**Effect of UK plain tobacco packaging and minimum pack size legislation on tobacco and nicotine product switching behaviour**

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**ABSTRACT**

**Background and aims:** The introduction of plain tobacco packaging and minimum pack size legislation in the United Kingdom between May 2016 and May 2017 was accompanied by substantial changes in tobacco product diversity and pricing. This study investigates the extent to which these changes were associated with consumer switching between tobacco product types and price segments, and from tobacco to non-tobacco nicotine products.

**Design:** Longitudinal study (changing trends in product and price choices) and survey (reasons for consumer choices).

**Setting:** Great Britain

**Participants:** We used 11,695 British households from Kantar Worldpanel who purchased tobacco and non-tobacco nicotine products from March 2011 to December 2017.

**Measurements:** Product choice was defined using household's monthly purchases of tobacco (cigarettes, roll-your-own (RYO) tobacco, cigar/cigarillo and pipe tobacco) and non-tobacco nicotine products (e-cigarettes and nicotine replacement therapy), while price was defined using price paid by pack size and by price quartiles. Our switching analysis considered three switching alternatives: switching to a different tobacco product or to a combination of tobacco products, switching to any non-nicotine tobacco product, and switching out of our dataset. We explored changes in price quartile purchasing behaviour using binary variables for whether a household purchased or not from each price quartile monthly. Finally, self-declared consumer's choice was assessed through survey responses.

**Findings:** The introduction of plain packaging and minimum pack sizes coincided with increased purchasing of pack sizes of 20 cigarettes or 30g RYO tobacco (accounting for 99% of purchases by January 2017) and a decreased in price paid for cigarettes. During the first 6 months of implementation the likelihood that cigarette smokers would switch to non-tobacco nicotine almost doubled compared to the period before the policy was implemented (OR 1.74, 95% CI: 1.18 to 2.57), predominantly to e-cigarettes. Survey results suggest that price was the main driver of changes in purchasing behaviour.

**Conclusions:** Implementation of plain packaging and minimum pack size legislation in the UK appears to be associated with tobacco users switching to lower price tobacco products and to e-cigarettes.

**INTRODUCTION**

In 2016 the United Kingdom (UK) government implemented legislation requiring all tobacco products to be sold in plain packs containing a minimum of 20 cigarettes or 30g of roll-your-own (RYO) tobacco [1]. The aim of the legislation, which was passed by the UK parliament in 2015 and included a 12-month transition period during which retailers were permitted to continue to sell branded stocks, was to reduce uptake of smoking among young people and encourage quitting among established smokers [2]. We have previously reported that the introduction of this legislation was associated with an increase in the price of cigarettes and RYO tobacco, a decrease in cigarette sales and an increase in sales of RYO tobacco [3].

This finding was consistent with earlier research indicating that increases in cigarette prices are associated with downtrading to cheaper cigarettes [4] and increases in RYO use [5]. Evidence from the introduction of plain packaging in Australia suggests that the policy led to price increases, to which smokers responded by increasing the consumption of value brands [6]. It is not clear however whether plain tobacco packaging and associated market changes cause smokers to switch to non-tobacco nicotine products such as electronic cigarettes. Using longitudinal commercial data on household purchases of tobacco product, this study aims to study the effect of UK plain packaging and minimum pack size legislation on consumer's switching behaviour, comparing trends in household tobacco and non-tobacco nicotine product purchases before, during and after the introduction of plain packaging in the UK; estimating changes in the likelihood of switching to a different tobacco product, to non-nicotine tobacco products and to different tobacco price segments; and explore consumer's choices after changes in product availability associated with implementation of plain packaging.

## METHODS

### *Data sources and research design*

We used Kantar Worldpanel (KWP) data from March 2011 to December 2017. KWP is a longitudinal panel of approximately 30,000 households recruited using stratified sampling to be representative of the population of Great Britain in relation to region, household size, age of main shopper and socioeconomic status, who use barcode scanners to scan receipts for all online and off-line purchases brought into the home (non-barcode purchases can also be included) [7]. More details of the dataset have been provided elsewhere [8, 9]. For this study we had access to the 11,695 households who provided data indicating that they had purchased cigarettes, RYO tobacco, cigars/cigarillos and pipe tobacco, electronic cigarettes (e-cigarettes) and nicotine replacement therapy (NRT). From these data, we explored aggregated household purchases, and price trends by month, and then estimated policy effects on product switching and purchases within product price quartiles. Ethics approval was not required to obtain nor use Kantar Worldpanel data. Our analysis plan was not pre-registered on a publicly available platform; hence our results are only exploratory.

Self-reported information on reasons for product switching and switching choices was collected by surveying a sample of panel participants in a bespoke study carried out by KWP between March and May 2018. Participants were panel members who had, within the past month, changed the tobacco brand or brand variant they used, or switched to a different tobacco product or to a non-tobacco nicotine product, or bought more than one product. Ethics approval for this survey was granted by the University of Nottingham Medical School Ethics Committee. We used these data to study product choice among tobacco consumers who switched after plain packaging full implementation.

### *Measures*

*Plain packaging policy implementation*

Based on a previous study [10], we used purchases of minimum plain pack sizes (20 cigarettes or 30 grams of RYO per pack) as a proxy marker for plain package sales. To define successive stages of the extent of purchasing of minimum plain pack sizes, which increased gradually during the implementation period [10, 11] we created a policy implementation variable with the following categories: before May 2016, 0 to 6 months after May 2016, 7 to 12 months after May 2016, and more than 12 months after May 2016.

