Historical trends in Australian tobacco consumption: *A case study*

British American Tobacco

November 2014

Building a better working world

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1. Executive Summary

1.1 Overview

Australia has some of the most extensive tobacco control policies in the World and has been at the forefront of policy development in this area for some time.

These policies include both significant price and other regulatory measures such as plain packaging and retail display bans, which have made the Australian tobacco market one of the World's most expensive and heavily regulated.

This, and the market's response to these policies, appears to make Australia a particularly relevant case study for other countries that are considering new policies to reduce tobacco consumption.

EY (United Kingdom) has been engaged by British American Tobacco (BAT) to assess the key drivers of historical trends in Australian tobacco consumption, particularly given the policy developments that have occurred over the last decade. This is likely to be the first of a series of more regular reports on these issues.

1.2 Approach

The approach relies on Ordinary Least Squares (OLS) regression analysis to examine the historical statistical relationship between changes in various economic variables and changes in total legal tobacco consumption. The objective has been to test the hypothesised relationship between the following factors and tobacco consumption in Australia:

- Retail prices
- Income level
- The implementation of plain packaging

This analysis aims to test these relationships at the market outcome level based on observed data (i.e. it incorporates the response of both consumers and producers).

The analysis is undertaken using both annual data since 2003 and monthly data since January 2011.

1.3 Key findings

The key findings from the analyses using annual data and monthly data are:

- The analysis using monthly data shows a negative relationship between changes in price and total consumption[1]
- We found no evidence that plain packaging in Australia has reduced total consumption to date. The analysis in this report does not seek to identify or predict any potential longer term impact of plain packaging.

Options for extending the analysis over time

There are undoubtedly ways in which this analysis could be extended:

[1] As price increases, total consumption decreases, and vice versa.

- Over time, obtaining a longer period of data to provide greater confidence in the results
- Analysing whether the effectiveness of excise increases have changed over time
- Extending the analysis to better understand how the market or industry responded to excise increases and other regulations
- Obtaining more detailed market data and consumer information on the Australian market to investigate any changes in market dynamics (i.e. how particular market segments are responding)
- Obtaining more consistent and agreed upon illicit market data in Australia to measure total market consumption (both legal and illicit).

2. Introduction

2.1 Scope of this report

EY (United Kingdom) has been engaged by British American Tobacco (BAT) to assess the key drivers of historical trends in Australian tobacco total consumption, particularly given the policy developments that have occurred over the last decade. The approach relies on Ordinary Least Squares (OLS)[2] regression analysis to examine the historical statistical relationship between changes in various economic variables and changes in total legal tobacco consumption.

Section 4 describes the data used and the approach adopted in detail, as well as the associated limitations and constraints.

This report presents the outcome of our analysis.

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Basis of Our Work

We have not independently verified, or accept any responsibility or liability for independently verifying, any data provided to us by British American Tobacco from external sources in regards to the accuracy or completeness of the data. In relation to the selection of data for this study, we have made decisions based on the credibility of the relevant sources and their descriptions of data collection methodology and measurements. The scope of this Report has not involved forecasting and this study does not seek to forecast, project or predict the future.

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2.3 Outline of this report

The remainder of this report is structured as follows:

- Section 3 provides the context for the analysis by describing developments in Australian tobacco control policies

[2] Ordinary Least Squares (OLS) or linear least squares is a statistical method for estimating the relationship between one or more explanatory variables (such as price) and an observed outcome (such as consumption of a good or service). This method minimizes the sum of squared vertical distances between the observed responses in the dataset and the responses predicted by the linear approximation.

- Section 4 describes the approach used to assess the variables that might have affected the observed trends in Australian tobacco consumption
- Section 5 outlines the results derived from applying that approach
- Sections 6 and 7 provide appendices which include additional statistical analysis to support the findings

3. Developments in Australian tobacco control policies

3.1 Key observations

Australia has some of the most extensive tobacco control policies in the World and has been at the forefront of policy development in this area for some time.

These policies include both significant price and other regulatory measures such as plain packaging and retail display bans, which have made the Australian tobacco market one of the World's most expensive and heavily regulated.

This, and the market's response to these policies, appears to make Australia a particularly relevant case study for other countries that are considering new policies to reduce tobacco consumption.

3.2 Australian tobacco control policies

The Australian Government's National Tobacco Strategy provides the context for its tobacco control policies.[3] The key objective of the strategy is to *"reduce the national adult daily smoking rate to 10 per cent of the population"* by 2018.

