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Distortionary effects of increased tax rates on taxable income in South Africa

Rikhotso, Singita

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University of the Witwatersrand



DISTORTIONARY EFFECTS OF INCREASED TAX RATES ON TAXABLE INCOME IN SOUTH AFRICA

RESEARCH REPORT SUBMITTED BY:

Name: **Singita Rikhotso**
Student Number: **545385**
Supervised by: **Dr Mthokozisi Mlilo**

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DECLARATION

I, **Singita Rikhotso**, declare that this dissertation is my own original work and that, to the best of my knowledge, necessary acknowledgements and accurate reporting of sources used within the text have been made. This report, in part or in its entirety, has not been submitted at any university in fulfilment of any other qualification.

Singita Rikhotso

ABSTRACT

With the use of tax administration data comprising a panel of more than 230000 individuals, this paper primarily investigates the consequences of personal income tax rate hikes in South Africa. It employs the prominently used elasticity of taxable income framework- together with revenue principles consistent with the basic concepts of the Laffer curve- to gauge the effect of the 2017/2018 personal income tax rate reform on reported taxable income and, ultimately, tax revenue collection. The findings give significantly high elasticity of taxable income values ranging between 0.99 and 1.95, values that show sensitivity to the sample used. The estimates suggest a loss of revenue in excess of R6 billion following the tax reform and reveal that the highest income earners are already being taxed beyond the optimal tax rate. These results show that the extent to which South Africa can rely on personal income tax rate hikes for increased revenue collection is very limited.

Keywords: Elasticity of Taxable Income, Tax Reform, Behavioural Changes, Tax Performance, Revenue Collection.

Dedicated to my very supportive parents, Thomas and Nelly Rikhotso.

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LIST OF ABBREVIATIONS

2SLS: Two-stage least squares

ETI: Elasticity of taxable income

i.i.d: Independently and identically distributed

OLS: Ordinary least squares

PIT: Personal income tax

RMSE: Root mean square error

SARS: South African Revenue Service

UNU-WIDER: United Nations University World Institute of Development Economics Research

VIF: Variance inflation factor

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1. INTRODUCTION

1.1 Background

The South African government's long-term objectives include the need to alleviate poverty, reduce high levels of income inequality and promote inclusive economic growth (National Planning Commission, 2012). Achieving these objectives has serious implications on the fiscus: spending requirements are high, the fiscal budget is strained, and the country's expenditure continues to exceed its revenue (Mboweni, 2019).

Given this, South Africa is constantly having to borrow. Its debt-to-GDP ratio stood at 56.7 percent in 2019 and is projected to rise (National Treasury, 2019). Unfortunately, high debt-to-GDP ratios promote leakages of tax revenue from the economy as the government services its debt, which would otherwise be used to finance other necessities (Moss and Chiang, 2003). The persistence of high levels of fiscal debt can also crowd out investment, decrease flexibility in budget allocations as well as create a high degree of instability, potentially leading to a fiscal crisis (Moss and Chiang, 2003). It is therefore imperative and urgent for the government to properly manage its accounts to mitigate the adverse effects high levels of debt are accompanied by. Accordingly, the government also plans to consolidate the fiscal budget in the medium term (Mboweni, 2019; National Treasury, 2019). This will most likely dominate the direction of fiscal policy in the next few years.

While the successful fulfilment of the government's goals, including fiscal consolidation, recognizes the need for the reprioritization of government expenditure, the effectiveness of public spending, as well as the elimination of corruption, the issue of raising more revenue through taxation cannot be ignored.

Arguably, with a moderate tax-to-GDP ratio, approximately 26.7 percent in 2018, the financial position of the country can be improved upon with higher taxes. Question however remains: Can we extract the extra revenue from personal income taxation or should other tax bases be considered? Can the already high top personal income tax rate of 45 percent, second in Africa and in the top 20 across the world, be hiked any further (Trading Economics, 2021a; Trading Economics 2021b)?

1.2 Problem Statement

Personal income taxes are the largest contributor to tax revenue in South Africa (SARS and National Treasury, 2019). As a result, the personal income marginal tax rate has been an attractive tax policy instrument widely considered for generating increased levels of revenue. In post-Apartheid South Africa, for example, the top marginal tax rate was first hiked to 45 percent from 43 percent in the 1995/1996 tax year, reduced to 42 percent in 2000/2001, and reduced further to 40 percent in 2002/2003. More recently, in the 2015/2016 tax year, all personal income tax (PIT) brackets saw a one percent point increase in their marginal tax rates. In 2017/2018, individuals at the upper end of the highest income tax bracket at the time, those earning above R1.5 million, became subject to a four percent point increase from 41 to 45 percent in the tax rate levied on their income. (SARS and National Treasury, 2019).

Marginal tax rate hikes are believed to distort the collection of revenue. At the individual level, personal income tax rate increases usually induce behavioural responses from taxpayers that decrease their taxable income (Feldstein, 1995). At the aggregate level, these changes in taxable income following tax rate hikes distort the tax liability of individuals and, ultimately, affect tax revenue collected by the government (Feldstein, 1995; Feldstein, 2008).

It is of critical importance to understand and to quantify the impact the behavioural responses to tax rate hikes have on tax revenue performance through the taxable income channel; the formulation of sound tax and budget policies are dependent on it (Feldstein, 1995). To achieve this, many studies borrow from the extensively used elasticity of taxable income (ETI) framework. The ETI is a measure commonly used to capture the degree of all possible incentive-induced responses associated with a change in income tax rates (Kemp, 2019). It is a key variable when quantifying efficiency and budgetary implications of tax policy changes, when making revenue forecasts or when analysing the optimal size of a government (Feldstein, 1995; Goolsbee, 2000).

Existing literature gives strong evidence of taxable income responses following tax rate changes, with a high degree of distortionary responses in the event of tax hikes and, on the other hand, a significant reduction in tax evasion or avoidance in the event of tax cuts. The literature, however, presents significantly varying values of the ETI and no consensus regarding its magnitude has been reached; even within the same countries (Gruber and Saez, 2002; Kemp, 2019). Understandably, tax elasticities are expected to differ across many different settings and are highly sensitive to methods and estimation techniques employed

(Gruber and Saez, 2002; Kemp, 2019). Notwithstanding the discrepancies between estimates presented in the literature, an emphasis is placed on the care that needs to be exercised to ensure that tax elasticities are calculated as accurately as is possible, given their significance.

Studies interested in the consequences of tax rate hikes on revenue collection also make use of revenue elasticity ideologies of the Laffer curve. The Laffer curve illustrates the relationship between the amount of tax revenue collected and the tax rate (Laffer, 2004). Its main premise is that there exists, beyond a threshold level, an inverse relationship between the tax rate and the amount of tax revenue collected (Hemming and Kay, 1980; Laffer, 2004). This relationship, as will be shown, is partly dependent on the ETI.

Motivation and Significance of the Study

Sound personal income tax policy design requires sufficient relevant evidence to serve as a point of departure and South Africa is lacking in this regard (Ebrahim, Gcabo, Khumalo and Pirttilä, 2019; Kemp, 2019). To contribute, this work purposes to conduct policy relevant research that will better inform marginal tax rate changes, particularly for the highest income earners. This is achieved by estimating the short-run distortionary effects of the 2017/2018 personal income tax rate hike on taxable income, as captured by the ETI and, subsequently, the effect on tax revenue. Ultimately, the goal is to gauge the extent to which South Africa can still rely on personal income tax rate hikes for increased revenue collection.

The few studies that have attempted to estimate ETI's or revenue implications of tax rate hikes in South Africa have done so through the use of the bracket creep phenomenon (Kemp, 2019; Kemp, 2020), microsimulation techniques (Jordaan and Schoeman, 2015) or aggregate analyses (Steenekamp, 2012b). This study is highly significant in that it evaluates tax rate hike effects using both individual-level tax administration data and an actual reform, something the existing South African studies have not done.

The study reviews literature on behavioural responses to tax rate changes, the ETI's and the Laffer Curve, to aid in understanding the mechanisms through which tax rate hikes become distortionary. Simple relations found in the literature are used to illustrate and to quantify the effect of the ETI on tax revenue changes as well as the optimal tax rate. The empirical analysis then makes use of anonymized tax administration data over the 2016-2018 tax periods and employs the difference-in-difference technique, coupled with two-stage least squares (2SLS) to estimate the effects of the 2017/2018 four percentage point tax rate increase on the

responsiveness of the top income earners. The study further identifies and controls for individual non-tax characteristics that potentially drive taxable income changes.

1.3 Paper Scheme

The paper is structured as follows: Section 2 gives a brief outline of the South African tax system with brief comments on international practices. Section 3 summarizes the relevant literature. Section 4 presents the theoretical underpinnings upon which the empirical analysis is based. Section 5 outlines the empirical strategy employed and section 6 discusses the results and conducts robustness checks. Section 7 highlights the policy implications, gives recommendations for future research and concludes.

2. INSTITUTIONAL FRAMEWORK

This section gives an overview of the South African tax system with brief comments on international tax practices.

2.1 The South African Tax System

The South African tax system consists of a wide range of tax instruments with the three largest sources of tax revenue- namely, personal income tax, corporate income tax and value-added tax, making up approximately 80 percent of total tax revenue in the 2018 tax year[1] (SARS and National Treasury, 2019). On its own, PIT accounted for 38.1 percent of tax revenue in 2017/2018, a 4.9 percent increase from the previous tax year. (SARS and National Treasury, 2019).

Information on personal income is collected using two main sources, the IRP5/IT3(a) [2]as well as the ITR12. The IRP5 (payroll) certificate is completed by each employer registered for the pay-as-you-earn tax on behalf of all employees who received remuneration from that employer. The ITR12 (assessed) return is prepopulated by information from the IRP5 certificate of an individual. To this, an individual or tax practitioner include any additional non-labour income earned as well as any additional deductions received. As of 2014/2015, for an individual earning less than R350,000 from only one employment income source, with no investment income above the exempt thresholds, and no additional deductions to claim, the submission of an ITR12 is not compulsory (Ebrahim and Axelson, 2019).

The tax liability of individuals is calculated using the IRP5 and the ITR12. While the PAYE tax amount calculated in the IRP5 is provisional, the amount in the ITR12 is final (Ebrahim and Axelson, 2019). Given this, the ITR12 takes precedence in the event that an individual submits both forms.

[1] 2017/2018 and 2018 are used interchangeably in this study to refer to the tax year that starts on the 1st of March 2017 and ends on the 28th of February 2018. This convention can be applied to any other tax year.

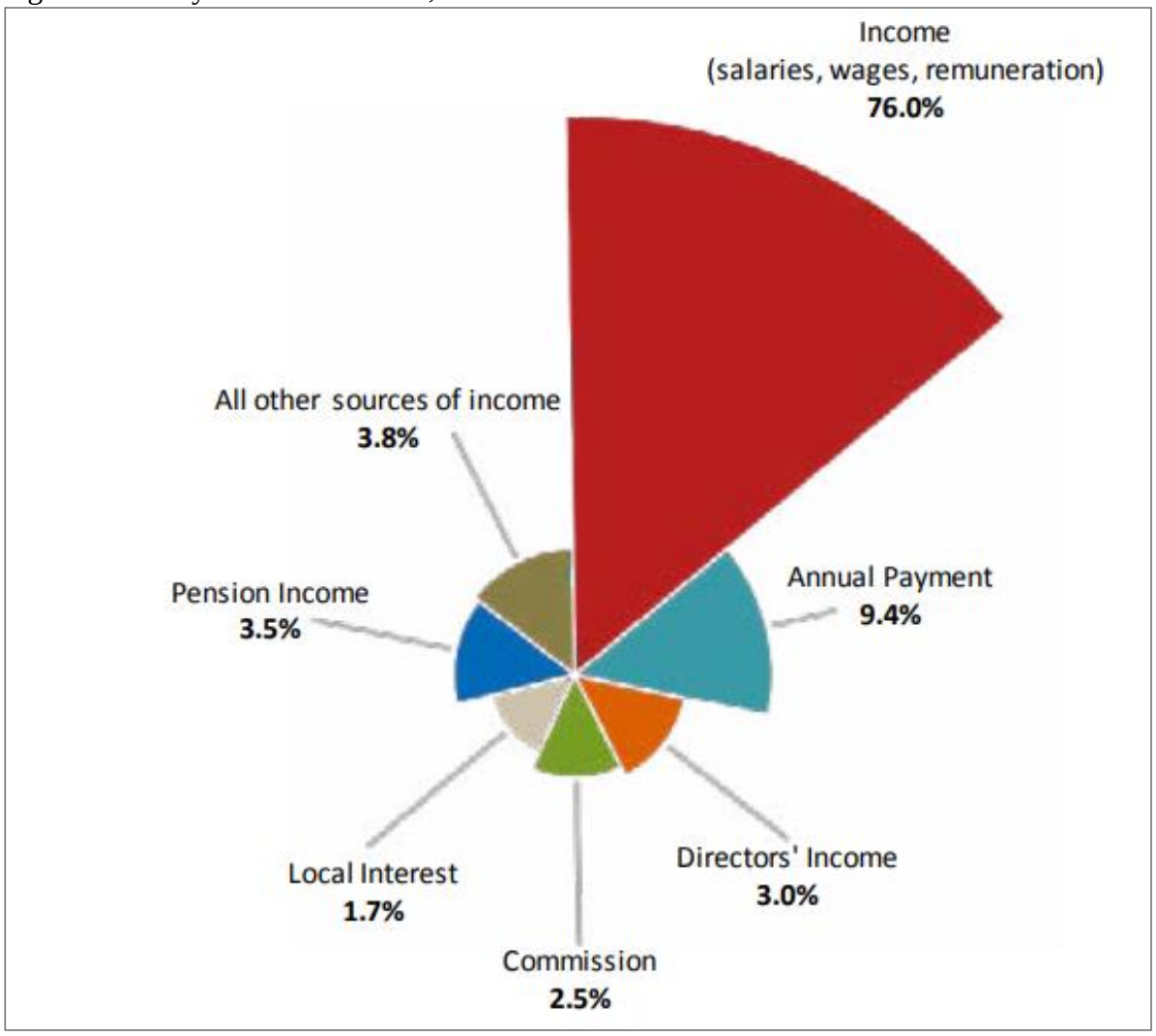
[2] Henceforth, just IRP5.