*Product type purchases*

We obtained data on all purchases of tobacco (cigarettes, RYO tobacco, cigar/cigarillo and pipe tobacco) and non-tobacco (e-cigarettes and NRT) nicotine products by the household each month; however, since the number of cigar/cigarillo and pipe purchase was very small these products were excluded from further analysis.

*Pack size*

To investigate changes in pack sizes purchased we defined four pack size categories for cigarettes (10, 11 to 19, 20, and more than 20 cigarettes per pack) and RYO (less than 12.5 grams, 12.5 to 29 grams, 30 grams and more than 30 grams per pack). We calculated the total number of cigarettes and grams of RYO purchased by each household monthly, and then computed percentages purchased by pack size category.

*Average price paid and price segments*

We computed the average real price paid per cigarette and per gram of RYO tobacco by dividing the amount spent on the cigarette or RYO tobacco pack by the number of cigarettes or grams of RYO tobacco it contained. We used the methods described in our earlier analysis of price trends [11] to create price quartiles for cigarettes and RYO tobacco products using price per cigarette and price per gram of RYO by pack size. Price quartiles were generated for products within each pack size separately, with Quartile 1 referring to the least and Quartile 4 the most expensive products. Products containing more than 20 cigarettes or less than 12.5 grams RYO per pack were excluded since they were sold in insufficient numbers for quartile definition and we eliminated one cigarette product from these averages (Carlton Superkings 10-pack) which was identified as an outlier due to a price almost twice that of other products. We then computed the monthly average real price paid per cigarette and per gram of RYO (by pack size and price quartile) by averaging across all households each month.

*Switching between product types*

To study switching we created a 'state' variable to classify each household monthly purchasing behaviour into one of the following categories: only cigarette purchaser, only RYO purchaser, purchases multiple tobacco products, purchases non-nicotine tobacco products, and a final category identifying households that left our dataset during that month (either stop purchasing tobacco products or left the panel altogether). We then divided our full sample into: Group 1, comprising those households starting the panel at any time point purchasing only cigarettes during their first observed

month; and Group 2, for those starting the panel purchasing only RYO tobacco during their first observed month.

We then identified changes in state by comparing consecutive months for each household for as long as the household was observed (households with at least two observations), and created three binary variables, each identifying a specific change in state for households in Group 1 and Group 2:

1. Switching to a different tobacco product or combination of tobacco products: with the value '0' if the household remained in its initial state (only cigarette in Group 1, and only RYO in Group 2) and '1' if the household started purchasing a different tobacco product or a combination of tobacco products during that month.
2. Switching to any non-tobacco nicotine product (NRT, electronic cigarette or any combination of cigarettes, RYO and these two products): with the value '0' if the household remained in its initial state, and '1' if the household purchased any non-tobacco nicotine product during that month.
3. Switching out of our dataset: with the value '0' if the household remained in its initial state, and '1' if no purchase was observed thereafter for that household in our dataset.

Households who started the panel as only purchasers of e-cigarettes (6%), only NRT (8%), only cigar (2%), dual user of cigarettes/RYO tobacco (5%), only pipe or other dual usages (1%), were excluded from this analysis.

*Price quartile purchasing behaviour*

Since around 27% of households purchase a combination of cigarette products from different price quartiles each month, and around 24% do the same for RYO products, we created four outcome binary variables, one per price quartile, in which each variable had the value '1' if the household purchased products from that price quartile during the month, and '0' if they purchased products from a different price quartiles (either from one different price quartile or a combination of price quartiles not including the one in '1'), using price quartiles defined for cigarettes in Group 1 and RYO tobacco in Group 2. We used all households purchasing products for which a price quartile mode could be defined.

*Self-declared consumer's choice*

From the total number of households in the panel, KWP identified those who had purchased tobacco products recently (between four weeks and six months before the survey) and asked them: what would they do if the product they usually purchase was not available when going to a store and what factors determined their decision to purchase a different product or a different variant in that case.

**Statistical analysis**

We used line graphs to plot the extent of plain packaging policy implementation as the percentage of cigarettes and grams of RYO purchased in minimum plain pack size after May 2016. We used stacked bars graph to compare percentage of purchases by product type and line graphs to compare number of households purchasing each product type. We used stacked percentage graphs to compare purchases by pack size and price quartile and line graphs to compare average price paid by pack size and price quartile for both cigarettes and RYO tobacco. We also used stacked graphs to explore monthly switching patterns.

We used panel data logistic regression to estimate the household's likelihood (Odds Ratio (OR)) of switching using our three binary outcome variables (switching to other tobacco product, switching to non-tobacco nicotine product or switching out of our dataset), and population averaged effects. We estimated the model for Group 1 and Group 2 separately and used our policy implementation variable as exposure. We adjusted our model for variables that deemed relevant to the decision to switch and to the decision purchase cigarettes/RYO tobacco. For the decision to switch, we incorporated the total number of switches performed by the household throughout the period observed (as a marker of product loyalty); and the number of monthly observations for the household, as a marker of regularity in purchasing. For the decision to purchase cigarettes/RYO tobacco, we incorporated one lag and one lead of average monthly real price per cigarette for Group 1 and real price per gram for Group 2 (obtained from the monthly average real price paid by households), and one lag and one lead of consumption, measured by the total number of cigarettes purchased by the household monthly for Group 1 and the total grams purchased by the household monthly for Group 2 [12-14]. The price and consumption lead variables were not included when modelling switching out of our dataset.

