

# A household-level trend analysis of tobacco consumption in South Africa: evidence from NIDS

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## **Abstract**

Between 1993 and 2003, active and consistent tobacco control policy caused a 33% decline in aggregate cigarette consumption (Van Walbeek, 2003:38). This led to a subsequent rise of “roll-your-own” cigarettes in South Africa (Van Walbeek, 2003). A large proportion of the current South African literature on tobacco consumption emphasises the impact of tobacco control legislation and the increasing tobacco excise tax on the South African fiscus. To date, sparse household-level analysis has been conducted in order to establish the kinds of household trends in tobacco and cigarette consumption since the tightening of South African tobacco control policies between 1993 and 2003. The aim of this study is to conduct a household-level analysis of tobacco consumption in South Africa by applying a series of non-regression techniques to three waves of household survey and panel data derived from the National Income Dynamic Study (NIDS). Some of the findings suggest that between 2008 and 2012, over 500 000 South African households contained at least one regular smoker and that, on average, between 13 to 15 million households consumed tobacco and cigarettes on a monthly basis. Furthermore, households with and without smokers claimed to have allocated, on average, a similar amount of their disposable income to tobacco and cigarettes. Other findings imply that while the household prevalence of smoking declined between 2008 and 2012, the budget share of household spending on tobacco and cigarettes was unchanged.

**JEL Codes:** I00, I10

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## **1. Introduction**

Between 1993 and 2003, active and consistent tobacco control policy caused a 33% decline in aggregate cigarette consumption (Van Walbeek, 2003:38). This led to a subsequent rise of “roll-your-own” cigarettes in South Africa (Van Walbeek, 2003). Low quality cigarettes may not only have adverse effects on the health of the smoker but could also have negative health effects on the surrounding non-smokers. The number of smoking households and smoking behaviour in South Africa is little investigated.

Hence very little is known about the kinds of household trends in tobacco and cigarette consumption that exist in South Africa since the tightening of South African tobacco control policies between 1993 and 2003. A relatively large proportion of the literature on tobacco consumption in South Africa relates to the impact of tobacco control legislation and the increasing tobacco excise tax on the South African fiscus (Van Walbeek, 2003 and 2015; Lemboe and Black, 2012).

The aim of this study is to conduct a household-level analysis of tobacco consumption in South Africa by applying a series of non-regression techniques to three waves of household survey and panel data derived from the National Income Dynamic Study (NIDS). The study is structured as follows: section 2 outlines the literature that frames the context of tobacco consumption both globally and in South Africa. Sections 3 and 4 specify the data and methodology, and data analysis. Section 5 presents our results of significance while section 6 summarises our overall findings. Finally section 7 concludes and discusses the limitations of our study.

## **2. Literature review**

A large proportion of the literature has focused on the impact of sin taxes on tobacco and cigarette consumption. Internationally, Adda and Cornaglia (2006) question the usefulness of sin taxes and argue that smokers increase their intensity of smoking in response to an increase in the cigarette sin tax. Becker, Grossman and Murphy (1991) reinforce Becker and Murphy’s model of rational addiction which argues that the price elasticities of addictive goods is relatively large. Choo (2000) builds on the model of rational addiction by including the health effects of smoking in order to understand smoking dynamics more holistically. Harris and Chan (1999) found a negative relationship between the price of premium brand cigarettes and cigarette smoking.

Furthermore, they found that nicotine addiction is reinforced over a period of time and that family income is adversely related to cigarette consumption.

Labeaga (1993) reinforced the notion that excise taxes and advertising campaigns significantly reduce cigarette consumption. Abedian *et al.* (1998) supports similar views in their policy analysis of tobacco control where various aspects of consumption, health and tax are examined in light of tobacco control policy. Laux (2000) uses rational addiction results for youth and adult smokers to validate tobacco regulation policies and its impact on welfare.

The South African literature has a relatively similar focus. Van Walbeek (2003 and 2005) discusses the economics of tobacco control, with focus of taxation and cigarette consumption, in the South African context. In addition, Van Walbeek (2013) examines the illicit cigarette market in South Africa using government revenue data. Similarly, Lemboe and Black (2012) examine the causes and consequences of cigarette smuggling in South Africa while Wherry *et al.* (2014) expand on the characteristics of the illicit cigarette market by identifying the characteristics of illicitly traded cigarettes in parts of South Africa. Furthermore, Blecher (2011) empirically analyses patterns of cigarette consumption, elasticity and affordability in low and middle-income countries and uses South Africa as a case study.

Very little of the South African literature focuses on establishing the kinds of household trends in tobacco and cigarette consumption since the tightening of South African tobacco control policies between 1993 and 2003. Black and Mohamed (2006) examine the unanticipated effects of sin taxes on poor households in South Africa and argue that sin taxes adversely affect the individual welfare, either directly (through a re-allocation of the household budget) or indirectly (through higher health expenses as a result of cheaper cigarette substitutes) and use a theoretical model to guide their reasoning. This study contributes to the literature by establishing tobacco consumption trends in South Africa and does this by applying a series of non-regression techniques to three waves of household survey and panel data derived from the National Income Dynamic Study (NIDS) between 2008 and 2012.

### 3. Data and methodology

The data we use to analyse trends in the consumption patterns of tobacco and cigarettes are drawn from waves one (2008), two (2010) and three (2012) of the National Income Dynamics Study (NIDS).

NIDS provides a useful dataset since it offers both cross-sectional and panel data. The NIDS questionnaires were also information-rich with questions at the household, adult, child and proxy levels. Questions per questionnaire cover a range of themes including livelihood changes, well-being, poverty, vulnerability and social capital, health and education, human capital formation, migration, labour market activity and economic activity, among others. Since NIDS contains an array of information related to household demographics, income and expenditure items, employment information, and tobacco and cigarette usage, it was an ideal survey to use for this type of analysis.

In order to investigate our research topic, we divided our sample into categories of tobacco and non-tobacco users. These groups are divided according to the self-reported responses of smokers and non-smokers (questions: Do you smoke? Do you smoke regularly?), which were also cross-checked with household monthly spend on cigarette and tobacco items (question: Average spent in last 30 days on cigarettes and tobacco). It is important to note that we excluded those who spent R0 or got it for 'free' in our sample.

We compare the proportion of tobacco users, which includes regular smokers, casual smokers and other tobacco users (excludes both regular and casual smokers) with non-tobacco users against the overall sample (which includes all households). We are interested to see if the number of tobacco users changed over time, which may indicate that some changes in tobacco consumption patterns due to the tobacco control policies occurred.

Additionally, each group of tobacco users' household demographics, tobacco usage, budget share, income and other factors that appear to be interesting from the descriptive statistics was examined. The calculation of the budget share was based on the fully imputed food, non-food, household rent and implied rent, and household expenditure data. For example, the food budget was taken as the ratio of the food amount divided by the monthly household expenditure. Similarly, household income was also based on the fully imputed household income variable.

All monetary amounts were deflated to August 2012 prices. All data were also weighted by the post-stratified weights of 'w\*\_wgt.'

In this study, the measures of tobacco and cigarette consumption patterns are based on the responses of two questions and thus, the two main variables of interest are "average number of cigarettes smoked per day" and "average spent in last 30 days on tobacco and cigarettes". The first variable is measured at the individual level and since the analysis is at the household level, the average of this number was computed for each household. The second variable is used as is since it is already at the household level. This study assumes that the head of the household is a permanent resident and does not consider absent heads in the sample.

