the determinants of tax revenue for East African countries and different estimation techniques used here thoroughly explain the estimation and discussion of results.

Descriptive statistics

Summary statistics

Table 3 below summarizes the descriptive statistics of the variables used in the study to analyze determinants of tax revenue in East African countries. Further, the graphical analysis of trend of tax revenue (see Appendix C) and growth of tax revenue (see appendix D) was shown for comparative analysis among the countries under the sample. As it can be seen from below, the overall average annual growth in tax revenue to GDP ratio is about 2.912% with the overall annual minimum growth of 2.192% and overall maximum growth of 4.046%. The variation in growth of tax revenue as a share of GDP within the East African countries varies from the overall average growth by about 0.402% showing that there is no significant difference.

Urbanization, measuring the percentage of population

living in urban areas, is also an important determinant of tax revenue. It has both demand and supply side effects. With demand side effects growth in urbanization leads to increase in demand for provision of public goods and services. On the supply side, growth in urbanization leads to increase in number of people living in urban areas leading to increase in tax revenue. On average for East African countries the overall growth in urbanization was 3.25% with maximum overall urbanization growth of 3.99% and minimum overall growth of about 1.89%.

Official exchange rate, the rate at which one countries local currency is exchanged for another United States dollar currency, is also potential variable influencing tax revenue of the region. Domestic currency devaluation leads to increase in export of goods and services so that revenue as a share of GDP also increases. Over the period of time the average overall exchange rate growth is about 4.48%. The maximum overall growth was about 8.08% and the minimum growth was -1.76%.

Macroeconomic condition is also another decisive factor posing influence on tax revenue of the region. Macroeconomic stability of any economy is explained by the degree as to which the fiscal and monetary policies are able to manage the performance of the economy on one hand and lead to achieve macroeconomic goals set by the policy makers. One of the indicators of such stability is change in prices over the period of time named as inflation. Abnormal increase in price of goods and services negatively affects the welfare of the society at large. It discourages the demand for goods and services which further leads to decrease in investment activities and production economy. The average overall rate of inflation is about 13.71% with maximum overall rate of inflation of 165.53% and minimum overall rate of inflation of -5.76%.

Pairwise correlation analysis

Table 4[2] shows the correlation matrix between the tax revenue as a ratio of GDP and its determinants for East African countries over the period of 1992 to 2015. The correlation between GDP per capita and tax revenue is positive and the correlation coefficient ($r_{ln(TR),\ lnGDDPC}$) is equal to 0.543. As this value is greater than 0.5 and statistically significant (p-value = 0.000 is less than 1%), there is strong and significant positive relationship between GDP per capita and tax revenue. Similarly, the there is a positive association between the net aid received as percentage of GNI and tax revenue with the correlation coefficient of 0.038 yet insignificant. Again there is a positive correlation between shares of industry (value added) as a percentage of GDP and tax revenue with correlation coefficient of 0.101 which is insignificant too.

Moreover, inflation and urbanization have negative correlation with tax revenue with correlation coefficient of -0.103 and -0.014 with significant impact respectively whereas official exchange rate has negative correlation with tax revenue with correlation of coefficient of -0.389 with significant impact. Furthermore, trade openness and shares of service (value added) as a percentage of GDP has positive correlation with tax revenue with correlation coefficient of 0.550 and 0.542, respectively with significant impact as shown with p-values.

Econometric analysis

Panel unit root tests

The regression results are supposed to be interpreted if and only if the test for unit root is clearly established and so that the order of integration can be set.The tests are done via the Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS) and the individual root-Fisher-Augmented Dickey Fuller (ADF) tests. The null hypothesis states that the data has panel unit root while the alternative hypothesis states that the series is stationary. The Panel unit root test results are shown in Table 5[3].

As shown in Table 5, both the LLC and IPS panel unit root tests show that *lnTR* is non-stationary at level as the null hypothesis of unit root is not rejected at conventional level of significance. However, when the first difference of *lnTR* (that is, Δ*lnTR)* is taken it is stationary for LLC, IPS and ADF tests at 1% level of significance.

Further the test shows that explanatory variables *(lnGDPPC, AID, lnURB, lnOPEN, lnOER, AGR, IND and SERV)* are all nonstationary except the variable inflation. Thus, we cannot reject the null hypothesis of unit root for almost all variables in levels. Yet, when the first differences are used, the null hypothesis of unit root (non-stationarity) is strongly rejected at the *p<0.01* statistical level. The study concluded that the variables were stationary first difference. According to these tests, all variables are integrated of the same order (that is, they are all integrated of order one, I (1)) except inflation which is I(0). This implies that the variables are stationary at first difference and integrated of I(1).

Thus, it can be concluded that the results of panel unit root tests (LLC, IPS and ADF tests) reported in Table 5 supports the hypothesis of a unit root in all variables across countries, as well as the hypothesis of zero orderintegration in first differences as all series strongly reject the unit root null at 1% significance level. Given the results of LLC, IPS, and ADF tests, it is possible to apply panel cointegration to test for the existence of the stable long-run relation among the variables.

[2]Description of the correlation matrix is for first column only as the interest is on assessing the impacts of variables on tax revenue.

[3]All the panel unit root tests were conducted using Eviews 7

Table 4. Pairwise correction matrix.

Correlation	lnTR	lnGDPPC	AID	lnURB	lnOPEN	lnOER	AGR	IND	SERV	INF
lnTR	1.000									
lnGDPPC	0.543** (0.000)	1.000								
AID	0.038 (0.577)	-0.509** (0.000)	1.000							
lnURB	-0.014 (0.8392)	0.670** (0.000)	-0.515** (0.000)	1.000						
lnOPEN	0.550** (0.000)	0.522** (0.000)	-0.195** (0.004)	0.437** (0.000)	1.000					
lnOER	-0.389** (0.000)	-0.379** (0.000)	-0.025 (0.715)	-0.204** (0.000)	-0.320** (0.000)	1.000				
AGR	-0.389** (0.000)	-0.639** (0.000)	0.338** (0.000)	-0.622** (0.000)	-0.688** (0.000)	0.351** (0.000)	1.000			
IND	0.101 (0.138)	0.427** (0.000)	-0.008 (0.904)	0.203** (0.003)	0.303** (0.000)	-0.348** (0.000)	-0.596** (0.000)	1.000		
SERV	0.542** (0.000)	0.628** (0.000)	-0.414** (0.000)	0.643** (0.000)	0.538** (0.000)	-0.273** (0.000)	-0.662** (0.000)	0.211** (0.002)	1.000	
INF	-0.103 (0.133)	-0.082 (0.232)	0.362** (0.000)	-0.073 (0.286)	-0.032 (0.642)	-0.226** (0.001)	0.059 (0.385)	0.273** (0.000)	-0.246** (0.000)	1.000

**Indicates the statistical significance at 5% (*P<0.05) and values in parenthesis shows p-values.
Source: Own Calculation (2017).

Table 5. Panel unit root test results.

Variable	Level			Variable	First difference			Order of integration
	LLC	IPS	ADF		LLC	IPS	ADF	
lnTR	-0.789	-1.760**	12.491	ΔlnTR	-6.768***	-5.965***	67.585***	I(1)
lnDPPC	4.592	-1.0572	17.391	ΔlnDPPC	-5.372***	-4.038***	47.604***	I(1)
AID	-3.507***	-2.752***	-0.881	ΔAID	-1.761**	-4.461***	52.920***	I(1)
lnURB	-1.392 *	0.620	22.532	ΔlnURB	-2.574***	2.181	25.442	I(1)
lnOPEN	-3.622***	-2.114**	7.464	ΔLnOPEN	-5.065***	-6.446***	72.256***	I(1)
lnOER	-0.2436	-0.9233	25.218	ΔlnOER	-1.958**	-2.680***	34.95***	I(1)
AGR	-0.2072	-0.758	25.917	ΔAGR	-6.111***	-7.074***	79.01***	I(1)
IND	0.659	0.559	13.483	ΔIND	-6.898***	-5.149***	66.215***	I(1)
SERV	0.3996	-2.703***	8.223	ΔSERV	-5.342***	-6.525***	45.879***	I(1)
INF	-2.914***	-7.389***	92.142***	ΔINF	-9.372***	-11.81***	130.21***	I(0)

Ho: Panels contain unit roots; Ha: Panels are stationary. ***, ** and * indicates statistical significances ***p<0.01, **p<0.05, *p<0.1 indicating the rejection of the null hypothesis (unit root) at 1%, 5% and 10% respectively. Where LLC=Levin -Lin- Chu, IPS=Im-Pesaran-Shin, ADF=Augmented Dickey Fuller.
Source: Own Calculation (2017).

