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STATISTICAL ANALYSIS OF LARGE
HEALTH WARNINGS ON CIGARETTE PACKS
IN MEXICO AND BRAZIL

Report prepared for
Japan Tobacco International (JTI)

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ABSTRACT

Objective:

To determine by statistical analysis whether large health warnings (LHWs) on cigarette packs reduce the sales of cigarettes in Mexico and Brazil.

Methods:

Using monthly Nielsen point of sale panel data for the periods 2009 to 2017 for Mexico and 2014 to 2017 for Brazil a number of fixed effects instrumental variable regressions have been run for all cigarette sales by sales channels (for Mexico) and types of cigarette for Mexico and Brazil.

Results:

The introduction of, and changes to, LHWs in both Mexico or Brazil were not associated with a statistically significant reduction in the volume of cigarette sales.

Conclusion:

There is no reliable statistical evidence using Nielsen point of sale data that the introduction of LHWs reduced cigarette sales in total or by type in either Mexico or Brazil.

TABLE OF CONTENTS

I.	INTRODUCTION.....	4
II.	LARGE HEALTH WARNINGS.....	5
	Mexico.....	5
	Brazil.....	6
III.	SHORT SURVEY OF EMPIRICAL RESEARCH.....	6
IV.	EMPIRICAL APPROACH.....	8
	Estimating Techniques.....	8
	General Data Considerations.....	10
V.	MEXICO.....	11
	Data Description and Issues.....	11
	Approach and Results.....	17
VI.	BRAZIL.....	20
	Data Description and Issues.....	20
	Regression Specifications.....	21
	Results.....	22
VII.	CONCLUSIONS.....	23
	REFERENCES.....	24
	ANNEX A: REGRESSION OUTPUT FOR MEXICO.....	25
	ANNEX B: OUTLIERS IN NIELSEN DATA FOR MEXICO.....	34
	ANNEX C: REGRESSION OUTPUT FOR BRAZIL.....	39
	ANNEX D: OUTLIERS IN NIELSEN DATA FOR BRAZIL.....	40

I. INTRODUCTION

This report has been commissioned by Japan Tobacco International (JTI) to examine the impact, if any, on the volume of cigarette sales of large health warnings (LHWs) on cigarette packaging in Mexico and Brazil.

The selection of Mexico and Brazil from the Latin American countries was based solely on the availability of suitable data to carry out a sufficiently rigorous statistical impact study.

This report represents the independent analysis and conclusions of its authors.

Main Findings

Based on an extensive statistical analysis of Nielsen point of sale (POS) data no statistically reliable evidence was found that LHWs reduced cigarette sales in either Mexico or Brazil. More specifically:

- There was no statistically significant reduction in cigarette sales associated with the introduction of LHWs in Mexico in 2010 and/or their subsequent enhancements in 2011 and 2013.
- The data was not sufficient to enable a full assessment of the likely impact of LHWs in Brazil. However, the 2016 enhancement was not associated with any statistically significant reduction in cigarette sales.

Organisation of Report

The report is organised as follows:

- A brief description of LHWs in Mexico and Brazil (Section II)
- Short survey of the econometric research on the impact of LHWs (Section 0)
- The approach adopted in this Report to assessing the impact of EHWs on cigarette sales (Section IV)
- A description and summary results of the analysis of data for Mexico (Section V)
- A description and summary results of the analysis of data for Brazil (Section VI)
- Conclusions (Section VII).

In addition there are four technical annexures which provide greater detail on the data, the econometric techniques used, and results of different regression specifications for Mexico (Annex A and C) and Brazil (Annex C and D).

II. LARGE HEALTH WARNINGS

LHWs are text messages together with pictorial or graphic images which aim to warn of the health risks of associated with smoking, and which cover most of the exterior surface of the tobacco packaging.

In recent years Mexico and Brazil have imposed LHWs along with other packaging regulations and bans on smoking in public places.

Mexico

The General Law for Tobacco Control (GLTC) - the Ley General para el Control del Tabaco - governs the exterior features of cigarette packaging, and other controls on cigarette sales and smoking in Mexico. These regulate tobacco advertising, packaging, and impose public smoking bans.

Articles 18 to 22 of the GLTC regulate packaging and labelling. These require that all packaging for tobacco products carries clear and visible health warnings.

The first LHWs were implemented in September 2010 under the GLTC. Tobacco packages in Mexico are required to bear three warnings on each pack or carton:

1. a pictorial warning together with text covering at least 30% of the front of the cigarette pack;
2. a text-only warning covering 100% of the back of the pack, and
3. a text-only message covering all of one side panel of the pack.

Table 1. Development of LHWs in Mexico, 2008-2014

Provision	Date	Requirements
Health Warning Accord 2010	September 2010	100% pictorial health warning cover all of the back panel; panel with quit line and information on health effects; 30% at top of front panel; 100% on one side panel
Health Warning Accord 2011	September 2011	New set of eight pictorial health warnings on 100% of back panel; panel with quit line and information on health effects
Health Warning Accord 2013	March 2013	New set of eight pictorial health warnings on 100% of back panel; panel with quit line and information on health effects

Source: www.tobaccocontrollaws.org

Mexico required frequent changes in LHWs pictorials (Table 1). Specifically, the first set of eight pictorials was introduced in September 2010. The second "Health Warning Accord" came into force

on September 2011 which designated eight new pictorials and required that two of these replace the existing pictorials each quarter. A third “Health Warning Accord” came into force on March 2013 which repeated this cycle – eight new pictorials with two new ones replacing existing pictorials on each cigarette pack every quarter. There have been no further Accords.

Cigarette packs must also display information on cigarette contents and emissions and contain specific statements about the dangers of toxins with warnings describing where toxic chemicals can be found in products other than cigarettes.

Brazil

Brazil is one of the largest producers of tobacco and is reported to have “one of the world’s most stringent anti-smoking control programmes” (Euromonitor 2016, p. 7). Controls have been imposed on packaging, advertising, smoking in public places, and on the content and type of cigarettes that can be sold and imported into Brazil.

Brazil was the first country in Latin America to require mandatory health warnings on cigarette packs (and the second worldwide). Since 2001 tobacco companies have been required to insert pictorials on the back and one side panel of each cigarette pack together with text health warnings. Three rounds of pictorial health warnings have so far taken place. The initial LHWs used during 2002 to 2004 were drawn from a set of nine pictorials (Cavalcante, 2003). A second group of 10 pictorial warnings were implemented in 2004; and third group of 10 images in 2009 with stronger text messages and more dramatic graphic images. This was followed in 2012 and 2013 by further health warnings on cigarette packaging.

Table 2: Development of LHWs for Brazil, 2001-2016

Date	Requirements
2001	LHWs on 100% of back panel and one side panel of pack drawn from nine pictorials.
2004	Second set of 10 new pictorials
2009	New set of 10 pictorials with more graphic images and stronger text
2016	New additional health text warning with quit line telephone number placed at bottom and covering 30% of front panel

Source : Euromonitor (2016), Cavalcante (2003)

ANVISA (National Health Surveillance Agency) passed a resolution¹ effective from 1 January 2016 requiring additional new text warning placed at the bottom and covering 30% of front panel. This

¹ Resolution ANVISA RDC No. 14 (April 10, 2015)

contains text (which translated) reads “This product causes cancer: quit smoking. For more information call the health line on 136.”

III. SHORT SURVEY OF EMPIRICAL RESEARCH

Research on health warnings on cigarette packaging is considerable. A number of different approaches have been used to measure the impact, if any, on cigarette sales, consumption and smoking prevalence ranging from surveys to econometric analysis.

The published studies vary considerably in quality and do not generate consistent or reliable evidence, positive or otherwise, of the impact of LHWs on smoking prevalence and/or cigarette sales.

Rather than review the research on LHWs ourselves we have drawn on the independent and scholarly survey by Monárrez-Espino *et al* (2014) published in the *American Journal of Public Health*. This critically reviewed 21 of the more credible of the nearly 2,500 studies published between 1993 and 2013 which attempt to measure behavioural responses to LHWs or what they term pictorial warnings on cigarette packaging (PWCPs).

Monárrez-Espino *et al* found that the quality of the published research was “generally low”:

We found very large heterogeneity across studies, poor or very poor methodological quality, and generally null or conflicting findings for any explored outcome.

... we considered 57% of the reviewed studies (n=12) to be of poor or very poor quality, and only 1 could be classified as being of good quality. (p. e15)

Monárrez-Espino *et al* also state that had they used stricter criteria to assess the quality of published studies even fewer studies would have been considered for review because they adopted unacceptable methodologies and lacked sufficient scientific rigour. Notwithstanding these methodological limitations and weaknesses Monárrez-Espino *et al* concluded that:

The evidence for or against the use of PWCP is insufficient, suggesting that any effect of PWCP on behaviour would be modest.

Of the studies reviewed, two were for Latin America and both for Mexico by the same lead author. Thrasher *et al* (2012) found a positive effect of PWCPs over text warnings as a reason for quitting smoking but their empirical analysis was evaluated by Monárrez-Espino *et al* as ‘poor or very poor quality’. A later study by Thrasher *et al* (2013) found that LHWs had no ‘effect’ on cigarette sales.

Both these studies for Mexico examined whether smokers quit in the previous year based on self-assessed responses to pictorial warnings using data for 2010 and 2011 and logit regressions; the latter for 2013 based on the interviewees’ recall of warnings. Monárrez-Espino *et al* (p. e27) have raised doubts about the use of such survey data which rely on interviewees’ stated intention to stop smoking:

The results of this systematic review showed that evidence concerning the effect of PWCP on smoking behavior is inconclusive, in contrast with previous reviews reporting a significant impact on smokers' intention to quit. These results are in line with the notion that turning the intention to quit smoking into actual and sustained behavioral change is an outcome more difficult to attain and demonstrate with formal tests of effectiveness in evaluation research.

In the light of these concerns we have undertaken an exhaustive and clearly explained analysis of the Nielsen data.

IV. EMPIRICAL APPROACH

Estimating Techniques

In this report multivariate analysis has been used to investigate whether LHWs had a statistically significant effect in reducing cigarette sales.

The technical details of the econometric approaches used are set out in Annexes A and C. Here a brief description of the key features of the approach is set out for the non-technical reader.

To determine whether LHWs have affected cigarette sales we have regressed the volume of cigarette sales on the price of cigarettes, a variable representing the introduction of LHWs, the characteristics of cigarettes, and other factors (control variables) that can be expected to influence the demand for cigarettes such as income per capita:

$$(1) \quad \text{Sales} = f(\text{Price, LHW, Cigarette Characteristics, Control Variables})$$

This type of equation is routinely used in the analysis of the determinants of cigarette sales and consumption (World Bank, 2001).

The data used to estimate the above equation is Nielsen point of sale (POS) panel data i.e. pooled timeseries and cross-sectional data on cigarette sales for Mexico and Brazil. This is aggregate panel data groups sales and prices by brand or product rather than by transaction or individual purchasers. To our knowledge this is the first time Nielsen aggregate panel data has been used to assess the impact of LHWs and tobacco controls.

The Nielsen data allows the use of panel econometric techniques. The technical nature of the panel regression approach which has been used is described in Annex A.