Various Australian Governments have implemented tobacco control policies over the last decade to reduce consumption. These policies have covered:

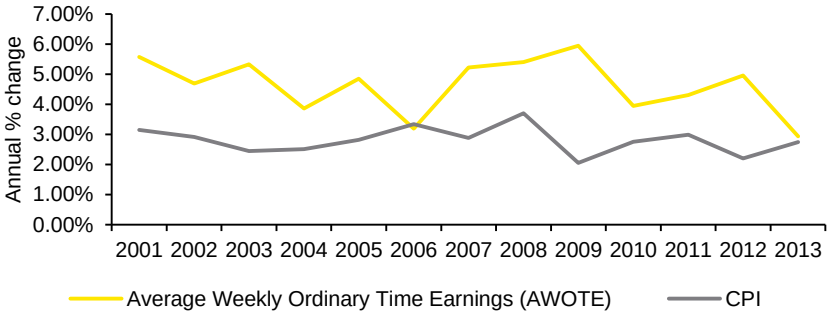
- Demand reduction (e.g. reducing the affordability of tobacco products)
- Constraining the ability of the industry to communicate with consumers (e.g. product display and channels to supply tobacco products)

The key demand reduction policies have included:

- Biannual indexation of tobacco excise duty (excise). From 1 March 2014, it includes changes to the biannual indexation of excise from a Consumer Price Inflation (CPI) adjustment to an Average Weekly Earnings (AWOTE) adjustment. Figure 1 below shows the recent changes in CPI and AWOTE. The latter is typically higher and the difference broadly reflects real earnings growth
- Various so called 'ad hoc' excise increases. This includes:
  - A 25% excise increase in May 2010
  - A 12.5% excise increase on 1 December 2013
  - A 12.5% excise increase on 1 September 2014 (with further increases of 12.5% on 1 September 2015 and 1 September 2016)

[3] National Tobacco Strategy 2012-2018, Intergovernmental Committee on Drugs

Figure 1: Annual percentage change in CPI and AWOTE



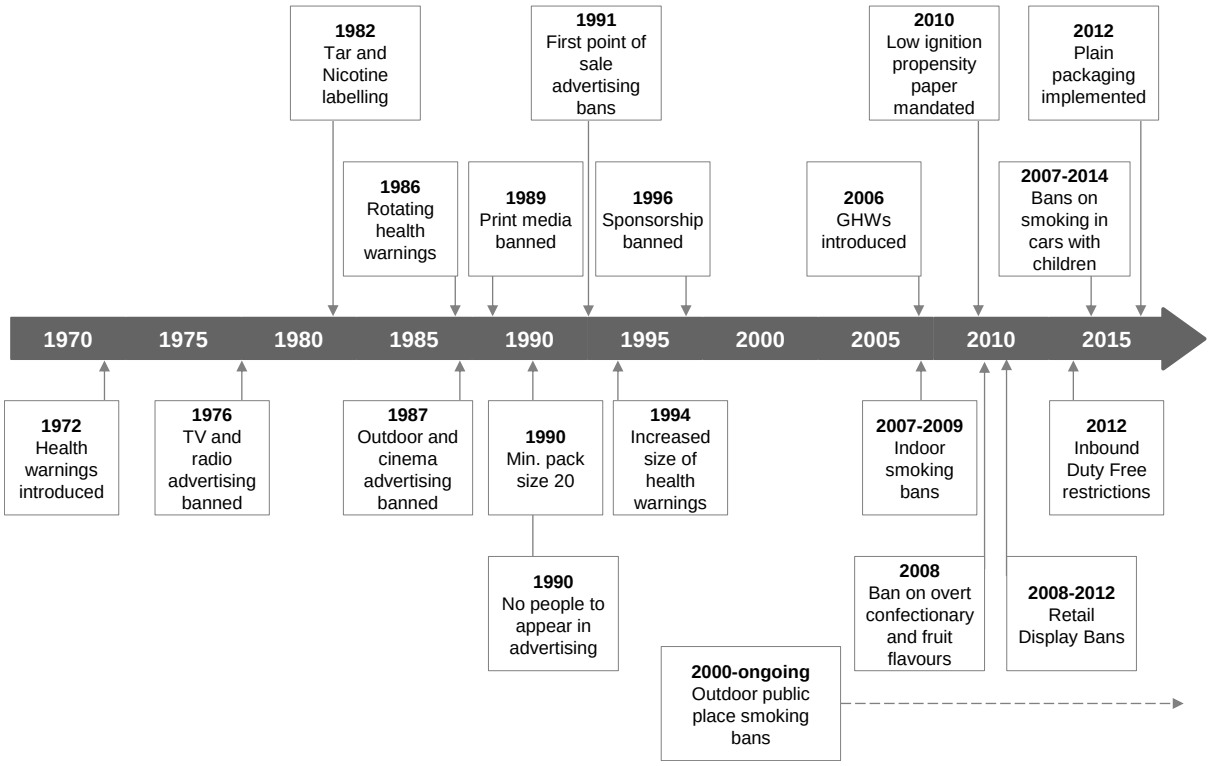
Source: Australian Bureau of Statistics

The key policies designed to constrain the ability of the industry to communicate with consumers have included:

- Graphic Health Warnings (GHWs) in 2006
- Ongoing Public Place Smoking bans and Indoor Smoking Bans in 2007
- Retail Display Bans in 2008
- Plain packaging (together with larger health warnings) from 1 December 2012

Figure 2 shows the long term history of non-price tobacco control regulation.