Table 6. Panel Pedironi Cointegration test results.

lnTR lnGDPPC AID lnURB lnOER SERV INF	Individual intercept		Deterministic intercept and trend	
Within-dimension	**Statistic**	**Weighted statistic**	**Statistic**	**Weighted statistic**
Panel v-Statistic	-0.909	-2.719	-1.497	-3.642
Panel rho-Statistic	1.827	1.865	3.077	3.479
Panel PP-Statistic	-2.547***	-1.983*	-2.142**	-2.408***
Panel ADF-Statistic	-1.704**	-3.057***	-2.043**	-2.937***
Between-dimension				
Group rho-Statistic	3.210		4.194	
Group PP-Statistic	-5.328***		-4.162***	
Group ADF-Statistic	-1.534*		-3.339***	
Null Hypothesis	No cointegration		There is cointegration	No cointegration
Trend Assumption	No deterministic trend		Deterministic intercept and trend	

***, ** and * indicates statistical significances at *p<0.1, **p<0.05, ***p<0.01.
Source: Own Calculation (2017).

Panel cointegration test

The econometric analysis makes sense with non-stationary variables only when their linear combination results in a stationary series. The test of cointegration in this section tests for existence of such a relationship among the nonstationary variables considered in this study.

Pedironi (Engle-Granger based) cointegration tests

The Pedironi cointegration test is based on an examination of the residuals of a spurious regression performed using I(1) variables. If the variables are cointegrated then the residuals should be I(0). On the other hand, if the variables are not cointegrated then the residuals will be I(1). Pedironi (1999, 2004) and Kao (1991) extend the Engle-Granger framework to tests involving panel data (Table 6).

The cointegration examination according to (Pedironi, 2004) has seven test statistics and tests the null of no cointegration. The panel tests are founded on the within-dimension form, which comprises four statistics, respectively panel v, panel rho, panel PP, and panel ADF that pool the autoregressive coefficients across dissimilar states for the unit root checks on the estimated residuals. The group tests are established on the between dimension form which cover three statistics: group rho, group PP, and group ADF, that are set on means of the individual autoregressive coefficients related with the unit root checks of the residuals for each state in the panel.

As such, panel PP-statistic, panel ADF statistic, group PP-statistic and group ADF statistic support that there is cointegration relationship.

From the Panel Pedironi cointegration test results, it can be seen that only three out of seven statistics fail to reject the null hypothesis of no cointegration and accept the alternative hypothesis meaning that the variables are cointegrated. The majority, four out of seven, rejects the null of no cointegration. Those three statistics are the panel v, panel rho and the group rho statistics. Thus, since all the other statistics conclude in favour of cointegration, and this, combined with the fact that the according to Pedironi (1999) the panel ADF and the group ADF statistics are more reliable, we conclude that there is a cointegrating relationship among our variables. And this works both for deterministic trend specifications, that is, individual intercept on one hand and individual intercept and individual trend on the other hand as specified earlier.

The cointegration test further assures that the regression performed using the I(1) variables is not spurious. When the variables are cointegrated the residuals are cointegrated of I(0).Thus, the result shows that the cointegrating equation does not result in non-stationary error term as majority of the p-values are significant at conventional levels (that is the null of no cointegration is rejected).

Kao (Engle-Granger based) cointegration tests

Kao panel cointegration tests are also used to examine the presence of cointegration relationship among the variables incorporated in the tax revenue model. The ADF test statistic rejects the null hypothesis of no cointegration at 5% level of significance as the probability is less than 5% (P_value = 0.0377). This implies that there exists a long-run relationship among variables

Table 7. Kao Cointegration test results [4].

Individual Intercept	(t-statistic)	Prob.
ADF	-1.7783**	0.0377
Residual variance	0.0136	-
HAC variance	0.007	-
Null Hypothesis:	No cointegration	
Trend Assumption:	No deterministic trend	

** Indicates statistical significances at ***p<0.05.
Source: Own Calculation (2017).

[4]Results calculated using Eviews 7

included in the model which means that they are cointegrated (Table 7).

Panel vector error correction model (VECM)

In PVECM, all exogenous variables considered in the long run equation entered into the right hand side of the model by differencing them with appropriate lag length. The intuition behind doing this is because of the fact that there is high degree of correlation between current and lagged values of a variable, which causes the problem of multicollinearity. In addition, error correction term (ECT), which is derived from the long run coefficients, enters in to the model by lagging one year, called the lagged error term as the dynamic shocks cannot adjust automatically.

In PVECM, all insignificant explanatory variables are continuously dropped until a parsimonious model with fewer explanatory variables but acceptable in terms of significance, economic interpretation and diagnostic validity is obtained after step- by step elimination of insignificant variables from the estimates.[5]

The panel VECM for determinants of tax revenue in East African countries with appropriate lag length is derived as follows:

$$\boldsymbol{Dln\,TR_{it} = \beta_0 + \beta_1 DlnTR_{it}(-1) + \beta_2 DlnTR_{it}(-2) + \beta_3 DlnGDPPC_{it}(-1) + \beta_4 DlnGDPPC_{it}(-2) + \beta_5 DAID_{it}(-1) + \beta_6 DAID_{it}(-2) + \beta_7 DlnURB_{it}(-1) + \beta_8 DlnURB_{it}(-2) + \beta_9 DlnOPEN_{it}(-1) + \beta_{10} DlnOPEN_{it}(-2) + \beta_{11} DlnOER_{it}(-1) + \beta_{12} DlnOER_{it}(-2) + \beta_{13} DAGR_{it}(-1) + \beta_{14} DAGR_{it}(-2) + \beta_{15} DIND_{it}(-1) + \beta_{16} DIND_{it}(-2) + \beta_{17} DSERV_{it}(-1) + \beta_{18} DSERV_{it}(-2) + \beta_{18} DINF_{it}(-1) + \beta_{19} DINF_{it}(-2) + \beta_{20}(ln(TR_{it}(-1) - \beta_i x_{it}(-1)) +} \quad (21)$$

where $(ln(TR_{it}(-1) - \beta_i x_{it}(-1))$ represents error correction term (ECT) generated from the long run panel cointegrating equation.

