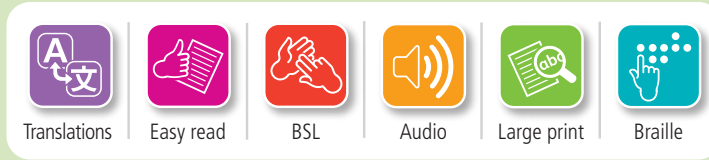**MESAS**

Public Health Scotland

Using alcohol retail sales data to estimate population alcohol consumption in Scotland: an update of previously published estimates

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March 2021

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Key points

Background

- Market research specialist Nielsen provides alcohol retail sales data to Public Health Scotland on an annual basis. These data are used to monitor alcohol consumption at a population level, as recommended by the World Health Organization.

- In September 2019, Nielsen implemented a change to their data collection and sampling methodology. The change increased their coverage of the independent sector, which makes up approximately 6% of the total off-trade market. The Monitoring and Evaluating Scotland's Alcohol Strategy (MESAS) team was not informed of this change. Nor were we supplied with revised data at our annual data delivery in March 2020. We have implemented a system to ensure this does not happen in the future.

- We have now received revised data back to 2017. This report assesses the impact that using the revised data has on previously published estimates of the volume of pure alcohol sold per adult in Scotland and England & Wales. Estimates published in the following reports were impacted and will be revisited here:

  - Report 1: MESAS Monitoring Report 2020.

  - Report 2: Evaluating the impact of minimum unit pricing (MUP) on sales-based alcohol consumption in Scotland: controlled interrupted time series analyses.

Report 1: MESAS Monitoring Report 2020 – per-adult alcohol sales by calendar year

- Overall, the change to Nielsen's data collection and sampling methodology increased estimates of per-adult alcohol sales. When comparing per-adult alcohol sales estimates using the revised data with our original estimates, the increase in the estimated volume of pure alcohol sold per adult ranged from 1.2% to 2.3%. The greatest impact was seen in Scotland in 2018 where the estimated total volume of pure alcohol sold per adult was 2.3% greater than original estimates, rising from 9.9 to 10.2 litres.

- In Scotland, the revised estimates show that alcohol consumption at a population level fell in both 2018 and 2019, from 10.4 litres per adult in 2017 to 9.9 litres per adult in 2019. The original estimates showed that sales of pure alcohol fell from 10.3 to 9.9 litres per adult between 2017 and 2018 and remained at that level (9.9 litres per adult) in 2019.

- In England & Wales, the revised estimates show that alcohol consumption at a population level rose between 2017 and 2018, from 9.1 to 9.3 litres per adult, before returning to 9.1 litres per adult in 2019. Original estimates showed per-adult sales rose from 9.0 to 9.1 litres per adult between 2017 and 2018 with no change between 2018 and 2019 (9.1 litres).

- The sales estimates show that alcohol consumption at a population level in Scotland remained at its lowest level since 1994. On average, 19.1 units per adult per week were sold in 2019.

Report 2: Evaluating the impact of minimum unit pricing (MUP) on sales-based alcohol consumption in Scotland: controlled interrupted time series analyses

- Using the revised data, we find that the introduction of MUP in Scotland was associated with a 3.5% (95% confidence interval: 2.2% to 4.9%) reduction in off-trade alcohol sales per adult after adjustment for the best available geographical control, disposable income and substitution. This was a smaller estimate of the effect of MUP than that previously published; using the original dataset we previously reported a net reduction of between 4 and 5%.

- The impact of MUP on different drink categories was similar to that previously reported; the biggest reductions were seen in cider, perry and spirits. We also saw increases in per-adult sales of fortified wine and ready-to-drink beverages, as with the original results. However, the magnitude of these changes varied compared to the originally published results.

Conclusion

- The change implemented by Nielsen to improve their coverage of alcohol sales in the independent sector has increased estimates of alcohol consumption at a population level. It is likely to have resulted in a more robust means of estimating alcohol sales from the independent sector and therefore provides a more accurate source of data on which to base population alcohol consumption estimates.

- The change implemented by Nielsen resulted in a small reduction in our estimates of the effect of MUP. When comparing the results obtained from the original and revised datasets the general conclusions drawn from the original analyses remain.

- The MESAS team will continue to use data based on the revised methodology for the purposes of monitoring and evaluating Scotland's alcohol policy.

Introduction

Background

Alcohol sales data are widely regarded as offering the most accurate estimate of population-level alcohol consumption in a country and are recommended by the World Health Organization (WHO).[1] The Monitoring and Evaluating Scotland's Alcohol Strategy (MESAS) programme has relied on alcohol retail sales data to monitor population alcohol consumption in Scotland for many years, presenting trends as far back as the mid-1990s. The MESAS programme, including the evaluation of minimum unit pricing (MUP), uses alcohol sales data from both the off-trade (supermarkets and other shops) and the on-trade (pubs, clubs and restaurants), obtained from market research specialists Nielsen and CGA, respectively, to monitor trends in per-adult alcohol consumption in Scotland and England & Wales. The validity and reliability of these data for this purpose has been shown in previous MESAS reports; these concluded that alcohol retail sales offer a robust source of data for monitoring population consumption.[2,3]

In September 2019, Nielsen implemented a change to its data collection and sampling methodology to increase its coverage of the independent sector. The independent sector includes small retailers and grocery stores with fewer than 10 outlets and accounts for approximately 6% of all off-trade sales (by value). The change was made possible due to Nielsen obtaining EPoS (electronic point of sale) data from a greater proportion of independent stores, rather than manual audit data as had been done previously. EPoS data are considered more reliable than other forms of data collection and thus provide a more robust measurement of the independent sector. Subsequently Nielsen were able to apply a more accurate weighting to their sample of independent stores and therefore more accurately estimate the total sales coming from that sector.

Nielsen implements a 'universe'[*] update every year to ensure that their data are representative at a UK level; the change to the coverage of the independent sector was in addition to this regular annual update. Importantly, Nielsen did not inform the MESAS team of the change at our annual delivery in March 2020; nor did they provide revised data. We have implemented a system to ensure this does not happen in the future.

Purpose of this report

The change in Nielsen's data collection and sampling methodology has impacted population alcohol consumption estimates previously published as part of the MESAS programme, both in the most recent MESAS Monitoring Report and in the evaluation of MUP. However, these different pieces of work are impacted in slightly different ways, as outlined below.

The purpose of this report is therefore to assess the impact of the change to Nielsen's data collection and sampling methodology on previously published estimates of population alcohol consumption and the impact of MUP. We will revisit the estimates published in the following reports:

- MESAS Monitoring Report 2020

- Evaluating the impact of minimum unit pricing (MUP) on sales-based alcohol consumption in Scotland: controlled interrupted time series analyses.

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[*] Nielsen's 'universe' is the totality of retailers that they obtain data from; this is all participating supermarkets (excluding Aldi and Lidl) and a sample of independent and convenience stores.

MESAS Monitoring Report 2020

At the time of publishing the MESAS Monitoring Report 2020[4] (June 2020), the MESAS team were unaware that Nielsen had implemented this change to their data collection and sampling methodology, nor did we receive any retrospectively revised data. In the alcohol retail sales data used in the MESAS Monitoring Report 2020, the change had only been applied to data for 2019, representing a methodological break in the time series between 2018 and 2019. We have now received revised data going back to the beginning of 2017 (the earliest Nielsen are able to provide) allowing us to revisit the population consumption estimates using this updated time series.

Evaluating the impact of Minimum Unit Pricing (MUP) on sales-based consumption in Scotland: controlled interrupted time series analyses

The data used in the work examining the impact of MUP on population alcohol consumption[5] were obtained prior to the implementation of the methodology change, and published prior to our knowledge of the change. While there is therefore no methodological break in the time series used for that work, the MESAS team felt it was important to revisit this to assess the impact, if any, that the methodology change had on the estimated impact of MUP on population alcohol consumption estimates.

Methods

The methods used here are the same as in the original reports.[4,5] These have been replicated in Appendices 1 and 2.

As stated, the purpose of this work is to assess the impact of the change to Nielsen's data collection and sampling methodology on previously published population alcohol consumption estimates. To that end we have obtained data with the methodology change applied retrospectively from January 2017 onwards. In assessing the impact on per-adult alcohol sales by calendar year, as published in the MESAS Monitoring Report 2020,[4] comparative analysis has been limited to 2017 onwards. In assessing the impact of MUP on per-adult alcohol sales, the full time

series, covering January 2013 to May 2019, has been used with revised data included from January 2017.

To assist the reader in interpreting the results of the controlled interrupted time series analyses, a brief overview of the method and presentation of results is given here. The full methods can be found in Appendices 1 and 2. We used controlled interrupted time series regression with seasonal autoregressive integrated moving average (SARIMA) errors as our main statistical method to assess the impact of MUP on off-trade alcohol sales in Scotland. Our analytical strategy consisted of initially modelling the alcohol sales data time series to obtain an adequate preliminary model and then modelling and testing the effect of the intervention with and without adjustment for covariates.

Results from all analyses performed are provided in Appendix 3; all tests of statistical significance were carried out at the 5% level.

In the main report, we graphically present the estimated impact of MUP from our primary analyses based on the following:

1   Separate unadjusted, uncontrolled models for Scotland and England & Wales.

2   Unadjusted, controlled models (in which the England & Wales series is incorporated in the model for Scotland).

3   Adjusted, controlled models (as above but also including as covariates trends in household disposable income, on-trade sales and, for analyses of specific drink categories, off-trade alcohol sales of other drink categories).

Results and commentary

MESAS Monitoring Report 2020

Per-adult alcohol sales by calendar year

Overall the change to Nielsen's data collection and sampling methodology has increased alcohol consumption estimates at a population level. The increase in the volume of pure alcohol sold per adult ranged from 1.2% to 2.3%, dependent on the year and area in question (Table 1, Figure 1). The greatest impact was seen in Scotland in 2018 where the total volume of pure alcohol sold per adult increased by 2.3% from 9.9 to 10.2 litres (Table 1, Figure 1).

Given that the change only impacted off-trade alcohol sales data, the effects are greater when we look at the off-trade in isolation, ranging from 1.6% to 3.2% (Table 1, Figure 2). Again, the greatest increase was seen in Scotland in 2018 where the volume of pure alcohol sold through the off-trade increased by 3.2% from 7.2 to 7.4 litres per adult (Table 1, Figure 2).

The revised estimates show that alcohol consumption at a population level fell year-on-year in Scotland, from 10.4 litres per adult in 2017 to 9.9 litres per adult in 2019. This is a slightly different pattern to that reported previously where the decline between 2017 and 2019 (from 10.3 to 9.9 litres per adult) was entirely attributable to a fall between 2017 and 2018, with the level remaining the same (9.9 litres per adult) in 2019 (Table 1, Figure 1). In England & Wales the revised estimates show that alcohol consumption at a population level rose between 2017 and 2018, from 9.1 to 9.3 litres per adult, before returning to 9.1 litres per adult in 2019. As in Scotland this is a slightly different pattern to that previously reported where no change was observed between 2018 and 2019 (9.1 litres per adult in both years) (Table1, Figure 1). The revised off-trade consumption estimates follow a very similar pattern to those seen for total alcohol (Table1, Figure 2).

There was no change to the estimates for 2019 published in the MESAS Monitoring Report 2020; this was due to the sales data provided to Public Health Scotland for 2019 having used the updated methodology. Thus the observation that 9.9 litres of pure alcohol per adult was sold in Scotland in 2019 remains; this is equivalent to

19.1 units of alcohol per adult per week and is the lowest level seen in Scotland over the available time series.

Price per unit of alcohol

The average price per unit of alcohol is routinely reported in the MESAS Monitoring Report and is also calculated using both volume and value sales data; this measure could therefore have been impacted in the revised data. Analysis shows that the average price per unit of alcohol was virtually unchanged (see additional excel file, 'MESAS Monitoring Report 2020 – revised alcohol sales').

