Elasticity and Buoyancy of Taxation in Nepal: A Revisit of the Empirical Evidence[#]

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Abstract

In this paper, we use autoregressive distributed lag (ARDL) approach to cointegration developed by Pesaran et al. (1999) to estimate the elasticity and buoyancy coefficients of various revenue heads. We find that long-run buoyancy coefficients are greater than unity for all revenue heads except for custom duty whereas elasticity coefficients except for VAT are smaller than unity. Short-run buoyancy and elasticity coefficients for all revenue heads are found smaller than unity. We find OLS estimates of these coefficients to be spurious for the sample 1975-2016. These coefficients will be biased if data generating process (DGP) excludes tax exemption. All components of revenue besides income tax and VAT are found to be neutral to inflation. Empirical evidence suggests that custom reform should get top priority in the reform of revenue administration.

Key Words: Taxation, Buoyancy, Elasticity

JEL Classification: C01, C22, E62, H2, H20

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I. INTRODUCTION

The need for higher revenue mobilization for developing countries is substantial. They need to spend a significant amount of public resources to meet high development aspirations of people without compromising macroeconomic balance and debt sustainability. Fiscal and debt sustainability of a country largely depends on to what extent an output growth can generate revenue. When a country has buoyancy and elasticity of taxation greater than unity, it has a revenue growth larger than the growth rate of national income. Buoyant and elastic tax system raises tax-to-GDP ratio and helps to keep fiscal and debt position consolidated, and reduces foreign dependence for development financing. Less buoyant and inelastic tax system warrants to enhancing allocative efficiency, fiscal reforms and strengthening institutional capacity to generate more resources.

The growth rate of national output raises revenue but the degree to which it raises revenue is also determined by the level of tax avoidance and tax evasion prevailing in the country. These leakages bring down both tax buoyancy and elasticity coefficients. The provisions of tax exemptions also reduce tax collection. While tax exemptions are necessary to encourage private investments in desired sectors and motivate workers for higher performance, they also make the tax system less buoyant and inelastic. If revenue side of the budget is less responsive to economic growth, this raises risk of increasing fiscal deficit and the debt level and the trajectory may develop ultimately to the extent of fiscal and debt crisis.

One of the major concerns in the areas of fiscal management is to understand how the fiscal position in the long-run would develop if the current tax structure and expenditure pattern continues. Elasticity and buoyancy are two important measures often used to answer these concerns. The elasticity coefficient refers to the tax system that is capable of generating maximum revenue from changes only in economic conditions, keeping the institutional set-up, tax rates and bases intact, while the tax buoyancy measures the revenue effect of both changes in economic conditions and exogenous policy changes including administrative reform. If sizes of these coefficients are larger than one, the tax system has the capacity to generate primary resources that constrain public debt to grow unlimitedly and helps the fiscal position keep consolidated. A rising tax-to-GDP ratio will help to reduce both fiscal deficit and debt level.

The tax buoyancy and elasticity for the short and long-run may be different. The short run buoyancy is closely related to the stabilization function of fiscal policy (Belinga, Benedek, Mooij and Norregard, 2014). The short run buoyancy larger than one refers to the tax system as a good stabilizer whereas long run buoyancy is used to assess the role of economic growth on fiscal and debt sustainability (Belinga et al., 2014). For the reliable prediction of revenues, the estimates of these coefficients should be consistent and efficient; otherwise the prediction can be misleading.

Empirical findings of the elasticity and buoyancy coefficients depend on the sample size and estimation methods. Bilquees (2004), Gillani (1986), Upender (2008), Rajaraman (2006) and Acharya (2011) used OLS method to estimate the tax elasticity and buoyancy in Pakistan and India. Bilquees (2004) found tax elasticity and buoyancy less than unity in Pakistan during 1975 to 2004 whereas Gillani (1986) had found Pakistan's tax system elastic and buoyant during the period 1971-82. Upender (2008) found higher tax buoyancy during the pre-reform period in India compared to the post tax reform period. Ashraf and Sarwar (2016) employed pool OLS estimator to examine the role of institutions on tax buoyancy using a panel data set from fifty developing countries. Their findings were: corruption has distortionary effects on tax collection while tax buoyancy and elasticity were found to be high in countries having democratic system of governance. Yousuf and Huq (2013) used cointegration technique and found buoyancy coefficients higher than elasticity coefficients in Bangladesh. Bruce, Fox, and Tuttle (2006) computed long-run elasticity for sales and income tax for each state using a single-equation cointegration method, namely dynamic ordinary least square (DOLS) (Stock and Watson, 1993).