The long run panel cointegration equation result hereby captured by ECT[6] is given as:

$$\boldsymbol{ECT_{t-1} = lnTR_{it}(-1) - \underbrace{0.31 lnGDPPC_{it}(-1)}_{[-3.157]} - \underbrace{0.039 AID_{it}(-1)}_{[-7.235]} + \underbrace{0.148 lnURB_{it}(-1)}_{[1.217]} + \underbrace{0.231 lnOPEN_{it}(-1)}_{[-1.524]} + \underbrace{0.048 lnOER_{it}(-1)}_{[2.732]} - \underbrace{0.05 AGR_{it}(-1)}_{[-4.299]} - \underbrace{0.017 IND_{it}(-1)}_{[-1.422]} - \underbrace{0.039 SERV_{it}(-1)}_{[-3.843]} + \underbrace{0.053 INF_{it}(-1)}_{[11.943]} + 2.93)} \quad (22)$$

Thus, estimable PVECM is given as:

$$\boldsymbol{Dln\,TR_{it} = \beta_0 + \beta_1 DlnTR_{it}(-1) + \beta_2 DlnTR_{it}(-2) + \beta_3 DlnGDPPC_{it}(-1) + \beta_4 DlnGDPPC_{it}(-2) + \beta_5 DlnAID_{it}(-1) + \beta_6 DlnAID_{it}(-2) + \beta_7 DlnURB_{it}(-1) + \beta_8 DlnURB_{it}(-2) + \beta_9 DlnOPEN_{it}(-1) + \beta_{10} DlnOPEN_{it}(-2) + \beta_{11} DlnOER_{it}(-1) + \beta_{12} DlnOER_{it}(-2) + \beta_{13} DAGR_{it}(-1) + \beta_{14} DAGR_{it}(-2) + \beta_{15} DIND_{it}(-1) + \beta_{16} DIND_{it}(-2) + \beta_{17} DSERV_{it}(-1) + \beta_{18} DSERV_{it}(-2) + \beta_{19} DINF_{it}(-1) + \beta_{20} DINF_{it}(-2) + \beta_{21} ECT_{t-1}} \quad (23)$$

The results for PVECM model divulges that the short run changes in growth of tax to GDP ratio is affected negatively and significantly by one period lagged changes in tax revenue. Economically it makes sense that the current tax revenue depends on previous period tax revenue. On the other hand, urbanization lagged by one period had a negative and significant impact while it has positive and significant impact when lagged by two periods. This implies that the growth impact of urbanization is

[5] Table 8. Panel Vector Error Correction Model: Long run casualty confirms this statement where all insignificant variables are dropped and we are left with few variables.

[6] Where **[ ]** represents the t-statistics

Table 8. Panel Vector Error Correction Model: Long run causality.

Variable	The dependent variable is Dln(TR)			
	Coefficient	Std. Error	t-statistic	Prob.
ECT(-1)	-0.0412	0.0244	-1.688	0.0933*
DlnTR(-1)	-0.1663	0.0819	-2.0297	0.0425**
DlnURB(-1)	-8.3711	3.3362	-2.5091	0.0122**
DlnURB(-2)	8.1761	3.3624	2.4317	0.0151**
DlnOER(-2)	0.1575	0.0842	1.8715	0.0615*
R-squared	0.154851	-	-	-
Adj.R-squared	0.048575	-	-	-
F-Statistics	1.45062	-	-	-
Log likelihood	138.3278	-	-	-
Akaike AIC	-1.23098	-	-	-
Schwarz SC	-0.853636			
Durbin Watson Stat	1.962740			

** and * indicates statistical significances at 5 %(**p<0.05) and 10% (*p<0.1) respectively.
Source: Own Calculation (2017).

observed over the period of time and it has long gestation periods like other productive investment activities. The official exchange rate lagged by two periods has negative and significant impact showing that it did not contribute towards enhancing tax revenue of the region over the given period. Moreover from the short-run analysis the coefficients of the error correction term (ECT) were used to explain the tendencies for the variable to return to equilibrium. The findings reveal that the long run causality determined by the ECT has the right sign (that is, negative) and significant (p-value =0.0933 lower than 10% significance level) showing that there is long run casualty running from independent variables to dependent variable. The appropriate sign of ECT further confirms the existence of cointegrating relationships between tax revenue and its determinants for East African countries for the period under considerations.

The PVECM model determines the required period to correct any chock or disequilibrium (speed of adjustment) among the variables. Hence, the result in Table 8 shows that the speed of adjustment from the short run towards the long run equilibrium is about 4.12% for tax revenue equation.

The estimated PVECM can be set as:

$$\begin{aligned} \boldsymbol{DlnTR} = &-\mathbf{0.0412}\boldsymbol{ECT}(-\mathbf{1}) - \mathbf{0166}\boldsymbol{DlnTR}(-\mathbf{1}) \\ &- \mathbf{8.371}\boldsymbol{DlnURB}(-\mathbf{1}) \\ &+ \mathbf{8.176}\boldsymbol{DlnURB}(-\mathbf{2}) \\ &+ \mathbf{0.158}\boldsymbol{DlnOER}(-\mathbf{2}) \end{aligned}$$

$$\boldsymbol{P_{value}}[\mathbf{0.0933}]^{*}[\mathbf{0.0425}]^{**}[\mathbf{0.0122}]^{**}[\mathbf{0.0151}]^{**}[\mathbf{0.0615}]^{*} \quad (24)$$

The PVECM short run casualty is determined with the test for the joint significance of the lagged explanatory variables using Wald test. As shown in Table 9 the null hypothesis for the Wald test states that the coefficients for DlnTR (-1), DlnURB (-1), DlnURB(-2) and DlnOER(-2) are jointly equal to zero (C(2)=C(8)=C(9)=C(13)=0). This is done to check their influence on current tax to GDP ratio. Accordingly, the PVECM of short run causality shows that the null hypothesis is rejected as the overall test (P_value) shows that the coefficients are statistically significant and they are different from zero. This indicates that there is short run causality running from independent variables to dependent variable. The computed χ^2 (16.81338) with *(P_value = 0.0021***)* the coefficients are statistically significant.

Accordingly the results from PVECM using ECT and Wald test confirms that there is both long run and short run causality running from the set of independent variables to the dependent variable. The regression result for short run causality is subsequently shown.

Results of the panel data regression model

The long run empirical result in Table 10 shows that the model is estimated using five different estimation techniques. These are the Pooled OLS (see Appendix E) method (model one), the fixed effect regression model (model two), random effect regression model (model three), Feasible generalized least square model (model four) and the dynamic panel data generalized methods of moments model (model five). This helps to compare and contrast different estimation techniques as well as the robustness of the results.

The F statistic value (412.7) with *(P_value = 0.000***)* is high and significant for model 1 (Pooled OLS); therefore the overall model is acceptable. As per the regression results the coefficient of determination (R^2) of 80.7% implies that 80.7% of variations in tax revenue is explained by its determinants. For Pooled OLS model all variables are statistically significant apart from inflation.

Table 9. Panel Vector Error Correction Model: Short run causality.

Wald Test:			
Test Statistic	**Value**	**df**	**Probability**
Chi-square	16.81338	4	0.0021***
Null Hypothesis: C(2)=C(8)=C(9)=C(13)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)*		**Value**	**Std. Err.**
C(2)		-0.166297	0.081930
C(8)		-8.371098	3.336244
C(9)		8.176185	3.362391
C(13)		0.157501	0.084160

Restrictions are linear in coefficients. *** Indicates statistical significances at 1 %(**p<0.01).
*Where C(2), C(8), C(9) and C(13) are the coefficients of DlnTR(-1), DlnURB(-1), DlnURB(-2) and DlnOER(-2) respectively.
Source: Own Calculation (2017).

Table 10. The long run estimates of tax revenue determinants (1992-2015).

Explanatory variable	**Dependent variable: lnTR**				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	Pooled OLS	**FE**	**RE**	**FGLS**	**GMM**
lnGDPPC	0.299*** (0.0272)	0.0483 (0.0866)	0.299*** (0.0273)	0.299*** (0.0267)	0.119 (0.0807)
AID	0.0106*** 0.00254)	0.00523** (0.00179)	0.0106*** (0.00163)	0.0106*** (0.00159)	0.00494** (0.00155)
lnURB	-0.467*** (0.0649)	0.0686 (0.114)	-0.467*** (0.0385)	-0.467*** (0.0376)	0.0984 (0.110)
lnOPEN	0.243*** (0.0271)	0.338*** (0.0500)	0.243*** (0.0472)	0.243*** (0.0461)	0.236*** (0.0613)
lnOER	-0.0226* (0.00924)	-0.00203 (0.0347)	-0.0226*** (0.00571)	-0.0226*** (0.00557)	-0.0820*(0.0375)
AGR	0.0309*** (0.00416)	0.0257*** (0.00426)	0.0309*** (0.00376)	0.0309*** (0.00368)	0.00928* (0.00396)
IND	0.0112* (0.00470)	0.0142*** (0.00348)	0.0112** (0.00380)	0.0112** (0.00371)	0.00385 (0.00300)
SERV	0.0276*** (0.00278)	0.0219*** (0.00356)	0.0276*** (0.00299)	0.0276*** (0.00292)	0.00757 (0.00462)
INF	-0.00187 (0.00114)	-0.000788 (0.000792)	-0.00187* (0.000823)	-0.00187* (0.000804)	-0.00353*** (0.000937)
L.lnTR	-	-	-	-	0.586*** (0.0587)
CONS	-0.888 (0.521)	-0.968 (0.946)	-0.888* (0.415)	-0.888* (0.406)	-1.061 (0.831)
No. of Observations	216	216	216	216	207
No. of Countries	9	9	9	9	9
R-sq	0.807	0.344	-	-	-
Adj.R-sq	0.1802	0.287	-	-	-
F	412.7	11.53	-	-	-
Prob>F	0.000***	0.000***	-	-	-
Wald chi2(9)	-	-	863.34	905.25	264.87
Prob>chi2	-	-	0.000***	0.000***	0.000***