Table 1: Volume of pure alcohol sold per adult in Scotland and England & Wales, original and revised, 2017–2019

	Scotland			England & Wales		
	2017	**2018**	**2019**	**2017**	**2018**	**2019**
Per adult sales of pure alcohol (litres per adult)						
Annual estimate – original dataset	10.3	9.9	9.9	9.0	9.1	9.1
Annual estimate – revised dataset	10.4	10.2	9.9	9.1	9.3	9.1
Absolute difference (litres per adult)	0.1	0.2	0.0	0.1	0.1	0.0
Relative difference (percentage)	1.2%	2.3%	0.0%	1.5%	1.4%	0.0%
Per adult sales of pure alcohol sold through the off-trade (litres per adult)						
Annual estimate – original dataset	7.4	7.2	7.2	6.3	6.5	6.5
Annual estimate – revised dataset	7.5	7.4	7.2	6.4	6.6	6.5
Absolute difference (litres per adult)	0.1	0.2	0.0	0.1	0.1	0.0
Relative difference (percentage)	1.6%	3.2%	0.0%	2.1%	2.0%	0.0%

Source: Nielsen/CGA

Figure 1: Volume of pure alcohol sold per adult in Scotland and England & Wales, original and revised, 1994–2019
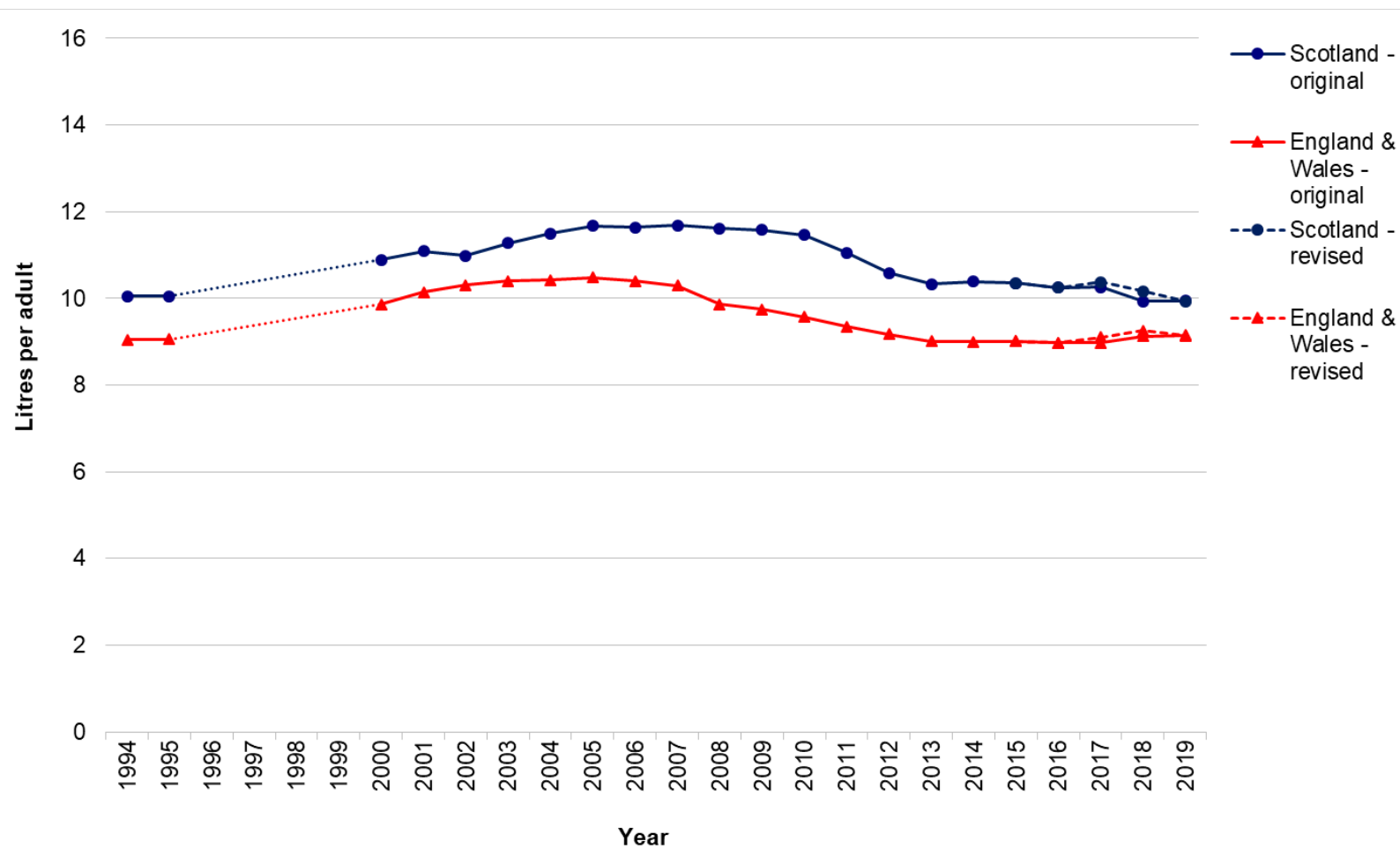
Source: Nielsen/CGA. Off-trade sales from 2011 onwards adjusted to account for the lack of data from discount retailers; see Appendix 1 for more details.
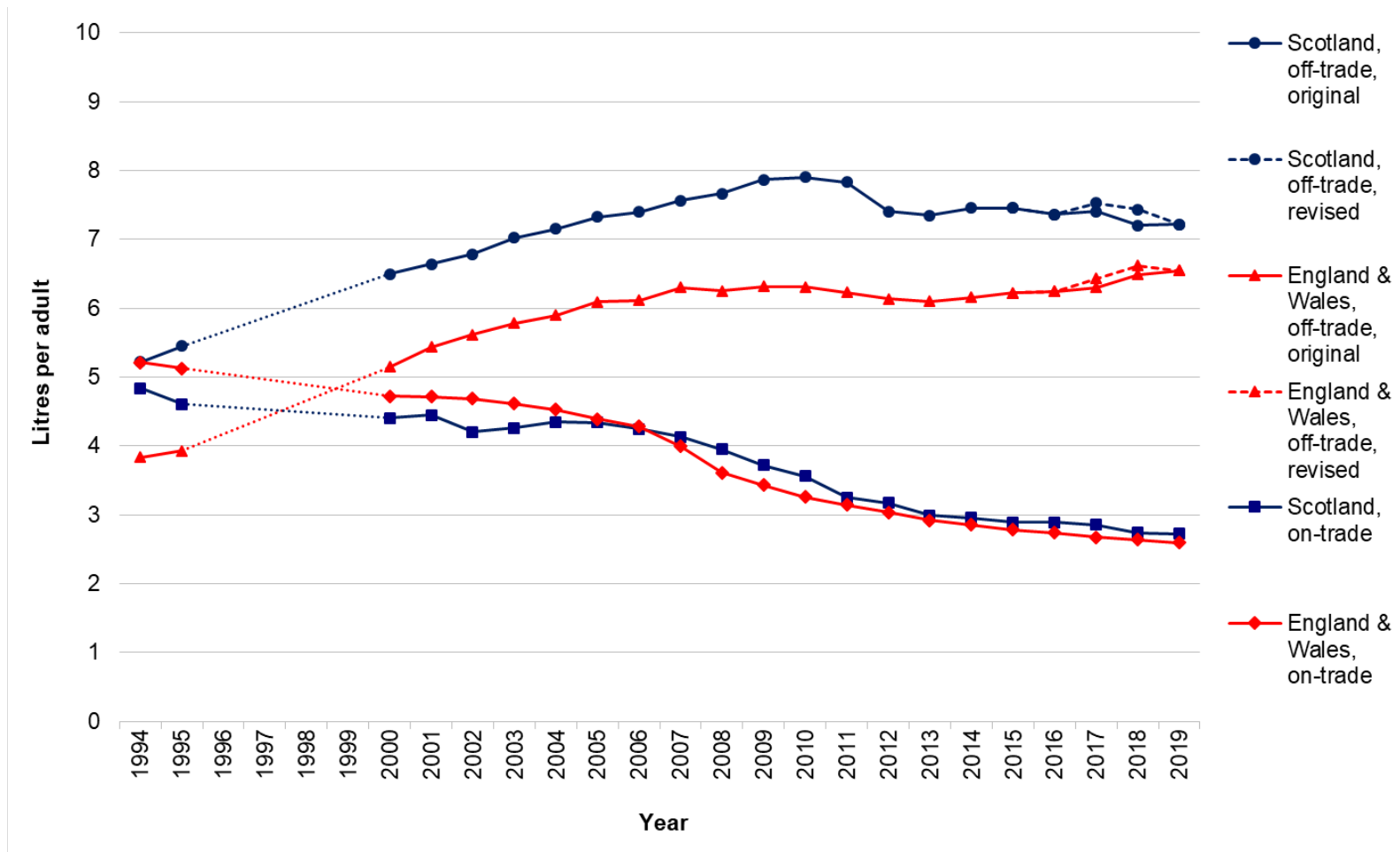
Figure 2: Volume of pure alcohol sold per adult in Scotland and England & Wales, original and revised, by trade sector, 1994–2019

Source: Nielsen/CGA. Off-trade sales from 2011 onwards adjusted to account for the lack of data from discount retailers; see Appendix 1 for more details.

Evaluating the impact of Minimum Unit Pricing (MUP) on sales-based consumption in Scotland: controlled interrupted time series analyses

The results of the estimated impact of MUP on off-trade alcohol sales using the revised alcohol retail sales time series are described in this section. A direct comparison with all of the previously published results is provided in Appendix 3 and Appendix 4.

Controlled interrupted time series – revised results

Figures 3a and 3b present the estimated impact of the introduction of MUP on overall off-trade alcohol sales, and by drink category. The results are summarised below and in Tables A1 to A4 (Appendix 3).

Total off-trade alcohol sales

In the unadjusted analysis, the introduction of MUP was associated with a 2.0% (95% confidence interval (CI): 0.4% to 3.6%) reduction in the total volume of pure alcohol sold per adult in Scotland. In England & Wales, there was a 2.4% (0.8% to 4.0%) increase over the same time period. In the unadjusted, controlled model, MUP was associated with a 3.3% (2.1% to 4.4%) reduction in total off-trade alcohol sales in Scotland. A similar estimate was produced when the controlled model was adjusted for disposable income and substitution (-3.5% (-4.9% to -2.2%)).

Spirits (32.5% of off-trade market share in post-MUP year)

In the unadjusted analysis, the introduction of MUP was associated with a reduction (-2.5% (-5.4% to 0.4%)) in the volume of pure alcohol sold per adult as spirits in Scotland, although this was not statistically significant. In England & Wales, there was a 3.9% (1.0% to 6.8%) increase over the same time period. In the unadjusted, controlled model, MUP was associated with a 5.4% (3.7% to 7.0%) reduction in off-trade spirits sales in Scotland. A greater reduction was estimated when the controlled model was adjusted for disposable income and substitution (-6.4% (-7.9% to -4.9%)).

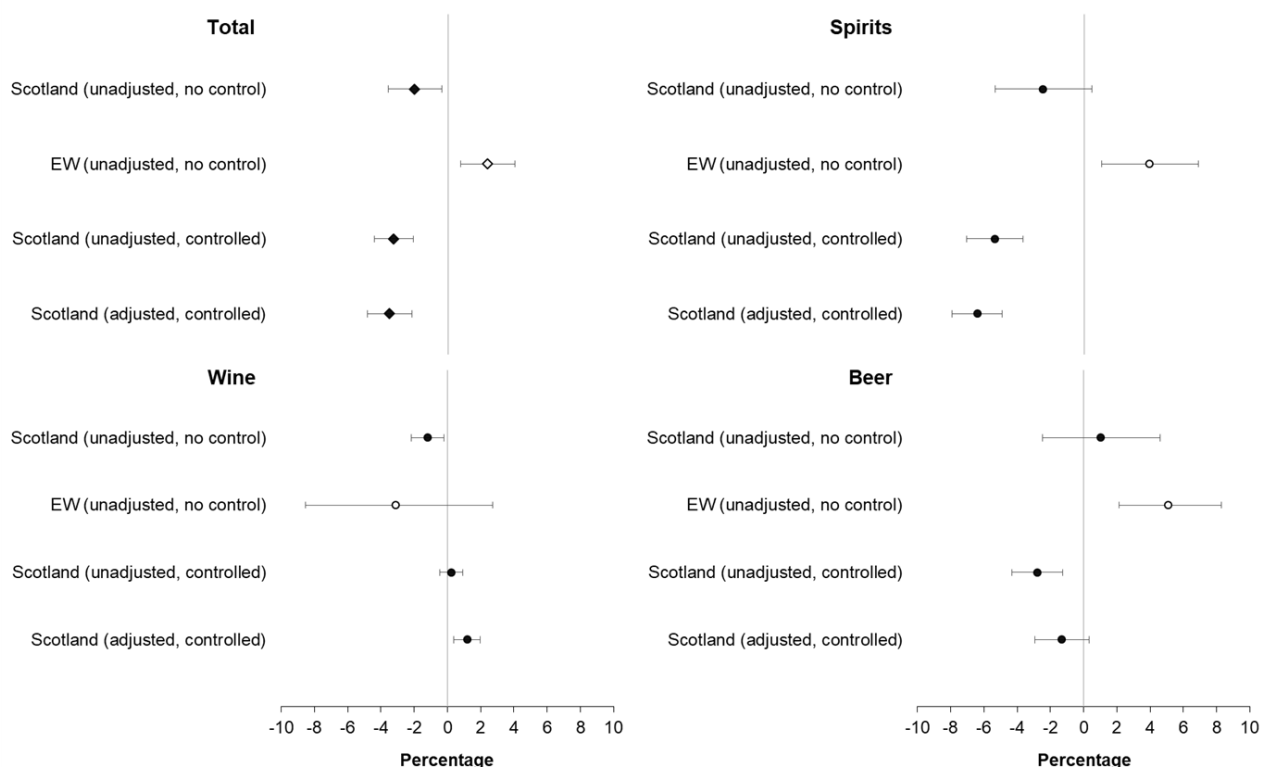## Wine (31.3% of off-trade market share in post-MUP year)

In the unadjusted analysis, the introduction of MUP was associated with a 1.2% (0.2% to 2.2%) reduction in the volume of pure alcohol sold per adult as wine in Scotland. In England & Wales, there was also a decrease ((-3.1% (-8.5% to 2.7%)) over the same time

period, but this change was not statistically significant. In the unadjusted, controlled model, the estimated effect of MUP on off-trade wine sales was close to zero (0.2% (-0.5% to 0.9%)). After adjustment for disposable income and substitution, MUP was associated with a 1.2% (0.4% to 2.0%) increase in off-trade wine sales in Scotland when controlling for sales in England & Wales.

