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TAX REVENUE AND THE ECONOMY OF SUB-SAHARAN AFRICA: A SYSTEMIC ANALYSIS

Joseph Eleojo Attah[1] , Simeon G. Nenbee[2] and Jamilu Aliyu Wamkko[3]
[3] Department of Economics, Faculty of Social Sciences, University of Port Harcourt, Port Harcourt, Nigeria

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ABSTRACT*: This paper examines the role of tax revenue in engineering economic growth in the Sub-Saharan Africa (SSA) region, analyzing data for 12 regional countries obtained from secondary sources such as the OECD database and World Bank World Development Indicators (WDI), covering the period 2005-2020, and analyzed using the fixed effect method, which accounts for possible heterogeneity among the SSA countries. Economic growth was measured using real gross domestic product, and tax revenue by ratio of tax revenue to GDP. The study controlled for other economic growth drivers such as trade openness, foreign direct investment, exchange rate, domestic investment and money supply. The salient findings indicate that taxation hampers the economic growth of SSA countries, and that domestic investment and favorable exchange rates promote economic growth in the SSA region, but domestic investment has a greater stimulating impact. Based on these findings, we recommend that governments of the SSA countries should implement tax cuts or expand the tax base of the local economy in order to reduce the deadweight loss of increased taxation.*

KEYWORDS: tax revenue, economic growth, sub-Saharan Africa countries, fixed effect model

INTRODUCTION

Increased state spending increases the revenue required by governments via taxation; taxation incurs costs on private sector productivity and can hamper growth. Consequently, it is an eternal quest for economists and policy makers to optimize taxation relative to public and private sector needs. When the public income level (i.e., tax revenue) is lower than public spending, states incur increasing national debts, which has numerous macroeconomic impacts (e.g., currency devaluation). Attempting to navigate the many complex and interwoven economic factors and effects of fiscal policy and market forces, countries generally seek to make their tax administration more efficient and less economically onerous. Tax revenue is essentially a compulsory levy by the government on citizens and their property to spend on common needs thought essential to guarantee socio-economic development and prosperity, such as defense, education, healthcare, and infrastructure.

Archaeological evidence suggests that taxes were first levied by King Scorpion I of the First Empire in Southern Egypt, c. 3300-3200 BCE, as attested by clay tablets, postage stamps, jars, and vases uncovered in the royal tomb indicating tax administration attempts. Like other discoveries, these artifacts are significant not only because of the taxes but that they contained the earliest examples of the hieroglyphic script, using symbols to describe constants and shape syllables. Similarly, they recorded that the King received linen and oil as tithes, with a list of subjects' names appearing next to the log of numbers in the billing organizations (Samson, 2002). The King viewed subjects themselves as personal properly, and levies of human beings as slaves to build pyramids or serve in the army were part of the same ethos as levies on trade goods. For those lacking trade goods/ wealth and property, providing labor to the government has often been a form of paying taxes. Biblical tithes of 10 percent of annual earnings (after expenses) were levied on the Israelites for the upkeep of the Temple and its priests (Ishida, 2015), as attested by the Bible, which may be considered a form of taxation (Dalton, 2020).

Regardless of the precise beginnings of the institutionalization of tax, and the actual beginnings of tax collection and administration, it is clear that tax is as old as organized human civilizations, and is essential to complex human societies, and its effective management can minimize negative impacts and maximize positive outcomes (Brown & Tourigian, 2006). Onerous fiscal raids (sudden and punitive taxes) may yield an immediate boost for government treasuries, but they undermine long-term productivity; conversely, moderate taxes for revenue investment in education and infrastructure development can increase national competitiveness (and thus boost economic growth) over the long term. Nevertheless, despite the rationale basis for taxation, people generally resent the state appearing to plunder and seize their capital, and those with more economic resources (and thus greater ability to pay tax) are better positioned to pay accountancy professionals and access schemes to avoid or evade tax.

