Monitoring and Evaluating Scotland's Alcohol Strategy: A review of the validity and reliability of alcohol retail sales data for the purpose of Monitoring and Evaluating Scotland's Alcohol Strategy

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Summary

Introduction

Scotland's relationship with alcohol is well documented and has increasingly become a focus for policy debate. It is important that the resultant policymaking is informed by valid and reliable data on the consumption of alcohol in the population.

This report reviews the validity and reliability of using alcohol retail sales data to estimate population alcohol consumption for the purpose of Monitoring and Evaluating Scotland's Alcohol Strategy (MESAS).

Approach

A brief literature review of the existing knowledge base on the validity and reliability of alcohol retail sales data as an indicator of per capita alcohol consumption was carried out. Potential sources of under- and over-estimation (i.e. bias) of per capita alcohol consumption derived from alcohol retail sales data were identified and, where possible, quantified. This enabled an assessment of the extent to which the different sources of identified biases might impact on alcohol consumption estimates reported as part of MESAS. The methods for deriving the sales estimates and their precision were also described.

Results

Several sources of bias that could potentially impact upon the validity and/or reliability of per adult consumption estimates derived from alcohol retail sales data were identified. The **Summary Table** on the next page details the potential sources of bias in using alcohol retail sales data as a means of estimating population per adult alcohol consumption in Scotland in 2010. The largest potential sources of bias are sources of underestimation due to unrecorded alcohol (1.7L per adult (15+ population)) and wastage/spillage (estimated at <1.2L per adult). These dwarf the potential overestimation due to biases such as tourism and the non-resident student population. The uncertainty in the estimate of per adult sales related to sampling variability (i.e. random error) is estimated at ±0.5L per adult.

Summary Table: Potential sources of bias and uncertainty in using retail sales data to estimate per adult alcohol consumption in Scotland and their estimated magnitude (based on per adult alcohol consumption estimate in 2010).

Sources of bias in estimation of per adult alcohol consumption	Litres per adult (range (±) around the 2010 estimate)		Comments
	Underestimation of consumption	Overestimation of consumption	
Student population	0	≤0.1	Overestimation is likely to be even smaller because there are no data on the numbers of Scottish residents studying internationally or at colleges in England & Wales.
Net effect of visitors coming into Scotland and Scottish residents making trips elsewhere	0.2	0.2	There are no data on the average number of nights spent by Scottish residents on international visits. Underestimation assumes Scottish residents spend an average of 9 nights on international visits; the resultant total estimated consumption is more than that of visitors to Scotland. Overestimation assumes Scottish residents spend an average of 1 night on international visits; the resultant total estimated consumption is less than that of visitors to Scotland.
Stockpiling of alcohol	Unknown	Unknown	Only likely to impact on time trends rather than differences between Scotland and England & Wales. Impact should be apparent on monthly sales data.
Wastage/spillage	0	<1.2	Based on industry estimate of <10%.
Sampling variation	0.5	0.5	
Non-inclusion of some outlets	Unknown	0	
Unrecorded alcohol	1.7	0	Based on estimate from the World Health Organization for UK population aged ≥15 years.
Total of known estimates	1.7 to 2.4	0 to 2.0	
Net estimate	-2.4 (underestimate) to 0.3 (overestimate)		Excludes the impact of stockpiling and alcohol sold through non-included outlets.

Conclusions

In the absence of a true gold standard, alcohol retail sales data offer a robust source of data for estimating per adult alcohol consumption for the purpose of Monitoring and Evaluating Scotland's Alcohol Strategy.

Overall, considering all the possible sources of overestimation and underestimation, and taking into account the potential for sampling variability to impact on the results, the range of uncertainty in 2010 was from an overestimate of 0.3L to an underestimate of 2.4L per adult. This excludes the impacts of alcohol stockpiling (which are likely to be minor and to even out over time) and alcohol sold through non-included outlets (which is likely to be a further source of underestimation which would impact on both Scotland and England & Wales estimates). On balance, there is therefore far greater scope for the retail sales data to be underestimating per adult alcohol consumption than there is for overestimation.

Consideration of sources of bias should be made when assessing trends in per adult alcohol consumption in Scotland, particularly unrecorded alcohol, non-inclusion of certain sales outlets, large-scale sporting or music events and substantial changes to the population denominator due to visitors, students and/or military personnel.

1 Purpose

This report aims to:

1. Briefly review the existing knowledge base on the validity and reliability of alcohol retail sales data as an indicator of per capita alcohol consumption;

2. Explore the potential sources of over- and underestimation of per capita alcohol consumption derived from retail sales data and the extent to which these are likely to impact on the conclusions drawn;

3. Describe how alcohol retail sales data used for Monitoring and Evaluating Scotland's Alcohol Strategy (MESAS) are collected;

4. Report on the overall validity and reliability of alcohol retail sales data as a measure of alcohol consumption in Scotland.

2 Introduction

2.1 Estimating how much a population drinks

Scotland's relationship with alcohol is well documented[1] and has increasingly become a focus for policy debate. It is important that the resultant policymaking is informed by valid and reliable data on the consumption of alcohol in the population.[2]

There are various methods of monitoring alcohol consumption in a population, all of which have potential strengths and weaknesses. It has been suggested that the following measures are required to obtain a full picture of the level of exposure to alcohol in a country[3]:

1. Adult per capita consumption of both recorded and unrecorded alcohol (the latter includes home brews, illicit alcohol and cross-border purchases). This relies upon a combination of retail sales and tax data along with estimates of unrecorded alcohol consumption.
2. The prevalence of abstention from drinking alcohol (including age and sex distribution of abstainers). These data are usually derived from population surveys and can be important when making international comparisons of alcohol consumption. This is particularly important if comparison is being made to countries with high abstinence rates.[4]
3. Volume of alcohol consumption by age (including children and young people), sex and social position to allow estimation of the patterning across the population. These data are derived from population surveys.
4. A method of evaluating the level of harm related to the total amount, type and pattern of drinking.

Harms attributable to alcohol are related to both the quantity of alcohol consumed and the pattern of drinking.[5] Accurate data with which to estimate per capita alcohol consumption are vital to quantify the relationship between alcohol consumption and consequent harms, to design appropriate policy measures to minimise adverse alcohol-related health and social effects, and to evaluate the effects of any policy or other changes upon alcohol consumption.[4,6] Unfortunately, there is no single reliable instrument with which to measure both per capita levels and underlying patterns of consumption. [4,7]

Population level data on alcohol consumption does not provide insights into the underlying patterning of alcohol consumption in the population. However, it is considered the key indicator of alcohol exposure in a population.[4,7] Population level measures of alcohol consumption are more stable than measures of individual consumption because of the variation in individual consumption patterns over time. As such, aggregate measures are more comparable over time[8] and are therefore suitable for monitoring the impact of policy interventions.

As the per capita consumption of a country increases, so does the prevalence of heavy drinkers and the rate of alcohol-related harm.[9,10] Scotland has therefore

adopted a population wide approach to alcohol problems[11] in line with World Health Organization (WHO) recommendations.[10]

Methods to measure alcohol consumption fall into two broad categories:

1. Self-reported measures from surveys which can be used to estimate per capita or per adult consumption as well as indicate the patterns of drinking;
2. Objective measures such as aggregate measures of per capita or per adult consumption from taxation and retail sales data.[7,12]

Each of the available methods has strengths and weaknesses with no single method able to provide sufficient information for all purposes.