There have been some empirical studies done in the context of Nepal to estimate elasticity and buoyancy coefficients (Dahal, 1984, Adhikari, 1995, Timsina, 2006). Adhikari (1995) transformed the data by the first order autoregressive process AR(1) to eliminate serial correlation and then applied OLS to the transformed data to estimate the size of the elasticity and buoyancy coefficients. He found the elasticity and buoyancy estimates to be 0.65 and 1.10 respectively in the data between 1975 and 1994. Similarly, Timsina (2006) first transformed the data by autoregressive and moving average ARMA (1,1) process to eliminate serial correlation and estimated the size of elasticity and buoyancy for the extended period from 1975 to 2005. The elasticity and buoyancy coefficients for this period were found to be 0.59 and 1.14 respectively. A study report by Inland Revenue Department (IRD, 2015) mentions the size of tax elasticity and buoyancy to be 0.64 and 1.27 respectively for 1999-2014. As period is extended in the empirical analysis the sizes of elasticity and buoyancy coefficients are found in an increasing order which suggests that the Nepalese tax system has been gradually improving to be better automatic stabilizer.

Table 1: Summary of Empirical Results

Author	Country	Sample	Estimator	Method	Result
Ram P. Adhikari	Nepal	1975-1994	GLS	Proportional Adjustment Method	Elasticity= 0.65 Buoyancy=1.1
Neelam Timsina	Nepal	1975-2005	GLS	Proportional Adjustment Method	Elasticity= 0.59 Buoyancy=1.14
Ministry of Finance	Nepal	1998-2013	GLS	Proportional Adjustment Method	Elasticity= 0.64 Buoyancy=1.27
Faiz Bilquees	Pakistan	1975-2003	VAR	Divisia Index	Elasticity= 0.88 Buoyancy=0.92
Hem Acharya	India	1991-2010	OLS	Proportional Adjustment Method	Elasticity= 1.2 Buoyancy= 1.3
Mohammed and others	Bangladesh	1980-2011	OLS	Exponential Smoothing Method	Elasticity>1
Donald Bruce and others	USA	1967-2000	DOLS and ECM		Short-run Elasticities are found asymmetry across states.

II. A SHORT OVERVIEW OF REVENUE MOBILIZATION IN NEPAL

Figure 1 shows Nepal's five years' average growth rate of real GDP and revenue. Average growth rate of real revenue is higher than average growth rate of GDP between 1980 and 2014. Figure 2 shows the alignment of government resources. Expenditure for social security and general administration is increasing and for development it is decreasing. Recurrent expenditure has reached 85 percent of total revenues in 2015 against 55 percent in 2000 (MoF, 2016). This pattern shows that the distribution of the tax revenue is biasing towards current expenditure which is less productive relative to capital expenditure. This is a worrisome situation for Nepal's development effort and may pose risks to fiscal sustainability. In the context of ever increasing regular expenditure and the need for heavy capital investment, government needs rebalancing public expenditure and create a stable and efficient tax system so that tax-to-GDP ratio increases autonomously and fiscal position does not deteriorate. The efficient tax system does not correspond only to the collection side of the revenue, but also to its uses side.