We also used panel data logistic regression to study changes in price quartile purchasing patterns using our policy implementation variable. We estimated the household likelihood (OR) of purchasing products in each price quartile using our four-outcome binary variables and policy implementation variable as exposure. We performed the analysis both for Group 1 and Group 2 separately, using the same adjustments as before, and additionally the proportion of time the household had been a cigarette-only purchaser in Group 1 and the proportion of time the household had been a RYO-only purchaser in Group 2. All analyses were adjusted for socioeconomic status, presence of children, life stage, household size and region, and Wald test statistics were reported [15]. Finally, we descriptively analysed the survey results to complement the secondary data analysis with consumer declared

changes in purchasing behaviour after full implementation of the plain packaging legislation. All analysis was performed in Stata version 16.0 and the confidence level was set to 95%.

## RESULTS

### Policy implementation

In May 2016 the proportion of purchases in minimum plain pack sizes represented around 17% of all cigarettes purchases in the KWP dataset, and this percentage increased slowly until January 2017 and then rapidly, to 93% of cigarette purchases, by May 2017 (Figure 1). For RYO tobacco, the proportion of legal pack size purchases represented around 70% of purchases in May 2016, which was entirely related to products purchases in more than 30 grams. Due to the appearance of 30 gram packs after May 2016, the percentage of legal pack size increased slowly until January 2017, reaching 99% of purchases by May 2017 (Figure 1).

**Figure 1 here**

### Monthly trends in purchases

The number of households purchasing tobacco or non-tobacco nicotine products each month between March 2011 and December 2017 averaged at 1,741 (range 1,332 to 2,186), having risen in the first year of the study period when KWP was building the panel, and then declined steadily until the end of the study period (Figure 2a). After the number of participating households reached a peak in May 2012, an average of 125 households left our dataset (stopped purchasing tobacco/nicotine products or left the panel altogether), and 88 households joined the panel, each month. There was a marked increase in the number of households leaving the panel in the final months of the study period (Figure 2a).

**Figure 2 here**

The number of households purchasing only cigarettes fell progressively during the study period, from 875 to 459, while the number purchasing only RYO increased from 396 to 512, from March 2011 to December 2017 (Figure 2b). Overall, for the whole of our study period, the majority of households purchased either only cigarettes or only RYO tobacco. The number of households purchasing e-cigarettes increased from zero in March 2013 to 149 in December 2017, with most of this increase occurring as e-cigarette-only purchasing (Figure 2b) and exceeding the number purchasing NRT after May 2016 (Figure 2b).

**Monthly purchases by pack size and price paid: Cigarettes and RYO tobacco**

For cigarettes, the percentage of purchases in 10-packs was relatively constant at around 13% between March 2011 and September 2016, after which purchasing fell rapidly to zero by August 2017 (Figure 3a). There was a steep increase in the proportion of 11-19 cigarette packs purchased after April 2014, with this pack size then accounting for an average of 68% of all purchases until January 2017, but this pack size decreased rapidly to around 2% by June 2017 and below 1% by December 2017. Purchases of packs of more than 20 cigarettes remained negligible throughout the study period (Figure 3a). Real price paid by pack size was lowest for cigarettes sold in packs of 11-19, and highest for those in packs of 10 throughout the study period. From March 2017, real price of cigarettes in packs of 20 decreased significantly, reaching values closer to those in packs of 11-19 (Figure 3b).

**Figure 3 here**

For RYO, packs larger than 30g accounted for more than 60% of purchases throughout the study period. The proportion of purchases in the smallest packs (<12.5g) and packs containing between 12.5 and 29 grams was relatively stable until June 2016, when pouches containing 30 grams appeared on the market for the first time and fully replaced smaller packs in line with the legislative requirements (Figure 3c). In contrast to cigarettes, real prices per gram were very similar across all pack sizes through most of the study period, before what is likely to have been discounting of the smallest packs immediately before their withdrawal in 2017 (Figure 3d).

**Monthly purchases by price quartile and price paid: Cigarettes and RYO tobacco**

Purchasing of cigarettes in the lowest price quartile (Q1) increased progressively throughout the study period and this trend was seemingly unaffected by variations in purchasing in other quartiles (Figure 4a). Across the entire study period, purchases in quartile 2 (Q2) also increased while those in quartiles 3 (Q3) and 4 (Q4) fell, but in the period between early 2014 and early 2017 when packs of 11-19 cigarettes dominated sales, the proportion of sales in Q3 and Q4 increased while those in Q2 decreased (Figure 4a). Differences in average real price paid for cigarettes in each price quartile remained relatively constant for most of the study period until May 2017, when Q1 and Q2 prices converged and Q4 prices increased substantially (Figure 4b).

**Figure 4 here**

In contrast to cigarettes, purchase of RYO in Q1 decreased until February 2017, while purchases in Q2 and Q3 increased throughout the study period. However, purchases of products in Q1 increased during the last year of the study period (Figure 4c). Average real prices by price quartile showed similar trends between the top two quartiles (Q3 and Q4) and the bottom two quartiles (Q1 and Q2) with a gap between the two that increased over time (Figure 4d).

**Plain packaging and switching behaviour**

Both among households that were cigarette-only purchasers in their first observation in the panel (Group 1) and among those that were RYO-only purchasers in their first observation in the panel (Group 2) the most frequent purchasing behaviour was to remain in their initial product of choice (Figure 5).

**Figure 5 here**

Our regression analysis indicates that among Group 1, the odds of switching to a non-tobacco nicotine product increased significantly during the first six months of the plain packaging implementation period (OR 1.74, 95% CI: 1.18 to 2.57) but not thereafter (Table 1). The likelihood of switching out of our dataset also increased between 7 to 12 months after May 2016 (OR 1.30, 95% CI: 0.08 to 1.58) and doubled after May 2017 (OR 2.44, 95% CI: 2.05 to 2.89). For Group 2, switching to other tobacco products became significantly less likely after full implementation (OR 0.64, 95% CI: 0.41 to 0.99), while the likelihood of switching out of our dataset almost doubled after the policy was fully implemented (OR 1.96, 95% CI: 1.64 to 2.36).

