The Short and Long Run Effects of Selected Variables on Tax Revenue - A Case Study

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Abstract

The main objective of this article is to empirically examine the short and long-run relationship between real tax revenue and real local government expenditure as well as investigate the relationship between real sales tax revenue and real individual tax revenue and selective variables in Washington, D.C. for the period ranging from 1984-2015. The study uses the Johansen co-integration techniques as well as the bivariate and multivariate vector error correction model (VECM). The results indicate that there is a unidirectional and one-way causality running from real local government expenditure to the real DC's tax revenue in the short and long-run, but not vice versa. The finding indicates that DC's tax revenue changes local government expenditure. As a result, budget deficits can be avoided by implementing policies that stimulate DC's tax revenue. The Granger-causality test shows that DC resident employment does affect real individual tax in the short and long-run, simultaneously. The Granger-causality test shows that DC resident employment, household's population and stock of housing does affect real sales tax revenue in the short and long-run simultaneously. Furthermore, the results of the impulse response function (IRF) indicate that household's population and stock of housing are the major short-run effect on the real individual income tax and real sales tax revenue.

Keywords: DC's tax revenue, local government expenditure, vector error correction model (VECM)

JEL Classification: C32, H20, H71, H72

1. Introduction

Analyzing short and long-run relationship between Washington DC's tax revenue and local government expenditure as well as identifying the key variables affecting DC's tax revenue can be effective in reducing the government's budget deficits, which in turn have a stabilizing effect on the government revenue. It is expected that the DC's tax revenue, as our case study, would highly depend on the main factor affected by i) resident employment, ii) household's population, iii) earnings of DC residents and other major variables. The open questions that are raised by policymakers, and this article explores, are as follows:

- What are the factors affecting DC's tax revenue and its major items including individual and sales taxes?
- What's the causal relationship between DC's tax revenue and local government expenditure?
- What factors affect individual and sales taxes in DC's tax revenue?

The main objective of this article is to identify the major determinants of tax revenue in DC and examine the short and long-run effects of the involved variables on DC's tax revenue using Vector Error Correction Model (VECM). More specifically, the study aims to present a review of DC's tax revenue for the period of 1981 to 2015. We also analyze the impulse response function (IRF) of selected variables on DC's tax revenue.

The outline of this article is as follows. Section 2 briefly reviews theoretical and empirical related literature. Section 3 presents a review of DC's tax revenue and local government expenditure for the period of 1981-2015. Section 4 briefly describes data and research methodology. Section 5 presents the empirical results, and Section 6 reports the conclusions and suggestions.

2. Literature Review

The causality relationship between government revenue and government expenditure has critical public policy concepts mainly due to the size of the government and budget deficits (Baffes and Shah, 1994; Baghestani and McNown, 1994; Darrat, 1998; Ross and Payne, 1998).

In theory, there are three possibilities for the existence of the relationship between government revenues and government expenditures:

1. The first possibility is characterized by unidirectional causality run from government revenue to government expenditure and argues that government revenue changes government's expenditure (Friedman, 1978). As a result, budget deficits can be avoided by implementing more effective policies that stimulate government's revenue. Buchanan and Wagner (1977) argue that taxpayers suffer from fiscal illusion which is the other version of the tax- and- spend hypothesis and may be seen in deficit spending (Young, 2009).

2. The second possibility is characterized by unidirectional causality run from government expenditure to government's revenue and suggests that government's expenditure leads to increase revenue for the government (Baghestani and McNown, 1994). Accordingly, government spends first and then pays later by raising revenues. Peacock and Wiseman (1979) explain how crisis situations will justify increases in expenditures and taxes to pay for them which is the other version of the spend- and- tax hypothesis.

3. The third possibility is characterized by bidirectional causality between government's revenue and government's expenditure and suggests that government's revenue and expenditure are jointly determined, simultaneously (Musgrave, 1966; Meltzer and Richard, 1981). If bidirectional causality does not hold, then government's revenue decisions are made independently from government's expenditure decisions.

Empirically, there is no consensus about the linkage between government's expenditure and revenue. Some studies indicate unidirectional causal evidence from government's revenue to expenditure, or vice versa. Also, some other studies claim bidirectional linkage between government's revenue and expenditure; while they exhibit independent relationship in some the other studies. For example, Barro (1974), and Peacock and Wiseman (1979) indicate that increased taxes and borrowings are due to increased government expenditures. Such observation might be due to the political system of countries (mostly in many developing countries) in which governments decide how much to spend and then tries to find resources for finance. Manage and Marlow (1986) find the presence of bidirectional causality between U.S. federal revenues and expenditures for the period of 1929-82.