Contrary to the expenditure side, progress to the revenue side of the budget is encouraging. The share of the revenue in the national income is increasing (Appendix 1). The tax structure is also shifting to the "ability to pay" base as the share of direct tax to the total tax is increasing. The share of the direct tax to GDP has reached 4.1 percent of GDP while it was 0.3 percent in 1975. The GoN has strengthened revenue administration, rationalized tax rates, introduced new bases and implemented institutional reform programs since the adoption of liberal policies to develop a good tax system for collecting maximum revenue, controlling tax leakages, and ensuring its efficiency, equity, effectiveness, and flexibility. For these reforms to have positive effect on the tax system, the buoyancy and elasticity of the tax with respect to the base should have improved. In this context, this study aims to revisit the empirical evidence of the earlier studies done in Nepal.

Figure 1: Growth of Real GDP and Real Revenue

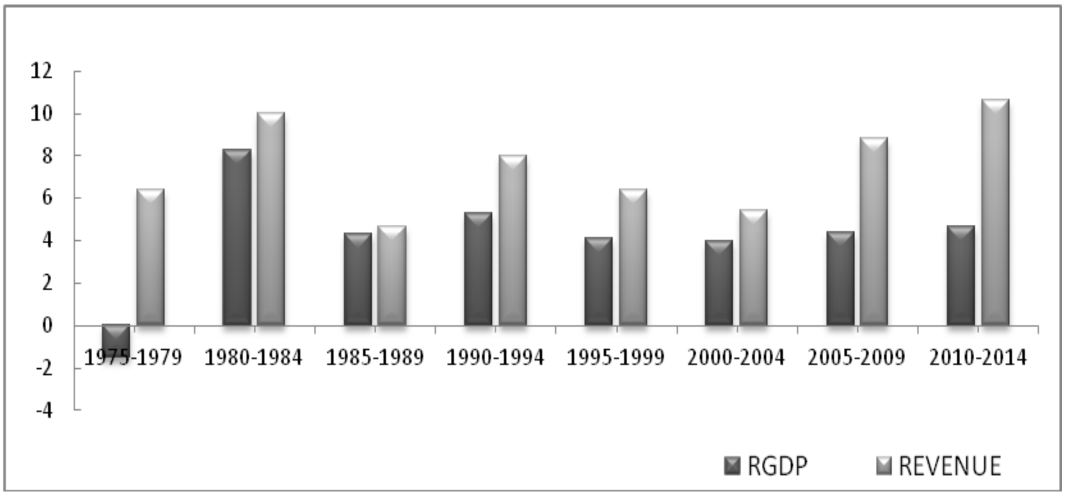
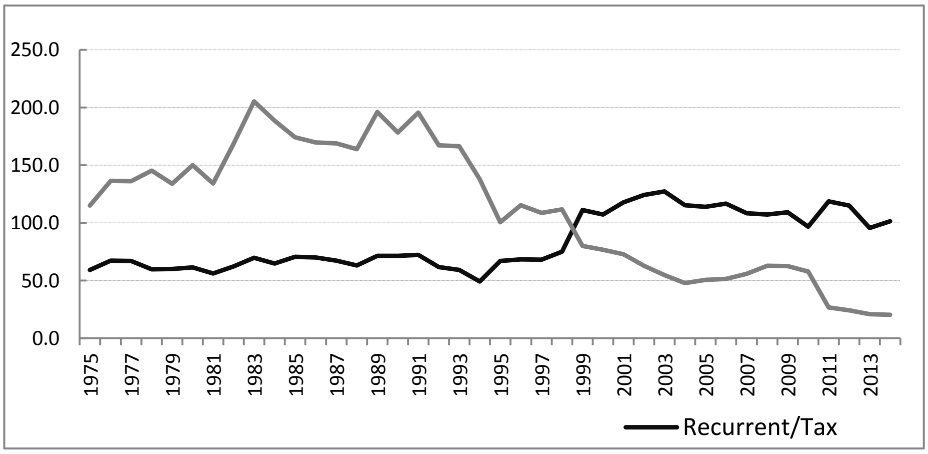


Figure 2: Recurrent and Capital Expenditure (% of Total Tax)