For instance, the 25 richest Americans pay little if any federal income tax. Consequently, tax administration is a tasking role for economic mangers and policy makers, but the very wealthiest individuals and corporations are easily able to avoid a massive part of their normative tax burden by means of legal tax avoidance schemes. This has increased calls for international taxations agreements and frameworks (Preston, Blundell, & Preston, 2019), but the integration of political and corporate elites makes it unfeasible to tax the super wealthy, particularly as the US – one of the world's largest and most transparent economies – is also a hub of tax avoidance for the super wealthy (Eisinger, Ernsthausen, & Kiel, 2021).

Taxation is a major contemporary economic issue that impacts all countries in the world (Karaawy & Albaag, 2018; McLure, Neumark, Fritz, & Cox, 2020). National governments seek to manage and manipulate taxation systems to achieve national socio-economic objectives, including in Sub-Saharan Africa (SSA) (Neubig, 2018). This paper examines the effect of tax revenue on the economy of this region.

EMPIRICAL LITERATURE REVIEW

To identify the relevant studies for review, we searched databases (Web of Science, Google Scholar, EMBASE and Scopus) to identify studies published in January 2006–November 2016 that evaluated the evidence of tax revenue and the economy in sub-Saharan Africa**.** Egbunike, Emudainohwo, and Gunardi (2018) employed the ordinary least squares (OLS), unit root and granger causality methods to examine the effect of tax revenue on economic growth in Nigeria and Ghana from 2000 to 2016. As reported, tax revenue impacted positively on gross domestic product (GDP) in both Nigeria and Ghana. No evidence of causality between tax revenue and GDP was found in Nigeria. In Ghana, GDP was found to granger cause tax revenue. Babatunde, Ibukun, and Oyeyemi (2017) used a dataset of 16 African countries spanning the period 2004 to 2013 to examine the nature of relationship between tax revenue and economic growth in Africa. Panel methods such as panel unit root, panel cointegration and the generalized least squares method were adopted for the study. The result of the analysis was in congruence with economic postulates as tax revenue had positive impact on output level. Foreign direct investment (FDI) exhibited the same positive impact, while inflation contrast sharply in negatively affecting output levels.

In examining the impact of indirect taxes on economic growth in Pakistan, Ahmad, Sial, and Ahmad (2018) used the autoregressive distributed lag (ARDL) method. Their study covered the period 1974 to 2010, and they controlled for other economic growth determinants such as physical capital (measured using gross fixed capital formation), human capital (proxy by ratio of primary school enrolment to labor force), and inflation. They confirmed through bound testing that indirect tax negatively affects economic growth in the long run, and they reported that physical capital has a positive effect on economic growth. Munir and Sultan (2018) also used ARDL to show that indirect taxes promote economic growth in Pakistan in the long and short run, reporting that from 1976 to 2014 direct taxes also stimulated the economy of Pakistan.

Ojong, Anthony, and Arikpo (2016) observed that petroleum profit tax and company income tax insignificantly affect the economy of Nigeria from 1986 to 2010. They reported that non-oil revenue enhances the economy of Nigeria. The findings of their study emanate from the use of OLS method for model estimation. However, the findings of Onwe, Udeh, and Ngwoke (2019) differed concerning petroleum profit tax exerting an insignificant effect on the economy of Nigeria; their OLS results contend that the effects of petroleum profit tax and company income tax on the economy of Nigeria are positive and significant, for a 13-years period from 2005 to 2017. With a longer time span of 1981 to 2019, Agunbiade and Idebi (2020) noted that the shocks to company income tax (CIT) and petroleum profit tax (PPT) tend to have a relatively low effect on GDP growth in Nigeria, while the shock of value added tax (VAT) more significantly affect GDP than PPT and CIT. This relationship was examined using the vector error correction mechanism (VECM).

Quarterly datasets from 1986Q1 to 2014Q4 were employed by Takumah and Iyke (2017) to examine the causal relationship between tax revenue and economic growth in Ghana. The causal

relationship was examined using the Toda Yamamoto test over the conventional Granger method. The result of the analysis point to the ability of tax revenue to influence economic growth as evidence of unidirectional causality from tax revenue to economic growth. Their findings were robust, as the direction of causality still prevailed even when tax revenue was disaggregated into corporate, custom, and individual taxes.