Baffes and Shah (1994) find bidirectional causality between government's revenue and expenditure for Argentina and Mexico, and unidirectional causality running from government revenue to government expenditure for Brazil. Ewing and Payne (1998) find the evidence of bidirectional causality between government's revenues and expenditures for Chile and Paraguay, and unidirectional causality from government's revenues to expenditures for Colombia, Ecuador, and Guatemala. Park (1998) finds supporting evidence for the tax- and- spend possibility over the period 1964 to 1992 for Korea.

Maghyereh and Sweidan (2004) find the evidence of bidirectional causality between government's revenue and expenditure, and a long-run interdependence relationship between the output and fiscal variables indicating effectiveness of fiscal policy. Chang and Ho (2002) find a cointegrating relationship between gross domestic product (GDP), government's revenues and expenditures, and also unidirectional causality running from government's revenues to expenditure over the period 1967 to 1999. Furthermore, Carneiro et al. (2005) investigate this issue for Guinea-Bissau over the period 1981 to 2002 and find spend- and- tax possibility.

Keho (2010) studies the data from 1960 to 2005 of European area to analyze the cause and effect relationship between government's expenditure and revenue collection and finds unidirectional causality from government's revenue to expenditure. Omo and Taofik (2012) find a long-run relationship running from government expenditure to government revenue in Nigeria by using an Autoregressive Distributed Lag (ARDL) bounds testing approach over the period 1970 to 2008. Gale and Samwick (2014) evaluate the effects of individual income tax on economic growth. They argue that if the tax rate cuts are not financed by spending cuts, it will increase budget deficits which reduce national saving and raise interest rates in the long-run. They find that not all tax changes will have the same effect on economic growth. Al-Zeaud (2015) examine the causal relationship between government revenues and government expenditures of the Jordan over the period from 1990 to 2011. The results confirm the existence of bidirectional causality running between government revenues and government expenditures.

Aslam (2016) examines the cointegration relationship between the tax revenue and the government expenditure for the period of 1950 to 2013 in Sri Lanka. He finds the sustained positive relationship between the tax revenue and the government expenditure. The partial coefficients of tax revenue are 0.695 in the short run and 1.031 in the long run. Gebreegziabher (2018) examines the effects of fiscal policy on economic growth in Ethiopia using the ARDL

modelling approach. The results show that the better human capital information will increase the availability of the economy's capital stock and labour force will has a significant positive impact on the economic growth in the both short and long run. Regarding the fiscal policy, the results show that a good performance in the collection of indirect tax revenue and increased productive government consumption will have a significant positive effect on the economic growth in the both short and long run.

3. A Review of DC's Tax Revenue and Local Government Expenditure (Historical Trends)

In this section, we present the structure of DC's government's expenditure and revenue (in terms of tax and nontax revenue) for the period of 1981-2015. As shown in Figure 1, DC's tax revenue has been higher than nontax revenue during this period. The DC's budget has faced a potential excess of revenue over expenditure. During this study period, total expenditure has been higher than tax revenue and financed by nontax revenue.
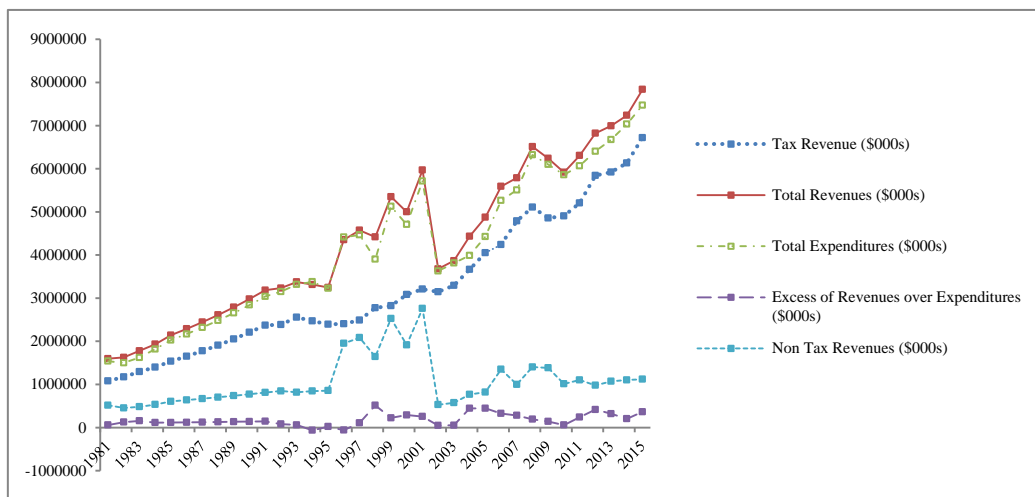

Figure 1. DC's Revenue and Expenditure, 1981-2015.