2.2 Self-reported measures

Per capita consumption and patterns of drinking can be estimated from survey data and this method has been used to monitor the alcohol intake of populations. However, estimates of per capita consumption from surveys have inherent problems in their validity and reliability.[13] Survey data rely upon self-reported consumption. In common with the use of other harmful products such as tobacco[14,15], self-reported alcohol consumption has been shown to substantially underestimate actual intake.[1] In addition, the increasing disparity between alcohol sales data and Scottish Health Survey (SHeS) consumption data casts further doubt upon the ability of surveys to accurately estimate per capita consumption (in 2010 SHeS estimates accounted for 51% of alcohol sales estimates).[16,17]

There are several possible reasons why population surveys may underestimate total population consumption of alcohol:

1. Selection bias may be introduced in two ways:

    - Sampling bias may occur because some groups are more likely to be missed in surveys than others. For example, those with no fixed address are automatically excluded (recruitment into the Scottish Health Survey is by postal address).[16]
    - Response bias may also lead to under-representation of some groups. It is recognised that the heaviest drinkers are less likely to respond than the general population to surveys of alcohol consumption.[13,18] The decreasing response rates in surveys such as the Scottish Health Survey (SHeS) are likely to exacerbate response bias in the collected data.[19]

Sampling bias should theoretically be possible to minimise.[20] Response bias, in particular the reluctance or inability of certain groups to participate in surveys, may be more difficult to reduce. Simply 'upweighting' the responses of participants in the survey with similar socio-demographic characteristics to those who do not respond does not fully address this problem because non-responders are likely to be systematically different from those who do respond.

2. Recall bias is a problem in survey data since nearly all methods (besides the use of diaries) rely upon retrospective subjective self-reported estimates of drinking. Recall problems may be more likely in those with high levels of alcohol consumption.[21] There may also be a tendency for responders to report more socially acceptable levels of consumption by underestimating drink size and alcohol content and by missing information about periods of heavier drinking.[13]

   The self-reporting of alcohol purchases rather than consumption may be closer to per capita sales figures.[22] Some surveys have managed to find much higher levels of concordance between reported purchases and sales data. For instance, a Swedish study found an 87% concordance between reported purchases and sales at one large outlet.[23] However, this was the only outlet from which the sales data were accrued (given that it is a monopoly trader for the country) and the survey data were specifically related to alcohol bought from this outlet to avoid overestimation of sales data due to imported alcohol. Furthermore, purchasing data will often include purchases for others by non-drinkers, an important caveat if assessing patterns of drinking.[22]

3. Measurement bias can be introduced in several ways. The definition of a standard drink proves difficult in many studies. Off-trade sales of alcohol have increased dramatically over the last few decades and home measures of consumption may vary widely[24,25], particularly with spirits.[26] The size of on-trade measures is also variable with differences, for example, in definitions of a 'small' glass of wine between that used in a research context (125ml) and a pub setting (175ml).[13] Furthermore, the alcohol content of various beverages may vary widely with consumers and researchers alike being unaware of the alcohol content of the drinks being reported.[13]

4. Survey structure may lead to inaccurate estimations of alcohol consumption. Merely administering the same survey with the same instructions will not lead to comparability of results either between countries or within areas over time. Timing of questionnaires, the method of delivery, inclusion or exclusion of periods of heavier drinking including seasonality and consideration of current social norms must all be taken into account.[20, 27-29]

5. Finally, misclassification bias can be introduced if participants are misclassified as non-drinkers or if the types of alcoholic beverage are misclassified by either the respondent or the researcher. Definitions of certain issues such as the 'standard drink', drunkenness and dependence may differ between respondents, between surveys and also potentially between observers.[8] The classification of abstainers may also be problematic when looking at links to alcohol-related harms since the non-drinking category may include ex-heavy drinkers who now abstain for medical reasons.[8]

Thus, although survey methods remain useful for recording patterns of drinking in a population, per capita alcohol consumption estimates from survey data are known to considerably underestimate the alcohol consumption in a population.[1] The WHO therefore recommends that survey data should not be used as a basis for per capita consumption estimates.[4] In the absence of a gold standard, sales

data provide the best indication of the amount of alcohol consumed by a population[7] and the preferred method for estimating per capita alcohol consumption to be used to monitor associations between per capita consumption and alcohol-related harms at the population level.[4]

2.3 Alcohol retail sales data

Alcohol retail sales data are used by MESAS to produce annualised estimates of per adult consumption.[i] The MESAS studies require robust estimates of per adult consumption for Scotland as well as England & Wales for comparative purposes. Her Majesty's Revenue and Customs (HMRC) taxation data are available for the UK as a whole but not for each individual nation. Therefore, retail sales data are used to quantify per adult consumption in each nation in the MESAS reports. Despite expert consensus that alcohol sales are the most reliable method,[4,7] the limitations of the available data should be clearly described to indicate whether the data provide an accurate estimate of per adult alcohol consumption. This is important when monitoring changes in consumption over time and between places so that there can be confidence that any changes are not related to limitations of the data.

There is a need to improve and clarify the validity and reliability of alcohol consumption data, including sales data, in order to inform alcohol policy.[30] In this context validity is the extent to which the data truly measure per adult alcohol consumption in Scotland and, where appropriate, in England & Wales. In the absence of a gold standard method for comparison, this requires consideration and, where possible, quantification of possible biases in the methodology as well as statistical techniques to quantify the precision of the estimates. Reliability refers to the reproducibility or consistency in performance of the data in measuring per adult consumption over time. The rest of this report is therefore concerned with reviewing the validity and reliability of the alcohol retail sales data used in the evaluation of Scotland's alcohol strategy.

[i] Alcohol consumption in Scotland is calculated as litres of pure alcohol per adult (≥16 years).

3 Potential sources of over- and underestimation (bias) when using alcohol retail sales data to estimate per adult alcohol consumption in Scotland

The WHO recommends that methods used to monitor trends within a country are consistent over time and that the extent of any bias does not alter over time.[4] The accuracy of retail sales data is limited by sources of over- or underestimation of the true level of consumption. There are various reasons for this, requiring consideration in two ways:

1. Could the potential limitation of the method lead to important inaccuracies in estimation of per adult consumption in a country at a specific point in time?
2. Could the potential limitation of the data lead to difficulties in comparing per adult consumption over time or between countries?

Each of the areas in **Table 1** has the potential to affect the validity of estimates of current per adult alcohol consumption based on retail sales data and also the reliability of the data if there are changes in the degree of bias over time.

Table 1: Potential sources of bias in per adult estimation of alcohol consumption from retail sales data.

Potential sources of bias leading to overestimation of per adult consumption	Potential sources of bias leading to underestimation of per adult consumption	Potential sources of bias where the direction of effect is unclear
a. Underestimated population denominator due to exclusion of some groups e.g. visitors to Scotland, non-Scottish resident students studying in Scotland and alcohol consumption by those aged <16 years	**f.** Alcohol consumed by Scottish residents when outside Scotland	**l.** Representativeness of the sample frame
b. Personal exports	**g.** Non-inclusion of some alcohol sales outlets	**m.** Non-response bias
c. Alcohol stockpiling	**h.** Personal imports	**n.** Measurement error
d. Wastage and spillage	**i.** Home-brewed alcohol	**o.** Potential inaccuracies in the population estimates used for the denominator when calculating per adult alcohol consumption
e. Alcohol used in food	**j.** Illegal sources (illegal imports, illegal manufacture, undeclared release of alcohol for sale)	
	k. Substitute alcohols (i.e. alcohol not intended for human consumption)	

3.1 Potential sources of bias leading to overestimation of per adult alcohol consumption

3.1.1 Underestimation of the denominator population (a)

Underestimation of the size of the population consuming alcohol may lead to an overestimation of the per adult alcohol consumption in that population. Three possible sources of underestimation of the population consuming alcohol in Scotland are: visitors to Scotland; students of non-Scottish domicile; and children under 16 years old consuming alcohol. Overall, it is not thought that any of these currently affect the validity of the alcohol sales data in estimating per adult alcohol consumption in Scotland because the additional number of individuals in each of these categories makes very little, if any, difference to the estimates. This is explored in more detail in **Sections 3.1.2-3.1.4**. If, however, any of these groups substantially change in size, consideration should be given to whether the validity of the sales estimates of per adult consumption is likely to be affected and the consequent impact on reliability over time.

The proportion of the population that abstains from alcohol use may also affect the interpretation of trends in per adult consumption over time and between countries. Per adult estimates of consumption calculated from sales data take no account of the proportion of the population that abstains completely from alcohol and therefore cannot distinguish changing numbers of abstainers from changing consumption amongst drinkers.[4] However, per adult consumption of alcohol *per se* is not affected by the proportion of abstainers.