Panel econometric models have a number of attractive properties. First, by providing repeated observations over time for the same group of products it is possible to control for missing or unobserved variables which affect the cross-sectional data. This minimises what statisticians call “heterogeneity bias” arising from omitted variables associated when cross-sectional data are correlated with the dependent variable.² In the context of cigarette sales/smoking studies these unobserved variables can be factors such as tastes, preferences, age and so on; or the different characteristics of cigarettes which may result in a different relationship between consumption and demand over time.

Secondly, the use of panel data greatly increases the sample size thereby increasing the efficiency of the estimated effects (coefficients) and their standard errors. For example, if only Nielsen timeseries data were used for Mexico there would be 28 quarterly or 104 monthly observations for each cigarette type; whereas the Nielsen panel dataset contains 23,000 observations (see Table 3 below).

Most off-the-shelf statistical packages enable panel econometrics to be applied easily such as Stata statistical package which we have used. Moreover, because individual cigarette brands and types have been introduced and removed from sale over the period in both Mexico and Brazil there are missing data for some dates and products. This creates an “unbalanced” panel data set. This is taken into account by Stata in the estimation of the panel models.

A further adjustment has been made to take account of the simultaneous determination of cigarette prices by both demand and supply factors. To ensure that the above approach estimates the impact of price on the demand for cigarettes, cigarette prices have first been regressed on cigarette taxes and US tobacco import prices to reflect supply-side influences on cigarette prices:

$$(2) \quad \text{Price} = (\text{Tax, Import Tobacco prices})$$

The adjusted cigarette prices estimated from this equation are then used as an explanatory variable to estimate the effects of LHWs on cigarette sales (in equation (1) above). Again, this is more fully explained in Annex A.

In most assessments of regulatory intervention there is a question of how to incorporate the qualitative changes brought about by regulation in a quantitative statistical assessment. Inevitably there is a conceptual and practical issue of how to adequately portray health warnings and other smoking restrictions. Specifically, the focus of this Report is the impact of changes to the exterior appearance of a cigarette pack which can be described but cannot be reduced to a single metric like the price or volume of cigarettes sales. This is routinely done in statistical research on cigarette consumption by time-related dichotomous or dummy variables. These are binary variables which take the value of zero (0) when the regulation under investigation is not present; and unity (1) for,

² The first use of panel data to estimate cigarette demand was by Baltagi and Levin (1986) which used pooled timeseries regional data by US state.

in our case, the months or quarters following the introduction of LHWs. For example, for Mexico LHWs are represented in the regressions reported in Table 4 (and Annex A) by a dummy variable which takes the value of 0 for each month prior to September 2010 when the first LHW was introduced, and 1 for each month thereafter. To illustrate what this does, one can think of the relationship between cigarette sales and other factors as a statistically measured straight line. When a dummy variable is included in the regression it shifts this line up, down, or not at all for the months or quarters when the packaging control are in place indicating that the control leads to higher, lower or negligible effects respectively on cigarette sales compared to the situation in the absence of the packaging requirements.³

General Data Considerations

The Nielsen data consists of monthly POS data collected from retail outlets on the volume of cigarette sales and revenues by brand, type, qualitative attributes (such cigarette diameter and length, flavour, filter type, pack size, etc.); type of sales outlet or “channel”; and separately by region.

Table 3: Nielsen data for Mexico and Brazil

Nielsen data	Mexico	Brazil
Brand	x	x
Flavour	x	x
Price perception	x	x
Package type	x	x
Perceived style	x	
Cigarette circumference	x	
Cigarette length	x	
Filter type	x	
Pack size	x	
Global brand owner (not used)	x	x
Blend type (not used)	x	x
Tar value (not used)	x	
Nicotine value (not used)	x	
Brand family (not used)	x	
Channels	2	4
Regions	x	7
No observations	23,000	80,000
Time period	Dec 2009-Feb 2017	Sept 2014-Feb 2017

Source: Nielsen

³ These are also referred to as “shift dummy”. Another approach is to use slope dummies to test whether the health warnings alter the slope of the line.

With the exception of price and sales volumes, the Nielsen cigarette-related variables used in the regressions - such as cigarette flavour, length, strength, filter type and pack size - are all categorical or dummy variables. For example, the variable "SUPRSLIM" which designates cigarettes with a super slim circumference is represented by a binary variable taking the value 1 for cigarettes that are super slim and 0 otherwise (for further details see Annex A, Table A1).

The Nielsen data for Mexico and Brazil differs in detail (see Table 3). For Mexico the Nielsen data is more comprehensive providing information on cigarette types and attributes for a longer period from December 2009 than Brazil which starts from September 2014. On the other hand, the Nielsen data for Brazil is broken down into more sales channels (four versus two for Mexico) and into seven regions. These differences have meant that the analysis for Mexico is more comprehensive than for Brazil, as explained below in the respective sections reporting the statistical results for the two countries.

In common with other data sources, the Nielsen data do not include data for illegal, illicit, and/or counterfeit cigarettes sales or consumption which can be, and are, significant. Given the clandestine and illegal nature of illicit cigarette sales, hard data on their volume and prices are unavailable. Estimates exist - such as those from Euromonitor International - but they may be incomplete, and lack the detail and frequency that allow them to be matched to the Nielsen aggregate panel data set. There are nonetheless ways of taking account of illicit cigarette sales. In some previous studies the lower price of cigarettes in contiguous countries/regions have been used to represent the incentive to bring in illicit cigarettes e.g. Baltagi and Levin (1986), or alternatively measures of the level of corruption and law enforcement in the country using indicators such as published by the World Bank. In this Report no adjustment has been made for illicit cigarette sales and consumption. This omission must be taken into account when interpreting the results below, but it is unlikely to affect the general conclusions about the impact of LHWs.

V. MEXICO

Data Description and Issues

The Nielsen data for Mexico is monthly sales data for the period December 2009 to February 2017 categorised by brand and type of cigarettes together with their attributes and the type of sales outlet where sold as set out in Table 3 above.

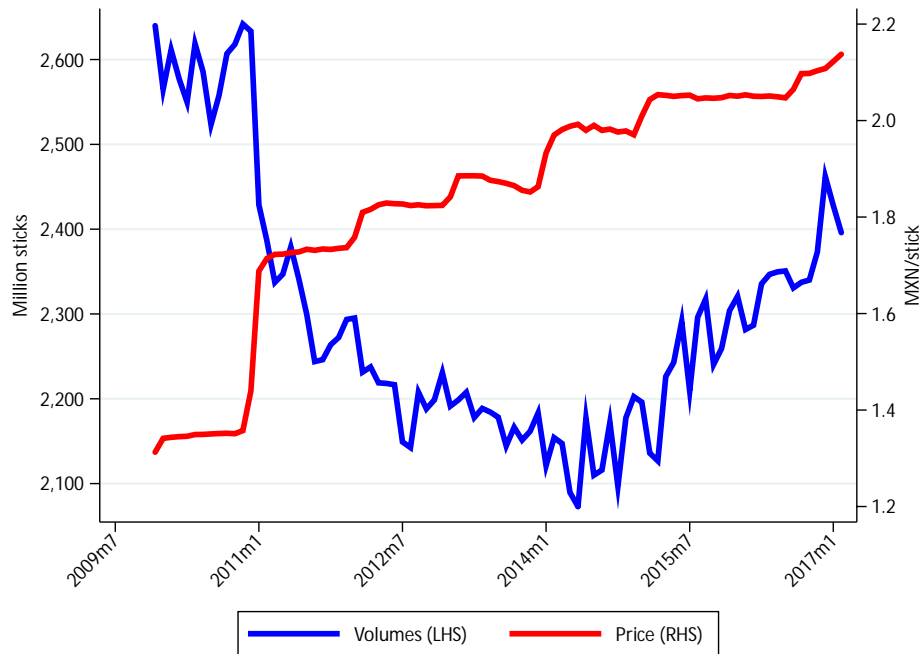
An inspection of the Nielsen data reveals some trends and differences which have been incorporated in the design of the statistical model below.

Cigarette Sales

Prior to 2014 there was an inverse relationship between aggregate cigarette sales and nominal cigarette prices as would be expected. In 2014 this changed - despite higher prices cigarette sales began and continued to increase (see Figure 1). To adjust for this the reported regressions for

Mexico have been run using data to the end of 2013 with the exception of unfiltered and menthol cap filter cigarettes that do not exhibit this structural break, and which are run for the whole period to February 2017.

Figure 1: Average monthly cigarette sales and prices, 2009 to 2017



The different trends in Nielsen cigarette sales by type suggests that smokers may react differently to the introduction of LHWs. Given the variety of cigarette brands and types smokers have considerable choice and based on their preferences, including those for the health risks associated with smoking, may switch between cigarette types. Those smokers preferring, say, a “low tar” cigarette type may in response to the introduction of LHWs change to a “very low tar” cigarette type.

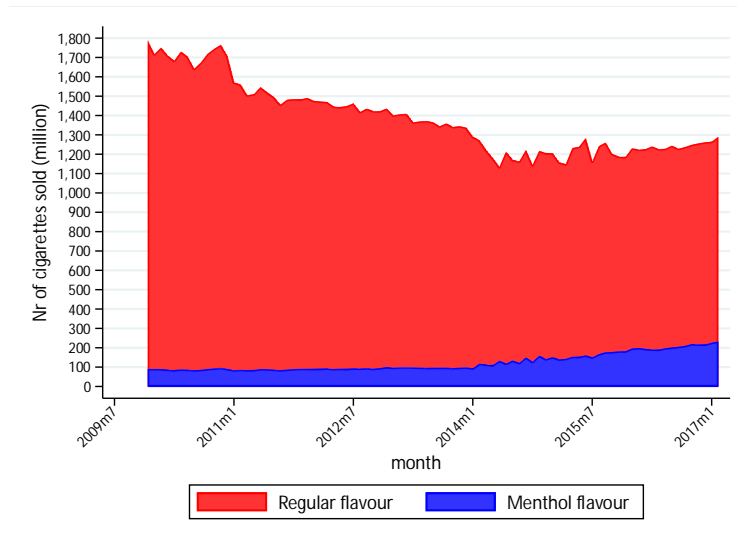
To test the hypothesis that smokers of different types of cigarettes may react differently to LHWs, separate regressions have been run for all cigarettes types (as reported in the main text below) and cigarettes categorised by Nielsen (i) by their flavour (“regular” or “menthol”); and (ii) by filter type (“regular filter”, “flavoured filter”, “non-filtered”⁴). The results of these regressions are reported in Annex A.

Other factors seem to be at play. Since 2014, the sales of menthol flavoured cigarettes relative to those for regular flavour cigarettes have increased (Figure 2 and 3 below).

⁴ “Non-filtered” cigarettes are not included in the econometric analysis due to a high degree of substitution between different non-filtered cigarettes over time.

