COMPASS LEXECON

The effects of standardised packaging: an empirical analysis

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Neil Dryden

Contents

Section 1

Introduction

1.1 I am Neil Dryden, Executive Vice President at Compass Lexecon, an economic consulting firm. Compass Lexecon is part of FTI Consulting Inc., a global business advisory firm. My experience and expertise is as a micro-economist, specialised in the economics of competition policy, regulation, public policy and market analysis. I have an M.Phil. in Economics from Oxford University and a postgraduate diploma in EC competition law (with distinction) from King's College, London. I have worked as a professional economist for over 20 years, including advising on numerous mergers, agreement cases, dominance cases, damages and market investigations. I was awarded the 2016 Economist of the Year by the *Global Competition Review*.

1.2 My CV is included at Annex A.

Instructions

1.3 I have been commissioned to prepare this report for British American Tobacco ("BAT").

1.4 I have been asked to:

a. set out my views on the expected impact that standardised packaging[1] regulations will have on the market for the supply of cigarettes from a theoretical point of view;

b. examine empirical data from Australia, where standardised packaging has been implemented,[2] to see what effect, if any, standardised packaging has had on:

   i. the consumption of cigarettes in Australia;

   ii. the prices of cigarettes in Australia; and

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1 Standardised or plain packaging generally refers to the use of the same uniform colour on all tobacco packs, with no brand imagery, and the brand name written in a specified font, colour and size.

2 Standardised packaging was introduced in Australia under the Tobacco Plain Packaging Act 2011, No. 148, 2011 with all tobacco products sold in Australia required to comply with the requirements from 1 December 2012.

iii. consumers shifting from premium to non-premium brands (i.e., down-trading); and

c. where appropriate, use New Zealand as a comparator.

1.5 For this purpose, I have been asked to analyse the following datasets:

a. Nielsen and IRI–Aztec retail data regarding cigarettes and roll your own tobacco from January 2009 to December 2016 for Australia; and

b. Nielsen scanner data regarding cigarettes and roll your own tobacco from January 2008 to December 2016 for New Zealand.[3]

Assistance

1.6 I was assisted in preparing this report by Nadine Watson and Stefano Trento, Senior Vice President and Vice President, respectively, at Compass Lexecon. However, the opinions contained in this report are mine alone.

Structure of the report

1.7 The next section sets out a summary of my conclusions.

1.8 The remainder of the report is then structured in three parts as follows.

a. In Section 3, I explain why standardised packaging may in theory increase cigarette consumption, contrary to the health objectives of such regulation. I also review the current state of the published research on the effects of standardised packaging on tobacco use, and explain how the data I have been provided with allows me to overcome some of the limitations of this research and undertake a significantly more robust analysis – on the questions that I have been asked – than any that has been published to date.

b. In Section 4, I set out the main empirical analyses I have carried out to analyse the effects of standardised packaging on cigarette consumption, prices and down-trading in Australia using four years' worth of post-implementation data.

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[3] I have previously written a number of economic expert reports for BAT analysing the impact of various regulations on competition in markets for tobacco products. In particular, I have submitted a number of reports considering the impact of standardised packaging, and providing an empirical analysis of the effects of standardised packaging on consumption, prices and down-trading in Australia, including expert reports submitted in legal proceedings in the UK and France. In this report I examine a longer data series than I had previously looked at, using data through to December 2016.

c. In Section 5, I set out alternative empirical analyses on the effect of standardised packaging on cigarette consumption, which I have carried out in addition to my main analysis, and on the basis that similar approaches been adopted by other authors analysing the effect of standardised packaging in Australia.

1.9 After Annex A, which sets out my CV, Annexes B, C and D set out the detailed results and robustness checks of my empirical analysis.

Section 2

Summary of conclusions

2.1 In this report, I first explain that, as a matter of economic theory, standardised packaging may result in an increase of cigarette consumption, contrary to the heath objectives of the regulation. I then briefly review the published academic research on the effects of standardised packaging on cigarette consumption, set out its limitations, and explain how the data I have been provided with allows me to overcome some of these limitations and undertake a significantly more robust analysis – on the questions that I have been asked – than any that has been published to date.

2.2 I secondly proceed to carry out my own empirical analysis on the effects of standardised packaging in Australia, using scanner sales data (i.e., data collected using scanner systems at retail store checkouts) up to and including December 2016, i.e., four years after the full implementation of standardised packaging in Australia.

2.3 In particular, I analyse the effects of standardised packaging on cigarette consumption, cigarette prices, and down-trading (i.e., consumers switching from premium to lower-quality brands). For this empirical analysis, I proceed in four steps.

2.4 **First**, I describe the methodology used to analyse consumption and pricing in my main analysis. In particular I explain how I analyse the impact of standardised packaging in Australia using New Zealand as a benchmark comparator (but taking account of differences between the two countries, such as different tax policies or a different evolution of income per capita).

2.5 I explain that, provided that New Zealand is a good benchmark comparator, such analysis, known as difference-in-differences ("DID"), is more reliable than other statistical methodologies (such as a before-during analysis of cigarette consumption in Australia) for analysing the effects of standardised packaging on cigarette consumption in the presence of confounding factors that also affect cigarette consumption but whose effects are difficult to measure.

2.6 **Secondly**, I carry out an econometric analysis to test whether New Zealand is a good comparator for Australia in relation to tobacco consumption. I find that this is the case.

2.7 **Thirdly**, I present the results of my main analysis on the effects of standardised packaging on consumption, prices and down-trading. That analysis shows the following:

a. First, standardised packaging is associated with an increase in the per capita consumption of cigarettes in Australia relative to the consumption that would have prevailed had standardised packaging not been implemented, i.e., relative to the counterfactual. In particular, I find that standardised packaging is associated with an increase in per capita cigarette consumption (relative to the counterfactual and up to December 2016) of 3.1%-3.5%, when control variables such as prices, excise taxes and income per capita are expressed in local currencies; and an increase of 2.2%-3.0% when these variables are expressed in purchasing power parity ("PPP").

b. Secondly, standardised packaging is associated with a reduction in the average retail price paid by consumers for cigarettes in Australia relative to the counterfactual. While average retail prices are also influenced by other factors, such as excise taxes and consumers' income, the methodology I use allows me to isolate the effect of standardised packaging from the effect of these other factors on those prices. In particular, I find that standardised packaging is associated with a decrease in the average price paid by consumers (relative to the counterfactual and up to December 2016) of 2.0-2.6%. I also analyse the effect of standardised packaging on each brand within the subset of brands (comprising 21 brands) that are sold both in Australia and in New Zealand.[4] I find that the weighted average price of these brands decreased by 6.8-7.3% (relative to the counterfactual and up to December 2016).

c. Thirdly, while consumers have been shifting from premium to non-premium brands ('down-trading') in Australia since at least 2009, the adoption of standardised packaging is associated with a significant acceleration of this down-trading trend.

2.8 These results are reliable across a large set of robustness checks.

2.9 **Fourthly**, in addition to my preferred DID analysis, I also carry out alternative analyses of the effect of standardised packaging on cigarette consumption. Although they are not based on my preferred method, I have included these alternative analyses on the basis that similar approaches have been adopted by other authors for estimating the effect of standardised packaging in Australia.

2.10 Although, in my opinion, these analyses are carried out in a less rigorous framework, the results are consistent with those of my DID analysis, and indicate that standardised packaging is associated with an increase in cigarette consumption per capita relative to the counterfactual.

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[4] For this analysis, I refer to brands in a broad sense. For example, I refer to Dunhill as a brand, although this brand comprises brand variants such as Dunhill, Dunhill Essence, Dunhill International and others.

Section 3

The contribution of this report to the debate on standardised packaging

3.1 Standardised packaging of tobacco products generally involves the use of the same uniform colour on all tobacco packs, with no brand imagery, and the brand name written in a specified font, colour and size.[5]

3.2 The primary objective of standardised packaging is to reduce smoking by, among other things, reducing the appeal of tobacco products to consumers.[6] The key question is thus whether standardised packaging reduces smoking. I note that this outcome is not necessarily the case from the point of view of economic theory, as explained immediately below.

Standardised packaging may lead to an increase in cigarette consumption

3.3 Economic theory shows that when products are similar to each other (or, in economic terms, homogenous) the main way for suppliers to compete is by offering competitive prices. If they were to attempt to charge a premium, they would experience an 'exodus' of consumers away from their product towards cheaper and similar products. By contrast, when consumers perceive the products as less similar (or, in economic terms, differentiated), price competition is reduced because consumers are more 'loyal' to their preferred product (meaning that they would not necessarily switch product as a result of a price increase) and thus suppliers can charge higher prices.

3.4 I understand that, but for branding, tobacco products are highly substitutable in the eyes of consumers, with research studies indicating that in the absence of brand information, many

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5 McNeill, A., Gravely, S., Hitchman, S. C., Bauld, L., Hammond, D., & Hartmann-Boyce, J. (2017). Tobacco packaging design for reducing tobacco use. The Cochrane Library. Issue 4. Art. No.: CD011244, page 3.

6 See for example UK Department of Health (2015) Standardised packaging of tobacco products: Impact Assessment, IA No:3080, page 1.

smokers are unable to identify different cigarette brands correctly.[7] I also understand that packaging helps cigarette producers build consumer loyalty and distinguish their products from those of their competitors,[8] thus allowing them to charge price premia for their products.

3.5 Standardised packaging eliminates by its very nature the ability of tobacco companies to compete through packaging differentiation. Since – due to limitations in advertising and other restrictions – packaging is the last means by which cigarette producers can communicate to consumers, standardised packaging can be expected to intensify price competition among tobacco companies and thus to reduce the price of tobacco products (relative to the counterfactual of no standardised packaging).[9]

3.6 To the extent that cigarette consumption responds to cigarette prices, of which there is abundant evidence in the economic literature,[10] standardised packaging may result in increased cigarette consumption.

3.7 Even if standardised packaging also had the effect of reducing the appeal of tobacco products in the eyes of consumers, as argued by proponents of such regulation,[11] the overall effect of standardised packaging on cigarette consumption would depend on the relative strength of the 'price' effect and of the 'appeal' effect. A variety of theoretical models could be used to shed light on the relative strength of these two effects. However, given that we now have four years' worth of post-implementation data for Australia, which allows for a robust identification of the effects of standardised packaging, in my opinion these effects (including those on consumption) are better analysed using an empirical approach.

3.8 In the next section I present the results of my empirical analysis, which uses cigarette consumption data (as proxied by scanner sales data) in Australia from January 2009 to

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7 Ramond, C. K.; Rachal, L. H.; Marks, M. R., (1950) Brand discrimination among cigarette smokers. Journal of Applied Psychology, Vol 34(4); and Jaffe A.J., Glaros A.G. (1986) Taste dimensions in cigarette discrimination: a multidimensional scaling approach. Addict Behav 11.

8 UK Department of Health (2015) Standardised packaging of tobacco products: Impact Assessment, IA No:3080, paragraph 63.

9 Davidson, S., and de Silva, A. (2014). The plain truth about plain packaging: An econometric analysis of the Australian 2011 tobacco plain packaging Act. Agenda: A Journal of Policy Analysis and Reform, page 29.

10 See HMRC (2010) "Econometric Analysis of Cigarette Consumption in the UK", Working Paper Number 9; HMRC (2015) "Econometric Analysis of Cigarette Consumption in the UK", Update to Working Paper Number 9. Chaloupka F.J. (1991) "Rational addictive behavior and cigarette smoking", Journal of Political Economy 1991; 99(4), page 735 ("current cigarette consumption is found to be significantly negatively related to the current price of cigarettes"). Chaloupka, F.J. (1992) "Clean indoor air laws, addiction, and cigarette smoking", Applied Economics 24(2), pages 202-203 ("increased cigarette prices […] are also found to have a negative significant impact on cigarette consumption").

11 See paragraph 3.2.

December 2016, i.e., data for four full years of post-implementation period.[12] Before doing so, I review below the academic research on the effect of standardised packaging on tobacco use, and I explain how the data I have been provided with allows me to overcome some of the limitations of this research and undertake a significantly more robust analysis – on the questions that I have been asked – than any that has been published to date.

Studies on the effect of standardised packaging on tobacco use

3.9 A recent review of the academic literature on the effects of standardised packaging on cigarette consumption can be found in the 2017 Cochrane Review.[13] This review only includes published, peer-reviewed articles and identifies five studies that analyse the effect of standardised packaging on tobacco use. It grades these studies as either:[14]

a. "*low quality*", meaning that the authors of the review had limited confidence in the study and that "*[t]he true effect may be substantially different from the estimate of the effect*"; or

b. "*very low quality*", meaning that the authors of the review had very little confidence in the study conclusions and "*the true effect is likely to be substantially different from the estimate of effect*".

3.10 One of these five studies (Diethelm and Farley 2015 ('[1]')) focuses on the effects of standardised packaging on smoking prevalence in Australia and finds that standardised

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12 To date, only Australia (in December 2012) and France (in January 2017) have implemented standardised tobacco packaging, although the French experience is too recent to allow for an empirical analysis.

13 The Cochrane Database of Systematic Reviews is a leading resource for systematic reviews in health care. The Cochrane Review on the effects of standardised packaging is McNeill, A., Gravely, S., Hitchman, S. C., Bauld, L., Hammond, D., & Hartmann-Boyce, J. (2017). Tobacco packaging design for reducing tobacco use. The Cochrane Library. Issue 4. Art. No.: CD011244

14 McNeill, A., Gravely, S., Hitchman, S. C., Bauld, L., Hammond, D., & Hartmann-Boyce, J. (2017). Tobacco packaging design for reducing tobacco use. The Cochrane Library. Issue 4. Art. No.: CD011244, pages 4-5. I note that one of the reasons (but not the only reason) why the authors have limited confidence on the results of some of these studies is that they analyse the effect of standardised packaging using data from Australia, where enhanced pictorial health warnings were implemented at the same time as standardised packaging, making it difficult to separate the effects of these two measures on tobacco use. This is a critique that applies inevitably to all studies that use observational data from Australia.

packaging is associated with a reduction of smoking prevalence using survey data on self-reported smoking status among Australian consumers.[15,16]

3.11 The other four studies focus on the effects of standardised packaging on tobacco consumption (rather than on smoking prevalence):

a. Scollo et al. (2015) ('[2]') use survey data on self-reported smoking status among Australian consumers from April 2012 (eight months before the full implementation of standardised packaging) to March 2014 (fifteen months after the full implementation of standardised packaging) and find that tobacco consumption did not change in the year after the implementation of standardised packaging, and that it decreased after the 12.5% tax increase on tobacco products of December 2013.[17]

b. Miller et al. (2015) ('[3]') use post-implementation survey data, where a limited number of cigar or cigarillo smokers (256) were asked to self-report changes in consumption since a period before the implementation of standardised packaging.[18] The authors find that more smokers report a decrease than an increase in consumption, but acknowledge the limitation of the study, especially with respect to the representativeness of the sample and the accuracy of self-report measures.

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15 Diethelm, P.A., and Farley, T.M., (2015) Refuting tobacco-industry funded research: empirical data shows decline in smoking prevalence following introduction of plain packaging in Australia, Tob. Prev. Cessation 2015; 1(November): 6.

16 The 2017 Cochrane Review also mentions, but does not review in depth, two additional unpublished studies that analyse the impact of standardised packaging on smoking prevalence using the same survey data as Diethelm and Farley (2015): a study by Kaul and Wolf (2014) that finds no evidence for a plain packaging effect on smoking prevalence (Kaul, A., and Wolf, M. (2014) The (possible) effect of plain packaging on smoking prevalence in Australia: A trend analysis); and a study by Dr Chipty (T. Chipty (2016). Study of the Impact of the Tobacco Plain Packaging Measure on Smoking Prevalence in Australia, Appendix A to the Australian Government's Post-Implementation Review on Tobacco Plain Packaging), which uses more updated survey data (to September 2015) and finds results similar to Diethelm and Farley (2015). I note that this is the study relied upon by the Australian Government in its Post-Implementation Review on Tobacco Plain Packaging.

17 Scollo, M., Zacher, M., Coomber, K., Bayly, M., and Wakefield, M. (2015). Changes in use of types of tobacco products by pack sizes and price segments, prices paid and consumption following the introduction of plain packaging in Australia. Tobacco control, 24 (Suppl 2).

18 Miller, C., Ettridge, K. A., and Wakefield, M. A. (2015). You're made to feel like a dirty filthy smoker when you're not, cigar smoking is another thing all together. Responses of Australian cigar and cigarillo smokers to plain packaging. Tobacco Control, 24.

c. The other two studies, Maynard et al. (2015) ('[4]')[19] and Moodie et al. (2013) ('[5]'),[20] use UK experimental data with a limited number of participants (128 and 187, respectively). Maynard et al. (2015) assign participants randomly to either of two groups of smokers: one group is given branded cigarette packs and the other group is given standardised cigarette packs; the authors analyse whether there is any difference in cigarette consumption between the two groups. Moodie et al. (2013) use a different but similar approach.[21] Maynard et al. (2015) find that standardised packaging does not affect consumption, while Moodie et al. (2013) find that standardised packaging reduces consumption.

The contribution of this report

3.12 The data I have been provided with allows me to overcome many of the limitations of the studies reviewed above and undertake a significantly more robust analysis – on the questions that I have been asked – than any that has been published to date.