Potential inaccuracies in population estimates are beyond the remit of this paper. If there are substantial changes in population estimates following publication of the 2011 census results, the impact on the validity and reliability of the per adult sales calculations will be considered in future reports, and the possibility of re-calculating using adjusted population denominators considered.

3.1.2 Underestimation of the denominator population: visitors coming to Scotland (a)

Visitors to Scotland for business, visiting friends and relatives, or on holiday, may consume alcohol while they are in the country. This may lead to an underestimation of the number of people who are consuming alcohol in Scotland, and a consequent overestimation of the per adult Scottish sales estimates. This is related to the converse situation (the population of Scotland buying and consuming alcohol whilst in other countries) which creates a bias in the opposite direction.

The size of these biases can be estimated by considering the number of visitors to Scotland and the number of trips taken out of Scotland by Scotland's residents. These data come from the International Passenger Survey (IPS) in the Travel Trends publication[31,32] and the United Kingdom Tourist Statistics (UKTS).[33,34]

International visitors

There were 2.36 million visits to Scotland of one or more nights by international residents in 2010 (**Table 2**). This compares to 3.57 million international trips of one or more nights made by Scottish residents. There was therefore an excess of 1.21 million trips of one or more nights made to international destinations by Scottish residents compared to incoming visits of one or more nights by international visitors.[31]

The total number of nights international visitors stayed in Scotland in the same year was 21.34 million, which is on average 9 nights per international visitor. Data for the number of nights spent abroad by Scottish residents are not included in Travel Trends.[31]

Travel to other regions of the UK

2010 data show that residents of England & Wales and Northern Ireland made a total of 6.01 million visits of one or more nights to Scotland (**Table 2**). This compares to 4.65 million visits made by residents of Scotland to England & Wales or Northern Ireland in the same year. There was therefore an excess of 1.36 million incoming visits of one or more nights from people resident in other nations of the UK than there were outgoing trips of one or more nights made by Scottish residents to these regions.[33] The total number of nights that visitors from England & Wales and Northern Ireland stayed in Scotland was 24.15 million compared to 18.03 million nights spent by Scottish residents in England & Wales or Northern Ireland; an excess of 6.12 million nights spent by residents of England & Wales or Northern Ireland in Scotland than nights spent by Scottish residents in these countries.

Balance of incoming and outgoing visits

Table 2 illustrates the net effect of incoming visitors to Scotland and outgoing trips made by Scotland's residents. In total there were 8.37 million visitors staying one night or more in Scotland in 2010 compared to 8.22 million trips of one night or more made by Scottish residents to other nations; an excess of 0.15 million visits of 1 night or more spent in Scotland by international visitors or those from other regions of the UK. This is less than 2009 when equivalent calculations suggest that an excess of 0.92 million trips of one night or more were made into Scotland.[32,34] However, there may be some discontinuity in the IPS data due to methodological differences between 2009 and 2010 (see **Appendix I** for more details). Longer term trends are not analysed here because of methodological differences across the different years. Nonetheless, in both 2009 and 2010, there is a relatively small difference between incoming and outgoing trips in terms of its effect on per adult alcohol consumption estimates (see **Table 3**).[ii]

[ii] The effect of an excess of incoming visitors on per adult estimates in Scotland in 2009 is not shown in **Table 3**. NHS Health Scotland analysis suggests that it is likely to reduce per adult estimates by a maximum 0L-0.2L of pure alcohol, assuming that the average number of nights of Scottish residents while on international trips is between 1 and 9 nights.

Table 2: Incoming visitors to Scotland and outgoing trips made by Scotland's residents, 2009 and 2010.

		2009		2010	
		Visits *(000s)*	**Nights** *(000s)*	**Visits** *(000s)*	**Nights** *(000s)*
Scotland Incoming	English residents visiting Scotland	6,008	26,987	5,538	22,413
	Welsh residents visiting Scotland	192	1,214	196	818
	NI residents visiting Scotland	424	1,286	277	916
	Total domestic to Scotland	6,624	29,487	6,011	24,147
	International tourists visiting Scotland	2,544	21,797	2,358	21,335
	Total Scotland Incoming	**9,168**	**51,284**	**8,369**	**45,482**
Scotland Outgoing	Scottish resident visiting England	4,035	15,118	4,129	16,075
	Scottish resident visiting Wales	155	431	231	638
	Scottish resident visiting NI	206	732	292	1,320
	All non Scotland domestic trips by Scottish residents	4,396	16,281	4,652	18,033
	International trips by Scottish residents	3,854	No data	3,572	No data
	Total Scotland Outgoing	**8,250**	**-**	**8,224**	**-**
Balance	**Excess incoming**	**918**	-	**145**	-

Sources: ONS Travel Trends[31,32]; UK Tourist Statistics.[33,34] Notes: NI, Northern Ireland.

The data are incomplete for the number of nights spent outside Scotland by Scottish residents. **Table 3** shows the estimated effects on per adult consumption estimates if all Scottish trips abroad lasted 1, 7, 9 or 14 nights. If Scottish residents spend an average of 1 night on international visits, per adult consumption in 2010 is overestimated by 0.2L. If, however, an average of 9 nights is assumed, the same average duration spent by international visitors in Scotland, tourism becomes a source of underestimation, with per adult consumption increasing by 0.2L.

It is therefore highly improbable that the incoming visitor population is large enough to account for a significant amount of Scotland's per adult alcohol consumption. For example, in order to reduce the 2010 per adult alcohol consumption estimates for Scotland by 0.5L[iii], the adult population denominator would have to increase by 189,907 people. This is equivalent to a net influx of 69.32 million nights spent in Scotland or an excess of 9.90 million visitors spending one week in Scotland. Furthermore, the sampling frame for the retail sales data does not include duty free or distilleries (see **Section 3.2.2**). Therefore, only alcohol bought by visitors in supermarkets, off licences and on-trade outlets will be included in the retail sales data. It has been assumed that visitors to Scotland consume the same volume of alcohol as Scottish residents. These calculations are likely to overestimate the effect of tourism since Scottish residents consume more alcohol than residents of England & Wales[35] and residents of many other countries.[36]

[iii] This is an arbitrary value used throughout the report to allow the extent of over- and underestimation to be illustrated.

Table 3: Effect of differing length of trips abroad by Scottish residents on per adult alcohol consumption estimates in 2010.

	Assumed number of nights per trip			
	1	7	9	14
International trips by Scottish residents (000s)	3,572	3,572	3,572	3,572
Total number of nights spent in international destinations by Scottish residents (000s)	3,572	25,004	32,148	50,008
Net influx of nights spent in Scotland (000s)	23,877	2,445	-4,699	-22,559
Adjusted Scottish population (000s)[1]	4,376	4,317	4,297	4,249
Adjusted per adult pure alcohol consumption (baseline 11.8L per adult in 2010).	11.7	11.8	11.9	12.0

Sources: ONS Travel Trends[31]; UK Tourist Statistics[33]; NHS Health Scotland analysis of alcohol sales data.[17]
Notes: Adjustments assume all trips are made by adults. Although per adult alcohol consumption in Scotland in 2010 was 11.8L per adult, because of rounding it is 0.2L higher than the per adult estimate calculated using the adjusted population (11.7L). [1]Calculated by converting the net influx of nights into person years.

Equivalent data for England & Wales are shown in **Table 4**. Despite an excess of 24 million outgoing trips in 2010, **Table 5** reveals that this is likely to have a very limited impact on per adult alcohol consumption estimates, irrespective of the average number of nights spent by England & Wales residents while on international visits.

As well as the likely marginal impact of tourism on alcohol consumption estimates, it should be noted that the IPS and UKTS data show wide 95% confidence intervals around their estimates. In addition, the survey methods have changed over time with a particular effect on regional estimates, which include Scotland (see **Appendix I** for more details). These data on visitors are therefore not considered sufficiently robust to judge whether any changes in Scotland's per adult alcohol consumption are a result of incoming or outgoing visitors. Hence, reliable comparisons regarding the impact of tourism cannot be made between Scotland and the other regions of the UK, or over time.