Figure 2: Sales of regular and menthol flavoured cigarettes by channel, 2009-2017

A. Traditional channel



B. Self-service channel

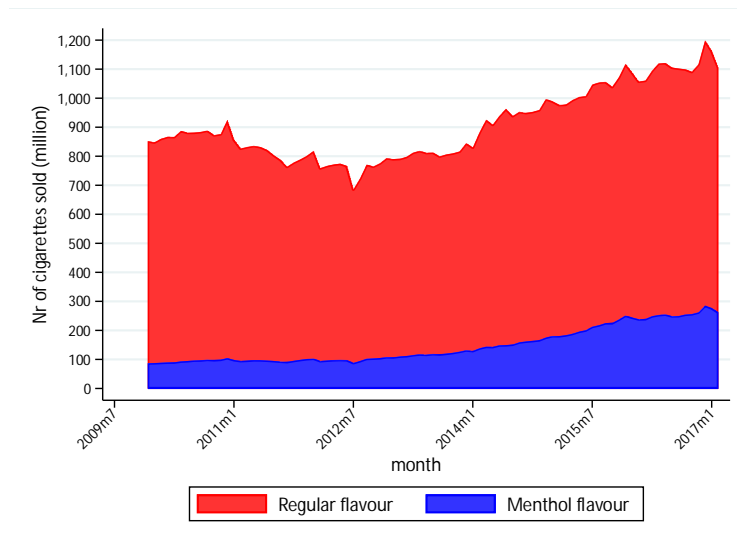
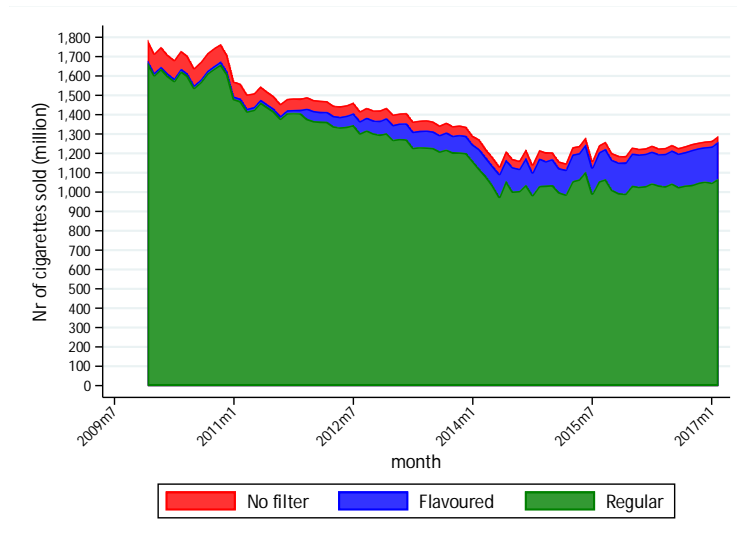
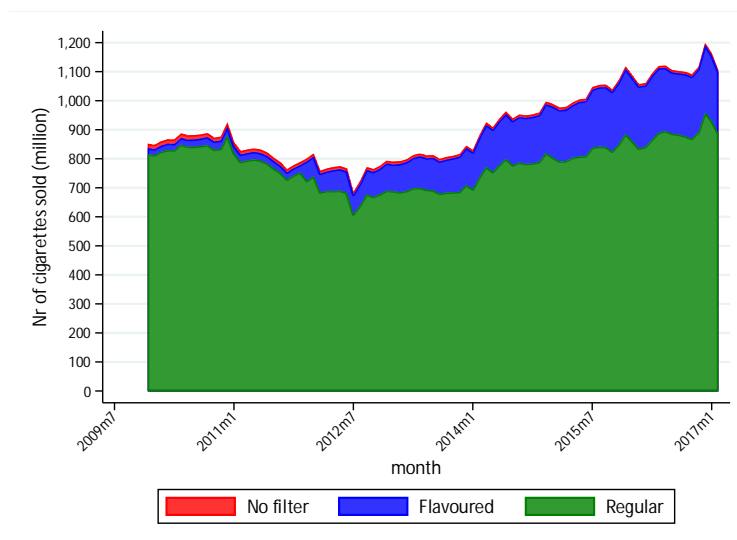


Figure 3: Sales of unflavoured and flavoured filter cigarettes by channels, 2009 to 2017

A. Traditional channel

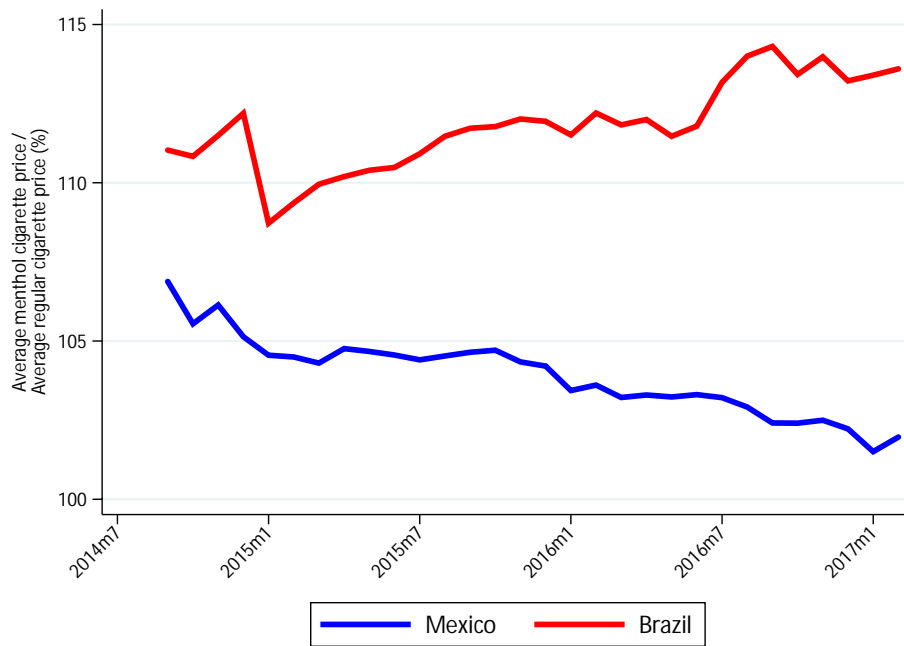


B. Self-service channel



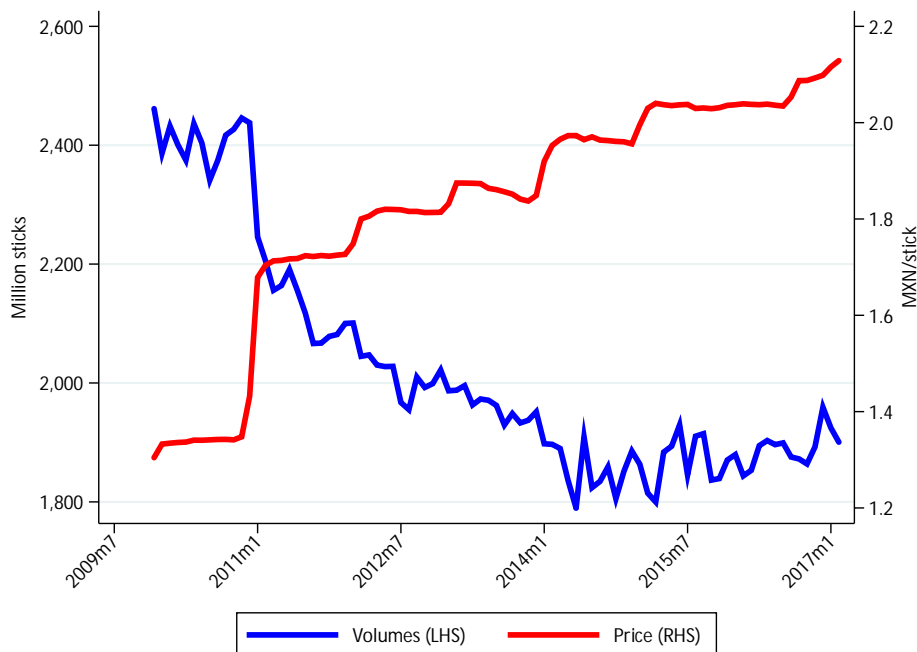
The increase in sales of this product has been attributed, in part at least, to their relatively low prices (see Thrasher *et al*, 2015). The Nielsen data (Figure 4) confirms that the prices of flavoured filter cigarettes were relatively low in Mexico, and became cheaper in relative terms after 2014 (which is not the case according the Nielsen data for Brazil).

Figure 4: Relative price of menthol flavoured cigarettes in Mexico & menthol cap cigarettes in Brazil, %, 2014-2017



However, the increase in sales menthol flavour cigarettes do not fully account for the increase in cigarette sales after 2014 as sales of regular cigarettes also increased slightly (see Figure 5 below).

Figure 5: Monthly sales and ASPs, regular cigarettes, 2009 to 2017



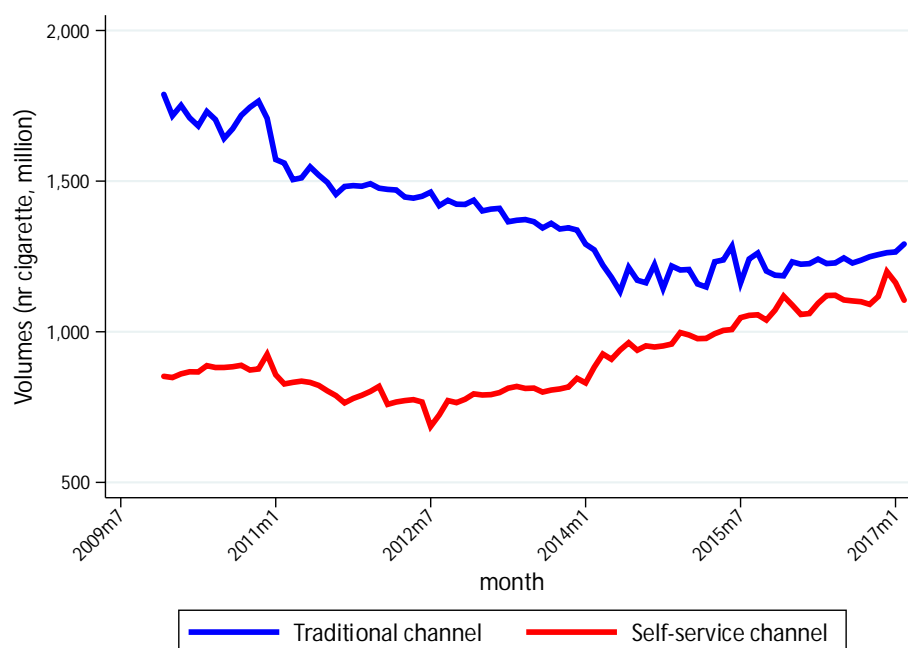
Sales Channels

The Nielsen data for Mexico segments sales into two types of retail outlets or channels:

- “Traditional/kiosk” which consists of groceries, emporia, warehouses and kiosks.
- “Self-service” which consists of supermarkets, cooperatives, convenience stores and gas stations.

These sales channels exhibit different trends in cigarette sales. Figure 6 (below) shows that cigarette sales from traditional outlets declined to about 2014 after which they increased. Over the same period cigarette sales in self-service outlets were much lower than those of traditional channels and declined until around 2012. Thereafter self-service cigarette sales increased rapidly so that today the market is more or less equally split between the two sales channels. This indicates the growing importance of self-service outlets, due possibly to the combine effect of customers migrating from traditional to service channels, and exogenous factors that led to the increase in cigarette sales from both channels after 2014 as already noted.