III. MODEL DESIGN AND ECONOMETRIC METHODOLOGY

Tax system has a dynamic relationship. Beyond having the impact of national income and other tax base on revenue growth, peoples' taxpaying habit and culture have also effects on both revenue growth and growth of national income. For example, condition on the tax base, improvement in tax habit could raise revenue growth. The impacts of such behavioral factors last long. Therefore, for consistent estimates of the elasticity and buoyancy coefficients, we should take care of such dynamic relationship. Econometrically, we can partly control these effects by introducing an autoregressive structure in the tax system. So, our specification of the DGP for tax revenue is:

$$Tax_t = \sum_{i=1}^{p} \alpha_i Tax_{t-i} + \sum_{j=0}^{q} \theta_j GDP_{t-j} + u_t \qquad \text{………. (1)}$$

The lagged dependent variable is assumed to capture behavioral factors, including habit and culture, and the effects of institutional reform and policy changes introduced in the past. We transform equation 1 into a single error correction form by subtracting the lag of dependent variable both sides, and adding and subtracting the lag of explanatory variables. Then our final estimating equation turns out to be;

$$\Delta \ln Tax_t = \lambda(lnTax_{t-1} - \beta_0 - \beta lnGDP_{t-1}) + \sum_{j=0}^{q} \theta_j \Delta lnGDP_{t-j} + u_t \qquad \text{………. (2)}$$

Where $\lambda < 0$ and refers to the adjustment parameter. Since all variables are nonstationary (Table 2), we use vector error correction rank test to examine whether they have cointegrating relation in the long-run. The rank test (Appendix 4) shows only one cointegrating relation and theory helps us to identify this cointegrating relation to be as specified in equation 2. Since we have only one cointegrating equation, we use ARDL approach (Pesaran et al., 1999) to cointegration to estimate equation 2. The advantages of using ARDL method are: we can (a) estimate a single error correction model, (b) estimate both short-run and long-run coefficients, c) remove serial correlation and reduce to some extent endogeneity bias by choosing the appropriate order of p and q.

We have chosen the order of $p = 1$ and $q = 1$ by the Bayesian information criterion. We have also checked the predictive content of GDP over tax and tax over GDP by granger causality test (Appendix 5). Further, we also augment variables such as changes in tax rates and bases in equation 2 as additional control variables that could affect both national income and revenue through various channels. The main motivation for including these variables is to avoid the misspecification problem. Further, we add inflation as an additional conditioning variable in equation 2 to examine whether revenue is neutral to inflation. If tax is neutral to inflation, it does not matter whether real or nominal variables are used to predict tax revenue for budgetary or planning purposes.

All scale variables have been transformed into logarithmic scale. Empirical results are based on annual data from 1975 to 2016 taken from Nepal Rastra Bank, Ministry of Finance and Central Bureau of Statistics.

IV. DISCUSSION OF THE RESULTS

Table 2 reports the unit root test. The test shows that all variables included in the DGP are integrated of order one (I(1)) in level and they are first difference stationary. Table 3 reports the bound test for equation 2. Bound test (Pesaran, Shin and Smith, 2001) shows that tax and tax-base are cointegrated (Table 3) in level for the sub-period 1975-2009, but they are not cointegrated for the full sample (1975-2016). VEC rank test (Appendix 4) also supports this result. This might be due to a shift in intercept term after 2009. We controlled this shift by using a level dummy [D=**1**(year>=2009)] and, then, the relationship between tax revenue and tax-base are found to have cointegrating relationship. Breaks for the VAT and income tax are controlled by level dummies; D=**1**(year>=1997) and D=**1**(year>=2008) respectively. Appendix 5 reports the granger causality test. The test rejects the null of GDP has no predictive content on tax and fails to reject the null of tax has no predictive content on GDP. Therefore, this test, to some extent, leaves less space for endogeneity concern.

