Does the District 2012 Income Tax Policy Increase Tax Revenue? Evidence from a Regression Discontinuity Design

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Abstract

Studies on tax reform use federal level data set to study the impact of income tax policy on the whole country, this paper use administrative city level data, and precise indicators such as taxable income, tax liability, business income, total deductions, capital gains, and the total tax revenue at the city level. This research assesses the impact of Washington, D.C. government income tax policy changes (that increase tax rate from 8.5 to 8.95 percent in year 2012 and 2016 on tax-payers who earn over $350,000 and $1 million, respectively) on tax revenue and tax payers' behaviors in response to income tax policy change. Providing precise and direct evidence on changing tax-payers behavior in response to income tax rate increase at the city level. In addition to the indicators, the increase in the income tax rate to tax payers who earn over $350,000 in 2012 and $1million in 2016 lends it-self to the use of regression discontinuity design to identify any behavioral change to tax payers. Result shows an insignificant discontinuity at the threshold indicating no policy effect. Using doughnut hole regression discontinuity design that control for biases from income management, it shows that tax payers around the threshold shift their income to reduce their tax liabilities.

Key words: Taxable income, business income, capital gains, total revenue, regression discontinuity, and income management

I. Introduction

Washington, D.C.'s income tax is the second largest sources of tax revenue that comes after real property. Tax revenue from the top 7 percent income earners contributes a share of about 25 percent of the total city's income tax revenue. In Washington, D.C. the income tax is progressive because higher income residents pay a larger share of their income in taxes than lower income residents do.

Over the past six years, the District of Columbia has experienced a rise of income tax rate in high income bracket of tax payers who earn over $350,000 in 2012 and then the tax policy reformed in 2016 to apply this tax policy on tax payers who earn over $1 million. These tax payers are required to pay additional 0.05 percent of their income. Their income tax rise from 8.5 to 8.95% in 2012 as a new income tax policy and get reformed in 2016. This new tax bracket will help protect the District of Columbia services that they provide to citizens against deeper and painful budget cuts as many services prior to this policy start to decline such as affordable housing development programs, families with children see TANF monthly benefit reduced, and the District homeless services system stop accepting new families.

Local fiscal income tax policy is viewed by some economists as an economic growth tool that helps foster and enhance economic growth in the city. (Gale and Samwick, 2014) However, many argue increase in taxable income divert and discourage workers to work harder when they see increasing portion of their paychecks taken due to increased efforts on their part. (Laffter,1974). Critics of increase income tax rate also say that progressivity of income taxes negatively affect GDP growth. (Chernick,1997). Opponents of raising the taxes that high income individuals face often point to findings that high income taxpayers respond to tax rate increase by reporting less income. However, (Slemord and Auerbach, 1997) state that such reductions in reported income largely reflect timing and other tax avoidance strategies that tax payers adopts to minimize their taxable income, not change in real work, savings, and investment behavior. Policy makers can limit high income tax payers' ability to respond to increases in tax rates by engaging in tax avoidance activities and enhance the efficiency of the tax code by broadening the tax base.

One possible reason why there tends to be a scarcity of accurate empirical evidence of significant economic benefits of state income tax policy is that consistent and reliable data are not often widely available for economic analysis on the city level. To help determine if the District of

Columbia government 2012 and 2016 increase income tax rate on high income level generate more tax revenue to the government, this study conducts an economic analysis on the city level of individuals who earn over $350,000 and $1 million respectively. The objective is to assess if the 2012 increase in income tax indeed resulted in increase in tax revenue in the local government. This city economic study uses parcel level administrative city income tax filer data. The data are used to assess whether the 2012- and 2016-income tax policy significantly increased the local government tax revenue (i.e. the treatment group of individuals who earn over $350,000) in 2012 and over $1 million in 2016 after implementing this policy in comparison to the control group. Unlike some studies that base broad and equivocal conclusions of the city income tax revenue on increase income tax rate on imprecise economic indicator or limitation of particular approach to address the issue (Gale, Kearney, and Orszag, 2015), this study draws conclusions using a Regression Discontinuity Design methodology and micro-level administrative data for every resident in the target group.