In order to hypothesise trends in tobacco and cigarette consumption among South Africans, the following two hypotheses were formulated:

1. HA1: There is a change in the average number of cigarettes smoked per day from waves one to two, waves two to three, and waves one to three
2. HA2: There is a change in the average spent in the last 30 days on tobacco and cigarettes from waves one to two, waves two to three, and waves one to three

The significance of the abovementioned hypotheses was tested using paired t-statistics and is based on our panel data set.

Before the abovementioned hypotheses were tested, an analysis of our cross sectional data was conducted. Each wave was analysed separately and pooled together for any indication of changes or interesting trends in tobacco and cigarette consumption patterns over time.

Panel data was analysed to further confirm these results. The panel data consisted of households that remained similar over time, that is, by construction we kept the household composition as similar as possible by limiting the following variables from changing: household head, household location, household size, and the corresponding household head characteristics of age, gender, race and marital status. Other household demographic variables such as the occupation and education levels of the household head, household spending on tobacco and cigarette consumption, income, expenditure, job information and budget shares, were left as is in order to tell us a story.

The use of our panel was to control for any heterogeneity and/or any confounding and unobservable or omitted variables that may affect changes in tobacco and cigarette consumption other than that of the tobacco control policies such as the increases in the sin taxes on cigarette consumption.

Using our panel data we also performed an additional significance test of the repeated ANOVA tests. Even though we tried to control for individual variations in our sample by restricting our panel, these and other changing demographics, may still impact our significance results. Hence a repeated ANOVA is included for robustness checks.

Additionally, the elasticity of smoking intensity using the variable 'average number of cigarettes smoked per day' with respect to sin taxes was calculated based on our panel data. This statistic was included to understand whether there was a direct impact on smoking behaviour and the health of a smoker between 2008 and 2012.

## **4. Analysis**

The study firstly analyses the cross sectional data before assessing the panel data. Similar tables and figures are constructed for both data sets for comparison. Additional data analysis on interesting demographic trends shown in the cross sectional and panel data was further assessed in sub section three.

### **4.1 Cross-sectional analysis**

The NIDS dataset offers over seven-, eight- and nine-thousand households for analyses for wave one, two and three, respectively. When weighted it represents between fourteen and sixteen million South African households.

An overview of the various groups of tobacco users shows that over 90% of households in our sample are tobacco users (Table 1). Casual smokers consist of 10% to 30% of households while regular smokers consist of 2% to 4% of households. Households with at least one regular smoker who also drinks at least once a week represent 18% to 42% of all households. These figures are overall increasing over time, although in 2010 there is a decline.

Scarily, the figures for total tobacco and alcohol consumption are consistently increasing over time. This category was included to see whether our regular smoker also enjoyed other sin goods.

Overall regular smoking households remain the smallest proportion of tobacco users, in weighted absolute terms it means that roughly half a million South Africans are regular smokers while between two and three million South Africans are casual smokers.

Casual smokers does not overlap with regular smokers except in the case of wave one where one household answered positive for both groups (see footnote 1 in the table for the question used to measure casual and regular smokers).

Finally the proportion of non-tobacco users is relatively small in the sample although there is a large increase in the proportion in wave two's sample population.

Table 1 below shows the changing numbers of various tobacco categories over time.

Table 1: Sample population and tobacco categories

	Sample population			Weight sample population		
	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3
<b>Observations</b>	7 296	8 919	9 909	14 400 683	14 080 929	15 389 729
<b>Casual Smoking</b>	1 599	966	1 275	3 281 622	2 388 931	3 058 391
<b>Regular Smoking</b>	289	136	196	511 814	458 459	491 463
<b>Total tobacco users</b>	7 151	3 642	9 713	14 152 300	2 974 774	15 028 562
<b>Total alcohol&amp; tobacco consumers</b>	1 320	2 741	4 192	2 940 743	1 025 929	3 776 624
<b>Non tobacco users</b>	145	5 277	196	248 383	11 106 155	361 167

*Notes: Number of households is restricted to households with resident household heads therefore absent heads are excluded from the sample analysis. <sup>1</sup>If at least one household member responded "Yes" to the question "Do you smoke?" <sup>2</sup>If at least one household member responded "Yes" to the question "Do you smoke regularly?" <sup>3</sup>Based on the positive response "Amount spent on cigarettes and tobacco in last 30 days" since there is no split between smoking and other tobacco usage <sup>4</sup>If at least one household member consumes both tobacco and drinks at least once a week for alcohol consumption.*

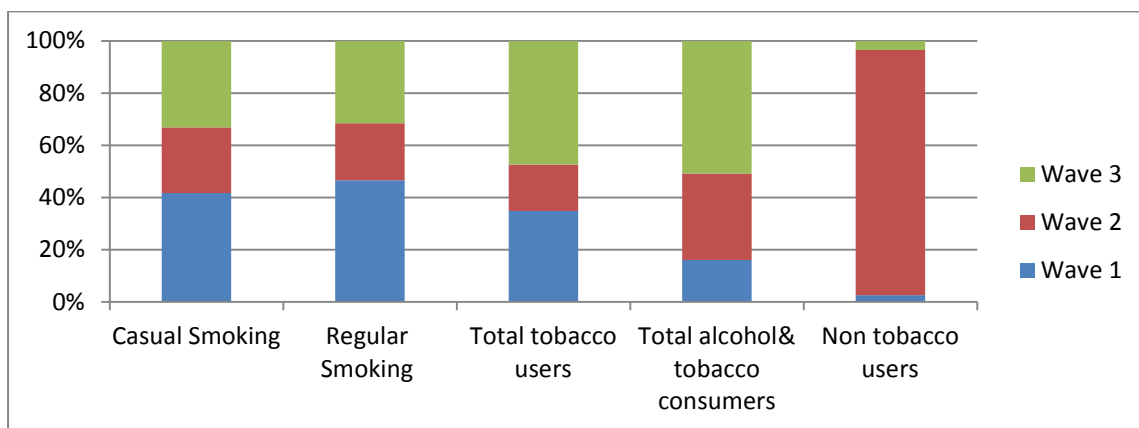
**Source:** Author's own compilation, NIDS waves 1 to 3

To evaluate whether there are any interesting changes over the sample period, analysis on our pooled dataset is conducted. Figure 1A and 1B below displays proportional changes across the tobacco categories over this time period.

Figure 1A shows that households containing regular smokers declined slightly over time. Similar trends can be seen in the households containing casual smokers. Total tobacco users, and total alcohol and tobacco users are increasing from waves one to three. Wave two has the highest proportion of non-tobacco users. The increases in the total tobacco user category and decrease in the regular (casual) smoking category suggests that smokers may be substituting cigarettes for other forms of tobacco consumption (chewing tobacco or rolling their own cigarettes) although this is not conclusive.