Figure 2 Policy timeline

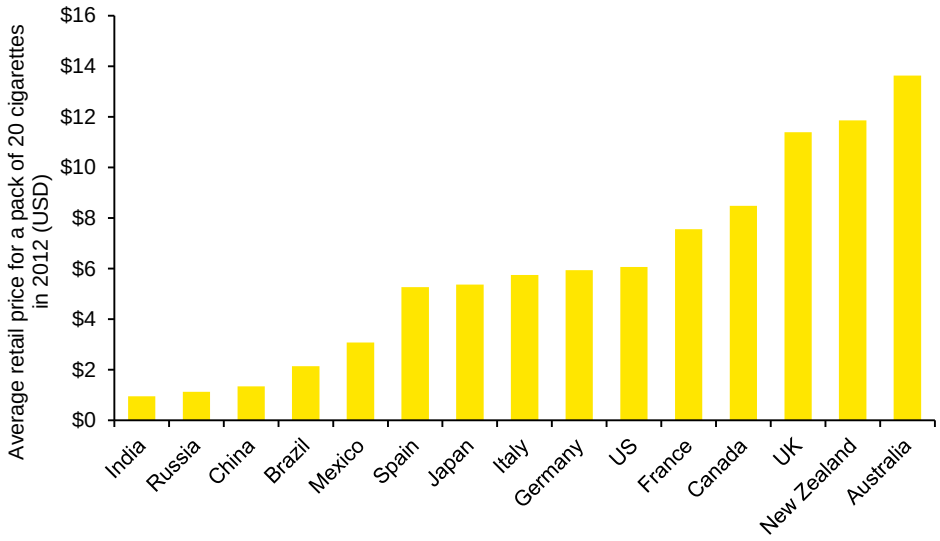


Source: BATA

As a result of these policies, the Australian tobacco market is one of the World's most expensive and heavily regulated.

Figure 3 illustrates the average retail prices (in USD) for a pack of twenty cigarettes in 2012.

Figure 3: Average retail price for a pack of twenty cigarettes in 2012 (USD)



Source: World Health Organization, 2013; Tobacco Manufacturers' Association[4]

In respect of other regulation, Australia was the first country to adopt plain packaging. Plain packaging was justified on the basis that it would reduce the attractiveness and appeal of tobacco products to consumers, particularly amongst young people.[5] Moreover, together with higher excise, it would *"reduce the consumption of tobacco by about 6 per cent and reduce the number of smokers by 2 to 3 per cent."*[6] The Government also argued that smoking incidence could drop from 15 to 10 per cent within six years as a result of plain packaging.[7]

Australia would therefore appear to be a relevant case study for other countries that are considering new policies to reduce tobacco consumption. We also understand that, in respect of plain packaging, the Australian Government has committed to commence a review of the policy no later than 1 December 2014.[8]

3.3 Impact of Australian tobacco control policies

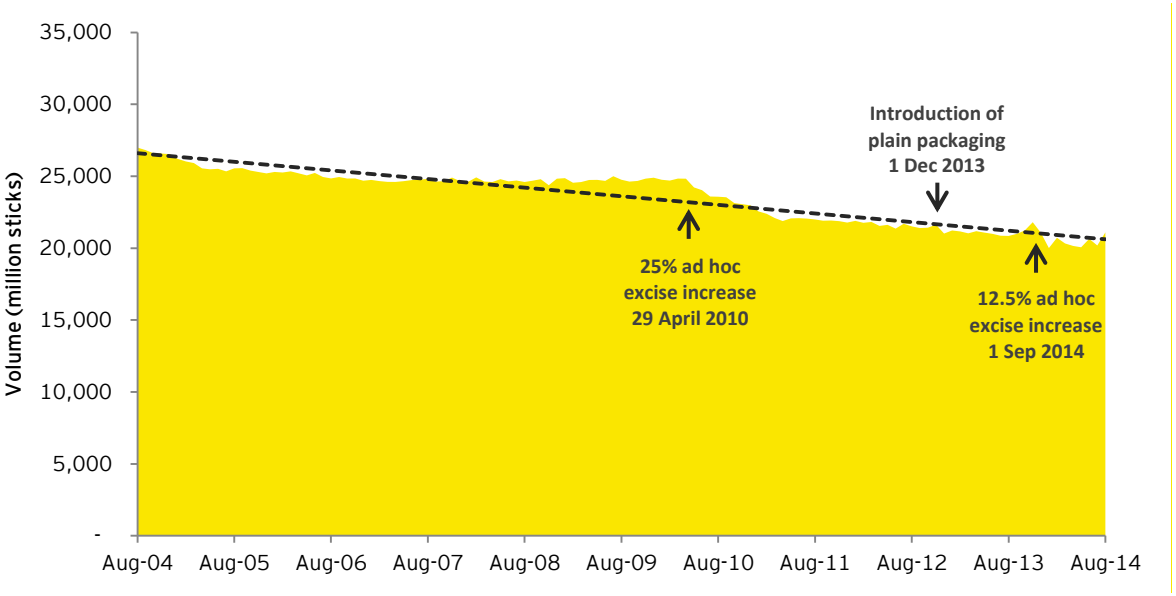
The relevance of Australia as a case study becomes more evident when considering the impact of policies implemented by successive Australian Governments on tobacco consumption.