3.13 First, among studies that review the Australian experience ([1], [2], [3]), I use a materially longer time series that provides information on cigarette consumption up to and including December 2016, i.e., **four years after the full implementation of standardised packaging in Australia**. This compares to the use of one year of post-implementation data in [1] and fifteen months of post-implementation data in [2].[22] [3] uses information collected in February and March 2014 (i.e., approximately fifteen months after the full implementation of standardised packaging) via a survey, and asks survey participants to self-report changes in consumption since a period preceding the implementation of standardised packaging. I note that reviewing a longer post-implementation period is an advantage because, as the Australian Post Implementation Review states, "*the full effect of the tobacco plain packaging measure is expected to be realised over time*".[23]

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19 Maynard, O. M., Leonards, U., Attwood, A. S., Bauld, L., Hogarth, L., and Munafò, M. R. (2015). Effects of first exposure to plain cigarette packaging on smoking behaviour and attitudes: a randomised controlled study. BMC public health, 15(1), 240.

20 Moodie, C. S., and Mackintosh, A. M. (2013). Young adult women smokers' response to using plain cigarette packaging: a naturalistic approach. BMJ open, 3(3), e002402.

21 In particular, participants to the Moodie et al. (2013) study self-reported their smoking habits during two weeks: in one week they used plain cigarette packs provided to them, and in the other week they used their own fully branded packs. Moodie et al (2013) analyse the differences in consumption between the two weeks.

22 In her report relied upon by the Australian Government for its Post Implementation Review (see footnote 16), Dr Chipty uses data up to September 2015. My report thus uses a fifteen month longer post-implementation period to that used by Dr Chipty.

23 Australian Government (2016) Post-Implementation Review on Tobacco Plain Packaging, page 4.

3.14 Secondly, in this report I proxy cigarette consumption using scanner sales data rather than self-reported smoking status like [1], [2], [3], and [5]. I consider this to be an advantage to the extent that the academic literature has shown that smokers tend to under-report their smoking status (a limit that is acknowledged by the authors of [3][24]).[25]

3.15 Thirdly, some of the studies reviewed above ([3], [4], and [5]) are based on a very limited number of observations, which casts doubt on the representativeness of their results, as expressly acknowledged by the authors of [3].[26] In contrast, in this report I use scanner sales data that covers the vast majority of the Australian tobacco market.

3.16 Fourthly, in this report I use observational data from the Australian experience rather than experimental data like [4] and [5]. In my opinion in this case actual rather than experimental data are preferable. This is because experiments such as those performed in [4] and [5] (i.e., giving branded packages to one group and standardised packaging to another group of smokers that are otherwise similar, and assessing whether there is any difference in consumption among the two groups) may capture the 'appeal' effect (if any),[27] but miss important effects of standardised packaging on cigarette consumption, e.g., through its impact on prices and down-trading. These effects are instead captured in analyses that use actual data, such as that used in this report.

3.17 In conclusion, the academic literature on the effects of standardised packaging on tobacco use is scarce and has some significant limitations. In this report I use data that allows me to overcome many of these limitations and undertake a significantly more robust analysis – on the questions that I have been asked – than any that has been published to date.

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24 Miller, C., Ettridge, K. A., and Wakefield, M. A. (2015). You're made to feel like a dirty filthy smoker when you're not, cigar smoking is another thing all together. Responses of Australian cigar and cigarillo smokers to plain packaging. Tobacco Control, 24, page ii64.

25 Gorber, S. C., Schofield-Hurwitz, S., Hardt, J., Levasseur, G., and Tremblay, M. (2009) The accuracy of self-reported smoking: a systematic review of the relationship between self-reported and cotinine-assessed smoking status. Nicotine & Tobacco Research, 11(1).

26 Miller, C., Ettridge, K. A., and Wakefield, M. A. (2015). You're made to feel like a dirty filthy smoker when you're not, cigar smoking is another thing all together. Responses of Australian cigar and cigarillo smokers to plain packaging. Tobacco Control, 24, page ii64. The limitations of a small sample size are also mentioned at paragraph 208 of *The Final Impact Assessment on standardised packaging of tobacco products* by the UK Department of Health, dated 10 February 2015.

27 See paragraph 3.7.

Section 4

Empirical analysis

Introduction

4.1 In this section, I set out the empirical analysis I carried out to assess the impact of standardised packaging in Australia.

4.2 Following this introduction, the rest of the section is organised in three subsections:

a. First, I describe the methodology used for my empirical analysis. In particular I explain the difference-in-differences (”DID”) methodology, that allows me to analyse the impact of standardised packaging in Australia using New Zealand as a benchmark comparator (but taking account of differences between the two countries, such as different tax policies or a different evolution of income per capita).

b. Secondly, I set out the results of the econometric analysis I carried out in order to establish that New Zealand is a good comparator for Australia in relation to tobacco consumption, and thus that the DID methodology is reliable.

c. Thirdly, I present the results of my econometric analysis on the effects of standardised packaging on cigarette consumption, cigarette prices and down-trading.

4.3 I find that:

a. First, standardised packaging is associated with an increase in consumption relative to the counterfactual of no standardised packaging.

b. Secondly, standardised packaging is associated with a reduction in prices relative to the counterfactual of no standardised packaging.

c. Thirdly, while consumers have been shifting from premium to non-premium brands in Australia since at least 2009, the adoption of standardised packaging is associated with a significant acceleration of this down-trading trend.

Methodology

4.4 Any statement such as ‘standardised packaging is likely to have increased/decreased consumption of cigarettes’ is inherently based on a view about what would have happened in the absence of standardised packaging.

4.5 In particular, any such statement implies that a comparison has been made between the actual level of consumption ("the factual") and the level of consumption that we would have observed in a hypothetical scenario where standardised packaging had not been adopted ("the counterfactual").

4.6 While the factual is observable from post-implementation data, the counterfactual is not (since the hypothetical scenario has not happened), and one thus needs to find a reliable way of estimating it. This is not a trivial exercise. For instance, it would be wrong to assume that – in the absence of standardised packaging – cigarette consumption in Australia would have been the same as in the pre-implementation period: on the contrary, cigarette consumption would have been likely to change due to some inertia from previous decreasing trends (e.g., because, as healthier lifestyles becomes more widespread, people may decide to quit or reduce smoking, and older generations of heavier smokers are replaced by younger generations of no-smokers or lighter smokers) and also due to the effects of other relevant policy measures (such as the excise tax increases in Australia, including the large excise tax increases introduced in December 2013 and September 2014, 2015 and 2016).

4.7 In this section, I estimate the counterfactual level of cigarette consumption using a DID approach. DID analyses are widely used in economics for impact evaluation of public policies, including for the evaluation of tobacco-related policies.[28] For instance, in their paper "Recent developments in the econometrics of program evaluation", Professors Imbens and Wooldridge note that "*since the seminal work by Ashenfelter (1978) and Ashenfelter and Card (1985), the use of Difference-In-Differences (DID) methods has become widespread in empirical economics*".[29]

4.8 In their simplest form, DID analyses are carried out as follows. Imagine if I were to test whether the free distribution of mosquito nets is effective at reducing the incidence of malaria in a malaria-plagued area. I would first randomly select two groups of families: those who will receive the mosquito net ("the treatment group") and those who will not receive it ("the control group"). I would then measure malaria incidence in these two groups before the distribution of the mosquito nets. I would then repeat the measurement (again, for the two groups) after the distribution of the mosquito nets.

4.9 I would then compare the average reduction in the malaria incidence between the two groups. If I were to find that malaria incidence had reduced more in the treatment group (e.g., by 20%) than in the control group (e.g., by 15%), and that this difference was

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28 For example see analysis carried out by the U.S. Food and Drug Administration on the impact of graphic health warnings on cigarette packets which used the U.S. as a comparator for analysing the effects of graphic health warnings introduced in Canada: U.S. Dept. of Health and Human Services, Food and Drug Administration, Required Warnings for Cigarette Packages and Advertisements – Final Rule, Federal Register, Vol. 76, No. 120, June 22, 2011, pp 36719-36721.

29 Imbens, G.M., and J.M. Wooldridge (2009), "Recent developments in the econometrics of program evaluation" *Journal of Economic Literature 47, no. 1, page 64*

statistically significant, I would conclude that the free distribution of mosquito nets reduces the incidence of malaria (e.g., by 20% - 15% = 5%).

4.10 The DID analysis is more reliable than other, less sophisticated, statistical methodologies. For instance, imagine if – between the first and the second measurement – a pesticide programme was carried out that reduced the incidence of malaria by 15% in the relevant area (which would explain why the incidence of malaria also decreased for the control group). Had I not used a DID analysis (i.e., a comparison with a control group) but only a simplistic approach of comparing the incidence of malaria for the treatment group before and after the distribution of mosquito nets), I would have incorrectly attributed the full reduction of malaria incidence of the group receiving free nets (i.e., 20%) to the mosquito nets.[30]

4.11 Other econometrics methods exist in theory to control for the effect of confounding factors. For example one could carry out a before-during regression that includes the pesticide programme as an explanatory variable for the change in malaria incidence.[31] However, these alternative methods are less reliable than the DID approach when the confounding factors are not observable or are difficult to control for, as is the case for the decreasing trend in cigarette consumption, e.g., as a result of healthier lifestyles becoming more prevalent. In those cases, the DID approach is more reliable because – insofar as the confounding factor has the same or similar effects in the treatment group and in the control group – it automatically isolate the effect of the relevant variable (e.g., standardised packaging, or mosquito nets) from the effect of the confounding factor (e.g., the decreasing trend in cigarette consumption, or the pesticide programme).

4.12 As is clear from the above, a DID approach requires a reliable benchmark comparator, or control group, which is similar to the treatment group but which is not affected by the policy. Some authors – including the Australian Bureau of Statistics and the New Zealand Ministry

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30 Gertler P.J., Martinez S., Premand P., Rawlings L.B., Vermeersch C.M.J. (2011) "Impact Evaluation in Practice", The World Bank, page 96: "*The difference-in-differences approach thus combines the two counterfeit counterfactuals (before-and-after comparisons and comparisons between those who choose to enrol [e.g., implemented standardised packaging] and those who choose not to enrol [e.g., did not implement standardised packaging]) to produce a better estimate of the counterfactual*" (emphasis added).

31 For a more detailed explanation of the before-during approach, see Section 5, and in particular paragraphs 5.3a, 5.10-5.20. That section also sets out an alternative approach, known as prediction approach (see paragraphs 5.3b, 5.21-0). This alternative approach is subject to the same limitations as the before-during approach, i.e., it is less reliable than the DID approach in the presence of confounding factors that also affect cigarette consumption but are difficult to control for.

of Social Development – have used New Zealand as a comparator for Australia, and vice versa.[32]

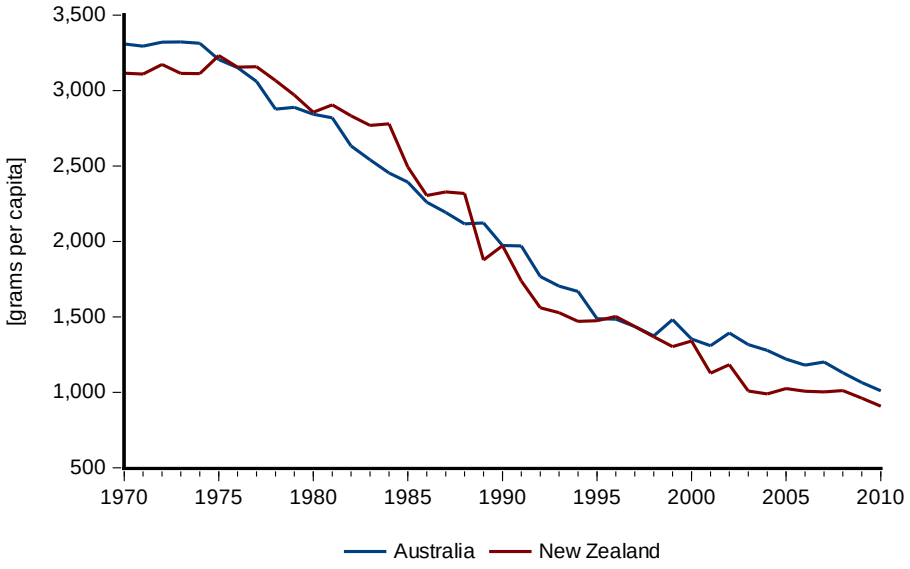
4.13 In the next subsection, I carry out my own analysis and find that New Zealand is a good comparator for Australia because there is a stable relationship between cigarette consumption in Australia and in New Zealand.

New Zealand is a good comparator for Australia

4.14 As explained in the previous section, the DID analysis only provides reliable results if the evolution of tobacco consumption in New Zealand is a good indicator of what the evolution of tobacco consumption would have been in Australia but for the adoption of standardised packaging.

4.15 In order to assess whether this is the case, I analyse long-term time series of tobacco consumption in the two countries. In particular, I use OECD data for 1970-2010 on consumption of tobacco products per capita among 15+ year old (Figure 1).

Figure 1: Evolution of tobacco consumption (grams per capita, 15+ year old) in Australia and New Zealand (1970-2010)



Source: Compass Lexecon based on OECD data.

4.16 The figure suggests that consumption of tobacco products in Australia and New Zealand followed similar trends and that New Zealand is thus a good candidate for a comparator.

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[32] See for instance Australian Bureau of Statistics (2001) "Australian Social Trends", and New Zealand Ministry of Social Development (2010) "2010 Social Report" (http://socialreport.msd.govt.nz/2010/comparisons/australia.html).

4.17 In order to assess whether New Zealand is indeed a good comparator, I empirically tested whether tobacco consumption in Australia and New Zealand co-move in the long-run using co-integration analysis techniques. Co-integration analysis allows for testing empirically whether two or more (non-stationary) series maintain a systematic equilibrium (or long-run) relationship.[33]

4.18 Intuitively, two non-stationary series that are co-integrated will not move too far apart over time.[34] At any one time they may be very close, while at another time they may be further apart, but over the long run they will move together.

4.19 This is the reason why two co-integrated series are often regarded as maintaining a long term equilibrium relationship over time. In other words, the difference between two co-integrated series is relatively stable over time.

4.20 To test whether tobacco consumption in Australia and New Zealand are co-integrated (i.e., they maintain a long-run equilibrium relationship) I ran a regression of the (log of) Australian consumption on (log of) New Zealand consumption and analysed whether the residuals of such regression (i.e., the component of the consumption in Australia not explained by the evolution of the consumption in New Zealand) are stationary or follow a trend.[35] Intuitively, if

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[33] A time series is said to be non-stationary when its mean and variance are not independent of time. For example, a series exhibiting an upward or a downward trend over time is non-stationary, since the mean of the series changes depending on the time period analysed. Hence, the mean of a stationary series is constant over time. In other words, non-stationarity, a property common to economic time series, means that a variable has no clear tendency to return to a constant value. An important feature of stationary time series is that they frequently cross their mean and exhibit a tendency to revert to it. Non-stationary series, on the contrary, do not necessarily have a constant mean and do not cross the mean line frequently, suggesting there is no such reversion to the mean value. Tobacco consumption series in Australia and New Zealand both exhibit a clear downward trend over time, suggesting they are not stationary. Formal statistical tests unambiguously indicate that tobacco consumption in Australia and in New Zealand are non-stationary.

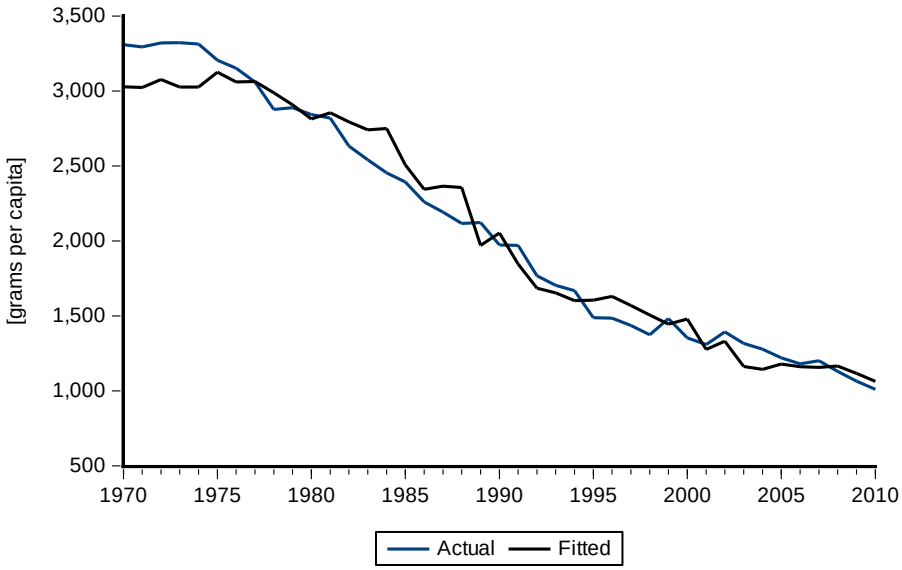
[34] Formally, two non-stationary series are said to be co-integrated if there is a unique linear combination of them that is stationary.

[35] These types of tests are commonly referred to as residual-based co-integration tests and are widely accepted and used in the analysis of non-stationary series to test for co-integration. Residual-based co-integration tests consist of testing whether the residuals resulting from running a regression between the two non-stationary variables of interest are stationary. If the residuals are stationary, this means there is a linear combination of the variables that is stationary, and therefore the variables are co-integrated. Residual-based tests are implemented in two stages. First, a regression between the non-stationary variables of interest (in this case tobacco consumption in Australia and New Zealand) is run. Second, unit root tests proposed in the literature are used to test whether the residuals resulting from the regression in the first stage are stationary [I(0)]. If the residuals are found to be stationary, the series included in the regression in the first stage are co-integrated. For a more detailed description of residual-based co-integration tests see Hamilton, J. (1994) “Time series analysis”, Princeton University

the residuals of the regression are stationary, the difference between the two consumption variables is stable in the long term, and therefore the consumption levels in New Zealand can be used to forecast the level of consumption in Australia.