Figure 6: Cigarette sales by channel 2000 to 2017



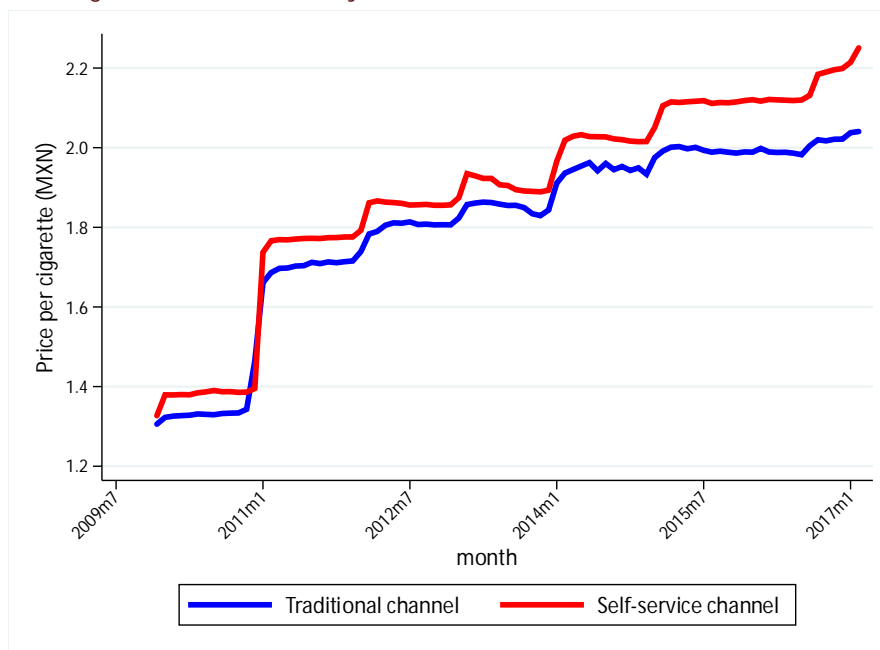
Prices

Nielsen collects monthly data on cigarette sales by volume and value. From this the Average Selling Price (ASP) per stick has been calculated. This “price” is not a transaction price as such but an average price for the sales of the specific type or brand of cigarette taking account of discounts, promotions and other variations in pricing

Four distinct trends in cigarette prices are evident from Figure 7 below:

1. The very significant and continuous increase in nominal cigarette prices.
2. The large increase in cigarette prices in 2011 due to a significant increase in excise taxes (see further below).
3. The discrete jumps in the way cigarette prices increase; and
4. Finally, the ASPs of cigarettes sold in self service outlets are higher and rose faster than for traditional outlets. On closer inspection this appears to be due the larger proportion of higher priced "premium" cigarettes sold in self-service outlets. There is no evidence that prices for the same brand were higher in self-service outlets.

Figure 7: Price trends by channel, 2009 to 2017



Implications

Based on the above trends in prices and cigarettes sales, the statistical analysis for Mexico has been separately undertaken for each sales channel and for the shorter period to 2014, by brand panels (rather than SKUs or cigarette types) to reflect smoker brand loyalty; and run separately for different types of cigarettes (all, flavoured filter, unflavoured filter, and menthol).

Approach and Results

Because of the different trends in the sales of cigarettes by sales channels separate regressions have been estimated for each channel. For each regression the volume of cigarette sales has been

regressed on their prices; and a number of dummy variables representing the cigarette characteristics such as flavour, filter type, cigarette length, diameter tar yield, and pack size (whether 15, 16, 18, 20, 24, or 25 cigarettes per pack). GDP per capita and the percentage urban population have been used to capture the wider influences on cigarette sales. These variables are defined in Table A1 in Annex A.

In the light of the evolution of LHWs in Mexico two representations of LHWs have been used – a single dummy (LHW) for the overall presence of LHWs; and, alternatively, three separate dummies, one each for the time intervals between the implementation of the “Accord 2010”, “Accord 2011” and “Accord 2013” respectively. The latter gives estimates of the impact of the separate Accords or more specifically whether the quarterly rotation of pictorials independent affected the volume of cigarette sales.

Table 4 below reports the results of regressions using quarterly data⁵ and brand panels separately for traditional and self-service sales channels⁶ for the period January 2010 to December 2013:

- Equations (1) and (4) exclude the LHW dummies providing a reference to see how their inclusion affect the regression estimates when the LHWs dummies are included.
- Equations (2) and (5) use a single LHW dummy to capture the introduction and subsequent effects, if any, of LHWs.
- Equations (3) and (6) use three LHW “Accord” dummies to test whether the introduction of LHWs in 2010, 2011 and 2013 respectively had separate incremental effects on the volume of cigarette sales.

Similar regressions are run for different types of cigarettes as reported in Annex A.

The explanatory power using brand-level fixed effects regressions is relatively high with a R^2 of over 0.4. The regressions explain demand well with the coefficients together significantly different from zero with a high F-test. The excise tax instrument (see Annex A) explains prices well. This suggests that a) that there is strong brand-loyalty as would be expected; and b) price is dependent on the level of specific excise taxes as would be expected.

⁵ Monthly data produced estimates with positive price elasticities. Possible explanations for this are that monthly data may be too short to pick up smokers’ reactions to price changes given the ‘stepped’ nature of cigarette price increases and the ‘addictive’ nature of smoking.

⁶ The first stage IV regressions omitted and reported in Annex A

Table 4: FE-IV regressions of all cigarettes by sales channels and brand panels, 2010 -2013

	Traditional/kiosk channels			Self-service channels		
	no LHW (1)	2010 LHW (2)	LHW Accords (3)	no LHW (4)	2010 LHW (5)	LHW Accords (6)
LHW		0.192 (0.113)			0.350*** (0.00939)	
Accord 2010			0.165 (0.135)			0.462*** (0.000780)
Accord 2011			0.129 (0.404)			0.579** (0.0132)
Accord 2013			0.171 (0.372)			0.376 (0.185)
ln(Traditional price)	-0.479 (0.240)	-0.710* (0.0838)	-0.847* (0.0646)			
ln(self-service price)				-0.211 (0.739)	-0.640 (0.384)	-0.0716 (0.931)
REGFLAV	2.094*** (0.00950)	2.095*** (0.00946)	2.096*** (0.00939)	1.295** (0.0410)	1.305** (0.0416)	1.292** (0.0417)
CIGLENGTH 81-90	-1.181 (0.137)	-1.174 (0.141)	-1.170 (0.144)	-1.654 (0.189)	-1.673 (0.184)	-1.655 (0.188)
CIGLENGTH 91-100	-1.077 (0.336)	-1.065 (0.343)	-1.057 (0.350)	-1.218 (0.412)	-1.199 (0.418)	-1.231 (0.410)
LIGHTS	-1.199*** (0.000679)	-1.198*** (0.000673)	-1.196*** (0.000678)	-0.336 (0.392)	-0.322 (0.415)	-0.341 (0.375)
MILD	-5.393*** (0)	-5.393*** (0)	-5.394*** (0)	-4.654*** (0.00436)	-4.750*** (0.00410)	-4.615*** (0.00481)
SUPRLGHT	-1.825*** (9.62e-09)	-1.809*** (9.88e-09)	-1.798*** (1.67e-08)	2.510*** (2.31e-05)	2.598*** (1.35e-05)	2.474*** (2.30e-05)
SPRSLIMS	-3.394*** (0)	-3.401*** (0)	-3.405*** (0)	-2.645*** (3.34e-05)	-2.744*** (2.85e-05)	-2.616*** (0.000167)
REGFLTER	-0.773 (0.219)	-0.786 (0.211)	-0.794 (0.206)	-1.210** (0.0482)	-1.254** (0.0455)	-1.199* (0.0593)
PACK 15	0.701 (0.285)	0.650 (0.310)	0.620 (0.347)	2.004** (0.0120)	1.932** (0.0166)	2.015** (0.0121)
PACK 18	0.00138 (0.998)	-0.00811 (0.988)	-0.0142 (0.979)	-0.649 (0.466)	-0.769 (0.360)	-0.608 (0.474)
PACK 20	1.846*** (4.40e-06)	1.833*** (4.82e-06)	1.825*** (4.54e-06)	1.123** (0.0201)	1.088** (0.0230)	1.132** (0.0168)
PACK 24	0.166 (0.915)	0.118 (0.940)	0.0889 (0.954)	2.760 (0.185)	2.713 (0.191)	2.778 (0.178)
PACK 25	2.102*** (0.00174)	2.054*** (0.00220)	2.027*** (0.00239)	2.007*** (8.34e-05)	1.924*** (0.000150)	2.030*** (6.05e-05)
ln(GDP capita)	-2.357 (0.612)	-4.739 (0.346)	-2.428 (0.679)	2.698 (0.764)	-1.744 (0.834)	-11.40 (0.209)
ln(URBAN)	1.885 (0.886)	7.805 -0.57	2.121 (0.906)	-20.63 (0.442)	-10.17 (0.687)	15.53 (0.531)
No. observations	1,842	1,842	1,842	1,958	1,958	1,958
R ²	0.461	0.462	0.462	0.436	0.431	0.438
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Brand-level dummies are included but not indicated in the output table (33 distinct product brands are indicated in the dataset). Robust *pval* in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The coefficients for LHW dummies are positive – indicating that LHW have increased cigarette sales - but statistically insignificant with the exception of the LHW 2010 and Accord 2010 dummies for the self-service channel regressions (Equations (5) and (6)) which are positive and statistically significant.

All regressions fail to find a statistically significant reduction in cigarette sales associated with the introduction of LHWs in Mexico.

For the self-service channel the LHW dummies increase in the volume of cigarette sales and this effect was statistically significant.

VI. BRAZIL

Data Description and Issues

The Nielsen data for Brazil is less detailed than for Mexico. It is for:

- a shorter period from September 2014 to February 2017; and
- only categorized by brand, manufacturer, brand segment, cigarettes type, pack type (soft or box), flavour and blend.

On the other hand, the data is broken down by four sales channels – “self-service” consisting of supermarkets, cooperatives, convenience stores, gas stations⁷; “bakeries”, “other traditional”⁸ (consisting of groceries, emporia, warehouses); and “bars” (consisting of bars and snack bars)⁹.

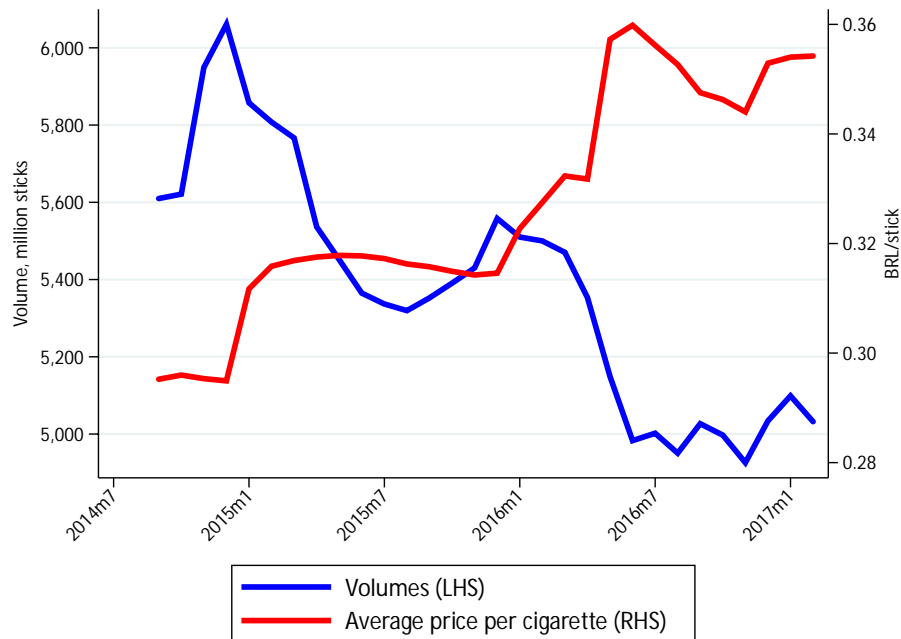
Unlike Mexico the Nielsen data show that cigarette sales and prices were inversely related over the period (Figure 8). Sales of cigarettes overall and by channel, flavour, brand segment, package type, and brand all fell during the period, with the exception of menthol cigarettes. Cigarettes with flavoured filters gained sales from 210 million sticks per month in 2014/15 to 239 million sticks per month despite an increase in ASPs (prices) from 0.34 BRL per stick to 0.39 BRL per stick.