Figure 4 below shows the Exchange of sales – shipment volumes (i.e. Shipment Data on wholesale volumes) over the period 2004 to 2014 and some of the key regulatory changes. It shows that the

[4] World Health Organization, WHO report on the global tobacco epidemic, 2013; Tobacco Manufacturers' Association website, UK Cigarette Prices (RRP) for 2012
[5] http://www.health.gov.au/internet/main/publishing.nsf/Content/tobacco-kff
[6] http://www.abc.net.au/news/2014-01-22/philip-morris-wrong-plain-packaging/
[7] http://www.smh.com.au/national/plain-packs-put-off-smokers-20121129-2aitp.html#ixzz39Oh0Sa8p
[8] http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22committees%2Festimate%2F5a8a7fa2-b9c7-4b7f-843c-89aa3b145886%2F0004%22

trend rate of decline in total consumption has not changed substantially over the period despite the considerable efforts to manage demand. Figure 4 also excludes changes in the consumption of illicit cigarettes, which is discussed in Section 5.

Figure 4: Year-to-date Australian Shipment Data



Source: InfoView

The recent trend in demand raises a question about whether the policies adopted by the Australian Government have had the anticipated impact. Learning more about the relationship in Australia between the regulatory measures adopted and demand could provide valuable lessons for policy making in other countries and new policies in Australia.

4. Approach

4.1 Summary

The analysis uses OLS regression analysis to test the hypothesised relationship between the following factors and tobacco consumption in Australia:

- Retail prices
- Income level
- The implementation of plain packaging

The analysis is undertaken using both annual data since 2003 and monthly data since January 2011.

4.2 Data selection

4.2.1 Dependent variable (total tobacco consumption)

This report focuses on testing the hypothesised relationship between:

- A number of potential drivers of tobacco consumption
- The changes in total legal Australian cigarette consumption

Consumption of illicit tobacco in Australia has not been incorporated in the quantitative analysis of total cigarette consumption in Australia. Section 5.3 discusses the trends in illicit tobacco consumption in Australia in a qualitative manner.

Three independent sources of data for tobacco consumption have been considered for use in this analysis:

- Exchange of sales – shipment volumes ('Shipment Data') – in essence wholesale shipment data (i.e. what leaves the warehouse for retail distribution) as discussed below[9]
- Off-take scan data ('Scan Data') – largely retail sales data (see below)[10]
- Australian Bureau of Statistics (ABS) household expenditure data[11]

Australian Shipment Data is collected by InfoView and is available by month. The data reflects the total exchange of sales between Australian tobacco wholesale and retail businesses.

This data is limited in the sense that it reflects the behaviour of retailers in the first instance (e.g. the decisions they make on stock). So there are likely to be some temporal mismatches between the purchasing decisions of retailers and final consumers, particularly in short term (i.e. a few months). However, over the longer term (e.g. annually), any mismatches are likely to be washed out of the data, as retailers can be expected to manage their stock levels to appropriately balance the risk of running out of stock with the risk of investing too much working capital in excessive stock on hand.

[9] InfoView Technologies Pty Ltd.
[10] Aztec Defined Total Market Database
[11] ABS, Australian National Accounts: National Income, Expenditure and Product, March 2014

Therefore, the total exchange of industry sales should reflect the retail sales volume on an annual basis, with a potential short period of lag effect depending on typical retail turnover.

Australian Scan Data is collected by Aztec Defined Total Market Database and is also available monthly, but only from January 2011 to August 2014. The data is recorded when a tobacco product is 'scanned' for purchase in Australia at the retail level. Whilst this data may be considered more appropriate for observing consumer behaviour, we understand that it contains some measurement errors which are likely to be common to Scan Data on some consumer products.[12] However, for the purpose of observing the changes in the volume over time, the impacts of these measurement constraints are unlikely to be material.[13]

The ABS publishes estimates of household final consumption expenditure as part of the Australian System of National Accounts (ASNA). The ASNA uses information from the Australian Customs Service from documents lodged for excise purposes, as well as for imports and exports to estimate tobacco expenditure.