PIT is calculated on an individual's (or trust's) taxable income, where taxable income is computed as:

$$Taxable\ Income = Gross\ Income - (Exemptions + Allowable\ Deductions) \quad (2.1)$$

Gross income can include, but is not limited to, salaries or wages (labour income), pension or annuity payments as well as business and investment income- including dividends, interest receipts as well as capital gains. Figure 1 summarizes the proportions of tax the different sources of personal income contribute. Evidently, a large portion of PIT collections comes from salaries and wages. This accounted for 76 percent in the 2017/2018 tax year.

Figure 1: PIT by source of income, 2017/2018



Source: SARS and National Treasury (2019)

South Africa has adopted personal income taxation with a degree of progressivity which plays the crucial role of redistributing income to mitigate the skewness of the income distribution

(Davis Tax Committee, 2016; Steenekamp, 2012a). Any adjustments made to the personal income tax system also constantly seek to preserve its progressivity (Steenekamp, 2012a).

In Table 1, which presents personal income tax brackets and their respective tax rates for the 2018 tax year, one can see the progressivity of the South African PIT system, with higher marginal tax rates for higher levels of income groups. The 45 percent rate is levied on the newly introduced tax bracket comprising of those earning taxable incomes above R1.5 million.

Table 1: PIT brackets, 2017/2018

Taxable Income Bracket (R)	**Current Tax Rate**
0 – 189,880	18%
189,881 – 296,540	26%
296,541 – 410,460	31%
410,461 – 555,600	36%
555,601 – 708,310	39%
708,311 - 1,500,000	41%
1,500,000 +	45%

Source: SARS and National Treasury (2019)

It is also worth mentioning here that taxable income brackets are adjusted upward at the beginning of each tax year, specifically to combat the effects of inflation on individuals' income, otherwise known as the fiscal drag (SARS and National Treasury, 2019).

2.2 Tax Practices Around the World: A Caveat

South Africa has, from time to time, relied on evidence from other countries. International trends and practices have set useful benchmarks for its tax policy formulation, especially when one considers its African counterparts and other emerging economies comparable to it (Davis Tax Committee, 2016). While this is the case, it is noted that there exist many country specific factors which invalidate, to some degree, the imitation of foreign tax policies. These factors include economic, structural, institutional and social characteristics (Bird, Martinez-Vazquez and Togler, 2008; Gupta, 2007; Piancastelli, 2001). It is emphasized, therefore, that although learning from the experiences of other countries is a good point of departure, it should not be authoritative. This should be kept in mind as the study progresses.

3. LITERATURE REVIEW

This section reviews literature concerned with the estimation of taxable income elasticities, tax revenue performance and revenue maximization.

3.1 Behavioural Responses

The study of behavioural responses to tax rate adjustments manifests through the effect on the number of hours worked (Goolsbee, 2000). Empirical studies which evaluated this relationship mostly found a very small and insignificant effect of taxation on labour supply, which is consistent with the idea of an inelastic labour supply curve in the short-run (Goolsbee, 2000).

A simple analysis of the decision of how much to work does not, however, reveal the complete truth about efficiency costs of tax hikes (Goolsbee, 2000; Slemrod, 1998; Slemrod, 2001). Given ample opportunity to alter or conceal one's income sources, attempts of extracting more revenue from taxation still risk being frustrated even if labour supply is irresponsive to tax rate increases (Goolsbee, 2000). In recent years the interest has, as a result, switched from the effect of tax rate changes on labour supply to the effect on reported taxable income, which encompasses more than just compensation for labour.

Taxable income responses due to tax rate changes are wide-ranging and include, for example, the already mentioned changes in the supply of labour- both in terms of hours worked and effort exerted-, increases in the itemization of deductions and tax expenditures (Feldstein, 1995; Kemp, 2019), reallocations of one's savings or investment portfolio (Carroll and Hrung, 2005; Feldstein, 1995), changes in the form of compensation as well as in the timing of income and deductions (Carroll and Hrung, 2005; Feldstein, 1995; Feldstein, 2008).

Noticeably, in the presence of tax rate hikes, the prevalence of large underground markets provides increased opportunity to bypass the tax system (Kramer and Snyder, 1988). The presence of highly integrated international markets can also lead to increased mobility of labour or income across differently taxed jurisdictions, especially by middle to high-income earners seeking to avoid high taxes (Davis Tax Committee, 2016). The quality of tax administration and the costs of compliance also determine the degree to which individuals react to taxation.

Low compliance costs and rigorous enforcement rules, for example, mitigate circumvention and lead to smaller responses to tax policy changes (Slemrod and Yitzhaki, 2000).

3.2 The Elasticity of Taxable Income

The ETI broadly encompasses all possible behavioural responses to a given change in the marginal tax rate, making it possible to analyse the overall impact of the change on taxable income without the need to know the exact dynamics at play (Carroll and Hrung, 2005; Creedy, 2009).

The bulk of empirical literature on the ETI was initially based on work conducted on the United States. This follows a series of tax reforms which were associated with substantial tax changes in the 1980's and 1990's. One such early study is by Lindsey (1987). The study looks at tax-induced behavioural responses following the United States Economic Recovery Tax Act of 1981 which constituted a tax cut. Using the TAXISM model of the National Bureau of Economic Research and tax return data from 1979, it generates a simulated, counterfactual dataset by making projections of the post-reform income distribution. This is done under the assumption that no reform took place and that macroeconomic conditions are the same as observed in the relevant years. Comparisons between the counterfactual income distribution and the actual distribution approximate a difference-in-differences model, finding a relatively high overall elasticity of taxable income ranging between 1.60 and 1.80.

A second study by Feldstein (1995) uses panel data, with a sample of 4000 taxpayers. The paper makes comparisons of the tax returns of the same set of individuals before and after the 1986 United States Tax Reform Act, which also decreased marginal tax rates. Using the difference-in-difference estimation technique, the analysis also concludes that taxable income is highly responsive to tax rate cuts. The elasticities reported by Feldstein (1995) are relatively large as well, ranging from 1.0 to 1.5, with taxable income increases being higher for those at the upper end of the income distribution. Reasonably, high-income earners who are more involved in tax planning, in addition to having ample opportunity to alter their taxable income, are expected to be more responsive.

Much empirical research has been conducted following the seminal work of Feldstein (1995) and Lindsey (1987). These studies give evidence of varying estimates which, notwithstanding, mostly reveal that tax rate changes, either tax rate hikes or cuts, lead to significant responses in taxable income. The bulk of the literature is, however, more focused on the United States and other developed economies, with very little evidence existing for emerging and underdeveloped countries. Additional literature useful for this study is discussed below, firstly for studies seeking to reconcile the large ETI's observed in Feldstein (1995) and Lindsey (1987), then for the South African context, followed by a few studies presenting evidence from emerging economies comparable to South Africa.

Results found in Auten and Carroll (1999) suggest that the large ETI estimates reported in the earlier studies might have resulted from the inability to properly control for non-tax factors that most likely affected taxable income. Using the United States 1986 Tax Reform Act, Auten and Carroll (1999) account for mean reversion and secular income trends, and include individual specific controls. Using panel data with more than 15000 middle- to upper- income individuals of working age, Auten and Carroll (1999) estimate a weighted least squares elasticity of approximately 0.57 with all controls, much lower than the earlier papers suggest. The exclusion of controls raises the ETI to 0.67 and results in even higher unweighted (just two-stage least squares) estimates. These findings emphasize the need to disentangle taxable income changes that result from tax rate adjustments, from changes induced by non-tax related factors.

Gruber and Saez (2002) build on the existing literature by using a series of United States tax reforms in the 1980's. This gives the advantage of examining the effects of more than one variation in the tax rates. The study explores and models the effects of mean reversion as well as heterogeneity across income groups and other taxpayer characteristics. It reports an overall elasticity close to 0.4. Moreover, the study finds an elasticity of 0.57 for individuals earning more than $100,000, significantly higher than the elasticity of individuals earning less. Those who itemize deductions are also found to be more responsive to tax rate changes.

Kopczuk (2005), Saez (2003) and Saez (2004) each submit a range of ETI estimates on the United States surrounded by a great deal of uncertainty. The overall elasticities differ significantly depending on the specification of the models employed. Disseminating the responses by different group-specific or individual specific- factors gives a whole different impression as well.

In using the phenomenon of the bracket creep resulting from the fiscal drag as a source of tax rate variation, Saez (2003) finds elasticities between -0.14 and 0.7. It analyses four income groups separately, further distinguishing individuals within each group by marital status and the choice of whether to itemize deductions. The responsiveness of those who are married, as well as that of single taxpayers who itemize deductions is relatively higher than for those who are not married and for non-itemizers. The overall elasticity is estimated to be 0.31.

With the use of a simple model to capture the effect of a series of tax rate cuts, Saez (2004) reports a statistically insignificant ETI estimated to be -0.44. The inclusion of a time trend increases the overall estimate to 0. Further including a time trend with its squared value increases the overall estimate to 0.20, while still being statistically insignificant. For the top 1 percent of income earners, however, the results are highly statistically significant with a high estimated degree of responsiveness. The estimates vary with different time trend controls. It is highest with no time trend at 1.83, then with a time trend at 0.71 and lowest at 0.50 with a time trend and the squared trend.

Kopczuk (2005) gives evidence of the delicacy of estimates to the selection of the sample coupled with intricate controls that account for exogenous changes in income. This also yields a broad range of elasticities. The study finds that the elasticity of taxable income for individuals earning more than $10,000 reduces to almost half when considering the entire sample of individual taxpayers.

To explain the disparities in the high estimates found in earlier United States studies and the lower estimates reported by later studies, Goolsbee (2000) suggests that significant differences in short-run and long-run elasticities may be the reason for the discrepancies reported. It uses a sample consisting of corporate executives in the United States and finds that elasticities observed immediately following a reform tend to be higher, in excess of 1, whereas the long-run responsiveness drops to less than 0.4.

Similar to the distinction between short-run and long-run responses, Giertz (2004) who reviews ETI literature particularly for the American context also emphasizes the need to differentiate between permanent and transitory responses when estimating the ETI. Also worth noting are findings by Chetty (2010) as well as Chetty, Friedman, Olsen and Pistafferi (2011), who highlight that small tax reforms usually result in small elasticities in contrast to large tax reforms. This is because the benefit of shifting income is attenuated by the presence of large

frictions such as adjustment costs or simply inattention, what Chetty (2012) refers to as optimization frictions. Such frictions are usually overcome by larger tax reforms.

In South Africa, no large enough tax rate reform sufficient to estimate taxable income elasticities had occurred before the 2017/2018 tax rate reform. In addition to the lack of sufficient micro-level data for the relevant years, many studies have rather focused on other types of techniques to estimate elasticities. A noteworthy study by Kemp (2019) uses tax administration data and the phenomenon of the bracket creep as a source of tax rate variation, coupled with difference-in-differences and the two-stage least squares estimation technique. The study estimates an overall elasticity of approximately 0.3, with the affluent reported to be slightly more responsive, having an elasticity of 0.4. Kemp (2019) highlights that although evidence shows significant ETI estimates, the effects of the bracket creep might yield lower estimates than those that would be derived from actual tax rate reforms. This is because the bracket creep is not expected to elicit as large a response as an announced tax rate change. A similar study by Kemp (2020) presents a slightly higher overall elasticity estimate equal to 0.4.

Considering the limited evidence from emerging economies, a range of elasticity estimates have also been found, emphasizing the lack of a consensus in the estimation of the ETI. Mattos and Terra (2016) estimated the ETI for Brazil to range between 0.4 and 1.3, a range stipulated to be within the revenue maximizing region. They were using a reform that affected the higher income tax bracket. He, Peng and Wang (2018) estimated the ETI for China to be 2.423 in the short-run using a tax reform, and much less, at 0.5, when using the bunching approach. Acharya (2011) estimated the Indian Elasticity for direct income and wealth to be 1.8 using a time series approach.

3.3 Tax Revenue Performance, Optimal Tax Rate and the Laffer Curve

A simple way of understanding the dynamics of tax revenue changes following a tax rate change is captured by the Laffer Curve described in Laffer (2004). The curve, shown in Figure 2, demonstrates that as the taxation of a productive activity[3] increases beyond a threshold point,

[3] In the context of personal income taxation, 'productive activity' refers to all productive means people use to generate income.