Table 4: Incoming visitors to England & Wales and outgoing trips made by England & Wales' residents 2009 and 2010.

		2009		2010	
		Visits *(000s)*	**Nights** *(000s)*	**Visits** *(000s)*	**Nights** *(000s)*
E&W Incoming	Scottish residents visiting England	4,035	15,118	4,129	16,075
	Scottish residents visiting Wales	155	431	213	638
	NI residents visiting England	700	2,837	874	3,118
	NI residents visiting Wales	59	298	22	112
	Total domestic to E&W	4,949	18,684	5,238	19,943
	International tourists visiting England	25,402	198,558	25,659	197,243
	International tourists visiting Wales	991	6,287	890	6,245
	Total international trips to E&W	26,393	204,845	26,549	203,488
	Total E&W Incoming	31,342	223,529	31,787	223,431
E&W Outgoing	England resident visiting Scotland	6,008	26,987	5,538	22,413
	England resident visiting NI	730	3,187	872	3,554
	Total non E&W domestic trips by English residents	6,738	30,174	6,410	25,967
	Wales resident visiting Scotland	192	1214	196	818
	Wales resident visiting NI	6	6	46	126
	Total non E&W domestic trips by Wales residents	198	1,220	242	944
	England resident visiting countries abroad	50,085	No data	47,157	No data
	Wales resident visiting countries abroad	2,066	No data	1,979	No data
	Total non E&W domestic trips by E&W residents	6,936	31,394	6,652	26,911
	Total international trips by E&W residents	51,251	No data	49,136	No data
	Total E&W Outgoing	58,187	-	55,788	-
Balance	**Excess outgoing trips**	**26,845**	**-**	**24,001**	**-**

Sources: ONS Travel Trends[31,32] UK Tourist Statistics.[33,34] Notes: NI, Northern Ireland. E&W, England & Wales.

Table 5: Effect of differing length of trips abroad by England & Wales residents on per adult alcohol consumption estimates in 2010.

	Assumed number of nights per trip			
	1	**7**	**9**	**14**
International trips by England & Wales residents (000s)	49,136	49,136	49,136	49,136
Total number of nights spent in international destinations by England & Wales' residents (000s)	49,136	343,952	442,224	687,904
Net influx of nights spent in England & Wales (000s)	147,384	-147,432	-245,704	-491,384
Adjusted England & Wales population (000s)[1]	45,330	44,522	44,253	43,580
Adjusted per adult pure alcohol consumption (baseline 9.6L per adult in 2010).	9.6	9.7	9.8	9.9

Sources: ONS Travel Trends[31]; UK Tourist Statistics[33]; NHS Health Scotland analysis of alcohol sales data[17]. Notes: [1]Calculated by converting the net influx of nights into person years. Adjustments assume all trips are made by adults.

3.1.3 Underestimation of the denominator population: students (a)

Students entering or leaving Scotland for the purpose of study may be captured by the International Passenger Survey data. However, they are considered separately here since different data sources exist on student numbers and students are likely to be domiciled for a longer period than tourists and business travellers. Scotland is an importer of students.[37] Data from the academic year 2009/10 show 29,075 students came from other regions of the UK (England, Wales, Northern Ireland, other) to study at Scotland's Higher Education Institutes (HEIs). In the same period, 445 students came from other regions of the UK to study at Scottish colleges. In 2009/10, 41,005 students came from outside the UK to Scottish HEIs and 1,135 to Scottish colleges. Thus, a total of 71,660 students domiciled in other regions of the UK or outwith the UK came to study at Scottish HEIs and colleges in 2009/10.[37]

Numbers on Scottish domiciled students studying outside Scotland are incomplete. Data are not available for the numbers of Scottish domiciled students studying at colleges in other regions of the UK and are not held for the numbers of Scottish domiciled students studying higher education overseas. It is known, however, that in 2009/10, 12,340 students domiciled in Scotland studied in Higher Education Institutes in the rest of the UK.[37]

Students may affect the validity of per adult alcohol consumption estimates through the denominator population used for calculation of per adult consumption. It is also possible that students are high consumers of alcohol when they are resident in the area of their academic institution. However, even assuming that Scotland imported an excess of 59,320 students in 2009/10 (which takes no account of Scottish domiciled students studying outside Scotland at UK colleges or international institutions) and that they were all resident in Scotland for the entirety of the academic terms (three 10-week terms), this would increase the Scottish adult population denominator by only 34,223 (whole time equivalent) residents. Adjusting the denominator by 34,223 people only reduces the 2010 per adult alcohol consumption estimate in Scotland from 11.86 litres of pure alcohol per year to 11.76 litres of pure alcohol per year. Therefore, even using the assumption that there are no students from Scotland studying outside the country, apart from other UK HEIs, the impact of including non-Scottish domiciled students in the denominator is small.

Using the same approach as has been used for visitors to Scotland (**see Section 3.1.2**) for students coming into Scotland to increase the population denominator such that per adult alcohol consumption in Scotland in 2010 was reduced by 0.5L, an excess (i.e. the number of non-domiciled students studying in Scotland less the number of Scottish domiciled studying outside Scotland) of 329,172 non-Scottish resident students staying for 30 weeks per year would be required.

3.1.4 Underestimation of the population denominator: consumption of alcohol by individuals under 16 years old (a)

There is a survey which provides self-reported alcohol consumption by individuals younger than 16 years. The Scottish Schools Adolescent Lifestyle and Substance

Use Survey (SALSUS) gives self-reported estimates of alcohol consumption for 13- and 15-year-old children.[38] Notwithstanding the issues of alcohol consumption estimates from survey data discussed earlier (see **Section 2.2**), this survey provides an estimate of alcohol consumption for this age group. In the 2010 survey, 44% of 13-year-olds reported ever having had a "proper" drink of alcohol (more than just a taste). Of these, 12% reported drinking at least weekly and a further 19% at least monthly. For 15-year-olds, 77% reported ever having a drink of alcohol with 27% of these drinking at least weekly and a further 33% at least monthly.[38] Population estimates in 2010 for 13-15-year-olds were: 59,618 13-year-olds, 59,269 14-year-olds and 60,173 15-year-olds.[39] If it is assumed that 14-year-olds drink half way between the frequency of 13- and 15-year-olds, then the proportion who have ever had a drink of alcohol would be 61% and of these 20% drink at least weekly and 26% at least monthly. To have any significant impact on Scotland's alcohol consumption, it is likely that these children would have to drink at least weekly. Using the assumptions detailed, this gives an additional drinking population of 22,650 to be added to the population denominator. This is not large enough to alter the per adult consumption estimates. Given the relatively small number of drinkers and infrequency of drinking, it has a negligible impact on per adult estimates (in 2010, it would have reduced the per adult estimate of 11.8L by 0.06L). Therefore, consumption of alcohol by those aged 13-15 years in Scotland does not currently affect the validity of the estimates of per adult consumption in Scotland.

3.1.5 Personal exports (b)

Personal exports of alcohol for consumption by non-Scottish residents are a source of overestimation of per adult alcohol consumption. However, it is expected that the overall direction of bias introduced by cross-border purchase, which includes both personal imports and personal exports, is towards an underestimation of per adult alcohol consumption in Scotland. Personal exports are therefore discussed in more detail in **Section 3.2.3**.

3.1.6 Stockpiling of alcohol after purchase (c)

The effect of stockpiling of alcohol on estimates of per adult consumption is thought to be small as this mainly occurs with the most expensive products in the market where less volume of alcohol is sold in Scotland.[4,36] Therefore, it is not expected that the validity of per adult estimates of alcohol consumption in Scotland has an important bias due to stockpiling.

If a change occurred in the volume of alcohol bought but not consumed this should be apparent using monthly alcohol retail sales data, which NHS Health Scotland currently purchase from Nielsen/CGA. Increased stockpiling would be expected to lead to a temporary rise and then fall in sales as people consume what they have stockpiled before returning to a pattern more reflective of typical consumption.