Changes in expenditure on tobacco products could be driven by a number of variables, including:

- Retail prices, including excise
- Consumption
- Brand selection (e.g. switching between higher and lower priced cigarettes)

As a result, expenditure data does not provide an appropriate basis for estimating the total number of cigarettes consumed in Australia, nor does it capture smoking rates for individuals. Moreover, it would be difficult to isolate changes in total consumption using this data without further information.[14]

For the purpose of this analysis, both Shipment Data and Scan Data are used to capture any changes in total tobacco consumption in Australia over time.

BATA provided Shipment Data collected by InfoView for the period of September 2003 to August 2014 and Scan Data by Aztec for the period of January 2011 to August 2014.

Based on our research, we believe that this is the best up to date evidence of the total volume of legal sales in the Australian market.

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[12] Some tobacco dealers may not have the scan facilities to allow this data to be collected, unless collected by other means. Also, due to the franchising model of a small number of retailers, we understand some products can be scanned twice – once at the warehouse and another at the point of sale.

[13] Since the measurement errors in this Scan Data are relatively small compared to the total consumption, the percentage change from one period to the next period should not be materially affected by the measurement errors, unless there has been a significant change in where cigarettes are purchased from or how they are treated (i.e. scanned) over the period that we have not been able to observe

[14] EY notes that a recent study (Davidson and Silva, 2014) has been completed on the impact of plain packaging using ABS data as a proxy for tobacco consumption, which recognised the limitations of the data but noted that it had the advantage of being publically available. The study concludes that: *"there is no empirical evidence to support the notion that the plain packaging policy has resulted in lower household expenditure on tobacco than there otherwise would have been"*. Sinclair Davidson and Ashton de Silva, *The Plain Truth about Plain Packaging: An Econometric Analysis of the Australian 2011 Tobacco Plain Packaging Act, available at* - http://press.anu.edu.au/wp-content/uploads/2014/11/The-Plain-Truth-about-Plain-Packaging-An-Econometric-Analysis-of-the-Australian-2011-Tobacco-Plain-Packaging-Act.pdf

4.2.2 Independent variables

For the purpose of this analysis, we have tested the following variables against tobacco consumption in Australia:

- Retail prices
- Income level
- The implementation of plain packaging (as a dummy variable)

For the purpose of this study, the above independent variables were selected based on our understanding of the market and the variables that may be most likely to influence demand.

Retail prices are measured using the weighted average cigarette price, weighted by the packet size, the respective brand, and sales over the respective period. Weighted average cigarette prices can be derived from the Shipment Data and/or the Scan Data where available.

Income is typically correlated with expenditure. Whilst higher income does not necessarily mean higher tobacco consumption by an average tobacco consumer, changes in income level may, to some extent, affect consumption over time. Average weekly earnings[15] from ABS are used to represent the average income of people living in Australia. The data series are available in annual and biannual form.

Given the significance attached to plain packaging as a policy by all parties, this analysis tests whether it has had an impact on total tobacco consumption based on the current market evidence. However, our analysis does not seek to identify or predict any potential longer term impact of plain packaging.

4.3 Econometric methodology

The approach involves using OLS regressions to estimate the linear relationships exhibited between the independent variables tested and tobacco consumption in Australia. It should be noted that there are limitations to this analysis. For example, there is a potential for omitted variable bias[16], as there may be other factors that could drive changes in demand.

This analysis aims to test the hypothesised relationships between the independent variables and the changes in total consumption in Australia at the market outcome level based on observed data (i.e. it reflects the response of both consumers and producers to changes in the identified variables). It is not able to determine the exact impact of different drivers, or to establish the extent to which government policy may have changed consumer behaviour independently of any supply side response. Understanding the reasons behind such market outcomes would require further investigation of the market and its dynamics.

This approach provides a reasonable balance between statistical robustness and simplicity, and provides results that are practical, easy to understand, and as robust as possible given the constraints in the availability of data.

[15] ABS, Average Weekly Earnings, Australia, May 2014

[16] Omitted variables bias in statistics is due to the exclusion from the model of one or more important causal factors. The "bias" is created when the model compensates for the missing factor by over- or underestimating the effect of one of the other factors.

4.4 Models and specifications

Given the data limitations discussed in the previous section, in order to provide the most robust conclusions possible, different models and specifications of variables have been used to reflect different data sources and address different limitations.

Regressions were undertaken on the annual consumption and the monthly consumption respectively for the two datasets. Whilst the annual data provides a longer term view of the Australian market, it only provides one full year of observation after the implementation of plain packaging; thus we deemed the results of this model not completely satisfactory, nonetheless results of the annual consumption analysis are reported in Appendix A. Analysis using monthly data, on the other hand, provides a closer investigation of any statistically significant relationship between that policy and consumption to date.