⁷ Convenience store channel not shown separately for all areas. Hence, we did not consider it as a sub-channel within self-service.

⁸ Other traditional = Total traditional – Bakeries (as per instructions of Nielsen)

⁹ Sales for the Horeca (hotels, restaurants, cafes) channel is not reported by Nielsen.

Figure 8: Cigarette sales and prices, Brazil 2014 -2017



There is evidence that the significant increase in prices resulted in reduction in cigarette sales (again with the exception of flavoured filter cigarettes). For example, the sales of “low tar cigarettes” (as classified by Nielsen) fell from 3.53 billion sticks/month in 2014/15 to 3.27 billion sticks/month in 2016/17 at the same time as their prices increased from 0.31 BRL per stick to 0.34 BRL per stick. Similarly, sales of “full flavoured” cigarettes decreased slightly from 1.26 billion sticks/month in 2014/15 to 1.17 billion sticks/month in 2016/17 while their ASPs increased from 0.30 BRL per stick to 0.33 BRL per stick.

Regression Specifications

Given the more limited data for Brazil the estimating regression equations have had to be modified and simplified.

After examining the underlying sales trends by region and sales channel regressions have been run for different cigarette types - for all cigarettes types as reported in Table 5 below, and separately as reported in Annex C for (i) cigarettes excluding menthol cigarettes, (ii) for the three brand segments low, medium and premium value; and (iii) for menthol filtered cigarettes only. The regressions have been estimated using brand, regional and channel fixed effects i.e. dummies. Because of the limited data for Brazil only a few cigarette attributes have been included as explanatory variables - pack type, light and whether superlight). The control variables GDP and population were not included as they were insignificant and correlated with other variables.

As the Nielsen data only starts in September 2014 it has only been possible to examine the LHWs introduced on 1 January 2016. Since LHWs were already in place prior to this date, our analysis at best, only estimates the incremental effect of the 2016 enhancement and not the overall impact of LHWs on cigarette sales in Brazil. The analysis is therefore less comprehensive than that for Mexico, and therefore caution must be exercised in extrapolating from the results to a generalisation about the possible overall impact of LHWs in Brazil.

Results

Table 5 below reports the regression results without and with the LHW 2016 dummy using monthly data for all cigarette sales and brand, regional, and sales channels panels (not reported) with standard errors in brackets and p-values in asterisks. The instrumental variable regressions are reported in Annex C.

The regression using all cigarettes has an R^2 of 0.4 (i.e. explains around 40% of the variation in cigarette sales) while those reported in Annex C based on different flavoured filter types and different brand segments explain between 40% to 60% of the variation in cigarette sales. This is relatively high explanatory power for aggregate panel data regressions.

Table 5: Regression for all cigarettes, Sept 2014 to Feb 2017

Independent variable	No LHW (1)	LHW 2016 (2)
LHW 2016		0.155*** (3.29e-05)
ln(price)	-0.0258 (0.921)	-1.213*** (0.000165)
SOFT PACK	0.175** (0.0363)	0.131 (0.102)
FLAVOUR = LIGHT	0.238** (0.0130)	0.226** (0.0191)
FLAVOUR = MENTHOL CAPSULE	-0.935*** (9.19e-09)	-0.921*** (1.84e-08)
FLAVOUR = SUPER LIGHT	-0.190 (0.218)	-0.180 (0.243)
No. observations	85,311	85,311
R^2	0.408	0.402
$Prob > F$	0.00	0.00

Notes: Panel dummies are included but not indicated (76 brands; 7 regions; 4 channels). Robust *pval* in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The LHW 2016 dummy did not lead to a statistically significant reduction in cigarette sales in Brazil. This is also true for regressions by type of cigarette reported in Annex C.

In many regressions the LHW 2016 dummy had a statistically significantly positive sign which has unexpected and indicates that the LHW dummy is picking up other factors that increased cigarette sales after 2016.

The statistical analysis for Brazil does not find a statistically significant reduction in cigarette sales associated with the enhancement of LHWs in 2014.

VII. CONCLUSIONS

The statistical analysis above does not find any evidence of a statistically significant reduction in cigarette sales associated with the introduction and/or enhancement of LHWs in either Mexico or Brazil.

References

Baltagi, B H and D Levin (1986) "Estimating Dynamic Demand for Cigarettes Using Panel Data: The effects of bootlegging, taxation and advertising reconsidered" *Review of Economics and Statistics*, Vol. 48, pp. 148-155.

Cavalcante, T M (2003) *Labelling and Packaging in Brazil*, World Health Organisation.

Deloitte (2011) *Tobacco Packaging Regulation – An International assessment of the intended and unintended impacts*, Report prepared for British American Tobacco, May.

Euromonitor (2016) *Passport – Tobacco in Brazil*, Euromonitor International.

Guindon, G E, G R Paraje & F J Chaloupka (2015) 'The Impact of Prices and Taxes on the Use of Tobacco Products in Latin America and the Caribbean', *American Journal of Public Health*, Vol 105(3), pp. e9–e19.

Jimenez-Ruiz, J. A. *et al* (2008) 'The Impact of Taxation on Tobacco Consumption in Mexico' *Tobacco Control*, Vol. 17, pp. 105-110.

Laffer, A B (2014) *The Handbook of Tobacco Taxation – Theory and practice*, The Laffer Center at the Pacific Research Institute.

Monárrez-Espino, J, B Liu, F Greiner, S Bremberg & R Galanti (2014) 'Systematic Review of the Effect of Pictorial Warnings on Cigarette Packages in Smoking Behavior', *American Journal of Public Health*, Vol 104(10), pp. e11-e30.

Thrasher, J F, M C Rousu, R Anaya-Ocampo, L M Reynales-Shigematsu, E Arillo-Santillán, M Hernández-Ávila (2007) 'Estimating the Impact of Different Cigarette Package Warning Label Policies: The auction method', *Addictive Behaviors*, Vol. 32, pp. 2916–2925.

Thrasher JF, R Perez-Hernandez, E Arillo-Santillan, & I Barrientos-Gutierrez (2012) 'Towards Informed Tobacco consumption in Mexico: Effect of pictorial warning labels in smokers' *Salud Publica Mexico* 2012, Vol. 54(3) pp 242-253.

Thrasher, J F, N Murukutla, R Perez Hernandez, *et al* (2013) 'Linking Mass Media Campaigns to Pictorial Warning Labels on Cigarette Packages: A cross-sectional study to evaluate effects among Mexican smokers' *Tobacco Control*, Vol 22(e1), pp. e57-e65.

Thrasher, J F, E N Abad-Vivero, C Moodie, *et al* (2015) 'Cigarette brands with Flavour Capsules in the Filter: Trends in use and brand perceptions among smokers in the USA, Mexico and Australia, 2012-2014' *Tobacco Control*, November 13, pp. 1-9.

Waters, H, B Sáenzde Miera, H Ross, L M Reynales Shigematsu (2010) *The Economics of Tobacco and Tobacco Taxation in Mexico*, International Union against Tuberculosis and Lung Disease.

Wooldridge, J M (2014) *Introduction to Econometrics*, Europe, Middle East & Africa edition, Cengage Learning.

World Bank (2001) *Economics of Tobacco Toolkit: Tool 3 - Demand Analysis: Economic Analysis of Tobacco Demand* by N Wilkins, A Yurekli and T-w Hu.

ANNEX A: REGRESSION OUTPUTS FOR MEXICO BY CIGARETTE TYPE

Regression Technique

The basic panel regression equation used for both Mexico and Brazil takes a double-log specification:

$$(1) \quad \ln Sales_{it} = a_i + \theta_t LHW_t + \theta_{it} \ln \widehat{Price}_{it} + \theta_i Y_i + \theta_2 \ln X_t + e_{it}$$

Where variables i are collected for each date t for periods $T = 1, 2, \dots, T$:

- $\ln Sales_{it}$ is the natural log of the sales of number of cigarette sticks.
- $\ln \widehat{Price}_{it}$ is the natural log of the (instrumented) average sales price (ASP) of a cigarette stick derived from Equation (2) below.
- LHW_t is a vector of dummy variables representing the introduction/modifications of LHWs.
- Y_i is a vector of dummy or categorical variables representing the quality attributes of different types of cigarettes such as cigarette length, circumference, filter flavor, whether menthol or not, and number in a pack.
- $\ln X_t$ is a vector of control variables – specifically GDP per capita (GDP) and urban population (URBAN) in logarithmic form (for Mexico only).
- a_i is a constant term.
- e_{it} is the error or disturbance term.

Based on an initial exploratory empirical analysis (not reported¹⁰) a large number of different specifications of the estimating equation were assessed. Drawing on statistical, economic and data considerations a fixed effects-instrumental variable (FE-IV) approach has been adopted. To adjust for individual fixed effects least squares dummy variable (LSDV) regressions have been used (Wooldridge, 2014, Chap 14).¹¹ For Mexico brand dummies have been used; while for Brazil brand, regional and retail sales channel dummies have been used. The difference in the type and number of dummies is due to differences in the detail of the Nielsen data for Mexico and Brazil respectively.

Fixed Effects (FE) models are routinely used by econometricians to analyse panel data when the impact of factors that vary over time is the core focus of their analysis.

¹⁰ We also considered pooled Ordinary Least Squares (OLS) and Fixed Effects only approaches. These were rejected because the pooled OLS approach does not take account of potential brand or product loyalty and the endogeneity of cigarette prices and sales. The Fixed Effects model without instrumental variables can accommodate brand or product loyalty but takes no account of the simultaneity between prices and cigarette sales.

¹¹ There are other approaches to FE regression analysis such “differencing” or “time-demeaning” the data. See Wooldridge, esp. pp. 391-394.

The Nielsen data is aggregate panel data that allows us to take into account both time series and cross-sectional data on cigarette sales and prices. The approach assumes that cigarette sales are dependent on certain product characteristics, and that changes in cigarette sales are mainly observed within groups of cigarettes featuring these characteristics.

Further, because market demand and supply are likely to be simultaneously determined, the price of cigarettes in Equation (1) will be endogenously determined. This means that the estimated coefficients using a pooled OLS or FE regression will be biased and inefficient. To ensure that the above estimates the impact of price on demand an instrumental variable (IV) approach has been used. This involves two sequential regressions. In the first-stage prices are regressed on a set of instrumental variables – cigarette taxes and US tobacco import prices - that are expected to explain changes in supply but not in demand conditions:¹²

$$(2) \quad \ln Price_{it} = \beta_1 + \beta_2 Excise_t + \beta_3 \ln US Tobacco Import Price_t + e_{it}$$

The adjusted (or instrumented) cigarette prices estimated from this equation $\widehat{\ln Price}_{it}$ are then used in a second regression (Equation (1) above) to estimate the effects of LHWs on cigarette sales.