Table 2: Unit Root Test[1]

Variables (log)	Level		First Difference	
	With drift	Result	With drift	Result
Gross Domestic Product (GDP)	-0.17	I(1)	-5.91	I(0)
Consumption	0.3	I(1)	-6.53	I(0)
Total revenue	0.52	I(1)	-6.21	I(0)
Custom duty	-0.47	I(1)	-6.61	I(0)
Value-added tax	-0.13	I(1)	-6.71	I(0)
Income tax	0.82	I(1)	-7.04	I(0)
Export duty	1.53	I(1)	-6.2	I(0)
Import tax	-1.1	I(1)	-5.84	I(0)
Consumer Price Index	-0.23	I(1)	-4.88	I(0)

Table 3: ARDL Bound Test

Sample	F-value	Remarks
1975-2009	13.99	F>Critical,Cointegrated
1975-2015b	9.7	F>critical, cointegrated

b refers to the control of break by level dummy for 2009-2015

[1] *Mackinnon (1996) critical value*

Table 4 and 4.1 report the OLS and ARDL regression results. The first and second columns in Table 4 report the results of the baseline model. Engle-Granger two-step procedures (Appendix 2) show that OLS residuals are non-stationary and therefore OLS results of the baseline model will be spurious. We cannot rely on these estimates. ARDL bound test also confirms this result. Therefore, for all baseline models which are not cointegrated we control the break. Model 1 controls break at D=**1**(year>=2009) in the regression of total revenue on GDP. Comparison of the model 1, model 2 and model 3 reveal that a simple regression of tax only on a tax-base will be misspecified if the DGP excludes tax exemption. Except for custom duty, long-run buoyancy coefficients for all taxes are found greater than unity whereas short-run buoyancy coefficients are found smaller than unity.

Table 4: Long-run and Short-run Buoyancy Coefficients

Buoyancy Coefficients	**Baseline Model (OLS)**	**Baseline Model (ARDL)**	**Model 1# (ARDL)**	**Model 2 (ARDL)**	**Model 3 (ARDL)**
Total Revenue : base GDP					
Long Run Buoyancy	1.17***	1.52	1.13***	1.16***	1.16***
Short Run Buoyancy		1.01***	0.51***	0.49***	0.46***
Speed of Adjustment		-0.03	-0.45**	-0.43***	0
ARDL Bound Test		Not cointegrated	Cointegrated	Cointegrated#	Cointegrated#
OLS Residual	I(1)				
Conditioning Variables				Income Tax Exemption	Income Tax Exemption, Inflation

Significant at 10 percent level, ** at 5 percent level and * at 1 percent level*
#Controls shift in intercept

The long-run buoyancy is found to be 1.13 with marginal increment (coefficient of D=**1**(year>=2009) of 0.022 after 2009. These results are invariant for model 2 and model 3 (Table 4). This marginal increment indicates the effect of reform ongoing in our tax system, but progressing at a very slow pace. For the reasons we discussed above, we introduced the level of tax exemption allowed to high income bracket as additional conditioning variables. Conditioning on the tax exemption marginally improves the buoyancy coefficient for the period after 2009 even if it itself is not found statistically significant. Though not statistically significant, the marginal increment in the buoyancy coefficient after controlling income tax exemption is an indicative of the positive impact of tax rationalization on revenue mobilization.

Model 3 has inflation as an additional conditioning variable. If the revenue is neutral to inflation, inflation term should not be statistically significant and buoyancy coefficient should not change. Results support this condition for total revenue, custom duty and income tax whereas value-added tax is found to be non-neutral to inflation. Inflation brings down buoyancy of VAT in both short-run and long-run.