Source: Comprehensive Annual Financial Report (CAFR).

Figure 2 shows that the local government expenditure has been lower than total general expenditure. It is observed that both local government expenditure and tax revenue are increased during this period. It raises the question of which one is cause and effect of the other. Does local government expenditure cause tax revenue or vice versa?
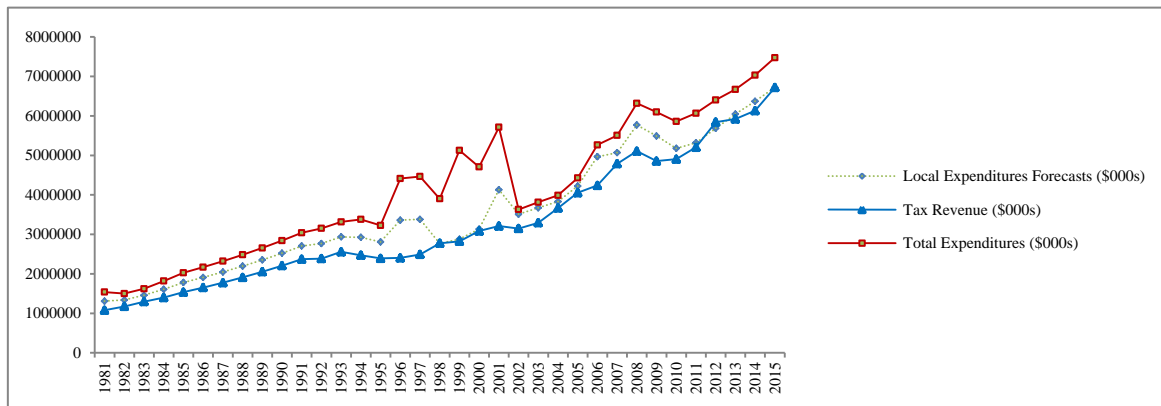

Figure 2. DC's Tax Revenue, Total Expenditure, and Local Expenditure, 1981-2015.

Source: Comprehensive Annual Financial Report (CAFR).

Figure 3 shows the ratio of DC's tax revenue to local government expenditure for the period of 1984 to 2015. As shown in Figure 3, the ratio of tax revenue to local government expenditure has been between 80% and 100% (with exception of 1996 and 1997) and it is expected to maintain in this range during next period.
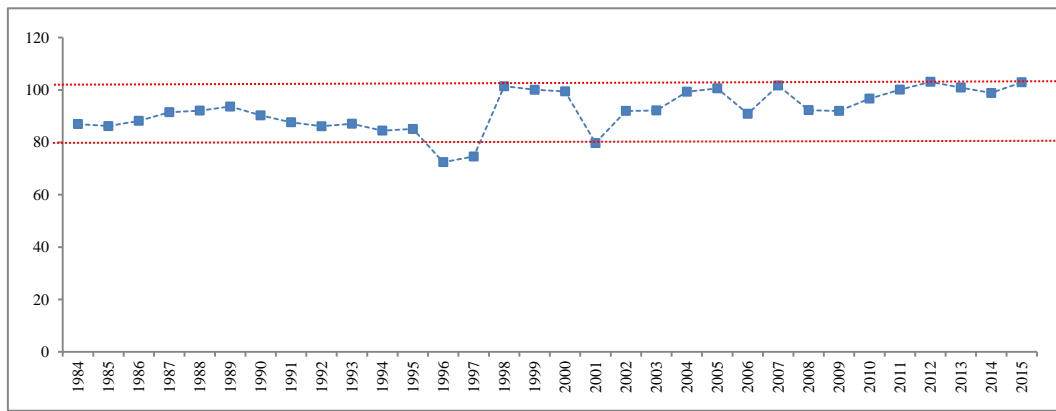
Figure 3. Ratio of DC's Tax Revenues to Local Expenditures, 1984-2015.