4.4.1 Monthly consumption

Regressions on monthly consumption are undertaken to give a month-on-month view of how changes in the monthly consumption may be affected by changes in these factors.

As discussed above, despite the potential measurement errors in the Scan Data, it appears to provide more accurate retail price data for analysis. For consistency purposes, the consumption as well as the weighted average price from the Scan Data is used. Results are further tested using the consumption from Shipment Data.

Since average weekly earnings are only available in biannual and annual form, the significance of this variable in monthly consumption changes is not tested.

To better understand how the implementation of plain packaging policy may have changed the market dynamic, an interaction variable[17] between the retail price and the plain packaging dummy variable is introduced.

4.4.2 Seasonal adjustments

Tobacco sales data exhibits seasonal patterns. We have used seasonally adjusted[18] sales data to address any seasonal impacts on consumption that are not affected by the independent variables tested.

[17] Interaction variable in regression analysis are a means to deal with non-independence of predictors. If two variables of interest interact, the relationship between each of the interacting variables and a third "dependent variable" depends on the value of the other interacting variable.
[18] The data has been adjusted using the US National Census Bureau's X-12 ARIMA approach, which is used remove the impact of seasonal variance on a data set.

5. Results

5.1 Key conclusions

The key findings from our analyses are:

- The analysis using monthly data shows a negative relationship between changes in price and total consumption.[19]
- We found no evidence that plain packaging in Australia has reduced total consumption to date. The analysis in this report does not seek to identify or predict any potential longer term impact of plain packaging.

5.1.1 Interpreting the results

The output of the regressions display the number of observations ('obs') used in the model, as well as the R^2, which is an estimate on the percentage of variation in the dependent variable (demand for cigarettes) that is explained by the explanatory/independent variables in the forms that they are specified. It should be noted that the R^2 statistic is not in itself a good measure of how 'good' a model is.

A coefficient is given for each explanatory variable to indicate the statistical relationships between the variables. The statistical significance level of each explanatory variable is indicated by the number of asterisks next to the coefficient of that variable. The statistical significance level represents how confident one can be that the variable is an explanatory variable of cigarette demand (and that the coefficient on the variable is not zero). For example, at the one-percent significance level (indicated by three asterisks), there would be a less than or equal to one percent chance that the variable does not have an effect on cigarette demand in any way, given the observed effect (coefficient) in the model.

A Log-log specification is chosen for each regression which means that the reported coefficient on each non-dummy variable is interpreted as its demand elasticity. The interpretation is that for every percentage increase in the explanatory variable (say price), there is on average an X percentage change in demand for cigarettes, where X is the reported coefficient on that variable (price for this instance). If the coefficient is between -1 and 1 and statistically significant, the demand elasticity is considered inelastic, meaning the consumer is relatively less responsive to changes in this particular variable. Similarly, if the coefficient is outside of this range, it indicates that the consumer is relatively sensitive to changes in this variable.

5.2 Analysis using monthly data

5.2.1 Seasonally-adjusted monthly data

Table 1 below shows the results using seasonally-adjusted monthly data from the Scan Data, available from January 2011 to August 2014.

[19] As price increases, total consumption decreases, and vice versa.

Table 1: Regression results for seasonally-adjusted monthly data

	Regression 1 Total cigarette volume (million sticks)	*Regression 2 Total cigarette volume (million sticks)*	*Regression 3 Total cigarette volume (million sticks)*
Independent variables	*obs = 44*	*obs = 44*	*obs = 44*
	R2 = 0.12	*R2 = 0.22*	*R2 = 0.24*
Price	*-0.13***	*-0.3****	*-0.49****
Plain packaging dummy		*0.03****	*0.15*
Interaction			*0.24*
Constant	*7.16****	*7.07****	*6.97****

Note: ***, **, * = significant at the 1%, 5%, and 10% level respectively.

The results from the price-only regression suggest a negative relationship between price and consumption, albeit with a much lower R^2 than when using annual data.

Results from the second regression with the dummy variable for plain packaging appear to show a more negative price elasticity of demand and a statistically significant but small positive impact of plain packaging on consumption. This implies that the introduction of plain packaging may have actually slightly increased cigarette consumption.

The inclusion of the interaction variable between price and plain packaging policy has found no significant impact of the plain packaging policy itself on either the consumption or on the implied price elasticity of demand.

It cannot be concluded that autocorrelation[20] is present in the regression once seasonality has been removed; nevertheless we applied statistical techniques to correct for any autocorrelation in the error term (see appendix B for more details).

5.3 Other relevant evidence: the illicit market

The analysis in this report focuses on the legal tobacco market and total consumption in it. Data constraints mean that is not possible to undertake the same statistical analysis for the illicit tobacco market.