4.21 Figure 2 below shows the actual tobacco consumption in Australia and the fitted values using the regression model. This figure shows that most of the variability in Australian consumption of tobacco products can be explained (and thus forecasted) using data on New Zealand consumption of tobacco products. In particular, above 97% of the observed variability in the series of tobacco consumption in Australia is explained by the evolution of the tobacco consumption in New Zealand.

Figure 2: Actual and fitted tobacco consumption in Australia (1970-2010)



Source: Compass Lexecon based on OECD data.

4.22 Figure 3 below depicts the residuals of the regression model. These residuals – the component of the consumption in Australia not explained by the evolution of the consumption in New Zealand – exhibit no trend, indicating that tobacco consumption in Australia and New Zealand do maintain a long-run equilibrium relationship (i.e., are co-integrated).[36] In other words, these results indicate that New Zealand tobacco consumption can be used to predict the evolution of the Australian consumption, and therefore is a valid

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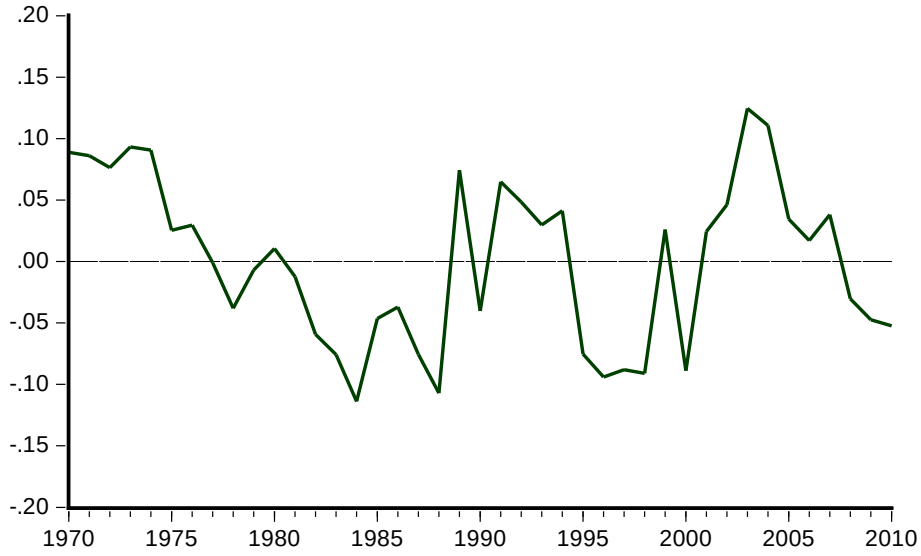
Press, and Engle, R.F. and Granger, C.W.J. (1987) "Cointegration and error correction: representation, estimation and testing", *Econometrica,* Vol. 55.

36 Formal statistical tests (Engle-Granger and Philips-Ouliaris residual-based co-integration tests) confirm that residuals are stationary [I(0)] at the 95% confidence level, indicating tobacco consumption in Australia and New Zealand are co-integrated.

benchmark to assess what the Australian consumption would have been had standardised packaging not been introduced.

Figure 3: Residuals of the regression of the (log of) tobacco consumption in Australia on the (log of) tobacco consumption in New Zealand (1970-2010)



Source: Compass Lexecon based on OECD data.

The impact of standardised packaging on the Australian tobacco market

Consumption

4.23 Having established that New Zealand is a good comparator for Australia in relation to consumption of tobacco products, I proceed to analyse the effect of standardised packaging on Australian consumption of cigarettes using New Zealand as a benchmark.

4.24 As a first step, I plot consumption in the two countries from January 2009 to November 2012 (i.e., before standardised packaging was fully implemented in Australia) in Figure 4.[37]

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[37] Note that the consumption data that I analysed in the previous section was for a different time period, i.e., 1970-2010.

Figure 4: Cigarette consumption (in millions of sticks) in Australia and New Zealand, January 2009 – November 2012

Source: Compass Lexecon based on Nielsen and IRI-Aztec data.

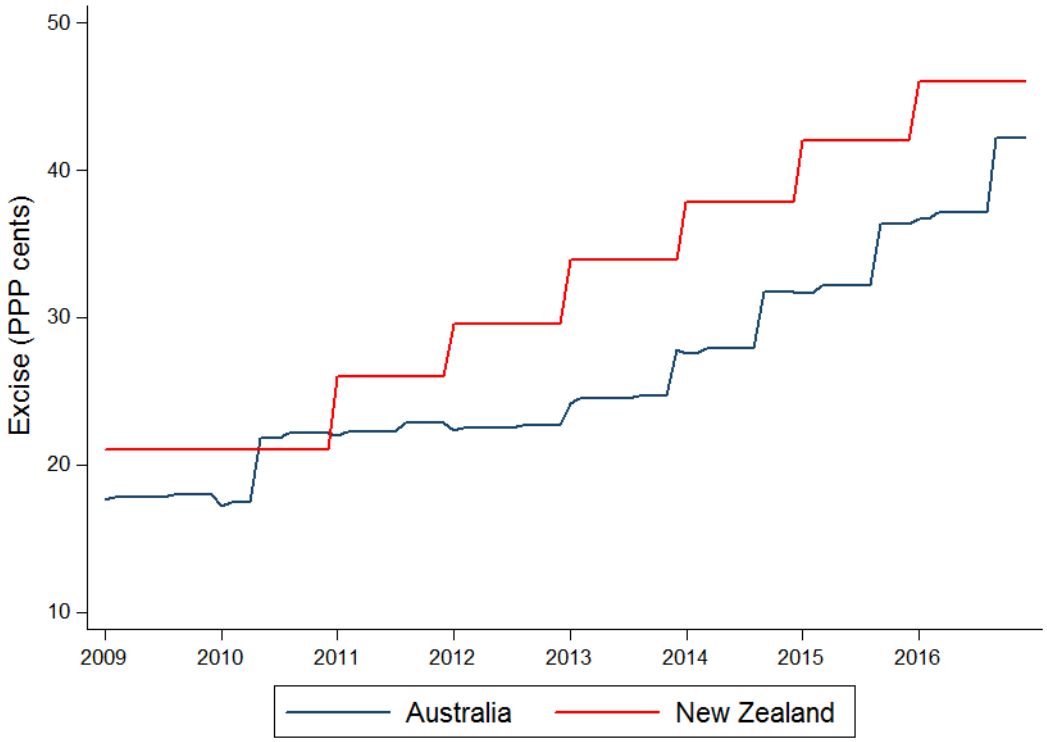
4.25 The above chart shows that, before the implementation of standardised packaging in Australia:

- Consumption in Australia (measured on the left-hand side axis) was higher than consumption in New Zealand (measured on the right-hand side axis);
- Consumption in both countries was seasonal;
- Consumption decreased in both countries; and
- New Zealand is a good comparator for Australia.

4.26 In order to analyse the impact of standardised packaging on cigarette consumption in Australia, I use an extended version of the DID approach, whereby I also control for differences between Australian and New Zealand trends that are not due to standardised packaging but rather to other factors such as different tax policies or a different evolution of income in the two countries.

4.27 The different evolution of excise taxes in the two countries is shown in Figure 5.

Figure 5: Excise taxes in Australia and in New Zealand, January 2009 to December 2016, in purchasing power parity cents



Source: *Compass Lexecon using data from www.comlaw.gov.au and from www.legislation.govt.nz.*

4.28 To the extent that increases in taxes result in price increases, taxes affect consumption. If I did not control for the different evolution of taxes in Australia and in New Zealand, I could incorrectly attribute to standardised packaging a divergence in cigarette consumption among these two countries that is in fact due to different tax policies.

4.29 In order to isolate the impact of standardised packaging on cigarette consumption from the impact of other factors, such as excise taxes and income (as measured by GDP per capita), I carry out a regression analysis using monthly data on per-capita cigarette consumption in Australia and New Zealand from January 2009 to December 2016.

4.30 Table 1 reports the effects of standardised packaging on consumption per capita according to my econometric analysis.[38] In particular, it reports the average percentage increase in

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38 As explained in Annex B, consumption per capita is computed as total consumption (from Nielsen and IRI-Aztec) divided by 20+ year old population (from Australian Bureau of Statistics and from Statistics New Zealand). Note that this definition of consumption per capita does not imply that I am focusing on consumption among 20+ year old consumers: in fact, I am considering consumption across the whole population (including consumption among e.g., teenagers), since the consumption data that I use come

consumption per capita (up to December 2016) due to standardised packaging relative to the counterfactual (e.g., the coefficient 0.035 means that standardised packaging is associated with an increase in consumption per capita of 3.5% relative to the counterfactual).

4.31 In both models of Panel A and Panel B of Table 1, I use year indicator variables and monthly dummies to control for time effects common to New Zealand and Australia. I also control for the effect of GDP per capita on consumption per capita. In Model 1, I control for the effect of excise taxes on consumption per capita. Since consumers care about excise taxes only insofar as these affect prices, in Model 2 I control for the indirect effects of taxes on consumption via prices (for this I use an Instrumental Variable approach).[39]

4.32 The difference between Panel A and Panel B is that, in the former, prices, excise taxes and GDP per capita are expressed in local currencies, while in the latter they are expressed in PPP.[40]

Table 1: DID regression analysis on the effect of standardised packaging on cigarette consumption per capita in Australia

	Model 1	**Model 2**
Controls for monthly dummies, year indicator variables and →	Excise tax, GDP per capita	IV: Price (instrument Excise tax and Inflation), GDP per capita
Panel A: local currencies		
Effect of standardised packaging	0.035**	0.031**
Panel B: PPP		
Effect of standardised packaging	0.030*	0.022*

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

4.33 Coefficients are always positive and statistically significant, indicating that standardised packaging is associated with an increase in Australian consumption per capita relative to the counterfactual.

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from scanner sales data. Thus, the denominator is only a scaling factor. Choosing a different denominator – e.g., 15+ year old population rather than 20+ year old population – does not change my results.

39 See Annex B for a more detailed explanation of the econometric models.

40 Since Australia and New Zealand have different currencies, I express prices and other variables in both countries in purchasing power parity ("PPP") terms. PPP eliminates price and value differences due to differences in the general levels of prices in the two countries.

4.34 These results are robust to whether prices, excise taxes and GDP per capita are expressed in local currencies or in PPP terms.[41]

4.35 In order to control for the fact that standardised packaging was rolled out progressively from October 2012 although it only came into full force in December 2012, I have also carried out robustness checks running the same analyses as those in Table 1 but using (i) 1 October, and then (ii) 1 November as the cut-off point for the adoption of standardised packaging. I have also carried out robustness checks using quarterly data (as opposed to monthly data). All of the results presented above are robust to these different specifications.[42]

Prices

4.36 I am not aware of sufficient, publicly available, time series data on cigarette prices being available to allow me to establish a long-run relation between the price of cigarettes in Australia and New Zealand.[43] Nevertheless, on the strength of the findings above regarding the co-movement of cigarette consumption in Australia and New Zealand, and given that prices are a very important determinant of consumption (as also confirmed by my consumption analysis), I proceed to analyse the effect of standardised packaging on prices using the same DID methodology that I used for consumption.

4.37 As a first step, I carry out a DID regression analysis to estimate the effects of standardised packaging on the average price paid by consumers. For this, I analyse the average post-tax price across all segments. The results of this analysis are reported in Table 2. This table reports the average percentage decrease in prices (up to December 2016) due to

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41 I note that in previous reports where I carried out similar empirical analyses, I imposed the assumption that the effect of GDP on consumption and on prices was the same in Australia and New Zealand. Given that for this report I have been provided with a longer time series (with an additional one and a half years' worth of data than my most recent previous analysis) I decided to test the assumption by including an interaction term between the variable GDP per capita and a dummy for Australia. I found this interaction term to be statistically significant, and thus I decided to include it in my regressions. This implies that I am no longer imposing that assumption and that I instead 'let the data speak'. I provide more technical details in Annex B and Annex C where I also show that, even if I were to apply the same model that I previously used, the results would not change, i.e., standardised packaging would still be associated with an increase in consumption and with a decrease in prices relative to the counterfactual (with results being statistically significant in seven out of the twelve model specifications).

42 The robustness checks and the full specifications of the model are presented in Annex B.

43 While I do have data that allow me to compute the average market prices for cigarettes both in Australia and in New Zealand (the data I use for the price analysis in this section), these data cover a period of seven years (2009-2016) and thus do not allow me to establish robustly whether there exists a long-run relation between the prices of cigarettes in the two countries (for establishing the long-run relationship between cigarette consumption in Australia and New Zealand, I used data that covered 40 years, see paragraphs 4.14-4.22).

standardised packaging relative to the counterfactual (e.g., the coefficient -0.020 means that standardised packaging is associated with a decrease in prices of 2% relative to the counterfactual).

4.38 For this analysis, I control for the effects on prices of excise taxes and GDP per capita. I also analyse prices (and control variables) both in local currencies (Model 1) and in PPP (Model 2).

Table 2: DID regression analysis on the effect of standardised packaging on the average cigarette price in Australia

	Model 1	**Model 2**
Controls for monthly dummies, year indicator variables and →	Excise tax, GDP per capita	Excise tax PPP, GDP per capita PPP
Effect of standardised packaging	-0.020**	-0.026**

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

4.39 This table shows that the effect of standardised packaging on average prices is negative and statistically significant, indicating that standardised packaging is associated with a decrease in the average cigarette price paid by consumers (relative to the counterfactual).

4.40 As was the case for consumption, these results are robust to whether prices, excise taxes and GDP per capita are expressed in local currencies or in PPP terms.[44]

4.41 In order to control for the fact that standardised packaging was rolled out progressively from October 2012, although it only came into full force in December 2012, I have carried out robustness checks using (i) October 2012, and then (ii) November 2012 as the start date of standardised packaging. I have also carried out robustness checks using quarterly data (as opposed to monthly data). All of the results presented above are robust to these different specifications.[45]

4.42 The average price decline in Australia (relative to the counterfactual) may be the result of down-trading (i.e., smoker switching from more expensive to cheaper brands), of lower

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[44] See footnote 41 and Annex C for an explanation of how these models compare to models I used in previous reports.

[45] The robustness check and the full specification of the model are presented in Annex C. For regression with quarterly data, the coefficients of interest are negative (indicating that standardised packaging is associated with a price decrease) but some of them are not statistically significant. Losing significance can be expected when one reduces the number of data points by two thirds (I aggregate three monthly data points into one quarterly data point) and with a short time period (given that I work with data from the 2009-2016 period, for the quarterly data I use only 32 data points per each country).

prices (i.e., brands reducing prices) or a combination of the two. Since it is possible that down-trading results in increased consumption (relative to the counterfactual),[46] the results presented in Table 1 and Table 2 would be sufficient for me to conclude that standardised packaging is associated with an increase in consumption (relative to the counterfactual).

4.43 Nevertheless, as a second step in my price analysis, I proceed below to analyse the effect of standardised packaging on brand-level prices for the subset of brands that are sold both in Australia and in New Zealand, and conclude that standardised packaging is also associated with a decrease in these prices (relative to the counterfactual).

4.44 For this analysis, I first identify the 21 brands that are sold both in Australia and in New Zealand: Ashford, Benson & Hedges, Camel, Chunghwa, Davidoff, Double Happiness, Dunhill, Easy, Holiday, Honeyrose, Horizon, JPS, Kent, Longbeach, Marlboro, Pall Mall, Peter Jackson, Peter Stuyvesant, Rothmans, Vogue, Winfield.[47]

4.45 I then analyse the effect of standardised packaging on each of these brands by using similar regression analyses as those used for the average market price. The results of these analyses are reported in Table 3. This table splits the brands into (i) brands whose price has increased relative to the counterfactual (and the increase is statistically significant); (ii) brands whose price has decreased relative to the counterfactual (and the decrease is statistically significant); and (iii) brands whose price has neither increased nor decreased relative to the counterfactual (i.e., those brands for which the model finds no statistically significant change in price).

4.46 For each category, and for each model,[48] the table reports (a) the weighted average percentage change in price (relative to the counterfactual); (b) the number of brands in that category; and (c) the 2016 volume in millions of sticks.

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46 This is because consumers who down-trade from premium to cheaper brands can buy more cigarettes while spending the same amount of money.

47 Given that New Zealand data is provided at the level of broad brands (e.g., Dunhill), I carry out the analysis at this level (e.g., I analyse the evolution of the price of Dunhill cigarettes) rather than at the brand variant level (e.g., analysing separately the evolution of the price of Dunhill, Dunhill Essence, Dunhill International, Dunhill Fine Cut …). In some cases variants within a brand belong to different market segments. Thus, a reduction of the average price of those brands in Australia may be partially due to the acceleration of down-trading (see next section) or to brand repositioning. However, given that this issue may arise for only three of the 21 brands analysed, I do not consider that it significantly affects my results.