Source: Comprehensive Annual Financial Report (CAFR).

In Figure 4, we show the composition of DC's tax revenue by property, sales, individual taxes, along with some other taxes. According to definition, a real property tax is a local tax on the value of real estate. The property may be assessed at full value, which is presumably the price that the owner could sell the property for in the current market or using some other valuation method. An income tax is a tax that governments impose on financial income generated by all entities within their jurisdiction. A sales tax is a consumption tax imposed on the sale of goods and services. A conventional sales tax is levied at the point of sale, collected by the retailer and passed on to the government. As shown in Figure 4, property, sales, and individual taxes are constituted about 75 percent of DC's tax revenue during the study period. The annual average of DC's tax revenue in terms of its major items for the period of 1984 to 2015 is equal to 28 percent for property tax, 27 percent for individual tax, 20 percent for sales tax, and other taxes with 25 percent.
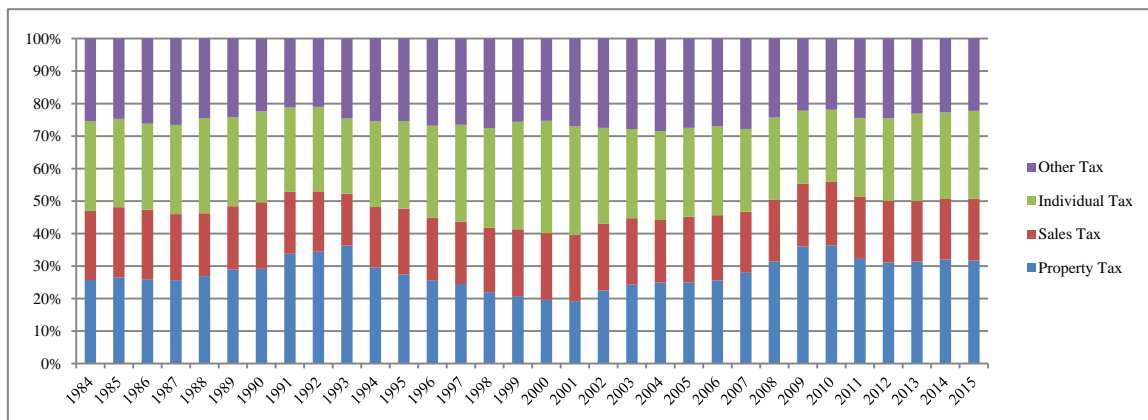

Figure 4. The Composition of DC's Tax Revenue, 1984-2015.

Source: The Office of Revenue Analysis (ORA) Database.

The ratio of total tax revenue to Gross State Product (GSP) is equal to 5 percent in DC. It states where tax revenue has increased significantly in comparison to GSP. Policymakers may decide to increase the percentage of tax revenue to address deficiencies in their budgets or other programs. The average percentage of tax revenue to GSP in terms of property, individual, and sales taxes are equal to 1.48 percent, 1.44 percent, and 1.02 percent, respectively.

4. Data and Research Methodology

The tax revenue data used in this article are obtained from the District of Columbia's Office of Revenue Analysis (ORA) covering annual data ranging from 1984 to 2015. The categories of data examined are real total tax revenue (RTT) and its two largest components: real sales tax (RST), and real individual income tax (RIT). The remaining data used in this research article can be organized into national and State variables including real local government expenditures (RLGF), resident employment (REMP), household's population (HPOP), earning of DC residents (EARNR), stock of housing (SH) and S&P500 Index. Table 1 presents data description in more details.

Table 1. Data Description

Data	Description
EARNR	Earnings of DC Residents (Bill. $)
HPOP	Households (Family and Nonfamily) ('000)
REMP	Resident Employment. (Household Survey) ('000)
SH	Stock of Housing
SAP500	S&P500
RST	Real Sales Tax Revenue (Bill. Chain wtd 2009$)
RIT	Real Individual Tax Revenue (Bill. Chain wtd 2009$)
RTT	Real Total Tax Revenue (Bill. Chain wtd 2009$)
RLGF	Real Local Government Expenditure (Bill. Chain wtd 2009$)

The purpose of this article is to evaluate the relationship between government's revenue and expenditure and its implication for managing the budget deficit. To do so, a bivariate relationship and multivariate contribution is formulated comprising DC's tax revenue, two major tax revenue items and main selected variables. Given our discussion in the previous section, let us briefly outline the approach taken in order to determine the presence of cointegration and the resulting error correction terms (ECM) that is used in formulating the vector error correction model (VECM) approach.