It is possible that an anticipated change in price and/or availability of alcohol may lead to a temporary increase in stockpiling. As described above, this should be apparent in monthly sales data. Thus, the longer term reliability of per adult

alcohol consumption estimates from sales data should not be compromised by stockpiling.

3.1.7 Wastage or spillage (d)

Reported industry estimates are that the proportion of alcohol wasted or spilled is less than 10% of that sold.[12] However, this estimate is not substantiated and the precision of the estimate has not been ascertained. This could mean a large overestimation of alcohol consumption thereby reducing the validity of the estimates of alcohol consumption. A reduction of 10% brings the annual per adult consumption estimates for 2010 down to 10.7L, a fall of 1.2L per adult.[iv]

Wastage and spillage of alcohol occurring in the off-trade before being sold by retailers will not be captured by retail sales data and is therefore not a source of bias. Wastage of alcohol by households in the UK has been estimated at 6% of all purchases.[40] For on-trade estimates, Nielsen/CGA data captures alcohol volumes before purchase and no comparable UK estimate of wastage and spillage is available. A US survey found a 3% wastage of alcohol left after purchase via the on-trade[41] but the lack of any estimate of spillage before actual purchase make this estimate less relevant to on-trade data provided by Nielsen/CGA. However, both support the estimate of less than 10% wastage and spillage.

There is no indication that there would be a difference in the wastage/spillage estimate between Scotland and England & Wales or any obvious reason why the proportion of alcohol wasted or spilled would change over time. It is theoretically possible that wastage may reduce if alcohol was less freely available or was more expensive; however, this would assume that current wastage is easily avoidable.

3.1.8 Alcohol used in food (e)

Some alcohol is used as an ingredient in food. Some cooking processes can reduce the alcohol content (e.g. boiling) and generate a source of overestimation, whilst other cooking processes have no impact (e.g. cold production of a trifle dessert). The volume of alcohol used in food, the proportions of alcohol used in different cooking processes and the reduction in the percentage Alcohol by Volume (ABV) as a result of different cooking processes is unknown. Therefore, the use of alcohol in food is included as a minor unquantifiable overestimation of the volume of pure alcohol consumed per adult in Scotland. The overall effect of this on the validity of the estimates of per adult alcohol consumption is expected to be small and it is unlikely that the reliability would be greatly affected by changes in price (although a price increase may reduce the volume of alcohol used and decrease the already small source of overestimation).

[iv] Although per adult alcohol consumption in Scotland in 2010 was 11.8L per adult, because of rounding it is 1.2L higher than the per adult estimate calculated to take into account wastage/spillage (10.7L).

3.2 Potential sources of bias leading to underestimation of per adult alcohol consumption

3.2.1 Alcohol consumed by Scottish residents while outside Scotland (f)

There are no data available which quantify the amount of alcohol consumed by Scottish residents whilst they are outside Scotland. As discussed above, there is a small net excess of visitors coming into Scotland as compared to Scottish residents visiting other countries. Assuming visitors to Scotland and Scottish residents visiting other areas drink similar quantities, this may create a small overestimation of consumption. However, Scottish residents have a higher per adult alcohol consumption than those of many countries[36], including England & Wales[35] (England & Wales residents account for approximately two thirds of all visitors to Scotland, see **Table 2**). An unknown number of Scottish residents also leave Scotland for holidays of a type where high levels of drinking take place. Although similar holidays are offered in Scotland's major cities for non-Scottish residents, Scotland's comparatively high per adult consumption suggests that Scottish residents may consume more alcohol when visiting other countries than visitors to Scotland consume in Scotland. Thus, this may actually be an unquantifiable underestimation of the per adult alcohol consumption for Scotland.

At present, it is not considered that the validity or reliability of the sales data estimates of per adult alcohol consumption in Scotland will be affected by tourism unless the balance of visitors to Scotland and trips taken outside Scotland by residents of Scotland changes considerably.

3.2.2 Non-inclusion of some sales outlets (g)

There are some alcohol sales not included in the data source used to inform the MESAS studies (see **Section 3.3.1** for a detailed description of Nielsen/CGA data collection methods). Nielsen/CGA data exclude a variety of sources, including: certain internet sites; mail order; off-trade sales on military bases; sales at whisky distilleries; certain music/entertainment festivals; duty free sales; and sales direct to the consumer via 'cash and carry' outlets. Assessment of the validity and reliability of retail sales data as an indicator of alcohol consumption must include consideration of the amount of alcohol these sampling limitations exclude.

Off-sales data for outlets selling to the Ministry of Defence, including NAAFI (Navy, Army and Air Force Initiatives) data, are not included in the Nielsen/CGA sales data. This could potentially lead to an underestimation of the amount of alcohol sold in a region. However, the number of military personnel located in Scotland was 12,190 in July 2010[42]; only 0.3% of the estimated Scottish adult population (aged ≥16 years) (note that this is where Scotland is listed as the permanent location and some of these may be on tour in other regions). It is therefore unlikely that sales at these outlets would be high enough to significantly increase the Scottish per adult alcohol consumption estimates, particularly since much of the alcohol sales to this group will occur through outlets included in the sampling frame. Thus, sales at military bases are not expected to affect the validity or reliability of estimates of per adult alcohol consumption derived from retail sales data unless the numbers of military personnel located in Scotland

dramatically increases. If numbers of military personnel were to increase, consideration should be given to the impact on the bias in sales data estimates of alcohol consumption introduced by non-inclusion of these sales.

Alcohol purchased at music festivals in Scotland is not included in retail sales data and is therefore an unquantified source of underestimation of per adult alcohol consumption in Scotland. The CGA data do not include the volume sold at temporary venues such as festivals or outdoor concerts though does include data from venues such as concert halls and sports stadia. Nonetheless, festivals also occur in other regions so should also be a source of underestimation in countries used in comparison with Scotland. Alcohol bought in the off-trade before entering a festival for consumption at the festival will be captured in Nielsen/CGA's alcohol retail sales data.

Approximate numbers of attendees at Scotland's five biggest music festivals were considered to determine the effect that this might have upon per adult alcohol sales estimates (**Table 6**). If every attendee was over the age of 16 years[v] then to raise Scotland's per adult alcohol consumption estimate in 2010 by 0.5L every attendee would need to consume 4.2 litres of pure alcohol per day of attendance. This equates to 423 units of alcohol or 149 pints of 5% ABV beer per person per day of festival attendance (in addition to any alcohol purchased before entry to the festival). Thus, this is highly unlikely to be a source of bias that would have a large impact on the validity of the sales data estimates of per adult alcohol consumption in Scotland.

Table 6: Estimated attendance at Scotland's five biggest music festivals, 2010.

Festival	Days	Tickets	Maximum person days[1]
T in the park	3	85,000	255,000
Rockness	3	30,000	90,000
Rewind	3	20,000	60,000
Belladrum	3	16,500	49,500
Wickerman	3	15,000	45,000
Be in Belhaven	1	10,000	10,000
Total	**16**	**176,500**	**509,500**

Source: Personal communication.[43] Notes: [1]Assuming all ticket holders attended the entire duration of the festival. Attendees of Scottish music festivals who come from outside Scotland may potentially affect the population denominator used for the estimates of per adult alcohol consumption. However, if staying overnight these visitors should be picked up on tourism data and are therefore not recounted here.

[v] Be in Belhaven is specifically aimed at children in the earlier part of the day whilst Wickerman and Belladrum are 'family friendly'. However, it is likely that the majority of attendees of these festivals will be aged 16 and over.

The same issues apply to temporary sporting events. Large scale events such as the Ryder Cup in 2014 will increase visitor numbers to Scotland, as well as the volume of alcohol sold to Scottish residents through outlets not included in the Nielsen/CGA sampling frame. Such events need to be considered individually in order to assess their potential impact on the reliability of the estimates over time should the numbers of attendees be sufficiently large.

Nielsen data do not include sales by mail order and internet operators, such as Direct Wine, Ocado and Tesco Wine Club. Supermarket online sales are captured where they are part of online grocery shopping, as these orders are packed and scanned at a local store. The degree of underestimation of per adult alcohol consumption in Scotland through mail order and internet operators is currently unquantified and could be important. It is possible that sales through this route could be sensitive to an increase in price or a decrease in availability of alcohol in Scotland, particularly if the operator is based outside Scotland. A potential means to explore this further would be via the use of other market research data that stipulates the location of alcohol purchases.