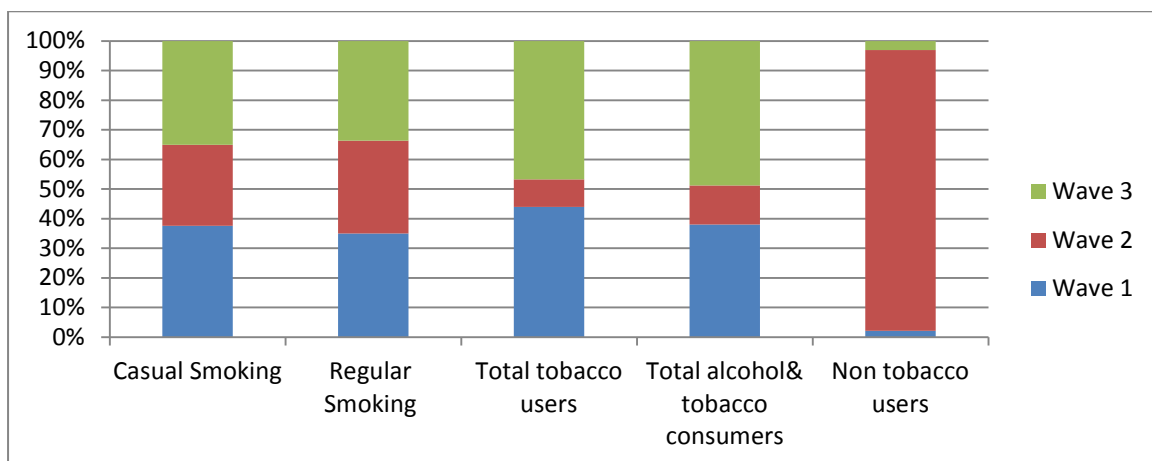
Across all categories, it can be seen that wave two has the lowest proportion of tobacco users. These results are also supported by the weighted data in Figure 1B.

Figure 1A: Proportion of tobacco categories, pooled dataset of sample households



Source: Author's own compilation, NIDS waves 1 to 3

Figure 1B: Proportion of smoking types, pooled dataset of weighted sample households



Source: Author's own compilation, NIDS waves 1 to 3

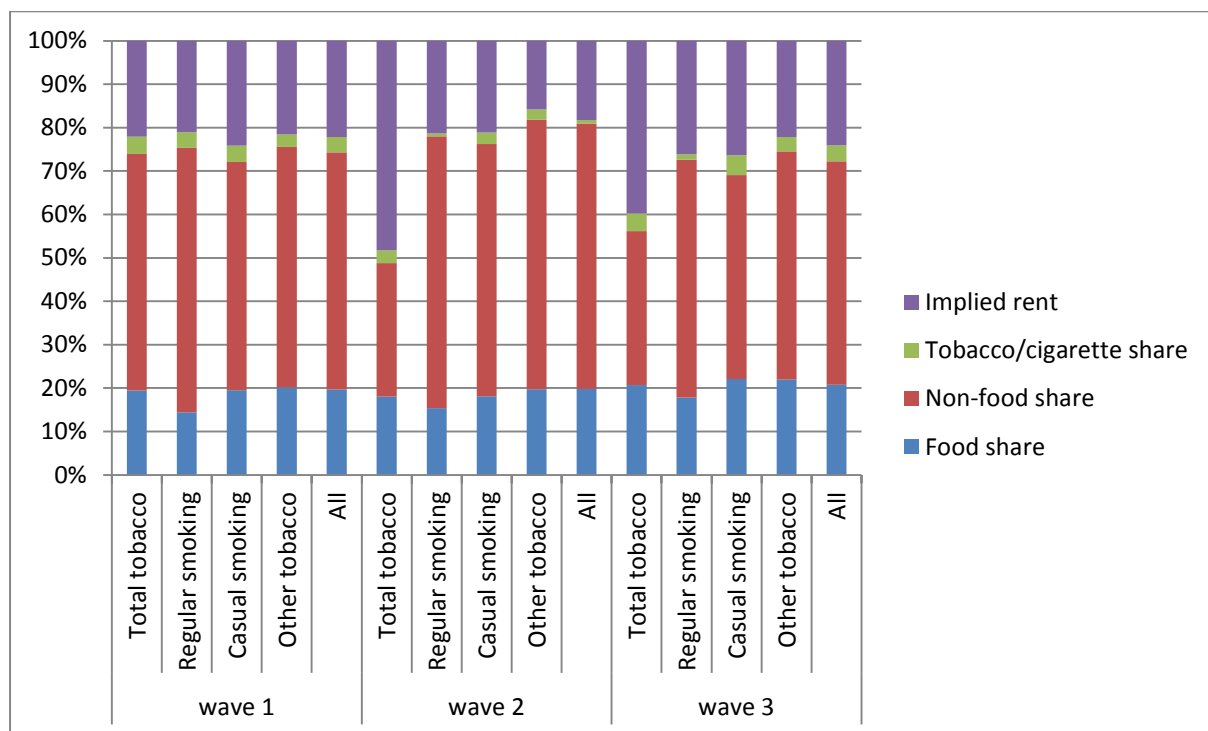


The above two figures suggest that tobacco consumption, based on the number of users in the various tobacco categories, is decreasing over time across all three samples.

A closer inspection of the budget share in Figure 2 below is investigated to see if this trend is supported in the expenditure patterns.

A category called 'other tobacco' is included in order to distinguish between spending patterns between smokers (regular and casual) from non-smoking but tobacco consuming users. The exact nature of tobacco consumption in this group is unknown.

Figure 2: Budget share of tobacco and cigarette consumption



Notes: Non-food share excludes spend on tobacco and cigarettes, as the authors have removed this from the imputed non-food expenditure data.

Source: Author's own compilation, NIDS waves 1 to 3

From Figure 2 above, the overall budget share dedicated to tobacco and cigarette spend is seen to be proportionally lower compared with the non-food, food and implied rent share. The total tobacco category displays the highest proportion of spending on tobacco followed closely by casual smoking and other tobacco users. It appears that casual smokers and other tobacco users dedicate more spending to tobacco consumption than regular smokers.

This may indicate that tobacco consumption, in the form of cigarettes, may be more costly. This again lends support for consuming tobacco in other forms such as roll your own cigarettes alternatively regular smokers may be buying cheaper brands.

Additionally, the perception of casual smokers in the sample may be skewed, that is, casual smokers may in fact be regular smokers that do not perceive themselves to be regular smokers. Then again casual smokers may also use tobacco in other forms since casual smokers do not exclude other forms of tobacco use, although regular smokers do. The 'all' category suggests that all households, except the non-users (Table 1), in the sample consume tobacco.

Looking at the budget share of non-food across the groups suggests that regular smokers may be in the higher income brackets since they display slightly higher proportions of spending on non-food items and lower proportions of expenditure on food items. To assess whether regular smokers are different from other tobacco categories, namely casual smokers and other tobacco users, the household characteristics of each of these tobacco groups are compared in Table 2. This is followed by Table 3 which helps to establish some general characteristics and consumption trends of regular smokers, casual smokers and other tobacco users.