Beer (24.1% of off-trade market share in post-MUP year)

In the unadjusted analysis, there was little evidence to suggest that the introduction of MUP was associated with a change in the volume of pure alcohol sold per adult as beer in Scotland (1.0% (-2.5% to 4.6%)). However, in England & Wales, there was a 5.1% (2.1% to 8.3%) increase in off-trade beer sales over the same time period. In the unadjusted, controlled model, MUP was associated with a 2.8% (1.3% to 4.3%) reduction in off-trade beer sales in Scotland. A smaller reduction was estimated when the controlled model was adjusted for disposable income and substitution (-1.3% (-2.9% to 0.3%)) and this change was not statistically significant.

Figure 3a: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland for all alcohol, spirits, wine and beer.

EW = England & Wales. 'Controlled' models include trends in off-trade alcohol sales in England & Wales as a covariate. 'Adjusted' models include trends in household disposable income, on-trade sales and, for analyses of specific drink categories, off-trade alcohol sales of other drink categories as covariates. All models are adjusted for underlying seasonal and secular trends.

Cider (6.4% of off-trade market share in post-MUP year)

In the unadjusted analysis, the introduction of MUP was associated with a 15.2% (11.7% to 18.6%) reduction in the volume of pure alcohol sold as cider per adult in Scotland. In England & Wales, there was a 9.3% (3.8% to 15.1%) increase over the same time period. In the unadjusted, controlled model, MUP was associated with a 22.4% (20.2% to 24.6%) reduction in off-trade cider sales in Scotland; a similar result was obtained after adjustment for disposable income and substitution (-21.8% (-24.4% to -19.1%)).

Fortified wine (4% of off-trade market share in post-MUP year)

In the unadjusted analysis, the introduction of MUP was associated with a 13.4% (6.1% to 21.3%) increase in the volume of pure alcohol sold as fortified wine per adult in Scotland. In England & Wales, there was also an increase (3.2% (-2.3% to 9.0%) over the same time period but this change was not statistically significant. In the unadjusted, controlled model, MUP was associated with a 15.2% (10.6% to 20.1%) increase in off-trade fortified wine sales in Scotland, which decreased after adjustment for disposable income and substitution (9.2% (2.4% to 16.7%)).

Ready-to-drink beverages (RTDs) (1.2% of off-trade market share in post-MUP year)

In the unadjusted analysis, the introduction of MUP was associated with an 18.2% (7.4% to 30.2%) increase in the volume of pure alcohol sold as RTDs per adult in Scotland. In England & Wales, there was a 21.4% (14.0% to 29.2%) increase over the same time period. In the unadjusted, controlled model, MUP was associated with a 9.4% (3.6% to 15.5%) increase in off-trade RTD sales in Scotland, which increased after adjustment for disposable income and substitution (15.5% (10.1% to 21.1%)).

Perry (0.4% of off-trade market share in post-MUP year)

In the unadjusted analysis, the introduction of MUP was associated with a 39.4% (35.6% to 43.0%) reduction in the volume of pure alcohol sold as perry per adult in Scotland. In England & Wales, there was a 6.0% (1.1% to 11.1%) increase over the same time period. In the unadjusted, controlled model, MUP was associated with a 45.0% (42.7% to 47.1%) reduction in off-trade perry sales in Scotland. A slightly lower estimate was produced when the controlled model was adjusted for disposable income and substitution (-41.9% (-44.5% to -39.3%)).

Figure 3b: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland for cider, fortified wine, RTDs and perry
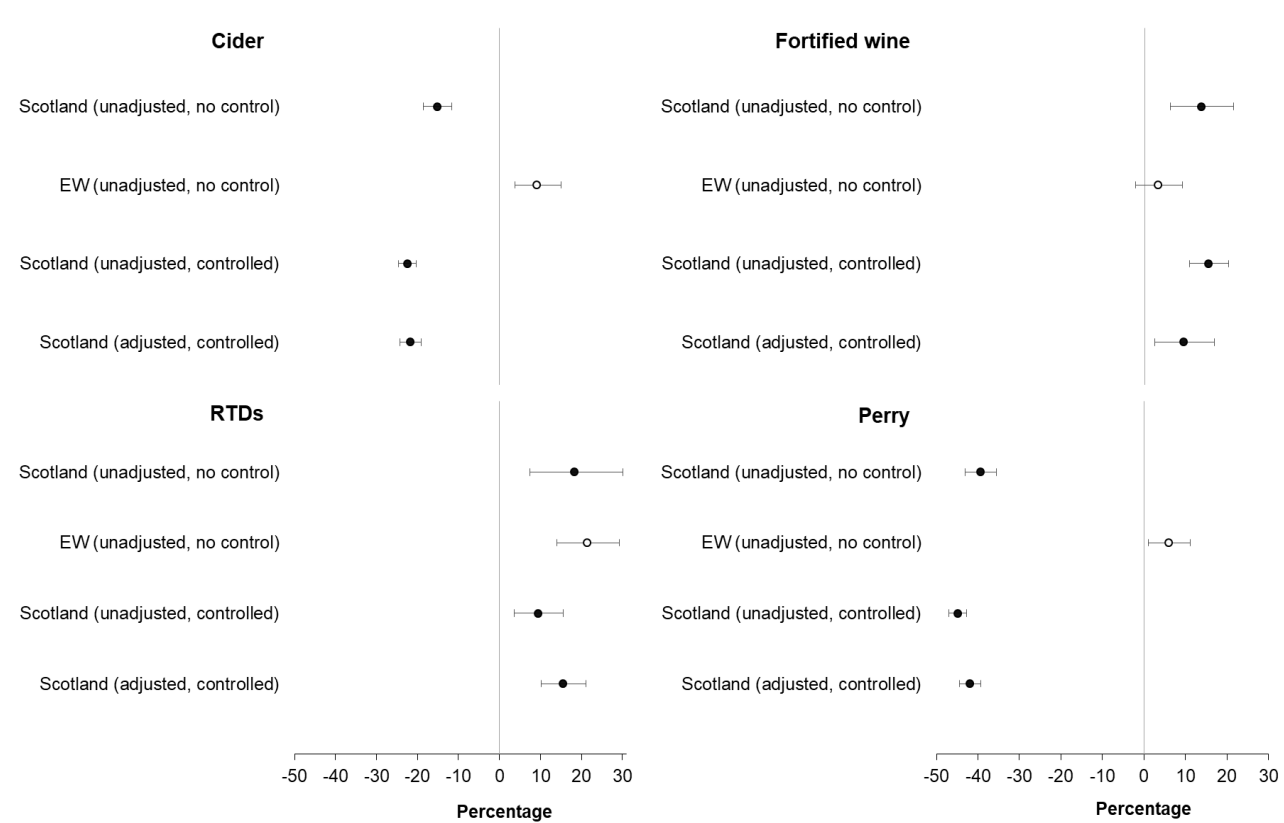
Note: EW = England & Wales. 'Controlled' models include trends in off-trade alcohol sales in England & Wales as a covariate. 'Adjusted' models include trends in household disposable income, on-trade sales and, for analyses of specific drink categories, off-trade alcohol sales of other drink categories as covariates. All models are adjusted for underlying seasonal and secular trends.

Sensitivity and supplementary analyses

Repeating our adjusted analyses using the difference in off-trade alcohol sales between Scotland and England & Wales as the outcome, produced a very similar result (-3.4% (-4.5% to -2.2%)) to our main controlled and adjusted model for total sales (Figure 4, Table A6). There was variation in the magnitude of the estimated effect for particular drink categories, but the direction of effect was mostly consistent between approaches for both unadjusted and adjusted models (Tables A5 and A6).

Nielsen data do not include sales of alcohol through the discount stores Aldi and Lidl; we can apply an uplift to the data based on the market share of Aldi and Lidl to account for the lack of these data (see Appendix 1). In the unadjusted model, the estimated reduction in per-adult off-trade sales in Scotland associated with the introduction of MUP was larger when the Aldi and Lidl alcohol market share was applied to the data (-3.3% (-4.9% to -1.6%)) (Table A7). In England & Wales, uplift for Aldi and Lidl produced a slightly larger (2.6% (0.4% to 4.7%)) estimated increase in per-adult off-trade sales in the post-MUP year (Table A7). This is likely due to the fact that the alcohol market share in Aldi and Lidl fell in Scotland in the post-MUP year, while it increased in England & Wales. The estimated net reduction in off-trade alcohol sales associated with MUP in the adjusted controlled model was greater (-4.4% (-5.8% to -3.0%)) than in the main analysis (Table A7, Figure 4).

Using off-trade alcohol sales in either north-west (NW) or north-east (NE) England as the geographical control resulted in a greater estimated reduction in per-adult alcohol sales in Scotland than when using England & Wales as the control (Table A8; Figure 4). When using NW England as the geographical control a 5.3% (3.1% to 7.4%) reduction was seen, while using NE England resulted in a 6.8% (4.5% to 9.0%) reduction.

Repeating our analyses using only 12 months pre-implementation data, in the adjusted, controlled model, the estimated effect of MUP was greater than in our main analysis or any of the sensitivity analyses (Table A9). However, the effect estimate was not significant and there was more uncertainty around this estimate reflected in the wider confidence interval.

Fitting an Unobserved Components Model (UCM) to the data (a form of structural time series), instead of a SARIMA model, produced very similar estimates of the MUP effect size in unadjusted models for Scotland (-2.1% (-3.7% to -0.5%)) and England & Wales (2.7% (1.3% to 4.3%)) (Table A10).

Applying the same analytical approach to all alcohol sales (i.e. off- and on-trade sales combined) produced similar results (-3.2% (-4.2% to -2.2%)) to the controlled, adjusted model in the main analysis (Table A11; Figure 4).

Our test of whether MUP had an impact on the variability of weekly off-trade sales in Scotland did not suggest a statistical difference in the frequency and magnitude of peaks and troughs in the post-MUP period (Table A12). This analysis did not incorporate data for England & Wales.