Current evidence on the illicit market is drawn either from Customs data (number and quantities of detections) or survey data. The customs data exhibits high volatility year on year in terms of the number of detections and the volume of those detections (i.e. in terms of the volume of detected illegally import tobacco and cigarettes).[21] The reasons for this volatility are unclear.

External parties began measuring the level of illicit trade of tobacco in Australia using survey data in 2007.[22] We understand that the industry, governments, and other relevant stakeholders have not agreed on a consistent measure on the illicit market.[23]

[20] Autocorrelation, also known as serial correlation, is the cross-correlation of a signal with itself. It can be interpreted as the similarity between observations as a function of the time lag between them.

[21] Using an average of the three years prior to the 25% ad hoc excise increase in May 2010 and the four years post it suggests that: total detections were up by 45%, tobacco detections were down by 23%, cigarette detections were up by 90%, and total equivalent tobacco detection was down by 2%. Duty evaded was up by 36%. Data compiled from various annual reports of Australian Customers and Border Protection (i.e. 2001-12 to 2013-14).

[22] Illicit Tobacco in Australia, 2013 Full Year Report, KPMG, April 2014. http://www.bata.com.au/group/sites/bat_7wykg8.nsf/vwPagesWebLive/DO9FC38M/$FILE/medMD9J35E3.pdf?openelement

An assessment of the validity of the evidence from these two sources is beyond the scope of this work. For the purposes of this report, however, the changes in the illicit market rather than its absolute size is more relevant.

Since 2007, according to the survey data, the consumption of illicit tobacco as a proportion of total consumption has increased significantly to reach 13.9% in FY 2013.[24] That growth has been particularly high since the 25% ad hoc excise increase in 2010 and the introduction of plain packaging. For example, it appears to have increased by:

- About 40% after the 25% excise increase
- About 18% in 2013, after plain packaging and the first 12.5% ad hoc excise increase were introduced

The relative price of cigarettes in Australia (particularly compared to South East Asia, as Australian prices are around three times as high) might provide part of explanation for the growth in the illicit market.

The more qualitative evidence from the illicit market would appear to suggest that total tobacco consumption (including illicit use) has fallen by less, perhaps materially less, than the evidence from the legal market would suggest.

5.4 Options for extending the analysis over time

There are undoubtedly ways in which this analysis could be extended:

- Over time, obtaining a longer period of data to provide greater confidence in the results
- Analysing whether the effectiveness of excise increases have changed over time
- Extending the analysis to better understand how the market or industry responded to excise increases and other regulations
- Obtaining more detailed market data and consumer information on the Australian market to investigate any changes in market dynamics (i.e. how particular market segments are responding)
- Obtaining more consistent and agreed upon illicit market data in Australia to measure total market consumption (both legal and illicit).

[23] http://www.cancervic.org.au/plainfacts/browse.asp?ContainerID=plainfacts-news
[24] Illicit Tobacco in Australia, 2013 Full Year Report, KPMG, April 2014.

6. Appendix A: Annual analysis

Annual consumption analysis

The time frame of the Shipment Data allows us to test the relationships between total tobacco consumption in Australia and the independent variables over ten years.

Whilst Shipment Data provides a longer time series for prices and consumption, it also has limitations. The price is the weighted average price of the recommended retail price (RRP), which can be different from the actual retail price because of retail discounts, retail margins, and potential inconsistencies in data measures from different sources. The weighted average RRP from the Shipment Data is therefore scaled using the weighted average price from the Scan Data to reflect more accurately the actual retail price.

Combining two sets of data from different sources can potentially compromise accuracy and therefore robustness of results. However, for the purpose of understanding the driving factors in changing legal tobacco consumption in Australia, the changes in these independent variables are more relevant rather than their absolute values. Statistical tests have been undertaken for the two price series and the results suggest that the two data series move closely together consistently over the available period from January 2011 to August 2014.

Results using annual data

Table A.1 below shows the results using annual Shipment Data between 2003 and 2013.

Table A.1: Results using annual data

	Regression 1 *Total cigarette volume (million sticks)*	*Regression 2* *Total cigarette volume (million sticks)*	*Regression 3* *Total cigarette volume (million sticks)*
Independent variables	***obs = 11*** $R^2 = 0.96$	***obs = 11*** $R^2 = 0.98$	***obs = 11*** $R^2 = 0.98$
Price	-0.41***	-0.70***	-0.71***
Weekly income		0.45***	0.46**
Plain packaging dummy			0.00
Constant	4.19***	2.69***	2.68***

Note: ***, **, * = significant at the 1%, 5%, and 10% level respectively.

The first regression includes only price, which appears to have a strong negative relationship with consumption as expected. The price elasticity of demand is within -1.0 and 1.0, meaning the demand is considered to be relatively inelastic.