The salient findings of Ali, Ali, and Dalmar (2018) included that tax revenue significantly contributes to the growth of the Kenyan national economy, with a positive link between tax revenue and GDP indicated by the application of OLS method in analyzing annual data from 1980 to 2007.

Durusu-Ciftci, Gokmenoglu and Yetkiner (2018) assessed the long-run relationship between taxation and income of 30 OECD countries. Tax revenue streams were decomposed into corporate profit, consumption, property, and personal income taxes, which were analyzed using the common correlated effects (CCE) panel cointegration method. The panel result indicated that for the period spanning from 1995 to 2016, only consumption tax negatively affected the long-run income level of the OECD countries.

Gbato (2017) analyzed 32 SSA countries from 1980 to 2010. Focusing on how taxes and economic growth relate in the long run, the dynamic common correlated effects (DCCE) results showed that indirect taxes dampen economic growth. A dataset of 18 SSA countries from 1990 to 2012 was analyzed using the fixed effect method by Ugwuanyi and Ugwunta (2017), who found distortionary taxes to be growth inducers. The Seemingly Unrelated Regression Estimator (SURE) was adopted by Oboh, Chinonyelum, and Edeme (2018) to examine the role of tax revenue in the long-run economic growth of five Economic Community of West African States (ECOWAS) nations. The five-country dataset was sampled from 2000 to 2015 and tax revenue was disaggregated into direct and indirect tax revenue. The panel result indicated that total tax and indirect tax revenues are productive in the five countries, with strong evidence of a dampening effect of direct tax revenue. On the same front, trade openness negatively affects economic growth, in relation to which FDI promotes economic growth in the five countries.

Raghutla (2020) found that trade openness is potentially helpful in ensuring that economic growth is achieved in the five emerging economies of Brazil, China, India, South Africa, and Russia (BRICS). Heterogeneous panel non-causality test showed one-way causation running from economic growth to trade openness. Similar findings by Banday, Murugan, and Maryam (2021) using pooled mean group (PMG) method indicated that FDI and trade openness enhance long-run growth in BRICS economies.

Generalized method of moments (GMM) was used to analyze 50 African countries from 1980 to 2009 by Gui-Diby (2014), who reported that FDI contributed positively to the economy of the countries studied. However, Adams and Opoku (2015) differed from this, applying GMM with a smaller dataset of similar duration, comprising 22 SSA countries from 1980 to 2011. They found

that FDI does not have a stand-alone significant impact on economic growth, rather it merely has a stimulating impact, which is conditional on the presence of effective regulations. Ibhagui (2020) also buttressed the argument and opined that the direct effect of FDI on economic growth is inconsistent and ambiguous; more precisely, it is able to stimulate economic growth in 45 SSA countries when the inflation level is below 10.23 percent, private sector credit does not exceed 14.58 percent of GDP, and an initial income level of $128 per annum is achieved.

METHODOLOGY

This Section discusses the choice of philosophical assumptions for the paper, methodology and methods including instruments for the data collection and its justification, population of the study, technique for data analysis. Methodology refers to theories of social reality and the procedures, methods, and techniques use to aggregate and analyse data. This was re-iterated by Somekh and Lewin (2005) who described methodology as the collection of methods by which a particular piece of research is undertaken and the principles theories and values that underpin the research approach. The choice of research methodology depends on the nature of the research question(s) which in turns determine the underpinning paradigms for the research. For this paper, a quantitative methodology is used to address the systematic review. The section discusses the research methodology, justification for the choosing methodology, research paradigms and justification for the selection of the appropriate paradigm for the paper, followed by research design. Subsequently, selection of the research population, source of data collection, technique for data analysis, variable measurement and model specification for the study are discussed.