, ** and * indicate statistical significances at 1% (p<0.01), 5 %(**p<0.05) and 10% (*p<0.1), respectively. Standard errors in parentheses. Pooled OLS = Pooled Ordinary Least Square, FE= Fixed Effects, RE= Random Effects, FGLS= Feasible Generalized Square and GMM = Generalized Methods of Moments.
Source: Own Calculation (2017).

The sign of per capita GDP, foreign aid, openness, share of agriculture, share of industry and share of industry. All are significant at 1% except share of industry which is significant at 5%. Thus, all contribute positively towards tax enhancement of East African countries. On the contrary growth in urbanization and official exchange rate affect the tax revenue negatively over the period under review. The effect of inflation is insignificant.

The first and second column shows the long run model estimation done using the Fixed Effect (FE) and Random

Effect (RE) approaches. The FE model is applied under a vital assumption that the unobserved cross-country heterogeneity is correlated with the regressors included in the models while in the RE estimation is done with the assumption of correlation between the unobserved heterogeneity and included regressors is relaxed.

Similarly the F statistic value (11.53) with *(P_value =0.000***)* is high and significant for model 2 (Fixed Effect Model); therefore the overall model is acceptable. As per the regression results the coefficient of determination (R^2) of 34.4% implies that 34.4% of variations in tax revenue is explained by its determinants. Thus, compared to model 1 higher variation in dependent variable is explained by model 2. For Fixed Effects model foreign aid, openness, share of agriculture, share of industry and share of services have significant positive on the tax revenue of East Africa countries. They are all significant at 1%. However, per capita GDP, urbanization, official exchange rate and inflation have insignificant impact over the study period.

The Wald Chi^2 (863.34) with *(P_value =0.000***)* is also high and statistically significant for model 3 (Random Effect model). Thus, the overall model is acceptable. Per capita GDP, foreign aid, share of agriculture, share of industry and share of services have positive and significant contribution for tax revenue of East African countries. All of them are statistically significant at 1% except the share of industry which is significant at 5%. On the other side inflation, official exchange rate and growth in urbanization contributes negatively towards tax revenue of the region. Growth in official exchange rate and urbanization is significant at 1% while inflation is weakly significant at 10%.

One of the merits of the use of RE over FE model is that it allows for the inclusion of time-invariant variables which may be relevant in explaining the determinants of tax revenue in East African countries. But in situation where the unobserved heterogeneity is correlated with the regressors of the model, the FE model produces consistent and efficient estimates while the RE model does not. On the other hand, if the null hypothesis of no correlation between the unobserved heterogeneity and regressors is accepted, the RE model produces estimates that are both consistent and efficient (See Appendix G). In this situation, the FE model estimates are consistent but inefficient. Here Hausman test (Appendix H) is used to differentiate between the two approaches (that is, FE or RE model in panel data) produces efficient and consistent estimates.

Accordingly the null of no correlation is rejected based on the Hausman test in favour of the fixed effect models. The diagnosis tests result from the FE regression model shows that there is autocorrelation problem ($Cov(U_i, X_b) = 0.2852 \neq 0$) in the model (Appendix F). This violates the Classical Linear Regression Model (CLRM) assumption of no correlation between vector of explanatory variables and the error term ($Cov(X_{it}, \varepsilon_{it}) = 0$). (See Appendix L).

Therefore, even though the Hausman test selects fixed effects model over the random effect model as there is autocorrelation problem it may result in inefficient estimates (Hausman, 1978). With the presence of autocorrelation and heteroskedasticity problems using the Feasible Generalized Least Square (FGLS) estimation technique is appropriate to come up with efficient estimates (Kelvyn and Andrew), 2014. As one can see the regression results for FGLS it controls both for autocorrelation and heteroskedasticity problems and works under the assumption of no autocorrelation and homoscedasticity (Appendix J). On the other way instead of allowing for serial correlation in error term, the econometric model specification could also capture the performance of tax revenue performance by including the lagged value of the dependent variable which is creates problem. Such problem of serial correlation is solved by using the dynamic panel data model called the generalized methods of moments (GMM).Thus, estimation and interpretation of the model follows FLGS (See appendix I) and GMM techniques (See Appendix K).

Results from the dynamic panel methods shows that The Wald Chi^2 (264.87) with *(P_value = 0.000***)* is also high and statistically significant for model 5 (the GMM model). Thus, the overall model is acceptable. Foreign aid, trade openness, share of agriculture and one period lagged tax revenue have positive and significant contribution for tax revenue of East African countries. Trade openness and lagged tax revenue are statistically significant at 1% while foreign aid is significant at 5%. Lastly share of agriculture to GDP is statistically significant at 10%. On the other hand official exchange rate and inflation have negative significant impact during the period. Inflation is statistically significant at 1% while official exchange rate is significant at 10%.

Per capita GDP (GDPPC) has positive and significant impact on tax-GDP ratio. The FGLS regression result shows that GDDPC is statistically significant at 1% growth in GDPPC leads to 0.299% increase in growth of tax to GDP ratio. Sustained increase in GDP leads to increase in GDP per capita used to measure the relative economic performances. It is a tool for making comparison in standards of living between countries and over a period of time. Thus, higher income leads to increased GDP per capita which further leads to higher tax GDP ratio. This result disagrees with Teera (2003) and agrees with Workineh (2016) and Oyetunji (2008), (Tesfaye, 2015), (Timothy and Tosten, 2013), (Bornhorst et al., 2009), (Francis, 1979), (Richard, 2010).

Foreign Aid (AID) has positive and significant impact on tax revenue both for FGLS and GMM model at 1 and 5% of level of significance respectively. This concurs with the argument that for the economies of less developing countries where vicious circle of poverty is availing the rationale for foreign aid is very straight forward. The gap model theories asserts that foreign aid inflow fill the saving gap, foreign exchange gap and the revenue gap models. Thus, it is conceivable to see that it has positive impact on the tax revenue of East African countries. This

further proof that there is a complementarity role between foreign aid and tax revenue in place on being substitutable (Gaalya, 2015; Morrissey and Clist, 2010; Khan and Hoshino, 1992; Morrissey and Clist, 2010; Ouattara, 2006). Some other scholars argued that the share is declining from time to time depending on the commitment of 28 donors (Todaro, 2000) and it is not dependable and sustainable source of finance (United Nations, 2010); (Weeks, 2010), (Aniket and Yiagadeesen, 2012).

Urbanization (URB) measuring the proportion of population dwelling in urban areas in an important determinant of tax revenue. The FGLS estimation result in Table 10 shows that urbanization growth has negative and significant impact on tax revenue of the region over the period under consideration. As described earlier it is only when the supply forces surpasses the demand forces the positive impact is observed. Here in less developing countries including East Africa higher population in cities are associated with lower incomes because of high cost of living which further leads to low tax revenue collection. The finding is consistent with Addison and Levin (2006) and Becker et al. (1999); (Al-Hakami, 2008) and inconsistent with Nnyanzi et al. (2016). In urban economy, though better off, offered limited opportunities for revenue generation. In less developing countries including East African countries the formal economies accountable for tax revenue collection comprises of small, micro and medium enterprises which had been devastated and begin to re-emerge now. That is, there is low potential to tax revenue collection with adverse population pressures due to urbanization.