Table 2: Household characteristics of tobacco users in cross sectional data

	Wave 1				Wave 2				Wave 3			
	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All
<b>Household head</b>												
<b>Age</b>	48	32	37	33	48	42	49	43	52	42	44	43
<b>Gender</b>	Male	Male	Female	Male	Male	Male	Female	Male	Male	Male	Female	Male/Female
<b>Education level</b>	GR 12	GR 12	GR 12	GR 12	GR 12 <sup>4</sup>	GR 12	None	GR 12	GR 12	GR 12	GR 12	GR 12
<b>Race</b>	African <sup>1</sup>	African	African	African	White <sup>5</sup>	African	African	African	African	African	African	African
<b>Marital status</b>	Married	Single	Single <sup>3</sup>	Single	Married	Single	Married	Single	Single <sup>6</sup>	Single	Single	Single
<b>Household</b>												
<b>Size</b>	3.05	2.78	4.87	3.44	3.13	2.69	5.72	3.53	2.98	2.55	4.70	3.29
<b>Location<sup>2</sup></b>	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban
<b>Average income</b>	R12 215.60	R7 676.23	R6 893.79	R6 791.88	R 16 208.71	R8136.317	R11 140.13	R9 605.42	R12 736.97	R7302.83	R8 477.33	R8 088.44
<b>Median income</b>	R4 683.53	R2 757.59	R2 232.43	R2 819.56	R11 951.22	R3683.491	R3 333.67	R3 428.89	R6 918.57	R3507.16	R3 000.00	R3 707.57

Notes: <sup>1</sup>Next highest are Whites (22%), Africans at (65%) then Coloureds (11%) and Asians (1%) <sup>2</sup>Using both 2001 and 2011 census <sup>3</sup>Single (35.66%) is closely followed by married (33.76%) <sup>4</sup>Matriculants (18.96%) is closely followed by those with matric and a post-secondary school certificate (16.71%) <sup>5</sup>White (40.96%) is closely followed by African (39.88%) <sup>6</sup>Single (39.44%) closely followed by married (38.15%)

Table 3: Tobacco user profiles in cross sectional data

	Wave 1				Wave 2				Wave 3			
	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All
<b>Average age</b>	41	30	32	29	48	40	35	36	48	41	37	32
<b>Average age smoker/s began</b>	17	16	NA	16	17	15	NA	16	17	17	NA	17
<b>Relationship to head</b>	Head	Head	Head	Head	Head	Head	Children	Head	Head	Head	Head	Head
<b>Education level</b>	GR 10	GR 12	GR 12	GR 12	GR 12	GR 12	GR 12	GR 12	GR 12	GR 12	GR 12	GR 12
<b>Occupation<sup>1</sup></b>	Professional /Crafts <sup>2</sup>	Crafts	Professional	Elementary	Services	Elementary	Elementary	Elementary	Plant & machine <sup>3</sup>	Elementary	Elementary	Elementary
<b>Average spent in last 30 days on tobacco and cigarettes</b>	R379.45	R219.03	R151.16	R221.26	R111.81	R177.48	R206.97	R250.56	R121.22	R237.85	R157.29	R223.83
<b>Average no. of cigarettes smoked per day</b>	8.5	7.5	NA	7.73	10.7	8.47	NA	10	10.93	8.03	NA	8.56

Notes: <sup>1</sup>Primary occupation code <sup>2</sup>Both occupations (Professionals 19.02%, Crafts/related trades workers 18.98%) consist of 19% each of regular smokers followed by Plant and machinery operators (16.54%) <sup>3</sup>Plant and machinery operators (23.39%) is closely followed by Clerics (22.67%) and Elementary occupations (21.26%)

Tobacco users in the sample are between the ages of 30 and 55 years old with casual smokers being the youngest tobacco users, on average. Casual smokers also tend to have smaller households followed by regular smokers. Other tobacco users have larger households, on average, ranging between 5 and 6 persons. These households are also typically headed by females. Finally, trends in the household incomes of the various tobacco users show that regular smokers are indeed, both on average and according to the median, richer than the other groups. This is in line with the claims made earlier based on Figure 2.

Table 3 shows the tobacco user profile in the sample. The average tobacco user is typically the head of the household between the ages of 30 and 50, similar to the age findings from Table 2, with the youngest being 29 years old. The average tobacco user also started smoking in high school (around 15 and 17 years old) and has matriculated. Differences in the tobacco user's profile can be seen in the occupations which, on average, differ between regular smoking households and the remaining tobacco categories. This implies that regular smokers are usually more skilled which could explain the higher monthly incomes of this group. Other users are typically found in the elementary occupations which typically require lower skills.

The last two variables are our variables of interest which we use as our measures to determine whether changes in consumption trends of tobacco and cigarettes have occurred between 2008 and 2012. From Table 3, we can see that the overall spending on all tobacco increased from just over R220 to R250 and back down to just over R220 again. The main drivers of this consumption increase are tobacco users from the other tobacco user group. This group increased their spending by over R50 from wave one to wave two but returns to the R150 amount in wave three. The remaining tobacco categories have a general decrease in spending; with regular smokers decreasing over 50% of their expenditure from wave one to wave two, but recovering slightly in wave three.

These expenditure trends based on Figure 2 and Table 3 suggest that wave two differs from the other waves' tobacco consumption trend. This is hardly surprising since two global events occurred during this time, namely the global financial crisis of 2007/8 and South Africa's hosting of the 2010 FIFA Soccer World Cup. Also, the effects of the Tobacco Control Product Acts implemented in 2008, that of increasing the legal

smoking age to 18 years, limiting advertising of tobacco companies and increasing the health warnings, may have only been fully felt two years later.

The increase in overall tobacco expenditure from Table 3 for the other tobacco user group and the decrease in both smoking groups from wave one to two suggest that both smokers may have switched to other forms of tobacco consumption in 2010. This trend seemingly reverses in wave three. Alternatively, it is possible that other tobacco consumption forms became more popular during 2010, perhaps caused by the 2010 FIFA Soccer World Cup. For example, there may have been an increase in the “roll-your-own” cigarettes (Van Walbeek, 2003 and Wherry *et al.*, 2014) as a cheaper alternative to buying a box of cigarettes. Moreover in light of the sporting festivities in the country during 2010, there could have been an increase in recreational and social smoking through the use of the water pipe (commonly known as the “hubbly bubbly”, “hookah”, “Shisha” or “Goza”).

Analysing the smoking intensity, which is represented by the average number of cigarettes smoked per day, also suggests that there were changes in cigarette smoking patterns. We see that smokers increased the number of cigarettes they smoked per day in 2010 from 2008 but decline from 2010 to 2012. Regular smokers have increased their smoking intensity over time compared with casual smokers. The increasing and subsequent decreasing trend of casual smoking may be due to the two global 2010 events and full effects of tobacco control policies implemented in 2008, although the causes of the direction of change (increase/decrease of cigarettes smoked) may be positive (World Cup, tobacco controls) or negative (global financial crisis, tobacco controls).

The increase in the smoking intensity of regular smokers suggests that factors driving smoking may have been increased. These factors could include work-related stress or anxiety related to job loss due to the adverse economic situation brought about by the 2007/2008 global financial crisis. These factors could have very likely affected regular smokers since regular smokers are typically higher skilled workers. While the analysis here is highly speculative in nature, it can be observed that there is something different with regards to wave two tobacco consumption patterns.

Another possibility is that both regular and casual smokers may have switched to cheaper brands and thus can afford to smoke more cigarettes per day.

Moreover, the average regular smoker may have preferred or adjusted to the cheaper brand and therefore, continued with this increase in cigarettes smoked per day into wave three.

The results in Table 3 suggest that trends in tobacco consumption may be changing over time although we cannot be sure if it is changing because the samples in each wave are characteristically different or because it is changing over time for consumption-related reasons. Hence, a true panel analysis is included in order to control for the changes in the sample population over time which may cause different consumption patterns to arise. A true panel analysis also controls for other heterogeneous variables that may account for changing trends, for example changing household compositions. The true panel controls for changing household composition by including only households that have remained similar over time (see Data and methodology for details).