3.2.3 Unrecorded alcohol (b, h, i, j, k)

The WHO describes unrecorded alcohol as:

> *" …alcohol that is not taxed and is outside the usual system of governmental control, because it is produced, distributed and sold outside formal channels. Unrecorded alcohol consumption in a country includes consumption of homemade or informally produced alcohol (legal or illegal), smuggled alcohol, alcohol intended for industrial or medical uses, alcohol obtained through cross-border shopping (which is recorded in a different jurisdiction), as well as consumption of alcohol by tourists."*[36(p5)]

An inevitable limitation of sales data, and indeed any other method of estimating per adult alcohol consumption, is the lack of data on unrecorded alcohol.[7] This will lead to underestimation of per adult alcohol consumption in Scotland and other regions, the extent and variability of which is not known. While most of the alcohol consumed in Scotland will be legally produced and sold, and therefore picked up by HMRC duty clearances and retail sales data, there is an unknown quantity that will not be included in either. The overall extent and consequent effect of these possible inaccuracies is not quantified. However, the unrecorded nature of these sources of alcohol means that no method exists to reliably quantify the volume of per adult alcohol consumption from them.

Estimates of the extent of unrecorded alcohol consumption generally rely upon expert judgements and therefore may be subject to considerable error.[44] Using such methods, the WHO estimates that UK unrecorded alcohol consumption is around 1.7 litres per capita (for the population aged 15+ years).[36] It is not known how valid this estimate is. Estimates for the period 1995-2001 were fairly consistent at 2 litres per capita (for the population aged 15+ years) per annum.[45] Also, it is not known if Scotland shows a different pattern of consumption of unrecorded alcohol to the rest of the UK.

WHO global level data suggest that increasing levels of unrecorded alcohol consumption are associated with increasing recorded alcohol consumption, but the percentage share of alcohol consumed from unrecorded sources decreases as the total amount of alcohol consumed increases.[36] If Scotland follows this pattern, the proportion of alcohol consumed from unrecorded sources will be low relative to the volume of alcohol consumed from recorded sources. However, there may still be a significant volume of alcohol consumed from unrecorded sources and there are some areas, such as Eastern Europe, where both total volumes of alcohol consumed and volumes of alcohol from unrecorded sources are a significant problem.[36]

It is known that cross-border alcohol purchasing and smuggling occur, that illegal alcohol is produced and that some people produce their own alcohol, legally, at home.[36] Therefore, even though the exact quantities may be unknown, the presence of unrecorded alcohol is a source of underestimation of the true per adult consumption of alcohol in Scotland.

Cross-border purchase

Cross-border purchase is used here to refer to alcohol that has been produced legally in a different jurisdiction and then legally imported into the country where it is consumed. This may be through cross-border travel or by internet or mail order shopping.

Research from Europe shows that considerable inaccuracies in per capita estimates of alcohol consumption in some regions occur due to the cross-border purchase of alcoholic beverages. Estimates of the proportion of per capita consumption that was unrecorded in Sweden, following specific changes to travel allowances and consequently to unrecorded imports, ranged up to 30%.[3]

There are no restrictions on the amount of alcohol that can be brought into the UK by travellers from EU regions for personal use.[46] Allowances for other regions including the US are considerably smaller.[47] Imports of alcohol are a source of underestimation of per adult alcohol consumption. In the UK, the HMRC estimates “tax gaps” (unpaid duty and VAT) for spirits and beer; the latter being a new methodology still under development. These figures are for the whole of the UK and the central estimates listed should be used to consider trends over the longer term rather than precise year-on-year differences.[48] No confidence intervals are given with the central estimates of UK market shares for spirits and only upper bounds are given for beer (**Table 7**). The British Beer & Pub Association (BBPA) also estimates personal imports as a percentage of UK consumption. Their estimates were lower than the HMRC estimates but are based on different estimates of overall consumption and exclude estimates of large scale smuggling.[49] The HMRC does not publish equivalent data for wine. From these estimates, the extent of such imports seems highly unlikely to be as high in Scotland as in Sweden. The Swedish example does, however, highlight the importance of considering such possibilities.

Table 7: Market share of cross-border purchases of spirits and beer in the UK, 2004/05 to 2008/09.

	Year				
	2004/05	2005/06	2006/07	2007/08	2008/09
Spirits[1] (%)	5	5	4	3	3
Beer[2] (%)	1	0	0	0	0

Source: HMRC.[48] Notes: [1]Spirits estimates are central estimates. [2]Beer estimates are upper estimates of the 95% confidence interval. Figures are independently rounded to nearest 1%.

Alcohol may be exported from Scotland by visitors to the country or by residents of Scotland. Exports by residents of Scotland may be for personal consumption, in which case they are appropriately retained in the estimates of per adult alcohol consumption, or consumed by others indicating a source of overestimation of consumption. Personal exports of alcohol are therefore an unmeasured source of overestimation in the per adult alcohol consumption. Personal allowances for alcohol vary depending on the country it is being taken to, but it is not possible to accurately quantify the degree of overestimation resultant from personal exports. However, given that it is only those personal exports which are for consumption by non-Scottish residents (i.e. not for personal consumption), the overall impact is likely to be negligible. It would require 3 bottles of whisky to be taken on each of the 3.6 million trips taken abroad by Scottish residents (see **Table 2**), for consumption by other people outside Scotland, to overestimate per adult sales estimates in 2010 by 0.5L. Alternatively, international visitors would have to return to their resident country with 3 bottles of whisky purchased on each of their 2.4 million visits to Scotland.

Changes in the price or availability of alcohol in Scotland may affect personal exports. For example, an increase in price or reduction in availability of alcohol in Scotland may reduce the volume of alcohol purchased for personal export (e.g. as gifts while travelling abroad to meet relatives). Likewise, should the price of alcohol increase or the availability of alcohol decrease in other regions, visitors to Scotland may export more from Scotland into the region with higher price or less availability. Therefore the reliability of the estimates of per adult alcohol consumption in Scotland may be affected should there be a change in the price of alcohol and/or a change in the availability of alcohol in Scotland or elsewhere, but given their current magnitude, this is not likely to be an important source of bias.

Home-brewed alcohol

Formal quantification of the amount of home-brewed alcohol in Scotland or the UK is not available. Studies elsewhere which have attempted to quantify home brewing of alcohol have proven difficult to undertake with any degree of accuracy.[50]

Illegal sources of alcoholic beverages (illegal imports, illegal manufacture, undeclared release of alcohol for sale)

Illegal sources of alcoholic beverages are a potential source of underestimation of per adult consumption. HMRC seizures of illegal alcohol have been reported in news bulletins.[51] The HMRC report that over the last year their "staff have also detained in excess of 1 million litres of alcohol at several premises around the UK".[52] It is highly unlikely that counterfeit alcohol will be included in retail alcohol sales data provided by Nielsen/CGA. First, most alcohol sold off-trade is accounted for by large multiple retailers who would be least likely to sell illegal alcohol. Second, it can be assumed that independent off-trade outlets that do sell illegal alcohol would either (a) be unwilling to participate in market research and/or (b) be unable or unlikely to electronically scan the illegal product at point of sale. Third, CGA estimate on-trade sales using data on the volume of different brands sold by, and/or delivered to, a large number of on-trade outlets (see **Section 3.3.1**). These data are sourced from large reputable pub groups and on-trade suppliers and so would be very unlikely to capture any illegal alcohol sold by individual on-trade outlets. Thus, it is not known how much illegal alcohol is sold in Scotland. Recent estimates from the HMRC suggest that the illicit market in spirits is in the region of 3% of the spirits consumed in the UK and an upper bound of 10-14% for beer (**Table 8**).[48] There are no equivalent data published for wine.

Table 8: Market share of illicit spirits and beer in the UK, 2004/05 to 2009/10.