The test for Granger-causality between government's revenue and expenditure, and between sales and individual tax revenues with selected variables is performed:

1. First, we implement the Augmented Dickey-Fuller (ADF) unit root test, to determine the order of integration of all variables.

2. Second, conditional on finding that these variables are integrated of order one, we test for cointegration relationship using Johansen's (1988) approach to determine whether any combinations of the variables are cointegrated. In Johansen's test, two criteria (maximum eigenvalue and trace statistic) are used to determine the number of long-run relationship between the variables. Based on the results of the trace and the maximum eigenvalue test, at least one cointegrated equation holds between the variables of each model. The results can be used for planning and policy making.

3. Third, we examine the Granger-causality between DC's tax revenue and government expenditures. Granger causality test is used to assess the short-run cointegration and the direction of causality between the variables (Siami-Namini, 2018; 2017a; 2017b).

The VECM approach is used to describe both long-run relationships and short-run dynamic adjustments between real DC's tax revenue and local government expenditure as below:

$$D(RTT_t) = \delta_1 + \emptyset_1 ECT_t + \sum_{j=1}^{k} \gamma_{1,j} D(RLGF_{t-j}) + \sum_{j=1}^{k} \theta_{1,j} D(RTT_{t-j}) + \varepsilon_{1,t} \qquad (1)$$

$$D(RLGF_t) = \delta_2 + \emptyset_2 ECT_t + \sum_{j=1}^{k} \gamma_{2,j} D(RTT_{t-j}) + \sum_{j=1}^{k} \theta_{2,j} D(RLGF_{t-j}) + \varepsilon_{2,t} \qquad (2)$$

Where t represents time trend $(t = 1, 2, \ldots, T), j$ is the optimum lag considering Schwarz Information Criterion (Siami-Namini & Siami Namin, 2018). Also, ECT is the lagged error correction term (ECM) derived from the long-run cointegrating relationship, $\emptyset_1$ and $\emptyset_2$ are adjustment coefficients and $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are disturbance terms. We identify the sources of causation by testing for significance of the coefficients on the lagged variables in equation (1) and (2). The Granger short-run causality is evaluated using F-statistic for testing null hypothesis (H_0: $\gamma_{1,j} = 0$) in equation (1) and (H_0: $\gamma_{2,j} = 0$) in equation (2). If the null hypothesis is rejected, the existence of Granger short-run causality is confirmed.

The coefficients of the ECT terms indicate how fast deviations from the long-run equilibrium are eliminated following changes in each variable. If the ECTs coefficients are zero ($\emptyset_1 = 0$ or $\emptyset_2 = 0$), then there is no Granger long-run causality from independent to dependent variables (Siami-Namini & Hudson, 2017). In the end, we impose an Impulse Response Function (IRF) to analyze the reaction of any dynamic system in response to some external change. This measure shows whether this model is stationary, and the shocks dependent variable returns to the first position and estimated variable can solve the shocks and can be remained stable.

5. Empirical Results

In analyzing the properties of time series, the results of ADF unit root test show that all series in level are integrated of order one or I (1). Therefore, we proceed with the Johansen cointegration test to determine whether there exists any long-run relationship between series (Siami-Namini, 2017c). As shown in Table 2, the results of Johansen cointegration

test in terms of both Eigenvalue and trace test confirm the existence of long-run relationship between series by three equations: real total tax revenue (RTT), real individual tax revenue (RIT), and real sales tax revenue (RST). It implies these dependent variables are causally related with independent variables such as local government expenditure at least in one direction. For example, the critical values for both eigenvalue and trace test (equal to 3.8415) in RTT equation show that there is at most one cointegrating vector between series. The results of the critical values for both eigenvalue and trace test in RIT and RST equations show that there are more than two cointegrating vectors between series.