#### **4.2 Panel data analysis**

The aim of this section is to analyse whether there are any changing trends in tobacco consumption in the same household over time. By construction households forming the panel have the same household head and therefore, uniform household head characteristics that is, the household head's age, gender, race and marital status are consistent over time. Furthermore, the size and location of the household also did not change over time. The panel was kept as 'true' as possible in order to attribute changes in spending on tobacco and cigarettes to changes in the tobacco control policies other than changing household characteristics. Although household characteristics are as stable as possible, other factors such as income, occupation and increases in sin taxes are all factors which could contribute to the changes in tobacco consumption trends. This paper does not test the determinants of tobacco consumption but merely analyses whether consumption trends of tobacco have changed over time.

Table 4: Sample population and tobacco categories

	Sample population			Weight sample population		
	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3
<b>Observations</b>	504	504	504	1 112 680	1 712 998	1 715 512
<b>Casual Smoking</b>	142	106	131	377 644	566 488	576 584
<b>Regular Smoking</b>	23	17	19	39 986	51 704	108 769
<b>Total tobacco users</b>	495	104	493	1 085 177	444 052	1 679 796
<b>Total alcohol&amp; tobacco consumers</b>	76	35	99	175 522	167 788	375 494
<b>Non tobacco users</b>	9	400	11	27 502	1 268 946	35 716

*Notes: Number of households is restricted to households with resident household heads therefore absent heads are excluded from the sample analysis. <sup>1</sup>If at least one household member responded "Yes" to the question "Do you smoke?" <sup>2</sup>If at least one household member responded "Yes" to the question "Do you smoke regularly?" <sup>3</sup>Based on the positive response "Amount spent on cigarettes and tobacco in last 30 days" since there is no split between smoking and other tobacco usage <sup>4</sup>If at least one household member consumes both tobacco and drinks at least once a week for alcohol consumption.*

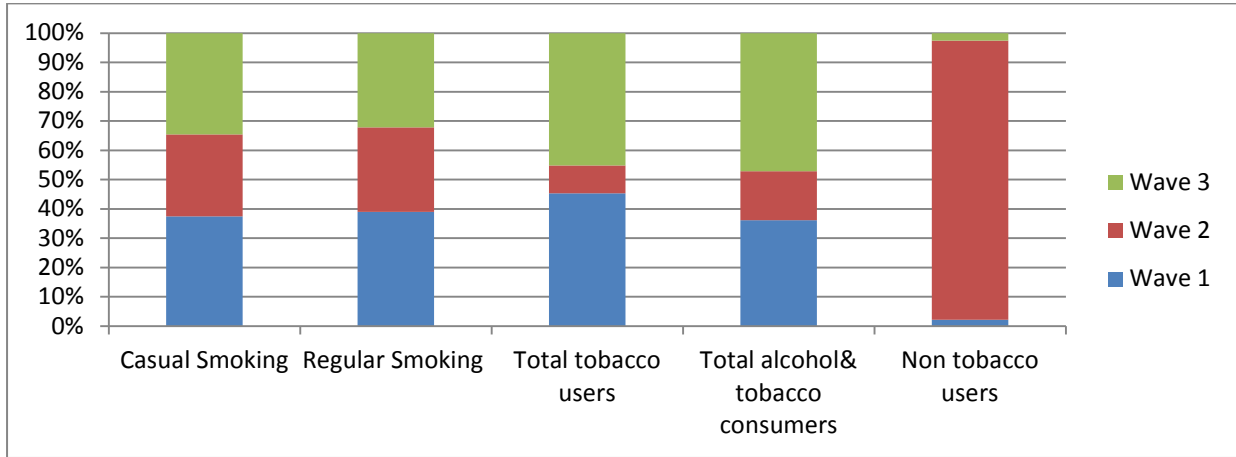
**Source:** Author's own compilation, NIDS waves 1 to 3

Our sample consists of 504 households which is representative of between one and two million households in South Africa. Again, we can observe that regular smokers are the smallest group of tobacco users relative to casual smokers. The total number of tobacco users is almost the entire sample. Similar to the cross-sectional analysis, the number of tobacco users in wave two declines but recovers in wave three.

Looking at the changes in the proportion of the various tobacco categories, Figure 3A shows slight declines in the proportion of both casual and regular smoking households while the proportion of total tobacco and alcohol users increases between 2008 and 2012. The proportion of total tobacco users is again at its smallest in 2010 which is similar to the cross sectional findings.



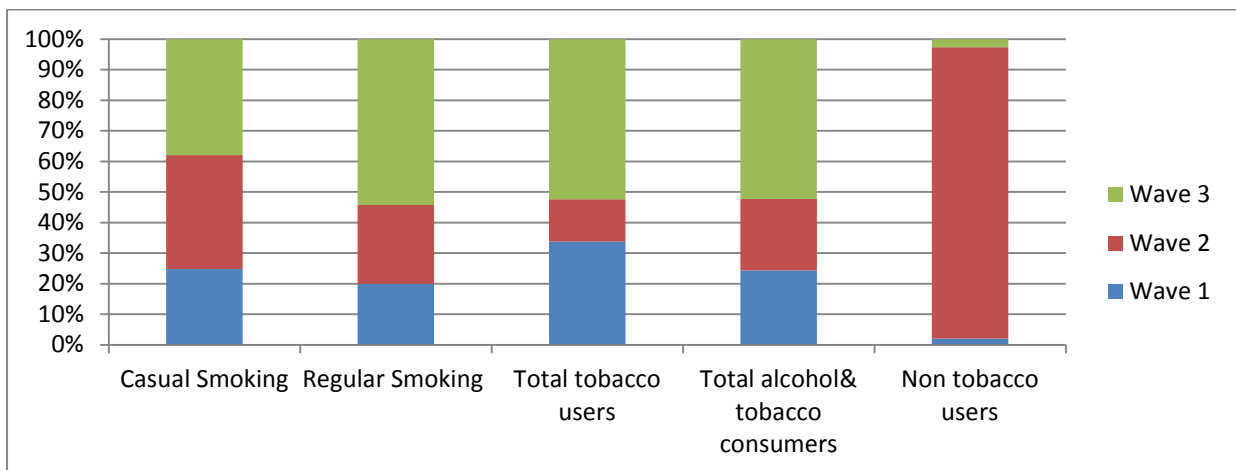
Figure 3A: Proportion of tobacco categories, pooled dataset of sample households