Paradigm

Since review emerge from diverse viewpoints, different research paradigms have evolved to match the criteria according to which one would select and define the problems of enquiry. Accordingly supporting the philosophical perspectives underpinning any research is crucial because it acts as a bridge between the ontological and epistemological grounds of a study and the methods used to conduct the research (Walter, 2006). it is therefore necessary to understand the philosophical assumptions underpinning any research and the justification for selecting appropriate paradigms the research. Additionally, the ontological and epistemological view have the capacity to influence the achievement of a study objectives. Therefore, this section describes the context of this study from a philosophical stance including justification of the appropriate paradigm for the research.

Data and Sources

The study employed secondary data in investigating the nature of relationship between economic growth (measured using real GDP) and the vector of independent variables. **Because we used only secondary data sources without any identifiable information and publicly available, this study was exempt from submission to ethics committee**. Data that span from 2005 to 2020 were sourced from the World Bank World Development Indicators (WDIs) and the Organization of Economic Co-operation and Development (OECD) database. Table 1 summarizes the data sources for each studied variable.

Model Specification

For this study, we employed seven variables in examining the relationship between tax revenue and economic growth in SSA, with a pooled dataset of 12 SSA countries (Appendix I). The seven variables include real GDP (used as proxy of economic growth), ratio of tax revenue to GDP, trade openness, net FDI inflows as percentage of GDP, exchange rate, investment (proxy by gross fixed capital formation), and broad money supply (Table 1)

Table 1: Variables, Measurements, and Sources

Variable	Measurement	Source
$rgdp_{it}$	Real GDP measures national economic growth.	WDI
tax_{it}	Ratio of tax revenue to GDP.	OECD
top_{it}	Trade openness is the sum of export and import expressed as a percentage of GDP.	WDI
fdi_{it}	Net FDI ratio to GDP was used to measure FDI.	WDI
exr_{it}	Exchange rate defines the value of the domestic currency in terms of the US dollar.	WDI
inv_{it}	This captures the volume of investment in country i, using gross fixed capital formation as a measure.	WDI
ms_{it}	This represents the volume of money in circulation in country i. The ratio of broad money to GDP was used as a proxy.	WDI

Source: Authors' computation

The choice of model for this study follows that employed by Babatunde, Ibukun, & Oyeyemi (2017). However, we made modifications to accommodate variables shown by empirical studies to have impact on economic growth (Gui-Diby, 2014; Idris, 2019; Ndambendia & AL-Hayky, 2011; Raghutla, 2020). The model for this study is functionally expressed as:

$$rgdp_{it} = f(tax_{it}, top_{it}, fdi_{it}, exr_{it}, inv_{it}, ms_{it}) \quad (1)$$

Equation (1) is expressed in pooled form and static specifications. The pooled model assumes that there is no heterogeneity in the countries studied. The static model is split into the fixed effect and random effect model. Both dimensions hold separate assumptions regarding heterogeneity and correlation of the country-specific effect in relation to the explanatory variables.

Pooled Regression Model

$$Y_{it} = \alpha + \beta X'_{it} + \mu_{it} \quad (2)$$

Where:

$Y_{i,t}$ is the dependent variable ($rgdp_{it}$)

$X'_{i,t}$ is a vector of independent variables ($tax_{it}, top_{it}, fdi_{it}, exr_{it}, inv_{it}, ms_{it}$)

α represents the common intercept across countries; and

μ_{it} represents the error term.

Fixed Effect Model

The fixed effect model is specified as:

$$Y_{it} = \alpha_i + \beta X'_{it} + \mu_{it} \quad (3)$$

Where:

α_i is the unobserved country-specific effects.

The properties of Equation 3 capture time-invariant effects specific to a particular country. In the specified model of 12 countries, the fixed effect model takes account of factors such as culture, geography, and natural endowments that vary across countries, but not across time. The model also allows for correlation between the time-invariant effects and explanatory variables.