II. Literature review

Analyzing the mechanical and behavioral change of increasing the income tax rate is very crucial to assess the tax policy effectiveness of the income earners of over $350,000 and $1 million in Washington, D.C. The objective of this research paper is to determine whether mechanical or behavioral change is the dominant in each income level over $350,000 to $500,000. A literature review on this subject is divided into two sections. The first section reviews the literature on the impact of 2012 and 2016 income tax policy reform on total government tax revenue and tax payers' behavior. The second section reviews the literature on fiscal policies analysis techniques.

The Impacts of Income Tax Policy Reform**:** Income tax policy is one of many important keys that government use to finance their budget. Therefore, evaluating this policy effectiveness is very crucial. Many researchers look in the relationships between increasing taxable income of top income earners and variety of indicators as a measure of effectiveness of the policy. Gale W, Kearney M, and Orszag P (2015), investigated the relationship between the increase of tax on top income earners and income inequality. On the other hand, Gale W. and Samwick A. (2014), estimated the relationship between Elasticity of Income Tax Changing on Economic Growth using GPD as the indicator of economic growth.

Fiscal Policies analysis technique: In evaluating the impact of increase in income tax rate policy, many studies investigated the responsiveness of income tax change to total government revenue. Lindsey (1987), Auten and Carrol (1995), (1999), Gruber and Saez (2002), and Saez (2004), estimate the elasticity of total tax due to increase in top income earners income tax rate and found that both tax revenue and income tax move in the same direction.

Other researchers use simulation to show the dynamic in the relationship between variables. Gale W., Kearney M, and Orszag P (2015), use Tax policy center micro simulation model. They used different income tax percentage to simulate the impact of total tax from different tax levels and assess the impact on inequality and whether certain income tax percentage will reduce inequality. Findings show there is a small impact of increasing income tax rate of 50% on inequality reduction.

Gale W. and Samwick A. (2014), use simulation model to study the effects of income tax changes on economic growth (expansion of the supply side and potential gross domestic product).

In both simulation and elasticity models study the relationship between change in tax and economic activities. However, they do not quantify the increment change.

Regression Discontinuity Design (RDD) is one of the recent empirical methods (along with instrumental variables, and DD, both of which economist are using to get closer to the gold standard of empirical research—randomized experiment. Subjects are randomly assigned to a control group and a treatment group, and the outcome are compared to statistically estimate that treatment's effect on the outcome. A randomized experiment is the most foolproof way of establishing causality between variables and measuring treatment effects. Unfortunately, randomized experiments are often not feasible in economics for ethical and practical reasons. So most of the time we are stuck with nonexperimental data or, nowadays, economists look for "natural experiments" to exploit in empirical research. RDD is a way of estimating treatment effects and establishing causality in nonexperimental setting. Observations in a data set are separated into a control group and a treatment group when an "assignment variable" exceeds a cutoff point. Think of say, the age requirement for the property tax senior credit. Where an age threshold (65) separates taxpayers, who pay one rate (control) from those with half that rate (treatment). Under some fairly week assumptions (subjects must not be able to precisely control the assignment variable, e.g, age. Data from RDD can be analyzed as if it is from a randomized experiment. RDD is a pretest-posttest design that elicits the causal effect of interventions by

assigning a cutoff or threshold above or below which intervention is assigned. By comparing observations lying closely on either side of the threshold.

The importance of RDD is Causal inferences from RDD designs are potentially more credible and transparent than those from typical "natural experiment" strategies (DD or IV). Moreover, the theoretical justification is formally showing that one need not assume the RDD isolates treatment variation that is "as good as randomized". Instead, such randomized variation is a consequence of agents' inability to precisely control the assignment variable near the known cutoff. RDD can be used in a wide variety of context covering a large number of important economic questions. RDD is very useful for program evaluation, whether it is tax incentives to promote business development, individual income tax policies to promote work and savings, and so on.