Openness (OPEN) has positive and significant impact on tax revenue to GDP ratio. As openness is the sum of export and import of goods and services the revenue obtained is tax of exports and imports also. The indication is that taxes on imports and exports do not have lots of administrative complications so that they can be easily collected and managed. The more the countries follows open economies trade among countries increases which has the repercussion effect of increasing in tax revenue from such trade interactions. For FGLS model 1% increase in growth of trade openness leads to about 0.243% increase in tax revenue to GDP ratio of the region while for GMM model 1% increase in growth of trade openness brings about 0.236% of growth in tax revenue to GDP ratio other things remain fixed. The FGLS model has more persistent impact then GMM model as it leads to higher increments for a given increase in trade openness. The result is consistent with (Addison and Levin, 2006); (Gaalya, 2015), (Gaalya et al., 2017), (Keen and Alejandro, 2004), (Rodrik, 1998).

Official exchange rate (OER) has negative and significant impact of the tax revenue of the region. Exchange rate appreciation will lead to decrease in export of goods and services. Such decrement in export has dual effects. One is decrease in production of exportable goods in the future and the other is decrease in income tax form exportable goods. Thus, the cumulative effect is that exchange rate appreciation leads to decrease in tax revenue of the region. The OER is statistically significant at 1 and 10% for FGLS and GMM models, respectively (Gaalya, 2015). Holding other things constant, for FGLS model a 1% growth in OER leads to 0.0226% decrease in growth of tax revenue as a ratio of GDP whereas for GMM model a 1% growth in OER leads to 0.236% decrease in growth of tax revenue.

The sectoral economic activities are other key factors influencing the revenue performances of the region. The FGLS regression result shows holding other factors constant 1% increase in share of agriculture value added as a % of GDP leads 3.09% increase in tax revenue as a ratio of GDP. In the same way the regression results GMM dynamic model shows that a 1% increase in share of agriculture leads to about 0.928% increase in tax revenue other things remaining constant. Thus over the period 1992-2015 agriculture contributes positively in supporting the tax revenue collection of East African countries. This shows agriculture is still backbone of the economy of less developing countries including the countries included in the study sample. Thus, as the contribution of the sector in imperative, modernization and transformation of the sector should key policy intervention. The finding is in contrary to Gupta (2007), Stotsky and Woldemariam (1997) and Teera (2003). Again the results from FGLS shows that share of industry have positive and significant impact on the tax revenue of the region even though it is significant for GMM model. A 1% increase in share of industry leads about 1.12% increase in tax revenue to GDP ratio holding other things fixed. This concurs with Teera (2003) and Workineh (2016). Moreover the FGLS regression result shows that share of service has positive and significant impact on tax revenue of East African countries. A 1% increase in share of service sector leads about 2.76% increase in tax revenue to GDP ratio holding other factors remaining constant.

Inflation rate (INF) measuring the over trend and movement in price of goods and services (a measure of macroeconomic stability of the region) has negative and significant impact on tax revenue both for FGLS and GMM model at 5 and 1% of level of significance, respectively. Both FGLS and GMM estimation results conforms this. According to the FGLS model a 1% increase in overall price of goods and services leads to about 0.187% decrease in tax revenue over the period under considerations hold other factors remaining constant. Like-minded for the GMM model 1% increase in overall price of goods and services leads to about 0.353 % decrease in tax revenue over the period under considerations hold other factors remaining fixed. This consistent with the findings of Ghura (1998); Agbeyegbe et al., (2009).

The GMM result confirms that lagged tax revenue is a strong and significant predictor of current revenue performance showing that higher tax revenue is the previous period leads higher tax revenue collection in the

current period. This is the superiority of the model in taking into account the lag of the dependent variable as explanatory variable. A 1% increase in lagged tax revenue leads to 0.586% increase in tax revenue as a ratio of GDP holding other factors remaining constant. The finding is agrees with (Nnyanzi et al., 2016).

Conclusion

The study examined the determinants of tax revenue in East African countries using the recent year's data ranging from 1992 to 2015 by employing panel data multivariate cointegration approach.

To achieve the objective of this study the econometric model capturing both dependent and set of independent variables is framed. Accordingly a panel econometric form encompassing the tax revenue as % of GDP (dependent variable) and other potential explanatory variables were set. Nevertheless, before we proceed for the panel cointegration test, all variables were tested for panel unit root test of stationarity using the LLC, IPS and ADF test of stationarity. The test for unit root shows that almost all variables are cointegrated of order one, I(1) except the variable inflation which is stationary at level. The panel cointegration test done using the Pedironi and Kao test cointegration test for residuals confirms the existence of long run relationship among variables.

The model estimation was made by using the FGLS and the dynamic panel data GMM model. As matter of fact, the estimation of the result shows that, there is divergence between the hypothesized sign and econometric results for some variables. But, the results are still supported by existing literatures. The long run estimated equation from the FGLS results indicates that per capita GDP, foreign aid, trade openness, share of agriculture, share of industry and share of services have positive contribution for tax revenue of east African countries over the study period. On the other hand, urbanization, official exchange rate and rate of inflation have negative impact of the tax revenue to GDP ratio. From the short run panel vector error correction model one period lagged tax revenue and urbanization has negative impact on the current period tax revenue while two period lagged urbanization and official exchange rate has positive impact.

POLICY IMPLICATION

In the context of recommendation based on the empirical conclusion, the following policy implications are drawn by the researcher.

It has been seen that the sectoral economic (share of agriculture, share of industry and share of share of services value added), contributes positively for tax revenue performance of East African Countries. This shows that these variables remain as key factors that can foster tax revenue of the region. Thus, East African countries should continuously take measures to improve the performance of each economic sector and for successful transformation of the economy. Introduction of new technologies, allowing innovation in production, policy incentives that supports sustainable resource use and the like should be practiced in an inclusive manner so that welfare of the general society is improved and tax revenue collected. Thus, a need to design policies and strategies to strengthen these sectors as they are the pillars to spur development and gear tax revenue potentials is a vital agenda.

The East African economy is characterized with the prevailing resource gaps. The regression result from FGLS and GMM shows that, foreign aid is used to finance this resource gap and keep on augmenting tax revenue of the region. But, since the issue financial sustainability by external funds is a key question. Thus, there should be attainable policies working towards enhancing tax revenue of the region via internal domestic resource mobilizations.

Empirical evidence obtained from this study is an indication that tax revenue will increase under stable macroeconomic environment. Hence, East African countries should therefore better pursue economic policies that reveal low inflation rate and favorable trade policies.

The overall result shows that the countries are required to set prudent macroeconomic policy environment which creates economic integrations among different sectors, mobilizes domestic resources and improve external trade policies to make each country's growth sustainable on the basis of domestic resource mobilizations. The cumulative effects lead to improved tax revenue collection of the region.

FURTHER RESEARCH

Since the research report do not incorporate all the determinants of tax revenue at a time, it is advisable for the study to further put emphasis on other determinants of tax revenue posing challenges on tax revenue of the region. Some of the factors include corruption, bribery, fragile human resource, extent of shadow economy and the likes. Thus, this deserves further study.

Further, the tax revenue model developed for this study is in the aggregated form. It would be more advisable if the model is in disaggregated form: (i) direct taxes, (ii) indirect taxes, (iii) VAT, (iv) tax from natural resources and (v) tax from non-natural resources and see how the fiscal policy works. By doing this, one can analyze the determinants of the disaggregated tax revenue types for the East African countries. Yet again this calls for further study.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Addison T, Levin J (2006). Determinants of tax revenue in Sub-Saharan Africa. https://pdfs.semanticscholar.org/84e0/fb345d98749b880a559a39ff8559cab96723.pdf

Agbeyegbe T, Stotsky G, WoldeMariam A (2009). Trade liberalization,exchange rate changes and tax revenue in Sub-Saharan Africa. IMF Working Paper No. 04-178.