Random Effect Model

This method is an alternative to the fixed effect model. The difference lies in how the constant parameter is treated. In the random effect model, the constant is not fixed, but functions as a random parameter. The model is expressed as:

$$Y_{it} = \beta X'_{it} + \epsilon_i \quad (4)$$

$$\epsilon_i = \alpha + \varepsilon_i \quad (5)$$

RESULTS AND DISCUSSION

The descriptive analysis of the dataset of 12 SSA countries is summarized in Table 2. It can be seen that the average regional values were 5.07E+10 for real GDP, 12.64 percent of GDP for tax revenue, 75.73 percent of GDP involvement in trade (trade openness), FDI of 5.34 percent of GDP, and domestic currency value in terms of the dollar average of 1168.45. Investment of 1.49E+10 investment was made in the region, and the volume of money averaged 28.80 percent of GDP. The maximum and minimum values for each series are also reported in Table 2. Real GDP had a

maximum value of 4.77E+11 and a minimum of 1.25E+09. The maximum and minimum for tax revenue were 27.37 percent and 4.38 percent of GDP respectively. The maximum and minimum calculated values were as follows for the studied variables: TOP (311.35 to 20.72 percent), FDI (103.33 to -6.36 percent of GDP), EXR (9829.92 to 0.90 of USD), INV (1.24E+11 to 1.42E+08). Money supply had a maximum of 52.70 percent and a minimum of 11.30 percent of GDP. From the result of the descriptive analysis, all the variables are positively skewed and not normally distributed (see probability value of the JarqueBera statistics).

Table 2: Descriptive Statistics

	RGDP	TAX	TOP	FDI	EXR	INV	MS
Mean	5.07E+10	12.64	75.73	5.34	1168.45	1.49E+10	28.80
Median	1.13E+10	11.83	69.45	2.56	446.00	2.35E+09	26.58
Maximum	4.77E+11	27.37	311.35	103.33	9829.92	1.24E+11	52.70
Minimum	1.25E+09	4.38	20.72	-6.36	0.90	1.42E+08	11.30
Std. Dev.	1.08E+11	4.71	38.06	13.02	2256.57	2.39E+10	9.44
Skewness	2.95	1.23	2.86	5.62	2.38	1.87	0.53
Kurtosis	10.62	4.74	16.56	37.10	7.58	6.17	2.58
J. Bera	745.78	70.20	1698.85	9670.62	347.87	187.32	10.13
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0062
Obs.	192	185	188	180	191	186	186

Source: Authors' computation (2021)

The results of model estimation (i.e., for models 2, 3, and 4) are presented in Table 3. Panel A contains the results of the pooled model, which assumes that no heterogeneity existed between the countries. The results for the fixed and random models are reported in panel B and C, respectively. The Hausman test was applied to decide between the fixed and random models. The null hypothesis of the test is that the random model is best in examining the relationship between tax revenue and economic growth in SSA. From the results of the test, we found that the probability value of the chi-square is less than zero. Following this, the study rejected the random model and analyzed the relationship between tax revenue and economic growth in SSA using the fixed effect model.

Table 3: Regression Results

	Pooled OLS (A)		**FE-Model (B)**		**RE-Model (C)**	
Variable	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
tax_{it}	-0.0725***	0.0117	-0.0930***	0.0122	-0.0725***	0.0117
top_{it}	-0.0019*	0.0011	-0.0015	0.0011	-0.0019*	0.0011
fdi_{it}	-0.0068**	0.0031	-0.0036	0.0033	-0.0068**	0.0031
$lexr_{it}$	0.0407**	0.0194	0.0756***	0.0201	0.0407**	0.0194
$linv_{it}$	0.8191***	0.0244	0.8725***	0.0262	0.8191***	0.0244
ms_{it}	-0.0109*	0.0057	0.0061	0.0067	-0.0109*	0.0057
C	6.5515***	0.6149	4.9270***	0.6880	6.5515***	0.6149
Model Diagnostic Checks						
R^2	0.8979		0.8917		0.8970	
F-Statistics	246.35***		258.03***		1478.09***	
$Hau-Test$			35.19[0.0000]			
observations	175		175		175	
Countries	12		12		12	

Note: *, ** and *** denote significance at 10%, 5% and 1% respectively.
Source: Authors' computation (2021)