Table 2. Johansen Cointegrating Test

Equation	Based on Maximum Eigenvalue of the Stochastic Matrix				Based on Trace of the Stochastic Matrix			
	Hypothesized No. of CE(s)	Eigenvalue	5% Critical Value	P-value	Hypothesized No. of CE(s)	Trace	5% Critical Value	P-value
RTT	None[*]	0.520324	14.26460	0.0033	None[*]	33.16315	15.49471	0.0000
	At most 1[*]	0.335627	3.841466	0.0006	At most 1[*]	11.85844	3.841466	0.0000
RIT	None[*]	0.823150	40.07757	0.0026	None[*]	143.2306	95.75366	0.0000
	At most 1[*]	0.731938	33.87687	0.0144	At most 1[*]	92.98942	69.81889	0.0003
	At most 2[*]	0.646883	27.58434	0.0226	At most 2[*]	54.80988	47.85613	0.0097
RST	None[*]	0.763367	33.87687	0.0046	None[*]	98.38608	69.81889	0.0001
	At most 1[*]	0.570521	27.58434	0.1179	At most 1[*]	56.58996	47.85613	0.0061
	At most 2[*]	0.456749	21.13162	0.1417	At most 2[*]	32.07968	29.79707	0.0268

To answer to the question "Is change in DC's tax revenue causing a change in local government expenditure or vice versa?" we apply the Granger-causality test based on VECM approach. The results of Granger-causality test between real total tax revenue (RTT) and real local government expenditure (RLGF) in a bivariate analysis are presented in Table 3. The results suggest that there is a unidirectional Granger- causality relationship running from RLGF to RTT in the short and long-run, but not vice versa. In other words, DC's tax revenue drives the local government expenditure. The Granger-Causality test indicates that real local government expenditure does not affect real total tax revenue in the short and long-run. However, real total tax revenue does affect real local government expenditure in the short and long-run.

Table 3. The Granger-Causality between DC's Tax Revenue and Government Expenditure.

Dependent Variables	Short-Run	Long-Run
	RLGF	RLGF
RTT	0.61123 (0.6605)	0.0003 (0.9874)
	RTT	RTT
RLGF	4.0230 (0.0191)	9.07795 (0.0083)

All figures are the calculated F-statistics.

The regression results for explaining the real local government expenditure (RLGF) are presented in Table 4. The positive significant coefficient of the real total tax revenue (RTT) in Model (1) is equal to 0.62 and reduces to 0.47 when a lagged dependent variable is added in Model (2). The positive significant coefficient of individual tax revenue (RIT) is equal to 0.26 in Model (3). Furthermore, the positive significant coefficient of real sale tax revenue (RST) is equal to 0.34 in Model (4).

Table 4. The Regressions Results

Independent Variable	Dependent Variable (RLGF)			
	(1)	(2)	(3)	(4)
Intercept	4.2004 (0.0000)	2.8792 (0.0227)	1.7655 (0.2337)	2.6507 (0.0570)
RTT	0.6152 (0.0000)	0.4659 (0.0003)	-	-
RIT	-	-	0.2635 (0.0153)	-
RST	-	-	-	0.3357 (0.0075)
RLGF (-1)	-	0.2710 (0.0908)	0.6073 (0.0001)	0.4725 (0.0037)
R^2	0.66	0.68	0.58	0.60

The results of Granger-causality relationship between individual tax revenue (RIT) and real sales tax revenue (RST) and selected variables in a multivariate analysis are shown in Table 5. It can be observed that there is a long-run relationship between variables (i.e., the p-value for both RIT and RST equations are less than the significance level at 0.05). Guo and Luo (2017) investigate the impact of sales by using a novel product-level dataset and find that retail sales have a large effect on consumer's purchases. Indeed, consumers are more prices sensitive when the product is on sale.

Regarding the short-run effect for RIT, there is a Granger-causality relationship running from RIT to the resident employment (REMP), but there is no any evidence on causal relationship running from RIT to household's population (HPOP), earnings of DC residents (EARNR), stock of housing (SH), and S&P500 index in the short-run. Regarding the short-run effect for RST, there is a Granger-causality relationship running from RST to the resident employment (REMP), household's population (HPOP), and stock of housing (SH). But there is no evidence of causal relationship running from RST to earnings of DC residents (EARNR) in the short-run.

Table 5. Granger-causality between RIT and RST and Selected Variables.

Dependent Variables	Short-Run					Long-Run
	REMP	HPOP	EARNR	SH	SAP500	
RIT	4.3423	0.9968	0.6203	1.2511	0.4597	12.3510
	(0.0359)	(0.3950)	(0.5530)	(0.3185)	(0.6413)	(0.0038)
RST	3.7704	3.6309	0.2604	2.9705	-	12.4002
	(0.0471)	(0.0518)	(0.7741)	(0.0819)	(-)	(0.0031)

All figures are the calculated F-statistics.