Ahmed Q, Mohammed D (2010). Determinants of tax buoyancy: Empirical evidence from developing countries. European Journal of Social Sciences pp. 408-414.

Al-Hakami A (2008). Trade liberalization, exchange rate and tax revenue in Egypt,Jordan, Morocco and Tunisia. Journal of Business Studies 4.

Aniket B, Yiagadeesen S (2012). Aid and Taxation: Is Sub-Saharan Africa Different? (http://www.nsi-ins.ca/wp-content/uploads/2013/02/2012-Aid-and-Taxation.pdf). Research Report: The North South Insitute, 1-26.

Becker G, Glaeser E, Murphy K (1999). Population and economic growth. The American Economic Review 89:145-149.

Bersley T, Persson T (2014). Why do developing countries tax so little? Journal of Economic Perspectives 28(4):99-120.

Bornhorst F, Gupta S, Thornton J (2009). Natural resource endowment and domestic revenue effort. European Journal of Political Economy pp. 439-446.

David A (2000). Resource mobilization for Economic development: The role of internal tax administration pp. 1-31.

Ehtisham A, Nicholas S (1989). Taxation for develoing countries (Vol. II). (H. Chenery, & T. Srinivation, Eds.) The London School of Economics: Elsevier Science.

Francis W (1979). Taxation and development: Effects of Dutch tax policy on taxation of multinationals in developing countries.

Gaalya S (2015). Trade liberalization and tax revenue in Uganda. Modern Economy pp. 228-244.

Gaalya S, Bbaale E, Hisali E (2017). Trade openness and tax revenue performance in East African Countries. Modern Economy: Scientific research Publishing.

Garner B (1999). Black's Law Dictionary 7th Edition. West Group. (7th edition ed.). West group.

Ghura D (1998). Tax Revenue in Sub-Saharan Africa: Effects of Economic Policies. MF Working Paper 98/135. Washington: International Monetary.

Gupta A (2007). Determinants of Tax Revenue Efforts in Developing Countries. IMF Working Paper No. WP/07/184. IMF Working Paper, No. WP/07/184.

Hausman J (1978). The specification tests in Econometrics. Econometrica 46:1251-1271.

Im K, Pesaran H, Shin Y (2003). Testing for unit root in heterogenous panels. Journal of Econometrics 115:53-74.

IMF (2015). Regional Economic Outlook. (https://www.imf.org/~/media/Websites/IMF/imported.../2015/.../_sreo0415pdf.ashx)

Jing C, Been-Lon C, Mei H (2006). Agricultural productivity and economic growth: Role of tax revenues and infrastructures. Southern Economic Journal 72(4):891-914.

Joyce N (2014). Determinants of revenue collection in developing countries: Kenya's Tax Collection. Journal of Management and Business Administration 1(1):1-2.

Kao C (199). Spurious regression and residual based test for cointegration in panel data. Journal of Econometrics 65(1):9-15.

Kayaga L (2007). Tax policy challenges facing developing countries: A cause study of Uganda. Master's thesis.

Keen M, Alejandro S (2004). Tax Policy in developing countries: Some lessons from 1990s and some challenges a head in helping countries develop: The role of fiscal policy, 302.

Kelvyn J, Andrew B (2014). Explaining Fixed Effects:Random effects modelling of time series cross sectional and panel data. European political science and association pp. 1-21.

Khan H, Hoshino E (1992). Impact of foreign aid on fiscal behaviour of LDC governments. World development pp. 1481-1488.

Kremers J, Ericson N, Dolado J (1992). The power of cointegration tests. Oxford Bulletin of Economics and Statistics 54:325-47.

Langford B, Ohlenburg T (2016). Tax revenue potential and effort: An empirical investigation. International Growth Center (IGC) pp.1-30.

Levin A, Lin F, Chu C (2002). Unit root test in panel data: Asymptotic and finite sample properties. Journal of econometrics 10:1-24.

Maddala G, Wu S (1999). A comparative study for unit root with panel data and a new simple test. Oxford Bulleting of Economics and Statistics 61:631-652.

Matsuyama K (1992). Agricultural productivity, comparative advantage, and economic growth. Journal of Economic Theory 58:317-34.

Michael C (2015). Taxation Challenges in Developing Countries. Asia and the Pacific Policy Studies 2(1):169-182.

Morrissey O, Clist P (2010). Aid and tax revenue: Signs of a positive effect since the 1980s. Journal of inernatinal development 23(2):165-180, DOI:10.1002/jid.1656.

Mwakalobo S (2009). Economic reforms in East African Countries:The impact on government revenue and public investment.

Nnyanzi B, Babyenda P, Bbale M (2016). Regional Economic Integration and Tax Revenue: East Africa Community. Journal of Economic Integration 31(4):932-967.

Nouriel R (1994). Taxation and endogenous growth in open economies. Working Paper No.4881.

OECD J (2008). Tax Effects on Foreign Direct Investment – Recent Evidence and Policy Analysis. (OECD Tax Policy Study No.17).

Ouattara B (2006). Foreign aid and governemnt fiscal behavor in developing countries: Panel data evidence. Economic MOdelling 23(3):506-514.

Oyetunji A (2008). Determinants of tax revenue in Nigeria (1986 -2010). M.Sc thesis.

Pedironi P (1999). Critical value for cointegration tests in heterogenous panels with multiple regressors. Oxford Bulletin of Economics and Statistics 61:653-670.

Pedironi P (2004). Panel cointegration:Asymptotic and finite sample properties of pooled time series tests with an application to PPP hypothesis. Economic theory 20(3):597-625.

Richard B (2010). Taxation and development: Economic Premise.

Rodrik D (1998). Why do more open economies have bigger governments? Journal of Political Economy 106:997-1032.

Saeid M (2008). The level and composition of tax revenue in developing countries: Evidence from unbalanced panel data. International revenue of Economics and Finance pp. 607-617.

Saibu M, Olasunbo S (2013). Macroeoconomic determinants of tax revenue in Nigeria (1970-2011). World applied sciences P 27.

Stotsky J, WoldeMariam A (1997). Tax effort in Sub-Saharan Africa. IMF Working Paper, No. 97-107.

Tanzi V (1977). Inflation, lags in collection, and the real value of tax revenue. IMF staff Paper 24:154-167.

Tanzi V (1989). The impact of macroeconomic policies on the level of taxation and the fical blance in developing countries. IMF staff papers 36:633-656.

Taylor L (1990). Three-Gap Model,Problems of Developing Countries in the 1990s. World Bank, Washington Dc pp. 55-90.

Teera J (2003). Determinants of tax revenue share in Uganda. Center for public economics: Working paper 09b–03. University of Bath.

Tesfaye A (2015). Determinants of Tax revenue in Ethiopia.

Timothy B, Tosten P (2013). Taxation and development. http://www.lse.ac.uk/economics/Assets/Documents/personal-pages/tim-besley/working-papers/taxation-and-development.pdf, pp. 1-81.

Todaro, M. (2000). Economic development. Harlow:Pearson Education.

United Nations. (2010). Millennium development goals report. New York: United Nations.

Weeks J (2010). Enabling recovery and macro stability in LDCs: A study for least developed countries. London: University of London.

Workineh A (2016). Determinants of tax revenue in Ethiopia (Johansen Cointegration Approach). International Journal of Business, Economics and Management 3(6):69-84.

Zulal S (2005). Endogenous growth,taxes and government spending: Theory and Evidence.