Definitions of Variables

The variables used to estimate the above equations for Mexico are defined in Table A1 together with their sources.

Table A1: Definition of variables used in Mexico regression equations

Variable name	Description*	Interpretation
Cigarette variables:		
In(Price)	Log of price per stick	1% change in prices leads to x% change in sales
In(traditional price)	Log of price per stick for traditional kiosk channel	
In(self-service price)	Log of price per stick for self-service channel	
REGFLAV	Binary variable which equals 1 if the cigarette is regular flavoured	Difference between sales of regular flavoured cigarettes and menthol flavoured cigarettes
CIGLENGTH	Binary variable which is one if the cigarette length is between 81 mm and 90mm and 91mm-100mm respectively	Difference between sales of 81-90mm/91-100mm cigarettes and 70-80mm cigarettes
LIGHT MILD SUPRLIGHT	Separate binary variables which equals 1 if the cigarette is light, mild, of super light respectively	Difference between sales of light, mild, and super light cigarettes and cigarettes with full flavour
SUPERSLIM	Binary variable which equals 1 if the cigarette circumference is super slim	Difference between sales of super slim cigarettes in comparison to cigarettes with regular circumference
REGFILTER	Binary variable which equals 1 if the filter type is regular	Difference between sales of regular filtered cigarettes in comparison to flavoured filtered cigarettes

¹² US import price is used as a proxy for internationally observed tobacco prices that do not have anything to do with demand in Mexico/Brazil. Since it is changes rather than the absolute price level that matter in an econometric setup, one can interpret it as a proxy for costs that affect every tobacco manufacturer, assuming that international import prices reflect changes in production costs.

PACK SIZE	Six binary variables equal to 1 if packs have 15, 16, 18, 20, 24 and 25 cigarettes respectively	Difference between sales of cigarettes sold in packs of 15/16/18/20/24/25 and packs of 14
Large health warning dummies		
LHW	Binary variable which equals one in 2010 (Q4) and afterwards, and zero prior to 2010	Effect of LHW on sales from 2010Q4, in comparison to prior sales
Accord 2010	Binary variable which equals one in 2010 (Q4) to September 2011	Effect on sales of respective Accords during the stated period compared with sales prior to 2010 and respective prior Accord
Accord 2011	Binary variable which equals one from October 2011 to September 2012, and zero otherwise	
Accord 2013	Binary variable which equals one from April 2013 to end of period	
Control variables		
ln(GDP/capita)	Log of seasonally adjusted GDP per capita in pesos Source: INEGI (GDP); World Development Indicators (population)	1% change in GDP/capita leads to x% change in sales
ln(urban)	Log of annual urban population smoothed quarterly Source: World Development Indicators	1% change in urban population leads to x% change in sales
Instrumental variables:		
Specific tax	Specific excise tax in pesos Source: JTI	1% increase in specific tax leads to x% increase in cigarette prices
ln(US Tobacco Import Price)	Natural logarithm of quarterly US import price of imported tobacco Source: Ycharts.com	1% change in US tobacco import price leads to x% change in prices (and through prices it affects sales volumes)

* Source for cigarette data is Nielsen

To estimate Equation (2) two instrumental variables have been used: cigarette taxes and US import prices of tobacco. A2 shows the excise taxes imposed on cigarettes over the period 2008 to 2017. Since the *ad valorem* excise tax did not change during the period it cannot be used as an instrument (since this requires variation in order to provide a statistical relationship between it and changes in the price level). Only the specific excise tax changed, and this has been used as an instrument as a dummy variable. US import prices of tobacco have been used as a proxy for the production costs of cigarette manufacturers.

Table A2: Tobacco excise taxes 2008-2017

Tax	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Ad-valorem excise (% price to trade)	150%	160%	160%	160%	160%	160%	160%	160%	160%	160%
Specific Excise (MXN per 1,000 cigarettes)	0	0	40	350	350	350	350	350	350	350

The results of estimating the above equations using brand panels separately for traditional and self-service retail outlets are shown in Table A3 below. The regressions have also been estimated without the LHW dummies to see the impact that the inclusion of these dummies has on the other estimated coefficients (and whether these are picking up effects correlated with these other variables). The results of our preferred regression are discussed in the main text.

Table A3: FE-IV regressions of all cigarettes by sales channels and brand panels, 2010 -2013

	Traditional/kiosk channels			Self-service channels		
	no LHW (1)	2010 LHW (2)	LHW Accords (3)	no LHW (4)	2010 LHW (5)	LHW Accords (6)
LHW		0.192 (0.113)			0.350*** (0.00939)	
Accord 2010			0.165 (0.135)			0.462*** (0.000780)
Accord 2011			0.129 (0.404)			0.579** (0.0132)
Accord 2013			0.171 (0.372)			0.376 (0.185)
ln(Traditional price)	-0.479 (0.240)	-0.710* (0.0838)	-0.847* (0.0646)			
ln(self-service price)				-0.211 (0.739)	-0.640 (0.384)	-0.0716 (0.931)
REGFLAV	2.094*** (0.00950)	2.095*** (0.00946)	2.096*** (0.00939)	1.295** (0.0410)	1.305** (0.0416)	1.292** (0.0417)
CIGLENGTH 81-90	-1.181 (0.137)	-1.174 (0.141)	-1.170 (0.144)	-1.654 (0.189)	-1.673 (0.184)	-1.655 (0.188)
CIGLENGTH 91-100	-1.077 (0.336)	-1.065 (0.343)	-1.057 (0.350)	-1.218 (0.412)	-1.199 (0.418)	-1.231 (0.410)
LIGHTS	-1.199*** (0.000679)	-1.198*** (0.000673)	-1.196*** (0.000678)	-0.336 (0.392)	-0.322 (0.415)	-0.341 (0.375)
MILD	-5.393*** (0)	-5.393*** (0)	-5.394*** (0)	-4.654*** (0.00436)	-4.750*** (0.00410)	-4.615*** (0.00481)
SUPRLGHT	-1.825*** (9.62e-09)	-1.809*** (9.88e-09)	-1.798*** (1.67e-08)	2.510*** (2.31e-05)	2.598*** (1.35e-05)	2.474*** (2.30e-05)
SPRSLIMS	-3.394*** (0)	-3.401*** (0)	-3.405*** (0)	-2.645*** (3.34e-05)	-2.744*** (2.85e-05)	-2.616*** (0.000167)
REGFLTER	-0.773 (0.219)	-0.786 (0.211)	-0.794 (0.206)	-1.210** (0.0482)	-1.254** (0.0455)	-1.199* (0.0593)
PACK 15	0.701 (0.285)	0.650 (0.310)	0.620 (0.347)	2.004** (0.0120)	1.932** (0.0166)	2.015** (0.0121)
PACK 18	0.00138 (0.998)	-0.00811 (0.988)	-0.0142 (0.979)	-0.649 (0.466)	-0.769 (0.360)	-0.608 (0.474)
PACK 20	1.846*** (4.40e-06)	1.833*** (4.82e-06)	1.825*** (4.54e-06)	1.123** (0.0201)	1.088** (0.0230)	1.132** (0.0168)
PACK 24	0.166 (0.915)	0.118 (0.940)	0.0889 (0.954)	2.760 (0.185)	2.713 (0.191)	2.778 (0.178)
PACK 25	2.102*** (0.00174)	2.054*** (0.00220)	2.027*** (0.00239)	2.007*** (8.34e-05)	1.924*** (0.000150)	2.030*** (6.05e-05)
ln(GDP capita)	-2.357 (0.612)	-4.739 (0.346)	-2.428 (0.679)	2.698 (0.764)	-1.744 (0.834)	-11.40 (0.209)
ln(URBAN)	1.885 (0.886)	7.805 -0.57	2.121 (0.906)	-20.63 (0.442)	-10.17 (0.687)	15.53 (0.531)
No. observations	1,842	1,842	1,842	1,958	1,958	1,958
R ²	0.461	0.462	0.462	0.436	0.431	0.438
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Brand-level dummies are included but not indicated in the output table (33 distinct product brands are indicated in the dataset). Robust *pval* in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A4: IV Regression of all cigarette prices, 2010-2013

	Traditional/kiosk channels			Self-service channels		
	no LHW (1)	2010 LHW (2)	LHW Accords (3)	no LHW (4)	2010 LHW (5)	LHW Accords (6)
Specific Excise	0.209*** (0)	0.205*** (0)	0.199*** (0)	0.202*** (0)	0.200*** (0)	0.201*** (0)
ln(US Tobacco Import Price)	-0.0207 (0.797)	-0.0604 (0.437)	-0.0848 (0.252)	-0.124* (0.0621)	-0.144** (0.0189)	-0.116* (0.0512)

The standard errors of the estimated coefficients are in brackets together with level of statistical significance denoted by asterisks as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.¹³

The absence of any statistical reduction in the volume of cigarette sales associated with the introduction of LHWs has already been discussed in the text.

The other estimates which warrant comment are those of the price elasticity of demand. The estimated price elasticities of demand - which measure the percentage change in cigarette sales in response to a percentage change in prices – have the expected negative sign but are generally statistically insignificant except for traditional retail outlets (in Equations (2) and (3)) where they are significant at the 10% level). The magnitude of the elasticity estimates – though statistically insignificant – without the LHWs dummies (Equations (1) and (4)) are similar to the mean of those estimated by other studies at around -0.4 to -0.5 i.e. inelastic.¹⁴ In the majority of the regressions the price elasticity estimates increase to between -0.6 to -0.8 when the LHWs dummies are included which suggests that the LHWs dummies are picking-up increased cigarette sales linked to cigarette prices, and hence exaggerating the negative effect of cigarette prices on sales.

Regressions by Type of Cigarettes

Similar regressions have been run for different types of cigarettes as reported below in Tables A5 to A8. These have been estimated to December 2013 for cigarettes with regular filters (Table A5); and to December 2016 for flavoured filtered cigarettes (Table A6), for unflavoured filtered

¹³ Instead of reporting the F-statistics themselves (as it is difficult to see right away if the F-statistics are high enough) we inserted the p-values of F-statistics in the regression output tables. This allows us to interpret the general reliability of the model in the same framework as p-statistics of individual regression coefficients are interpreted (e.g. with critical value of 1% or 5%). The regression results show p-values close to zero meaning that there is a strong indication that our regression coefficients are jointly different from zero. Hence they (jointly) explain variations in sales volumes very well.

¹⁴ Elasticities are described as elastic and inelastic depending on whether the percentage quantity response is greater or less than the percentage price change. Research on the demand for cigarettes exhibits a wide range of elasticities varying from low to very elastic. These differences can be due differences in data, time period, country and statistical approach as much as any underlying economic factors (see Laffer, 2014; Waters *et al*, 2010; Guindon *et al*, 2015).

cigarettes (A7) and menthol flavoured cigarettes (Table A8) because there was no structural break in the sales data for these types of cigarettes.