Source: Author's own compilation, NIDS waves 1 to 3

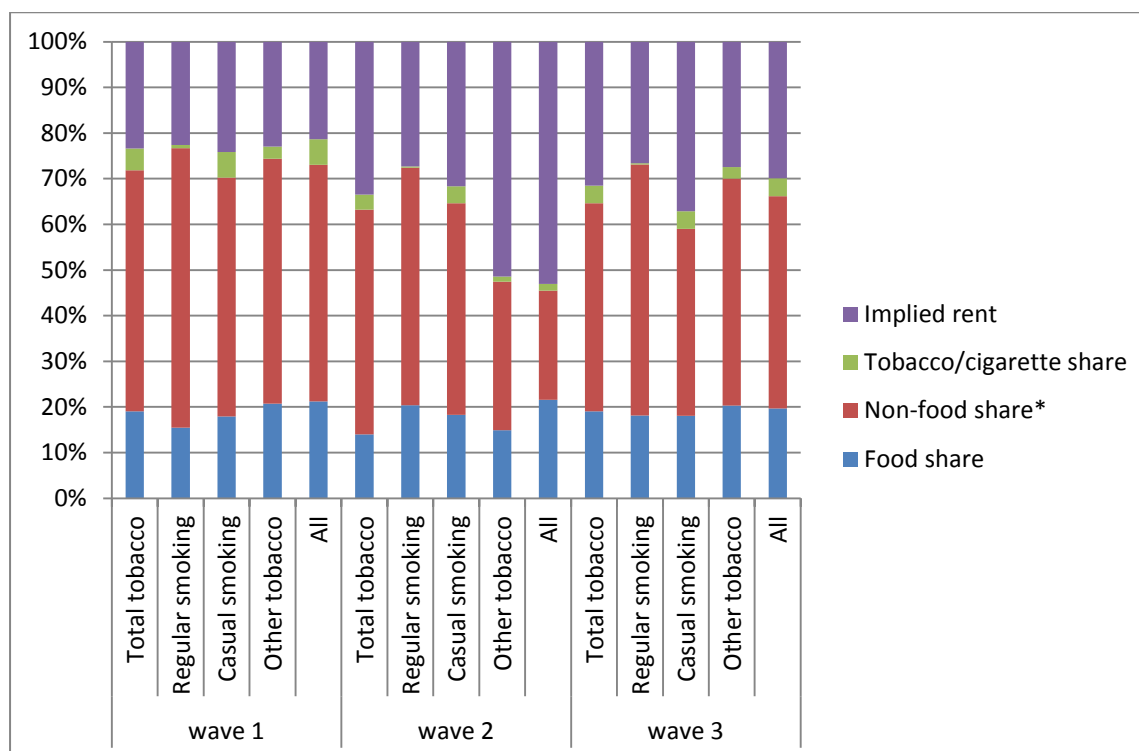
However, the trends in Figure 3A do not appear to be supported by the weighted data in Figure 3B. In Figure 3B, the proportion of smokers appears to be showing the opposite trend where the number of smokers is increasing over time. This increasing trend can also be observed in the other tobacco groups.

Figure 3B: Proportion of smoking types, pooled dataset of weighted sample households



Source: Author's own compilation, NIDS waves 1 to 3

Figure 4: Budget share of tobacco and cigarette consumption



Source: Author's own compilation, NIDS waves 1 to 3

The budget share shows similar trends to the cross-sectional data where a decrease in the budget share spent on tobacco and cigarettes is observed from wave one to wave two, but then recovers in wave three. On average, regular smokers spend less on tobacco compared with casual smokers and other tobacco users. This implies that the total tobacco users' spending patterns are mainly driven by casual smokers and the other tobacco group. Furthermore, regular smokers appear to spend less and less over time. Their food and non-food shares, however, suggest that they can be found in the higher income group.

Budget shares in wave two again suggest that there is a general decline in the year 2010, similar to the cross-sectional findings. However, the trends in wave two show that implied rent takes up a larger proportion of the budget relative to the food and non-food share, especially in households that consume tobacco but do not smoke it.

We look next at the demographic characteristics of the household to understand the general make-up of our tobacco users in our panel and their tobacco consumption behaviour.

Table 5: Household characteristics of tobacco users in panel data

	Wave 1				Wave 2				Wave 3			
	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All
<i>Household head</i>												
<b>Age</b>	50	40	47	41	49	41	48	43	57	44	47	45
<b>Gender</b>	Male	Male	Male	Male	Female	Male	Female	Male	Male	Male	Female	Male
<b>Education level</b>	GR 12	GR 12	GR 12	GR 12	GR 12	GR 12	NTC3	GR 12	GR 10	GR 12	GR 12	GR 12
<b>Race</b>	African	African	African	African	White	African	African	African	White	African	African	African
<b>Marital status</b>	Married	Single	Married	Single	Single	Single	Married	Single	Single	Single	Married	Single
<i>Household</i>												
<b>Size</b>	1.82	1.39	3.83	1.88	1.88	1.40	3.97	1.77	1.52	1.37	3.56	1.73
<b>Location</b>	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban
<b>Average income</b>	R 11 001.43	R5 369.82	R9 411.26	R6 117.44	R7 037.65	R10 065.54	R8 271.90	R15 914.01	R 15 711.28	R9 870.88	R10 527.63	R9 401.40
<b>Median income</b>	R9 320.84	R2 296.63	R3 009.77	R2 615.73	R4 791.98	R3 969	R2 793.09	R3 816.03	R7 659.32	R3 507.16	R4 335.39	R4 000.00

*Source:* Author's own compilation, NIDS waves 1 to 3

Table 6: Tobacco user profiles in panel data

	Wave 1				Wave 2				Wave 3			
	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All	Regular smoking	Casual smoking	Other tobacco	All
<b>Average age</b>	58	30	40	41	18	48	41	36	60	32	44	45
<b>Average age smoker/s began</b>	19	17	NA	17	17	15	NA	12	18	16	NA	16
<b>Relationship to head</b>	Head	Head	Head	Head	Head	Head	Spouse	Head	Head	Head	Head	Head
<b>Education level</b>	GR 12	GR 12	GR 12	GR 12	GR 10	GR 12	GR 12	GR 12	GR 10	GR 12	GR 12	GR 12
<b>Occupation</b>	Crafts	Elementary	Professionals	Elementary	Elementary	Elementary	Plant and machinery	Elementary	Plant and machinery	Elementary	Elementary	Elementary
<b>Average spent in last 30 days on tobacco and cigarettes</b>	R86.56	R260.49	R110.77	R258.69	R23.98	R258.75	R92.06	R84.51	R20.35	R243.87	R133.66	R228.07
<b>Average no. of cigarettes smoked per day</b>	5.92	7.3	NA	7.49	10.7	10.62	NA	8.74	18.35	9.61	NA	11.17

*Source:* Author's own compilation, NIDS waves 1 to 3

Household demographics in our panel show, on average, an older sample population with the head of the household ranging between the ages of 40 and 50 years old. Household size in our panel is also different from our cross sectional data, being smaller in size. Aside from these two main differences, similar patterns for cross sectional data can be seen in our panel. For example, the household size of the other tobacco user group is still the largest compared with regular and casual smokers, and regular smokers average and median income still suggest that this group can be found in the higher income brackets.

The profile of tobacco users in the panel shows some differences compared with our cross sectional data. Firstly, the age of our panel smokers varies a lot more with ages ranging between 18 and 60 years old. Secondly, changes in expenditure on tobacco and cigarettes are much lower compared with our regular smokers in the cross section. Casual smokers still appear to spend more although there is an overall decrease in spending on these items over time. Thirdly, the average number of cigarettes smoked is much higher in the panel compared with the cross sectional data. Regular smokers show the greatest increase from smoking just over a quarter of a box in 2008, to half a box in 2010 and to almost a full box in 2012. Casual smokers on the other hand remain consistent, although slightly higher by 1.5 cigarettes per day, with our cross sectional findings.

The huge increase in average number of cigarettes smoked per day for our regular smokers could suggest a lot more stress experienced by this group of users. Alternatively, regular smokers may have a higher addiction to nicotine or are better able to substitute for cheaper cigarette brands. Again, our suggestions are speculative.