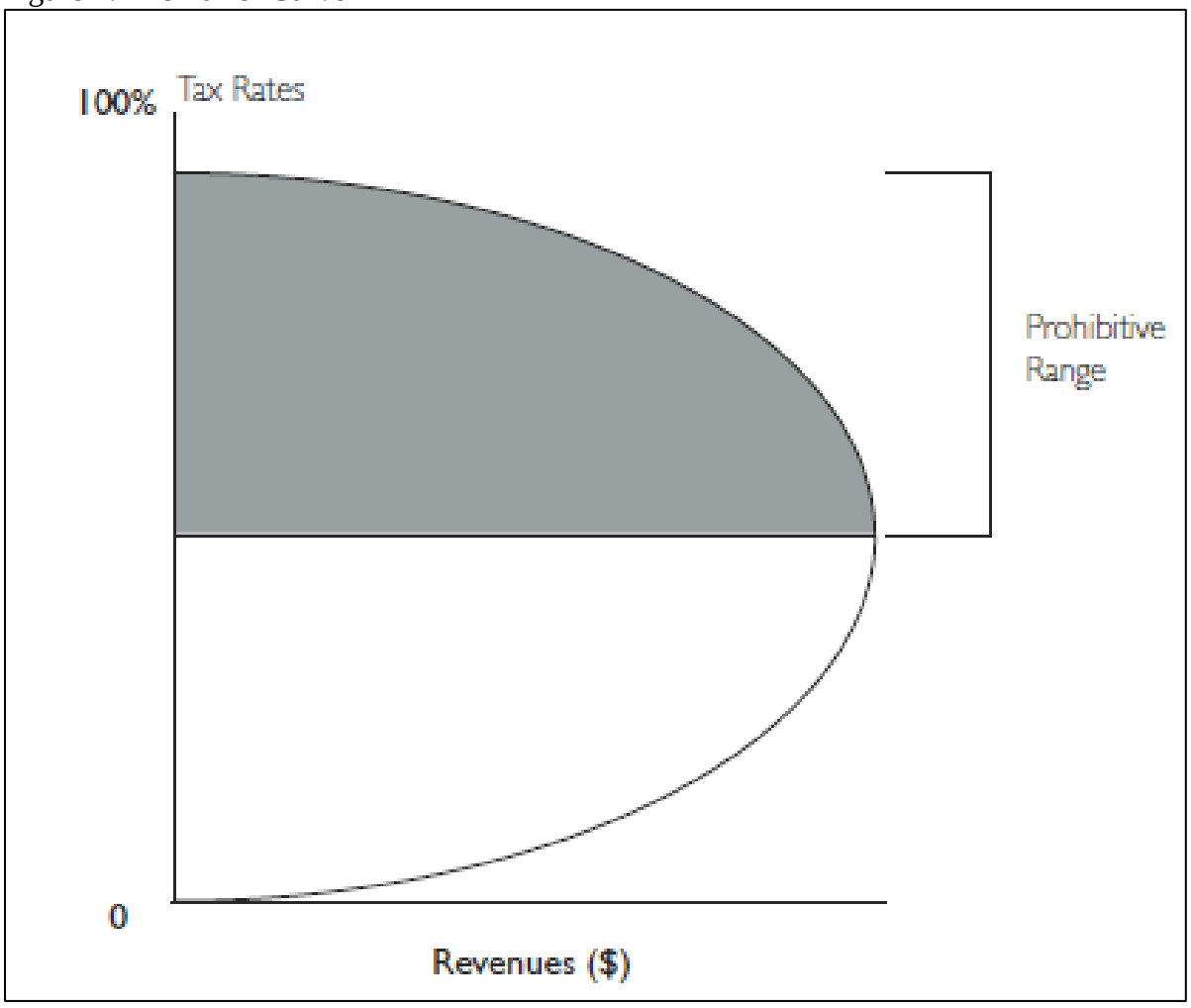
the tax rate at which revenue is maximized, a decline in the overall revenue collected will be realized. This occurs when the tax system is in the prohibited range. On the other hand, at tax rates below the threshold point, revenue is expected to increase, albeit at a decreasing rate.

Through the Laffer curve one can also be able to understand the effect of the ETI on tax revenue performance following a tax rate change, and the revenue-maximizing tax rate. To better comprehend this, it is important to note that there are two channels through which tax revenue is affected given a change in the tax rate. In the event of a tax rate increase, for example, a higher proportion of taxation is levied on all reported taxable income. This yields a direct increase on revenue. The second effect is due to the distortionary behaviour of individuals. It affects tax revenue in the direction opposite to the tax change. The first effect is known as the mechanical[4] effect and the second is the substitution[5] effect, otherwise known as the distortionary effect in the event of a tax hike. This effect is as discussed in sections 3.1 and 3.2, and is captured by the ETI (Steenekamp, 2012b).

[4] Laffer (2004) refers to this as the arithmetic effect

[5] Laffer (2004) refers to this as the economic effect

Figure 2: The Laffer Curve



Source: Laffer(2004)

The direction in which revenue changes given a tax change is dependent on the magnitude and direction of both the mechanical and the substitution effects (Laffer, 2004). Essentially, beyond the revenue-maximizing tax rate, in the prohibitive range, the distortionary effect resulting from weakened incentives to do more of the taxed productive activity yields a higher decrease in taxable income than the increase resulting from the mechanical effect. Below the revenue-maximizing tax rate, the tax rate is not high enough to induce a negative response sufficient to reduce the aggregate revenue collected. In this case, although individuals might still have an incentive and means to circumvent taxation, the resulting distortionary effect is lower than the mechanical effect, in absolute terms. (Laffer, 2004). From this, it is clear that the dynamics of the Laffer Curve are partly dependent on the ETI. Moreover, ETI's are relatively larger at tax rates within the prohibitive range then they are outside of it. Ultimately, the point on the Laffer

curve a government looking to maximize revenue would like to operate is at the rate yielding the highest revenue. This tax rate is referred to, here, as the optimal tax rate[6] (Laffer, 2004).

In the South African context, Kemp (2019) estimated an optimal tax rate of approximately 40 percent for individuals in the top tax bracket. Steenekamp (2012b) uses long-run aggregated tax statistics and shows that a 10 percent increase in the tax rate of the top bracket- 40 percent at the time- would lead to revenue losses of up to R340 million, not as high as the losses expected (Steenekamp, 2012b). This finding results from an estimated elasticity of 0.8 for high-income earners. Using the microsimulation techniques and the Laffer analysis, Jordaan and Schoeman (2015) find that the degree of responsiveness to marginal tax rates is strong and present results that show that the lowering of marginal tax rates would increase PIT revenue closer to the its optimal level. When considering the Laffer curve, this implies that the tax rates being levied are already in the prohibited region.

3.4 Literature Summary

Having considered a portion of existing empirical evidence, it is already clear that a sole focus on the single ETI estimate conceals a lot of disparities in the methodologies employed, methodologies to which the ETI is highly sensitive. It is noted, however, that the use of differences-in-differences is common in the extant literature (Giertz, 2004). In addition to this, the correction for mean reversion, for time trends as well as for other exogenous taxable income factors is integral to the accurate estimation of elasticities. It is also apparent that a distinction between short-run and long-run elasticities, as well as between transitory and permanent responses, is important.

In line with the literature, this study seeks to estimate the elasticities as accurately as is possible by using appropriate estimation techniques and by controlling, where possible, for factors which potentially affected taxable income changes in the sample period employed.

The basic premise of the Laffer curve is also used in the study to understand the dynamics of tax rate changes. It is noted, however, that in a few studies, the use of the Laffer Curve has not

[6] In this study, optimality refers to revenue maximization.

fared well as a testable hypothesis as it is assumed to be simplistic[7] (Goolsbee, 1999). Even so, a couple of important studies have supported its notions, finding it to be fairly accurate and useful[8] (Goolsbee, 1999).

[7] See Mirowski (1982).

[8] See Slemrod and Yitzhaki (2000) and Steenekamp (2012b).

4. THEORETICAL FRAMEWORK

This section presents the theoretical underpinnings upon which the analysis of this study is based. The basic model of interest follows discussions in Feldstein (1999)- which assume a utility function dependent on consumption and taxable income- and is as seen in Gruber and Saez (2002). Taxpaying individuals are assumed to maximize a utility function $u(c, z)$, where $\boldsymbol{c}$ represents consumption and $\boldsymbol{z}$ gives the reported taxable income of individuals. Consumption, which is equal to disposable income, is taken to have a positive relationship with utility. On the other hand, taxable income is negatively related with utility: Generating a higher level of reported taxable income is considered costly, given the equivalent trade-off of leisure (Kemp, 2019).

The optimization of the function $u(c, z)$ is subject to the budget constraint $c = z * (1 - \tau) + R$. Here τ gives the tax rate, with $(1 - \tau)$ giving the net-of-tax rate. R is virtual income, an intercept of the budget constraint when z = 0, which gives income not dependent on the tax rate. Maximizing the utility function subject to the budget constraint, with respect to R and τ, produces the following reported taxable income function- dependent on virtual income and the slope of the budget constraint, $(1 - \tau)$:

$$dz = -\frac{\partial z}{\partial(1-\tau)}d\tau + \frac{\partial z}{\partial R}dR \tag{4.1}$$

Further to the equation above, Gruber and Saez (2002) introduce the uncompensated elasticity of income, $e^u = \frac{(1-\tau)}{z} * \frac{\partial z}{\partial(1-\tau)}$, as well as the income effect parameter $\eta = \frac{(1-\tau)}{\partial R}\partial z$ to obtain the equation:

$$dz = -e^u z\frac{\partial \tau}{1-\tau} + \eta\frac{dR}{1-\tau} \tag{4.2}$$

The introduction of the compensated elasticity of taxable income together with the Slutsky equation $e^c = e^u - \eta$ then yields equation 4.3 below:

$$\frac{dz}{z} = -e^c\frac{d\tau}{1-\tau} + \eta\frac{dR - zd\tau}{z(1-\tau)} \tag{4.3}$$

Equation 4.3 gives the change in reported taxable income as a decomposition of two terms. The first term shows the substitution (behavioural) effect, which summarizes the effect of behavioural responses to tax changes. The second term gives the income effect, which gives changes in the tax liability of individuals (Gruber and Saez, 2002).

The extant ETI literature focuses on estimating the substitution effect, with very little consideration for the income effect (Kemp, 2019). In this case, the value of the income effect parameter η is assumed to equal zero. Saez (2003) motivates for this by highlighting that in the presence of the bracket creep, individuals who experience tax rate changes and those who do not are affected by income effects in the same way. As in many other studies interested in estimating the ETI, Kemp (2019) also ignores income effects. For the few studies that do estimate income effects, Saez, Slemrod and Giertz (2012) highlight that varying estimates are reported- with most of the studies estimating small or negligible income effects (Gruber and Saez, 2002), and a few others finding significantly large income effects (Blundell and Macurdy, 1999).

In the event that one assumes away income effects, so that the uncompensated and compensated elasticities are equal, the elasticity of taxable income, given with respect to the net-of-tax rate, is as follows:

$$e = \frac{(1-\tau)}{z} * \frac{\partial z}{\partial(1-\tau)} \tag{4.4}$$

This measure of elasticity gives the percentage change in taxable income with respect to the percentage change in the net-of-tax rate (Creedy, 2009). It captures the effect of all sources of behavioural responses that distort the collection of taxable income (Feldstein, 1999; Kemp, 2019). Notably, this estimate will always be positive as the net-of-tax rate always moves in the same direction as the behavioural responses.

To calculate the resulting change in tax revenue due to distortionary behavioural responses, dB, Saez et al. (2012) derives the following equation:

$$dB = -N * e * z^m * \frac{\tau}{1-\tau} * d\tau \tag{4.5}$$

Where *e* is as described in equation 4.4, N is the number of individuals in a tax bracket and $\boldsymbol{z^m}$ is the average income of that tax bracket. As expected, dB, is dependent on the ETI. Equation 4.5 is also consistent with the idea that very high and negative ETI values, resulting from large decreases in tax rates, will lead to large decreases in tax revenue. This is in line with the basic notion of the Laffer curve discussed above.

Finally, according to Saez et al. (2012), the revenue-maximizing tax rate can then be calculated, particularly for high-income earners, as shown in equation 4.6.

$$\tau^* = \frac{1}{1 + a * e} \tag{4.6}$$

Where

$$a = \frac{z^m}{z^m - \bar{z}} \tag{4.7}$$

The term z^m refers to the average income in the top bracket and $\bar{z}$ measures the lower bound of the income bracket. It is seen from equation 4.6 that the optimal tax rate is related to the elasticity of taxable income. The higher the ETI at a given level of income, the lower the optimal tax rate is expected to be.

It is noted that the optimal rate in equation 4.6 is derived from equation 4.8 below

$$\tau^* = \frac{1 - g}{1 - g + a * e} \tag{4.8}$$

Where *g* gives a welfare function of society's preferences; a function difficult to measure. At the upper bound of the highest marginal tax rate, the function g, assumed to be a decreasing function of income (Kiss, 2013), can be set to equal 0, (Kemp, 2019). This yields equation 4.6 which is especially plausible for individuals in the top 1 percent of the income distribution (Diamond and Saez. 2011). Notably, given this assumption, equation 4.6 only takes into account the substitution and mechanical effects, not factoring in welfare effects. (Brewer, Saez and Shephard., 2010; Diamond and Saez, 2011; Kemp, 2019; Saez et al., 2012).

5. EMPIRICAL METHODOLOGY

This section outlines the empirical methodology to be followed. It starts off by giving a brief description of the data; the variables to be used are described and any assumptions and adaptations made discussed. Thereafter the model is presented, statistical testing procedures used in conjunction with the estimation are explained, and additional data as well as methodological issues associated with the analysis are noted.

5.1 Data source

The study's main source of data is the South African Revenue Service (SARS). Anonymized administrative tax records are made available for research use by SARS, in partnership with the National Treasury and the UNU-WIDER, providing a rich source of data for tax policy analysis. Given the sensitivity of the data, all results are checked in order to comply with the non-identification of individuals. Available data spans from the 2008 to 2018 tax years.