Regression discontinuity method works best in an environment where:

- A threshold in a continues forcing variable such as (income) generates a large change in a policy variable (the amount of education tax credit for which a student qualifies);
- The threshold is strictly enforced;
- There are very dense data near the threshold for the forcing, policy, and outcome variables;
- Other factors that might affect the outcome (college-going) do not change discontinuously at the threshold;
- People do not manipulate the forcing variable near the threshold in an attempt to make themselves eligible.

This paper addresses the most important benefit of using the Regression Discontinuity Design, which is quantifying the average treatment effect at the cutoff threshold and it is impact on total revenue. This paper adds to the existing literature by providing the most precise approach for causality inference of enforcement policy, in which compliers are adhere to the law. A comprehensive understanding of the issue requires micro-tax data Washington, DC, tax policy, including components such as individual income tax administrative data that involve building microeconomic models required for the analysis. Moreover, this study indicates some tax payers' behavioral change such as using tax shelter to minimize the income tax subject to tax payers.

III. Data

This study uses administrative city individual income tax (IIT) data. From the IIT data, annual income (Taxable-Income) for top income filers, $200,000 and up will be used as a measure of household income that is subject to tax. Year2011 to 2016 are used in this study.

For each of the new income tax policy that was implemented in 2012, a panel of data is constructed to measure the effectiveness of the income tax policy on the individuals who earn over $350,000. This entails comparing the income data for the individuals who earn over $350,000 (treatment group) and comparison individuals within Washington, D.C. who earn less than $350,000 (control area). The panel contains IIT data for years 2011 to 2016 which covers the pre-tax increase period and the post-tax increase period for each of the two groups. The pre-tax increase period for both the group earns over $350,000 and the group earn less than $350,000 to $200,000. This study investigated whether there was a statistically significant effect of the income tax increase of % 0.05 on the total tax revenue at the state level of their treatment group (individuals earn over $350,000) during year 2012. The data for top income earners values are adjusted for inflation and are in 2015 dollars.

Income data for only top income earners was used because they are the concern of this study and their income is the largest share and most dynamic sector of the city's total tax revenue and income tax data base.[1] For the treatment group, they represent %7 of Washington, D.C. population and %25 of the city income. Income data is used to assess the new income tax policy affects and how the RDD is implemented and results are interpreted in two cases: individuals who always understand the income tax rules and accept paying the %0.05 increase in 2012 and individuals who always understand the income tax rules and try to use tax shelter. The concern is about how these cases imply for the analysis because there is a substantial behavioral economic interest. In additional to assess whether this is an effective tax policy or not, how tax payers think about the state tax increase matters.

The treatment group (individuals earn over $350,000) exposes the new income tax policy while control group are comparable individuals in the same City (Washington, D.C.). The control