From panel B, about 89 percent of the variation in economic growth is explained by the independents. The difference of 11 is caused by variables captured by the error term. The study found a negative relationship between tax revenue and economic growth, which affirms economic theory suggesting that the marginal effect of tax is negative. An increase in tax rate (tax revenue) will lead to a reduction in aggregate output in the long run. The negative impact of tax is statistically significant. While Ojong, Anthony, and Arikpo (2016) found the impact of tax revenue to be insignificant, our findings concur with those of Durusu-Ciftci, Gokmenoglu, and Yetkiner (2018) and Gbato (2017), who showed that tax revenue hampers economic growth. These findings are contrary to those of other studies, which reported a positive relationship between tax revenue and economic growth (Ali, Ali, & Dalmar, 2018; Babatunde, Ibukun, & Oyeyemi, 2017; Oboh, Chinonyelum, & Edeme, 2018; Onwe, Udeh, & Ngwoke, 2019).

In contrast, we found a positive relationship between exchange rate and economic growth in the long run. A fall in currency value will stimulate economic growth by 0.0756 percent in the long run, in agreement with economic theory. The inelastic effect of exchange rate is statistically significant. The results show that FDI inflow leads to a decline in economic growth, contravening extant mainstream economic theories and political rationales promoting FDI for developing countries (Babatunde, Ibukun, & Oyeyemi, 2017; Oboh, Chinonyelum, & Edeme, 2018), however the degree of this impact is insignificant. Investment was found to have the greatest degree of impact on economic growth in the SSA countries; increased investment in the SSA countries significantly stimulates real GDP by 0.8725 percent, in line with the Keynesian position on

investment as a catalyst of economic growth, and validating the findings of Ahmad, Sial, and Ahmad (2018), indicating that physical capital promotes economic growth.

CONCLUSION AND RECOMMENDATION

Economic growth is the most sought-after indicator of political success by governments, as it is the basis for socio-economic development, including an improved standard of living, poverty reduction, increased employment opportunities, and swollen state coffers. To this end, countries have designed monetary and fiscal policies to stimulate economic growth. This study approached the goal of economic growth through the fiscal angle, examining the effect of tax revenue on economic growth using panel data for 12 SSA countries during the period 2005 to 2020. We relied on the fixed model result to reach a conclusion on the nature of the relationship between tax revenue and economic growth in SSA. The fixed effect result showed that increased taxes slow down economic growth in Nigeria. In addition, we found exchange rate and domestic investment to be drivers of economic growth in the SSA region. Based on these findings, the following recommendations are made:

i. In order to drive economic growth, SSA countries should seek to implement tax cuts, in order to stimulate consumption and investment spending. This will address the current impasse of low revenue generation in African countries, thereby expanding the tax base over the long term. The tax base should also be expanded to capture the informal sectors of the economy, whereby increased revenue can be realized without increasing the deadweight loss of the fiscal burden.
ii. SSA countries should increase infrastructural spending, which will attract investment into the country and stimulate economic growth.

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Appendix I: List of Selected SSA Countries

Countries	Countries
Angola	Guinea
Botswana	Liberia
Burkina Faso	Mali
Cote d'Ivoire	Nigeria
Gambia	Sierra Leone
Ghana	Togo

Source: Authors' compilation

APPENDIX II

	RGDP	TAX	TOP	FDI	EXR	INV	MS
Mean	5.07E+10	12.64534	75.73696	5.345081	1168.452	1.49E+10	28.80654
Median	1.13E+10	11.83761	69.45026	2.560884	446.0000	2.35E+09	26.58290
Maximum	4.77E+11	27.37420	311.3541	103.3374	9829.927	1.24E+11	52.70287
Minimum	1.25E+09	4.380000	20.72252	-6.369877	0.905209	1.42E+08	11.30051
Std. Dev.	1.08E+11	4.719197	38.06193	13.02816	2256.578	2.39E+10	9.448274
Skewness	2.959962	1.232542	2.860691	5.622006	2.380274	1.877774	0.533238
Kurtosis	10.62739	4.740818	16.56987	37.10261	7.587996	6.172901	2.586898
Jarque-Bera	745.7802	70.20042	1698.858	9670.621	347.8788	187.3287	10.13720
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006291
Sum	9.74E+12	2339.388	14238.55	962.1146	223174.3	2.78E+12	5358.016
Sum Sq. Dev.	2.23E+24	4097.832	270908.8	30382.19	9.68E+08	1.06E+23	16514.93
Observations	192	185	188	180	191	186	186