Individual tax administration records are an attractive source of data for researchers believed to contain more accurate information than survey data, in addition to having a lower degree of attrition (Ebrahim and Axelson, 2019). Panel structured data allows for the comparison of the same set of individuals across time (Feldstein, 1995). In addition to hosting such records on gross and taxable income, by income source, the individual panel created by Ebrahim and Axelson (2019) from the SARS records provides a restructured and cleaned dataset that is researcher friendly[9], while retaining as much information from the raw data as possible.[10]

The individual panel combines ITR12 and IRP5 tax records to create a comprehensive version of individual level income and employment data. The dataset, an unbalanced panel with tax years 2011 to 2018, represents roughly 13 million unique individuals per year, with some individuals submitting only IRP5 certificates and others submitting only ITR12 certificates. Given that IRP5 tax records are used to prepopulate the ITR12 tax forms, there exists a

[9] Raw SARS tax administration records are not collected for research purposes and require a significant amount of cleaning for research use.

[10] See Ebrahim and Axelson (2019) for a detailed description of the dataset.

significant level of overlap in the data with over 4 million individuals submitting both forms in each year (Ebrahim and Axelson, 2019).

The data used for the analysis is an adaptation of the individual panel. The study mainly employs the dataset as a short, balanced panel which looks at a set of individuals from 2015/2016 to 2017/2018. The panel is restructured and cleaned further to suit the analysis of this study; this is discussed in the following subsections.

5.2 The Model

The 2017/2018 tax reform acts as a quasi-experiment, allowing for the use of difference-in-differences analysis to estimate changes in taxable income that are induced by the 2017/2018 tax rate hike. Using the basic difference-in-differences discussions of Angrist and Pischke (2009), coupled with the relevant ETI literature, this study sets up a difference-in-differences model to help estimate the ETI.

5.2.1 The Regression Model

The following difference-in-differences model is used for the analysis:

$$\ln(TINC_{ijt}) = \alpha_0 + \alpha_1 TREAT_j + \alpha_2 POST_t + \alpha_3 TREAT_j * POST_t + X_{ijt} + \varepsilon_{ijt} \quad (5.1)$$

Where the exclusion of X_{ijt} simply gives the basic difference-in-differences model. The difference-in-differences model is a version of the fixed effects model and compares aggregates between a control and a treatment group using regression analysis (Angrist and Pischke, 2009). The variables and parameters of the model are discussed in detail below:

a. Explained Variable: The Outcome

The main empirical strategy seeks to relate changes in taxable income to the net-of-tax rate change introduced by the 2017/2018 tax reform. In line with the extant literature, the dependent (or outcome) variable of interest is the natural logarithm of taxable income, ln ($TINC_{ijt}$), given for every individual *i* in group *j* in year *t* (Feldstein, 1995; Gruber and Saez, 2002; Kemp,

2019). TINC is a derived variable found in the individual panel, calculated for every individual in each year using the following steps:

STEP 1: Amount source codes found in the SARS data are used to classify all sources of income into a total of 12 categories. These categories are normal income, investment income, business income, allowances, fringe benefits, activity income, lump sum income, lump sum retirement, deductions, withheld tax income, withheld tax retirement income and contributions.

STEP 2: To calculate gross income, the sum of amounts in normal income, business income, investment income, fringe benefits, allowances, lump sum income, lump sum retirement and activity income is generated for each individual in each year, as in equation 5.2 below.

$$\boldsymbol{gross\ income} = \sum_{\boldsymbol{c=1}}^{\boldsymbol{8}} \boldsymbol{income\ from\ category}_{\boldsymbol{c}} \tag{5.2}$$

Where "$\boldsymbol{category}_{\boldsymbol{c}}$" refers to any of the eight categories being summed.

STEP 3: Exempt income- that is, non-taxable income- is calculated by taking the sum of amounts in gross income that are non-taxable. This is as shown in equation 5.3.

$$\boldsymbol{exempt\ income} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{k}} \boldsymbol{non-taxable\ income} \tag{5.3}$$

Where $\boldsymbol{k}$ gives the number of non-taxable income sources for each individual in each year.

STEP 4: Following equation 2.1, with the deduction of an additional variable, Ebrahim and Axelson (2019) calculate taxable income[11] using equation 5.4.

$$\boldsymbol{taxable\ income} = \boldsymbol{gross\ income} - \boldsymbol{exempt\ income} - \boldsymbol{deductions} - \boldsymbol{lump\ sum\ retirement} \tag{5.4}$$

In Ebrahim and Axelson (2019), lump sum retirement amounts are deducted from taxable income because they are subject to different tax tables. This is not cause for concern in this

[11] This measure excludes capital gains in the individual panel which, as Kemp (2019) stipulates, is highly useful in the ETI an analysis.

study. The introduced tax change is not expected to majorly affect taxable income through the lump sum retirement channel specifically because they are taxed differently.

It is highlighted that while taxable income is given in nominal form in the raw SARS data, the inflation adjusted, real income values of taxable income are used here instead. The purpose for doing this is to factor out inflation-related effects on income that have nothing to do with tax rate changes. The correction for inflation is done using annual inflation measures between the years of interest. With the base tax year as 2018, TINC (100% + ***x***%) gives the real taxable income values for 2016/2017 and TINC (100% +***x*** %) (100% + ***z***%) gives the inflated taxable income values for 2015/2016 taxable. The parameter ***x*** above represents the inflation rate between the 2017 and 2018 tax year, whereas ***z*** represents the inflation rate between the 2016 and 2017 tax years. [12]

b. Explanatory Variable: The Treatment

In line with the result of equation 4.4, the "treatment" of the experiment is taken to be the percentage change in the net-of-tax rate introduced by the reform. The percentage change in the net-of-tax rate is easily computed using pre- and post-reform tax rates. Table 2 summarizes this information for the income brackets of interest in the year before the tax reform, 2017, and the year after the tax reform, 2018.

[12] Because the analysis considers the top income earners whose incomes generally grow at a much faster rate than the inflation rate, using the inflation rate would undermine the rate of taxable income growth in the years of interest. For a more accurate depiction of real income, the inflation rates ***x*** and ***z*** are calculated based on the average inflation rates of taxable income for individuals in the sample used.

Table 2: 2017 - 2018 net-of-tax rate changes

	2017		2018		
Income groups	**Income range (R)**	**Net-of-tax rate**	**Income range (R)**	**Net-of-tax rate**	**% change**
group A	701,301 – 1,500,000	59%	708,311 – 1,500,000	59%	0%
group B	1,500,000 +	59%	1,500,001 +	55%	-6.78%

Source: Author's own calculations and SARS and National Treasury (2019)

In 2017, both ***group A*** and ***group B*** in Table 2 comprised of individuals in the highest income bracket, taxed then at a marginal tax rate of 41 percent. In the 2018 tax year, income ***group A*** was not affected by the tax reform and remained with the same marginal tax rate. Individuals in income ***group B***, which comprises of those who earned more than R1,5 million in taxable income during the 2018 tax year, were affected by the treatment and moved to a newly introduced tax bracket. Individuals in this bracket became subject to a 45 percent marginal tax rate- a 4 percent point tax rate hike, alternatively, a 6.78 percent decrease in the net-of-tax rate.

Given the above information, ***group A*** is taken to be the control group and ***group B*** the treatment group. A dummy variable *TREAT* is generated using this information to indicate individuals affected by the tax reform. The variable assumes the value 1 if an individual is in the treatment group, and 0 if the individual is in the control group. An additional dummy variable, *POST* is also generated to indicate the post-reform period. *POST* is equal to 1 for observations in the post reform period and 0 otherwise. In a difference-in-differences model, the multiplicative interaction between *TREAT* and *POST*, *TREAT*POST* is the main explanatory variable of interest. The significance of this term toward estimating the ETI, in addition to the significance of *TREAT* and *POST*, is discussed in more detail in the next subsection.

From the individual panel, the analysis of this study is only interested in individuals included in the control and the treatment group, that is, those with a taxable income of more than R708,311 in 2018. The study further restricts the analysis to only individuals who were in the highest income bracket in 2017, that is, individuals reporting more than R701,301 in taxable income. Similarly, for any year prior to 2017, only individuals in the highest income bracket remain in the sample. That is, individuals with a taxable income greater than the lower bound of the highest income bracket in those years. This is an iterative process which can be applied

to any number of years. The result of this is a balanced panel which observes the same set of individuals in each year from the first year appearing in the sample to the last.

One more restriction is placed on the sample. Individuals who either crept into the 41 percent bracket due to the fiscal drag- or those who reported large increase in taxable income that shifted them into either the control or the treatment group from lower tax brackets- are also excluded from the analysis. The purpose of this is to exclude individuals who experienced tax rate changes over the sample period that had nothing to do with an announced tax reform. This will simplify the model employed and minimise bias in the estimation of the ETI. Given the restriction of individuals as stipulated above, part of this task has already been done. To add to it, individuals who were not in the control or treatment group in the year before the first year appearing in the sample, 2015, are eliminated.

It is noted here that 2017/2018 is the first and only post-reform year available in the data. This limits the analysis of this study to only the short-run. Although an analysis of long-run responses would be useful in adding to the current literature (Goolsbee, 2000), the contributions of this study are still expected to be of significance. The reason for this, as suggested by the literature, is that the majority, and the most severe behavioural responses following a tax rate change are observed within the short-run (Goolsbee, 2000). Notwithstanding, the study also cannot investigate the differences between transitory and permanent responses as suggested by Giertz (2004).

c. The treatment effect and the ETI

The parameter α_0 in equation 5.1 gives the intercept for the model. Parameters α_1 and α_2 represent the coefficients of $TREAT_j$ and $POST_t$, respectively. In the regression model $TREAT_j$ represents individuals in the treatment group. It captures group-specific fixed effects (Auten and Carroll, 1999). $TREAT_j$ is expected to show a positive effect given that treated individuals are in a higher income bracket than those in the control group, usually experiencing higher levels of income growth. Variable $POST_t$ represents the post-reform period and captures period-specific fixed effects (Auten and Carroll, 1999). It is also expected to exhibit a higher change in income under the premise that the average person's income increases over time. This is especially true for the high-income earners who make up both the treatment and control group. Essentially, average income in the post-reform period, is expected to be higher than that

of the pre-reform period. The coefficient of the interactive term $TREAT_j * POST_t$, given by α_3, gives the treatment effect- the change in taxable income resulting from the change in the net-of tax-rate. The treatment effect is expected to exhibit a negative relationship with the dependent variable due to distortionary effects of the tax rate hike.

The significance of the parameters of the model in estimating the treatment effect is illustrated using Table 3.

Table 3: Parameter significance

	Treatment	**Control**	**Difference**
Pre	(a) $\alpha_0 + \alpha_1$	(b) α_0	(g) α_1
Post	(c) $\alpha_0 + \alpha_1 + \alpha_2 + \alpha_3$	(d) $\alpha_0 + \alpha_2$	(h) $\alpha_1 + \alpha_3$
Difference	(e) $\alpha_2 + \alpha_3$	(f) α_2	(i) α_3

Source: Author's own illustration

The basic difference-in-differences model uses a double-differencing technique to estimate the treatment effect, α_3. To illustrate, each entry in the highlighted cells of Table 3 gives the resulting values that can be generated for the distinct sets of observations in the sample, based on the basic difference-in-differences equation. If one considers an individual in the treatment group observed in the pre-reform period, for example, variable $TREAT_j$ assumes the value 1 whereas variable $POST_t$ assumes the value 0. Substituting in the relevant values yields the value $\alpha_0 + \alpha_1$, as seen in the cell labelled (a). The same can be done for the other three scenarios, namely: looking at an individual in the control group, observed in the pre-reform years; looking at an individual in the treatment group, observed in the post-reform years; looking at an individual in the control group, observed in the post-reform year. The results of these scenarios are seen in the cells labelled (b), (c) and (d), respectively.

The comparison of the average ln ($TINC_{ijt}$) values of individuals in the treatment group between the pre- and post-reform years is as shown in the "Treatment" column. The resulting difference between the two periods is $\alpha_2 + \alpha_3$. Towards estimating the treatment effect this result is incomplete in that it does not factor out the change in taxable income that would have been experienced by individuals in the group even if they had not been subjected to the tax reform; a counterfactual that can be observed using the control group. In a similar manner, comparing the treatment and control groups only in the pre-reform period, as shown in the "Post" row, is not sufficient to estimate the treatment effect. The result $\alpha_1 + \alpha_3$ fails to account for differences in ln ($TINC_{ijt}$) between the two groups across time.

The double-differencing technique of the difference-in-differences method is able to capture the treatment effect by accounting for both differences in taxable income between pre-and post-reform periods and between the control and the treatment group. Following the first incomplete approach, an additional step is to difference out the change in ln ($TINC_{ijt}$) experienced by the control group between the pre- and post-reform years, α_2, shown in column 2. The result is as shown in row 3 in the table, giving the parameter α_3. Alernatively, an additional step following the second approach is to difference out the change in ln ($TINC_{ijt}$) that was experienced by those who were not affected by the tax rate change between the two periods, α_1. The result would be as illustrated by column 3 in the table; also yielding a treatment effect, α_3.

The difference in a natural logarithm of a variable gives the percentage change of that variable (Gujarati and Porter, 2009). Considering the functional form of the regression, this means that the estimate α_3 gives the percentage change of taxable income due to the treatment. It is also known, in line with the literature review and the theoretical framework, that the ETI is given as the percentage change in taxable income, relative to the percentage change in the net-of-tax rate. Given this, the elasticity of taxable income, $\boldsymbol{e}$, can be calculated as follows (Feldstein, 1995)[13]:

$$e = \frac{\alpha_3}{\%\ (change\ in\ net - of - tax\ rate)} \tag{5.4}$$

In line with Saez et al. (2012), the resulting revenue change following the tax reform can then be calculated using equation 4.5 and the optimal tax rate with equation 4.6. The sensitivity of the optimal tax rate to other plausible values of the welfare function, g, can also be examined using equation 4.8.

d. Control Variables: Non-Tax Factors

In equation 5.4, $\boldsymbol{X_{ijt}}$ is a vector consisting of all the control variables included in the analysis. These are BINC, AGE, GEND, RET, SEMP, INV, and DED. The inclusion of these variables is expected to capture changes in taxable income from various group specific factors and also

[13] Note that the regression functional forms used in other studies, for example, Kemp (2019) and Gruber and Saez (2002) directly estimate the elasticity of taxable income without the need for this additional step. These studies use a double-log relationship between taxable income and the net of tax rate which cannot be employed here given the lack of variability in the net of tax rate. That is, the analysis looks at a single net-of-tax rate change for only one group of individuals.

mitigate the problem of model misspecification due to omitted variable bias. The last term ε_{ijt} gives the error term of the equation.

It is clear that this list of control variables only includes available individual specific controls. Time varying year-specific factors such as the economic growth rate, interest rate or institutional characteristic changes are not included. The very short time period of the sample, in particular, does not allow for this. With only two or three time periods, very little variability in year specific factors exists, the inclusion of such factors as controls would result in high degrees of collinearity with the $POST_t$ term. Notwithstanding, this is not a serious concern. The variable $POST_t$, captures all period specific differences between the pre-reform and post-reform periods and prevents a significant amount of bias due to the exclusion of year specific controls.

One of the main concerns of this study involves identifying other factors that account for changes in taxable income from year to year and adequately controlling for them. Doing this reduces error in the estimation. From the literature this study adopts the need to correct for mean reversion- including changes in the income distribution between the control and the treatment group- and a couple of individual-specific characteristics. These controls are discussed below.

Following Auten and Carroll (1999), this study controls for mean reversion by including the log of base year income (BINC) as part of the controls. Mean reversion here refers to the tendency of an individual's income to converge to an average level over time, following periods of either unusually high- or low- income levels (Giertz, 2004). This phenomenon is usually pronounced at the tails of an income distribution. Given this, controlling for mean reversion is important here given that the study is concerned with the highest income earners who are expected to experience much more severe shocks in income over their income lifecycle. For this undertaking, 2017/2018 is used as the base year. The natural log of incomes in this base year are simply incorporated into the regression specification to be employed. This is done for every individual in each of the years used in the sample. It is noted that Auten and Carroll (1999) used initial income[14] as a control for mean reversion. The choice to use the final year appearing in the sample in this study is immaterial to the effectiveness of BINC in controlling

[14] Income in the first year appearing in the sample

for mean reversion. The only difference expected here, contrary to the results found in Auten and Carroll (1999), is a positive relationship between BINC and the dependent variable. This is because, overall, high-income earners are, on average, expected to experience a positive trend in their income relative to the chosen base year, 2017/2018.

It is noted that the use of BINC as a control is also useful in the correction for changes in the income distribution in the sample (Kemp, 2019). This is especially important for South Africa- one of the most economically unequal societies in the world.

To disseminate taxable income changes a few additional individual-specific characteristics are included as control variables. This is done to examine heterogeneity in the dependent variable across various population subgroups, and possibly highlight areas that hold some of the solutions to efficient tax collection.

To begin, the study makes use of age (AGE) and gender (GEND) controls. There is reason to believe that observed taxable income changes are dependent on the age of individuals. As one grows older, they become more experienced and established, with a higher ability to generate increased levels of income. For GEND, differences in taxable income changes between males and females are expected, especially given the prevalence of gender-based income inequality at very high-income levels in South Africa. In this case one would expect males to experience larger positive changes in income over time.

Data on both age and gender is available in the individual panel. Adjustments are made to the variable AGE in the sample to control for, presumably, incorrect entries. In particular, clashing age entries in the sample are replaced as missing. For gender, some entries are reported as numerical values in the individual panel and are assumed to be due to data entry error. From this, only entries reported to be male or female are kept and the rest of the entries are reported as missing. There also exist conflicting gender entries for a few individuals across the years used in the sample. The gender entries for these individuals are also replaced as missing. Lastly, it is noted that gender is a derived variable in the data, derived from individuals' South African identity numbers (Ebrahim and Axelson, 2019). Because of this, gender estimates in the model used will only be able to capture the effects of gender from South African citizens.

An exception to the effect of age on taxable income changes is noted. Retired individuals' incomes, outside of lump sum amounts that do not form part of TINC in this study, are expected to be much lower than the employment income earned before retirement (Yang, 2011). This is

especially the case for individuals with no additional sources of income (Yang, 2011). To explicitly capture this effect on taxable income, a dummy variable RET is generated to flag retired individuals. RET is equal to 1 if an individual is retired and is equal to 0 otherwise.

Furthermore, this study is concerned with the dissemination of taxable income changes by whether an individual is self-employed or whether their sole source of income is employment. Self-employment promises higher earnings as businesses become more established across years, this is especially the case for those in incorporated businesses (Levine and Rubinstein, 2017). The fact that this study analyses individuals in the highest income brackets gives reason to believe that, on average, this is the case. On the other hand, it is also expected that an individual who is self-employed is afforded more room to alter their taxable income over time, which could give a negative effect on income in the presence of the tax reform. In this study, individuals with business income, directors' remuneration, or those who earn income as independent contractors are used as proxies for self-employment. Using these criteria, an identifying dummy variable, SEMP, is generated to represent those who are self-employed. SEMP assumes the value 1 if an individual is considered self-employed and the value 0 if they are not.

For reasons similar to those discussed on self-employment, the study controls for taxable income changes by whether an individual invests or not. An investment indicator INV is generated using the investment income category. INV takes the value 1 for all individuals who invest and 0 for those who don't.

Finally, a dummy indicator DED is included in the analysis for individuals with deductions. It is expected that taxable income changes will be emphasized for individuals with deductions, especially for individuals with itemized deductions (Feldstein, 1995; Gruber and Saez, 2002; Saez, 2003). In each year, if an individual has deductions, DED takes the value 1. DED takes the value 0 if an individual does not have deductions.

The need to control for income effects as highlighted in section 4 is briefly revisited here. Considering that the theoretical underpinnings used to evaluate changes in marginal tax rates are the same as those used when employing the bracket creep as a source of tax rate variation, the study follows Saez's (2003) idea as discussed in section 4. It assumes that individuals subjected to the 2017/2018 tax rate change and those who are not are affected by income effects in the same way. For this reason, this study is also not concerned with income effects.

Following the discussion above, including that of the literature, this section concludes with a summary of hypothesized signs for the regression estimates, shown in Table 4.

Table 4: Hypothesized signs

Explanatory Variables	Expected Sign
TREAT	+
POST	+
TREAT*POST	-
BINC	+
AGE	+
GEND	+
SEMP	+
INV	+
DED	-
RET	-

Source: Author's own illustration

5.2.2 The Estimation Technique and Instrument Selection

There is reason to believe that endogeneity- an issue common in experimental research- is present in the model (Giertz, 2004). In the event that this is true, it renders the use of the basic ordinary least squares (OLS) in the estimation of equation 5.4 unreliable.

As already seen, taxable income directly affects the assignment of individuals into either the treatment or the control group. This fails to account for the occurrence of self-selection as a possible source of endogeneity (Clougherty, Duso and Muck, 2016). In the context of this study, there potentially exists individuals assigned to the control group who were, in years before the tax reform, found in the treatment group. In a similar manner, there might exist individuals whose taxable income, in the absence of the tax reform, could have grown sufficiently enough to move them from the control group into the treatment group. Due to the tax hike, the responsiveness of these individuals might have been vast to the extent that they end up reporting incomes lower than the R1.5 million threshold in the post-reform year. This, in essence, is self-selection. Because of it, the treatment group is not representative whereas the control group contains individuals whose behavioural response due to the tax change cannot be captured by α_3 when using the basic OLS technique. Such unaccounted changes are then captured by the error term, giving rise to endogeneity. As a result of this, there is not enough

premise to establish a causal relationship between the tax rate change and the ensuing taxable income changes. The treatment effect cannot, therefore, be accurately identified.

To address this problem, instrumental variable techniques such as the two-stage least squares are employed in most studies that use difference-in-differences. Gruber and Saez (2002) and Kemp (2017), for example, employ two-stage least squares with the use of an instrument which assigns an individual to the control or treatment group based on the taxable income that the individual would have most likely attained if the tax reform had not taken place. This study adopts a similar approach. In assigning individuals to either the control or treatment group, the study flags all individuals who are found in the control group, but whose taxable income- in accordance to the average growth rates of taxable income in the sample- should have been above R1.5 million in 2018. With this, an instrumental variable TREAT2 is generated for the variable TREAT. A second instrument, TREAT2*POST for the interactive term, TREAT*POST, is also generated.

5.2.3 Statistical Tests and Corrections

The robustness of the estimation techniques employed, as well as the results attained, are probed by the following tests:

a) Test for common trends

A key identifying assumption when using the difference-in-differences method, referred to as the common (or parallel) trends assumption, requires taxable income trends before the reform to be the same between the control and the treatment groups, else series detrending or modifications conditional on observed covariates need to be made (Angrist and Pishcke, 2009). A simple way of checking that the assumption holds is by conducting a visual inspection. This entails plotting time plots of the dependent variable, $\ln(TINC_{ijt})$, for both groups on one graph and evaluating them. In this study, time plots are plotted using all the years in the individual panel, 2011 to 2018, taking into consideration only individuals in the sample. If the trends over time are roughly the same, one can assume that the common trends assumption holds.

It is highlighted that the exercise above is not necessarily sufficient to shed light on the statistical significance of the similarities in the trends in the pre-reform years (Fredriksson and Oliveira, 2019). A more formal approach that examines said statistical significance using regression analysis could be employed (Fredriksson and Oliveira, 2019, Schnabl, 2012). Such an approach requires a longer time period in the pre-reform years of the sample. Given that the sample employed only contains two pre-reform years, this study only makes use of a graphical illustration.

b) Test for bunching

A couple of studies use the concept of bunching at kink points to analyse taxpayer behaviour and to estimate ETI's (Saez, 2010). The basics of this concept are employed here to gauge the behaviour of individuals around the newly introduced threshold, R1.5 million. The idea is that because of distortionary responses in the attempt to avoid higher tax rates, some individuals settle for taxable income values just below the threshold, creating an increased concentration of individuals there. To examine this, comparisons can be made between the tax year just before the tax change and the tax year right after the tax change for the sample. This is done using frequency distribution plots. The expectation is that there will be a slightly higher level of individuals just before the R1,500,000 threshold for the 2018 tax year than for the 2017 tax year. Essentially, the gap between the frequency distributions of the two tax years, 2017 and 2018, is expected to be lower just immediately after the threshold level than it is before it.

c) Correction for Heteroscedasticity

Heteroscedasticity occurs when the magnitudes of an error term are not independently and identically distributed (i.i.d), often measured using the variance (Gujarati and Porter, 2009). The phenomenon can be caused by a wide range of issues including omitted variables or outliers and is common in data with a large number of cross-sectional units, as with the sample of this study (Gujarati and Porter, 2009). When unaccounted for, it is most likely to lead to unreliable standard errors (Gujarati and Porter, 2009). Given that this study makes use of a significantly large sample of individuals, with the omission of theoretically useful controls due to data limitations, the regression analysis makes use of robust standard errors.

d) Test for multi-collinearity

Multi-collinearity[15] refers to the existence of linear correlations between explanatory variables in a regression (Gujarati and Porter, 2009). It can be problematic as it can inflate variances and bias the estimates (Gujarati and Porter, 2009). To test for multi-collinearity, the variance inflation factor (VIF) is computed. The VIF detects multi-collinearity between variables in addition to testing the strength of the correlations. If a variable exhibits close-to-perfect collinearity with the rest of the variables, it will be dropped, depending also on its relevance in the model. This is a fairly good solution to the problem as multi-collinearity affects only the variances of the variables found to be collinear (Gujarati and Porter, 2009). In cases where multi-collinearity is not severe, the regression analysis ignores it.

e) Test for endogeneity

In the presence of endogeneity, results of coefficient estimates from standard regressions cannot be causally interpreted (Clougherty et al., 2016). To test for the existence of endogeneity in the model, given the use of robust standard errors, a regression-based test for endogeneity, as well as Wooldridge's (1995) score test, are used.

f) Instrument validation

To capture the first stage degree of correlation between TREAT and TREAT2, a basic OLS model is used. The same is done for TREAT*POST and TREAT2*POST. For a more formal test for the validity of the instruments used, the joint first-stage regression of the instruments is tested for using the Kleibergen-Paap[16] statistic, given robust standard errors to correct for the potential absence of i.i.d errors. The Kleibergen-Paap statistic, against Stock and Yogo's (2005) critical values, specifically checks whether the instruments used are weak or strong in the 2SLS model.

[15] Simply collinearity in the case of only one linear relationship.
[16] See Kleibergen and Paap (2006) for discussion.

5.3 Additional Checks and Limitations

Any changes in tax rules during the sample period mean that care still needs to be exercised when estimating the treatment effect. The 2015/2016 marginal tax rate reform, which saw a 1 percent point increase in tax rates across all income brackets, is one such tax rule who's impact needs to be taken into consideration. Suffice it to say, this is a small change that is not expected to have caused a great change in taxable income. There is one thing to note in this regard; given that the tax reform affected both the treatment and control group, which at the time were in the same tax bracket, their responses are expected to have been roughly the same. Notably, the restriction of the sample's pre-reform period to a maximum of two years was driven by the complexity the 2015/2016 reform might contribute.

At the start of the 2017 tax year, a retirement funding reform was introduced. The reform incorporated two changes. The first change stipulated that contributions made to provident funds be allowed as a deduction whereas the second made the employer's contribution, in the hands of the employee, a taxable fringe benefit (SARS and National Treasury, 2018). The incorporation of the retirement indicator RET is expected to account for these changes. In addition, because this reform affected both the control group and the treatment group in the same manner, no bias is expected to be caused in the estimation of the treatment effect. Otherwise, the difference-in-differences method is also expected to cancel out any potential bias in the treatment effect.

Finally, in addition to the tax changes highlighted above, the following is noted: The manner in which the sample is structured does not account for changes observed in the behaviour of individuals who completely disappeared from the individual panel, those who migrated out of the country or those who moved to much lower income brackets in response to the tax change. Because of this, it is expected that the treatment estimates might undermine the actual impact of the tax reform. On the other hand, the tax reform took place at a time of reduced trust in SARS, in the presence of the so-called "state capture" and high political unrest. These types of factors might overemphasize the treatment effect in the event that the highest income earners exhibited higher responses as a result.

6. ANALYSIS OF RESULTS

This section summarizes the data and analyses specific trends observed in it. Following this, the results of the analysis as well as sample robustness checks are presented.

6.1 Sample Summary

6.1.1 Generating the Sample

Overall, 22753607 individuals are represented throughout all the years and across all tax brackets in the unbalanced individual panel. For individuals who submitted both the IRP5 and ITR12, only the information from the ITR12 is kept. Table 5 below shows the changes in the number of individuals as the sample is created.

Table 5: Generating the sample, 2016-2018

	Control Number	Treatment Number	Overall Number
Number in 2018	373874	79391	453265
Number in 2017 - 2018	270797	75262	346059
Number in 2016 - 2018	203539	71580	275119
Number in 2015 - 2018	164898	67196	232094
Total outliers dropped	0	1	1
Number in sample	164898	67195	232093
Conflicting gender	1059	414	1473
Conflicting ages	114	87	201
Incorrect gender	5029	2889	7918

Source: Author's own calculations

As described in section 5.2.2, the sample creation starts with a consideration of all individuals in either the control group or the treatment group in the post-reform tax year, 2018. A total of 373874 individuals are found in the control group whereas 79391 individuals are found in the treatment group. Individuals in the treatment group constituted less than one percent of

taxpayers in 2018. In total, the top two tax brackets consist of 453265[17] individuals in 2018. In line with the restrictions described in section 5.2.2, individuals are eliminated for the creation of a balanced sample- in addition to eliminating those who experienced other tax rate changes that were not related to a tax reform. A higher level of concentration in the control group, as opposed to the treatment group, is observed at each step, highlighting the fact that a small proportion of individuals are at the top end of the income distribution in South Africa. The sample size consists of 232094 individuals. This is given by the number of individuals who are in the individual panel from at least 2015, as already explained. Finally, the data was purged of outliers. Individuals with conflicting age as well as incorrect and conflicting gender entries were also found. These entries were replaced as missing.

6.1.2 Summary Statistics

Table 6 reports summary statistics on the sample employed- calculated for the 2018 tax year. In the table, a summary for continuous variables TINC, ln(TINC) and AGE, as well as a summary for categorical variables GEND, SEMP, DED, RET and INV is presented. The summaries are given for each group as well as for the entire sample.

The average values of TINC are R1 063 031 for the control group and R2,798,241 for the treatment group. The average degree of dispersion, as shown by the standard deviation, is significantly high for the treated group. This highlights the wide range of incomes that exist in the treated sample from as little as R1 500 000 to billions of Rands. Variable ln(TINC) also exhibits a higher degree of dispersion for the treated group. The dispersion in income is largely attributed to the treatment group whose standard deviation is more than the mean value.

The average age is 47.52 for the whole sample. It is reasoned from this that most individuals reach the top two income brackets around middle age. The proportion of retired individuals in the sample is 14.81 percent with a slightly higher proportion of retired individuals in the treatment group.

8.43 percent of individuals in the control group are self-employed. Almost double that number, at 16.28 percent, is the number of self-employed individuals in the treatment group. The

[17] This number may not be a true reflection of the number of individuals in the top two brackets. Because of late filing, new data for most recent years continues to trickle in at SARS.

number of individuals recorded to be receiving investment income is only slightly higher for the treated group, at 4.00 percent, than for the control group, at 3.27 percent. This finding of a higher number of investors as well as self-employed individuals is as expected at these high levels on income. Individuals earning more than R1,500,000 are expected to be more business savvy than those in the control group, with high income levels that allow them to invest and undertake new business ventures.

Table 6: Summary statistics, 2016-2018

	Control		Treatment		Overall	
	AVERAGE	**SD**	**AVERAGE**	**SD**	**AVERAGE**	**SD**
TINC (R)	1,063,031	196,081	2,798,241	3,693,031	1,565,405	1,827,650
ln(TINC)	13.86	0.18	14.68	0.50	14.10	0.48
AGE	47.41	9.94	48.20	9.47	47.64	9.82
	%		**%**		**%**	
SEMP	9.22		16.64		11.37	
INV	3.97		4.70		4.18	
DED	88.37		86.87		87.94	
RET	14.66		14.87		14.81	
MALE	69.59		73.70		70.78	
FEMALE	26.76		21.40		25.21	
UNALLOCATED	3.65		4.90		4.01	

Source: Author's own calculations

Turning to deductions, a slightly higher proportion of individuals in the control group are observed to be having deductibles than individuals in the treatment group, contrary to the expectation that those with higher income have a higher degree of deductions as a means to reduce their tax liability. Overall, it is evident that the majority of individuals in the sample have deductibles, in excess of 80 percent.

Gender inequality is evident and quite severe, in both the treatment and control groups as seen in Table 6. On average, approximately 70.78 percent of individuals in the entire sample are reported as male and 25.21 percent as females. This number remain fairly the same for each of the two groups, although gender inequality is slightly higher for the treated group.

6.2 Pre-Regression Checks

This section tests for the assumption of common trends and examines the possibility of bunching around the R1,500,000 threshold level.

6.2.1 Common Trends Assumption

The study now turns to the assumption of common trends. Figure 3 shows the trends of the average log of taxable income, ln(TINC), for both the treatment and the control group. Looking at the time trends of the two groups before the 2017 threshold, it is safe to assume that they follow roughly the same ln(TINC) trend. Given this, it is assumed that the assumption of common trends for the difference-in-differences model to be estimated holds. On the other hand, considering the post-reform trend, a slightly unexpected outcome is observed. The control group exhibits a decrease in its trend whereas that of the treatment group is only slightly affected. At face value, this finding gives the impression that there is no taxable income effect on the treatment group due to the reform. This is not necessarily true for two reasons.

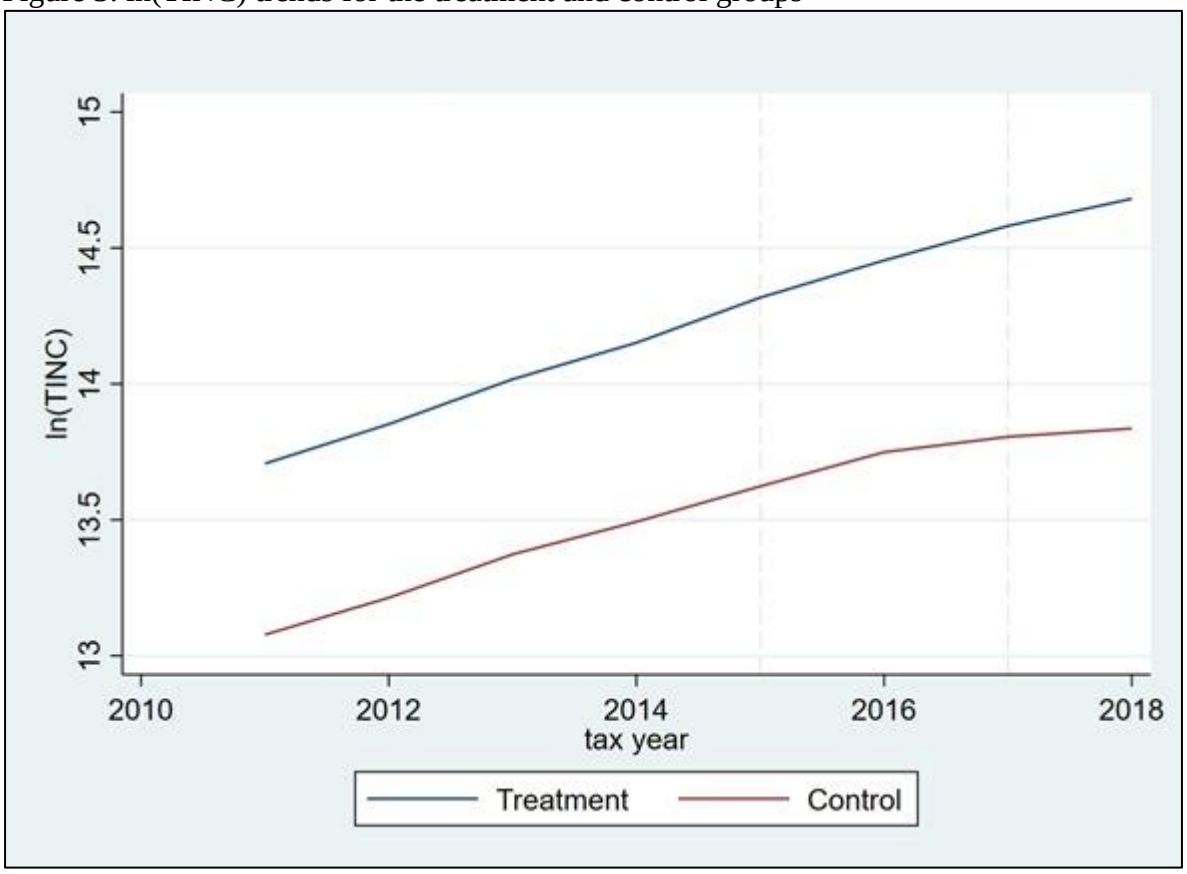
Firstly, the significant decline in the growth of taxable income for the control group can be partly attributed to the decline in economic growth in the past few years. It is argued that this decline is not so apparent when looking at the treatment group simply because the higher the income one earns, the easier it is to cushion themselves against the loss of income due to a recession. Secondly, the assignment of individuals into either the control or the treatment group used here is one believed to be subject to self-selection-based endogeneity as discussed in section 5.2.3. If this is true, part of the post-reform control group trend captures the distortionary effects of individuals who were impacted by the treatment but were not assigned to the treatment group. To support the second claim, endogeneity is formally tested for in the next sub-section.

In the event that negative economic growth and endogeneity are truly the reasons for the lower post-reform trend observed in Figure 3, the difference-in-differences model, with controls for other taxable income trends as already defined, as well as the two-stage least squares technique should be able to address this. In other words, there is still potential for the estimation of a significantly high treatment effect even though it is not evident in Figure 3.

It is noted that the use of the log of taxable income as a dependent variable is useful in relation to the assumption of common trends. On its own, the variable TINC does not give parallel

trends for the control and the treatment group. This is especially because, on average, treated individuals exhibit a higher level of growth over time. For example, the taxable income growth rate between 2016 and 2017 was observed to be 16.24 for the control group and 25.28 for the treatment group. Taking the natural logarithm of TINC essentially detrends the trend over time, yielding a satisfactory level of parallel trends.

Figure 3: ln(TINC) trends for the treatment and control groups

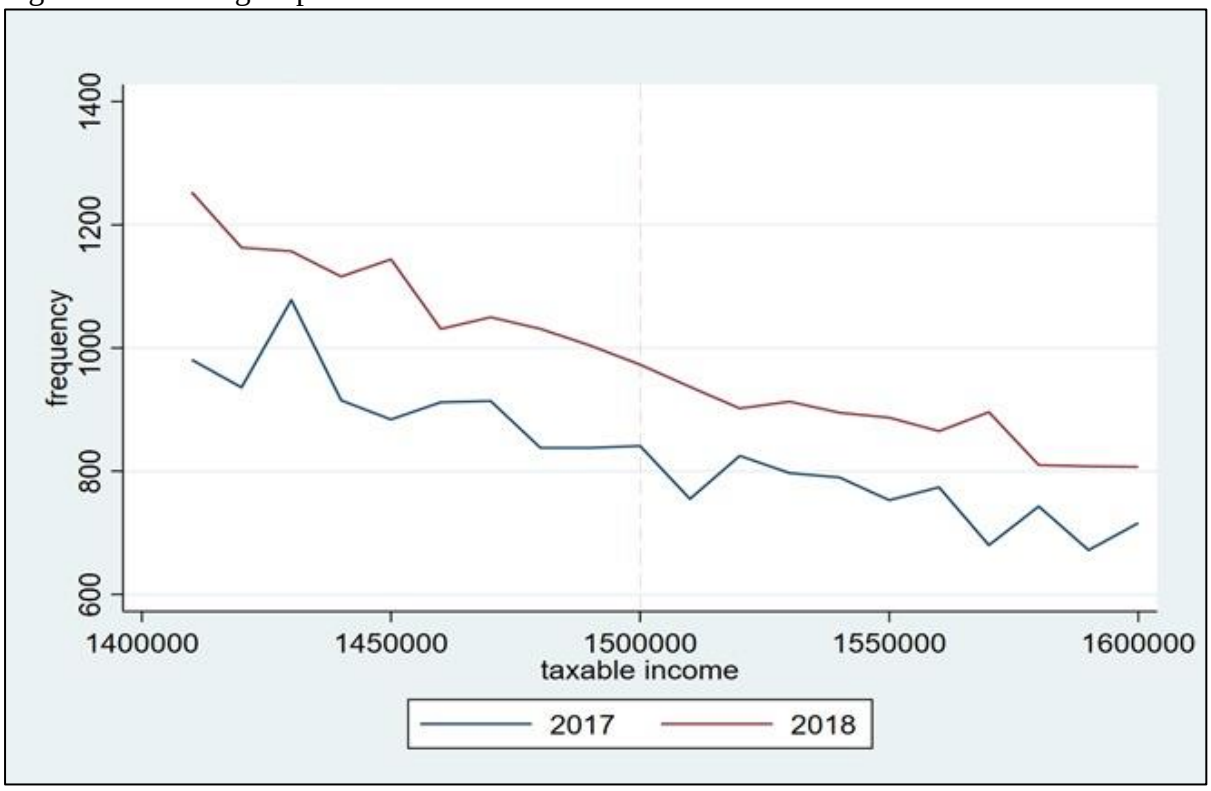


Source: Author's own illustration

6.2.2 Bunching

Figure 4 gives a physical illustration of the change in the number of individuals near the R1,500,000[18] threshold level between the tax years 2017 and 2018. With an income range equal to R100,000 on both sides of the threshold, two frequency distribution plots are plotted for both the years. Given the short range covered, one only expects to see the gap in frequency between the two graphs to be larger on the immediate left of the threshold than it is on the immediate right due to behavioural responses following the tax reform. The overall gap on the left is observed to be slightly larger than that on the right, giving the impression that more individuals than usual were concentrated in the area just before the threshold. This evidence further supports the idea of self-selection.

Figure 4: Bunching inspection



Source: Author's own illustration

[18] The use of TINC yields a similar result as that of ln(TINC) as the graph gives the frequency at each income level. TINC is used here to clearly show the R1,500,000 threshold level in the graph.

6.3 Regression Results

This section presents OLS and 2SLS results. For each of these, 3 different regressions are generated. Regressions labelled (1) give estimates for the basic difference-in-differences model with no controls. Regressions labelled (2) include only BINC as a control. Regressions labelled (3) give the difference-in-difference estimates with all control variables defined in the methodology, BINC, GEND, AGE, SEMP, INV, DED and RET. This convention applies to all regression and test tables presented. From the findings of the regressions, this section also calculates the ETI, revenue changes and the optimal tax rate, concluding with some robustness checks.

6.3.1 OLS Estimation

To test for multicollinearity, VIF results are presented in Table A 1[19] of the appendix. For all the variables, none of the VIF values exceed 5, as a rule of thumb, to can lead to the conclusion that there is multicollinearity in the model (Sheather, 2009). The average VIF gives a value of less than 2, giving even more reason to not be concerned about multicollinearity.

Basic OLS results with the use of robust standard errors are presented in the first 3 columns of Table 7. The results in all of the regressions give statistically significant estimates, at the 1 percent level of significance, for all parameters. The correlation coefficient, R^2, is 0.55 for the sample when considering the first regression. The addition of BINC into the regression increases the goodness of fit measure significantly to 0.79. It must be noted that, when not explicitly included in the regressions, BINC, a time-invariant individual fixed effect variable is captured by the group specific fixed effects, TREAT. This is seen clearly in the significant reduction in the estimate of TREAT once BINC is added, signifying the possibility of mediation. Evidently, the control for mean reversion and changes in the income distribution improves the model. This is consistent with what is observed in the literature. Kemp (2019) and Kemp (2020), for example, present evidence of an improvement in the fit of their models with the inclusion of the log of base year income as a control. Notably, the use of the final tax

[19] Tables A1 – A4 in the appendix give the results of statistical tests conducted using the sample already discussed (2016-2018), as well as corresponding results from the sample (2017-2018) to be used when conducting robustness checks in section 6.3.4.

year in the sample yields a positive effect here, whereas their use of the first year in their sample yields a negative effect, as expected.

As in Auten and Carroll (1999) who used a dummy for financial wealth, the results give evidence that higher income earners, those in the treatment group, experience higher levels of income growth compared to those who are not. This is specifically seen in this context when looking at TREAT. The estimates show approximately a 15.9 percent change in the taxable income of treated individuals relative to non-treated individuals, when looking at regression (3).

Variable POST gives roughly the same estimates for all the regressions. Understandably, none of the additional regressors introduced in regressions (2) or (3) are time-specific to factor out some of the unspecified effects captured by POST.

The treatment effect also remains fairly constant with additional controls. This is not surprising given that the common trends assumption holds without the need for conditionality on other factors. Essentially, the additional controls are included in the model to control for other taxable income changes that would otherwise bias TREAT or POST than they are to ensure the correct estimation of the treatment effect. From the OLS estimates, a positive change in taxable income of 10.4 percent is observed for treated individuals. This positive effect clearly captures what is observed in Figure 3, where treated individuals appear to be generating increased levels of income than those who are not in the post-reform period. This is contrary to what is expected. Arguably, these OLS estimates are believed to be subject to bias due to endogeneity in the model. If this is true, the use of 2SLS will address it.

The signs exhibited by the control regressors are as hypothesized. Given the significance of these estimates, it is evident that non-tax factors have a significant effect on taxable income changes. While the signs are as expected, the coefficient estimates are relatively low with the exception of DED, SEMP and RET.

Table 7: OLS and 2SLS results, 2016-2018

	OLS			2SLS		
ln(TINC)	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
TREAT	0.721 ***	0.170 ***	0.159 ***	1.016 ***	0.619 ***	0.596 ***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
POST	0.049***	0.049 ***	0.051***	0.098 ***	0.098 ***	0.099 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
TREAT*POST	0.104 ***	0.104 ***	0.103 ***	- 0.068 ***	- 0.068 ***	- 0.067 ***
	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)
LBINC		0.708 ***	0.712 ***		0.437 ***	0.448 ***
		(0.002)	(0.002)		(0.003)	(0.003)
GEND			0.009 ***			0.005 ***
			(0.001)			(0.001)
AGE			0.001 ***			0.002 ***
			(0.000)			(0.000)
SEMP			0.066 ***			0.046 ***
			(0.001)			(0.001)
INV			0.013 ***			0.007 ***
			(0.002)			(0.002)
RET			- 0.025 ***			-0.016 ***
			(0.001)			(0.001)
DED			-0.093***			-0.061 ***
			(0.001)			(0.001)
_cons	13.81 ***	3.874 ***	3.818 ***	13.73 ***	7.612 ***	7.419***
	(0.000)	(0.029)	(0.030)	(0.001)	(0.460)	(0.047)
R^2	0.51	0.73	0.74	0.45	0.66	0.67
RMSE	0.34	0.25	0.24	0.36	0.28	0.27
Observations (N*T)[20]	696 279	696 279	667 736	696 279	696 279	667 736

The values in brackets are the standard errors. Significance at 1% level (***), at 5% level (**), at 10% level (*)

[20] The number of observations is given as the number of cross-sectional units (or individuals), N, and the number of time periods, T.

6.3.2 2SLS Estimation

Test results for endogeneity that go in conjunction with the 2SLS results are presented in Table A 2 of the appendix. In the table, Woolridge's (1995) test score as well as a regression-based F statistic are given. Both statistics are significantly high with reported p-values close to 0.00. Evidently, the statistics decrease with the addition of more controls but remain statistically significant. This leads to the rejection of the null hypothesis that the regressors are exogenous, supporting the use of the 2SLS technique.

Two-stage least squares results are presented in the last 3 columns of Table 7. Considering the overall estimation, an increase in the measure for goodness of fit as well as that of the RMSE is observed as more regressors are added. The biggest change, once again, occurs when one adds the variable BINC, highlighting that mean reversion or income distribution changes both have a significant level of explanatory power. Finally, all estimates are statistically significant at the 1 percent level of significance, with low robust standard errors.

The variable TREAT shows a percentage change in taxable income for the treatment group relative to the control group of greater than a 100 percent in the first regressions. With the addition of BINC this value decreases to roughly 60 percent, decreasing slightly further with the inclusion of all other controls. As already stipulated, before the inclusion of control variables like BINC, some of the individual specific effects are captured by TREAT. Once these are explicitly added to the model, the effect is factored out of TREAT, reducing its estimate. It is noted that, compared to the OLS regressions the instrumented variable TREAT, explains a higher degree of changes in taxable income supporting the notion that some individuals classified in the control group should be in the treatment group. With the use of instrumental variable analysis, this is now corrected for.

POST has consistent estimates for all the regressions. The reason for this is the same as that of the OLS regressions presented. From the estimations, it is seen that in the post-reform years, taxable income is roughly 9.8 percent higher than pre-reform years. Once again, this gives the impression that, on average, high-income earners are able to maintain increases in income over time, even in the midst of the economic decline[21] experienced in most recent years. This idea

[21] At least in nominal terms given that taxable income is taken in its nominal form.

is especially attributed to individuals in the treatment group given the observed post-reform trends in Figure 3.

Turning to the treatment effect, it is seen that the coefficient of TREAT*POST does not fluctuate across the three different regressions presented, as with the OLS estimation. As opposed to the OLS estimates, however, the treatment effect captures negative responses to the tax change. This is the expected result with the difference in the sign between the OLS and 2SLS estimations being attributed to the correction for endogeneity. According to the estimates, individuals who experience the treatment show a taxable income decline of roughly 6.8 percent than those who are not treated. With the inclusion of all controls, this value reduces only slightly to 6.7 percent. These findings, as will be shown in the next section, imply significantly high ETI estimates.

It must be noted, contrary to the findings of Gruber and Saez (2002) and Kemp (2019), amongst other studies that control for mean reversion, that the control for mean reversion in this study does not affect the estimated response to the tax rate change. Given the functional form used in this study, this is attributed to the fact that the group fixed effect, TREAT, captures the time-invariant individual fixed effect, essentially the group fixed effect, BINC. While the explicit inclusion of BINC as a control improves the goodness of fit, it does not affect the treatment effect as this was already accounted for.

The control regressors used in the model still yield expected signs as with the OLS results. In addition, DED, SEMP and RET still give higher coefficients than the other control variables. DED shows that those with itemized deductions have a taxable income decrease of 6.1 percent than those who do not have them. This is in line with results observed in Gruber and Saez (2002) and Saez (2003). SEMP shows that the taxable income of those who are self-employed increases by roughly 4.6 percent relative to those who are not. This result is consistent with Auten and Carroll's (1999) finding of a higher change in taxable income for those classified as entrepreneurs- those with business income, or simply those with entrepreneurial skills. In the sample, RET exhibits a 1.6 percent decrease in taxable income relative to those who are not retired. This result supports the idea of Yang (2011) who gives evidence of a decline in income for retired individuals. From a policy perspective, these results highlight the fact that deductions create a loophole for tax evasion and tax avoidance for high-income earners; that new business start-ups and investments, not forgetting the economic environments required for

them to thrive, are integral to increased revenue performance; and that the tax rebates currently afforded those who are retired are necessary.

To test for the validity of the instruments, the analysis starts by checking the basic[22] correlations between TREAT and TREAT2 and between TREAT*POST and TREAT2*POST, as shown in Table A 3. For TREAT and TREAT2, the estimates show a significant and high correlation between the two variables. A coefficient equal to 0.72 is estimated with an R^2 or adjusted R^2 value equal to 0.58. For TREAT*POST and TREAT2*POST the findings give an even higher degree of correlation, with a correlation of 0.86. The measure for goodness of fit is the same as that of TREAT and TREAT2.

For a more reliable test for the validity of the instruments used as well as their strength, the Kleibergen-Paap statistic is used. Against this statistic, Stock and Yogo's (1995) critical values are employed to test for weakness in the instruments. The results are presented in Table A 4 for the regression with all controls. Given significantly high values of the Kleibergen-Paap statistic relative to the Stock-Yogo critical values, the null hypothesis of weak instruments is rejected. This gives evidence that the use of TREAT and TREAT*POST is appropriate in controlling for endogeneity.

Given the findings of this section, 2SLS results take precedence over OLS results. Going forward, the analysis focuses on the findings from the 2SLS analysis.

6.3.3 ETI, Tax Performance and the Optimal Tax Rate

From the 2SLS results, equations 4.5, 4.6 and 5.5 are used to calculate the resulting ETI, the ensuing revenue changes as well as the optimal tax rate. The results are summarized in Table 8.

Table 8: ETI estimates, revenue changes and the optimal tax rate, 2016-2018

		2016-2018	
2SLS	(1)	(2)	(3)
α_3	-0.68	-0.68	-0.67

[22] Just an OLS regression with no additional controls

e	1.00	1.00	0.99
dB	-R 6.18 billion	-R6.18 billion	-R6.12 billion
τ^*	0.32	0.32	0.32

Source: Author's own calculations

Given a -6.78 percent change in the net-of-tax rate, and the estimated treatment effects, equation 5.5 gives an ETI value of 1.00, with an estimated ETI of 0.99 when all controls are included. These results are significantly larger than the ETI values presented in Kemp (2019) and Kemp (2020) within the South African context, which found ETI for the top bracket of not more than 0.5 for the top 10 percent income earners. This is as expected, in accordance with Kemp (2019), as the reform considered in this study is expected to have yielded a higher response than that resulting from the bracket creep phenomenon. This argument is also in line with He, Peng and Wang (2018) who found a bracket creep ETI of 0.5 and a tax reform ETI of 2.423 for China. The results are also on par with the early findings of Feldstein (1995) whose ETI ranged from 1.0 to 1.5. The findings of this paper also fall within the range of 0.4 to 1.3 calculated for Brazil in Mattos and Terra (2016). Relative to more recent literature, however, these findings are large even after controlling for mean reversion and non-tax factors. Arguably, the estimates give the short-run responsiveness of taxable income to tax rate changes which, according to Goolsbee (2000) are expected to be fairly high, decreasing over time.

It is also argued here that, relative to the most recent findings discussed in the literature which evaluated tax cuts, the ETI estimates are expected to be higher, even after correcting for mean reversion. This is because the incentive to evade taxation to salvage one's income is relatively higher than the incentive to increase taxable income due to a tax cut. In other words, once one finds a means to circumvent taxation, there will be very little incentive to reduce the degree of circumvention even with lower tax rates as a rational taxpayer's goal is expected to be that of minimising tax liability.

In order to gauge revenue performance and to calculate the optimal tax rate various information is required. This information is summarized in Table 9 below. These measures are generated by equations 4.5 and 4.6, respectively.

Table 9: Parameters to calculate revenue changes and the optimal tax rate, 2016-2018

Parameter	2016-2018
N	79391

z^m	R2,798,241
τ	0.41
$1-\tau$	0.59
$d\tau$	0.04
$\bar{z}$	R1,500,000
a	2.155

Source: Author's calculations and SARS and National Treasury (2019)

The calculated ETI measures suggest that approximately R6.12 billion in revenue was lost following the 2017/2018 tax rate hike. The optimal tax rate is calculated to be roughly 32 percent. These values are significantly lower than the current top bracket tax rate of 45 percent and, with reference to the Laffer curve, suggest that the government is already taxing individuals beyond the threshold level of the Laffer curve- in the prohibited region. This means that further hiking tax rates for individuals at the top end of the income distribution, *ceteris paribus*, will yield significantly lower levels of revenue. To yield higher levels of revenue, tax rate cuts are suggested, as in Jordaan and Schoeman (2015)

Due to the differences in elasticities presented here and those presented in Kemp (2019) and Kemp (2020), the optimal tax rates presented here are much lower. The optimal tax rate given for the top 10 percent income earners in Kemp (2019) is approximately equal to 40 percent. The revenue loss here is also significantly higher than that found in Steenekamp (2012b) for an even larger hypothetical increase in the top tax rate in South Africa. Steenekamp (2012b) estimated a revenue loss of not more than R340 million given a 10 percent tax rate hike.

It is noted that for the optimal tax rate, the unknown society's welfare function, *g*, does not necessarily have to assume the value 0. The sensitivity of the optimal tax rate to the other plausible values of *g* is tested for using Table 10 below. The results are given using the elasticity estimate obtained when using all control variables, 0.99.

Table 10: Optimal tax rate as a function of g for *e* = 0.99, 2016-2018

g	Optimal tax rate
0.1	29.46
0.2	27.07
0.3	24.52

0.4	22.60
0.5	18.83

Source: Author's own calculations

The results show that the optimal tax rate is a decreasing function of society's preferences. In addition, it is highly sensitive to values of g. As stipulated in Kemp (2019), higher elasticities are expected to yield higher changes in the optimal tax rate given small changes in the value of g.

6.3.4 Robustness Checks

To probe the robustness of the findings above, particularly in relation to the sample used, this section concludes with an analysis that uses a larger set of individuals over a shorter time period. Using only one pre-reform year, the sample period ranges from 2017 to 2018. In addition to including all individuals in the 2017-2018 sample used above, it also includes individuals who were eliminated from the 2016-2018 sample because they were not in the tax brackets of interest in 2015. The sample can be seen in Table 5 under the "Number in 2016-2018" row, consisting of 203539 individuals in the control group and 71580 individuals in the treatment group. Summary statistics for this sample are shown in Table A 5. The corresponding statistical test results are shown in Tables A 1 – Table A 4 of the appendix and yield the same inferences as those made in the previous analysis.

The results observed from the new sample, shown in Table 11, are fairly similar to those estimated with the 2016-2018 sample. A significant difference worth noting is, however, observed for the treatment effect. In this case, the treatment effect is relatively large, at 13.2 percent in absolute terms, showing that the additional individuals in the 2017-2018 sample are slightly more responsive to tax rate changes. This response is more than 6 percentage points higher than that observed for the 2016-2018 sample.

The ETI calculated given the finding here is estimated to be 1.95, almost a value of 1 higher than the estimates from the previous sample. This estimated ETI value is larger but is still close to findings observed in Lindsey (1987). Compared to other emerging economies this elasticity estimate is similar to that of India, found in Acharya (2011), an ETI of 1.8. Even so, it is not as high as the short-term elasticity measure of 2.423 found in He, Peng and Wang (2018) for China. On the other hand, it is much higher than other ETI's observed in the literature including

the ETI range of 0.4 to 1.3 estimated by Mattos and Terra (2016) for Brazil. These disparities give even more evidence of the complexity associated with estimating ETI's. The optimal tax rate and revenue changes are equal to 20 percent and R12 billion, respectively. These findings are calculated using Table A 6 in the appendix.

Table 11: 2SLS Results, 2017-2018

	2017-2018		
Ln(TINC)	(1)	(2)	(3)
TREAT	1.068 ***	0.599 ***	0.574 ***
	(0.003)	(0.004)	(0.004)
POST	0.082 ***	0.082 ***	0.081 ***
	(0.001)	(0.001)	(0.001)
TREAT*POST	-0.132***	-0.132 ***	-0.132 ***
	(0.003)	(0.002)	(0.002)
LBINC		0.521 ***	0.537 ***
		(0.003)	(0.003)
GEND			0.003 ***
			(0.001)
AGE			0.0004 ***
			(0.000)
SEMP			0.034 ***
			(0.001)
INV			0.013 ***
			(0.002)
RET			-0.029 ***
			(0.001)
DED			-0.101 ***
			(0.001)
_cons	13.73 ***	6.449***	6.293 ***
	(0.001)	(0.046)	(0.047)
R^2	0.51	0.74	0.75
RMSE	0.33	0.25	0.24
Observations	550 236	550 236	528 162

The values in brackets are the standard errors. Significance at 1% level (***), at 5% level (**), at 10% level (*).

Differences between the two samples are worth highlighting. Individuals in the new sample are those who were continuously in the tax brackets of interest at least since 2016. Individuals in the previous sample are those who were continuously in the brackets of interest for at least a year more, since 2015. Given this information, a case for attrition is argued. Individuals who are in the sample for longer are more established and are, as a result, not as impulsive as those who are relatively new to the high-income brackets. Those who are relatively new are fast to act in response to a tax reform to prevent significant losses in their newfound high income

levels. This gives evidence of a high degree of the sensitivity of taxable income responses to the sample used.

7. CONCLUSION AND RECOMMENDATIONS

This paper empirically estimated the short-run elasticity of taxable income for individuals in the personal income tax bracket following the 2017/2018 tax rate hike. The paper mainly considered a sample of individuals over the period 2016-2018. The estimated elasticity of taxable income is found to be approximately equal to 1, giving evidence of a significantly high degree of responsiveness to the tax rate change. From this estimate, the study calculated the impact of the distortionary behavioural responses on tax revenue and derived an optimal tax rate for the tax bracket of interest. The findings show an optimal tax rate of not more than 32 percent and give evidence of a significant loss in tax revenue following the tax rate change. These findings suggest that individuals in the highest income bracket are already being taxed beyond the revenue-maximizing tax rate, and highlight that the use of tax rate hikes as a tax policy tool to collect more revenue going forward is less likely to be efficient or sustainable.

The high elasticity value for top income earners poses a serious concern for South Africa, especially with its current budgetary constraints. The inability to collect the desired revenue from the highest income earners implies the failure for government to address the prevalence of the large income gap through the redistributive function of taxes. With an already strained budget, the issue of inequality and the marginalization of the poor is most likely to persist. Moreover, the government will most likely continue to struggle to finance other types of expenditure, which has direct implications on fiscal consolidation and sustainability. Quite clearly, these results highlight that for South Africa, the need to diversify its revenue sources to sustain development and avoid a further economic decline is crucial.

Noteworthy methodological findings are also observed in the analysis of this study. The results support the correction for mean reversion applied in the extant literature. The use of other control variables in the model also emphasizes the need to disseminate changes in taxable income by individual level characteristics. From the study, it is deduced that the itemization of deductions, in particular, creates a loophole against efficient tax collection. The results also show that the success of self-employment, essentially that of businesses, is integral to high levels of revenue collection. Furthermore, the use of tax rebates to relieve the elderly from high tax rates is supported.

The study also probed the robustness of the findings using a sample with a larger set of individuals over a shorter period. The results showed a significant increase in the elasticity of

taxable income, giving evidence of a high degree of sensitivity to the sample of individuals and time period employed.

Given that this study estimated the short-run elasticity, it is expected that long-run elasticities may dampen down, improving the efficiency of tax collection with time. Notwithstanding, there is still a need for improved administrative efficiency and tax policy design to mitigate the tendency of individuals in the top bracket to evade and avoid taxes. A few recommendations are, for the purpose of designing improved tax policy, highlighted.

The reform under consideration was significantly high, in turn eliciting a higher degree of responsiveness. As a policy recommendation, it is argued, that relatively smaller changes in tax rate hikes could be more efficient in collecting tax revenue, through reducing the elasticity of taxable income observed following tax rate increases. Where possible, it is further stipulated that tax rate cuts might be more useful in generating the desired levels of revenue. With this, it follows that alternative avenues for tax revenue collection might need to be considered, given the urgent need to meet the countries spending requirements and to consolidate South Africa's debt. Lastly, it is also worth mentioning that some of the solutions to South Africa's fiscal concerns might lie in the promotion of economic growth and the creation of jobs, in turn widening the tax base.

There exists a huge scope and need for further research to contribute to sound and relevant tax policy formulation. Most notable, is that with time, the availability of more pre-reform years in the tax administration data will allow for a long-run analysis of elasticities as well as for permanent and transitory responses. Additionally, it will also be useful to examine the exact dynamics behind distortionary taxable income responses. This could include examining the effect of tax rate hikes on factors such as labour productivity, migration or the level of deductions, amongst others. This would be especially relevant in directly addressing the issues that drive tax evasion and avoidance.

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APPENDIX

Table A 1: VIF results

	2016-2018	2017-2018
VIF	(3)	(3)
TREAT	2.68	3.25
POST	1.41	1.35
TREAT*POST	1.90	2.34
LBINC	2.19	2.26
SEMP	1.02	1.02
DED	1.05	1.07
INV	1.01	1.00
RET	1.16	1.17
GEND	1.02	1.02
AGE	1.21	1.22
Mean VIF	**1.47**	**1.57**

Source: Author's own calculations

Table A 2: Tests for endogeneity

	2016-2018			2017-2018		
	(1)	(2)	(3)	(1)	(2)	(3)
Wooldridge's statistic	54719.5	24053.5	21912.9	28743.8	28743.8	13426.8
p-value	0.00	0.00	0.00	0.00	0.00	0.00
Robust F statistic	67724.9	19896.4	17815.6	53874.3	53874.3	16335.7
p-value	0.00	0.00	0.00	0.00	0.00	0.00

Source: Author's own calculations

Table A 3: First-stage results

Basic regressions between:	2016-2018	2017-2018
TREAT and TREAT2	0.72***	0.79***
TREAT*POST and TREAT2*POST	0.86***	0.90***
R2	0.579	0.663
Adjusted R2	0.579	0.663
Observations	696279	550236

The values in brackets are the standard errors. Significance at 1% level (***), at 5% level (**), at 10% level (*)

Table A 4: Instrument validation, Kleibergen-Paap test results

	2016-2018	2017-2018
	(3)	(3)
Kleibergen-Paap F-statistic	1266.20	1675.95
Stock-Yogo critical values		
5% maximal IV relative bias	17.70	
10% maximal IV relative bias	10.22	
20% maximal IV relative bias	6.20	
30% maximal IV relative bias	4.73	
10% maximal IV size	25.64	
15% maximal IV size	14.31	
20% maximal IV size	10.41	
25% maximal IV size	8.39	

Source: Author's own calculations

Table A 5: Summary Statistics, 2017-2018

	Control		Treatment		Overall	
	AVERAGE	**SD**	**AVERAGE**	**SD**	**AVERAGE**	**SD**
TINC (R)	1,038,852	197,026	2,786,674	3,007,495	1,488,351	1,714,229
ln(TINC)	13.83	0.19	14.68	0.47	14.05	0.47
AGE	48.50	9.56	47.18	10.11	47.52	9.99
	%		%		%	
SEMP	8.79		16.09		10.67	
INV	3.32		3.93		3.48	
DED	90.46		87.75		89.76	
RET	15.20		15.55		15.29	
MALE	68.63		72.66		69.67	
FEMALE	27.83		22.36		26.42	
UNALLOCATED	3.54		4.98		3.91	

Source: Author's own calculations

Table A 6: Parameters to calculate revenue changes and the optimal tax rate, 2017-2018

	2017-2018
N	79391
z^m	R2,786,674
τ	0.41
$1-\tau$	0.59
$d\tau$	0.04
$\bar{z}$	R1,500,000
a	2.166

Source: Author's own calculations and SARS and National Treasury (2019)