Table 4.1: Long-run and Short-run Buoyancy Coefficients

Buoyancy Coefficients	Baseline Model (OLS)	Baseline Model (ARDL)	Model 1# (ARDL)	Model 2 (ARDL)	Model 3 (ARDL)
VAT: base consumption					
Long Run Buoyancy	1.27***	1.28***	1.13***	1.10***	1.00***
Short Run Buoyancy		0.98***	0.35***	0.38***	0.28***
Speed of Adjustment		-0.13***	-0.31***	-0.35***	-0.28***
ARDL Bound Test		Not Cointegrated	Not Cointegrated	Cointegrated#	Cointegrated#
OLS Residual	I(1)				
Custom Duty: base Import					
Long Run Buoyancy	0.88***	0.89***		0.81***	0.81***
Short Run Buoyancy		0.39***		0.49***	0.49***
Speed of Adjustment		-0.44***		-0.60***	-0.60***
ARDL Bound Test		Cointegrated		Cointegrated	Cointegrated
OLS Residual	I(0)*				
Income Tax: Base GDP					
Long Run Buoyancy	1.44***	1.48***		1.31***	1.31***
Short Run Buoyancy		0.56***		0.51***	0.46***
Speed of Adjustment		-0.38***		-0.38***	-0.37***
ARDL Bound Test		Cointegrated		Cointegrated	Not Cointegrated
OLS Residual	I(0)*				
Conditioning Variables				Income Tax Exemption	Income Tax Exemption, Inflation

Significant at 10 percent level, ** at 5 percent level and * at 1 percent level.*
#Controls shift in intercept

Table 5 and 5.1 report the long-run and short-run elasticity coefficients. These coefficients are estimated based on the tax series derived by removing a part of the tax announced by the government in the budget speech to be collected from administrative reform and changes. As in Adhikari (1995) and Timsina (2007), we also applied Sahota (1961) method to remove the exogenous part of the revenue. Since actual tax collection from administrative reform and changes is not observed and if the adjusted tax significantly deviates away from reality, estimates of the elasticity coefficients will be biased. The degree of the biasedness depends on the magnitude of the adjustment error. If the adjustment error is high, results will be seriously distorted. Therefore, emphasis is given to overall revenue forecast rather than the revenue forecast based on endogenous economic changes excluding the impact of administrative changes and reforms.

Table 5: Long-run and Short-run Elasticity Coefficients

Elasticity Coefficients	Baseline Model (OLS)	Baseline Model (ARDL)	Model 1# (ARDL)	Model 2 (ARDL)	Model 3 (ARDL)
Total Revenue : base GDP					
Long Run Buoyancy	0.63***	0.67***	0.57***	0.93***	0.87***
Short Run Buoyancy		0.16***	0.19***	0.33***	-0.67
Speed of Adjustment		-0.23***	-0.33**	-0.35***	-0.47***
ARDL Bound Test		Not	Cointegrated	Cointegrated#	Cointegrated#
OLS Residual	I(1)				
Conditioning Variables				Income Tax Exemption	Income Tax Exemption, Inflation

Significant at 10 percent level, ** at 5 percent level and * at 1 percent level*
#Controls shift in intercept

In our empirical results, elasticity coefficients for all revenue heads except for VAT are found to be less than unity. Engle-Granger two step procedures (Appendix 3) show that OLS estimates for adjusted total revenue and income tax are spurious. For all baseline models which are not cointegrated we control the break. This is the model 1. Model 2 augments income tax exemption in model 1 and model 3 augments income tax exemption and inflation. Augmentation of inflation to model 2 for the DGP of income tax breaks down the cointegrating relation, suggesting that this tax does not share a common trend with inflation in the long run. We suggest discarding all models which are not cointegrated. Empirical results show that inflation and income tax exemption have mixed effects. Inflation reduces long-run elasticity of total revenue, VAT and income tax while tax exemption improves long-run elasticity of total revenue, VAT and custom duty.

Important messages are in order from our empirical evidence illustrated in Table 4.1 and 5.1. Long-run buoyancy coefficient is highest for income tax and is lowest for custom duty. Long-run buoyancy coefficient for custom duty is not only the lowest, but it is also less than unity. Long-run elasticity coefficient for custom duty is also the lowest. We are not sure whether the low elasticity of custom revenue is due to reduction in custom taxes or leakage. But what we certainly infer from this empirical evidence is that reform in custom administration should get top priority in our fiscal reform program.