Figure 4: Change (%) in alcohol sales in the year after MUP was implemented in Scotland estimated from sensitivity and supplementary analyses.
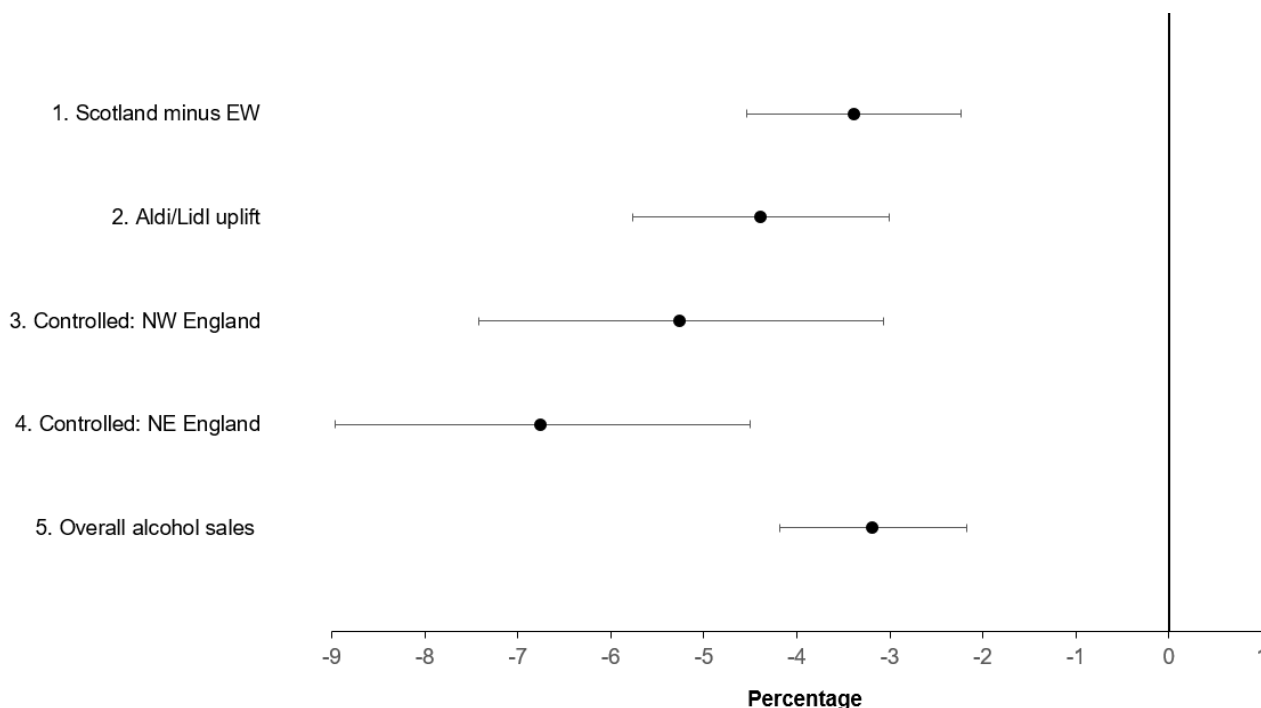

Note: EW = England & Wales. NE = North East. NW = North West. Models 1, 2 and 5 incorporate off-trade alcohol sales in England & Wales as control. All models include trends in on-trade sales and household disposable income as covariates and are adjusted for underlying seasonal and secular trends. In the original report the results for a model incorporating only 12 months pre-MUP data was included in the equivalent figure; the results have been excluded from this figure due to very large confidence intervals, but can be found in Table A9 in Appendix 3.

Controlled interrupted time series – comparison with previously published results

In our original report we concluded that our best estimate of the impact of MUP on per-adult off-trade alcohol sales was a reduction of between 4 and 5% based on the results from both the main and supplementary analyses. From the revised results we conclude a similar but slightly lower reduction; several of our models that incorporate data for England & Wales and are adjusted for other relevant factors show a reduction of between 3% and 4%. This can be illustrated by comparing the results from the controlled and adjusted model in the main analysis. The result from using the revised data was a reduction of 3.5% (2.2% to 4.9%), compared to a 4.2% (3.0% to 5.4%) reduction reported

in the original analysis (Table A4); this is typical across many of the results for total alcohol (Figure 5).

Figure 5: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, total alcohol
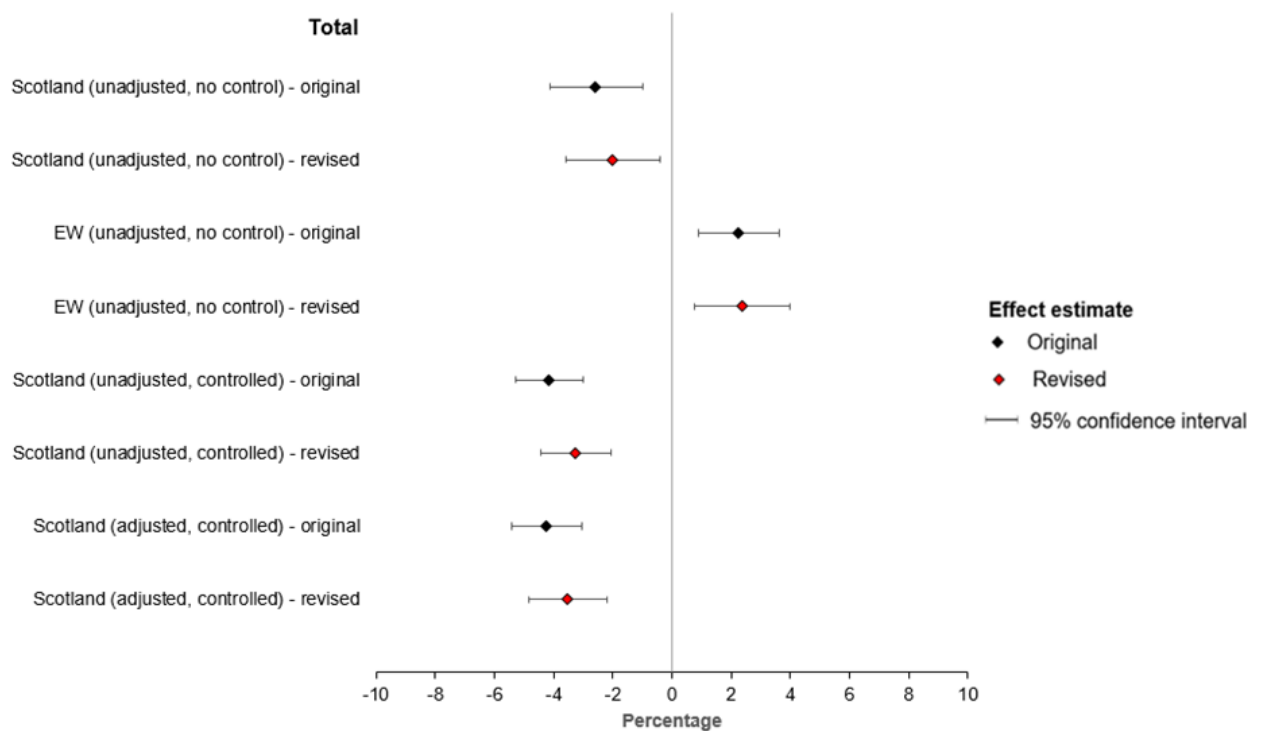
Note: EW = England & Wales. 'Controlled' models include trends in off-trade alcohol sales in England & Wales as a covariate. 'Adjusted' models include trends in household disposable income and on-trade sales. All models are adjusted for underlying seasonal and secular trends.

As with the original analyses, when we look at the impact of MUP on sales of specific drink categories, we find the biggest reductions for cider and perry, with a smaller reduction seen for spirits. To illustrate, in the controlled and adjusted models we found a 21.8% (19.1% to 24.4%) reduction for cider (compared to -18.8% (-20.5% to -17.1%) in the original analysis), a 41.9% (39.3% to 44.5%) reduction for perry (compared to -28.9% (-31.8% to -25.8%) in the original analysis) and a 6.4% (4.9% to 7.9%) reduction for spirits (compared to -4.7% (-6.7% to -2.5%) in the original analysis) (Table A4). Similarly, we found increases for both RTDs (15.5% (10.1% to 21.1%)) and fortified wine (9.2% (2.4% to

16.7%)) sales in the controlled and adjusted model, which were consistent with the original findings (13.4% (6.8% to 20.5%) and 5.7% (1.3% to 10.3%), respectively) (Table A4). Finally, a small reduction (-1.3% (-2.9% to 0.3%)) in per-adult sales of beer through the off-trade was found when using the revised dataset and this was a similar result to the original analysis (-1.9% (-3.6% to -0.2%)) (Table A4), although the small reduction found in the revised data was not statistically significant.

A full comparison of all the results from the analyses using both original and revised data can be found in Appendix 3 and Appendix 4.

Discussion

Main findings

In September 2019, Nielsen implemented a change to their data collection and sampling methodology within the independent sector of the off-trade alcohol retail market. The change resulted from improved data collection methods from independent stores within Nielsen's sample, leading to more robust measurement of this segment of the market. We have subsequently been able to obtain revised data (from 2017 onwards); using these data we have revisited recently published population consumption estimates.

Overall, the change has served to increase population alcohol consumption estimates in each of the years analysed. Revision of estimated sales of pure alcohol per adult by calendar year in Scotland and England & Wales has shown that the increase ranges from 1.2% to 2.3%, with the greatest increase being observed in Scotland in 2018. The revised data have resulted in a slight change to the pattern of recent trends, with reductions in per-adult sales of pure alcohol being seen between 2018 and 2019 in both Scotland and England & Wales; this is contrary to the flat trend we reported between 2018 and 2019 in both areas in the original data.[4] Our estimate in Scotland in 2019 remains at 9.9 litres of pure alcohol per adult, equivalent to 19.1 units of alcohol per adult per week and the lowest level of pure alcohol sold in Scotland since 1994.

Using the revised data to assess the impact of MUP on per-adult sales of alcohol through the off-trade, we observed similar results to those previously published. Our revised results suggest a reduction of 3.5% (2.2% to 4.9%) in off-trade sales in the year following MUP implementation, after adjustment for the best available geographical control, disposable

income and substitution. While lower, this is comparable with the 4% to 5% reduction that we estimated in our original report.[5] By drink category, the biggest net reductions were observed for cider, perry and, to a lesser extent, spirits. As with the original analyses we saw increases in per-adult sales of RTDs and fortified wines through the off-trade. When comparing the results obtained from the original and revised datasets the general conclusions drawn from the original analyses remain, although the magnitude of the reported change varies.

Strengths and limitations

Using alcohol retail sales data to monitor and evaluate the impact of interventions on alcohol consumption at a population level is considered the most reliable and objective approach.[1] We have provided our own assessment of the validity and reliability of using alcohol retail sales data in this manner and have found that they provide one of the best sources available.[2,3] While this work did not set out to assess the validity and reliability of this revised dataset explicitly, this view has not changed based on this analysis. The recent change in Nielsen's data collection and sampling methodology has presented a challenge in terms of estimating and reporting per-adult alcohol sales over time. However the change is likely to have resulted in a more robust means of estimating alcohol sales from the independent sector and therefore provides us with a more accurate source of data on which to base population alcohol consumption estimates.

In relation to the methodology used to assess the impact of MUP on off-trade alcohol sales, we documented a number of potential strengths and limitations in our original report.[5] Given that we have performed the same analysis here, simply using revised data, the strengths and limitations documented previously remain valid. As before, we accounted for underlying trends in our analyses, as well as other covariates that may explain part of the effect of MUP on off-trade sales.

Interpretation

The revised calendar year estimates show a slightly different pattern between 2017 and 2019 than those published in the MESAS Monitoring Report 2020. While the change over the whole period is largely the same, we previously reported virtually all the reduction observed in Scotland had occurred between 2017 and 2018, with per-adult sales remaining flat in 2019. The revised estimate shows a more gradual decline with reductions

occurring in both 2018 and 2019. In England & Wales the impact is less obvious, however a reduction is seen between 2018 and 2019 in the revised estimate which was not observed in the originally published data.

In relation to assessing the impact of MUP on per-adult alcohol sales, the magnitude of the impact is slightly smaller than when using the original data, though the primary interpretation offered in the original report stands.[5] We accounted for underlying trends, other covariates that may explain part of the effect of MUP on off-trade sales, and incorporated a geographical control where the policy was not implemented. It is reasonable to conclude that the introduction of MUP can explain the reductions observed. Our findings are consistent with others[6] and the reduction observed is most likely explained by the policy's effect on alcohol prices.

The smaller impact observed using the revised data may reflect a slight shift in consumer behaviour to purchase alcohol in the convenience and independent sector. We have reported elsewhere[7] that MUP has reduced price differences between retail sectors for certain products that could lead to shifts in consumer behaviour. This may explain why, with improved data from the independent sector, we see a slightly smaller estimated impact compared to our original findings.

Conclusion

Overall, the change implemented by Nielsen to improve their coverage of alcohol sales in the independent sector has increased estimates of alcohol consumption at a population level. In relation to MUP we observed a slightly lower but comparable estimated effect to that reported previously.

The change has presented a challenge in estimating and reporting per-adult alcohol sales over time. However, it is likely to have resulted in a more robust means of estimating alcohol sales from the independent sector and therefore provides us with a more accurate source of data on which to base population alcohol consumption estimates. The MESAS team will continue to use data based on the revised method for the purposes of monitoring and evaluating Scotland's alcohol policy.

Appendix 1: Methods

The following presents the methods as provided in the original reports. The same methods have been used in this report but with data revised retrospectively to 2017. Data prior to 2017 have not changed.