**Table 1 here**

**Plain packaging and price quartile purchasing behaviour**

For cigarette-only purchasers (Group 1) at baseline, the largest increase was observed in the likelihood of purchasing cigarettes from Q2, which increased between seven and twelve months after May 2016 (OR 2.03, 95% CI: 1.73 to 2.38) and double after full implementation (OR 2.16, 95% CI: 1.98 to 2.37), while the likelihood of purchasing cigarettes in Q3 and Q4 decreased significantly (Table 2). For RYO-only purchasers at baseline (Group 2), the highest increased was observed for products in Q1 in the later phases of policy implementation, between 7 to 12 months (OR 2.25, 95% CI 1.86 to 2.72) and

after full implementation (OR 4.00, 95% CI 3.30 to 4.84) and for products in Q3, mainly at 7 to 12 months after the policy was implemented (OR 1.71, 95% CI: 1.53 to 1.92) and after full implementation (OR 1.61; 95% CI: 1.42 to 1.82), while products in Q4 significantly decreased.

**Table 2 here**

**Consumer's choice after plain packaging**

Our survey sample consisted of 1,061 participants. Only 350 participants reported purchasing tobacco recently and 127 participants reported that their most recent purchase was an e-cigarette. Among those who made a tobacco product purchase within the four weeks before the survey we identified 46 who reported switching to a different tobacco brand, 29 who reported switching to a different variant of the same brand, and 191 who remained loyal to the product they used. Those who stayed loyal to their brand reported that the reason for their loyalty was that the product was at the right price for them, and because of product taste.

**DISCUSSION**

This study demonstrates that the introduction of plain packaging and minimum pack sizes for cigarettes and RYO tobacco in the UK between May 2016 and May 2017 was associated with a pronounced decrease in cigarette-only purchases, with switching to non-tobacco nicotine products (predominantly e-cigarettes) at the beginning of the policy implementation period, and with leaving the dataset after full implementation. Those consumers who continued to purchase cigarettes were forced by the minimum pack size policy to switch from packs of 10 to 19 to packs of 20 cigarettes, and then tended to switch to lower priced cigarettes, while those who remained in RYO were already purchasing in pack sizes of more than 30 grams before May 2016 with relatively little subsequent switch in pack size. There was no evidence of a marked switch from cigarettes to RYO. These patterns of switching, in conjunction with the survey results indicate that price is a key determinant of nicotine product choice, and that implementation of plain packaging and minimum pack size legislation was associated with switching to lower price tobacco products, or to non-tobacco nicotine products, or with stop purchasing nicotine products altogether.

KWP is a longitudinal panel with a large number of households providing frequent and long-term data on tobacco purchasing, thus creating a unique facility to explore time trends and switching in a novel way. However, our data are of necessity derived from those willing to participate in the panel – and the same applies to our bespoke survey –, it does not include information regarding the number of smokers at home, and it does not allow us to investigate whether those that stopped providing data did so due to quitting smoking or leaving KWP. The data do not therefore allow us to control for the number of smokers in the home, but only for the total number of household members; and we are unable to distinguish households who remained part of KWP but stopped purchasing nicotine from those who left KWP completely. However, the sustained decline in numbers purchasing any nicotine product, in line with the declining national smoking prevalence during the same period [16], suggests that an appreciable number might have left because they had ceased using these products. Regarding the second, the data did not allow us to control for the number of smokers but only for the total number of household members. Our analysis was also limited by the fact that we used two possible initial states for simplicity, and complicated by the fact that scanning of products brought into the home may not be complete, and products purchased and consumed outside the home are excluded, though in contrast to products such as alcoholic drinks it is relatively unlikely that a pack of cigarettes would be purchased and consumed without entering the home premises. However, we have not been able to include in our analysis the effect of increases in minimum excise duty applied to tobacco

products during the study period, so the changes we have described are not entirely attributable to pack size and plain packaging effects.

Australia was first country to introduce plain packaging and a post-implementation review concluded that the policy had contributed to an increase in the rate of decline in smoking prevalence [17]. Our findings, with the caveats above, are consistent with this interpretation since they demonstrate that an appreciable proportion of tobacco smokers switched to non-tobacco nicotine products or ceased purchasing any nicotine product after full implementation of the policy. A comprehensive analysis of purchasing and prices paid in Australia before, during and after the introduction of plain packaging found some changes similar to those we have observed, and some that are different. Thus, Scollo et al report much higher proportions of Australian smokers consuming cigarettes than RYO tobacco, which we do not observe, and less switching between these categories than in our study [6]. This difference may arise from differences in pricing structure between Australia and the UK. Scollo et al also report a shift to multipack cigarettes, which we did not study; and while they did not observe the major shift to lower cost packs of 11-19 cigarettes in advance of the plain packaging legislation that occurred in the UK, they did see an increase in purchasing of value (low cost) brands after plain packs were implemented [6]. These differences from our findings are likely to reflect other underlying differences in the tobacco markets in these countries but show consistency in the shift to lower cost brands. Scollo et al did not report data on use of e-cigarettes, use of which to consume nicotine is illegal in Australia. We are not aware of any other published analyses of market changes in other countries that have introduced plain packaging.