48 The models are explained extensively in Annex C.

Table 3: DID regression analysis on the effect of standardised packaging on the average cigarette price in Australia

		Model 1			Model 2		
		% change in price	Number of brands	Million sticks (2016)	% change in price	Number of brands	Million sticks (2016)
(i)	Increase in price	6.1%	7	514	5.0%	9	1,213
(ii)	Decrease in price	-15.4%	4	6,496	-16.3%	3	5,670
(iii)	No effect on price	0.0%	10	5,533	0.0%	9	5,659
	Weighted average	**-7.7%**			**-6.9%**		

Source: Compass Lexecon analysis

4.47 The table shows similar results for both models. In Model 1, the average price decrease (relative to the counterfactual) for brands in category (ii) (-15.4%) is larger than the average price increase (relative to the counterfactual) for brands in category (i) (6.1%). Also, despite the fact that the number of brands that increase price (relative to the counterfactual) exceeds the number of brands that decrease price (relative to the counterfactual) (7 vs 4), the brands that decrease price (relative to the counterfactual) account for more than ten times the volume of the brands that increase price (relative to the counterfactual). As a result of a stronger impact that affects larger volumes of consumption, the price decrease dominates the price increase, and – on average – the price of the brands analysed decreased by 7.7% relative to the counterfactual.

4.48 A similar analysis applies for Model 2, whereby, on average, the price of the brands analysed decreased by 6.9% relative to the counterfactual.

4.49 The above results suggest that at least part of the average price decrease can be explained by a decrease in the price of some brands.

Down-trading

4.50 As explained in Section 3, standardised packaging severely restricts the scope for branding. In particular, by reducing consumers' valuation of premium brands vis-à-vis lower-quality brands, it may induce a shift from premium to lower-quality brands.

4.51 My before-after regression analysis on down-trading confirms that high-quality brands lost market share following the introduction of standardised packaging in Australia. This analysis is based on Nielsen's scanner data for Australia from January 2009 to March 2012 and IRI-Aztec retail data from April 2012 to December 2016.[49]

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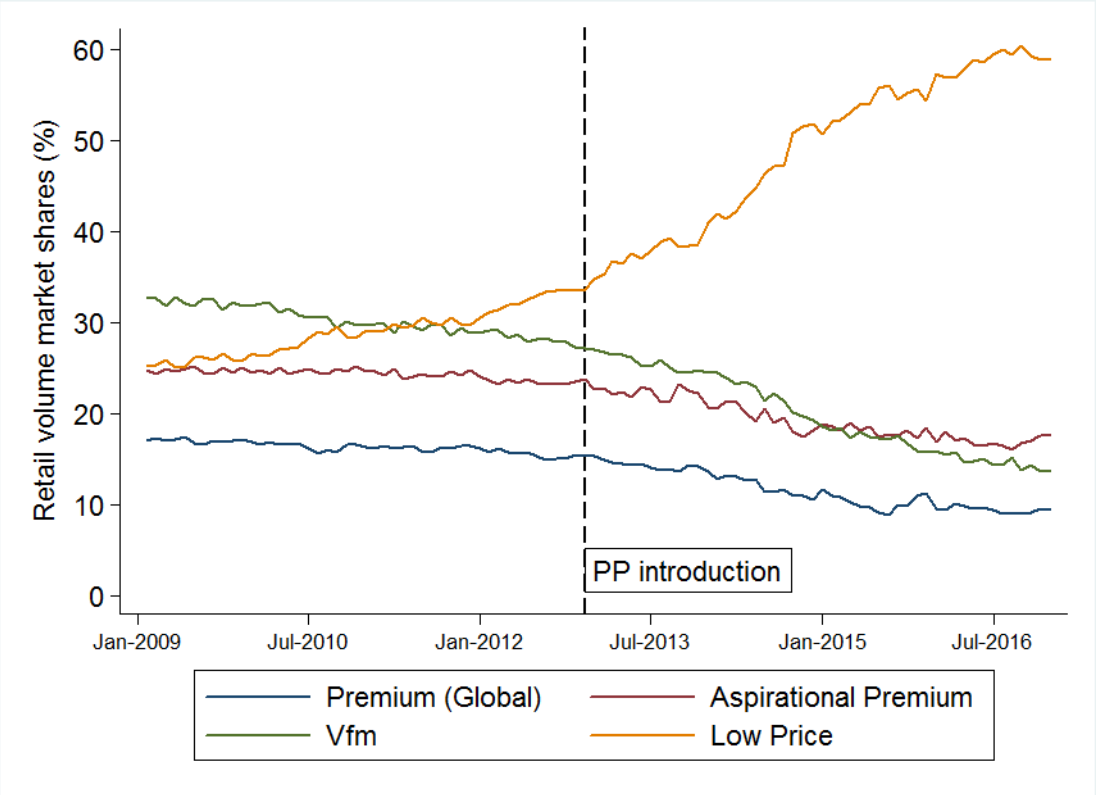
[49] Cigarette brands are classified by the industry into the following segments (in decreasing order of value): Premium, Aspirational Premium, Value for Money ("VFM"), and Low Price.

4.52 These data are reported in Figure 6, which shows that the increasing trend of low value brands (the yellow line) at the expense of more premium brands (the other three lines) can be dated back to at least 2009.

Figure 6: Market shares of different brand segments, Australia January 2009 – December 2016



Source: Compass Lexecon based on Nielsen and IRI-Aztec data.

4.53 In order to assess whether standardised packaging is associated with an acceleration of this trend, I carry out a two-step regression analysis.

4.54 First, I assess whether the market share of each segment followed a linear or a quadratic time trend before the adoption of standardised packaging. The results of this analysis are reported in Table 4.

Table 4: Results of the regressions of market shares on a quadratic time trend

	(1)	(2)	(3)	(4)
	Premium (Global)	Aspirational Premium	VFM	Low Price
Time trend	-0.027**	0.020	-0.118***	0.125***
	[0.012]	[0.014]	[0.019]	[0.019]
Quadratic term of the time trend	-0.000	-0.001***	0.000	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]
Constant	17.223***	24.735***	32.983***	25.059***
	[0.109]	[0.137]	[0.199]	[0.173]
Observations	47	47	47	47
Adjusted R-squared	0.753	0.682	0.924	0.961

Notes: *Robust standard errors in brackets.*
**** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

4.55 Each column of the table represents one segment. For instance column (1) reports the results of the time-trend analysis for the Premium (Global) segment. The coefficients of this regression show that this segment was following a decreasing time trend (-0.027**) before the adoption of standardised packaging, and that this trend may have been linear since the coefficient of the "Quadratic term of the time trend" is not statistically significant.

4.56 Table 4 suggests that:

a. The Premium (Global) and the VFM segments followed a decreasing linear trend;

b. The Aspirational Premium segment followed a decreasing quadratic trend where only the quadratic term is significant; and

c. The Low Price segment followed an increasing quadratic trend.

4.57 Secondly, I analyse whether the above trends have changed after the adoption of standardised packaging. For this, and following the results in Table 4, I use a linear trend for the Premium (Global) and the VFM segments, and a quadratic trend for the Aspirational Premium (without including a linear term) and the Low Price segment (including both a linear and a quadratic term).

4.58 Table 5 shows that standardised packaging is associated with an acceleration of the down-trading to the Low Price segment.

Table 5: Regression analysis on the effect of standardised packaging on down-trading in Australia

	(1)	(2)	(3)	(4)
	Premium (Global)	Aspirational Premium	VFM	Low Price
Time trend	-0.040***		-0.114***	0.125***
	[0.003]		[0.004]	[0.019]
Change in time trend	**-0.094*** **		**-0.193*** **	**1.371*** **
	[0.007]		[0.008]	[0.180]
Quadratic term of the time trend		-0.001***		0.001***
		[0.000]		[0.000]
Change in the quadratic term of the time trend		**-0.000** **		**-0.008*** **
		[0.000]		[0.001]
Dummy for standardised packaging	3.878***	-0.504	9.120***	-49.388***
	[0.422]	[0.406]	[0.508]	[6.305]
Constant	17.327***	24.917***	32.958***	25.059***
	[0.082]	[0.068]	[0.131]	[0.173]
Observations	96	96	96	96
Adjusted R-squared	0.962	0.945	0.989	0.991

Notes: *Coefficients of interest in bold.*
Robust standard errors in brackets.
**** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

4.59 The variables of interest are "Change in time trend"[50] (for Premium, VFM and Low Price) and "Change in the quadratic term of the time trend"[51] (for Aspirational Premium and Low Price). In particular:

50 This variable represents the interaction between the linear time trend and a dummy variable that takes the value of 1 for December 2012 and for the following months (i.e., the months when standardised packaging was fully in place), and the value of 0 for earlier months.

a. For the Premium (Global) and the VFM segments, the coefficients of "Change in time trend" are negative and significant, indicating that standardised packaging is associated with an acceleration of consumers' shift away from these segments;

b. For the Aspirational Premium segment, the negative and significant coefficient of the variable "Change in the quadratic term of the time trend" indicates that standardised packaging is associated with an acceleration of consumers' shift away from this segment; and

c. For the Low Price segment, the combination of coefficients of the "Change in time trend" and "Change in the quadratic term of the time trend" terms indicates that standardised packaging is associated with an acceleration of consumers' shift to this segment. [52]

4.60 As a robustness check, I have run similar regressions whilst taking into account the potential effect of excise taxes on down-trading. Table 6 shows that results are robust to this different specification.[53]

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51 This variable represents the interaction between the quadratic term of the time trend and a dummy variable that takes the value of 1 for December 2012 and for the following months (i.e., the months when standardised packaging was fully in place), and the value of 0 for earlier months.

52 In the Low Price segment, the coefficient of "Change in time trend" is positive (indicating an acceleration of down-trading to this segment) and the coefficient to "Change in the quadratic term" is negative (indicating a deceleration of down-trading to this segment). However, the overall effect of these two coefficients implies that down-trading to the Low Price segment's market shares has accelerated. The reader can check this result by computing estimated values of market share with and without the change in slopes. When the change in slopes is taken into account, the market share of the Low Price segment is significantly higher than when the change in slopes is not taken into account. The time trend is a stepwise variable that takes values from 1 (January 2009) to 96 (December 2016).

53 In the Low Price segment, the coefficient of "Change in time trend" is positive (indicating an acceleration of down-trading to this segment) and the coefficient to "Change in the quadratic term" is negative (indicating a deceleration of down-trading to this segment). See paragraph 4.59c and footnote 52 for an explanation of why the overall effect of these two coefficients implies that down-trading to the Low Price segment's market shares has accelerated.

Table 6: Regression analysis on the effect of standardised packaging on down-trading in Australia, after controlling for the effect of excise taxes

	(1)	(2)	(3)	(4)
	Premium (Global)	Aspirational Premium	VFM	Low Price
Excise tax	4.942	0.216	-6.694*	15.439**
	[3.544]	[3.308]	[3.520]	[7.293]
Time trend	-0.053***		-0.097***	0.040
	[0.010]		[0.010]	[0.043]
Change in time trend	**-0.108*** **		**-0.173*** **	**1.455*** **
	[0.011]		[0.012]	[0.178]
Quadratic term of the time trend		-0.001***		0.002***
		[0.000]		[0.001]
Change in the quadratic term of the time trend		**-0.000** **		**-0.009*** **
		[0.000]		[0.001]
Dummy for standardised packaging	4.836***	-0.498	7.822***	-49.677***
	[0.687]	[0.397]	[0.733]	[6.121]
Constant	16.090***	24.857***	34.633***	21.563***
	[0.873]	[0.916]	[0.895]	[1.665]
Observations	96	96	96	96
Adjusted R-squared	0.963	0.944	0.990	0.992

*Notes: Coefficients of interest in bold. Robust standard errors in brackets. *** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

4.61 Consistent with economic theory, the results of this empirical analysis suggest that the adoption of standardised packaging was associated with an acceleration of down-trading from more premium to low price brands.

Section 5

Alternative consumption analyses

Introduction

5.1 In Section 4, I have set out the results of my DID analysis on the effect of standardised packaging on cigarette consumption, i.e., that standardised packaging is associated with an increase in consumption per capita (relative to the counterfactual and up to December 2016) of between 2.2% and 3.5%.

5.2 In this section, I set out alternative analyses of the effect of standardised packaging on cigarette consumption. I have included them in addition to my preferred DID analysis, and on the basis that similar approaches have been adopted by other authors for estimating the effect of standardised packaging in Australia.

5.3 These analyses are:

a. A **before-during** approach, whereby I estimate the effects of income and other relevant factors (including standardised packaging) on cigarette consumption per capita in Australia using the full time series of data (from January 2009 through December 2016).[54]

b. A **prediction** approach, whereby I estimate the effects of income and other relevant factors on cigarette consumption per capita in Australia using the before-period only, i.e., the period preceding the implementation of standardised packaging. Using the results of this estimation, I project the level of cigarette consumption per capita that would have prevailed had standardised packaging not being implemented.[55] I finally estimate the

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54 Other authors have also employed a before-during approach for estimating the effect of standardised packaging in Australia. In particular, Chipty (2016) employs this approach in analysing the effect of standardised packaging on smoking prevalence in Australia. I use retail sales data as opposed to self-reported smoking status data used by Dr. Chipty. I also use a materially longer time series that provides a fifteen month longer post-implementation period to that used by Dr Chipty.

55 For example, if I estimate that in the pre-implementation period a 1% increase in income results in an average increase in cigarette consumption by 0.3%, and in the post-implementation period income increased by 2%, I predict that – everything else equal – in the same period cigarette consumption would have increased by 0.6% (i.e., 2 x 0.3%).

effect of standardised packaging to be the difference between the actual and the predicted level of consumption.

5.4 These two analyses have different advantages and disadvantages, and thus they complement each other.[56]

5.5 Although, in my opinion, these analyses are carried out in a less rigorous framework,[57] the results are consistent with those of my DID analysis, and indicate that standardised packaging is associated with an increase in cigarette consumption per capita relative to the counterfactual.

The need to account for the declining trend in cigarette consumption

5.6 As explained in Section 4,[58] cigarette consumption follows a downward trend, in part for reasons not directly related to tobacco control policies. If this downward trend were neglected, the statistical analysis would incorrectly attribute the associated reduction in cigarette consumption to the implementation of standardised packaging, and thus the estimated effect of standardised packaging on cigarette consumption would be unreliable. This is acknowledged by experts engaged by regulatory authorities to analyse the effects of standardised packaging.[59]

5.7 My DID approach controls for the downward trend in cigarette consumption as follows:

a. It assumes that, in the absence of standardised packaging and save for the different evolution of other modelled factors in the two countries, cigarette consumption in

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56 The standard before-during approach is preferable if standardised packaging does not change the effect of modelled variables (such as prices and income) on cigarette consumption. In this case, the before-during approach estimates these effects more robustly because it uses a longer time series, and thus more information. Instead, if standardised packaging does affect the impact of prices and income on cigarette consumption (e.g., it makes consumers more sensitive to price increases), then the prediction approach is preferable because – contrary to the standard before-during approach – it attributes to standardised packaging not only its direct effect on consumption, but also these indirect effects.

57 See paragraphs 5.28-5.37.

58 See paragraphs 4.6 and 4.11.

59 See, for instance, Chipty, T. (2016) "*Study of the Impact of the Tobacco Plain Packaging Measure on Smoking Prevalence in Australia*", Annex A to the Australian Department of Health's "Post-Implementation Review - Tobacco Plain Packaging 2016", paragraph 23: "*To the extent there is a societal trend causing a decline in smoking prevalence or important omitted factors that vary over time, failure to include a time trend will falsely credit the packaging changes for the decline in prevalence that would have otherwise occurred anyway*".

Australia would have followed a similar trend as cigarette consumption in New Zealand; and

b. It captures the consumption trend in these two countries by mean of yearly indicator variables,[60] i.e., allowing the trend to be non-linear.

5.8 The same approach of using yearly indicator variables to capture the downward trend in consumption cannot be used in the alternative approaches set out in this section.

a. In the before-during approach, this is because the model would attribute any increase (or decrease) in consumption in each year from 2013 to 2016 to the year indicator variables, even if the increase (or decrease) was due to standardised packaging. As a result, such a model would only attribute to standardised packaging the effect this policy had in December 2012 (but not the effect it had from January 2013 onwards).

b. In the prediction approach, it would make no sense to include yearly indicator variables because I could only estimate the effect of these variables for the pre-implementation period but not for the post-implementation period.

5.9 As a result, the two alternative approaches to DID set out in this section control for the downward trend in cigarette consumption differently (and less robustly[61]) than the DID approach, as explained in more detail when setting out those approaches.

The before-during approach

5.10 As explained above,[62] in this approach I use data from January 2009 through December 2016 to estimate the effects of income and other relevant factors (including standardised packaging) on cigarette consumption per capita in Australia. The results of this approach indicate that standardised packaging is associated with a statistically significant increase in cigarette consumption per capita relative to the counterfactual. These results are summarised in Table 7 and set out in more detail in Annex D.[63]

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60 See paragraphs B.3-B.4 for details of the DID model for cigarette consumption.

61 See paragraphs 5.28-5.37.

62 See paragraph 5.3a.

63 As explained in paragraph 5.12, Model 1 is included for completeness but cannot be relied on. Models 2 and 3 show a statistically significant increase in cigarette consumption per capita relative to the counterfactual.