MESAS Monitoring Report 2020

Data on alcohol retail sales in Scotland and England & Wales were obtained from market research specialists, Nielsen and CGA Strategy (CGA) (hereafter 'Nielsen/CGA'), for 1994, 1995 and 2000–2019. The volume of alcohol sold (litres) was provided for the on-trade by CGA and for the off-trade by Nielsen across eight alcoholic drink categories: spirits, wine, beer, cider, ready-to-drink beverages (RTDs), perry, fortified wine and 'other'. The volume of each drink category sold was converted into pure alcohol volume using a category-specific percentage alcohol by volume (ABV). The ABV used was based on the typical strength of drinks sold in that category (except for wine where the same standard ABV was applied across all years due to the complexity of the wine market) and was provided by the data suppliers. Nielsen also provided data on the volume of alcohol sold on promotion by large, multiple retailers for each drink category. Per-adult alcohol sales were calculated by dividing pure alcohol volumes (litres of pure alcohol) by the total population aged 16 years or older. Mid-year population estimates and projections for Scotland were obtained from National Records of Scotland and for England & Wales from the Office for National Statistics. To calculate alcohol sales per adult drinker, the denominator was adjusted to account for the proportion of the population reporting non-drinking in the Scottish Health Survey (the prevalence of non-drinking in 2019 was assumed to be the same as in 2018 as 2019 SHeS data are not yet available). These data are presented in an accompanying dataset at www.healthscotland.scot/publications/mesas-monitoring-report-2020. A detailed description of the methods used by Nielsen/CGA to produce alcohol retail sales estimates is provided in an earlier MESAS report available at www.healthscotland.com/documents/5761.aspx

Retail sales estimates may differ slightly to those previously published as they continue to be improved retrospectively after being supplied. Consequently, the most recent data provided by Nielsen/CGA are considered the best available because they provide the most robust review of the alcohol market.

Since 2011, off-trade sales data were provided by week (Sunday to Saturday), and were aggregated to produce annual volumes and values. In cases where the week started in one year and finished in another the volumes and values were split in direct proportion to the portion of the week in each year. This is a change to the method previously used and has been applied from 2011 onwards, the years for which weekly data is available. Prior to 2011 each year is an aggregated 52-week period as defined by Nielsen.

From September 2011, Nielsen was no longer able to estimate off-trade sales by discount retailers Aldi and Lidl. As such, all off-trade sales data provided since September 2011 (including estimates for the full 2011 calendar year) have been defined as 'Off-trade excluding discount retailers'. To enable continuation of the time series presented in earlier reports, adjustment factors have been applied to off-trade sales estimates from 2011 onwards.

Adjustment factors have been based on the market share of Aldi and Lidl drawn from Kantar Worldpanel consumer panel data. Kantar Worldpanel data are collected by a panel of households (participants aged 18 years or older) who record their grocery purchases, including alcohol, using a barcode reader. Data are only collected on purchases brought into the home and include details such as quantity, price and the store of purchase. Kantar analysts use these data to estimate the market share of discounters in Scotland and England & Wales, by drink category. Market share estimates based on both sales volumes and values are provided on an annual basis. These volume market share estimates are then applied to the drink category pure volumes (described above) resulting in adjusted pure volumes. The adjusted pure volumes are used to calculate per-adult sales as described above.

Evaluating the impact of minimum unit pricing (MUP) on sales-based alcohol consumption in Scotland: controlled interrupted time series analyses

Study design

We used controlled interrupted time series analytical methods to assess whether the introduction of MUP was associated with a change in the volume of pure alcohol sold per adult in the off-trade in Scotland in the 12-month period after it was introduced, overall and

by drink category. Our approach incorporated a number of methodological features to strengthen the interpretation of the impact of MUP. These included:

- Employing multiple approaches to how data for England & Wales, our geographical control, were incorporated into our analyses.

- Adjusting all statistical models for underlying seasonal and secular trends.

- Testing how robust our results were after adjusting our statistical models for covariates that may explain any impact of MUP on off-trade sales. Disposable income and substitution between drink categories and trade sectors were identified for this purpose.

- Performing a range of sensitivity and supplementary analyses to test the robustness of our results to changes in the analytical approach deployed.

Outcome measures

The primary outcome measure in this study was the volume (litres) of pure alcohol sold per adult in the off-trade.

Study time period

We included off-trade alcohol sales data from January 2013 to May 2019. This provided us with data for over five years before, and one year after, the implementation of MUP.

Data

Off-trade alcohol retail sales

Weekly off-trade alcohol sales data were obtained from market research specialists Nielsen for the period January 2013 to May 2019. Data were obtained for Scotland, England & Wales (combined), north-east (NE) England and north-west (NW) England. Nielsen estimates alcohol sales in Great Britain using electronic sales records from large retailers (retailers with 10 or more retail shops operating under common ownership) and a weighted stratified random sample of smaller 'impulse' retailers (retailers in which the consumer mainly uses the store for impulse or top-up purchases, i.e. not the main grocery shop). A detailed description of the methods used by Nielsen to produce alcohol retail sales estimates is provided in an earlier MESAS report.[2]

The volume of alcohol sold (litres) was provided across eight alcoholic drink categories: spirits, wine, beer, cider, ready to drink beverages (RTDs), perry, fortified wine and 'other'. The volume of each drink category sold was converted into pure alcohol volume using a category-specific percentage alcohol by volume (ABV) provided by the data suppliers. The ABV used was based on the typical strength of drinks sold within subtypes of the category, except for wine where the same standard ABV was applied across all products due to the diversity of the wine market.

Alcohol sales by discount retailers, Aldi and Lidl, are not included in the Nielsen off-trade alcohol sales estimates. We adjust for their exclusion in supplementary analysis using alcohol volume market share estimates for calendar years 2013 to 2019 provided by Kantar Worldpanel. Linear interpolation was used to calculate weekly alcohol market share estimates for Aldi and Lidl, by drink category, from the annualised data provided.

On-trade alcohol sales data

On-trade alcohol sales data (litres of pure alcohol) were obtained from market research specialists CGA Strategy, whose estimates are based on a combination of delivery, sales and survey data from a stratified sample of on-trade retailers.[2] Data were obtained for the same drink categories and geographies as noted for the off-trade. Linear interpolation was used to calculate weekly on-trade sales data per adult by drink category from the four-weekly data provided.

Mid-year population estimates

Per-adult alcohol sales were calculated by dividing pure alcohol volumes (litres of pure alcohol) by the total population aged 16 years or older. Mid-year population estimates and projections for Scotland were obtained from National Records of Scotland[8] and for England & Wales from the Office for National Statistics.[9] The NE and NW England regions used in this study were defined by the data providers based on postcode sectors and are not coterminous with the official Government Office Regions. Mid-year population estimates for these areas were therefore based on the aggregation of mid-year population estimates for Lower Super Output Areas[10] within each postcode sector within each region. Weekly population estimates were interpolated linearly from the mid-year estimates.

Disposable household income

Quarterly gross disposable household income data were obtained for Scotland[11] and the United Kingdom[12] and expressed per adult aged 16 years or older. As equivalent data were not available directly for England & Wales, a proxy measure was created by subtracting Scottish data from the UK data.

Statistical methods

We used controlled interrupted time series regression with seasonal autoregressive integrated moving average (SARIMA) errors as our main statistical method to assess the impact of MUP on off-trade alcohol sales in Scotland. In line with the guidance produced by Beard et al (2019)[13] and based on our previous approach when evaluating the impact of the Alcohol etc. (Scotland) Act 2010, our analytical strategy consisted of initially modelling the alcohol sales data time series to obtain an adequate preliminary model and then modelling and testing the effect of the intervention with and without adjustment for covariates. A full description of our statistical methods is provided in Appendix 2.

Comparison with a geographical control

In interrupted time series analyses, data for a control series can be used in various ways. Separate models can be fitted to the intervention and control series, with results compared to assess if there is a change in the level or slope of the data in the intervention series that is not seen in the control series. Alternatively, a single model can be fitted by combining the intervention and control series. In line with Lopez-Bernal et al's (2019)[14] guidance, we used a two-step approach. First, we used the approach described above in separate analysis of off-trade alcohol sales data in Scotland and England & Wales. Second, we entered the England & Wales time series data as a covariate in the SARIMA models for Scotland to produce a 'controlled' model.

Adjusting the model for covariates

Models were fitted to the off-trade alcohol sales data series with and without adjustment for covariates that plausibly could explain part of any identified relationship between MUP and off-trade sales. We included data for the following covariates in adjusted models:

- Disposable household income

- On-trade alcohol sales (Scotland only)

- Sales of other alcoholic drink categories (in models of specific drink categories for Scotland only)

Sensitivity and supplementary analyses

We performed a number of additional analyses to test the robustness of our results:

- We repeated our analyses using the difference between Scotland and England & Wales at each time point in the outcome series. This was performed for total off-trade alcohol sales and by drink category using both unadjusted and adjusted models.

- We assessed the impact of applying volume market share uplift factors to off-trade alcohol sales data to account for the exclusion of sales by Aldi and Lidl (see Appendix 5). This was performed for total off-trade alcohol sales using separate unadjusted models in Scotland and England & Wales, and in an adjusted, controlled model.

- It has been suggested that Northern England is a more appropriate control group for Scotland than England & Wales due to a more similar sociodemographic make-up and alcohol culture[15]. We therefore repeated our analyses using NW and NE England as geographical controls. This was performed for total off-trade alcohol sales using separate unadjusted models for each region and in an adjusted, controlled model that incorporated the region as a covariate in the model for Scotland.

- We repeated our analyses using only 12 months pre-implementation data as it has been suggested that equal proportions of data before and after an intervention exposure can enhance statistical power.[16] This was performed for total off-trade alcohol sales using separate unadjusted models in Scotland and England & Wales, and in an adjusted, controlled model.

- We applied our analytical approach to overall alcohol sales (i.e. off- and on-trade sales combined). This was performed for total sales in an adjusted, controlled model.

- We assessed the impact of MUP on off-trade alcohol sales using an alternative analytical approach. Specifically, we used an Unobserved Components Model

(UCM), a form of structural time series method, across the entire outcome series. UCM presents an alternative to SARIMA as it does not assume the data are 'stationary' (i.e. statistical properties of the data series, such as the mean and variance, are constant over time).[17] In addition model output is typically presented as a series of plots of the trend, seasonal and cyclical components making the analysis easier to comprehend compared to the regression output format of a SARIMA model. This was performed for total off-trade alcohol sales using separate unadjusted models for Scotland and England & Wales.

- We also tested whether MUP had an impact on the variability in weekly off-trade alcohol sales. In other words, did MUP affect the frequency and magnitude of peaks and troughs in the data series in the year after it was introduced compared with the pre-intervention period?

Presentation of results

Results from all analyses performed are provided in Appendix 3; all tests of statistical significance were carried out at the 5% level.

In the main report, we graphically present the estimated impact of MUP from our primary analyses based on the following:

1 Separate unadjusted, uncontrolled models for Scotland and England & Wales.

2 Unadjusted, controlled models (in which the England & Wales series is incorporated in the model for Scotland).

3 Adjusted, controlled models (as above but also including as covariates trends in household disposable income, on-trade sales and, for analyses of specific drink categories, off-trade alcohol sales of other drink categories).

To ease visual interpretation, we present our modelled estimates of the impact of MUP (displayed as percentage changes) in two separate figures for the following groups of drink categories:

- Total off-trade, wine, spirits and beer.
- Cider, perry, fortified wine and RTDs.

Note that the separate figures use a different scale. We provide an indication of uncertainty around our estimates of the impact of MUP using 95% confidence intervals. This is in line with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidance[18] and the guidelines produced by Beard et al (2019)[7] for using time-series analyses in addiction research. In addition, we report results from both uncontrolled and controlled analyses (with equal prominence) as recommended by Lopez-Bernal et al (2019).[11]

Appendix 2: Detailed description of controlled interrupted time series methods

Preparing the data

We assessed whether the outcome measures have a normal distribution using Kernel Density plots. As our primary outcome measure, weekly off-trade alcohol sales per adult, was not normally distributed, these data were transformed using the natural logarithm. This is often an important step for meeting the assumption of a normal distribution when performing ARIMA modelling.

Diagnosing autocorrelation and non-stationarity

The presence of serial and seasonal autocorrelation and non-stationarity was diagnosed using autocorrelation (AC) and partial autocorrelation functions (PAC). These enabled any significant correlation between error terms at different lag periods and the number of autoregressive (AR) and moving average (MA) terms to be identified and accounted for. Inclusion of deterministic terms was sufficient to address non-stationarity in the mean and variance of the off-trade sales series meaning that differencing was not required.