Table 5.1: Long-run and Short-run Elasticity Coefficients

Elasticity Coefficients	**Baseline Model (OLS)**	**Baseline Model (ARDL)**	**Model 1# (ARDL)**	**Model 2 (ARDL)**	**Model 3 (ARDL)**
VAT: base Consumption					
Long Run Elasticity	0.69***	0.66***	1.10***	1.33***	1.20***
Short Run Elasticity		0.13**	0.24***	0.24**	0.31**
Speed of Adjustment		-0.20**	-0.22**	-0.18**	-0.26***
ARDL Bound Test		Not Cointegrated	Cointegrated	Cointegrated#	Cointegrated#
OLS Residual	I(0)				
Custom Duty: base Import					
Long Run Elasticity	0.49***	0.47***		0.57***	0.65***
Short Run Elasticity		0.20***		0.25***	0.24***
Speed of Adjustment		-0.42***		-0.44***	-0.38**
ARDL Bound Test		Cointegrated		Cointegrated	Cointegrated
OLS Residual	I(0)*				
Income Tax: Base GDP					
Long Run Elasticity	0.57***	0.69***	0.47***	1.05*	0.98*
Short Run Elasticity		0.12**	-1.34	0.19*	0.20**
Speed of Adjustment		-0.17**	-0.37***	-0.18*	-0.20*
ARDL Bound Test		Not Cointegrated	Cointegrated	Not Cointegrated#	Not Cointegrated#
OLS Residual	I(1)*				
Conditioning Variables				Income Tax Exemption	Income Tax Exemption, Inflation

Significant at 10 percent level, ** at 5 percent level and * at 1 percent level*
#Controls break,

Finally, for the forecast of total revenue we suggest using model 2 or model 3 depending on whether revenue components (Custom, VAT etc.) are neutral or non-neutral to inflation. For total revenue forecast either model 2 or model 3 can be used. Long-run buoyancy coefficient should be used to estimate the revenue effects of output growth. Table 6 reports the summary statistics of actual revenue and revenue predicted by the model 2 in Table 4. The mean of actual revenue and predicted revenue exactly coincide when we use GDP and interaction of GDP with level dummy (**D=1** if year>=2009) as the predictors of the total revenue.

Table 6: Summary of Actual Revenue and Predicted Revenue, (log)

Variable	**Obs**	**Mean**	**S.D.**	**Min**	**Max**
Total Revenue	42	9.930812	1.819648	6.91612	13.08724
Total Revenue **(Prediction)**	42	9.930812	1.818018	7.104651	12.8966

V. CONCLUSION

We found a break in the the relationship between total revenue and income from 2009. Therefore, OLS estimates of the elasticity and buoyancy coefficients for the sample 1975-2016 will be spurious. The cointegrating relationship exists when we control the break by level dummy [D=**1**(year>=2009)]. All coefficients for interaction term are positive, though marginal, and statistically significant, implying a gradual improvement in our revenue administration. Further, we found estimates to be biased if the DGP is not conditioned by income tax exemption. Empirical results show that long-run buoyancy and elasticity coefficients for custom duty are the lowest, indicating the areas of reform to be focused in revenue administration. Results also show that some components of revenue heads are non-neutral to inflation. Inflation reduces buoyancy coefficients of income tax and VAT, and elasticity coefficients of all taxes besides custom duty in the long-run.

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APPENDICES

Appendix 1: Revenue Mobilization as percentage of Gross Domestic Product

Year	Custom	VAT	Income	Excise	Other	Direct	Indirect
1975	2.0	1.1	0.3	0.7	0.9	0.3	4.8
1980	2.6	1.7	0.4	0.9	0.4	0.4	6.2
1985	2.3	1.8	0.7	1.0	0.7	0.7	6.1
1990	2.6	1.5	0.9	0.0	0.9	0.9	6.2
1995	3.2	2.8	1.2	0.8	1.2	1.2	7.8
2000	2.8	2.8	2.1	0.9	2.1	2.1	6.7
2005	2.3	3.3	1.7	1.0	1.7	1.7	7.1
2010	2.6	4.5	3.1	1.9	3.1	3.1	9.9
2014	3.5	5.2	4.1	2.4	4.1	4.1	12.2