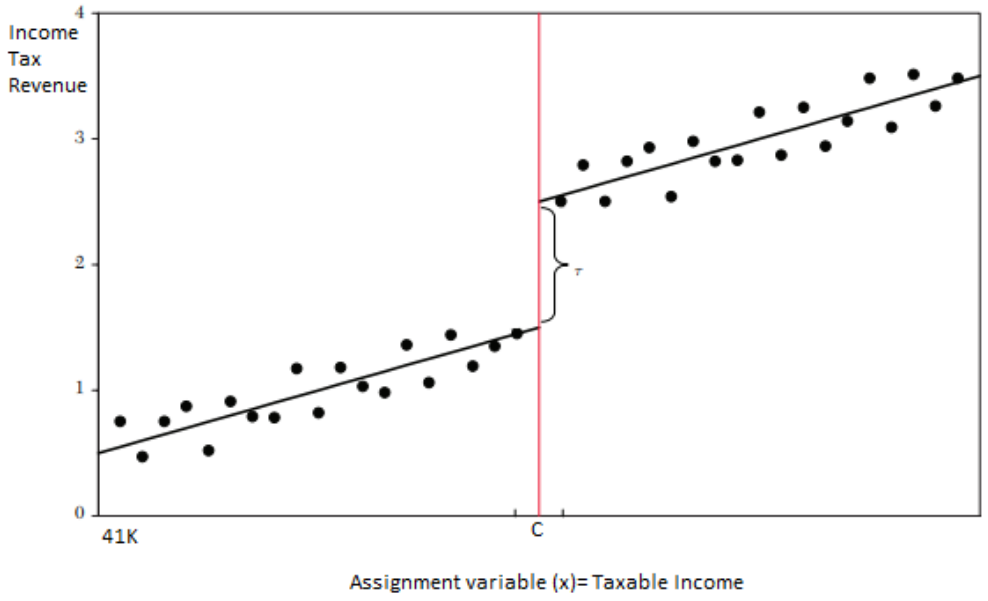
group were selected based on the individuals in income level that new policy is not applicable to them. The sharp regression discontinuity and doughnut- hole regression discontinuity only consider the Taxable Income of top income filers in the city, that is individuals who earn at least $350,000 a year in 2012 and $1 million a year in 2016. The effects for the new income tax policy will be assessed in terms of the growth rates in the treatment group's taxable income compared to the taxable income growth rates of control group.

IV. Methodology:

A. Estimation of the Average Treatment Effect (ATE) in a Sharp Regression Discontinuity Design (SRDD):

The Average Treatment Effect at the threshold point, c, is represented by the area $\mathcal{T}$ in figure 1:

Figure 1 Sharp Regression Discontinuity Design



The average effect on the total tax revenue for the population who would have paid the proposed increase in income tax versus population that this policy does not apply to. Casual effect analysis this example enables us to estimate the ATE with casual interpretation, which is of general scientific interest. For policy making purposes, it is more interesting to examine the effectiveness of a program or treatment for those who did participate. The average treatment effect for the treated

(ATT) is the concept. It measures the treatment effect conditional on those who are subject to the tax rate change. Assumptions: (i)The Probability of treatment receipt must be discontinuous at cutoff. More of those receiving treatment should be on treatment side of cutoff than the other side. If all are, then "sharp" RD. (ii) No discontinuity in potential outcomes in the cutoff (the "continuity restriction"). That is, no alternative interpretation should also show a discontinuity at the cutoff. If so, it would serve as a causal confound. In this research, the interest is in the causal effect of a binary treatment. The sample N has about 10,000 units of individuals, drawn randomly from a large population. For individual i, $i = 1, \ldots., N$, the variable $Yi(1)$ denotes the potential outcome for unit i (total tax revenue) given treatment, and $Yi(0)$ the potential outcome without treatment. For individual I, the observation is based on if the treatment has received, Wi, equal to one it individual i was exposed to the treatment (pay additional tax rate) and 0 otherwise, and the outcome corresponding to the treatment received:

$$Y_i = (1 - W_i).\ Y_i\ (0) + W_i.Y_i(1) = \begin{cases} Y_i(0) & if\ W_i = (0), \\ Y_i(1) & if\ W_i = (1). \end{cases}$$

The observation also, include a scalar covariate for each individual "the forcing variable", denoted by Xi. $m(x) = \mathbb{E}[Y_i \backslash X_i = x]$, Since this paper is interested in estimating the Sharp regression discontinuity design (SRDD), the treatment Wi is determined only by the value of the forcing variable Xi (the increase of income tax of individuals who earns 350k and more), being on either side of a fixed, known threshold c, or: $W_i = (1x_i \geq c)$. The average treatment effect for individuals with covariate values equal to the threshold (new income tax policy): $\mathcal{T}\text{SRD} = \mathbb{E}[Y_i(1) - Y_i(0)|X_i = c] = \lim_{x \downarrow c} m(x) - \lim_{x \uparrow c} m(x)$, The difference of the two regression functions evaluated at boundary points. This research focus on estimating $\mathcal{T}$SRD by local linear regression on the $W_i = 1\{X_i \geq c\}$ side of the threshold.

$$\hat{T}\text{SRD} = ATE = \lim_{d \downarrow c} E[Y|d] - \lim_{d \uparrow c} E[Y|d] = \beta + \lim_{d \downarrow c} E[\mathcal{E}|d] - \lim_{d \uparrow c} E[\mathcal{E}|d].$$

The causal effect on increase income tax rate on total tax revenue. Where d is the distance between Taxable Income and the tax-rate (x-c) from either side of the cut-off.