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. regress lrgdp tax top fdi lexr linv ms
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Source	SS	df	MS		
Model	379.075773	6	63.1792955	Number of obs	= 175
Residual	43.0859124	168	.256463764	F(6, 168)	= 246.35
				Prob > F	= 0.0000
				R-squared	= 0.8979
				Adj R-squared	= 0.8943
Total	422.161685	174	2.42621658	Root MSE	= .50642

lrgdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tax	-.0725554	.0117372	-6.18	0.000	-.0957268	-.0493841
top	-.0019656	.0011453	-1.72	0.088	-.0042266	.0002954
fdi	-.006882	.0031489	-2.19	0.030	-.0130985	-.0006655
lexr	.0407416	.0194273	2.10	0.037	.0023886	.0790947
linv	.8191032	.024483	33.46	0.000	.7707692	.8674372
ms	-.0109466	.0057584	-1.90	0.059	-.0223147	.0004216
_cons	6.551579	.6149008	10.65	0.000	5.337651	7.765507

```
. xtreg lrgdp tax top fdi lexr linv ms, fe

Fixed-effects (within) regression               Number of obs      =       175
Group variable: year                            Number of groups   =        15

R-sq:                                           Obs per group:
     within  = 0.9095                                         min =        10
     between = 0.9698                                         avg =      11.7
     overall = 0.8917                                         max =        12

                                                F(6,154)           =    258.03
corr(u_i, Xb)  = -0.3192                        Prob > F           =    0.0000

------------------------------------------------------------------------------
       lrgdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         tax |  -.0930759   .0122406    -7.60   0.000     -.117257   -.0688948
         top |  -.0015983   .0011181    -1.43   0.155     -.003807    .0006105
         fdi |  -.0036663   .0033032    -1.11   0.269    -.0101918    .0028592
        lexr |   .0756445   .0201775     3.75   0.000     .0357841    .1155049
        linv |   .8725322   .0262228    33.27   0.000     .8207295     .924335
          ms |   .0061263   .0067469     0.91   0.365    -.0072021    .0194548
       _cons |   4.927066   .6880528     7.16   0.000     3.567826    6.286306
-------------+----------------------------------------------------------------
     sigma_u |  .24733718
     sigma_e |  .49011534
         rho |  .20297932   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(14, 154) = 1.81                     Prob > F = 0.0412
. xtreg lrgdp tax top fdi lexr linv ms, re

Random-effects GLS regression                   Number of obs      =       175
Group variable: year                            Number of groups   =        15

R-sq:                                           Obs per group:
     within  = 0.9051                                         min =        10
     between = 0.9805                                         avg =      11.7
     overall = 0.8979                                         max =        12

                                                Wald chi2(6)       =   1478.09
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       lrgdp |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         tax |  -.0725554   .0117372    -6.18   0.000    -.0955598    -.049551
         top |  -.0019656   .0011453    -1.72   0.086    -.0042104    .0002791
         fdi |   -.006882   .0031489    -2.19   0.029    -.0130537   -.0007103
        lexr |   .0407416   .0194273     2.10   0.036     .0026649    .0788184
        linv |   .8191032    .024483    33.46   0.000     .7711174     .867089
          ms |  -.0109466   .0057584    -1.90   0.057    -.0222328    .0003397
       _cons |   6.551579   .6149008    10.65   0.000     5.346396    7.756762
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .49011534
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
         tax |   -.0930759    -.0725554       -.0205205        .0034742
         top |   -.0015983    -.0019656        .0003674               .
         fdi |   -.0036663     -.006882        .0032157        .0009978
        lexr |    .0756445     .0407416        .0349028         .005451
        linv |    .8725322     .8191032         .053429        .0093923
          ms |    .0061263    -.0109466        .0170729        .0035159
------------------------------------------------------------------------------
                           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(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       35.19
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```