Appendix 2: Engle-Granger test for cointegration between total Revenue and GDP

Sample Pd: 1975-2015

N(1st Step) = 42
N (test) = 41 test

	Test Statistic	1% critical value	5% critical value	10% critical value
Z(t)	-1.185	-4.177	-3.489	-3.15

Critical values from MacKinnon (1990, 2010)

Appendix 3: Engle-Granger test for cointegration between adj. total Revenue and GDP

Sample Pd: 1975-2015

N(1st Step) = 42
N (test) = 41 test

	Test Statistic	1% critical value	5% critical value	10% critical value
Z(t)	1.798	-4.177	-3.489	-3.15

Critical values from MacKinnon (1990, 2010)

Appendix 4: Vector Error Correction (VEC) Rank Test

(Total Revenue and Gross Domestic Product)

Johansen Test for Cointegration (1977-2008)

Trend: Constant — No. of obs.:32

Lags: 2

Maximum Rank	Parms	LL	Eigen values	Trace Statistic	5% critical value
0	6	123.4207		16.0668	15.41
1	9	131.2631	0.38747	0.382	3.76
2	10	131.4541	0.01187		

Johansen Test for Cointegration (1977-2016)

Trend: Constant — No. of obs.:40

Lags: 2

Maximum Rank	Parms	LL	Eigen values	Trace Statistic	5% critical value
0	6	155.66341		4.6695	15.41
1	9	157.94429	0.10778	0.1078	3.76
2	10	157.99818	0.00269		

Johansen Test for Cointegration with D=1(year>=2009) and Interaction Term

Trend: Constant — No. of obs.:40

Lags: 2

Maximum Rank	Parms	LL	Eigen values	Trace Statistic	5% critical value
0	20	296.35472		64.5449	47.21
1	27	316.55290	0.63575	24.1486	29.68
2	32	325.62717	0.36474	6.0000	15.41
3	35	328.62087	0.139.2	0.0126	3.76
4	36	328.62718	0.00032		

Appendix 5: Granger Causality Wald Test

Equation	Excluded	Chi^2	df	Prob>Chi^2
Total Revenue	GDP	6.5677	2	0.037
Total Revenue	D=1(>=2009)*GDP	7.5203	2	0.023
Total Revenue	All	9.2541	4	0.055
GDP	Total Revenue	1.8072	2	0.405
GDP	D=1(>=2009)*GDP	2.3757	2	0.305
GDP	All	3.7674	4	0.438
D=1(>=2009)*GDP	Total Rev	3.6478	2	0.161
D=1(>=2009)*GDP	GDP	1.5237	2	0.467
D=1(>=2009)*GDP	All	6.9839	4	0.137
VAT	Total Consumption	16.494	2	0.000
VAT	D=1(>=1997)*Consumption	11.816	2	0.003
VAT	All	20.279	4	0.000
Total Consumption	VAT	2.0172	2	0.365
Total Consumption	D=1(>=1997)*Consumption	0.20216	2	0.904
Total Consumption	All	2.8504	4	0.583
D=1(>=1997)*Consumption	VAT	0.0076	2	0.996
D=1(>=1997)*Consumption	Total Consumption	2.2936	2	0.318
D=1(>=1997)*Consumption	All	6.3099	4	0.177
Custom Revenue	Import	8.8034	2	0.012
Custom Revenue	D=1(>=2009)*Import	6.4496	2	0.040
Custom Revenue	All	11.807	4	0.019
Import	Custom Revenue	1.6267	2	0.443
Import	InterIMP	2.3159	2	0.314
Import	All	4.1960	4	0.380
D=1(>=2009)*Import	Custom Revenue	1.6026	2	0.449
D=1(>=2009)*Import	IMP	0.14225	2	0.931
D=1(>=2009)*Import	All	4.3782	4	0.357
Income Tax	GDP	25.139	2	0.000
Income Tax	All	25.573	4	0.000
GDP	Income Tax	1.5581	2	0.459
GDP	All	4.4137	4	0.353