The second regression adds in the average weekly income, which appears to have a strong positive relationship with consumption. This implies a positive income elasticity of demand that is consistent with most consumer products that are considered as "normal goods"[25] in economics. This positive income effect may have contributed to the relatively low price elasticity of demand from the first regression.

The third regression tests any potential impact of the plain packaging policy on reducing consumption at a given price level and weekly income.

[25] Demand for which increases when income increases when price remains constant

It should be noted that for the annual regressions, the R^2's seem implausibly high at 0.96 to 0.98. Given that the models only include a few variables, it is unlikely that they in reality explain more than 96% of the total variation in consumption. Rather, it is likely that the models exhibit positive autocorrelation, something which further tests support, due the non-stationary of the times series. The Johansen cointegration fails to reject the null hypothesis of rank zero indicating there is no cointegration vector, consequently the results of this analysis should be interpreted as indicative and no conclusion should be drawn (see Appendix B).

7. Appendix B: Testing undertaken

Three important issues in the econometric analysis of time series data are stationarity, heteroscedasticity and autocorrelation. This appendix addresses each issue and the extent to which it may have impacted on the analysis.

The outcome of this exercise is that, in order to ensure the accuracy and validity of the results, the variables are expressed in percentage changes and robust standard errors are used in the regressions.

Stationarity – annual data

In order to prevent a problem known as 'spurious regression', time series in an OLS regression must be stationary. A stationary time series is one that has a constant mean throughout the sample period. If the variables in the regression are non-stationary, the results will often give R^2 and t-statistics that imply a strong relationship when in reality there is none. An example of this problem, known as 'spurious regression', is a regression of the GDP of the United Kingdom and the population of Turkey. The results are likely to suggest that the population of Turkey is a key determinant of the United Kingdom's GDP, but this is clearly not true.

Due to the high R-squares in the annual data regressions, tests were undertaken for stationarity in the dependent and explanatory variables as well as a test to check for co-integration.

The Augmented Dicky Fuller (ADF) test is used to test whether the variables included in the model are stationary. The null hypothesis of this test is that the time series has a unit root, which means it is not stationary in its current form. If the null hypothesis is rejected (a p-value below 0.1), it indicates that the series is stationary and appropriate for inclusion in a regression.

The results for the ADF tests for each of the variables in level form are as follows:

The dependent variable

Variables	*Total cigarette volume*
Observations	8
Lags	3
Test Statistic: Z(t)	0.156
P-Value	0.9699

The p-value for total cigarette volume is > 0.1 and as such we fail to reject the null hypothesis, and cannot conclude that total cigarette volume is non-stationary.

The explanatory variables

Variables	*Price*	*Weekly income*
Observations	9	9
Lags	3	3
Test Statistic: Z(t)	0.169	0.073
P-Value	0.9707	0.9637

The p-value for price and weekly income is > 0.1 and as such we fail to reject the null hypothesis, and cannot conclude that the independent variables are non-stationary.

We can therefore conclude that the variables used in the annual data regression are non-stationary and that the regression may be producing spurious results.

In order to test whether a regression is producing spurious results we used the Johansen test for cointegration. The Johansen test is a procedure for testing cointegration of several time series. This test permits more than one cointegrating relationship so is more generally applicable than the Engle–Granger test which is based on the Dickey–Fuller (or the augmented) test for unit roots in the residuals from a single (estimated) cointegrating relationship.

Johansen test of cointegration

Rank	*Trace test*	*p-value*
0	21.357	0.3459
1	6.4253	0.6499
2	0.20748	0.6487

The results of the Johansen test involving volume, price and income variables in the yearly regression suggest there is no cointegration. Thus no sound conclusion can be drawn from this specific regression due to spuriousness. For the purposes of this study however, the yearly regression was useful for gaining an indication of any significant impact of the plain packaging variable on the consumption, and as such we are not as concerned about stationarity and the explanatory power of the model (i.e. the R^2 value).

Heteroscedasticity & Autocorrelation

The second important assumption required for accurate regression results is that the variables are homoscedastic. Homoscedastic means that the series has a constant variance over time, whereas heteroscedastic series have a changing variance. This is important as statistical tests of significance assume that the error term is uncorrelated and normally distributed. When the variance of the error term fluctuates (e.g. becomes more volatile over time), the assumption is broken and the estimated standard errors of each of the estimates are incorrect. This means that tests of significance are invalid and wrong conclusions could be drawn from the model.

The third issue of time series analysis is autocorrelation, which exists when the value of the error term at period t is dependent on the value of the residuals in previous periods.

Autocorrelation can be problematic for the development of a regression model as it violates assumptions of OLS that the residuals are uncorrelated. This might lead to underestimated standard errors of the regression estimates and overestimated t-values, and thus potentially invalid tests of significance and conclusions drawn from the regression model.

In all the models, we have corrected the standard errors for heteroscedasticity and autocorrelation using Newey-West HAC estimator.