Figure 5 shows the response of the real local government expenditure (RLGF) to a positive shock in the real DC's total tax revenue (RTT). The empirical results suggest that a positive shock in RTT has a positive and significant effect on the RLGF (after the initial increases), and then back to its long-run equilibrium after 5 years. The positive short-run effect of real tax revenue in the real local expenditure is between 2 and 3 years.
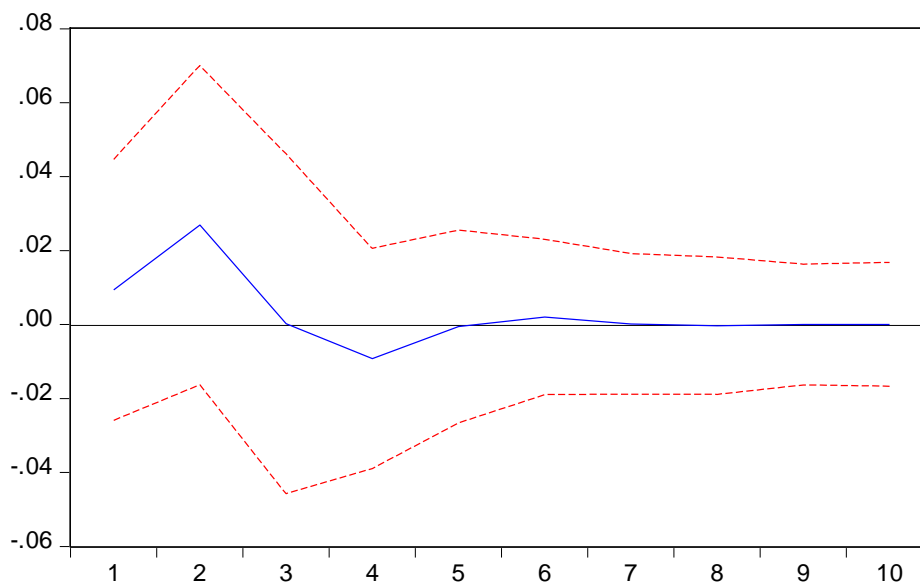

Figure 5. Response of the RLGF to a Positive Shock in the RTT

Figure 6 shows the response of real individual tax revenue (RIT) to the positive shocks in the selected variables including: resident employment in panel (a), earnings of DC residents in panel (b), S&P 500 index in panel (c), household's population in panel (d) and stock of housing in panel (e). As shown in Figure 6, the negative response of the RIT to the positive shocks in the resident employment and earnings of DC residents is longer than positive response of the RIT to the positive shocks in the S&P500 index, household's population and stock of housing. We conclude that earnings of DC residents, S&P 500 index, household's population and stock of housing have the major short-run effect on the RIT.