All other factor stays fixed at the cutoff, then: $\lim_{d \downarrow c} E[\mathcal{E}|d] - \lim_{d \uparrow c} E[\mathcal{E}|d] = 0$

β, is change in total tax revenue outcome at the tax-rate-increase threshold, is the causal effect of the new income tax rate policy. This implies the standard estimating equation:

$$Y_{ih} = \beta_0 + \beta_1 f(d_h) + \beta_2 . tax\_rate_h + \beta_3\ f(d_h).tax\_rate_h + \mathcal{E}_{ih}$$

Where i indexes potential individuals, h indexes taxable income thresholds, f is a continuous function such as a polynomial, and tax_rate is an indicator for the binary variable of household who earns over $350,000 and thus, is subject to the new income tax policy on the basis of its taxable income. How individuals respond to increase in income tax rate? There are two cases: (i)Individuals who always understand the Increase in Taxable Income rule and accept paying the increase rate of income tax. (ii) Individuals who always understand the Increase in Taxable Income rule and try to use tax shelter to avoid paying the increased amount of tax. The concern is about how these cases imply for the analysis because there is a substantial behavioral economic interest. In additional to assess whether this is an effective tax policy or not, how tax payers think about the state tax increase matters. Thus, the regression discontinuity should be set up with year t choices as the dependent variables and year t tax increase enforcement and distance from the cutoff as the independent variables: $Y_{iht} = \beta_0 + \beta_1 f(d_{ht}) + \beta_2 . tax\_rate_{ht} + \beta_3 f(d_{ht}) . tax\_rate_{ht} + \varepsilon_{iht}$
Where β_3 is interpreted as the effect of a change in the taxable income of individuals who earn over $350,000 equal to the increase in income tax rate.

V. Robustness check: Doughnut-hole Regression Discontinuity Design:

As an alternative to covariate adjustment, we are also considering a "Doughnut-hole Regression Discontinuity Design" analysis that ignores data immediately surrounding the threshold (Barreca et al. 2011). In settings where the sorting appears to be limited to the immediate neighborhood of the threshold, this approach has the advantage that one does not need to measure and control for all potentially unbalanced covariates, nor does one need to worry about measurement error due to misreporting of the running variable. Since tax-payers may be who are compliance to the new income tax policy change, the all in the same tax year regression with a doughnut-hole will be estimated (Hoxby, 2015):

$Y_{iht} = \beta_0 + \beta_1 f(d_{ht}) + \beta_2 . tax\_rate_{ht} + \beta_3 f(d_{ht}) . tax\_rate_{ht} + \varepsilon_{iht}$, $\{h : r < d_{ht} < b\}$

Where r is the radius of the doughnut-hole (for instance, $150,000 on either side of the cut-off) and b is the bandwidth (for example, $50,000 on either side of the cut-off).

VI. Results

A. Average Treatment Effect:

Table 1 :Estimation of the Average Treatment Effect (ATE) in a Sharp Regression Discontinuity Design (SRDD)

	Parameter estimate	Standard Error	t-Value	Pr>|t|	Pr>F	R-Square
Average Treatment Effect	-0.04	0.001	-37	<.0001	<.0001	0.81

Table 1 show a significant discontinuity at the threshold of %-4, indicating that the treatment group who are expose to additional %5 increase in their income tax rate because they earn over $350,000 decrease total revenue.