The interesting demographic trends observed from both our cross sectional and panel data suggest that further analysis is required. The variables of interest are namely the ages and gender of our household heads and various tobacco users, their occupations and monthly income. Other demographic variables that could present relevant trends are race and marital status. To evaluate whether these variables could highlight richer profile information on tobacco users in South Africa, sub section three investigates these variables separately below.

### **4.3 Additional demographic analysis**

To be inserted

## **5. Results**

To understand whether tobacco consumption has changed over time, we significance test our two hypotheses mentioned in section 3. We first test the significance of the changing trends over time by using a paired t-test in sub section 1. This is followed by our repeated ANOVA tests in sub section 2. Finally we assess the elasticity of smoking intensity with respect to sin tax percent changes in sub section 3 to observe any significant impacts on smoking behaviour and health. All values are log transformed for normality. A correlation of our two main variables of interest was also performed and is included in the Appendix: Table 10 and 11.

### **5.1 Paired t-tests**

We utilise the paired t-test with a two-tailed t-test distribution since our true panel has the same sample sizes and we do not limit the direction (positive or negative) of change in the consumption patterns of tobacco in households. The significance level is therefore 2.5% equivalently 97.5% confidence levels.

A household is considered to change tobacco consumption if the expenditure values are different from wave one. That is wave one's mean average spending and average cigarettes smoked values is the benchmark. This is tested for waves two and one, waves three and one, and similarly for waves three and two, where wave two's means are the benchmark values.

Table 7 below displays the results of our t-tests over time.

Table 7: T-test significance of tobacco consumption trends

		2008	2010	2012
	Observations	504	504	504
<b>Average spent in the last 30 days on cigarettes and tobacco</b>	Mean	4.67	5.11*** (18.68)	4.89*** (26.27) [21.69]
	Standard deviation	1.37	1.32	1.16
	Variance	1.87	1.75	1.34
<b>Average number of cigarettes smoked per day</b>	Mean	1.92	2.07*** (24.44)	2.15*** (20.33) [20.93]
	Standard deviation	0.74	0.86	0.80
	Variance	0.55	0.73	0.63

*Notes: Numbers in round parentheses are t-statistics compared with 2008, for example, 18.68 is the t-statistic between 2008 and 2010 changes in mean expenditure. Square parentheses show the t-statistic of 2012 compared with 2008. \*\*\*1% significance level.*

**Source:** Author's own compilation, NIDS waves 1 to 3

It can be seen that both variables' changes are significantly different from the initial benchmark values in 2008. This implies that the changes in expenditure and average number of cigarettes smoked over time have been impacted by the tobacco control policies. All t statistics are significant at the 1% level. We therefore accept both alternative hypotheses of HA1 and HA2.

To ensure that these significant changes are robust, that is they can be attributed to the tobacco control policies and not to other individual characteristics which we have attempted to control, we look at our repeated ANOVA tests.

## 5.2 Repeated ANOVA

Since our panel has three separate time recordings of the expenditure and average number of cigarettes smoked per day, we can test whether two out of the three means are statistically significantly different from each other. This test is more robust as it accounts for any individual variation in the data, that is, it controls for individual spending and smoking behaviour by taking out the variation in the means caused by each households spending and smoking trends.

Table 8: Repeated ANOVA measures

		Average spent in last 30 days on cigarettes and tobacco	Average number of cigarettes smoked per day	
<b>Observations</b>	N	504	504	<b>Degrees of freedom</b>
<b>Sum of squares</b>	Time	55.90748091	3.37560781	2
	Subjects	5824.661299	1326.200229	503
	Error	-4567.489179	-1010.222309	505
<b>Mean squares</b>	Time	27.95374045	1.687803905	
	Error	-4.540247692	-1.004197126	
<b>F stat</b>	<b>F(2, 503)</b>	<b>-6.156875648</b>	<b>-1.680749588</b>	
<b>Significance</b>		1% level	25% level	

*Source:* Author's own compilation, NIDS waves 1 to 3

Our F statistic shows that the average household spend on cigarettes and tobacco is statistically significantly different over time, whether it is from wave one to three, wave one to two or wave two to three is not known. The results do however suggest that there are significant changes to the spending patterns over time and that this can be attributed to the tobacco control policies and not to any variation in individual spending habits.

The F statistic for the average number of cigarettes smoked per day however does not show any significance over time. This suggests that individual smoking behaviour is partially contributing to the changes in smoking patterns. It therefore does not support the t statistics results of significant changes over time. Hence, both tobacco control policies and individual smoking behaviour is influencing the number of cigarettes our household smokes on average per day. We therefore accept HA2 at the 1% level but reject HA1 at the 25% significance level.

To understand whether smoking intensity is directly correlated with sin tax changes we determine the elasticity of smoking intensity with respect to percent changes in cigarette sin taxes in the below section.

### 5.3 Elasticity of smoking intensity with respect to percent changes in cigarette sin taxes

We determine the elasticity of smoking intensity using the variable average number of cigarettes smoked per day with respect to the percentage changes in cigarette sin taxes with the corresponding years in our sample.



Table 9: Elasticity of smoking intensity

	Wave 1 to 2	Wave 2 to 3
<b>% change in average no. of cigarettes smoked per day</b>	0.15	0.04
<b>% change in sin taxes</b>	0.88	-0.53
<b>Elasticity</b>	0.17	0.07*** (22.46)

Notes: \*\*\*1% significance level.

*Source:* Author's own compilation, NIDS waves 1 to 3

Our results indicate that there is a positive correlation between percent changes in sin taxes and percent changes in average number of cigarettes smoked per day. This implies that if sin taxes increased then average cigarettes smoked per day would also increase. The results suggest that our regular smokers may suffer huge health costs due to the increase in sin taxes, although these results may also be due to individual smoking behaviour. However, overall the positive correlation between sin taxes and smoking behaviour has crucial implications for the health of smokers in South Africa.

## 6. Summary of findings

A summary of our findings from both cross sectional and panel data sets, as well as our tests of significance and elasticity, show that there are various groups of tobacco users, there are demographic differences across our user groups, and there are significant changes in spending patterns on tobacco and cigarettes from 2008 to 2012.

From our cross sectional data, we observe that households who consume tobacco consist of over 90% of our sample. Furthermore, households who reported themselves to be regular or casual smokers were typically headed by males while households who identified itself as other tobacco user were headed by females. Overall, across all tobacco user groups, household heads were found to be between the ages of 30 and 50, started smoking in high school, has a matric, lives in urban areas and were typically married.

The prevalence of smoking and tobacco use from our data sets describes the decrease in overall smoking prevalence in our cross section, although there is an increase in our total tobacco users which is attributed to our other tobacco users.

There is, in general, an overall decrease from 2008 compared with 2012 of 4.3% of regular smokers, 6.71% of casual smokers while a rise in total (other) tobacco users of 6.22% occurred. When comparing this to the estimated total number of South African households, there is an overall decrease across the various tobacco categories. The highest decline are casual smokers (15.5% decrease) followed by regular smokers (12.88% decrease) and total (other) tobacco users (3.7% decrease).