5.11 Since cigarette consumption in Australia follows a downward trend and it is seasonal,[64] if I want to reliably estimate the effect of standardised packaging on consumption I need to control for both features.[65]

5.12 I use two methods for doing this: in the first method (Model 1 in Table 7) I use a linear trend to capture the downward trend and monthly indicator variables to capture the seasonality. In the second method (Models 2 and 3 in Table 7), and given that the downward trend and the seasonality of cigarette consumption are features that are common to many countries, I use information from cigarette consumption per capita in a different country to control for these features. In both methods, and consistently with my DID approach, I also control for the effect of income and excise taxes (or, alternatively, cigarette prices) on cigarette consumption.[66] As explained in the next subsection, the first method, at least as applied to the data I use, is fatally flawed, but I set it out to explain why this is the case.

Table 7: regression analysis on the effect of standardised packaging on cigarette consumption per capita in Australia – before-during approach

	Model 1 OLS	**Model 2 OLS**	**Model 3 IV**
Controls for GDP per capita and →	Linear trend, excise taxes, month fixed effect	New Zealand consumption per capita, excise taxes	New Zealand consumption per capita, prices
Standardised packaging	-0.013	**0.026*** **	**0.038*** **

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

First method: linear trend and monthly indicator variables

5.13 Other authors have also employed the first method, i.e., a before-during approach with the assumption of a linear downward trend and the use of monthly indicator variables to control for seasonality. In particular, Chipty (2016) finds, using this approach, that standardised

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64 See Figure 4.

65 As explained above (see paragraph 5.7), in my DID approach I control for the trend using yearly indicator variables. I also control for seasonality using monthly indicator variables.

66 This implies that the linear trend method that I employ is not what Diethelm and Farley (2015) refer to as a "crude" or "simple" linear model, but also attributes part of the decrease in cigarette consumption to other variables (such as the increase in excise taxes and, to the extent that these are passed through to consumers, to the increase in cigarette prices). In this sense, my methodology is similar to those of Diethelm and Farley (2015) and of Chipty (2016) (see footnote 67).

packaging is associated with a statistically significant *reduction* in smoking prevalence in Australia, i.e., the *opposite* of the result that I obtain using DID.[67]

5.14 Although I analyse the effects of standardised packaging on cigarette consumption rather than on smoking prevalence,[68] I find – using a before-during approach with linear trend and monthly indicator variables – that standardised packaging has no statistically significant effect on cigarette consumption.[69]

5.15 However, more importantly, I do not consider that any reliance can be placed on this approach because the model confounds the effect of the linear trend variable with the effect of standardised packaging variable on cigarette consumption.[70] This is not surprising, because these variables take a high value at the beginning of the period and a low value at the end of the period (the linear trend), or the other way around (the indicator variable for standardised packaging). Since cigarette consumption in Australia is higher at the beginning of the period than at the end of the period, the model does not know whether this decline is due to the trend or to standardised packaging.

5.16 Since the model cannot perfectly distinguish between the effect of the linear trend variable and the effect of the standardised packaging variable on consumption, it assigns effects arbitrarily to these two variables. In other words, this approach very likely attributes to standardised packaging changes in cigarette consumption that are in fact due to the decreasing trend, or *vice versa*.

Second method: including consumption in a different country as an explanatory variable

5.17 Since the downward trend and the seasonality of cigarette consumption are features that are common to many countries, the second method I use to control for these features is to use

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67 Chipty, T. (2016). Study of the impact of the tobacco plain packaging measure on smoking prevalence in Australia. Appendix A, Post-implementation review tobacco plain packaging. Diethelman and Farley (2015) also find a similar result using a linear trend but without controlling for seasonality (see Diethelman, P. A., and Farley, T. M. (2015). Refuting tobacco-industry funded research: empirical data shows a decline in smoking prevalence following the introduction of plain packaging in Australia. Tobacco Prevention & Cessation, 1(November): 6).

68 I use retail sales data as opposed to self-reported smoking status data used by Dr. Chipty. I also use a materially longer time series that provides a fifteen month longer post-implementation period to that used by Dr Chipty.

69 See Model 1 in Table 7.

70 As explained in Annex D (paragraph D.6), which reports the full results of this model, the correlation between the coefficient on the trend and the coefficient on the standardised packaging variable is very high. The higher the correlation between these two coefficients, the higher the risk identified above, i.e., that the model confounds the effect of the linear trend and the effect of standardised packaging on cigarette consumption.

information from cigarette consumption per capita in a different country. In particular, due to data availability, I use data on cigarette consumption per capita in New Zealand (Models 2 and 3 in Table 7).

5.18 Two important remarks are as follows:

a. First, this method is not subject to the same problem as the previous one, i.e., that the model confounds the effect of standardised packaging with the effect of the trend on cigarette consumption. This is because New Zealand cigarette consumption captures both the seasonality and the trend, and thus allows the model more easily to identify the effect of standardised packaging on Australian consumption without confounding it with the effect of the trend.

b. Secondly, while this method uses data from New Zealand, it is fundamentally different from the DID approach. In particular, the DID approach assumes that cigarette consumption per capita in Australia would have followed a similar trend as in New Zealand, save for the different evolution of other modelled factors in the two countries. This is not the case in this alternative method. In particular, in this method I 'ask the data' whether we can learn something about cigarette consumption per capita in Australia from cigarette consumption per capita in New Zealand. I also ask the data whether, if this is the case, the relationship between the two series (if any) is statistically significant. Thus, even if one were sceptical about the assumption underlying the DID analysis, i.e., that New Zealand is a good comparator for Australia, one would not need to be sceptical about this alternative method for controlling for trend and seasonality because it does not use the same assumptions as the DID analysis. While this is a potential advantage of this method over the DID approach, the DID approach is overall preferable, as explained in detail in paragraphs 5.32 to 5.37.

5.19 In both Model 2 and Model 3, I control for the effect of GDP per capita on consumption per capita. In Model 2, I control for the effect of excise taxes on consumption per capita. Since consumers care about excise taxes only insofar as these affect prices, in Model 3 I control for the indirect effects of taxes on consumption via prices (for this I use an Instrumental Variable approach[71]).

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[71] The Instrumental Variable approach is a standard method to control for endogeneity issues, i.e., that if I want to estimate the effect of prices on consumption, a problem arises because my analysis may actually capture the opposite effect, i.e., the effect of demand (and thus consumption) on prices. The Instrumental Variable methodology allows me to only analyse the effects of prices on consumption that are due to general inflation and to excise tax increases, and thus to disregard as irrelevant any change in price that is due to e.g., standardised packaging or change in cigarette demand. See paragraph D.3c for a more detailed explanation of this method.

5.20 Coefficients are positive and statistically significant in both models, indicating that standardised packaging is associated with an increase in cigarette consumption per capita relative to the counterfactual (of 2.6%-3.8% on average up to December 2016).

The prediction approach

5.21 As explained above,[72] in the prediction approach I estimate the effects of relevant factors (such as income and excise taxes) on cigarette consumption per capita in Australia using the before-period only, i.e., the period preceding the implementation of standardised packaging. Using the results of this estimation, I project the level of cigarette consumption per capita that would have prevailed had standardised packaging not being implemented. I finally compare the actual and the predicted level of consumption and attribute the difference between the two to the effect of standardised packaging.

5.22 I again use two different methods to control for the declining trend and for the seasonality of cigarette consumption: a linear trend combined with monthly indicator variables (Model 1, Figure 7), and NZ cigarette consumption per capita (Model 2, Figure 8). Both models also control for the effect of income (GDP per capita) and excise taxes on cigarette consumption in Australia.

First method: linear trend and monthly indicator variables

5.23 Model 1, which implements the prediction analysis and uses a linear trend, is not subject to the same limitations of the before-during analysis when employing a linear trend. In particular, since it only estimates the effect of relevant factors (including a linear trend) on cigarette consumption during the pre-implementation period, this analysis cannot – by construction – confound the effects of the pre-implementation trend with the effect of standardised packaging.

5.24 The results of Model 1 are summarised in Figure 7. The blue line indicates the evolution of actual cigarette consumption per capita from January 2009 to December 2016, and the red line represents post-implementation cigarette consumption per capita as predicted by the model.[73] Since actual consumption is higher than predicted consumption, this model associates the implementation of standardised packaging to an increase in consumption per capita relative to the counterfactual.

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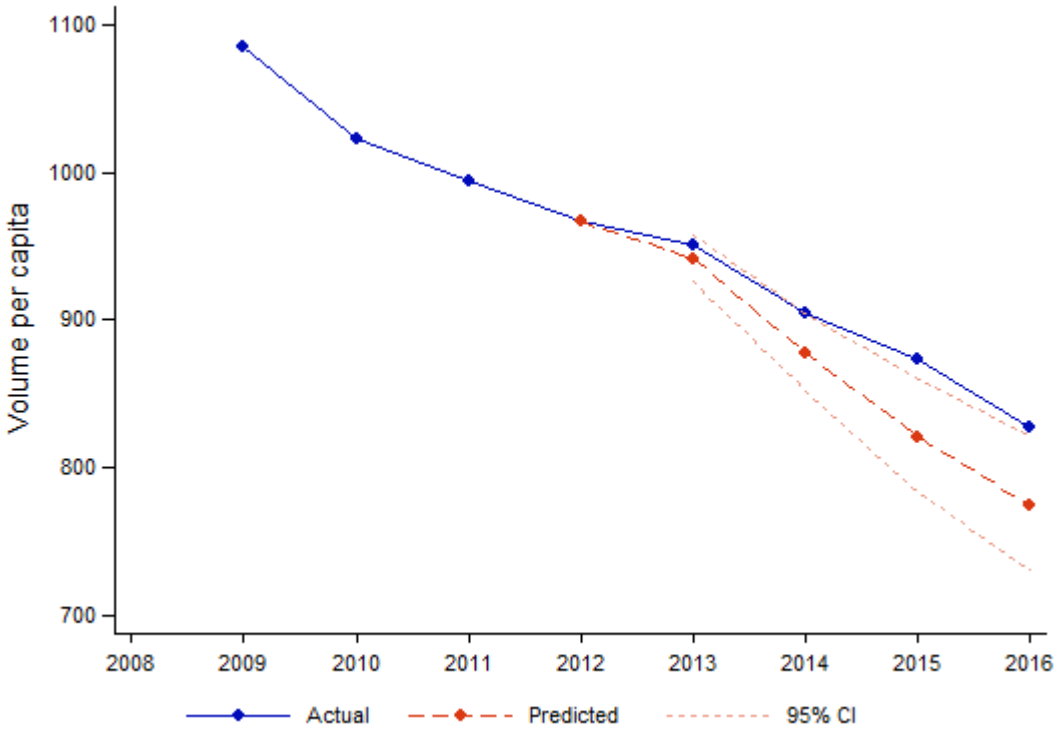
72 See paragraph 5.3b.

73 See Annex D for a more detailed explanation of the methodology for predicting consumption using pre-implementation data only.

Figure 7: Actual and predicted cigarette consumption per capita in Australia – Prediction analysis – Model 1 (linear monthly trend + monthly indicator variables)



Source: Compass Lexecon analysis

5.25 In particular, Model 1 estimates that standardised packaging is associated with a 4.0% average increase in cigarette consumption per capita relative to the counterfactual and up to December 2016. This increase is statistically significant: there is a 95% probability that cigarette consumption, as predicted by Model 1, falls in the area between the dotted lines in Figure 7. Actual consumption falls outside this area, indicating that the increase in consumption is statistically significant at 5% level.

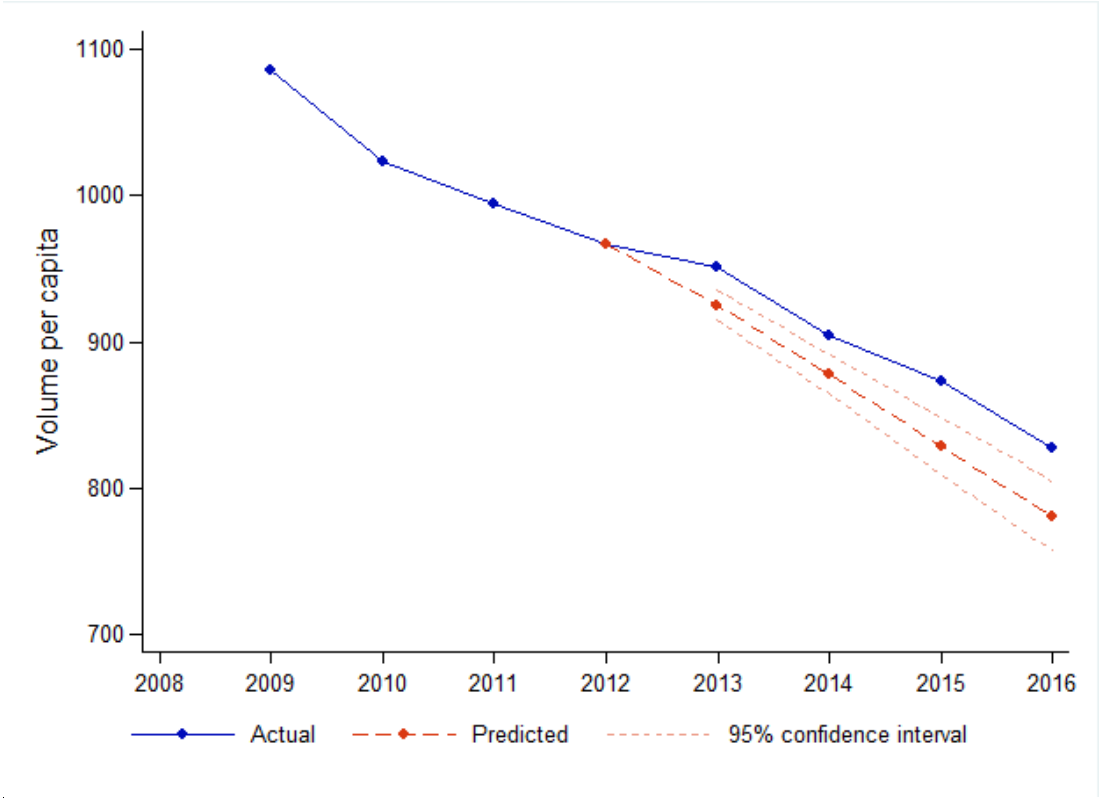
5.26 Model 1 also predicts that the post-implementation increase in consumption is more pronounced as time goes by and the full effects of standardised packaging unfold, consistently with the predictions of the Australian Post Implementation Review, according to which "*the full effect of the tobacco plain packaging measure is expected to be realised over time*".[74]

74 Australian Government (2016) Post-Implementation Review on Tobacco Plain Packaging, page 4.

Second method: including consumption in a different country as an explanatory variable

5.27 The results of Model 2 are summarised in Figure 8. This figure indicates that standardised packaging is associated with a 4.0% average increase in cigarette consumption per capita relative to the counterfactual and up to December 2016. Again, the effect is statistically significant, and the increase in post-implementation consumption is more pronounced as time goes by, consistently with the predictions of the Australian Post Implementation Review.

Figure 8: Actual and predicted cigarette consumption per capita in Australia – Prediction analysis – Model 2 (NZ cigarette consumption per capita)



Source: Compass Lexecon analysis

Reasons for preferring the DID approach

5.28 In Section 4 I explained that the DID approach is more reliable than alternative methods, such as the before-after and the prediction approaches, for estimating the effect of standardised packaging on cigarette consumption as it enables me to better control for confounding factors.[75] In what follows, I also explain why the way my DID approach controls for the downward trend in consumption is superior both to the use of a linear trend and to the use of cigarette consumption per capita in New Zealand among the explanatory variables.

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75 See paragraph 4.11.

5.29 As explained above, my DID approach controls for the downward trend in cigarette consumption in a particularly robust way. In particular:

a. Based on the strength of the results of my analysis of New Zealand as a good comparator for Australia, I assume that – save for different evolution of factors that can affect cigarette consumption, such as standardised packaging, excise taxes, income, and cigarette prices – cigarette consumption in Australia would have followed a similar trend as cigarette consumption in New Zealand; and

b. I capture the consumption trend in these two countries by means of yearly indicator variables,[76] which – as explained immediately below – is a very flexible approach to accounting for the downward trend in cigarette consumption and it is superior to alternative approaches, including those employed in the analyses set out in this section.

The way my DID approach captures the declining trend in cigarette consumption is superior to the linear trend method

5.30 As explained above, the first method I use to capture the declining trend in consumption in my before-during and in my prediction approaches assumes that – save for the influence of factors that affect cigarette consumption, such as income, excise taxes, prices and the implementation of standardised packaging – cigarette consumption in Australia would have followed a linear trend, i.e., it would have decreased by the same proportion in each year.

5.31 My DID approach, instead, does not make such a strong assumption and rather 'lets the data speak', i.e., it allows the model to capture year-on-year differences in the downward trend of cigarette consumption. If the downward trend in consumption was actually linear, my DID analysis would capture that linearity, and thus would not be inferior to the linear trend method; if the trend was non-linear, the DID approach would capture the non-linearity, but the linear trend method would not. The DID is thus more reliable.

The DID approach is superior to including New Zealand cigarette consumption per capita as an explanatory variable

5.32 As explained above, the second method I use in my before-during and in my prediction approaches to control for the downward trend and the seasonality of consumption is to include cigarette consumption per capita in New Zealand among the explanatory variables, because this variable is both seasonal and follows a declining trend.

5.33 However, as explained, while this method uses data from New Zealand, it is fundamentally different from the DID approach. In paragraph 5.18b, I set out a potential advantage of this method (the "New Zealand method") over the DID approach, namely that – while the latter assumes that Australian and New Zealand cigarette consumption would have followed a similar trend, save for different evolution of other modelled factors in the two countries – this

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76 See paragraphs B.3-B.4 for details of the DID model for cigarette consumption.

is not the case for the former. I also explained that, while this is a potential advantage of the New Zealand method over the DID approach, the DID approach is overall preferable, as I set out in what follows.