However, comparing individuals who earn $350,000 in 2012 and being subject to the new tax policy to 2011, a year prior to income tax change, findings in table 2, show a positive discontinuity at the threshold, indicating that the new income tax policy increased total revenue.

Table 2 RDD simulation on Individuals who earn over $350,000 in year 2011

	Parameter estimate	Standard Error	t-Value	Pr>|t|	Pr>F	R-Square
Average Treatment Effect	0.035	0.0001	293.89	<.0001	<.0001	0.6

Table 2 shows the coefficient of the simulated regression discontinuity design in prior to 2012 of the new income taxes to see if the target group would have paid more. this result based on year 2011 with simulated income tax rate of 2012. The results show that increase in tax rate increase total revenue.

B. Doughnut-hole regression discontinuity design:

Table 3 Doughnut-hole regression discontinuity design excluding income tax earner $200,000-$500,000.

	Parameter estimate	Standard Error	t-Value	Pr>|t|	Pr>F	R-Square
Average treatment effect	.035	.0004	74	<.0001	<.0001	0.6

Table 3 shows that the doughnut-hole is imposed on both years (2011-2012) because, the type of tax-payers is unknown, and this is the only way to exclude bias due to taxable-income management.

C. Breaking individuals who earn over $350,000 to five income levels:

In this section, the individuals who earn over $350,000 are break down to five groups to be able to see the diversity of individuals behavior at different income levels. As shown in table 4.

Table 4 The Average treatment effect at five income levels:

Variables	Parameter estimate	t-Value	Pr >|t|	R-Square
ATE(350-375K)	52.060 (1079.14)	0.05	0.9616	0.02
ATE(375-400K)	-3840.40 (1176.89)	-3.26	0.0012	0.04
ATE(400-450K)	-4854.89 (1176.13)	-4.13	<.0001	0.1375
ATE(450-500K)	-8511.38 (1765.32)	-4.82	<.0001	0.1010
ATE(500K-∞)	4612.48 (623.84)	7.39	<.0001	0.6770***

Table 4 shows that the ATE of income of five income group, only the income group that earn above $500,000 payment of the increase amount of tax generate a high tax revenue. This prompt us to think of what economic behavior individuals who earn less than $500,000 due to reduce their tax liabilities.

VII. Channels for Income Managements:

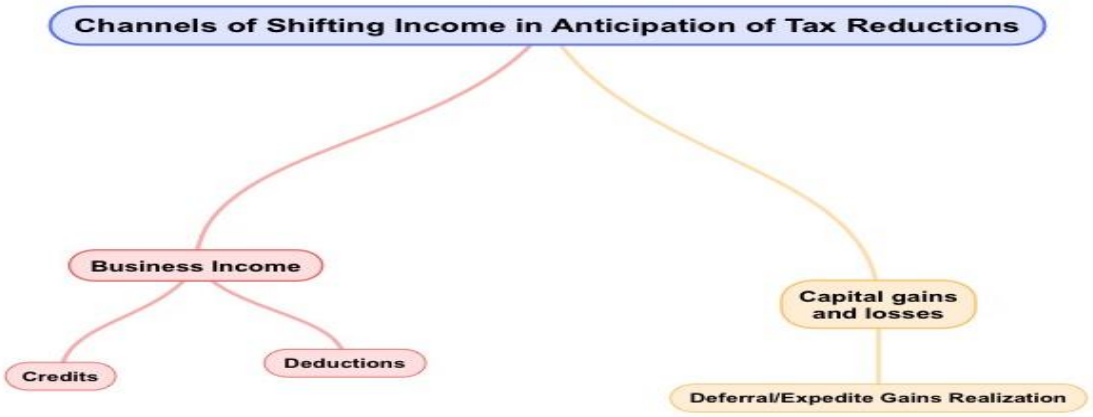


Table 5 Self-employment Income (Business Income):

Business income(Self-employment Income)				
Variables	Parameter Estimate	t-Value	Pr >|t|	R-Square
ATE (350-500K)	-127,208	-2.00	0.08*	0.6
ATE (500K-∞)	-224.96	-0.01	0.99	0.003

Table 5 shows that the group of income level that earn less than $500,000 significantly report their income as income generated from their business and claim a significant toss than group of income level that earn $500,000 and more, where they have insignificant claim of business income loss.