Table 10: Prevalence rates of tobacco usage across tobacco groups

	2008	2010	2012	% change: w1 to w2	% change: w2 to w3	% change: w1 to w3
<b>Population (millions)</b>	49.56	50.9	52.27	2.70%	2.69%	<b>5.47%</b>
<b>Household population estimate*</b>	14.41	14.42	15.89	0.09%	10.18%	<b>10.28%</b>
<b>Average household size estimates*</b>	3.44	3.53	3.29	2.62%	-6.80%	<b>-4.36%</b>
<b>Cross Section (millions)</b>						
<b>Number of households</b>	14.40	14.08	15.39	-2.22%	9.30%	<b>6.88%</b>
<b>Regular smokers</b>	0.51	0.46	0.49	-10.16%	6.52%	<b>-4.30%</b>
<b>Casual smokers</b>	3.28	2.39	3.06	-27.13%	28.03%	<b>-6.71%</b>
<b>Total tobacco users</b>	14.15	2.97	15.03	-79.01%	406.06%	<b>6.22%</b>
<b>% of SA population</b>						
<b>regular smokers</b>	3.55%	3.18%	3.09%	-10.45%	-2.71%	<b>-12.88%</b>
<b>casual</b>	22.77%	16.56%	19.24%	-27.28%	16.21%	<b>-15.50%</b>
<b>total tobacco</b>	98.21%	20.62%	94.58%	-79.00%	358.57%	<b>-3.70%</b>
<b>Panel (millions)</b>						
<b>Number of households</b>	1.11	1.71	1.72	54.05%	0.58%	<b>54.95%</b>
<b>Average household size</b>	1.88	1.77	1.73	-5.85%	-2.26%	<b>-7.98%</b>
<b>Regular smokers</b>	0.04	0.05	0.11	25.00%	120.00%	<b>175.00%</b>
<b>Casual smokers</b>	0.38	0.57	0.58	50.00%	1.75%	<b>52.63%</b>
<b>Total tobacco users</b>	1.09	0.44	1.68	-59.63%	281.82%	<b>54.13%</b>
<b>% of SA population</b>						
<b>regular smokers</b>	3.60%	2.92%	6.40%	-18.86%	118.72%	<b>77.47%</b>
<b>casual</b>	34.23%	33.33%	33.72%	-2.63%	1.16%	<b>-1.50%</b>
<b>total tobacco</b>	98.20%	25.73%	97.67%	-73.80%	279.60%	<b>-0.53%</b>

\*Estimates based on dividing population estimates from the World Bank by average household size in our weighted cross sectional data.

Our panel data on the other hand does not describe the same trends in tobacco prevalence rates.

In fact, there is an increase of tobacco usage across our various categories. Regular smokers increased by the highest amount. According to our weighted sample, regular smokers increased by 175% while casual smokers and total (other) tobacco users increased by over 50% from 2008 compared with 2012. When comparing these figures to the total household population in South Africa, the proportional changes are less dramatic however it still shows that regular smokers have increased by a lot 77% while casual and total (other) tobacco users have declined.

Regular smokers appeared to be characteristically different as suggested by their average and median incomes and occupation. They were observed to be in higher income groups and were highly skilled compared with the other user groups.

Other tobacco users also differed in that their household sizes were much larger (4 to 6 persons) compared with regular and casual smoker households (2 to 4 persons). Casual smokers were observed to spend more on cigarettes and tobacco over time. Overall, the study noticed that wave two data was uniquely different from waves one and three.

From our panel data, we observe similar demographic trends namely households who were smokers were headed by males while households who were other tobacco users were headed by females. Our household heads also began smoking in high school, has a matric, lives in urban areas and were typically married. The ages of our household head however varied a lot more ranging between 18 and 60 years old. Household sizes were also found to be much smaller in our panel, on average between one to two persons, with our other tobacco users having the largest household size compared with regular and casual smokers (3 to 4 persons). It was again observed that wave two data was uniquely different from waves one and three.

The decreasing patterns in average expenditure on tobacco and cigarettes suggest that household tobacco consumption behaviour was significantly impacted by the tobacco control policies, and although the trends were decreasing overall wave two suggests that there is something more to 2010 that needs deeper analysis. The tobacco control policies did not however appear to impact smoking behaviour but seemed to increase the average number of cigarettes smoked per day in the household.

This positive correlation between sin taxes and cigarettes smoked per day suggests that the health of our smokers may be compromised. This is another issue that our data highlights which requires further investigation.

Finally the proportional changes in the number of smokers and users over time across both cross sectional and panel data, coupled with the changes in expenditure data suggest that tobacco control policies may have a distorting effect on our tobacco users by reshuffling them into other user groups. For example, regular smokers may change their self-reported status to casual smokers or consume tobacco in other ways. Similarly casual smokers could also change to other tobacco users (Figure 1 and 3). This reshuffling effect of cigarette sin taxes could imply there is mobility in changing tobacco user groups (with implications into addiction and behaviour) and that there may be various methods of tobacco consumption which could be complementary or substitutable.

## **7. Conclusion**

The aim of this study was to understand whether there were any trends in household tobacco and cigarette consumption patterns over time. It contributes to the tobacco literature by analysing changes in tobacco and cigarette consumption at the household-level, adding to analyses conducted at the firm-level, and sin taxes and government level.

Using a series of non-regression techniques, the study investigated various demographic and consumption trends in the NIDS data sets of waves one, two and three. The study looked at both cross sectional and panel data estimates of households that consumed cigarettes and tobacco. The demographic trends provided a generalised profile of South African tobacco users and user groups namely regular smokers, casual smokers and other tobacco users. The consumption patterns on the other hand provided details on any significant changes in spending and smoking behaviour over time. Using these two variables we formulated our hypotheses and tested our expectations.

Both the cross-sectional and panel data showed that there was a decline in the spending and smoking trends of tobacco and cigarettes in 2010 from 2008. This trend increased in 2012, although not to the original levels of 2008. The change in spending was statistically significant over time however changes in smoking behaviour were not.

Although the study attempted to control for confounding and omitted variables, it was limited by the fact that it did not control for the consumption variations in 2010 which may be caused by the global financial crisis of 2007/8 and/or the FIFA Soccer World Cup.

Our study suggests that further research should be conducted in understanding what the predictors of household tobacco usage are and the determinants of households who are regular smokers, casual smokers and other tobacco users. Furthermore, investigation into the direct effects of cigarette sin taxes and smoking behaviour that is smoking intensity on health is another interesting area our study highlighted. Finally, the reshuffling effect of sin taxes that is for example, of moving regular smoker to casual smoker status is also another area of research that could show various consumption methods of tobacco and mobility of tobacco usage (addictive behaviour) and status among households.

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## Appendix

Table 11: Correlation of log of average spent in last 30 days on cigarettes and tobacco

	<b>Log cigarette spend 2008</b>	<b>Log cigarette spend 2010</b>	<b>Log cigarette spend 2012</b>
<b>Log cigarette spend 2008</b>	1		
<b>Log cigarette spend 2010</b>	0.6143	1	
<b>Log cigarette spend 2012</b>	0.6876	0.6989	1

*Source:* Author's own compilation, NIDS waves 1 to 3

Table 12: Correlation of log of average cigarettes smoked per day

	<b>Log cigarette smoked 2008</b>	<b>Log cigarette smoked 2010</b>	<b>Log cigarette smoked 2012</b>
<b>Log cigarette smoked 2008</b>	1		
<b>Log cigarette smoked 2010</b>	0.5821	1	
<b>Log cigarette smoked 2012</b>	0.4343	0.5306	1

*Source:* Author's own compilation, NIDS waves 1 to 3