In our previous studies using *Nielsen Scantrack* data we demonstrated that plain packaging legislation was associated with an increase in price for both cigarettes [11] and RYO tobacco [10] above the expected tax increase and inflation. However, our results on purchase and price trends for legal pack sizes presented here have shown that even though consumers switched to bigger pack size cigarette products, they paid a lower average price per cigarette, closer to that of the 11 to 19 cigarette packs available before the new policy was implemented, by moving down by one price quartile to cheaper products. We recognize that *Nielsen Scantrack* data are more comprehensive in terms of the number of products included [8], but KWP is representative of consumers' purchasing behaviour. Trends in prices by price quartile observed in this study were consistent with those observed in studies using alternative methods for price segmentation [10, 11, 18]. Therefore, our results suggest that either consumers are searching for price deals or places where their preferred products are sold cheaper, or that they are happy to switch to a lower priced product when their preferred product becomes too

expensive, or a combination of these alternatives. Further research is needed to investigate whether consumers' are brand loyal or loyal only to the tobacco product of their choice, as well as on the effects of the policy in consumers' consumption and expenditure on tobacco products. Our finding of little evidence of a shift from cigarettes to RYO in the present study contrasts with inferences drawn from our earlier analysis of *Nielsen Scantrack* data, but the fact that the present analysis is based on longitudinal data from a panel of households, rather than product scanning at the point of sale, makes our present finding more likely to be correct.

In conclusion, it appears that implementation of plain packaging and minimum pack size legislation in the UK was associated with major changes in the purchasing and pricing of tobacco products and resulted in switching from tobacco cigarettes to e-cigarettes and towards cheaper products among consumers who are loyal to the tobacco product of their choice. Whether the reduction in the number of purchasers of the most expensive tobacco products reflects an effect of plain packaging and related price changes, or higher quitting rates in those groups, or indeed the effect of other policies such as higher tax or a combination of all of these influences is not certain. However, our findings indicate that consumers are loyal to the tobacco product of their choice, but are also price-conscious consumers, and hence will search for cheaper options or switch to alternative sources of nicotine, such as e-cigarettes, when tobacco policy renders their usual tobacco product less attractive.

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**Figure 1:** Percentage of cigarettes and grams of RYO purchased in minimum legal plain pack size (20 cigarettes or more for cigarettes and 30 grams or more for RYO) from Kantar Worldpanel (May 2016 – February 2018)

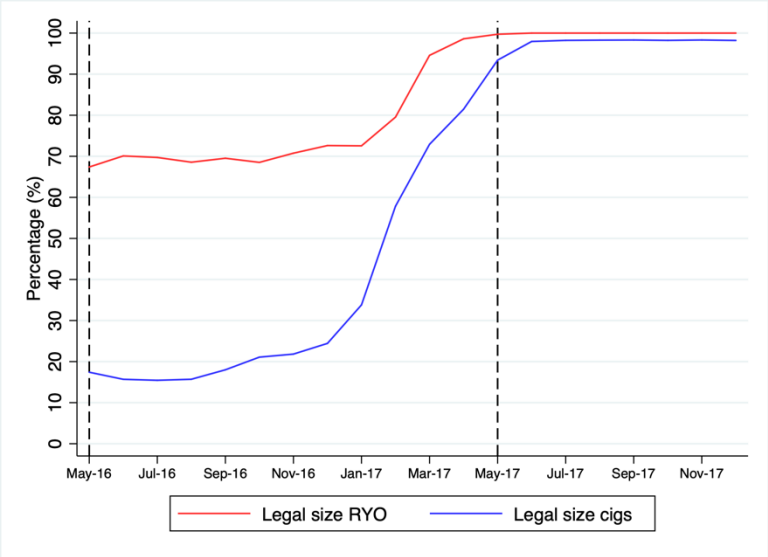
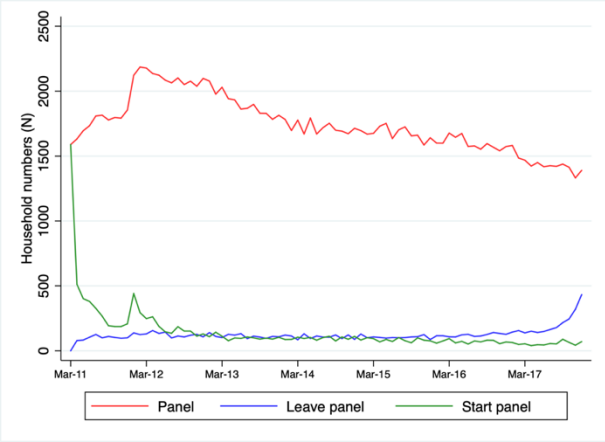



**Figure 2:** Number of households participating, joining and leaving the panel and monthly distribution of households by type of product purchased (Great Britain: March 2011 – December 2017)