Selecting the baseline model

Candidate SARIMA models were investigated using plots and AC/PAC plots of the stationary data series. The most appropriate and parsimonious model was selected using the Akaike Information Criterion (AIC) and Bayesian Information Criteria (BIC) statistics.[19] Lagged effects of MUP were not explored in light of findings from other studies in the MUP Evaluation portfolio which have shown that the legislation has been complied with and implemented effectively.[20] Similarly, our preliminary analysis of data on the average sales price of off-trade alcohol did not suggest that there was an anticipatory effect prior to MUP being introduced in Scotland compared with England & Wales.[21]

Testing the effect of the intervention

We estimated the magnitude and uncertainty of the effect of MUP implementation on off-trade alcohol sales by including a binary explanatory variable in our SARIMA models, with the value of zero for the time before MUP is introduced (January 2013 to April 2018) and the value of one after the introduction of MUP (May 2018 to April 2019). Models were

all fitted assuming a change in level. This was based on a comparison of AIC and BIC statistics of separate models testing for either: a change in level only; a change in trend only; a change in level and trend.

Assessment of model fit

For all models, standard diagnostic tests were performed to ensure that the residuals of the fitted models were not significantly different from those expected from white noise or a random series.[22] In addition, AIC and BIC statistics were obtained and compared, and R^2 values were obtained by performing linear regression analyses using predicted values as the explanatory series and observed values as the outcome series.

Software

Analysis were performed using the following statistical software:

- MATLAB (Version 9.7 update 1) for all SARIMA modelling.

- Python 3.7 for Unobserved Components Model analysis (using the UCM procedure in the 'statsmodels' package.

Appendix 3: Controlled interrupted time series – results tables

Table A1: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, by drink category (unadjusted, no control)

Drink category	Original results					Revised results				
	MUP effect (%)		95% CI		p value	MUP effect (%)		95% CI		p value
All	-2.6	-4.1	to	-1.0	0.001	-2.0	-3.6	to	-0.4	0.014
Spirits	-2.4	-5.0	to	0.2	0.067	-2.5	-5.4	to	0.4	0.093
Beer	-0.7	-4.1	to	2.7	0.675	1.0	-2.5	to	4.6	0.570
Wine	-1.3	-2.4	to	-0.1	0.034	-1.2	-2.2	to	-0.2	0.020
Cider	-17.4	-20.1	to	-14.7	<0.001	-15.2	-18.6	to	-11.7	<0.001
Perry	-37.8	-40.4	to	-35.2	<0.001	-39.4	-43.0	to	-35.6	<0.001
Fortified wine	6.7	3.1	to	10.5	<0.001	13.4	6.1	to	21.3	<0.001
RTDs	12.3	3.8	to	21.4	0.004	18.2	7.4	to	30.2	<0.001

Table A2: Change (%) in off-trade alcohol sales in the year after MUP was implemented in England & Wales, by drink category (unadjusted, no control)

Drink category	Original results					Revised results				
	MUP effect (%)		95% CI		p value	MUP effect (%)		95% CI		p value
All	2.3	0.9	to	3.6	0.001	2.4	0.8	to	4.0	0.004
Spirits	3.8	1.5	to	6.2	0.001	3.9	1.0	to	6.8	0.007
Beer	4.9	1.8	to	8.0	0.002	5.1	2.1	to	8.3	<0.001
Wine	-1.8	-3.1	to	-0.5	0.007	-3.1	-8.5	to	2.7	0.288
Cider	11.4	9.5	to	13.4	<0.001	9.3	3.8	to	15.1	<0.001
Perry	5.0	1.2	to	8.9	0.008	6.0	1.1	to	11.1	0.015
Fortified wine	-6.0	-8.2	to	-3.8	<0.001	3.2	-2.3	to	9.0	0.261
RTDs	20.2	13.9	to	26.9	<0.001	21.4	14.0	to	29.2	<0.001

Table A3: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, by drink category (unadjusted, controlled)

Drink category	Original results MUP effect (%)			95% CI	p value	Revised results MUP effect (%)			95% CI	p value
All	-4.2	-5.3	to	-3.0	<0.001	-3.3	-4.4	to	-2.1	<0.001
Spirits	-6.2	-7.5	to	-4.8	<0.001	-5.4	-7.0	to	-3.7	<0.001
Beer	-4.0	-5.6	to	-2.4	<0.001	-2.8	-4.3	to	-1.3	<0.001
Wine	-0.1	-0.8	to	0.6	<0.001	0.2	-0.5	to	0.9	0.494
Cider	-21.9	-23.5	to	-20.3	<0.001	-22.4	-24.6	to	-20.2	<0.001
Perry	-28.1	-30.6	to	-25.4	<0.001	-45.0	-47.1	to	-42.7	<0.001
Fortified wine	4.8	0.4	to	9.3	<0.001	15.2	10.6	to	20.1	<0.001
RTDs	7.5	1.7	to	13.7	<0.001	9.4	3.6	to	15.5	0.001

Table A4: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, by drink category (adjusted, controlled)

Drink category	Original results MUP effect (%)			95% CI	p value	Revised results MUP effect (%)			95% CI	p value
All	-4.2	-5.4	to	-3.0	<0.001	-3.5	-4.9	to	-2.2	<0.001
Spirits	-4.7	-6.7	to	-2.5	<0.001	-6.4	-7.9	to	-4.9	<0.001
Beer	-1.9	-3.6	to	-0.2	0.03	-1.3	-2.9	to	0.3	0.117
Wine	1.3	0.4	to	2.2	0.003	1.2	0.4	to	2.0	0.003
Cider	-18.8	-20.5	to	-17.1	<0.001	-21.8	-24.4	to	-19.1	<0.001
Perry	-28.9	-31.8	to	-25.8	<0.001	-41.9	-44.5	to	-39.3	<0.001
Fortified wine	5.7	1.3	to	10.3	0.01	9.2	2.4	to	16.7	0.009
RTDs	13.4	6.8	to	20.5	<0.001	15.5	10.1	to	21.1	<0.001

Table A5: Change (%) in difference between off-trade alcohol sales in Scotland and England & Wales in the year after MUP was implemented in Scotland, by drink category (unadjusted)

Drink category	Original results					Revised results				
	MUP effect (%)		95% CI		p value	MUP effect (%)		95% CI		p value
All	-4.8	-6.1 to		-3.4	<0.001	-3.6	-4.6 to		-2.7	<0.001
Spirits	-3.3	-4.9 to		-1.8	<0.001	-5.3	-7.1 to		-3.5	<0.001
Beer	-5.1	-6.2 to		-4.0	<0.001	-3.7	-5.1 to		-2.4	<0.001
Wine	1.1	0.5 to		1.6	<0.001	2.1	1.4 to		2.9	<0.001
Cider	-25.1	-26.6 to		-23.6	<0.001	-23.5	-25.1 to		-22.0	<0.001
Perry	-28.9	-31.3 to		-26.3	<0.001	-36.7	-43.1 to		-29.7	<0.001
Fortified wine	-5.2	-15.6 to		6.5	<0.001	10.9	-1.9 to		25.3	0.098
RTDs	3.7	-2.1 to		9.8	<0.001	-1.8	-10.8 to		8.1	0.709

Table A6: Change (%) in difference between off-trade alcohol sales in Scotland and England & Wales in the year after MUP was implemented in Scotland, by drink category (adjusted)

Drink category	Original results					Revised results				
	MUP effect (%)		95% CI		p value	MUP effect (%)		95% CI		p value
All	-4.5	-5.5 to		-3.5	<0.001	-3.4	-4.5 to		-2.2	<0.001
Spirits	-4.2	-5.7 to		-2.7	<0.001	-4.5	-6.7 to		-2.4	<0.001
Beer	-5.2	-6.0 to		-4.5	<0.001	-4.0	-5.6 to		-2.3	<0.001
Wine	-3.0	-3.8 to		-2.2	<0.001	2.2	1.2 to		3.2	<0.001
Cider	-19.6	-21.2 to		-18.0	<0.001	-16.4	-18.6 to		-14.1	<0.001
Perry	-9.7	-12.0 to		-7.2	<0.001	-21.8	-24.9 to		-18.6	<0.001
Fortified wine	-4.6	-6.4 to		-2.8	<0.001	3.9	-6.2 to		15.0	0.462
RTDs	-5.3	-6.0 to		-4.6	<0.001	-9.3	-13.2 to		-5.3	0.023

Table A7: Change (%) in off-trade alcohol sales (all alcohol) in the year after MUP was implemented in Scotland after uplift for Aldi and Lidl

Model	Original results MUP effect (%)		95% CI		p value	Revised results MUP effect (%)		95% CI		p value
Scotland (unadjusted, no control)	-3.3	-5.2 to		-1.5	<0.001	-3.3	-4.9 to		-1.6	<0.001
EW (unadjusted, no control)	2.5	1.1 to		4.0	<0.001	2.6	0.4 to		4.7	0.018
Scotland (adjusted, controlled)	-4.9	-6.1 to		-3.6	<0.001	-4.4	-5.8 to		-3.0	<0.001

Table A8: Change (%) in off-trade alcohol sales (all alcohol) in NE England, NW England and Scotland (with NE England and NW England as control) in the year after MUP was implemented in Scotland.

Model	Original results MUP effect (%)		95% CI		p value	Revised results MUP effect (%)		95% CI		p value
North East (NE) (unadjusted, no control)	2.9	1.3 to		4.6	<0.001	2.5	0.6 to		4.5	0.011
North West (NW) (unadjusted, no control)	1.9	0.0 to		3.9	0.046	1.6	-0.5 to		3.7	0.134
Scotland (adjusted, NE control)	-5.3	-6.6 to		-3.9	<0.001	-6.8	-9.0 to		-4.5	<0.001
Scotland (adjusted, NW control)	-4.4	-5.4 to		-3.3	<0.001	-5.3	-7.4 to		-3.1	<0.001

Table A9: Change (%) in off-trade alcohol sales (all alcohol) in the year after MUP was implemented in Scotland using only 12 month pre-MUP data

Model	Original results				Revised results			
	MUP effect (%)		95% CI	p value	MUP effect (%)		95% CI	p value
Scotland (unadjusted, no control)	3.0	-22.9 to	37.7	0.836	0.1	-39.2 to	64.8	0.998
EW (unadjusted, no control)	6.2	-10.4 to	25.9	0.485	10.7	-32.6 to	81.8	0.685
Scotland (adjusted, controlled)	-5.5	-8.5 to	-2.6	<0.001	-8.4	-62.1 to	122.6	0.844

Table A10: Change (%) in off-trade alcohol sales (all alcohol) in the year after MUP was implemented in Scotland using the Unobserved Components Method (UCM)

Model	Original results				Revised results			
	MUP effect (%)		95% CI	p value	MUP effect (%)		95% CI	p value
Scotland (unadjusted, no control)	-2.5	-4.7 to	-0.4	<0.001	-2.1	-3.7 to	-0.5	0.012
EW (unadjusted, no control)	2.6	0.0 to	5.3	0.05	2.7	1.3 to	4.3	<0.001

Table A11: Change (%) in all alcohol sales (off- and on-trade sales combined) in the year after MUP was implemented in Scotland

	Original results				Revised results			
Model	**MUP effect (%)**		**95% CI**	**p value**	**MUP effect (%)**		**95% CI**	**p value**
Scotland (adjusted, controlled)	-4.4	-5.5 to	-3.2	<0.001	-3.2	-4.2 to	-2.2	<0.001

Table A12: Change (%) in the variability of off-trade alcohol sales in the year after MUP was implemented in Scotland

	Original results				Revised results			
Model	**MUP effect (%)**		**95% CI**	**p value**	**MUP effect (%)**		**95% CI**	**p value**
Scotland (adjusted, no control)	0.1	-0.1 to	0.4	0.278	0.1	-0.1 to	0.2	0.597

Note: RTDs = Ready to Drink drinks; EW = England & Wales. All models are adjusted for underlying seasonal and secular trends.

Controlled models include trends in off-trade alcohol sales in England & Wales as a covariate (NE or NW England in Table A8). Adjusted models include trends in household disposable income, on-trade sales and, for analyses of specific drink categories, off-trade alcohol sales of other drink categories as covariates. For the test of variability (Table A12) residuals from a SARIMA on off-trade alcohol sales in Scotland were squared; an ARIMA model was then run on the squared residuals with MUP as the only covariate.

Appendix 4: Controlled interrupted time series – charts

Note: EW = England & Wales. 'Controlled' models include trends in off-trade alcohol sales in England & Wales as a covariate. 'Adjusted' models include trends in household disposable income, on-trade sales and, for analyses of specific drink categories, off-trade alcohol sales of other drink categories as covariates. All models are adjusted for underlying seasonal and secular trends.