	Year				
	2005/06	**2006/07**	**2007/08**	**2008/09**	**2009/10[3]**
Spirits[1] (%)	6 (0-11)	9 (3-14)	8 (2-14)	2 (0-8)	3 (0-11)
Beer[2] (%)	8	13	12	10	14

Source: HMRC.[48] Notes: [1]Spirits estimates are central estimates; 95% confidence intervals are in brackets. [2]Beer estimates are upper estimates of the 95% confidence interval. [3]2009/10 estimates are provisional only. Central estimates are best used to give an indication of the trend over the longer term rather than a precise estimate of year on year differences. Negative numbers have been truncated at zero.

Substitute alcohols (alcohol not intended for human consumption)

In addition to a lack of data about the pattern of consumption of alcohol, sales data also miss information about the quality of the alcohol consumed and this is of particular note with unrecorded sources of alcohol, especially substitute alcohols.[53]

The use of substitute alcohol is not formally captured by any robust data source. This is therefore another unquantified potential source of underestimation of per adult alcohol consumption. There is also a dearth of systematic research on the health impacts of substitute alcohol. Whilst the quantity of consumption of substitute alcohol is small in scale compared to the consumption and subsequent harms of legal alcohol, it is increasingly recognised that the harms of these

substances can contribute to the harms caused by alcohol consumption.[54] The evidence base for the harms caused by these alcohol sources is, however, less developed than that of legally produced alcohols intended for human consumption.[44]

A cross-sectional survey of 377 patients with "serious alcohol problems" was conducted in Edinburgh in 2008/09 and enquired about the most recent week of drinking.[55] Only one patient reported consuming very small amounts of substitute alcohol in the form of perfume and none reported illicit purchase or consumption of illicitly produced alcohol. This suggests that substitute alcohol use is unlikely to be a source of bias in the per adult estimates.

Impact of unrecorded alcohol on the validity and reliability of alcohol sales data estimates of per adult alcohol consumption

It is expected that unrecorded alcohol including cross-border purchase, home brew, illegal alcohol and substitute alcohol accounts for a large underestimation of per adult alcohol consumption in Scotland. Updates to the WHO estimates of unrecorded alcohol may be a means to consider the reliability of the estimates over time but the precision of the WHO estimates is not known.

Unrecorded alcohol use could be altered by changes in attitudes and social norms or by changes in the availability of support services. Increased price or decreased alcohol availability could also make unrecorded alcohol more attractive to some drinkers.

3.3 Sources of possible bias where the direction of effect is unclear

3.3.1 Representativeness of the sample frame (I)

As explained in **Section 3.2.2**, retail sales data provided by Nielsen/CGA do not capture certain alcohol sales in GB. Nonetheless, the sampling methods described in the following sections ensure a representative estimate of alcohol sold through the on- and off-trade *premises* in Scotland and England & Wales.

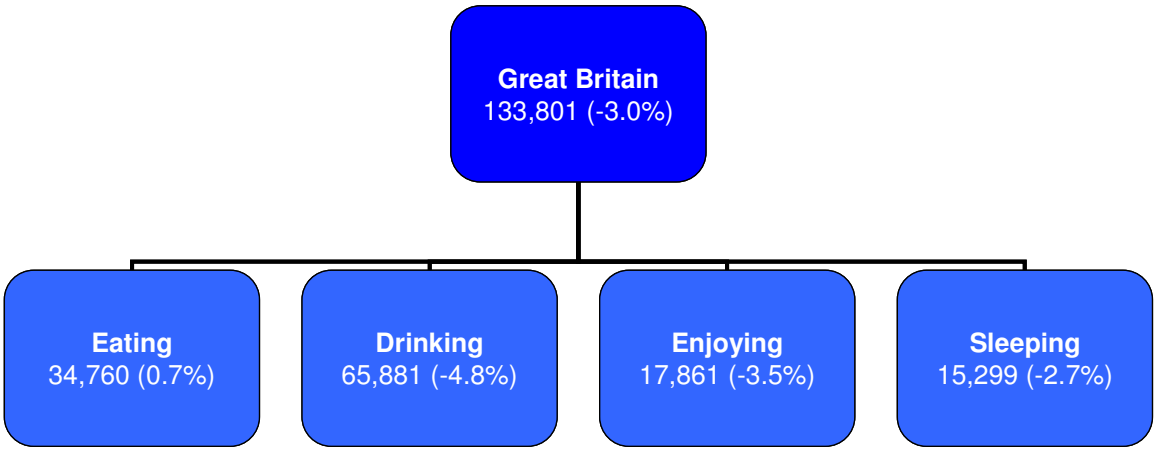
Method used to estimate on-trade alcohol sales

On-trade universe

CGA maintain a database of all licensed on-trade premises in GB, referred to as the **outlet index universe** (**Figure 1**). In 2010, there were c.134,000 outlets. The outlet index universe is maintained by a full-time production team using desk, field and phone research to keep abreast of openings, closures, refurbishments, changes of ownership, trading patterns, and changes of stocking profiles with respect to drink brands. At its most basic level, each outlet index record comprises: full name and address information; ownership details; management tenure information; outlet type (e.g. Irish-theme bar, hotel, Italian restaurant). Multiple data sources are used to keep the database up to date, including: retailer estate lists; retailer Electronic Point of Sale (EPoS) data; brewer/supplier account

listings; technical services data; wholesaler delivery data; account data from other supply companies such as utility companies; CGA desk research teams; and other data sources (e.g. Royal Mail). Where a full classification of the outlet is not available from the data source, CGA's research team work to complete and verify the available information. Every year, details for approximately 85% of the total universe (and 95% of all pubs in the universe) are obtained and, if necessary, refreshed.

Figure 1: Size and structure of CGA's Outlet Index Universe, Great Britain 2010.



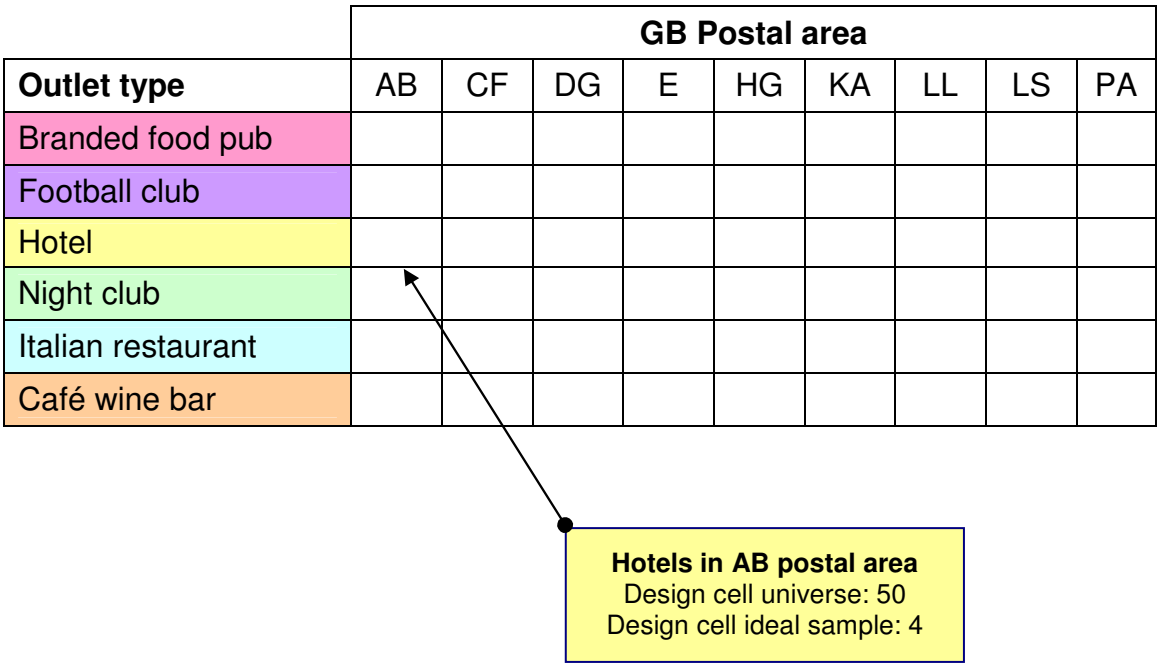
Source: CGA Strategy. Notes: Chart shows selected breakdowns only. Percentages in brackets indicate change in number of outlets between March 2009 and March 2010. '**Eating**' includes restaurants, food-led pubs (pubs with a significant food trade (approximately 40% and above)) and transport (motorway services). '**Drinking**' includes wet-led pubs, circuit bars [bars located in a town/city high street location and/or a geographical link where customers use a particular route (or circuit) when on a night out. It is also refers to outlets which are more likely to be mainstream/younger demographic orientated with a likely later (weekend) terminal hour and/or entertainment offers such as DJs. Drinks offers are also likely to be orientated more towards mainstream lagers and ciders along with spirits/mixers and cocktails], student bars and social clubs. '**Enjoying**' includes bingos, casinos, cinemas, conference suites, nightclubs, sports clubs and country clubs. '**Sleeping**' includes hotels, B&Bs, guest houses and holiday parks.