a. Monthly number of households in the panel




b. Monthly distribution of households by type of purchase

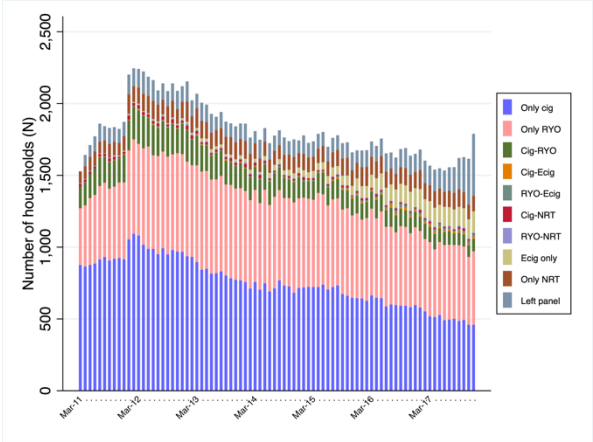
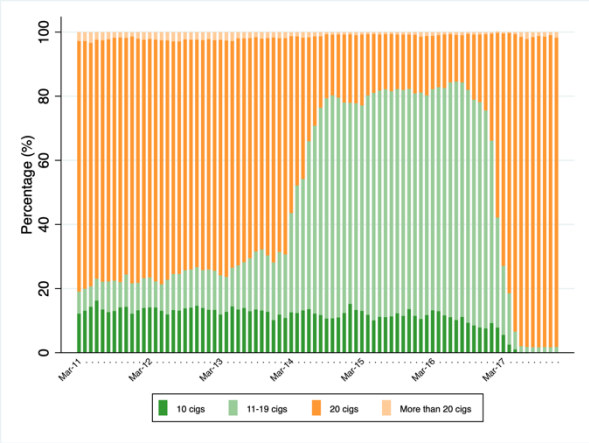
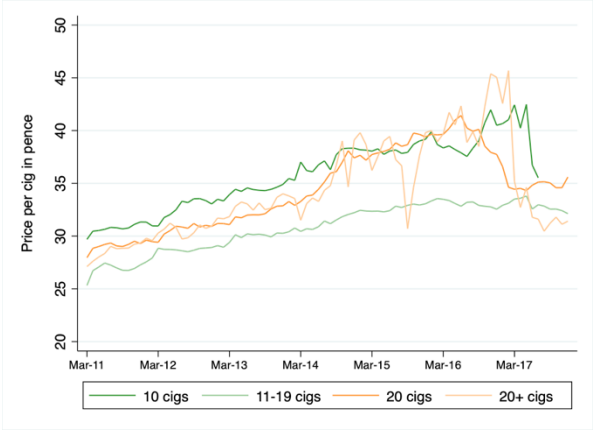


**Figure 3:** Percentage of cigarettes and RYO tobacco purchases and average price paid by pack size (Great Britain: 2011 – 2018)

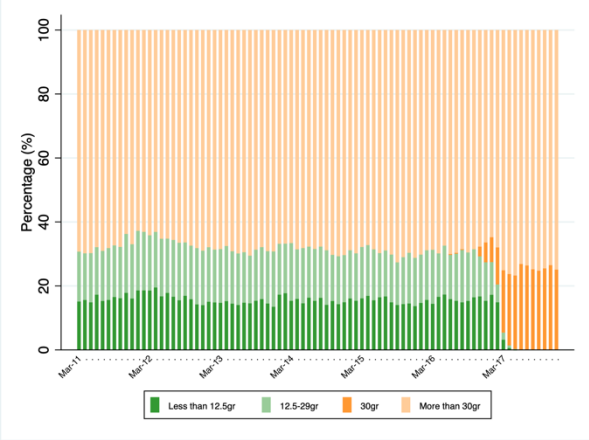
a. Cigarette purchases by pack size




b. Average real price paid per cigarette by pack size




c. RYO purchases by pack size




d. Average real price paid per gram by pack size

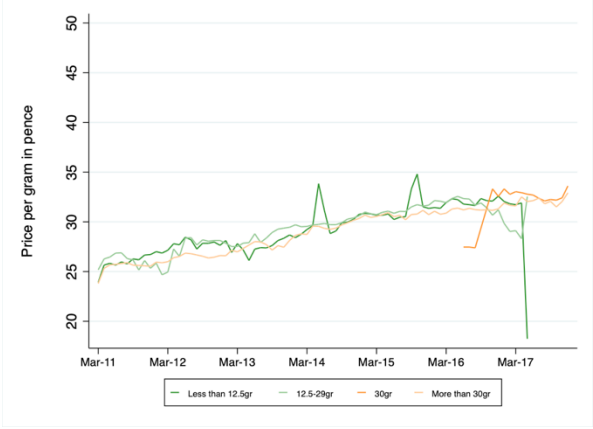
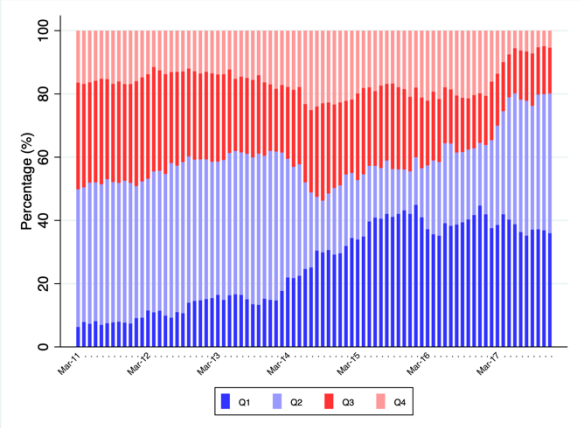
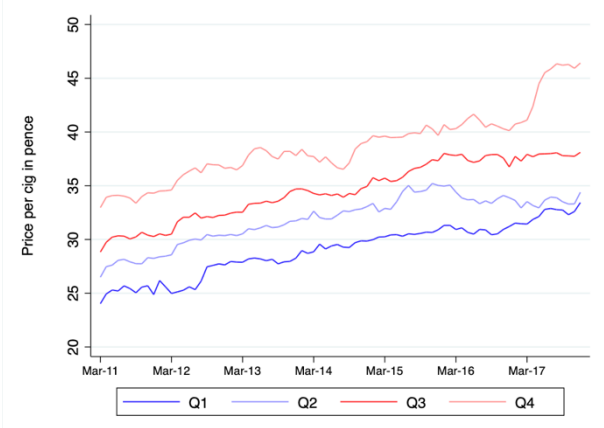



**Figure 4:** Percentage of cigarettes and RYO tobacco purchases and average nominal price paid by price quartile (Great Britain: Marh 2011 – December 2017)

a. Cigarette purchases by price quartile




b. Average real price paid per cigarette by quartile




c. RYO purchases by price quartile

d. Average real price paid per gram RYO by pack size

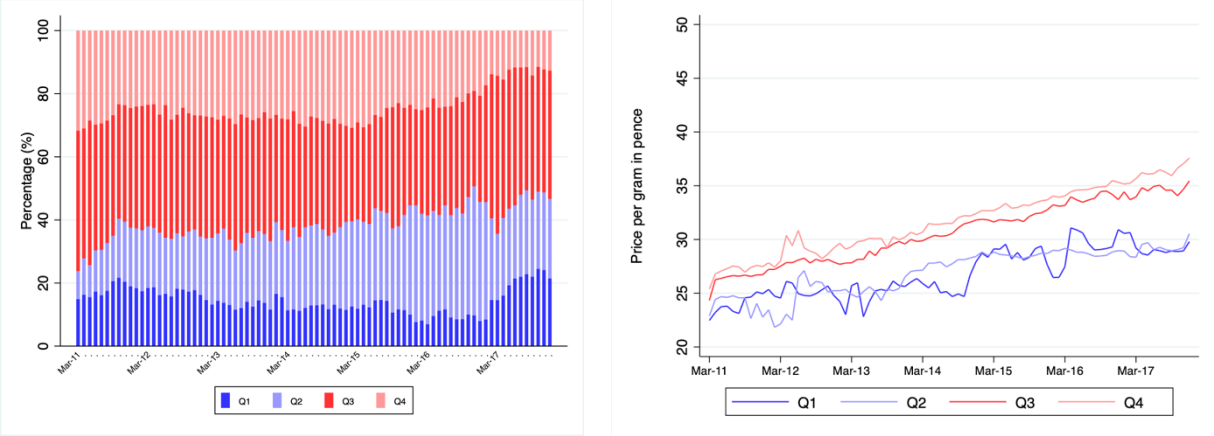



**Figure 5:** Monthly number of households by switching behaviour among households who were only cigarette purchasers (Group 1) or only RYO tobacco purchasers at baseline (Group 2) at baseline (Great Britain: March 2011 – December 2017)

a. Switching behaviour Group 1

b. Switching behaviour Group 2

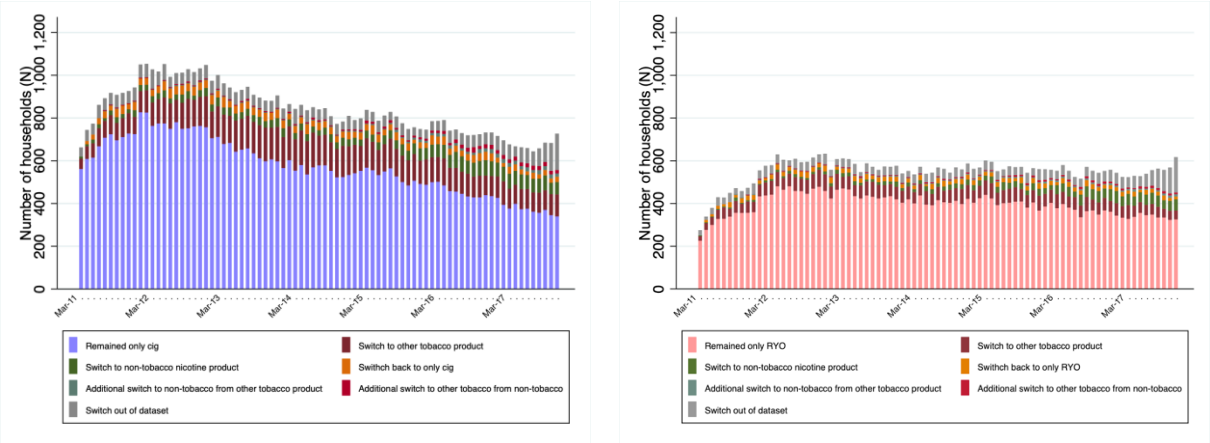


**Table 1:** Regression results for switching to other tobacco products, to a non-tobacco nicotine product or out of the dataset during and after plain packaging implementation for households who were only cigarette purchasers (Group 1) or only RYO purchasers (Group 2) in their first observation (March 2011 to December 2017)