Panel (a): Resident Employment

Panel (d): Housholds

Panel (b): Earnings of DC Residents

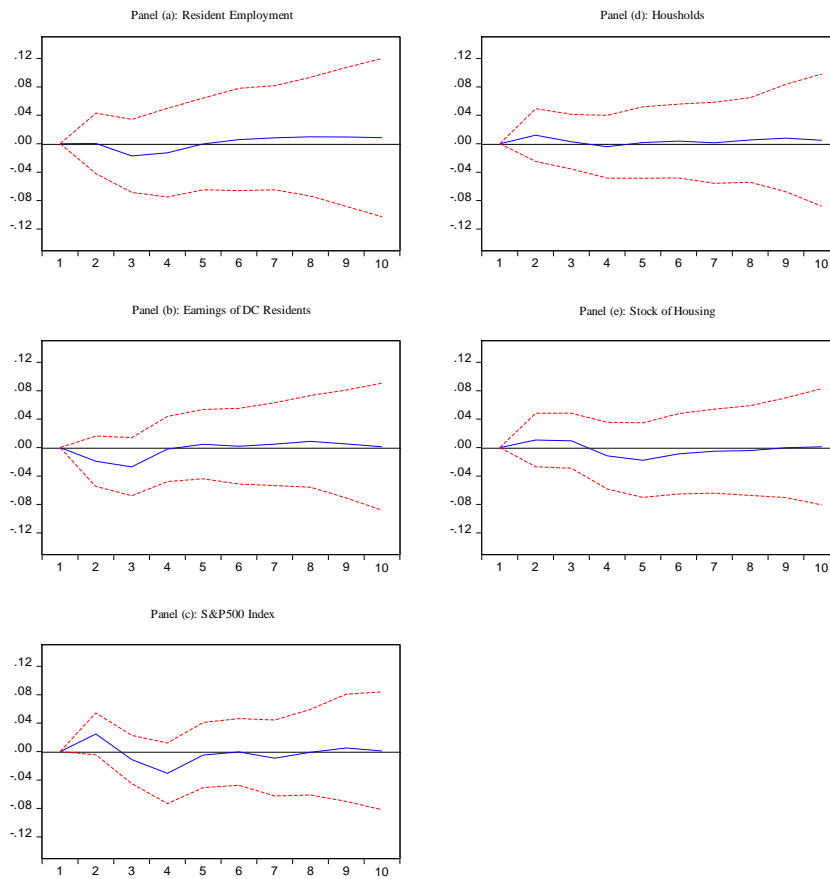Panel (e): Stock of Housing

Panel (c): S&P500 Index

Figure 6. Responses of the RIT to the Positive Shocks in the Selective Variables

Figure 7 shows the response of real sales tax revenue (RST) to the positive shocks in the selected variables including: resident employment in panel (a), earnings of DC residents in panel (b), household's population in panel (c) and stock of housing in panel (d). As shown in Figure 7, the short-run effect of household's population and stock of housing in the RST is about 2 and 3 years, and then return to its long-run equilibrium after 5 or 6 years. We conclude that household's population and stock of households have the major short-run effect on the RST.
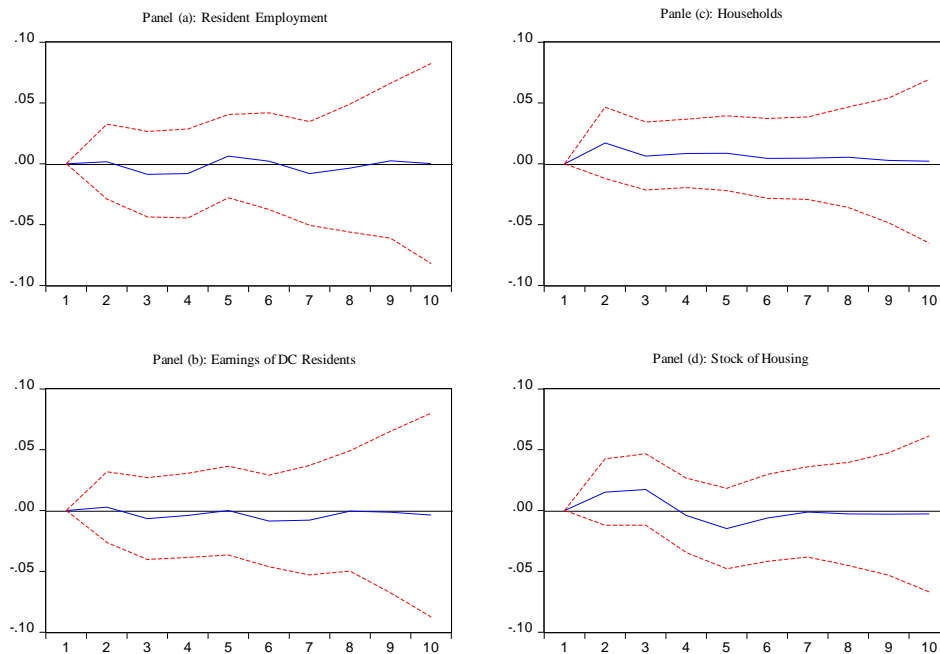
Panel (a): Resident Employment

Panle (c): Households

Panel (b): Earnings of DC Residents

Panel (d): Stock of Housing

Figure 7. Responses of the RST to the Positive Shocks in the Selective Variables

6. Conclusions

In this research article, we examined an important topic - the nexus between local government expenditure and government tax revenue in DC - in the area of public economics. The results show that DC's government tax revenue drives the local government expenditure. The Granger-causality test showed that local government expenditure does not affect total tax revenue in the short and long-run, but real total tax revenue does affect real local government expenditure in the short and long-run. The long-run coefficient show that DC's government does not spend each additional of total tax revenue in local government expenditure (Surplus). Also, the results showed that household's population and stock of housing are the major short-run effect on both the real individual and sales tax revenues in DC.

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