List of Appendices

Appendix A: List of East African Countries included in the sample

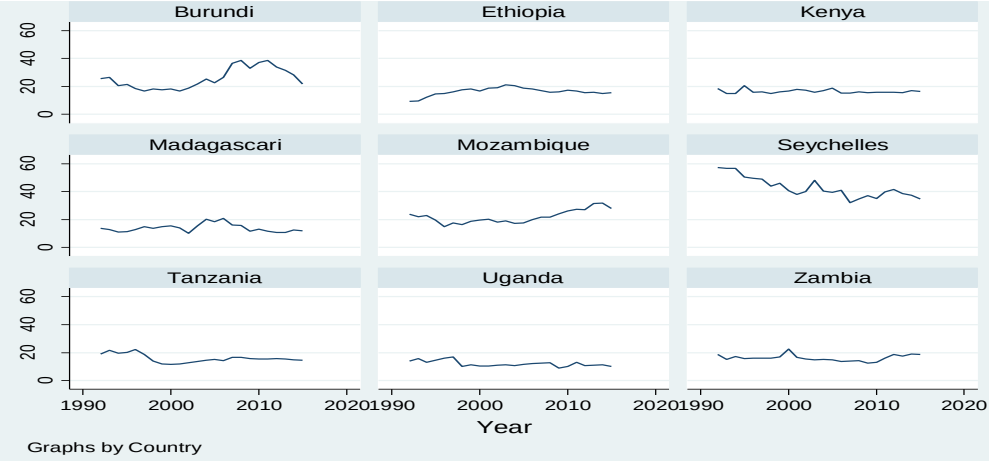
(1) Burundi
(2) Ethiopia
(3) Kenya
(4) Madagascari
(5) Mozambique
(6) Sechychelles
(7) Tanzania
(8) Zambia
(9) Uganda

Appendix B. Definition of variables.

Name	Definition of variables	Source
TR	Tax revenue (% of GDP)	WDI[7]
GDPPC	Gross domestic product divided by midyear population.	WDI
AID	Net ODA received (% of GNI).	WDI
URB	People living in urban areas defined as % of total population	WDI
OPEN	Openness measured as the sum of exports and imports of goods and services a ratio of GDP	WDI
OER	Official exchange rate (LCU per US$, period average) calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar).	WDI
AGR	Agriculture, value added (% of GDP)	WDI
IND	Industry, value added (% of GDP)	WDI
SERV	Is Services, etc., value added (% of GDP)	
INF	Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole	IMF[8]

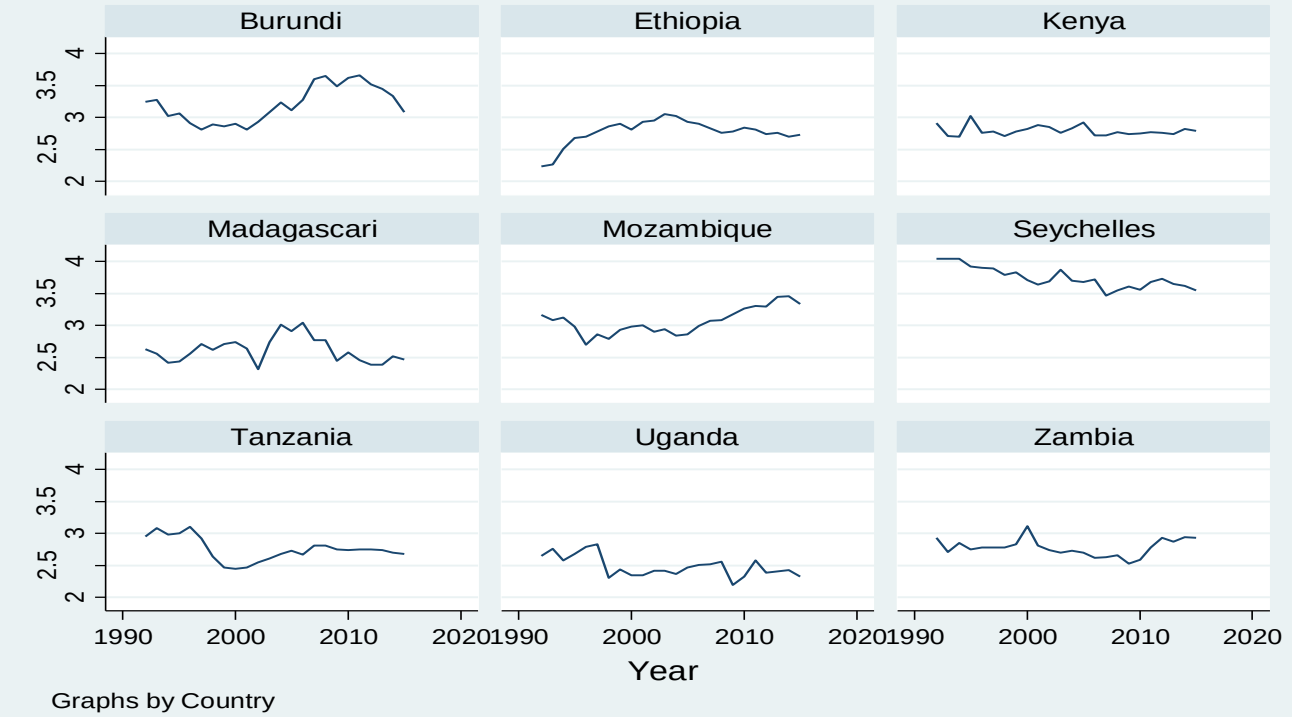
IMF: International Monetary Fund, WDI=World Development Indicator

Appendix C: Trends of tax revenue for East African countries.



[7]Extracted from World Bank data bank
[8]Extracted from the World Economic Outlook data base

Appendix D. Growth rate of Tax revenue as a share of GDP over the period 1992 -2015 for East African countries.



Appendix D. Summary of basic summary regression results.

Appendix E. Pooled OLS.

```
. xtscc lnTR lnGDPPC AID lnURB lnOPEN lnOER AGR IND SERV INF

Regression with Driscoll-Kraay standard errors   Number of obs      =       216
Method: Pooled OLS                               Number of groups   =         9
Group variable (i): country1                     F(  9,     23)     =    412.72
maximum lag: 2                                   Prob > F           =    0.0000
                                                 R-squared          =    0.8074
                                                 Root MSE           =    0.1802
```

lnTR	Drisc/Kraay Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnGDPPC	.2991245	.0271884	11.00	0.000	.242881	.3553679
AID	.0105826	.0025403	4.17	0.000	.0053276	.0158376
lnURB	-.4673258	.0649035	-7.20	0.000	-.601589	-.3330626
lnOPEN	.2429886	.027095	8.97	0.000	.1869382	.299039
lnOER	-.0226171	.0092449	-2.45	0.022	-.0417416	-.0034927
AGR	.030923	.0041611	7.43	0.000	.0223151	.0395309
IND	.0111748	.0046995	2.38	0.026	.001453	.0208965
SERV	.0275969	.0027785	9.93	0.000	.021849	.0333448
INF	-.0018678	.0011404	-1.64	0.115	-.004227	.0004913
_cons	-.8880204	.5206628	-1.71	0.102	-1.965094	.1890528

Appendix F. Fixed effect regression results.

```
. xtreg lnTR lnGDPPC AID lnURB lnOPEN lnOER AGR IND SERV INF,fe

Fixed-effects (within) regression               Number of obs      =       216
Group variable: country1                        Number of groups   =         9

R-sq:  within  = 0.3438                         Obs per group: min =        24
       between = 0.5831                                        avg =      24.0
       overall = 0.5241                                        max =        24

                                                F(9,198)           =     11.53
corr(u_i, Xb)  = 0.2852                         Prob > F           =    0.0000
```

lnTR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnGDPPC	.048307	.0865844	0.56	0.578	-.122439	.219053
AID	.0052251	.0017878	2.92	0.004	.0016995	.0087507
lnURB	.0685911	.1135788	0.60	0.547	-.1553883	.2925704
lnOPEN	.3384711	.0500493	6.76	0.000	.239773	.4371691
lnOER	-.0020331	.0347024	-0.06	0.953	-.0704668	.0664006
AGR	.0257301	.0042593	6.04	0.000	.0173306	.0341295
IND	.0142222	.0034799	4.09	0.000	.0073597	.0210846
SERV	.0218669	.0035557	6.15	0.000	.014855	.0288788
INF	-.0007878	.000792	-0.99	0.321	-.0023496	.000774
_cons	-.9677647	.9464845	-1.02	0.308	-2.834249	.8987193
sigma_u	.25864061					
sigma_e	.1546192					
rho	.73671197	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(8, 198) =    10.24                 Prob > F = 0.0000
```

Appendix G. Random Effects Regression Results.