5.34 First, I have tested with data the DID assumption that New Zealand is a good comparator for Australia, and confirmed that the assumption is valid with 95%-99% probability.[77] Therefore, it is unclear that the potential advantage of the New Zealand method over the DID approach is actually realised.

5.35 Secondly, the DID approach has material advantages over the New Zealand method. In particular, the DID approach, but not the New Zealand method, allows me to control for factors (other than the trend) that affect New Zealand consumption, such as increases in excise taxes on tobacco product, or reduced consumer income.

5.36 For example, when excise taxes increase in New Zealand but not in Australia, the DID approach recognises that such increase would reduce New Zealand consumption but not Australian consumption. This approach thus attributes to the trend any decline in consumption that is common to both countries, and attributes to the increase in New Zealand excise taxes any reduction in New Zealand consumption in excess of the decline due to the common downward trend.

5.37 Following the same increase in New Zealand excise tax, the New Zealand method would instead expect Australian consumption to also fall. If, as expected, Australian consumption does not fall, this method would look for alternative explanations of why that is the case. As a result, it would incorrectly attribute the lack of the decline in Australian consumption to other factors, such as a small increase in Australian income.

Conclusions

5.38 In this section, have set out alternative analyses of the effect of standardised packaging on cigarette consumption. Although, in my opinion, these analyses are carried out in a less rigorous framework, the results are consistent with those of my DID analysis, and indicate that standardised packaging is associated with an increase in cigarette consumption per capita relative to the counterfactual.

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77 See paragraphs 4.14-4.22 and in particular footnote 36.

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Neil A. Dryden

10 October 2017

Compass Lexecon

Davidson Building, 200 Aldersgate Street,

London, EC1A 4HD

Annex A

Curriculum vitae of Neil Dryden

A.1 I am an Executive Vice President in Compass Lexecon's European competition policy practice, based in the firm's London office. I have worked as a professional economist for over 20 years and during that time I have advised on numerous mergers, agreement cases, dominance cases, damages and market investigations.

A.2 My significant cases since 2010 include acting as an expert in the pay TV and tobacco cases (both at the Competition Appeal Tribunal), and advising in outdoor advertising (OFT), Sports Direct/JJB (Competition Commission and Competition Appeal Tribunal), Asda/Netto (OFT) and Level 3/Global Crossing (OFT).

A.3 In addition to numerous cases in the European Union, I have advised on cases in India and South Africa. I also have extensive experience in regulatory economics, including a series of projects for the UK postal regulator. I have prepared submissions in the context of a number of UK government inquires including the Barker review of land use planning.

A.4 In my career I have advised on several important matters for government and NGOs including for the Shareholder Executive in the Department for Business, Innovation and Skills in relation to the future ownership of the Royal Mail and for the Department of International Development on energy market reforms.

A.5 I have analysed cases in sectors including advertising, banking and financial services, chemicals, energy, FMCG, grocery retailing, healthcare, manufacturing, media and broadcasting, mining, petroleum, pharmaceuticals, postal services, publishing, scientific instruments, sports, technology, telecommunications, tobacco, transport, and water.

A.6 I was educated at Oxford University where I obtained a B.A. in Philosophy, Politics and Economics (first class) and an M.Phil. in Economics, and held a college lectureship for two years. At King's College, London, I obtained a postgraduate diploma in EC competition law (with distinction). I co-authored "What makes firms perform well?" published in the European Economic Review.

A.7 Prior to joining Compass Lexecon, I worked as a Director at LECG and prior to that as an Associate Director in NERA's European competition policy practice for seven years. I spent the first six years of my career in Arthur Andersen's economic and financial consulting practice, where I was a Senior Manager.

A.8 My full CV can be found at http://www.compasslexecon.com/professionals/bio?id=209.

Annex B

Consumption analysis

B.1 In Section 4 I present the results of my econometric analysis on the effects of standardised packaging on consumption. In this annex, I set out this econometric analysis in more detail and also show that the results presented in Section 4 are reliable across a wide range of robustness checks.

B.2 As explained in footnote 41, in prior reports, I used a slightly different model than the one I use in this submission. In this Annex I explain the reasons why I now use a slightly different model. For completeness, I also present the results of the econometric analysis using the model I used in previous reports. I show that this model confirms the results presented in Section 4, i.e., that standardised packaging is associated with an increase in cigarette consumption per capita relative to the counterfactual.

Benchmark analysis

B.3 In order to analyse the effect of standardised packaging on cigarette consumption per capita, I use the following DID model:

$$consumption_{cjk} = \alpha + \beta_1 AUS_c + \beta_2 PP_{jk} + \beta_3 AUS_c * PP_{jk} + \sum_j \beta_{4,j}\, year_j + \sum_k \beta_{5,k}\, month_k + \sum_h \beta_{6,h}\, Control^h_{cjk} + \sum_h \beta_{7,h}\, Control^h_{cjk} * AUS_c + \varepsilon_{cjk}$$

B.4 Where subscripts *c, j* and *k* refer to country, year and month, respectively; $consumption$ is measured as the log of cigarette consumption per capita; α is the constant; AUS is an indicator variable for Australia ($AUS = 0$ for New Zealand and $AUS = 1$ for Australia) which captures the average difference between Australia and New Zealand consumption; PP is an indicator variable for standardised packaging ($PP = 0$ for pre-implementation period and $PP = 1$ for post-implementation period)[78] which captures the average change in consumption (common to Australia and New Zealand) after the implementation of standardised packaging; the interaction term $AUS * PP$ is an indicator variable for the Australian standardised packaging (it takes the value of 1 for Australia during the post-implementation period, and it takes the value of 0 for the pre-implementation period and for New Zealand);

78 PP stands for Plain Packaging, which has the same meaning as Standardised Packaging.

$year$ is set of indicator variables – one for each year – which capture the difference between the average consumption in that year and the average consumption in a year of reference (2009); $month$ is set of indicator variables – one for each month – which capture the difference between the average consumption in that month and the average consumption in a month of reference (January); both $year$ and $month$ fixed effects are common to Australia and New Zealand. $Control$ is a set of control variables, which change from model to model. In particular, $Control$ includes:

a. Model 1: logarithm of excise taxes in each country in local currencies, logarithm of GDP per capita in each country in local currencies;

b. Model 2 (Instrumental Variables approach): This is the same as Model 1 but it uses prices (in local currencies) instead of excise taxes as a control variable. For this analysis, I use a two-stage-least-square approach where I first regress the logarithm of prices on a set of instrumental variables which includes the logarithm of excise taxes, the quarterly change in the consumer price index, its square, and the interaction of these variables with the AUS indicator. I then use the predicted values of this regression as a control variable; and

c. Models 3 and 4 are the same as Models 1 and 2, respectively, but the control variables are expressed in PPP rather than in local currencies.

B.5 For the consumption analysis, I use the following data sources: for cigarette volumes (measured in millions of sticks) I use Nielsen data from January 2009 to January 2012, and IRI-Aztec data from February 2012 to December 2016 for Australia, and Nielsen data for New Zealand. Nielsen and IRI-Aztec datasets are consistent: for the period in which the two datasets overlap, from March 2012 through December 2013, the correlation coefficient between the Nielsen data and the IRI-Aztec data is 0.999 and is highly statistically significant at the 1% level. I thus combine Nielsen and IRI-Aztec data after omitting sales through convenience independent stores from Nielsen data.[79]

B.6 I compute cigarette per capita by dividing cigarette volumes by the adult population (20+ years), sourced from the Australian Bureau of Statistics and from Statistics New Zealand. For excise taxes I use information from the Australian Government website (www.comlaw.gov.au) and from the New Zealand Parliamentary Counsel Office (www.legislation.govt.nz). For GDP per capita, I use data from the Australian Bureau of

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79 I note that in previous reports where I analysed data from New Zealand Nielsen included sales through the convenience independent channel. Since January 2016 Nielsen only provides scan data in New Zealand so they have provided back data from 2008 based on the scanning component only which excludes the convenience independent channel. I have found the evolution of prices and volumes in the new data excluding the convenience independent channel to be very similar to the data I used previously.

Statistics and from Statistics New Zealand. For PPP I use annual data downloaded from the OECD website.

B.7 The coefficient to the interaction term $AUS * PP$ (i.e., β_3) captures the effect of standardised packaging on average prices. I use two standard econometric methods – ordinary least square ('OLS') and Instrumental Variables ('IV') to estimate the regression coefficients and I report robust standard errors.

B.8 The results of Models 1-4 are reported in Table 8. As a robustness check, in the following two tables I also report the results of robustness checks where I have assumed different start dates for the implementation of standardised packaging (November 2012 and October 2012, respectively).

Table 8: Results of consumption – monthly – PP from December 2012

	Log (consumption)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
AUS	1.185**	2.096***	1.389***	2.284***
	[0.011]	[0.000]	[0.009]	[0.000]
PP	0.005	0.004	0.009	0.009
	[0.795]	[0.850]	[0.650]	[0.638]
AUS*PP	**0.035****	**0.031****	**0.030***	**0.022***
	[0.021]	[0.014]	[0.055]	[0.081]
Log(Excise)	-0.199***			
	[0.000]			
Log(Excise)*AUS	-0.083*			
	[0.067]			
Log(GDPpc)	0.390***	0.447***		
	[0.001]	[0.000]		
Log(GDPpc)*AUS	0.039	0.271**		
	[0.738]	[0.015]		
Log(Price)		-0.403***		
		[0.000]		
Log(Price)*AUS		-0.173***		
		[0.000]		
Log(ExcisePPP)			-0.205***	
			[0.000]	
Log(ExcisePPP)*AUS			-0.081*	
			[0.056]	
Log(GDPpcPPP)			0.430***	0.461***
			[0.000]	[0.000]
Log(GDPpcPPP)*AUS			0.089	0.304***
			[0.462]	[0.007]
Log(PricePPP)				-0.419***
				[0.000]
Log(PricePPP)*AUS				-0.169***
				[0.000]
Year fixed effect	YES	YES	YES	YES
Month fixed effect	YES	YES	YES	YES
Constant	4.830***	5.051***	5.092***	5.123***
	[0.000]	[0.000]	[0.000]	[0.000]
Observations	192	192	192	192
Adjusted R-squared	0.998	0.998	0.998	0.998

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Table 9: Results of consumption – monthly – PP from November 2012

	Log (consumption)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
AUS	1.124**	2.038***	1.354**	2.252***
	[0.019]	[0.000]	[0.013]	[0.000]
PP	-0.006	-0.007	-0.003	-0.002
	[0.678]	[0.635]	[0.837]	[0.855]
AUS*PP	**0.035****	**0.030****	**0.030****	**0.022***
	[0.018]	[0.014]	[0.049]	[0.079]
Log(Excise)	-0.199***			
	[0.000]			
Log(Excise)*AUS	-0.079*			
	[0.073]			
Log(GDPpc)	0.393***	0.447***		
	[0.001]	[0.000]		
Log(GDPpc)*AUS	0.023	0.257**		
	[0.845]	[0.025]		
Log(Price)		-0.404***		
		[0.000]		
Log(Price)*AUS		-0.167***		
		[0.000]		
Log(ExcisePPP)			-0.204***	
			[0.000]	
Log(ExcisePPP)*AUS			-0.079*	
			[0.060]	
Log(GDPpcPPP)			0.434***	0.463***
			[0.000]	[0.000]
Log(GDPpcPPP)*AUS			0.081	0.297**
			[0.517]	[0.012]
Log(PricePPP)				-0.417***
				[0.000]
Log(PricePPP)*AUS				-0.166***
				[0.000]
Year fixed effect	YES	YES	YES	YES
Month fixed effect	YES	YES	YES	YES
Constant	4.843***	5.053***	5.113***	5.134***
	[0.000]	[0.000]	[0.000]	[0.000]
Observations	192	192	192	192
Adjusted R-squared	0.998	0.998	0.998	0.998

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Table 10: Results of consumption – monthly – PP from October 2012

	Log (consumption)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
AUS	1.050**	1.952***	1.301**	2.180***
	[0.034]	[0.000]	[0.022]	[0.000]
PP	-0.010	-0.009	-0.007	-0.005
	[0.474]	[0.418]	[0.631]	[0.633]
AUS*PP	**0.036****	**0.032*****	**0.031****	**0.025***
	[0.013]	[0.009]	[0.037]	[0.052]
Log(Excise)	-0.197***			
	[0.000]			
Log(Excise)*AUS	-0.076*			
	[0.078]			
Log(GDPpc)	0.399***	0.452***		
	[0.001]	[0.000]		
Log(GDPpc)*AUS	0.005	0.236**		
	[0.967]	[0.047]		
Log(Price)		-0.398***		
		[0.000]		
Log(Price)*AUS		-0.163***		
		[0.000]		
Log(ExcisePPP)			-0.201***	
			[0.000]	
Log(ExcisePPP)*AUS			-0.077*	
			[0.063]	
Log(GDPpcPPP)			0.441***	0.469***
			[0.000]	[0.000]
Log(GDPpcPPP)*AUS			0.069	0.281**
			[0.594]	[0.022]
Log(PricePPP)				-0.410***
				[0.000]
Log(PricePPP)*AUS				-0.164***
				[0.000]
Year fixed effect	YES	YES	YES	YES
Month fixed effect	YES	YES	YES	YES
Constant	4.872***	5.079***	5.148***	5.172***
	[0.000]	[0.000]	[0.000]	[0.000]
Observations	192	192	192	192
Adjusted R-squared	0.998	0.998	0.998	0.998

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Quarterly regressions

B.9 Below, I also present the results of consumption regressions where I use quarterly rather than monthly data. For such regressions, I replace $month$ indicator variables with $quarter$ indicator variables. The rest of the model is the same as the model set out at paragraphs B.3-B.4. Since the full implementation of standardised packaging happened at the end of 2012Q4, meaning that some of the sales in 2012Q4 were still made under branded packaging, I present the results of two regressions with different starting dates for standardised packaging: Table 11 assumes that standardised packaging may already had an effect in 2012Q4, while Table 12 assumes that standardised packaging may only had a statistically significant effect from 2013Q1. Both models confirm the result that standardised packaging is associated with an increase in consumption.

Table 11: Results of average consumption per capita – quarterly – PP from 2012Q4

	Log (consumption)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
AUS	0.519	0.868	0.711	1.057*
	[0.399]	[0.111]	[0.312]	[0.070]
PP	-0.012	-0.012	-0.010	-0.010
	[0.431]	[0.284]	[0.516]	[0.377]
AUS*PP	**0.049*** **	**0.049*** **	**0.046** **	**0.045*** **
	[0.004]	[0.000]	[0.010]	[0.000]
Log(Excise)	-0.117**			
	[0.014]			
Log(Excise)*AUS	-0.047			
	[0.344]			
Log(GDPpc)	0.466***	0.493***		
	[0.006]	[0.000]		
Log(GDPpc)*AUS	-0.129	-0.041		
	[0.393]	[0.759]		
Log(Price)		-0.189***		
		[0.004]		
Log(Price)*AUS		-0.092*		
		[0.076]		
Log(ExcisePPP)			-0.127***	
			[0.004]	
Log(ExcisePPP)*AUS			-0.047	
			[0.331]	
Log(GDPpcPPP)			0.492***	0.505***
			[0.004]	[0.000]
Log(GDPpcPPP)*AUS			-0.070	0.014
			[0.661]	[0.916]
Log(PricePPP)				-0.208***
				[0.001]
Log(PricePPP)*AUS				-0.094*
				[0.060]
Year fixed effect	YES	YES	YES	YES
Quarter fixed effect	YES	YES	YES	YES
Constant	6.326***	6.462***	6.573***	6.615***
	[0.000]	[0.000]	[0.000]	[0.000]
Observations	64	64	64	64
Adjusted R-squared	0.999	0.999	0.999	0.999

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Table 12: Results of average consumption per capita – quarterly – PP from 2013Q1

	Log (consumption)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
AUS	0.837	1.250**	0.929	1.323**
	[0.147]	[0.014]	[0.154]	[0.013]
PP	-0.235***	-0.192***	-0.169***	-0.179***
	[0.000]	[0.000]	[0.000]	[0.000]
AUS*PP	**0.046****	**0.047*****	**0.042****	**0.042*****
	[0.012]	[0.001]	[0.032]	[0.005]
Log(Excise)	-0.128***			
	[0.007]			
Log(Excise)*AUS	-0.066			
	[0.194]			
Log(GDPpc)	0.434***	0.468***		
	[0.006]	[0.000]		
Log(GDPpc)*AUS	-0.049	0.054		
	[0.727]	[0.662]		
Log(Price)		-0.208***		
		[0.001]		
Log(Price)*AUS		-0.122**		
		[0.024]		
Log(ExcisePPP)			-0.140***	
			[0.002]	
Log(ExcisePPP)*AUS			-0.060	
			[0.211]	
Log(GDPpcPPP)			0.459***	0.476***
			[0.004]	[0.000]
Log(GDPpcPPP)*AUS			-0.019	0.076
			[0.894]	[0.533]
Log(PricePPP)				-0.233***
				[0.000]
Log(PricePPP)*AUS				-0.116**
				[0.024]
Year fixed effect	YES	YES	YES	YES
Quarter fixed effect	YES	YES	YES	YES
Constant	6.167***	6.336***	6.389***	6.449***
	[0.000]	[0.000]	[0.000]	[0.000]
Observations	64	64	64	64
Adjusted R-squared	0.999	0.999	0.999	0.999

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Results with the model used in previous submissions

B.10 In previous reports where I have analysed Australian data, using data for a shorter time period (with my most recent previous analysis using data up to May 2015, as opposed to data up to December 2016 used in this report) I used a slightly different model from the one I use in this submission.