| | Group 1 (Starts as only cigarette purchaser) | | | | Group 2 (Starts as only RYO purchaser ) | | | |
|---|---|---|---|---|---|---|---|---|
| *Policy variable:* | Reference: Remains as only cigarette purchaser % (N*) | Switches to other tobacco product OR (P-value) [95% CI] | Switches to non-tobacco nicotine OR (P-value) [95% CI] | Switches out of the dataset OR (P-value) [95% CI] | Reference: Remains as only cigarette purchaser % (N*) | Switches to other tobacco product OR (P-value) [95% CI] | Switches to non-tobacco nicotine OR (P-value) [95% CI] | Switches out of the dataset OR (P-value) [95% CI] |
| Before May 2016 | 70.9% (38,863) | Reference | Reference | Reference | 74.4% (25,342) | Reference | Reference | Reference |
| 0 to 6 months after May 2016 | 60.5% (2,651) | 0.96 (0.800)) [0.72 to 1.29] | 1.74 (0.005) [1.18 to 2.57] | 1.04 (0.725) [0.85 to 1.26] | 66.6% (2,169) | 1.09 (0.651) [0.74 to 1.61] | 1.15 (0.606) [0.67 to 1.96] | 0.92 (0.448) [0.74 to 1.14] |
| 7 to 12 months after May 2016 | 58.5% (2,471) | 0.81 (0.185) [0.59 to 1.11] | 1.39 (0.126) [0.91 to 2.10] | 1.30 (0.007) [0.08 to 1.58] | 64.2% (2,074) | 0.91 (0.652) [0.60 to 1.38] | 1.40 (0.222) [0.82 to 2.39] | 0.99 (0.953) [0.80 to 1.23] |
| > 12 months after May 2016 | 53.6% (2,525) | 0.79 (0.191) [0.55 to 1.13] | 1.24 (0.399) [0.75 to 2.02] | 2.44 (<0.001) [2.05 to 2.89] | 60.6% (2,371) | 0.64 (0.044) [0.41 to 0.99] | 1.60 (0.087) [0.93 to 2.75] | 1.96 (<0.001) [1.64 to 2.36] |
| Observations | | | | | | | | |
| Households | - | 2,151 | 2,066 | 4,735 | - | 1,504 | 1,439 | 3,717 |
| Households-months | 46,510 | 31,246 | 30,431 | 40,258 | | 17,919 | 17,396 | 25,503 |
| Wald statistic for policy variable (p-value) | - | 2.90 (0.407) | 99.1 (<0.001) | 108.7 (<0.001) | - | 4.80 (0.187) | 3.36 (0.339) | 67.5 (<0.001) |

**Note:** Reference category for policy variable: 'Before May 2016'. Reference category for each binary outcome: households remaining in their initial product of choice (remaining only cigarette purchaser for Group 1 and only RYO tobacco purchaser for Group 2). Adjustments: Number of switches, number of monthly purchasing observations, one lag and one lead for average price and consumption, social class (social classes D and E for low, and A, b and C for medium-high socioeconomic status), age (household wife aged <35, 35-54, 55+ years old), child presence (yes or no), life stage (family and retired/empty nesters or old dependents), household size (1, 2, 3+ household members), and region (East, North, Midlands, London, South, West and Wales and Scotland).

* "N" refers to number of household-months observations.

**Table 2:** Regression results for studying household's purchase by price quartile during and after plain packaging implementation for households who were only cigarette purchasers (Group 1) or only RYO purchasers (Group 2) in their first observation (March 2011 to December 2017)

| | Group 1 (Starts as only cigarette purchaser) | | | | Group 2 (Starts as only HRT purchaser ) | | | |
|---|---|---|---|---|---|---|---|---|
| | Purchase Q1 OR (P-value) [95% CI] | Purchase Q2 OR (P-value) [95% CI] | Purchase Q3 OR (P-value) [95% CI] | Purchase Q4 OR (P-value) [95% CI] | Purchase Q1 OR (P-value) [95% CI] | Purchase Q2 OR (P-value) [95% CI] | Purchase Q3 OR (P-value) [95% CI] | Purchase Q4 OR (P-value) [95% CI] |
| *Policy variable:* | | | | | | | | |
| 0 to 6 months after May 2016 | 1.02 (0.600) [0.94 to 1.11] | 1.06 (0.183) [0.97 to 1.16] | 0.77 (<0.001) [0.70 to 0.84] | 1.04 (0.250) [0.97 to 1.12] | 0.89 (0.303) [0.71 to 1.11] | 1.09 (0.169) [0.96 to 1.23] | 0.92 (0.182) [0.82 to 1.04] | 0.82 (<0.001) [0.74 to 0.92] |
| 7 to 12 months after May 2016 | 1.22 (<0.001) [0.13 to 1.33] | 1.67 (<0.001) [1.54 to 1.82] | 0.80 (<0.001) [0.73 to 0.88] | 0.89 (0.003) [0.83 to 0.96] | 2.25 (<0.001) [1.86 to 2.72] | 0.98 (0.772) [0.86 to 1.12] | 1.71 (<0.001) [1.53 to 1.92] | 0.75 (<0.001) [0.66 to 0.84] |
| > 12 months after May 2016 | 0.99 (0.800) [0.91 to 1.08] | 2.16 (<0.001) [1.98 to 2.37] | 0.62 (<0.001) [0.56 to 0.69] | 0.37 (<0.001) [0.33 to 0.41] | 4.00 (<0.001) [3.30 to 4.84] | 0.77 (<0.001) [0.67 to 0.90] | 1.61 (<0.001) [1.42 to 1.82] | 0.60 (<0.001) [0.52 to 0.69] |
| Observations | | | | | | | | |
| Households | 2,188 | 2,189 | 2,188 | 2,189 | 1,522 | 1,522 | 1,522 | 1,522 |
| Households-months | 53,527 | 53,567 | 35,541 | 35,543 | 20,111 | 20,115 | 20,115 | 20,115 |
| Wald statistic for policy variable (p-value) | 28.04 (<0.001) | 358.2 (<0.001) | 96.75 (<0.001) | 366.61 (<0.001) | 221.98 (<0.001) | 16.45 (<0.001) | 126.96 (<0.001) | 64.92 (<0.001) |

**Note:** Reference category for policy variable: 'Before May 2016'. Reference category for each binary outcome: households purchasing cigarettes from price quartiles different than the one named in the column. Additional controls: Proportion of time household is cigarette user for Group 1 and RYO user for Group 2, number of monthly purchasing observations, one lag and one lead for average price and consumption, social class (social classes D and E for low, and A, b and C for medium-high socioeconomic status), age (household wife aged <35, 35-54, 55+ years old), child presence (yes or no), life stage (family and retired/empty nesters or old dependents), household size (1, 2, 3+ household members), and region (East, North, Midlands, London, South, West and Wales and Scotland).