Table A5: Cigarettes with regular filters, 2010(Q1) - Q42013(Q4)

	Traditional/kiosk channel		Self-service channel	
	no LHW (1)	2010 LHW (2)	no LHW (3)	2010 LHW (4)
LHW		0.204* (0.0884)		0.433** (0.0114)
ln(Traditional price)	-0.514 (0.236)	-0.752* (0.0908)		
ln(self-service price)			0.273 (0.625)	-0.262 (0.694)
REGFLAV	2.327** (0.0101)	2.328** (0.0101)	1.321* (0.0696)	1.331* (0.0720)
CIGLENGTH 81-90	-1.490** (0.0342)	-1.484** (0.0360)	-1.954 (0.112)	-1.973 (0.108)
CIGLENGTH 91-100	-1.940** (0.0255)	-1.929** (0.0270)	-2.065 (0.105)	-2.041 (0.108)
LIGHTS	-1.421*** (0.00166)	-1.419*** (0.00164)	-0.621 (0.217)	-0.604 (0.230)
MILD	-5.952*** (0)	-5.953*** (0)	-5.205*** (0.00231)	-5.324*** (0.00216)
SUPRLGHT	-2.005*** (4.74e-08)	-1.988*** (4.99e-08)	2.073*** (0.00111)	2.182*** (0.000653)
SPRSLIMS	-3.319*** (0)	-3.327*** (0)	-2.258*** (8.79e-07)	-2.383*** (6.73e-07)
PACK 15	0.713 (0.333)	0.659 (0.359)	2.292*** (0.00514)	2.200*** (0.00826)
PACK 18	-0.141 (0.760)	-0.151 (0.746)	-0.457 (0.614)	-0.605 (0.475)
PACK 20	1.870*** (1.40e-05)	1.856*** (1.46e-05)	1.405** (0.0278)	1.362** (0.0308)
PACK 24	0.0343 (0.981)	-0.0152 (0.992)	2.829 (0.171)	2.772 (0.178)
PACK 25	1.950*** (0.00190)	1.899*** (0.00244)	2.168*** (5.22e-05)	2.064*** (8.95e-05)
ln(GDP / capita)	-0.0156 (0.998)	-2.604 (0.656)	-0.610 (0.940)	-6.169 (0.399)
ln(URBAN)	-7.577 (0.628)	-1.137 (0.944)	-13.89 (0.571)	-0.741 (0.974)
Number of observations	1,665	1,665	1,755	1,755
R-squared	0.493	0.493	0.471	0.466
Prob > F	0.00	0.00	0.00	0.00

Brand-level dummies (fixed-effects) are not indicated but are included in the model.

Robust pval in parentheses *** p<0.01, ** p<0.05, * p<0.1

Price instruments

Specific Excise	0.209*** (0)	0.205*** (0)	0.197*** (0)	0.196*** (0)
ln(US Tobacco Import Price)	-0.0199 (0.833)	-0.0600 (0.505)	-0.140* (0.0654)	-0.156** (0.0235)

Table A6: Cigarettes with flavoured filters, 2010(Q1) -2016 (Q4)

	Traditional/kiosk channel		Self-service channel	
	no LHW (1)	2010 LHW (2)	no LHW (3)	2010 LHW (4)
LHW		0.904*** (0.00591)		1.375 (0.230)
ln(Traditional price)	4.191* (0.0646)	1.273 (0.593)		
ln(self-service price)			0.242 (0.948)	-5.368 (0.469)
REGFLAV	-0.0490 (0.840)	-0.107 (0.685)	-0.919*** (0.00328)	-0.704 (0.203)
CIGLENGTH 81-90	1.785** (0.0463)	1.926** (0.0297)	4.209** (0.0145)	2.977 (0.284)
CIGLENGTH 91-100	3.451*** (0.000212)	3.595*** (0.000279)	6.938*** (1.34e-05)	7.084*** (0.000119)
LIGHTS	-0.262 (0.274)	-0.202 (0.449)	1.226* (0.0561)	1.315* (0.0975)
PACK 15	1.034 (0.369)	0.625 (0.597)	-0.275 (0.816)	0.110 (0.943)
PACK 18	0.213 (0.856)	0.152 (0.901)	-2.464 (0.312)	-4.098 (0.347)
PACK 20	2.033*** (0.00729)	1.891** (0.0118)	1.347** (0.0484)	1.096 (0.220)
ln(GDP / capita)	-2.800 (0.732)	-6.682 (0.415)	7.023 (0.796)	4.015 (0.877)
ln(URBAN)	-8.454 (0.698)	9.235 (0.707)	-30.08 (0.676)	-7.070 (0.932)
Number of observations	518	518	562	562
R-squared	0.513	0.523	0.537	0.412
Prob > F	0.00	0.00	0.00	0.00

Brand-level dummies (fixed-effects) are not indicated but are included in the model.

Robust pval in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Price instruments

Specific Excise	0.215*** (0)	0.191*** (0)	0.122** (0.0165)	0.145*** (0.000735)
ln(US Tobacco Import Price)	0.0878 (0.550)	0.0822 (0.579)	0.247** (0.0416)	0.253** (0.0437)

Table A7: Unflavoured cigarettes, 2010(Q1) -2016 (Q4)

	Traditional/kiosk channel		Self-service channel	
	no LHW (1)	2010 LHW (2)	no LHW (3)	2010 LHW (4)
LHW		0.119 (0.351)		0.384** (0.0387)
ln(Traditional price)	-0.473 (0.276)	-0.585 (0.179)		
ln(self-service price)			-0.0363 (0.958)	-0.472 (0.537)
CIGLENGTH 81-90	-1.455* (0.0957)	-1.452* (0.0972)	-1.995 (0.138)	-2.011 (0.134)
CIGLENGTH 91-100	-1.985 (0.149)	-1.981 (0.150)	-2.100 (0.186)	-2.082 (0.190)
LIGHTS	-1.425*** (0.00105)	-1.424*** (0.00105)	-0.658* (0.0585)	-0.645* (0.0684)
MILD	-5.920*** (0)	-5.921*** (0)	-5.524*** (0.000921)	-5.624*** (0.000843)
SUPRLGHT	-2.059*** (3.40e-10)	-2.049*** (2.30e-10)	1.499*** (5.93e-07)	1.562*** (5.57e-07)
SPRSLIMS	-2.053*** (2.38e-05)	-2.055*** (2.29e-05)	-1.666* (0.0925)	-1.781* (0.0759)
REGFLTER	-0.903 (0.175)	-0.913 (0.171)	-2.170*** (0.00678)	-2.213*** (0.00611)
PACK 15	0.773 (0.203)	0.748 (0.222)	2.516*** (0.00131)	2.440*** (0.00210)
PACK 18	-0.251 (0.629)	-0.254 (0.626)	-0.476 (0.553)	-0.592 (0.439)
PACK 20	2.012*** (3.83e-05)	2.006*** (4.19e-05)	1.542*** (0.00698)	1.513*** (0.00777)
PACK 24	-0.0542 (0.970)	-0.0764 (0.957)	2.844 (0.158)	2.801 (0.164)
PACK 25	1.923*** (0.00387)	1.901*** (0.00468)	2.289*** (6.64e-05)	2.206*** (0.000100)
ln(GDP / capita)	-0.0606 (0.990)	-1.683 (0.756)	-0.263 (0.975)	-5.266 (0.499)
ln(URBAN)	-6.062 (0.682)	-2.106 (0.892)	-12.83 (0.618)	-1.048 (0.965)
Number of observations	1,483	1,483	1,562	1,562
R-squared	0.520	0.521	0.465	0.461
Prob > F	0.00	0.00	0.00	0.00

Brand-level dummies (fixed-effects) are not indicated but are included in the model.

Robust pval in parentheses *** p<0.01, ** p<0.05, * p<0.1

Price instruments

Specific Excise	0.214*** (0)	0.211*** (0)	0.208*** (0)	0.207*** (0)
ln(US Tobacco Import Price)	-0.0707 (0.457)	-0.106 (0.236)	-0.154* (0.0694)	-0.170** (0.0270)

Table A8: Menthol flavoured cigarettes, 2010(Q1) -2016 (Q4)

	Traditional/kiosk channel		Self-service channel	
	no LHW (1)	2010 LHW (2)	no LHW (3)	2010 LHW (4)
LHW		0.390 (0.288)		0.248 (0.705)
ln(Traditional price)	-0.548 (0.769)	-1.689 (0.315)		
ln(self-service price)			-5.453 (0.606)	-7.195 (0.373)
CIGLENGTH 81-90	0.0224 (0.972)	0.0696 (0.916)	1.032 (0.607)	1.015 (0.648)
CIGLENGTH 91-100	1.248** (0.0423)	1.321** (0.0401)	4.624* (0.0847)	5.027** (0.0303)
LIGHTS	-0.0438 (0.901)	-0.0292 (0.935)	1.000** (0.0479)	1.090** (0.0188)
SPRSLIMS	-4.384*** (0)	-4.426*** (0)	-5.518** (0.0336)	-5.927*** (0.00406)
REGFLTER	-1.604*** (0.000765)	-1.634*** (0.000878)	-3.368** (0.0216)	-3.627*** (0.00111)
PACK 15	1.111 (0.391)	0.983 (0.459)	1.064 (0.408)	1.085 (0.399)
PACK 16	0.640* (0.0875)	0.550 (0.128)	2.353* (0.0834)	2.204* (0.0982)
PACK 18	0.698 (0.441)	0.671 (0.463)	-2.366 (0.414)	-2.736 (0.326)
PACK 20	2.225*** (0.000292)	2.182*** (0.000424)	1.112 (0.278)	0.986 (0.266)
ln(GDP / capita)	0.698 (0.930)	-0.729 (0.928)	31.72 (0.185)	32.02 (0.175)
ln(URBAN)	-4.942 (0.835)	1.283 (0.957)	-90.38* (0.0743)	-87.43* (0.0933)
Number of observations	815	815	891	891
R-squared	0.491	0.487	0.354	0.298
Prob > F	0	0	0	0

Brand-level dummies (fixed-effects) are not indicated but are included in the model.

Robust pval in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

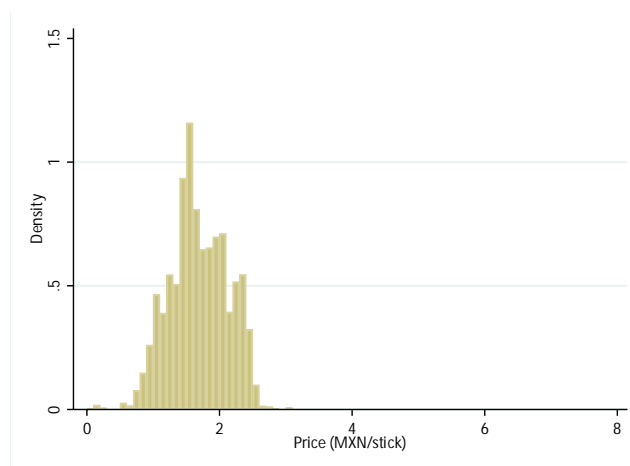
Price instruments

Specific Excise	0.207*** (0)	0.179*** (0)	0.0499 (0.297)	0.0611 (0.211)
ln(US Tobacco Import Price)	0.159 (0.150)	0.138 (0.212)	0.224** (0.0496)	0.233** (0.0420)

ANNEX B: OUTLIERS IN NIELSEN DATA FOR MEXICO

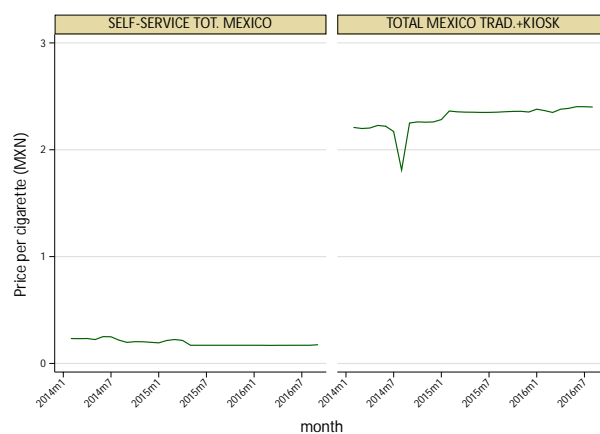
Based on the histogram below observations with stick prices lower than 0.6 MXN or higher than 2.6 MXN have been excluded with the exception of two products with higher prices which have been verified as genuine observations.