B.11 The only differences are:

a. In the previous submission I presented the results of two models where I did not control for the effect of income (as measured by GDP per capita) on consumption per capita. Since I find that GDP per capita does affect consumption, I do not use those models here.

b. The old model did not allow for the effect of GDP per capita on consumption per capita to differ in the two countries. In practice this means that the old model assumed that the elasticity of cigarette consumption to income was the same in the two countries. In this report, I instead allow this elasticity to differ, i.e., I do not impose any assumption but I let the data speak. I find that indeed the effect of GDP per capita on cigarette consumption per capita differs in the two countries, which makes the model in this report more reliable.

c. For the instrumental variable regression, I use a different set of instrumental variables.[80] The instrumental variables I used previously did not pass the standard tests used to assess the validity of the instruments with the new data.

B.12 For completeness, however, I have also carried out the econometric analysis using the old model. The results are reported in Table 13, and confirm that standardised packaging is associated with an increase in consumption, with the effect being statistically significant in 6 out of the 8 models.

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80 See paragraph B.4b.

Table 13: DID regression analysis on the effect of standardised packaging on consumption in Australia – models in the previous submission

	Model 1	Model 2	Model 3	Model 4
Controls for monthly dummies, year indicator variables and →	Excise tax	Excise tax, GDP per capita	IV: Price (instrument Excise tax)	IV: Price (instrument Excise tax), GDP per capita
Panel A: local currencies				
Effect of standardised packaging	0.022	0.036**	0.013	0.031**
Panel B: PPP				
Effect of standardised packaging	0.033*	0.034**	0.033**	0.033**

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

Annex C

Price analysis

C.1 In Section 4 I present the results my econometric analysis on the effects of standardised packaging on the price of cigarettes. In this annex, I set out this econometric analysis in more detail and also show that the results presented in Section 4 are reliable across a wide range of robustness checks.

C.2 As explained in in footnote 41 and in Annex B, in prior reports where I analysed data from Australia I used a slightly different model than the one I use in this report. For completeness, I also present the results of the econometric analysis using the model I used in previous reports. I show that this model confirms the results presented in Section 4, i.e., that standardised packaging is associated with a decrease in average cigarette prices relative to the counterfactual (with the effect being statistically significant in one of the models).

Average price

C.3 In order to analyse the effect of standardised packaging on average prices, I use the following DID model:

$$price\ per\ stick_{cjk} = \alpha + \beta_1 AUS_c + \beta_2 PP_{jk} + \beta_3 AUS_c * PP_{jk} + \sum_j \beta_{4,j}\ year_j + \sum_k \beta_{5,k}\ month_k + \sum_h \beta_{6,h}\ Control^h_{cjk} + \sum_h \beta_{7,h}\ Control^h_{cjk} * AUS_c + \varepsilon_{cjk}$$

C.4 Where subscripts c, j and k refer to country, year and month, respectively; $price\ per\ stick$ is measured as the log of price per stick, in local currencies for Model 1, and in PPP for Model 2; α is the constant; AUS is an indicator variable for Australia ($AUS = 0$ for New Zealand and $AUS = 1$ for Australia) which captures the average price difference between Australia and New Zealand; PP is an indicator variable for standardised packaging ($PP = 0$ for pre-implementation period and $PP = 1$ for post-implementation period)[81] which captures the average change in price (common to Australia and New Zealand) after the implementation of standardised packaging; the interaction term $AUS * PP$ is an indicator variable for the Australian standardised packaging (it takes the value of 1 for Australia during the post-

81 PP stands for Plain Packaging, which has the same meaning as Standardised Packaging.

implementation period, and it takes the value of 0 for the pre-implementation period and for New Zealand); $year$ is set of indicator variables – one for each year – which capture the difference between the average price in that year and the average price in a year of reference (2009); $month$ is set of indicator variables – one for each month – which capture the difference between the average price in that month and the average price in a month of reference (January); both $year$ and $month$ fixed effects are common to Australia and New Zealand; $Control$ is a set of control variables, which change from model to model. In particular, $Control$ includes:

a. Model 1: logarithm of excise taxes in each country in local currencies, logarithm of GDP per capita in each country in local currencies;

b. Model 2: logarithm of excise taxes in each country in PPP, logarithm of GDP per capita in each country in PPP.

C.5 For this analysis, I use the following data sources: for cigarette volumes (measured in sticks) and values (measured in local currencies) I use Nielsen data from January 2009 to March 2012, and Aztec data from April 2012 to December 2016 for Australia; and Nielsen data for New Zealand.[82] I compute prices by dividing revenues by volumes. For excise taxes I use information from the Australian Government website (www.comlaw.gov.au) and from the New Zealand Parliamentary Counsel Office (www.legislation.govt.nz). For GDP per capita, I use data from the Australian Bureau of Statistics and from Statistics New Zealand. For PPP I use annual data downloaded from the OECD website.

C.6 The coefficient to the interaction term $AUS * PP$ (i.e., β_3) captures the effect of standardised packaging on average prices. I use OLS to estimate the regression coefficients and I report robust standard errors.

C.7 The results of the regressions are reported in Table 14. As a robustness check, I also report in Table 15 and Table 16 the results of additional regressions where I have assumed different start dates for the implementation of standardised packaging (November 2012 and October 2012, respectively).

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82 As explained in paragraph B.5 above, Nielsen and Aztec data are nearly identical during the overlap period from March 2012 through December 2013. As explained in footnote 36, the Nielsen data for New Zealand that I am using in this report excludes sales through the convenience independent channel.

Table 14: Results of average price analysis – monthly – PP from December 2012

	Model 1	**Model 2**
	Log(price)	Log (pricePPP)
AUS	1.534***	1.510***
	[0.000]	[0.001]
PP	0.002	0.005
	[0.762]	[0.507]
AUS*PP	**-0.020****	**-0.026****
	[0.043]	[0.015]
Log(Excise)	0.537***	
	[0.000]	
Log(Excise)*AUS	-0.115***	
	[0.000]	
Log(GDPpc)	0.089	
	[0.345]	
Log(GDPpc)*AUS	0.422***	
	[0.000]	
Log(ExcisePPP)		0.535***
		[0.000]
Log(ExcisePPP)*AUS		-0.111***
		[0.000]
Log(GDPpcPPP)		0.045
		[0.641]
Log(GDPpcPPP)*AUS		0.387***
		[0.000]
Year fixed effect	YES	YES
Month fixed effect	YES	YES
Constant	0.376	0.013
	[0.383]	[0.978]
Observations	192	192
Adjusted R-squared	0.994	0.995

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Table 15: Results of average price analysis – monthly – PP from November 2012

	Model 1	**Model 2**
	Log(price)	Log (pricePPP)
AUS	1.579***	1.540***
	[0.000]	[0.001]
PP	0.003	0.005
	[0.616]	[0.476]
AUS*PP	**-0.020****	**-0.026****
	[0.034]	[0.015]
Log(Excise)	0.535***	
	[0.000]	
Log(Excise)*AUS	-0.116***	
	[0.000]	
Log(GDPpc)	0.083	
	[0.384]	
Log(GDPpc)*AUS	0.433***	
	[0.000]	
Log(ExcisePPP)		0.535***
		[0.000]
Log(ExcisePPP)*AUS		-0.114***
		[0.000]
Log(GDPpcPPP)		0.040
		[0.686]
Log(GDPpcPPP)*AUS		0.394***
		[0.000]
Year fixed effect	YES	YES
Month fixed effect	YES	YES
Constant	0.350	-0.015
	[0.428]	[0.975]
Observations	192	192
Adjusted R-squared	0.994	0.995

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Table 16: Results of average price analysis – monthly – PP from October 2012

	Model 1	**Model 2**
	Log(price)	Log (pricePPP)
AUS	1.617***	1.549***
	[0.000]	[0.001]
PP	0.005	0.006
	[0.484]	[0.450]
AUS*PP	**-0.020****	**-0.025****
	[0.041]	[0.027]
Log(Excise)	0.535***	
	[0.000]	
Log(Excise)*AUS	-0.119***	
	[0.000]	
Log(GDPpc)	0.081	
	[0.411]	
Log(GDPpc)*AUS	0.443***	
	[0.000]	
Log(ExcisePPP)		0.536***
		[0.000]
Log(ExcisePPP)*AUS		-0.118***
		[0.000]
Log(GDPpcPPP)		0.037
		[0.712]
Log(GDPpcPPP)*AUS		0.397***
		[0.000]
Year fixed effect	YES	YES
Month fixed effect	YES	YES
Constant	0.338	-0.026
	[0.456]	[0.958]
Observations	192	192
Adjusted R-squared	0.994	0.995

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Quarterly regressions

C.8 Below, I report the results of the average price regressions where I use quarterly rather than monthly data. For such regressions, I replace $month$ indicator variables with $quarter$ indicator variables. The rest of the model is the same as the model set out at paragraphs C.3-C.4. Since the full implementation of standardised packaging happened at the end of

2012Q4, meaning that some of the sales in 2012Q4 were still made under branded packaging, I present the results of two regressions with different starting dates for standardised packaging: Table 17 assumes that standardised packaging may already had an effect in 2012Q4, while Table 18 assumes that standardised packaging may only had a statistically significant effect from 2013Q1. Both models find that standardised packaging is associated with a decrease in average prices, although the effects are in some cases not statistically significant (to that end, as explained in footnote 45, losing significance can be expected when one reduces the number of data points by two thirds).

Table 17: Results of average price analysis – quarterly – PP from 2012Q4

	Model 1	**Model 2**
	Log(price)	Log (pricePPP)
AUS	1.356***	1.270**
	[0.003]	[0.021]
PP	0.004	0.004
	[0.628]	[0.657]
AUS*PP	**-0.021**	**-0.024***
	[0.118]	**[0.093]**
Log(Excise)	0.591***	
	[0.000]	
Log(Excise)*AUS	-0.120***	
	[0.008]	
Log(GDPpc)	0.070	
	[0.615]	
Log(GDPpc)*AUS	0.375***	
	[0.001]	
Log(ExcisePPP)		0.593***
		[0.000]
Log(ExcisePPP)*AUS		-0.120***
		[0.008]
Log(GDPpcPPP)		0.023
		[0.873]
Log(GDPpcPPP)*AUS		0.331**
		[0.010]
Year fixed effect	YES	YES
Quarter fixed effect	YES	YES
Constant	0.365	0.003
	[0.570]	[0.997]
Observations	64	64
Adjusted R-squared	0.995	0.995

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Table 18: Results of average price analysis – quarterly – PP from 2013Q1

	Model 1	**Model 2**
	Log(price)	Log (pricePPP)
AUS	1.197***	1.121**
	[0.006]	[0.027]
PP	0.225***	0.151***
	[0.000]	[0.000]
AUS*PP	**-0.016**	**-0.019**
	[0.298]	**[0.221]**
Log(Excise)	0.604***	
	[0.000]	
Log(Excise)*AUS	-0.118**	
	[0.017]	
Log(GDPpc)	0.092	
	[0.479]	
Log(GDPpc)*AUS	0.337***	
	[0.003]	
Log(ExcisePPP)		0.603***
		[0.000]
Log(ExcisePPP)*AUS		-0.115**
		[0.015]
Log(GDPpcPPP)		0.044
		[0.742]
Log(GDPpcPPP)*AUS		0.298**
		[0.013]
Year fixed effect	YES	YES
Quarter fixed effect	YES	YES
Constant	0.479	0.124
	[0.417]	[0.847]
Observations	64	64
Adjusted R-squared	0.995	0.995

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets*

Brand level prices

C.9 In order to analyse the effect of standardised packaging on brand-level prices using a DID approach I have first identified a list of 21 brands that are sold both in Australia and in New Zealand: Ashford, Benson & Hedges, Camel, Chunghwa, Davidoff, Double Happiness,

Dunhill, Easy, Holiday, Honeyrose, Horizon, JPS, Kent, Longbeach, Marlboro, Pall Mall, Peter Jackson, Peter Stuyvesant, Rothmans, Vogue, Winfield.

C.10 I then run the following regression:

$$price\ per\ stick_{cjki} = \alpha + \beta_1 AUS_c + \beta_2 PP_{jk} + \beta_3 AUS_c * PP_{jk} + \sum_i \beta_{4,i} brand_i + + \sum_i \beta_{5,i}\ brand_i * AUS_c * PP_{jk} + \sum_i \beta_{6,i}\ brand_i * PP_{jk} + \sum_i \beta_{7,i}\ brand_i * AUS_c + \sum_j \beta_{8,j}\ year_j + \sum_k \beta_{9,k}\ quarter_k + \sum_h \beta_{10,h}\ Control^h_{cjk} + \sum_h \beta_{11,h}\ Control^h_{cjk} * AUS_c + \varepsilon_{cjki}$$

C.11 Where subscripts c, j, k and i refer to country, year, quarter and brand, respectively; $price\ per\ stick$, α, AUS, $year$, $Control$ are defined in paragraph C.4; $brand$ is set of indicator variables (one for each brand) which capture the average price difference between that brand and a reference brand (Ashford); $quarter$ is a set of indicator variables (one for each quarter) which capture the difference between the average price in that quarter and the average price in a quarter of reference (Q1). The $quarter$ fixed effects are common to Australia and New Zealand.

C.12 For this analysis, I use the same data sources indicated in paragraph C.5.

C.13 Given the model, the coefficient β_3 indicates the effect of standardised packaging on the price of the brand of reference (Ashford). For the other brands, the effect of standardised packaging is captured by $\beta_3 + \beta_{5,i}$. The statistical significance of the coefficients for these other brands is tested using a F-test on the joint significance of the two coefficients. The p-values of these tests (where the null hypothesis is that the two coefficients are not statistically significantly different from zero) are reported in the column next to the column with the coefficient.

C.14 All regressions use OLS and robust standard errors.

C.15 The results of the regressions are presented below. The regressions in Table 19 assume the start date for standardised packaging at 2012Q4 (i.e., $PP = 0$ for 2009Q1 to 2012Q3, and $PP = 1$ from 2012Q4 onwards). However, since the full implementation of standardised packaging only happened on 1 December 2012 (i.e., at the end of 2012Q4), the regressions in Table 20 assume the start date for standardised packaging at 2013Q1 (i.e., $PP = 0$ for 2009Q1 to 2012Q4, and $PP = 1$ from 2013Q1 onwards).

C.16 For simplicity, I have identified in green the brands whose price decrease is statistically significant, and in red the brands whose price increase is statistically significant.

Table 19: Results of brand-level price analysis – PP from 2012 Q4

	Model 1		**Model 2**	
	Log (price)	Joint significance p-value	Log (pricePPP)	Joint significance p-value
AUS	-0.048		-0.071	
	[0.878]		[0.847]	
PP	-0.045***		-0.048***	
	[0.010]		[0.005]	
AUS*PP	-0.096		-0.089	
	[0.226]		[0.263]	
Benson & Hedges	0.221***		0.221***	
	[0.000]		[0.000]	
Camel	0.228***		0.228***	
	[0.000]		[0.000]	
Chunghwa	0.000		0.255***	
	[1.000]		[0.000]	
Davidoff	0.296***		0.296***	
	[0.000]		[0.000]	
Double Happiness	0.092***		0.093***	
	[0.000]		[0.000]	
Dunhill	0.233***		0.233***	
	[0.000]		[0.000]	
Easy	-0.024***		-0.024***	
	[0.005]		[0.005]	
Holiday	0.111***		0.111***	
	[0.000]		[0.000]	
Honeyrose	-0.631***		-0.629***	
	[0.000]		[0.000]	
Horizon	0.107***		0.107***	
	[0.000]		[0.000]	
JPS	0.034***		0.034***	
	[0.003]		[0.004]	
Kent	0.258***		0.258***	
	[0.000]		[0.000]	
Longbeach	0.017**		0.017*	
	[0.041]		[0.051]	
Marlboro	0.224***		0.224***	
	[0.000]		[0.000]	
Pall Mall	0.084***		0.084***	

	Model 1		Model 2	
	[0.000]		[0.000]	
Peter Jackson	0.035***		0.035***	
	[0.006]		[0.000]	
Peter Stuyvesant	0.223***		0.223***	
	[0.000]		[0.000]	
Rothmans	0.248***		0.248***	
	[0.000]		[0.000]	
Vogue	0.431***		0.433***	
	[0.000]		[0.000]	
Winfield	0.183***		0.183***	
	[0.000]		[0.000]	
AUS*PP*Benson & Hedges	0.123	0.102	0.124	0.037
	[0.131]		[0.125]	
AUS*PP*Camel	0.135	0.073	0.136*	0.036
	[0.102]		[0.097]	
AUS*PP*Chunghwa	0.016	0.006	0.019	0.018
	[0.852]		[0.823]	
AUS*PP*Davidoff	0.174**	0.000	0.175**	0.000
	[0.035]		[0.034]	
AUS*PP*Double Happiness	0.111	0.608	0.112	0.442
	[0.176]		[0.173]	
AUS*PP*Dunhill	0.131	0.039	0.133	0.015
	[0.106]		[0.102]	
AUS*PP*Easy	0.132	0.128	0.134	0.064
	[0.112]		[0.107]	
AUS*PP*Holiday	0.082	0.490	0.083	0.780
	[0.321]		[0.310]	
AUS*PP*Honeyrose	0.029	0.206	0.033	0.294
	[0.762]		[0.732]	
AUS*PP*Horizon	0.066	0.056	0.068	0.190
	[0.415]		[0.403]	
AUS*PP*JPS	0.019	0.000	0.021	0.002
	[0.813]		[0.798]	
AUS*PP*Kent	0.245***	0.000	0.247***	0.000
	[0.004]		[0.004]	
AUS*PP*Longbeach	0.117	0.285	0.119	0.138
	[0.153]		[0.146]	
AUS*PP*Marlboro	0.175**	0.000	0.176**	0.000
	[0.033]		[0.031]	