```
. xtreg lnTR lnGDPPC AID lnURB lnOPEN lnOER AGR IND SERV INF,re

Random-effects GLS regression                   Number of obs      =       216
Group variable: country1                        Number of groups   =         9

R-sq:  within  = 0.2371                         Obs per group: min =        24
       between = 0.9907                                        avg =      24.0
       overall = 0.8074                                        max =        24

                                                Wald chi2(9)       =    863.34
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

lnTR	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnGDPPC	.2991245	.027337	10.94	0.000	.2455449	.352704
AID	.0105826	.001627	6.50	0.000	.0073937	.0137715
lnURB	-.4673258	.038491	-12.14	0.000	-.5427668	-.3918849
lnOPEN	.2429886	.0472167	5.15	0.000	.1504456	.3355316
lnOER	-.0226171	.0057087	-3.96	0.000	-.0338059	-.0114283
AGR	.030923	.0037639	8.22	0.000	.0235458	.0383001
IND	.0111748	.0037991	2.94	0.003	.0037286	.0186209
SERV	.0275969	.0029946	9.22	0.000	.0217275	.0334663
INF	-.0018678	.0008229	-2.27	0.023	-.0034806	-.000255
_cons	-.8880204	.4152831	-2.14	0.032	-1.70196	-.0740805
sigma_u	0					
sigma_e	.1546192					
rho	0	(fraction of variance due to u_i)				

Appendix H. *Hausman Test for fixed versus random effect model.*

hausman FE RE, sigmamore

	Coefficients			
	(b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnGDPPC	.048307	.2991245	-.2508175	.0971644
AID	.0052251	.0105826	-.0053575	.0013025
lnURB	.0685911	-.4673258	.5359169	.1266876
lnOPEN	.3384711	.2429886	.0954825	.0342751
lnOER	-.0020331	-.0226171	.020584	.0400499
AGR	.0257301	.030923	-.0051929	.0032384
IND	.0142222	.0111748	.0030474	.0014226
SERV	.0218669	.0275969	-.00573	.002866
INF	-.0007878	-.0018678	.00108	.0004187

```
                b = consistent under Ho and Ha; obtained from xtreg
     B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test:  Ho:  difference in coefficients not systematic

              chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =       60.30
            Prob>chi2 =      0.0000
```

Appendix I. Feasible generalized least square (FGLS).

```
. xtgls lnTR lnGDPPC AID lnURB lnOPEN lnOER AGR IND SERV INF

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        homoskedastic
Correlation:   no autocorrelation

Estimated covariances      =         1          Number of obs      =       216
Estimated autocorrelations =         0          Number of groups   =         9
Estimated coefficients     =        10          Time periods       =        24
                                                Wald chi2(9)       =    905.25
Log likelihood             =  68.72644          Prob > chi2        =    0.0000
```

lnTR	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnGDPPC	.2991245	.0266967	11.20	0.000	.2467999	.351449
AID	.0105826	.0015889	6.66	0.000	.0074684	.0136968
lnURB	-.4673258	.0375894	-12.43	0.000	-.5409997	-.3936519
lnOPEN	.2429886	.0461108	5.27	0.000	.1526132	.333364
lnOER	-.0226171	.005575	-4.06	0.000	-.0335438	-.0116904
AGR	.030923	.0036758	8.41	0.000	.0237186	.0381274
IND	.0111748	.0037101	3.01	0.003	.003903	.0184465
SERV	.0275969	.0029245	9.44	0.000	.021865	.0333288
INF	-.0018678	.0008036	-2.32	0.020	-.0034428	-.0002928
_cons	-.8880204	.4055561	-2.19	0.029	-1.682896	-.093145

Appendix J. Linear regressions with Panel Corrected Standard Errors (PCSE).

Linear regression, correlated panels corrected standard errors (PCSEs)

Group variable:	country1	Number of obs =	216
Time variable:	Year	Number of groups =	9
Panels:	correlated (balanced)	Obs per group: min =	24
Autocorrelation:	no autocorrelation	avg =	24
		max =	24
Estimated covariances =	45	R-squared =	0.8074
Estimated autocorrelations =	0	Wald chi2(9) =	941.46
Estimated coefficients =	10	Prob > chi2 =	0.0000

lnTR	Panel-corrected Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnGDPPC	.2991245	.0311143	9.61	0.000	.2381415	.3601074
AID	.0105826	.0016866	6.27	0.000	.007277	.0138882
lnURB	-.4673258	.0610665	-7.65	0.000	-.5870141	-.3476376
lnOPEN	.2429886	.0539705	4.50	0.000	.1372084	.3487688
lnOER	-.0226171	.0053283	-4.24	0.000	-.0330604	-.0121738
AGR	.030923	.00411	7.52	0.000	.0228675	.0389785
IND	.0111748	.004294	2.60	0.009	.0027588	.0195908
SERV	.0275969	.0031672	8.71	0.000	.0213893	.0338045
INF	-.0018678	.0008922	-2.09	0.036	-.0036164	-.0001192
_cons	-.8880204	.4797743	-1.85	0.064	-1.828361	.05232

Appendix K. Generalized Methods of Moments (GMM) regression.

Dynamic panel-data estimation

Group variable: country1	Number of obs =		207
Time variable: Year	Number of groups =		9
	Obs per group:	min =	23
		avg =	23
		max =	23
Number of instruments = 163	Wald chi2(10) =		264.87
	Prob > chi2 =		0.0000

One-step results

lnIR	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnIR						
L1.	.5662035	.0566914	9.99	0.000	.4711723	.7012386
lnGDPPC	.1190248	.0807066	1.47	0.140	-.0391573	.2772069
AID	.0049397	.0015461	3.19	0.001	.0019093	.00797
lnURB	.0983874	.1103191	0.89	0.372	-.117834	.3146088
lnOPEN	.233553	.061308	3.84	0.000	.1153916	.3557145
lnOER	-.0519944	.0374866	-2.19	0.029	-.1554668	-.008522
AGR	.0092754	.003956	2.34	0.019	.0015218	.017029
IND	.0038522	.0030033	1.28	0.200	-.0020342	.0097386
SERV	.0075725	.0046164	1.64	0.101	-.0014755	.0166205
INF	-.0035291	.0009368	-3.77	0.000	-.0053652	-.0016931
_cons	-1.060351	.8313619	-1.28	0.202	-2.689991	.5692879

Instruments for differenced equation
GMM-type: L(2/.).lnIR
Instruments for level equation
Standard: _cons

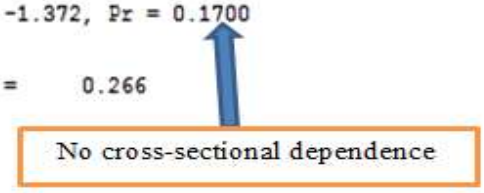
Appendix L: Testing for cross-sectional dependence/ contemporaneous correlation

Note: Cross-sectional dependence (CD) is an issue of macro panels with long time series (over 20-30 years) than in micro panels. CD test is used to test whether the residuals are correlated across entities. Cross-sectional dependence can lead to bias in tests results (also called contemporaneous correlation). The null hypothesis is that residuals are not correlated.

```
. xtcsd, pesaran abs

Pesaran's test of cross sectional independence =    -1.372, Pr = 0.1700

Average absolute value of the off-diagonal elements =     0.266
```



Related Journals: