Using a Natural Experiment to Examine Tobacco Tax Regressivity

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Abstract

We take advantage of a tobacco tax hike that occurred during the collection of the South African Income and Expenditure Survey to examine the regressivity of tobacco taxes. We are also able to examine the relative change in regressivity following the tax increase. Like previous research into commodity taxes, we find that tobacco taxes are regressive. However, we find that tobacco tax increases reduce the tax burden at the lower end of the income distribution, such that after the cigarette tax increase, cigarette taxes are less regressive than before the increase.

1 Introduction

According to the Cancer Society of South Africa (2013), around 44 000 people die each year of tobacco related diseases in South Africa. Any intervention purporting to effect a reduction in the

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number of tobacco linked deaths will hinge upon its ability to reduce tobacco usage. Increased cigarette taxation, along with a number of other control strategies, have been implemented around the world in order to increase either the direct or indirect cost of purchasing or consuming tobacco products, and, thus, reduce consumption. It is argued that raising the price of cigarettes is one of the most effective tobacco control strategies, Centres for Disease Control and Prevention (2007), primarily because the empirical tobacco demand literature repeatedly provides support for the law of demand, Chaloupka, Yurekli & Fong (2012).

However, tobacco taxes are regressive, and, therefore, increases in tobacco taxes could impose additional burdens on poor households, unless the less well-off reduce their smoking expenses at least enough to offset the increase in the tax. Such a reduction could come in the form of reduced purchases, even cessation, as well as substitution towards less expensive tobacco products. Research in the United States finds all of these effects. Gallet & List (2003) find evidence of cessation, although more recent studies find lower quit elasticities than earlier studies; see Franks, Jerant, Leigh, Lee & Lewis, II (2007), Farrelly, Pechachek, Thomas & Nelson (2008). Other US studies find evidence of substitution; recent examples include Connelly, Goel & Ram (2009), DeCicca, Kenkel & Liu (2013a) and DeCicca, Kenkel & Liu (2013b). Recently, however, new lines of thinking related to tobacco tax regressivity have started to emerge.

One of these new lines of thinking is characterized by Gruber & Köszegi (2004), O'Donoghue & Rabin (2006), Kotakorpi (2008) and Haavio & Kotakorpi (2011). They suggest that tobacco taxes may not be regressive, if those taxes prevent (especially, poorer) individuals from making mistakes. Intuitively, their models rely upon an inefficiency that might be overcome through government intervention. Individuals are framed as Becker & Murphy (1988) rational addicts, although these individuals may not know the extent to which they could become addicted, Orphanides & Zervos (1995) and Orphanides & Zervos (1998). Becoming an addict is worse than not becoming an addict, and because information regarding addiction propensity is costly to acquire, the poor are less likely to acquire that information. Such an individual may benefit from government regulation or higher taxes, as the increased start-up costs keep at least some potential addicts from ever walking that path towards destruction.

In another line of thinking, and the one most relevant for this research, Warner (2000), Chaloupka,

Straif & Leon (2011) and Chaloupka et al. (2012) argue that tobacco tax increases can be progressive, because the poor are more responsive to price increases than the rich. There is ample empirical evidence supporting the hypothesis that price elasticities are higher for poorer individuals. Siahpush, Wakefield, Spittal, Durkin & Scollo (2009), DeCicca & McLeod (2008) and Matire, Mattick, Doran & Hall (2010), for example provide support; however, not all studies, such as Franks et al. (2007), do. Under this line of thinking, the poor will reduce their consumption further than the rich, in the face of price increases. Thus, researchers and anti-smoking advocates are warming to the idea that, not only are tobacco taxes an important instrument in the fight for improved public health, they are also a useful instrument in the fight against poverty.

However, regardless of whether or not the poor are more responsive to price increases, little, if any, robust evidence in support of the Warner (2000) hypothesis exists. Only Coleman & Remler (2008) and, to a lesser extent, Farrelly, Nonnemaker & Watson (2012) examine the plausibility of this hypothesis. They find, in the US, that the price responsiveness is not large enough to lead to reductions in tax regressivity. In what follows, we examine the Warner (2000) hypothesis in a middle income country. The analysis considers tax regressivity, before and after the imposition of a tax hike. The middle income country chosen for the analysis, South Africa, is a country that has, since its democratic transition, imposed a relatively robust and consistent cigarette tax policy. In fact, the tax structure is such that taxes rise every year. van Walbeek (forthcoming) outlines this consistency; the total tax burden, which is the combined excise tax and value-added tax (VAT), has been set at 52% of the most popular brand's recommended retail price.[1] Given the 14% VAT, which translates to 12.3% of the VAT-included price, the 39.7% excise tax as a share of the total price is below the global average of approximately 52%, the African region average of around 42%, and Chaloupka et al.'s (2012) recommended 70%.

In line with South Africa's stated tax policy, National Treasury announced a tax increase of 52 cents on a pack of 20 cigarettes, implementable in April 2006, although the announcement was made during March 2006. Fortunately, for this research, the tax increase coincided with a national survey, the 2005-06 South African Income and Expenditure Survey (IES), which

[1] Between 1994 and 2003, the target was set at 50%.

was collected between September 2005 and August 2006. Given this coincidence along with the consistency of policy, the data spans a natural experiment, and, therefore, it is possible not only to examine tobacco tax regressivity but also to examine changes to that regressivity caused by changes in the tobacco tax level. Therefore, the objective of this research is to describe tobacco tax regressivity in South Africa, and, further, to test the hypothesis laid out in Warner (2000) that tobacco tax increases can be progressive.[2]

The remainder of the paper follows a common structure. In Section 2, we describe South African tobacco tax policies. In Section 3, we describe the data available to us, and the quasi-experimental setting. As part of the preliminary discussion, we provide empirical evidence that the cigarette tax hike imposed by the South African government did yield increases in cigarette prices. The methodology is described in Section 4, the results and a discussion of those results is presented in Sections 5 and 6. Finally, in Section 7, we conclude.

2 South African Tobacco Policies

Throughout the twentieth century, tobacco excise tax was an important source of government revenue, increasing from around 1.0 per cent of total revenue in 1911-12, to a peak of 7.6 per cent in 1960-61, although decreasing to about 1.1 per cent in 1990. However, van Walbeek (2003) argues that, given the high inflation rate between 1970 and 1980, the real excise tax per pack of cigarettes decreased. Furthermore, the close relationship that existed between the apartheid government and the tobacco industry likely contributed to decreasing real tobacco excise taxes and a long period of tobacco control inaction between 1960 and the early 1990s, Asare (2007). Despite that close relationship, however, revenue collection from tobacco took precedence over public health concerns, Asare (2009), even though there was an increase in focus, during the early 1990s, towards increased tobacco control.

[2]Since we are focusing the analysis on households, and the data is not collected over a long period of time, this research does not describe long term elasticities. Furthermore, it cannot provide any information on the potential for long-run decreases in tax revenues that might arise if tax increases led to large enough consumption decrease, Azagba & Sharaf (2011).

Apart from increasing taxes on cigarettes and tobacco, other policies were proposed to discourage smoking in South Africa. In the latter part of 1991 the Minister of Health introduced the control of smoking and advertising of tobacco products draft bill in the assembly, Asare (2009). The proposed bill set out to give the Minister power to restrict smoking in certain public areas, make it illegal to sell cigarettes to children under 16 years and force cigarette advertising to carry health warnings, Malan & Leaver (2003). After amendments, the bill was passed in 1993 as the Tobacco Products Control Act; however, compliance was not enforced until 1995. According to van Walbeek (2003), smoking prevalence declined from 32.2 per cent to 27.9 per cent between 1995 and 1999.

The 1993 law was further stiffened with the Tobacco Products Control Amendment Act (TPCAA) 1999. The new legislation specifically prohibited: smoking in workplaces and other public areas; all tobacco advertising and promotion of tobacco products, including promotions through sponsored events; the sale of tobacco products to persons under the age of 16 years; and free distribution of tobacco products (Leaver (2002); Blecher (2006); Government of South Africa (1999)). Although promulgated in 1999, the TPCAA only came into effect in 2001. Smoking prevalence at the end of 2001 stood at 24.5 per cent, although it is unlikely that the newly implemented law was responsible for this further reduction – from 27.9 % to 24.5% - price increases arising from tax increases probably were.

Although there was no major cigarette or tobacco policy changes during 2005 and 2006, the period under review in this research, further changes were afoot. The South African Government aimed to further strengthen tobacco control, and keep the country in line with the requirements of the World Health Organisation's Framework Convention on Tobacco Control (FCTC), by introducing new legislation in 2007, Government of South Africa (2007), which has received presidential assent. Two further pieces of legislation have since been added: the 2007 Tobacco Products Control Amendment Act, No. 23, and the 2008 Tobacco Products Control Amendment Act, No. 63. These Acts increased smoking fines, made it illegal for adults to smoke in a car if there is a child under 12 years of age inside the car, and paved the way for picture warnings on cigarette packs. These non-tax policy measures are likely to further assist in reducing smoking prevalence, although the impact of these measures is not yet known, and cannot be examined with our data.

3 The Data

The primary data for the analysis was sourced from the 2005-06 Income and Expenditure Survey (IES), conducted by Statistics South Africa. The survey is nationally representative, and, because it contains information about consumption, it underpins South Africa's Consumer Price Index. In addition, the data allows for the examination of expenditure patterns in South African households, especially when it is combined with other information regarding individuals in the household.

Previous South African tobacco studies have made extensive use of the 2000 Income and Expenditure survey data, van Walbeek (2002*a*), Ground & Koch (2008) and Tshiswaka-Kashalala & Koch (2008), although van Walbeek (2002*b*) used the All Products Market Survey (AMPS) data, Berg & Kaempfer (2001) used the 1993 Living Standards Measurement Survey and Boshoff (2008) makes use of wholesale cigarette shipments from one of the large manufacturers in South Africa. What is generally not available in South Africa is an individual level survey of quantity used, and price paid per pack. Therefore, we make use of consumption expenditure.

Starting in 2005-06 the quinquennial IESs were completed over a lengthy period of time, from September 2005 through August 2006 in this case, rather than a few weeks. Importantly, households in all provinces were interviewed each month, so there is a national spread to the data. Furthermore, Statistics South Africa implemented a diary method, as well, incorporating both the diary and recall methods during the IES sampling period. Since data was collected over time, all expenditure data was adjusted to March 2006 using the consumer price index.

Before undertaking any analysis, the applicability of the experimental structure must be checked. Firstly, it is necessary to test whether or not cigarette prices were affected by the tax change. Given the consistent nature of tax policy, it is possible that prices could have been raised earlier, in anticipation of the tax change. Secondly, since the data is not a household panel, it is necessary to check the comparability of the before and after households. Below, we address those two concerns.

3.1 How Natural is the Experiment? Price Effects

In order to provide some indication of the effect of tax hikes, provincial level cigarette price data was sourced from Statistics South Africa, although this data is not generally available to the public. From that, average provincial prices (per stick) were calculated for each month between September 2005 and August 2006.[3] The average price data ($\overline{p}_{jt}$) for each province and month was estimated within a simple panel setting. Controls included provincial fixed effects (X_j), a time trend (t), and an indicator representing the timing of the tax change (τ), which was interacted with the time trend and the provincial fixed effects. In other words, fixed effects and time trends were allowed to differ before and after the tax. Specifically, since taxes were increased in March 2006, effective April 2006, the tax indicator is "off" before April 2006 and "on" afterwards, as in (1).

$$\overline{p}_{jt} = X_j\gamma_0 + \delta_0 t + \tau \cdot X_j\gamma_1 + \tau \cdot \delta_1 t + u_{jt} \tag{1}$$

The regression results, see Figure 1 and Table 1, provide evidence of the impact the cigarette tax had on cigarette prices. Although the figure is for only two provinces, we present the estimated price and the predicted 95% confidence interval for those provinces; the table contains province-specific tax effects for all provinces. The salient feature of the illustration is the significant price differential for these two provinces at the time of tax implementation, and those results are confirmed for all but two provinces. The tax was not found to increase the average price of cigarettes in either the Free State or the Northern Cape.

3.2 How Natural is the Experiment? Covariate Balance

Another worry that arises in a quasi-experimental design is covariate balance. Intuitively, it is inappropriate to compare households before and after a policy change, unless those households

[3]It was not possible to create a weighted average, based on sales of particular brands; thus, the average is the sample average price.

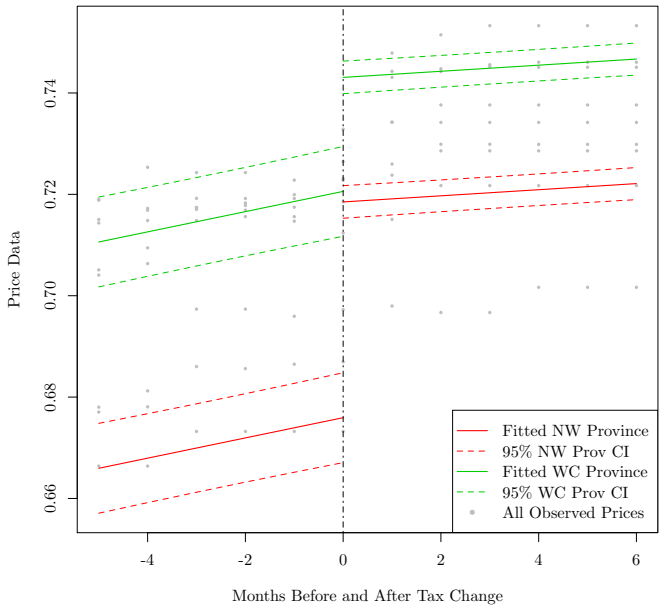

Figure 1: Effect of Tax on Cigarette Prices for Two Provinces: Western Cape Province and Northwest Province. Illustration includes observed average prices, OLS estimates of the tax effect on prices for the two provinces and 95% confidence intervals.

are similar. Therefore, a simple covariate balance test, based on ordinary least squares regression, is performed. The dependent variable in the regression is the tax indicator (τ), while the control variables (Z_i) include all household level variables. These include household income, the proportion of males in the household, the proportion of adults in the household, and categories representing various household sizes. In addition to these, we include the first two components of an asset index, the sex and population group of the head of the household and the provincial location of the household, as well as an indicator of whether or not the household is in a rural location. There are also a series of measures related to education, including whether or not the household head can read or write, attended university or received extra training, as well as categorical indicators for years of schooling.

The regression results are contained in Table 2. With a few exceptions, there appears to be balance. In other words, there are some differences between the households surveyed before and after the tax change. Those differences relate to household income and assets, population group, rural residence and household size. We address covariate imbalance, through conditioning, and the approach is outlined in Section 4.

Table 1: Province Specific Estimates of Tax Effect on Prices

	Estimate	Std. Error	$t-$value	Pr(> |t|)
Eastern Cape	0.0089	0.0017	5.32	0.0000
Free State	-0.0013	0.0018	-0.71	0.4784
Gauteng	0.0050	0.0020	2.49	0.0148
KwaZulu-Natal	0.0098	0.0025	3.88	0.0002
Mpumalanga	0.0216	0.0033	6.62	0.0000
Northern Cape	-0.0003	0.0023	-0.13	0.9004
Limpopo	0.0130	0.0023	5.76	0.0000
Northwest	0.0336	0.0019	17.83	0.0000
Western Cape	0.0136	0.0026	5.26	0.0000

OLS estimates from (1), reporting γ_1, the province-specific tax effect on average prices. Regression includes n = 108 observations: 9 provinces captured over 12 months. The regression R^2 = 0.9839. White Heteroscedastic-consistent standard errors reported.

3.3 Unconditional Differences in Cigarette Purchases

However, to see if conditioning has the potential to solve the problem, we first undertake two more descriptive analyses. First, unconditional differences before and after the tax change are estimated; see Table 3, which contains descriptive statistics of cigarette purchase behaviour of the households, as well as $t-$tests of differences before and after the tax change. The breakdown covers all households (Table 3a), tobacco purchasing households (Table 3b) and cigarette purchasing households (Table 3c).

Second, given the results in Table 2, one might worry that the statistically significant share reduction observed in all of the panels of Table 3 is a direct result of the statistically significant differences in income. Therefore, cigarette expenditure differences were also estimated for households matched on their characteristics - see Table 2 for details. The matched differences are outlined in Table 4. The matches are nearest-neighbour (for one neighbour), estimated with Sekhon's (2011) matching package for R. Importantly, the matched differences, especially with regard to expenditure shares, remain, and, therefore, the unconditional differences are not driven by differences in income across the samples. As before, they are presented for all households (Table 4a),tobacco purchasing households (Table 4b) and cigarette purchasing households (Table 4c).

Table 2: Two-Stage Least Squares Balance Test of Covariates Before and After Tax Change

	Estimate	Std. Error	t−value	Pr(> |t|)
(Intercept)	0.4239	0.0287	14.78	0.000
HH Income	0.0001	0.0000	4.11	0.000
Proportion Males	-0.0226	0.0148	-1.53	0.126
Proportion Adults	0.0018	0.0204	0.09	0.931
Asset Component I	0.0342	0.0280	1.22	0.222
Asset Component II	-0.3100	0.0961	-3.23	0.001
Female HH Head	-0.0157	0.0092	-1.71	0.087
Coloured HH Head	0.0138	0.0134	1.03	0.303
Asian HH Head	-0.0744	0.0282	-2.63	0.008
White HH Head	0.0357	0.0175	2.04	0.041
Eastern Cape	-0.0053	0.0155	-0.34	0.731
Northern Cape	0.0090	0.0159	0.57	0.572
Free State	0.0219	0.0172	1.27	0.203
KwaZulu-Natal	0.0251	0.0154	1.63	0.104
Northwest Province	0.0012	0.0180	0.06	0.949
Gauteng Province	0.0030	0.0162	0.18	0.853
Mpumalanga Province	0.0091	0.0179	0.51	0.611
Limpopo Province	0.0215	0.0178	1.21	0.226
Rural	0.0204	0.0086	2.37	0.018
HH Head Can't Read	0.0461	0.0767	0.60	0.548
HH Head Can't Write	-0.0609	0.0774	-0.79	0.432
HH Head University Degree	-0.0261	0.0222	-1.18	0.239
HH Head Extra Training	-0.0334	0.0162	-2.06	0.039
Two HH Members	-0.0232	0.0122	-1.90	0.058
Three Members	-0.0049	0.0135	-0.36	0.719
Four Members	-0.0143	0.0143	-1.00	0.315
Five Members	-0.0219	0.0155	-1.42	0.157
Six Members	-0.0215	0.0172	-1.25	0.212
Seven Members	-0.0263	0.0189	-1.39	0.166
Eight Members	-0.0222	0.0223	-1.00	0.318
Nine Members	-0.0605	0.0259	-2.34	0.019
Ten Members	-0.0442	0.0291	-1.52	0.129
Eleven Members	-0.0167	0.0402	-0.41	0.679
Twelve Members	-0.0008	0.0471	-0.02	0.987
More than Twelve	-0.0286	0.0354	-0.81	0.419
HH Head One Year of School	0.0565	0.0452	1.25	0.212
Two School Years	0.0127	0.0296	0.43	0.669
Three Years	-0.0378	0.0247	-1.53	0.126
Four Years	0.0160	0.0240	0.67	0.504
Five Years	-0.0061	0.0263	-0.23	0.817
Six Years	-0.0419	0.0257	-1.63	0.103
Seven Years	0.0165	0.0250	0.66	0.509
Eight Years	-0.0349	0.0241	-1.45	0.147
Nine Years	0.0010	0.0239	0.04	0.965
Ten Years	-0.0142	0.0254	-0.56	0.575
Eleven Years	-0.0045	0.0243	-0.19	0.852
Completed Matric	-0.0037	0.0247	-0.15	0.882
Some University	0.0120	0.0233	0.52	0.606

Source: Authors' calculations from linear regression of tax change (dependent variable) on all covariates. Significant estimates point to a lack of balance in covariates.

4 Methodology

The analysis of tax regressivity is underpinned by a common definition of regressivity. which is extended to incorporate the fact that the available data spans a cigarette tax hike, and,

Table 3: Unconditional Mean Difference by Tax Status

(a) All Households

	Pre-Tax Mean	Post-Tax Mean	Difference Estimate	Test of Pre>Post Pr(> |t|)
Annual Cigarette Expenditure	272.6	265.9	-6.7	0.588
1[Cigarette Expend >0]	0.249	0.243	-0.007	0.270
Cigarette Budget Share	0.930	0.787	-0.144	0.002
Annual Tobacco Expenditure	336.4	330.1	-6.3	0.622
1[Tobacco Expend >0]	0.390	0.387	-0.003	0.666
Tobacco Budget Share	1.354	1.235	-0.119	0.002

(b) Tobacco Purchasing Households

	Pre-Tax Mean	Post-Tax Mean	Difference Estimate	Test of Pre>Post Pr(> |t|)
Annual Cigarette Expenditure	699.8	687.9	-11.9	0.684
1[Cigarette Expend >0]	0.640	0.628	-0.012	0.256
Cigarette Budget Share	2.388	2.035	-0.353	0.002
Annual Tobacco Expenditure	863.5	853.9	-9.6	0.741
Tobacco Budget Share	3.475	3.195	-0.281	0.001

(c) Cigarette Purchasing Households

	Pre-Tax Mean	Post-Tax Mean	Difference Estimate	Test of Pre>Post Pr(> |t|)
Annual Cigarette Expenditure	1092.9	1095.4	2.5	0.953
Cigarette Budget Share	3.730	3.240	-0.489	0.003

$T-$tests of unconditional mean differences (before and after tax change). Panel (3a) includes all households, (n = 20952); Panel (3b) includes only tobacco purchasing households, (n = 8136). Panel (3c) includes only cigarette purchasing households, (n = 5168). Note: 1[·] represents the indicator function. Shares listed as percentages rather than proportions.

therefore, it is possible to examine whether or not the underlying estimate of regressivity is affected by the tax hike.

Intuitively, a tax is defined to be regressive, if the effective tax rate increases as the level of income falls. It is a share measurement, referred to as r_ω. Specifically, consider the relationship between the tobacco tax (T) share of income (y) – or the tax rate (T/y) – and total income.

$$r_\omega = \frac{\partial(T/y)}{\partial y} \tag{2}$$

This measure can fall anywhere along the real number line, and, if $r_\omega < 0$, as expected, the tobacco tax is regressive in nature. Furthermore, it is possible to examine changes in the regressivity (progressivity) of the tax. For example, a tax change is more regressive if $\partial r_\omega/\partial\tau < 0$, where τ is a change in the tax, and less regressive, if the opposite is true.

Empirically, we take advantage of the consistency of tobacco tax policy in South Africa. In

Table 4: Matched Mean Differences by Tax Status

(a) All Households

	Difference Estimate	Std. Error	t value	Test of Pre>Post Pr(> |t|)
Annual Cigarette Expenditure	-23.86	13.13	-1.82	0.069
1[Cigarette Expend >0]	-0.008	0.01	-1.28	0.212
Cigarette Budget Share	-0.137	0.05	-2.98	0.003
Annual Tobacco Expenditure	-23.2	13.59	-1.70	0.088
1[Tobacco Expend >0]	-0.000	0.01	-0.02	0.981
Tobacco Budget Share	-0.121	0.04	-3.02	0.002

(b) Tobacco Purchasing Households

	Difference Estimate	Std. Error	t value	Test of Pre>Post Pr(> |t|)
Annual Cigarette Expenditure	-24.93	34.18	-0.73	0.466
1[Cigarette Expend >0]	-0.004	0.01	-0.38	0.385
Cigarette Budget Share	-0.330	0.12	-2.67	0.008
Annual Tobacco Expenditure	-33.7	33.97	-0.99	0.322
Tobacco Budget Share	-0.237	0.09	-2.74	0.006

(c) Cigarette Purchasing Households

	Difference Estimate	Std. Error	t value	Test of Pre>Post Pr(> |t|)
Annual Cigarette Expenditure	-71.4	50.53	-1.41	0.157
Cigarette Budget Share	-0.55	0.19	-2.85	0.004

$T-$tests of unconditional mean differences (before and after tax change). Panel (3a) includes all households, (n = 20952); Panel (3b) includes only tobacco purchasing households, (n = 8136). Panel (3c) includes only cigarette purchasing households, (n = 5168). Note: 1[·] represents the indicator function. Shares listed as percentages rather than proportions.

essence, tobacco taxes, as outlined in policy documents, are to be 52% of the retail price of the most popular brand. Unfortunately, our data does not contain brand information, or even total pack purchases; thus, for purposes of this analysis, we need reasonable assumptions for identification. In what follows, we assume that tobacco taxes account for 50% of total tobacco expenditure, which less than the stated policy, but is an easier proportion to analyse.

Under that assumption, $T = .5C \leftrightarrow C = 2T$, where C is total cigarette consumption expenditure. Defining $\omega = C/y$ as the share of total expenditure devoted to cigarettes, along with (2), yields a budget share definition of tax regressivity.

$$r_\omega = \frac{\partial(T/y)}{\partial y} = \frac{\partial(0.5C/y)}{\partial y} = \frac{\partial(0.5\omega)}{\partial y} = \frac{1}{2}\frac{\partial \omega}{\partial y} \tag{3}$$

In order to estimate the parameter r_ω, a linear conditional expectation of the cigarette expenditure share is specified. The conditioning is over a variety of household level control variables

outlined in the data section, denoted by z_i, as well as household income (y_i), the tax change indicator (τ_i), and an interaction between household income and the tax change ($\tau_i \cdot y_i$).

$$\omega_i = \beta_1 y_i + \beta_2 \tau_i + \beta_3 \tau_i \cdot y_i + \Xi' z_i + \nu_i \tag{4}$$

The regression in (4) includes two parameters of interest. The first is β_1, which describes the regressive/progressive nature of the relationship before the tax hike was implemented, and, therefore, is a *pre-tax* estimate of r_ω. The other is β_3, which describes $\partial r_\omega / \partial \tau$, the change in regressivity arising from the change in the tax. Although it is possible to calculate a *post-tax* estimate of r_ω, it is unnecessary, as the preceding two estimates describe the results of interest.

We report estimates of (4) for a variety of subsets of the data in order to see if the results are broadly similar, if the regressivity measure varies by the level of household income, or if that measure depends on smoking 'prevalence', defined by purchases of tobacco and cigarettes. Specifically, there are two sub-sample categorizations. The first grouping is based on income quartiles in the data, Quartile 1 - Quartile 4. This categorization provides us with a more detailed breakdown of cigarette tax regressivity across the income distribution. The second grouping is based on household purchases of tobacco: all households, regardless of whether or not they purchase any tobacco products; tobacco purchasing households and cigarette-only purchasing households.

As noted above, tobacco taxes, especially a change in the tax policy, will be revealed as more or less progressive, depending on the overall household response. At the household level, tobacco expenditure could increase, decrease or stay the same, depending on the household's ability to shift the taxes or mitigate the tax burden. Such a shift might arise from reduced purchases, even cessation, as well as substitution towards less expensive tobacco products or cigarettes, possibly because of search activities (DeCicca et al. (2013a)). By looking across the smoking prevalence categorization, we learn about average regressivity within that categorization, while remaining agnostic with respect to what drives the changes in overall observed tobacco expenditures. By extending that to income groupings, the results point to the ability various types of households have to shift some of these costs.

5 Regressivity Results

Before presenting the regressivity results, we present a descriptive analysis of tax regressivity, through the illustration of concentration curves, Kakwani (1977) and O'Donnell, van Doorslaer, Wagstaff & Lindelow (2008). A concentration curve that lies above the 45-degree line is regressive in nature, because it illustrates that poorer households pay disproportionally more (a larger share of their budget) for cigarettes. Figure 2 contains the curves for all households, one for households surveyed before the tax change, and one for households surveyed after the tax change.[4]

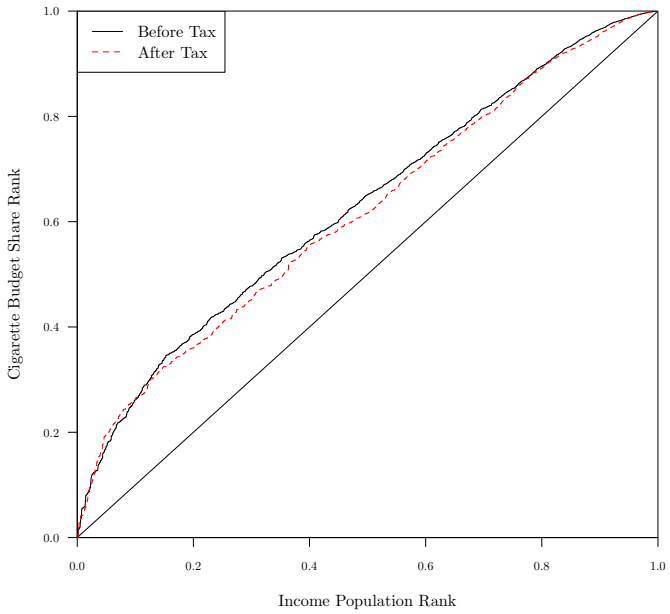

Figure 2: Concentration curves of cigarette budget shares for all households in the data before and after tax.

As implied by Figure 2 and will be seen in the empirical analysis, cigarette expenditure shares are regressive. Therefore, assuming that a near constant fraction of these shares is devoted to taxes, which is reasonable, given the history of cigarette tax policy in the country, as well as limited illicit cigarette trade, van Walbeek (forthcoming), cigarette taxes are also regressive. The descriptive evidence contained in these concentration curves suggests one other feature of

[4]Figures for tobacco purchasing and cigarette purchasing households are also available from the authors. However, the figures are similar to Figure 2, and, therefore, they are not included.

the March 2006 cigarette tax hike in South Africa: the tax hike may have been progressive, i.e., reduced the regressivity of the tax.

The empirical estimation of (4), which formalizes both the degree of progressivity and the potential (relative) progressivity of the tax hike, is undertaken across a number of sub-samples. Initially, we estimate using all households in the data, including those who do not report any cigarette purchases. In a subsequent analysis, the estimates are based only on households purchasing tobacco products. Finally, the estimates are based only on cigarette purchasing households. Within each analysis, in addition to estimating for the cigarette/tobacco purchase sub-sample of interest, we also estimate for household expenditure quartiles. Each of these sets of regressions are based on ordinary least squares. The results are reported in Tables 5, 6 and 7, in which we highlight only the variables of interest.[5] In addition, we report a simple measure of model fit. Shares, by definition are required to lie within the unit interval, and, therefore, we report the proportion of predictions that do so. Fortunately, the reported fits are reasonable, never less than 85.7%; therefore, we do not feel it is necessary to also consider fractional models of expenditure, Pu, Lan, Chou & Lan (2008) or Koch (2010).