Figure B1: Price histogram before dropping outliers



There were 23,708 observations in the original dataset reduced to 23,476 with cleaning, including the removal of one particular product sold in self-service retail outlets because its price was exceptionally low compared to prices in the traditional/kiosk channel (see chart below).

Figure B2: Monthly prices, Camel Smooth C/Feltre Caseville 20s by channel



The first and last quarters have been excluded as they are incomplete.

All non-filtered cigarettes have been excluded because there is a high degree of substitution between different non-filtered cigarettes over time which cannot be controlled in our panel-based approach. Non-filtered cigarettes do not constitute a significant part of the total volume sold:

Filter type	Total volume sold ('000 sticks, Dec 2009-Feb 2017)
Regular filter	176,330
Flavoured filter	17,703
Non-filter	5,536

ANNEX C: REGRESSION OUTPUTS FOR BRAZIL

The same basic approach and specification have been used for Brazil as used for Mexico (see Annex A above). However, the more limited data has led to the inclusion of fewer variables and for a shorter time period, the latter preventing the assessment of the overall impact of LHWs.

Table C1 below lists and defines the variables used together with their source.

Table C1: Variable definitions for Brazil

Variable name	Description*	Interpretation
Cigarette variables		
In(Price)	Log of price per stick	1% change in prices leads to x% change in sales
SOFT PACK	Binary variable which equals one if the cigarette is soft packaged	Difference between sales of boxed cigarettes and soft packaged cigarettes
<i>Flavour:</i> LIGHT MENTHOL CAPSULE SUPER LIGHT	Binary variables which equals one if the cigarette is either light, menthol capsule, or super light	Difference between sales of light/menthol capsule / super light cigarettes and cigarettes with full flavour
<i>Brand segment</i> LOW MEDIUM PREMIUM	Cigarettes classified as low, medium or premium value by Nielsen	Used as dependent variable in some regressions to see whether different value segments have been affected.
LHW Dummy		
LHW 2016	Binary variable equal to one from January 2016 onwards and zero before <i>Source: JTI</i>	Effect of LHW on sales from Jan 2010 onwards
Instrumental variable		
<i>Excise Tax:</i> IPI excise = 8.1% + 65 IPI excise = 9.0% + 65 IPI excise = 9.5% + 70 IPI excise = 10.0% +75	Binary variable for applicable IPI excise plus specific excise of amount in BRL/1,000 cigarettes for relevant year 2014-2017 (See Table X) <i>Source: JTI</i>	Effect of excise on sales through prices compared to position with IPI excise of 8.1% + specific excise of 60 BRL/1,000 cigarettes.
In(US Tobacco Import Price)	Log of US tobacco import prices in pesos <i>Source: Ycharts.com</i>	1% change in US tobacco import price leads to x% change in prices (and through prices it affects sales volumes)

* If source is not shown, data is from Nielsen.

The regressions have been estimated with brand, regional and channel panels (dummies). The control variables have been omitted from the regressions as they were statistically insignificant.

The same instrumental variables have been used i.e. US import tobacco prices and cigarette taxes. However, the calculation of the tax variable for Brazil is complicated due to the number and rate structure of cigarette taxes (Table C2 below). Brazil imposes three types of taxes on cigarettes - (i) PIS (welfare tax); (ii) COFINS (social tax); and (iii) the IPI or "Imposto sobre Produtos Industrializados" (Tax on Industrialized Products") excise tax. The IPI requires the cigarette manufacturer to pay the higher of either 45% of the retail cigarette price: or over the period 2014

to 2017 8.1% to 10% of the retail price plus 60 BRL per 1,000 cigarettes for soft packages; or 65 BRL per 1,000 boxed and increased annual as shown in Table C2.

Table C2: Taxes on Cigarettes, Brazil 2014-2017

Tax/Excise	2014	2015	2016	2017	
PIS (Welfare Tax) (% of retail price)	2.22%	2.22%	2.22%	2.22%	
COFINS (Social Tax) (% of retail price)	8.75%	8.75%	8.75%	8.75%	
IPI (Excise) (% of retail price)	45.0%	45.0%	45.0%	45.0%	nominal rate of 300% applied to 15% of retail price
<u>Specific Taxes</u>	or	or	or	or	
IPI (Excise) (% of retail price)	8.1%	9.0%	9.5%	10.0%	increasing nominal rate applied to 15% of retail price
Soft - Specific Excise (BRL per 1,000 cigarettes)	60	65	70	75	
Box - Specific Excise (BRL per 1,000 cigarettes)	65	65	70	75	

Source: JTI

Since taxes other than the IPI have remained the same through out the period, the tax instrument has been generated from the second component of the IPI as set out in the last three rows of Table C2 (below) to create four excise tax dummy variables as defined in Table C1.

Regression results

Table C3 reports the result of our preferred regression using all cigarette types:

Table C3: Regression for all cigarettes, Sept 2014 to Feb 2017

Independent variable	LHW 2016 (1)	No LHW (2)
LHW 2016	0.155*** (3.29e-05)	
ln(price)	-1.213*** (0.000165)	-0.0258 (0.921)
SOFT PACK	0.131 (0.102)	0.175** (0.0363)
FLAVOUR = LIGHT	0.226** (0.0191)	0.238** (0.0130)
FLAVOUR = MENTHOL CAPSULE	-0.921*** (1.84e-08)	-0.935*** (9.19e-09)
FLAVOUR = SUPER LIGHT	-0.180 (0.243)	-0.190 (0.218)
No. observations	85,311	85,311
R ²	0.402	0.408
Prob > F	0.00	0.00

Notes: panel dummies are included but not indicated (76 distinct brands; 7 regions; 4 channels). Robust *pval* in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The results reported in Table C3 show that the LHW 2016 enhancement increased cigarette sales and that this was statistically significant. Again this is most likely to be a spurious effect as suggested by the dramatic decline in the price elasticity estimates in all regressions when the LHW is left out of the estimating regression (Equation (1) and those with the LHW in Table C5).

Like Mexico the inclusion of the LHW dummy significantly increased the price elasticity estimates from highly inelastic but statistically insignificant, to elastic and statistically significant. This suggests that the LHW dummies are picking up increases in cigarette sales due to other factors that have the spurious effect of increasing the price elasticity estimates.

Table C4: IV Regression results

Instrumental variables	All cigarettes
IPI excise 8.1% + 65	0.00765*** (0.00717)
IPI excise 9.5% + 70	0.168*** (0)
IPI excise 9.0% + 65	0.0633*** (0)
IPI excise 10.0% + 75	0.177*** (0)
ln(US Tobacco Import Price)	0.696*** (0)

The excise tax instruments are statistically significant but appear to have had a minor effect on cigarette prices. Given the complexity of the Brazilian cigarette tax regime and the rather crude way it has been represented in the regressions by a series of dummy variables, this weak effect is not surprising. The other instrument, US tobacco import prices, explained prices relatively well (although not for all regressions listed in Table C5).

In Table C5 separate regressions have been run for all cigarettes excluding menthol flavoured cigarettes, separately for low, medium and premium value segments, and cigarettes with menthol caps each with and without the LHW dummy. These are similar to the results reported above.

Table C5: IV with fixed-effects regression analysis by type of cigarette, Sep 2014 – Feb 2017

	All cigarettes exc menthol		Premium exc menthol		Medium exc menthol		Low exc menthol		Menthol only	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
LHW 2016	0.186*** (1.62e-06)		0.0548 (0.329)		0.136*** (0.00206)		0.310*** (6.17e-06)		0.0577 (0.433)	
ln(price)	-1.612*** (2.62e-05)	-0.132 (0.631)	-0.735** (0.0306)	-0.420* (0.0870)	-2.452*** (3.50e-08)	-1.560*** (9.85e-08)	-2.786*** (0.00303)	1.063 (0.264)	-0.621 (0.164)	-0.238 (0.473)
SOFT PACK	0.207** (0.0348)	0.259** (0.0100)	-0.169 (0.241)	-0.156 (0.279)	0.493*** (2.66e-05)	0.505*** (2.17e-05)	0.380*** (0.00122)	0.457*** (0.000279)	-0.320** (0.0199)	-0.311** (0.0258)
LIGHT FLAVOUR	0.239** (0.0117)	0.248*** (0.00832)	-0.598*** (8.43e-08)	-0.598*** (8.73e-08)	0.253** (0.0358)	0.252** (0.0369)	0.715*** (2.55e-08)	0.729*** (9.98e-09)		
SUPER LIGHT FLAVOUR	-0.452*** (0.00250)	-0.464*** (0.00201)	-2.170*** (0)	-2.170*** (0)	-0.242 (0.122)	-0.246 (0.114)	0.386 (0.505)	0.00368 (0.994)		
No. observations	67,752	67,752	18,498	18,498	23,789	23,789	20,393	20,393	17,559	17,559
R ²	0.444	0.450	0.684	0.685	0.371	0.373	0.504	0.495	0.288	0.290
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Brand, regional and sales channel level dummies included but not reported

Robust pval in parentheses *** p<0.01, ** p<0.05, * p<0.1

Price instruments

IPI = 8.1%/spec. excise = 65	0.00924*** (0.00252)	0.00924*** (0.00252)	-0.0118*** (0.000283)	-0.0118*** (0.000283)	0.0189*** (3.18e-10)	0.0189*** (3.18e-10)	0.0466*** (1.10e-06)	0.0466*** (1.10e-06)	0.0166** (0.0223)	0.0166** (0.0223)
IPI = 9.5%/spec. excise = 70	-0.00855*** (9.36e-06)	0.163*** (0)	0.210*** (0)	0.210*** (0)	0.199*** (0)	0.199*** (0)	0.109*** (0)	0.109*** (0)	0.199*** (0)	0.199*** (0)
IPI = 9.0%/spec. excise = 65	0.0642*** (0)	0.0642*** (0)	0.0587*** (0)	0.0587*** (0)	0.0821*** (0)	0.0821*** (0)	0.0707*** (0)	0.0707*** (0)	0.0714*** (0)	0.0714*** (0)
IPI = 10.0%/spec. excise = 75	0.669*** (0)	0.172*** (0)	0.214*** (0)	0.214*** (0)	0.216*** (0)	0.216*** (0)	0.104*** (0)	0.104*** (0)	0.211*** (0)	0.211*** (0)
ln(US Tobacco Import Price)	0.669*** (0)	0.669*** (0)	0.725*** (0)	0.725*** (0)	0.888*** (0)	0.888*** (0)	0.362*** (1.12e-08)	0.362*** (1.12e-08)	0.799*** (0)	0.799*** (0)

ANNEX D: OUTLIERS IN NIELSEN DATA FOR BRAZIL

Observations with prices lower than 0.1 BRL/stick and higher than 0.6 BRL/stick have been excused as outliers (see Figure D1). This removed 87 observations or 0.1% of total number of observations in the dataset.

Figure D1: Price density before and after removing outliers