Figure A1: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, total alcohol
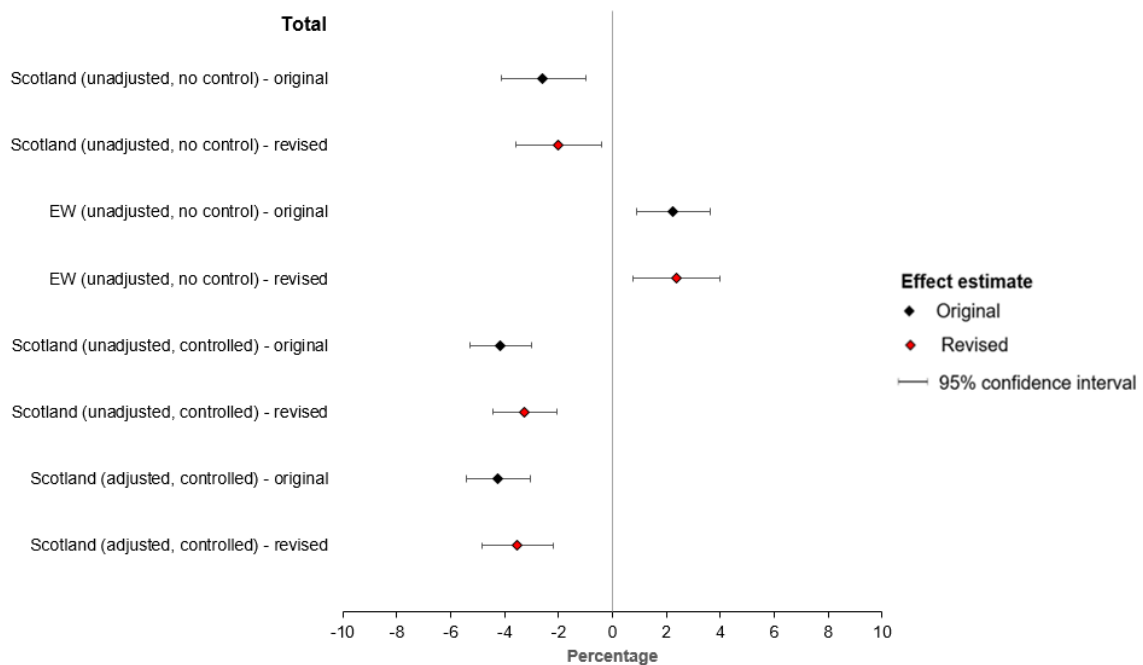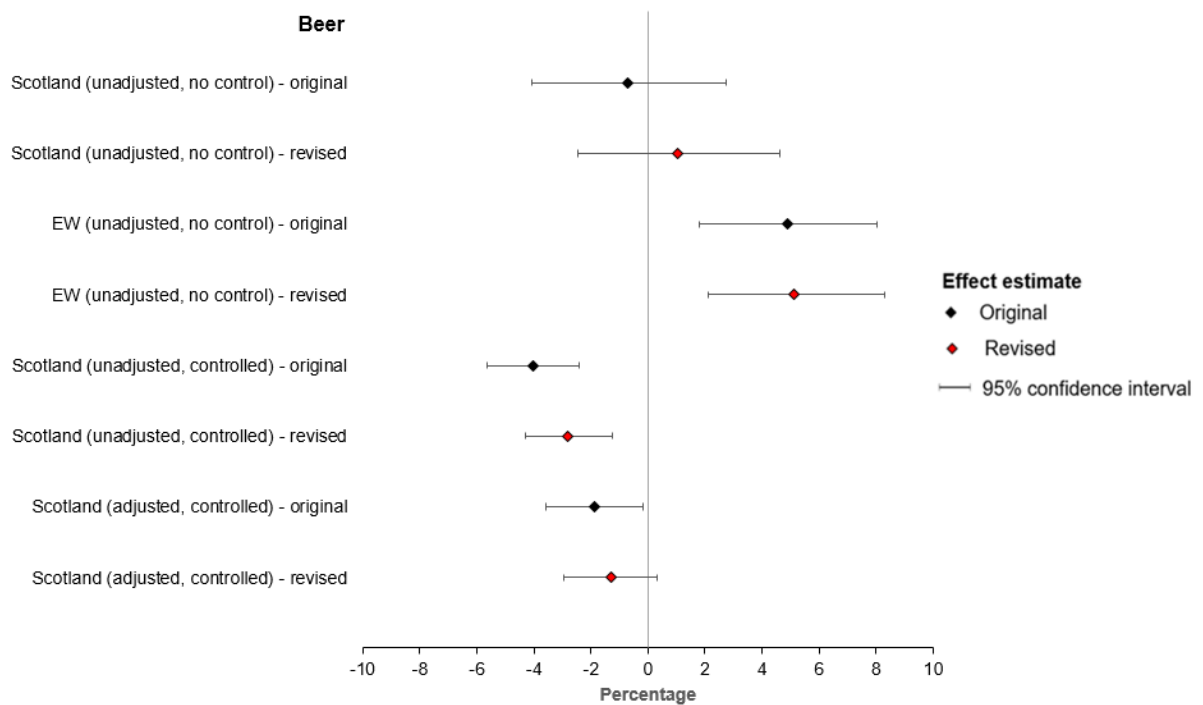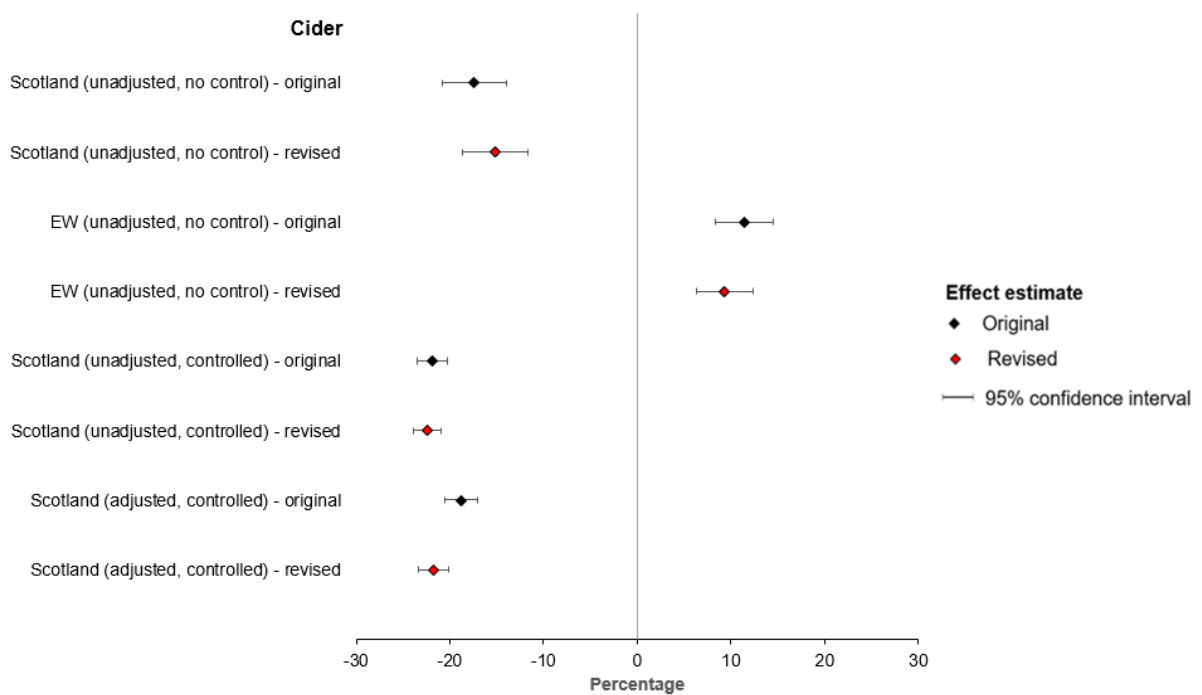
Figure A2: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, spirits
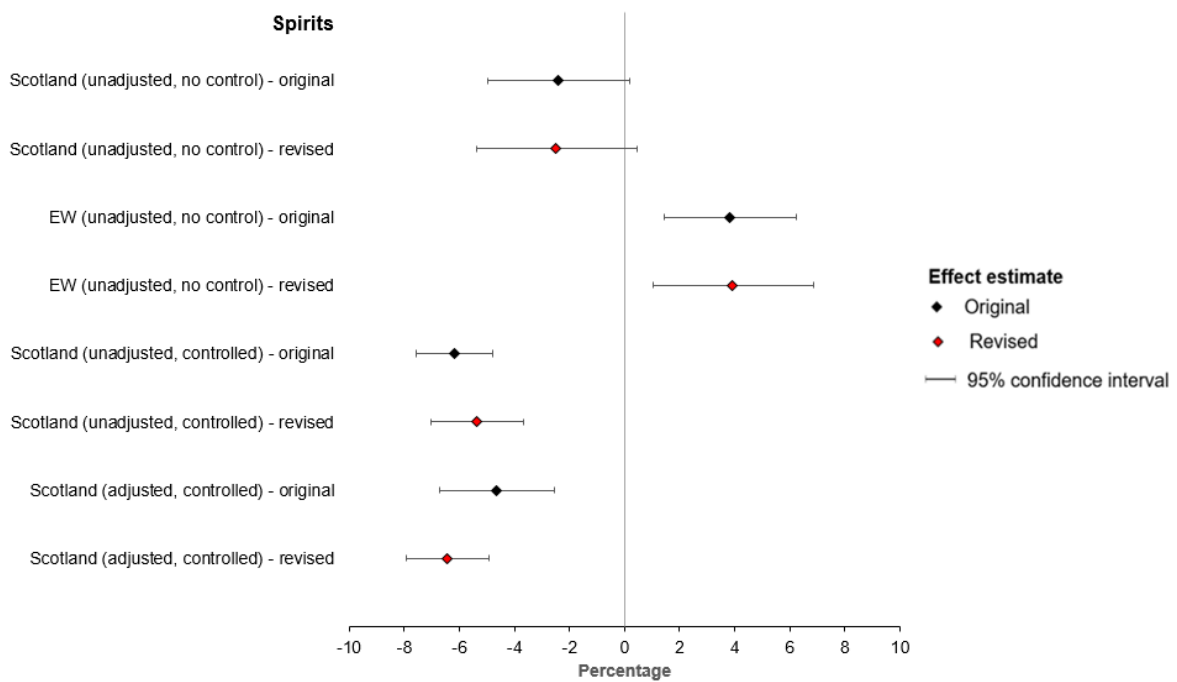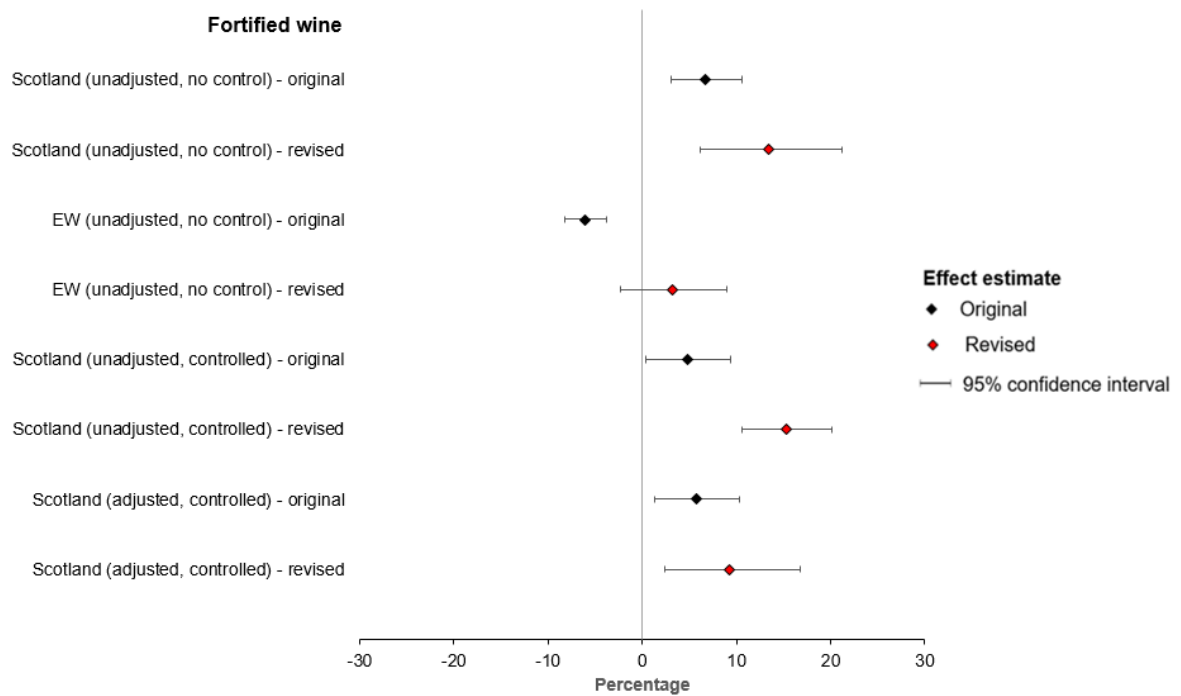