	Model 1		Model 2	
AUS*PP*Pall Mall	0.174*	0.073	0.176*	0.050
	[0.056]		[0.054]	
AUS*PP*Peter Jackson	0.083	0.577	0.084	0.823
	[0.314]		[0.310]	
AUS*PP*Peter Stuyvesant	0.091	0.708	0.092	0.852
	[0.263]		[0.254]	
AUS*PP*Rothmans	-0.199*	0.000	-0.198*	0.001
	[0.080]		[0.082]	
AUS*PP*Vogue	0.160*	0.037	0.162*	0.019
	[0.063]		[0.059]	
AUS*PP*Winfield	0.075	0.212	0.076	0.463
	[0.358]		[0.347]	
Log(Excise)	0.587***			
	[0.000]			
Log(Excise)*AUS	-0.018			
	[0.624]			
Log(GDPpc)	-0.004			
	[0.960]			
Log(GDPpc)*AUS	0.023			
	[0.777]			
Log(ExcisePPP)			0.615***	
			[0.000]	
Log(ExcisePPP)*AUS			-0.033	
			[0.343]	
Log(GDPpcPPP)			-0.008	
			[0.917]	
Log(GDPpcPPP)*AUS			0.022	
			[0.801]	
Year fixed effect	YES		YES	
Quarter fixed effect	YES		YES	
Brand*PP fixed effect	YES		YES	
Brand*AUS fixed effect	YES		YES	
Constant	-0.125		-0.256	
	[0.689]		[0.455]	
Observations	1,261		1,261	
R-squared	0.971		0.972	

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Table 20: Results of brand-level price analysis – PP from 2013 Q1

	Model 1		**Model 2**	
	Log (price)	Joint significance p-value	Log (pricePPP)	Joint significance p-value
AUS	-0.111		-0.212	
	[0.717]		[0.535]	
PP	0.231***		0.210***	
	[0.000]		[0.000]	
AUS*PP	-0.110		-0.097	
	[0.189]		[0.249]	
Benson & Hedges	0.225***		0.225***	
	[0.000]		[0.000]	
Camel	0.233***		0.233***	
	[0.000]		[0.000]	
Chunghwa	0.261***		0.263***	
	[0.000]		[0.000]	
Davidoff	0.299***		0.299***	
	[0.000]		[0.000]	
Double Happiness	0.097***		0.098***	
	[0.000]		[0.000]	
Dunhill	0.237***		0.237***	
	[0.000]		[0.000]	
Easy	-0.016		-0.016	
	[0.127]		[0.127]	
Holiday	0.116***		0.116***	
	[0.000]		[0.000]	
Honeyrose	-0.628***		-0.627***	
	[0.000]		[0.000]	
Horizon	0.111***		0.111***	
	[0.000]		[0.000]	
JPS	0.041***		0.041***	
	[0.001]		[0.001]	
Kent	0.263***		0.263***	
	[0.000]		[0.000]	
Longbeach	0.022**		0.022**	
	[0.024]		[0.026]	
Marlboro	0.229***		0.229***	
	[0.000]		[0.000]	
Pall Mall	0.089***		0.089***	

	Model 1		Model 2	
	[0.000]		[0.000]	
Peter Jackson	0.043***		0.043***	
	[0.002]		[0.003]	
Peter Stuyvesant	0.228***		0.228***	
	[0.000]		[0.000]	
Rothmans	0.253***		0.253***	
	[0.000]		[0.000]	
Vogue	0.437***		0.439***	
	[0.000]		[0.000]	
Winfield	0.187***		0.187***	
	[0.000]		[0.000]	
AUS*PP*Benson & Hedges	0.141*	0.059	0.143*	0.005
	[0.097]		[0.092]	
AUS*PP*Camel	0.160*	0.021	0.162*	0.003
	[0.063]		[0.060]	
AUS*PP*Chunghwa	0.045	0.038	0.048	0.122
	[0.609]		[0.587]	
AUS*PP*Davidoff	0.195**	0.000	0.196**	0.000
	[0.024]		[0.024]	
AUS*PP*Double Happiness	0.127	0.564	0.128	0.713
	[0.136]		[0.123]	
AUS*PP*Dunhill	0.151*	0.017	0.153*	0.001
	[0.077]		[0.073]	
AUS*PP*Easy	0.155*	0.061	0.157*	0.013
	[0.074]		[0.070]	
AUS*PP*Holiday	0.099	0.599	0.101	0.866
	[0.251]		[0.242]	
AUS*PP*Honeyrose	0.053	0.240	0.056	0.399
	[0.580]		[0.559]	
AUS*PP*Horizon	0.084	0.100	0.086	0.474
	[0.323]		[0.312]	
AUS*PP*JPS	0.044	0.002	0.046	0.017
	[0.608]		[0.594]	
AUS*PP*Kent	0.272***	0.000	0.274***	0.000
	[0.002]		[0.002]	
AUS*PP*Longbeach	0.134	0.230	0.136	0.047
	[0.118]		[0.112]	
AUS*PP*Marlboro	0.195**	0.000	0.197**	0.000
	[0.023]		[0.022]	

	Model 1		Model 2	
AUS*PP*Pall Mall	0.201**	0.043	0.203**	0.020
	[0.035]		[0.033]	
AUS*PP*Peter Jackson	0.107	0.898	0.108	0.654
	[0.218]		[0.215]	
AUS*PP*Peter Stuyvesant	0.110	0.990	0.112	0.342
	[0.195]		[0.187]	
AUS*PP*Rothmans	-0.202*	0.000	-0.200*	0.000
	[0.083]		[0.086]	
AUS*PP*Vogue	0.187**	0.011	0.189**	0.002
	[0.036]		[0.035]	
AUS*PP*Winfield	0.091	0.277	0.093	0.807
	[0.286]		[0.275]	
Log(Excise)	0.602***			
	[0.000]			
Log(Excise)*AUS	-0.022			
	[0.581]			
Log(GDPpc)	0.017			
	[0.801]			
Log(GDPpc)*AUS	0.008			
	[0.916]			
Log(ExcisePPP)			0.635***	
			[0.000]	
Log(ExcisePPP)*AUS			-0.043	
			[0.238]	
Log(GDPpcPPP)			0.014	
			[0.840]	
Log(GDPpcPPP)*AUS			-0.006	
			[0.945]	
Year fixed effect	YES		YES	
Quarter fixed effect	YES		YES	
Brand*PP fixed effect	YES		YES	
Brand*AUS fixed effect	YES		YES	
Constant	-0.019		-0.124	
	[0.949]		[0.705]	
Observations	1,261		1,261	
R-squared	0.972		0.973	

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

Results with the model used in previous submissions

C.17 Finally, as explained above in footnote 41 and in Annex B, in previous reports where I have analysed data from Australia, using data for a shorter time period I used a slightly different model from the one I use in this report. The differences and the reasons for employing a different model are explained in paragraph B.11.

C.18 For completeness, however, I also carried out the econometric analysis using the old model. The results are reported in Table 21 and Table 22, and confirm that standardised packaging is associated with a decrease in (i) the average price of cigarettes, with results being statistically significant for Model 1 (Table 21); (ii) the price of individual brands: the results of the econometric analysis using the model in the previous submission (Table 22) are very similar to the results in Table 3.

Table 21: DID regression analysis on the effect of standardised packaging on the average cigarette price in Australia – model of previous submission

	Model 1	**Model 2**	**Model 3**	**Model 4**
Controls for monthly dummies, year indicator variables and →	Excise tax	Excise tax, GDP per capita	Excise tax PPP	Excise tax PPP, GDP per capita PPP
Effect of standardised packaging	-0.022**	-0.012	-0.007	-0.006

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.*

Table 22: DID regression analysis on the effect of standardised packaging on the average cigarette price in Australia – model of previous submission

Model		Increase in price	Decrease in price	No effect on price	Weighted average
Model 1	% change in price	6.1%	-12.7%	0.0%	**-5.1%**
	Number of brands	8	7	6	
	Million sticks (2016)	3,274	6,643	2,626	
Model 2	% change in price	6.1%	-12.7%	0.0%	**-5.1%**
	Number of brands	8	7	6	
	Million sticks (2016)	3,274	6,643	2,626	
Model 3	% change in price	6.9%	-11.7%	0.0%	**-4.3%**
	Number of brands	9	6	6	
	Million sticks (2016)	3,436	6,643	2,464	
Model 4	% change in price	6.9%	-11.7%	0.0%	**-4.3%**
	Number of brands	9	7	5	
	Million sticks (2016)	3,436	6,643	2,464	

Source: Compass Lexecon analysis

Annex D

Alternative consumption analyses

D.1 In Section 5, I present the results of my alternative (i.e., non-DID) econometric analysis on the effects of standardised packaging on cigarette consumption. In this annex, I set out this econometric analysis in more detail.

Before-during approach

D.2 The before-during approach is as follows:

$$consumption_{jk} = \alpha + \beta_1 PP_{jk} + \sum_h \beta_{2,h}\, Control_{jk}^h + \varepsilon_{jk}$$

D.3 Where subscripts j and k refer to year and month, respectively; $consumption$ is measured as the log of cigarette consumption per capita; α is the constant; PP is an indicator variable for standardised packaging ($PP = 0$ for pre-implementation period and $PP = 1$ for post-implementation period)[83] which captures the average change in consumption after the implementation of standardised packaging; $Control$ is a set of control variables which change from model to model. In particular, $Control$ includes:

a. Model 1: the logarithm of excise taxes, the logarithm of GDP per capita, a linear monthly trend, and monthly indicator variables.[84]

b. Model 2: the logarithm of excise taxes, the logarithm of GDP per capita, the logarithm of cigarette consumption per capita in New Zealand.

c. Model 3 (Instrumental Variables approach): This is the same as Model 2 but it uses prices instead of excise taxes as a control variable. For this analysis, I use a two-stage-least-square approach where I first regress the logarithm of prices on a set of instrumental variables which includes the logarithm of excise taxes, the quarterly change in the consumer price index, and its square. I then use the predicted values of this regression as a control variable.

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83 PP stands for Plain Packaging, which has the same meaning as Standardised Packaging.

84 These indicator variables do not change from one year to another.

D.4 The data is the same used for the DID analysis and described in paragraphs B.5-B.6.

D.5 The results of this approach are reported in Table 23. The coefficient of interest, i.e., the coefficients that indicates the effects of standardised packaging on cigarette consumption per capita, is that on the variable PP. This coefficient is negative but not statistically significant in Model 1, which uses a linear trend and monthly indicator variables.

D.6 I note that this model is problematic because it confounds the effect of the trend with the effect of standardised packaging on cigarette consumption, making the result set out immediately above unreliable. This can be seen in the last row of Table 23, which shows that the correlation between the coefficient on the trend and the coefficient on the standardised packaging variable is very high. In practice, this implies that the model is likely to attribute to standardised packaging changes in cigarette consumption that are in fact due to the decreasing trend, or vice versa. Most likely as a result of this inability to distinguish the two effects, the model predicts that – save for the effects of other modelled factors – cigarette consumption in Australia would have followed a slightly increasing trend (because the coefficient on the 'Linear monthly trend' variable is positive[85]). The negative coefficient on the GDP per capita variable, estimating that an increase in income would reduce consumption, is a further warning that the model is unreliable.

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85 The coefficient is very small (0.000) and possibly positive from the fourth decimal. If it were negative, it would have a minus sign in front.

Table 23: regression analysis on the effect of standardised packaging on cigarette consumption per capita in Australia – before-during approach – PP from December 2012

	Log (consumption)		
	Model 1	**Model 2**	**Model 3**
PP	**-0.013**	**0.026*** **	**0.038*** **
	[0.311]	[0.005]	[0.000]
Log(GDPpc)	-0.156	0.225***	0.380***
	[0.191]	[0.002]	[0.000]
Log(Excise)	-0.347***	-0.251***	
	[0.000]	[0.000]	
Log(Price)			-0.366***
			[0.000]
Linear monthly trend	0.000		
	[0.420]		
Log(NZ consumption per capita)		0.593***	0.558***
		[0.000]	[0.000]
Constant	3.407***	3.195***	4.011***
	[0.000]	[0.000]	[0.000]
Month fixed effect	YES	NO	NO
Observations	96	96	96
Adjusted R-squared	0.918	0.892	0.891
Beta correlation between trend (or NZ consumption) and PP	-0.7402	-0.079	-0.119

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

D.7 The same problem does not arise for Models 2 and 3, which include cigarette consumption per capita in New Zealand as an explanatory variable.

D.8 Although I do not present the results here, I have carried out sensitivity analyses where I have assumed different start dates for the implementation of standardised packaging (November 2012 and October 2012). These analyses confirm the results reported in Table 23, i.e., (i) that Model 1 is unreliable for estimating the effect of standardised packaging on cigarette consumption; and (ii) that Models 2 and 3 indicate that standardised packaging is associated with a statistically significant increase in cigarette consumption per capita in Australia relative to the counterfactual.

Prediction approach

D.9 The prediction approach is as follows:

$$consumption_{jk} = \alpha + \sum_{h} \beta_{1,h}\, Control_{jk}^{h} + \varepsilon_{jk}$$

D.10 Where $consumption$ is defined in paragraph D.3, and $Control$ is a set of control variables which change from model to model. In particular, $Control$ includes:

a. Model 1: the logarithm of excise taxes, the logarithm of GDP per capita, a linear monthly trend, and monthly indicator variables.[86]

b. Model 2: the logarithm of excise taxes, the logarithm of GDP per capita, the logarithm of cigarette consumption per capita in New Zealand.

D.11 The prediction model only estimates the effect of relevant factors on consumption in the pre-implementation period, and – as a result – Model 1 is not subject to the same limitations as the before-during model, as explained in paragraph 0.

D.12 The results of the prediction models are shown in Table 24.

Table 24: regression analysis on the effect of standardised packaging on cigarette consumption per capita in Australia – prediction approach – PP from December 2012

Log (consumption)		
	Model 1	**Model 2**
Log(GDPpc)	0.356*	0.305***
	[0.061]	[0.001]
Log(Excise)	-0.326***	-0.298***
	[0.000]	[0.000]
Linear monthly trend	-0.002***	
	[0.001]	
Log(NZ consumption per capita)		0.632***
		[0.000]
Constant	5.644***	3.349***
	[0.000]	[0.000]
Month fixed effect	YES	NO
Observations	47	47
Adjusted R-squared	0.967	0.904

Notes: **** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level. p-values in brackets.*

D.13 I use the results of this analysis to estimate the level of cigarette consumption that would have prevailed in the absence of standardised packaging. For example, the coefficient of the

86 These indicator variables do not change from one year to another.

GDP per capita (log) variable in Model 1 indicates that, in the pre-implementation period, when GDP per capita increases by 1%, cigarette consumption increases by 0.356%. Using this estimated effect (and that of other relevant variables) and the actual increases of GDP per capita (and that of other relevant variables) in the post-implementation period, I estimate the level of consumption that would have prevailed in the absence of standardised packaging. For example, if GDP per capita increased by 3% in the post-implementation period, I estimate that – everything else equal – cigarette consumption per capita would have increased by 1.068% (i.e., 0.356% x 3) in the absence of standardised packaging.

D.14 I call this estimated level of cigarette consumption per capita in the post-implementation period 'predicted consumption' and compare it to the actual cigarette consumption per capita in Table 25 (Model 1) and Table 26 (Model 2). These tables show that actual consumption per capita is on average 4.0% higher than predicted consumption per capita, indicating that standardised packaging is associated with an increase in consumption relative to the counterfactual up to the end of 2016. This increase is more pronounced as time goes by and the full effects of standardised packaging unfold.

D.15 As explained in Section 5, this increase is statistically significant.

Table 25: Actual vs Predicted consumption – Model 1 – PP from December 2012

Year	Actual consumption [a]	Predicted consumption [b]	Difference ([a]-[b])/[a]
2013	951	942	0.9%
2014	904	878	2.9%
2015	873	821	5.9%
2016	828	775	6.4%
Total	3,556	3,416	**4.0%**

Source: Compass Lexecon analysis

Table 26: Actual vs Predicted consumption – Model 2 – PP from December 2012

Year	Actual consumption [a]	Predicted consumption [b]	Difference ([a]-[b])/[a]
2013	951	925	2.7%
2014	904	878	2.9%
2015	873	829	5.1%
2016	828	781	5.7%
Total	3,556	3,413	**4.0%**

Source: Compass Lexecon analysis

D.16 Although I do not present the results here, I have carried out sensitivity analyses where I have assumed different start dates for the implementation of standardised packaging

(November 2012 and October 2012). These analyses confirm the results reported above, i.e., that standardised packaging is associated with an increase in cigarette consumption per capita relative to the counterfactual.