Table 6 Deduction reported at different income levels

Deduction				
Variables	Parameter Estimate	t-Value	Pr >|t|	R-Square
ATE (350-500K)	-2,818.539	-3.39	0.0007	0.6
ATE(500K-∞)	-3,266.78069	-0.19	0.0944	0.0009

Table 6 confirms our findings that the group of income level that earn less than $500,000 significantly claim deduction from loss of business income.

Table 7 shows the impact of government income tax policy reform in 2016 of income tax filers who earn over $1milion. It does support the findings earlier. It shows that the new income tax policy reform of tax payers who earn over $1milion. A 0.05 percent increase in income tax rate increases income tax revenue 8.7 percent.

Table 7 Average Treatment Effect of Income Tax Policy Reform in 2016 on Taxable Income of over $1million on Government Tax Revenue.

	Parameter estimate	Standard Error	t-Value	Pr>|t|	Pr>F	R-Square
Average treatment effect	8.7	2.14	4	<.0001	<.0001	0.24

VIII. Conclusion:

The empirical analysis of the impact of increasing income tax rate from 8.50 to 8.95 percent in the District of Columbia of individuals who earn over $350,000 in 2012 and then shift the income bracket that this policy applied to over $1milion in 2016 on local government revenue. It shows

that tax-payers of income level that earn less than $500,000 use tax shelter significantly to reduce their tax liability. Therefore, the 2012 income tax policy seems to be more effective on the tax payers that earn over $500,000. Tax increase was born primarily of group earning over $500,000.

However, the income tax policy in 2016 that shift the enforcement of the increase of income tax rate from the income bracket of $350,000 to $1milion shows significant increase of income tax revenue. No tax payers behavioral change shows in our findings. Therefore, 2016 income tax policy is very effective to increase the government revenue.

Reference:

Bulman, G. and Hoxby, C. 2015. The Effects of The Tax Deduction for Postsecondary Tuition: Implications for Structuring Tax-Based Aid. National Bureau of Economic Research. Cambridge, MA.

Barreca, Alan I, Melanie Guldi, Jason M Lindo and Glen R Waddell. 2011. "Saving Babies? Revisiting the effect of very low birth weight classification." The Quarterly Journal of Economics 126(4):2117–2123.

Chernick, H. 1997. Tax Progressivity and State Economic Performance. Economic Development Quarterly. 249-267.

Gale, W. and Samwick, A. 2014. Effects of Income Tax Changes on Economic Growth. The Brookings Institution and Tax Policy Center and Dartmouth College and National Bureau of Economic Research.

Hahn, J. Todd, P. and Klaauw, W. 2001. Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design. Econometrica. 69(1):201-209.

Imbens, G. and Lemieux, T. 2007. Regression Discontinuity Desgins: A Guide to Practice. Department of Economics, Harvard University and NBER, M-24 Littauer Center, Cambridge, MA. USA and Department of Economics, University of British Columbia and NBER, 997-1873 East Mall, Vancouver, BC, Canada.

Kaylanaraman, K. and Imbens, G. 2009. Optimal Bandwidth Choice for the Regression Discontinuity Estimator. National Bureau of Economic Research. Cambridge, MA.

Lee, David S. and Thomas Lemieux. 2010. Regression Discontinuity Design in Economics. Journal of Economic literature. 48(2):281-355.

Christina Romer & David Romer. 2010. The macroeconomic effects of tax changes: estimates based on a new measure of fiscal shocks, 100 American Economic Review 763-801.

Slemrod, J. 2001. A General Model of the Behavioral Response to Taxation. International Tax and Public Fiance. Kluwer Academic Publishers.