Table 5: Ordinary Least Squares: All Households

	All	Quartile 1	Quartile 2	Quartile 3	Quartile 4
HH Expenditure	-0.0019	-0.0538	-0.0339	-0.0136	-0.0012
	(0.000)	(0.007)	(0.004)	(0.002)	(0.000)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Tax Effect	-0.1892	-0.4219	-0.3869	-0.3423	-0.2063
	(0.050)	(0.174)	(0.139)	(0.127)	(0.094)
	[0.00]	[0.02]	[0.01]	[0.01]	[0.03]
Expenditure x Tax Effect	0.0010	0.0151	0.0135	0.0084	0.0007
	(0.000)	(0.011)	(0.005)	(0.002)	(0.000)
	[0.00]	[0.17]	[0.01]	[0.00]	[0.04]

Selected OLS estimates from (4) for all households in the data. Quartiles taken with respect to household income. Additional control variables include: age, gender, race and education of household head, location, household size and household composition. Table 2 lists most of the variables. Percentage of estimated shares contained in the unit interval: 85.7%; $N = 20952$. Standard errors in parentheses and $p-$values in brackets.

As noted previously, the share results are contained in three separate tables. The first, Table 5, implies an average tax regressivity coefficient of 0.0010; this is half the value reported in the

[5] As described above, a number of additional control variables are included in the regression. These include a number of socio-demographic factors: categorical indicators of the age of the household head; the ratio of males in the household; the ratio of adults in the household; household size; race interacted with gender; province interacted with an urban indicator; categorical indicators of the household head's education; household head literacy indicators; and a categorical asset index.

first column and row of the table as outlined in (2). However, the regressivity coefficient is much larger for the lower three quartile households. Given the definition of the variables in the model, for each ZAR1000 increase in household expenditure (for those households surveyed before the tax was changed) the share of the household's budget devoted to cigarette taxes decreases by 0.0010 share points.[6] The increase in the tax led to a statistically significant reduction in the average share, albeit only by 0.18 share points, although that is nearly one-third the average share. Similarly, there is, on average, a statistically significant reduction in the regressivity coefficient, due to the increase in the tax; see row 3 of the table.

Table 6: Ordinary Least Squares: Tobacco Consuming Households

	All	Quartile 1	Quartile 2	Quartile 3	Quartile 4
HH Expenditure	-0.0065	-0.0090	-0.0194	-0.0028	-0.0077
	(0.001)	(0.002)	(0.003)	(0.001)	(0.002)
	[0.00]	[0.00]	[0.00]	[0.02]	[0.00]
Tax Effect	-0.4083	-0.4435	-0.8225	-0.3322	-0.2441
	(0.121)	(0.238)	(0.294)	(0.231)	(0.230)
	[0.12]	[0.06]	[0.01]	[0.15]	[0.29]
Expenditure x Tax Effect	0.0016	0.0029	0.0066	0.0005	0.0011
	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)
	[0.12]	[0.17]	[0.04]	[0.77]	[0.60]

Selected OLS estimates from (4) for tobacco purchasing households only. Quartiles taken with respect to household income. Additional control variables include:age, gender, race and education of household head, location, household size and household composition. Table 2 lists most of the variables. Percentage of estimated shares contained in the unit interval: 93.1%; $N = 8136$. Standard errors in parentheses and $p-$values in brackets.

In Table 6, only tobacco purchasing households are considered. As was observed in Table 5, cigarette tax shares are regressive; the coefficient of regressivity, 0.0032, is three times larger for the tobacco-only sample than for all households. The tax hike is also found to have led to reductions in cigarette budget shares both on average and for each of the three poorest expenditure quartile households, implying that 'price elasticities' are larger amongst the poor.

Once the sample has been limited to cigarette consuming households only, see Table 7, the average tax regressivity coefficient increases further, although by less than the jump between all households and only tobacco purchasing households. Furthermore, the estimated tax effect is larger for the average cigarette purchasing household than for the average tobacco purchasing household, and that difference is stark for the poorest households. Therefore, we observe

[6]Shares are out of 100, rather than unity; therefore, an estimate of 1.0 would be 1 share point (out of 100) or 1%. For further reference, the average cigarette expenditure share is 0.93 (also out of 100, so less than 1%), such that the average tax share is 0.47.