Figure A3: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, wine
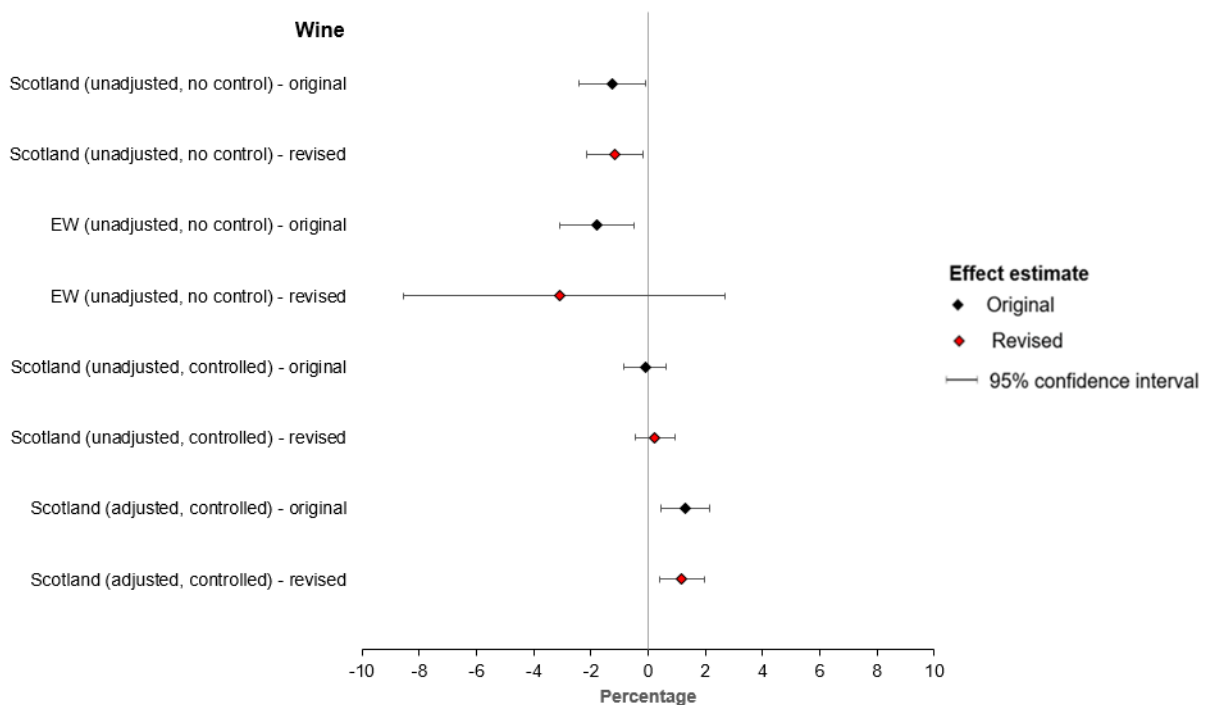
Figure A4: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, beer

Figure A5: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, cider

Figure A6: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, fortified wine

Fortified wine

Figure A7: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, ready-to-drink beverages
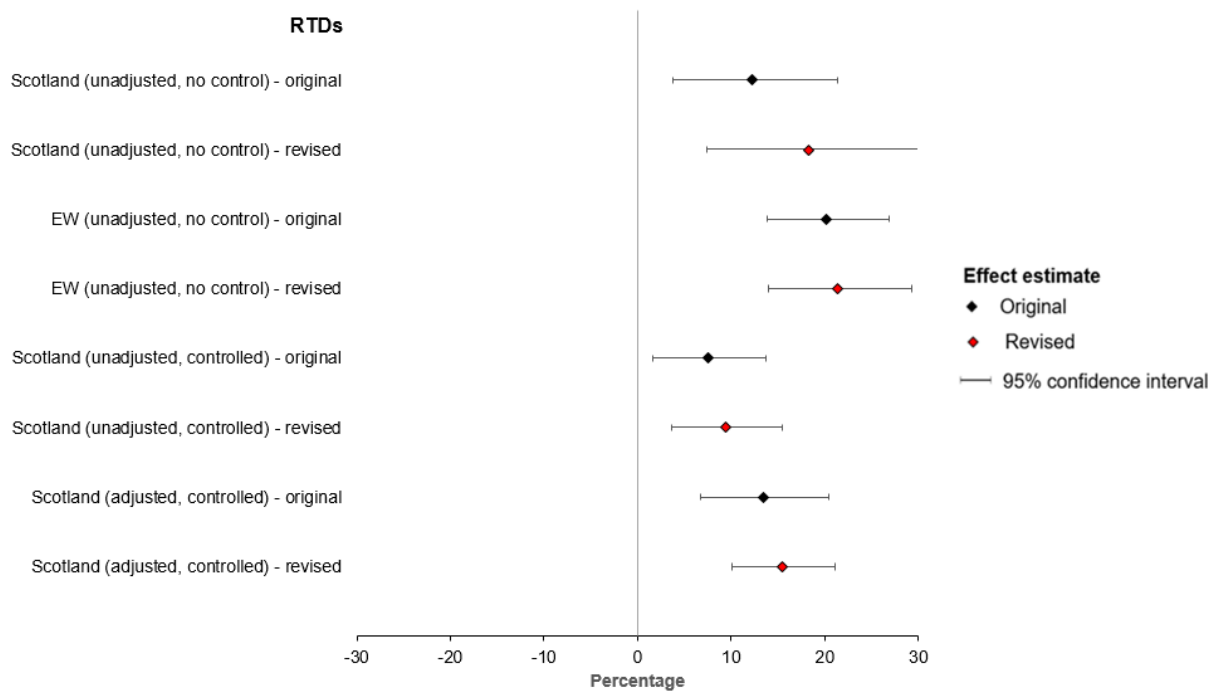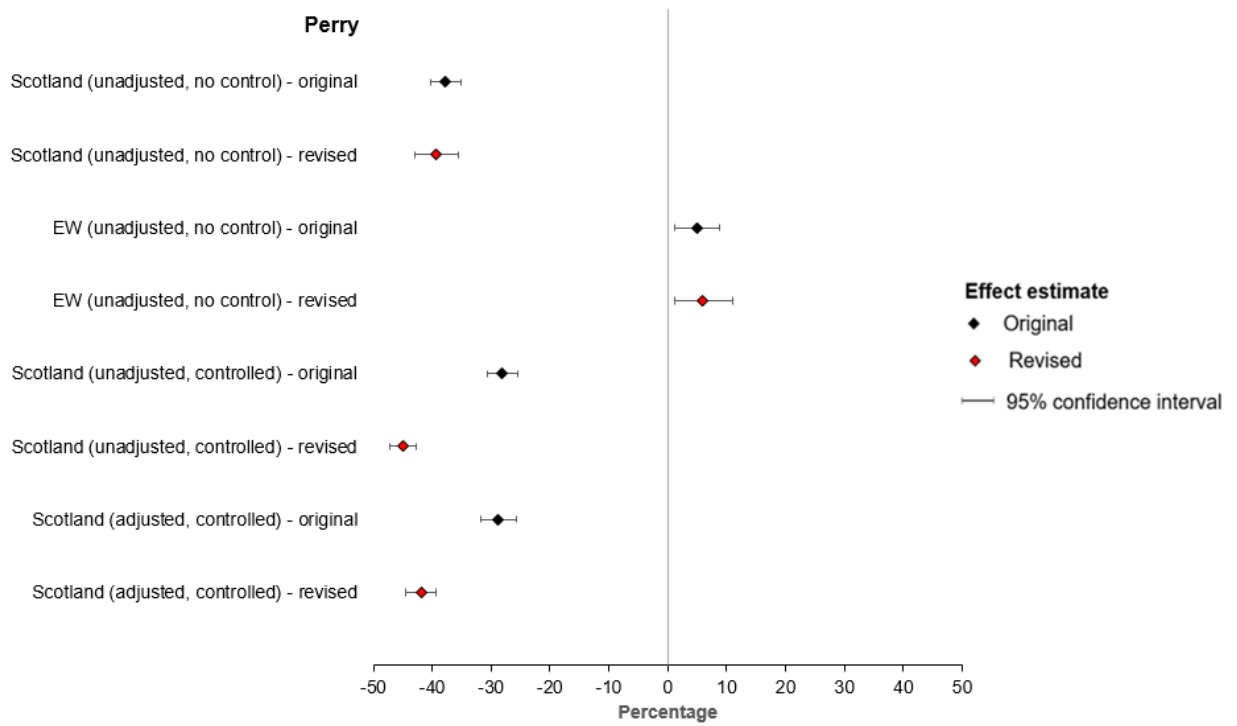
RTDs

Figure A8: Change (%) in off-trade alcohol sales in the year after MUP was implemented in Scotland, comparison of original and revised results, perry

Appendix 5: Alcohol market share of Aldi and Lidl

Nielsen off-trade alcohol sales data do not include data for the discount stores Aldi and Lidl. In order to account for the proportion of alcohol sold within the discount retail sector, adjustment factors have been applied to off-trade sales estimates. Adjustment factors are based on the market share of Aldi and Lidl sales volumes drawn from Kantar Worldpanel consumer panel data, which were provided for Scotland and England & Wales for calendar years 2011 to 2019. Figure A1 shows the Aldi and Lidl market share estimates in Scotland and England & Wales for all alcohol between 2011 and 2019.

Figure A9: Aldi and Lidl market share estimates in Scotland and England & Wales for all alcohol, 2011–2019
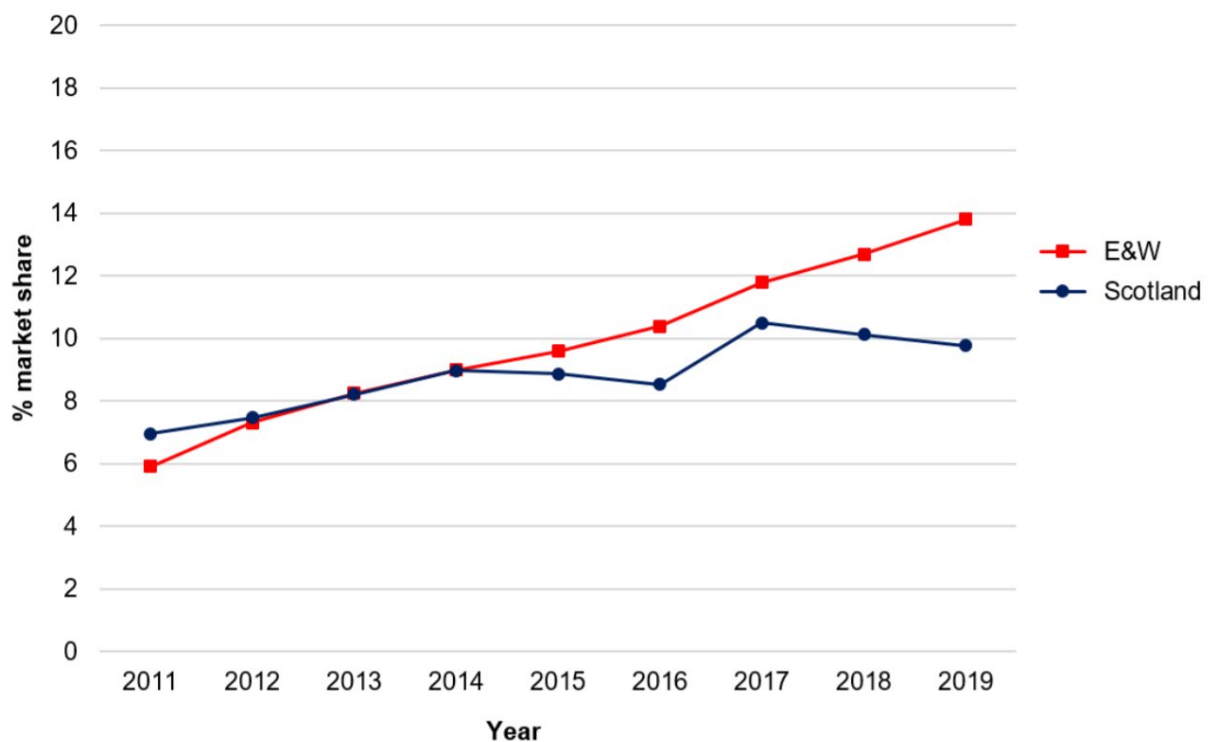
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