Table 7: Two-Stage Least Squares: Cigarette Consuming Households

	All	Quartile 1	Quartile 2	Quartile 3	Quartile 4
HH Expenditure	-0.0073	-0.0096	-0.0033	-0.0148	-0.0142
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)
	[0.00]	[0.00]	[0.05]	[0.00]	[0.00]
Tax Effect	-0.6229	-1.2131	-0.0998	-1.3665	-0.2724
	(0.185)	(0.383)	(0.423)	(0.365)	(0.358)
	[0.09]	[0.00]	[0.81]	[0.00]	[0.45]
Expenditure x Tax Effect	0.0022	0.0057	-0.0016	0.0098	0.0013
	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)
	[0.09]	[0.03]	[0.54]	[0.00]	[0.68]

Selected OLS estimates from (4) for cigarette consuming households only. Quartiles taken with respect to household income. Additional control variables include: age, gender, race and education of household head, location, household size and household composition. Table 2 lists most of the variables. Percentage of estimated shares contained in the unit interval: 96.5%; N = 5168. Standard errors in parentheses and $p-$values in brackets.

that poorer cigarette purchasing households have higher 'price elasticities' than richer ones, and that poorer cigarette purchasing households have higher 'price elasticities' than other poorer households. Since the elasticity, if calculated, would be for an expenditure share rather than a quantity, the effect does not necessarily refer to reduced quantities (or even cessation); instead, the effect could simply arise from a re-arrangement of cigarette purchases to lower priced cigarettes, similar to Scollo, Younie, Wakefield, Freeman & Icasiano (2003) or DeCicca et al. (2013b). However, despite the empirical observation that the average tax regressivity coefficient falls by approximately one-quarter, following the tax hike, this effect is only separately observed in quartiles one and three of cigarette purchasers.

6 Discussion

From the results, we observe similarities across all three tables. Each points to a negative income estimate, corresponding to β_1 in (4). Therefore, the share estimates confirm that cigarette taxes, as applied in South Africa and under our constant tax proportion assumption, are regressive. Furthermore, for the most part, regressivity is estimated to be larger for lower quartile households. Encouragingly, there is evidence that the tax hike has reduced expenditure on cigarettes, which is β_2 in (4). The response to the tax hike tends to be larger amongst poorer households,

confirming higher 'price elasticities' amongst the poor. These larger price elasticities, as suggested by Chaloupka et al. (2011) and Chaloupka et al. (2012), support the possibility that tax hikes could be progressive. Most encouragingly, at least, on average, the tax change has also mitigated the degree of regressivity, which is the estimate corresponding to β_3 in (4). In other words, there is empirical support for the hypothesis that cigarette tax hikes can be progressive, on average, for this South African sample under these assumptions. However, two worries arise, when attempting to generalize these results.

The first is that there might be significant illicit trade in cigarettes. Although van Walbeek (forthcoming) suggests that there was a slight underestimation of cigarette tax revenues in South Africa in 2006, his estimates suggest that the illicit share of the market decreased during both 2005 and 2006, and, therefore, it is unlikely that the results are driven by increased purchases of illicit cigarettes. It is not possible, however, to test whether the observed reductions are due to illicit trade. Individuals are not asked whether they purchase licit or illicit cigarettes, and, if packaged the same, it is not clear that individuals would know whether or not they were purchasing illicit cigarettes.[7]

The second relates to the limited information regarding consumption and purchase behaviour. The analysis presented above is based upon expenditure share data, rather than pack (or stick) purchase behaviour. Although we were able to access very detailed price data for this research, we were not able to match it to the brand of cigarette purchased. It was also not feasible to base estimates on unit values, as done by John (2008), or use average prices in the analysis. Even though it was possible to calculate the average price (per stick) for each province and each month, 108 values, there were only 69 unique values in the data. Furthermore, the variance in average price per stick was 0.0005 cents (or 19 cents per pack) across the country over the survey period. In order to provide better information about smoking behaviour, better data about smoking behaviour (preferably, inclusive of brand) is needed.

[7]It is important to keep in mind that cigarette taxes increased by a large proportion during the 1990s, van Walbeek (2002*a*), such that National Treasury forecasts of cigarette tax revenue, which form the basis of van Walbeek's (forthcoming) analysis, may not have correctly estimated the level, even if they correctly estimated growth. Furthermore, if the observed reductions are a result of increased illicit trade, rather than reduced quantities, which also cannot be tested, the purported public health benefits of higher cigarette taxes will not be realized.

7 Conclusion

This research made use of the 2005-06 South African IES to examine the regressivity of tobacco taxes. The analysis was based on ordinary least squares regression, in order to correct for covariate imbalances in the surveyed populations before and after the March-April 2006 cigarette tax hike. Although the analysis was based on expenditure shares, rather than unit values or pack-per-day consumption habits, South African household level cigarette expenditure shares are found to be more responsive to cigarette tax increases amongst poorer households than richer households. Furthermore, cigarette taxes are found to reduce the share of the household's budget devoted to cigarette purchases. Although these effects cannot be interpreted directly as price (or tax) elasticities of demand, they are in line with our expectations of those elasticities.

The focus on expenditure shares, however, was much more beneficial in the examination of tax regressivity, than it was for price elasticities. Due to the fact that the standard definition of a regressive tax is one for which the tax share falls as income rises, and the fact that South African tobacco tax policy has consistently imposed excise taxes to keep the tax share of the price around 52%, cigarette expenditure shares are proportional to the tax share. Therefore, our share analysis exposed the degree of regressivity in tobacco taxes. As seen in Figure 2, about 40% of the cigarette tax share burden is paid by the poorest 20% of the population.[8] However, that burden is estimated to have fallen, as a result of the tax hike imposed in April 2006.

[8]This statement arises from the assumption that the tax share is directly proportional to the cigarette share burden.

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