Outlet sampling

On-trade sales estimates provided by CGA are based on a stratified random sample of approximately 5,600 outlets[vi], derived from the outlet index universe. Stratification means grouping together outlets that are likely to do business in a similar way. CGA stratifies the on-trade universe into 109 outlet types, which are further stratified by GB postal area, thereby creating a total of over 8,000 **design cells**. Each design cell is randomly sampled and processed separately (**Figure 2**).

[vi] Figure based on sample in 2011.

Figure 2: Simplified version of the CGA sampling design cell structure (figures presented are arbitrary).



Data collection

Brand data

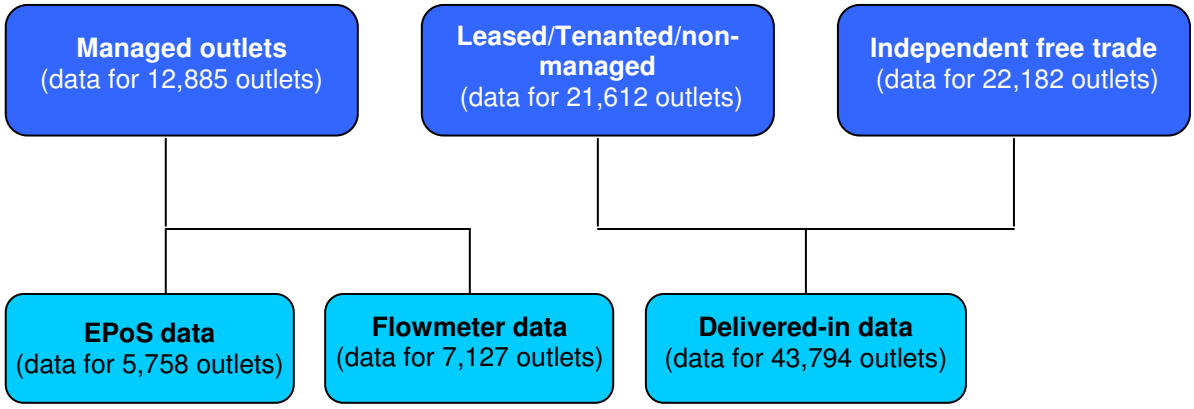
Sample outlets are visited in person and/or through telephone research every 3 months by a dedicated full time production team. A detailed interview with the outlet publican is conducted to collect data on what brands of products are stocked. The sample outlets are therefore referred to as the **brand index sample**. Specific information collected from the brand index sample includes: brands stocked in the bar, in the fridge and on the back bar (a set of shelves of bottles behind the counter); price at which brands are sold; and visibility of brands.

Volume data

In addition to the data collected on brands stocked by outlets in the brand index sample, CGA also has access to data on the volume of different brands sold by, and/or delivered to, a further c.57,000 outlets. This is known as the **volume pool**. Volume pool data are supplied by CGA's partners, who provide daily or weekly data at least once a month, and represent the three major categories of on-trade outlet types: independent free trade outlets (n=22,182); leased/tenanted/non-managed outlets (n=21,612); and managed outlets (n=12,885)(**Figure 3**). The data, sourced from major multiple groups and suppliers, are based on a combination of: Electronic Point of Sale (EPoS) till data from 5,758 large managed outlets such as Mitchells and Butlers, Fullers, Enterprise etc; flowmeter data for 7,127 managed outlets relating to the volume of draught beer dispensed; and 'delivered-in' data held at brand level for 43,794 leased/tenanted/non-managed outlets and independent free-trade outlets, sourced from a variety of

wholesale sources including the two biggest GB distribution companies. An overview of the volume pool is depicted in **Figure 3**.

Figure 3: An overview of CGA's volume pool, 2010.



Source: CGA Strategy. Notes: **Free-trade outlets** are independently owned outlets or small regional groups, where the owner is often the licensee, and which have the freedom to make all their own purchasing decisions. This can relate to various channels including clubs, pubs and restaurants, etc. **Leased/tenanted/non-managed outlets** are primarily businesses where the licensee rents the building from the property owner. In many cases these are pub companies or brewers. The licensee is the business owner in most cases although in some cases the pub may be run by a manager where they are employed by the individual or company that rent the pub from a landlord. **Managed outlets** are operated by a company (e.g. JD Wetherspoon) and the licensee of the pub is a manager and an employee of that company. The company retains all profits from the business and pays the manager a salary. The company mostly decides the price and range of products stocked.

Statistical expansion of sample to universe

Data from the volume pool are profiled against the Outlet Index Universe, enabling the average volume sales of a brand in each design cell (i.e. outlet type and postal area) to be determined. These data are then applied to sample outlets in each postal area that stock the given brand. Each sample outlet is given an individual weighting to represent outlets of a similar type in its postal area. Thus, the sample structure is outlet-weighted as opposed to volume-weighted, thereby ensuring reliable unbiased performance measurement in any drink category. This process enables representative estimates of on-trade alcohol sales at brand and category level for different outlet types at different geographies to be determined.

Maintenance of the Brand Index Sample

The CGA brand index sample has an approximately 6% year-on-year turnover due to closures, openings, and non-response. It is crucial that there is a balance between (1) maintaining a consistent sample and (2) reflecting changes in the outlet index universe without causing issues in the data due to sample variance. CGA therefore adopt a combination of methods to maintain a representative sample. In brief, if a sample outlet refuses to participate, or if the outlet has closed down, CGA's automated system ensures that the sample remains representative. It does so by checking if a like-for-like replacement is appropriate or, alternatively, whether the outlet profile of the design cell has changed substantially enough to

warrant a change in the replacement outlet type. This is tracked through the continuously maintained outlet index universe.

Method used to estimate off-trade alcohol sales

Off-trade universe

Nielsen maintains a database of all licensed off-trade premises in GB, referred to as the **off-trade universe**. In 2010, there were c.44,000 outlets (**Figure 4**). To obtain a detailed knowledge of outlets in the universe, information is collected on outlets' names and addresses, outlet size, indication of turnover and sales area, and information about fascia and category of store.[vii] This information is obtained from a variety of sources including tape data (data direct from retailer), trade information, store visits, UK retail reports, company reports, and the internet. Tape data and trade information are the preferred sources.

Sampling and data collection

Off-trade alcohol sales estimates are obtained using weekly store-census data from most large multiple retailers (n=8,096) and several smaller retailer groups (n=669). These data represent an estimated three-quarters of all alcohol sold through the off-trade (The Nielsen Company 2011, personal communication). For 'impulse' outlets (independent outlets and most of the smaller multiple retailers), weekly data are provided by a stratified random sample of outlets in a similar way to that described above for CGA's on-trade. The data comprise scanned readings at EPoS of the type and volume of each item sold, and a net retail price, which takes discounts and special offers into account.

Off-trade stratification into design cells is by outlet type (as shown in **Figure 4**) and TV region.[viii] Sample sizes are determined by a number of factors, including universe size and the degree of variation between outlets in the same design cell, and are designed to give a maximum national standard error of 2.5% at the 95% confidence interval level.

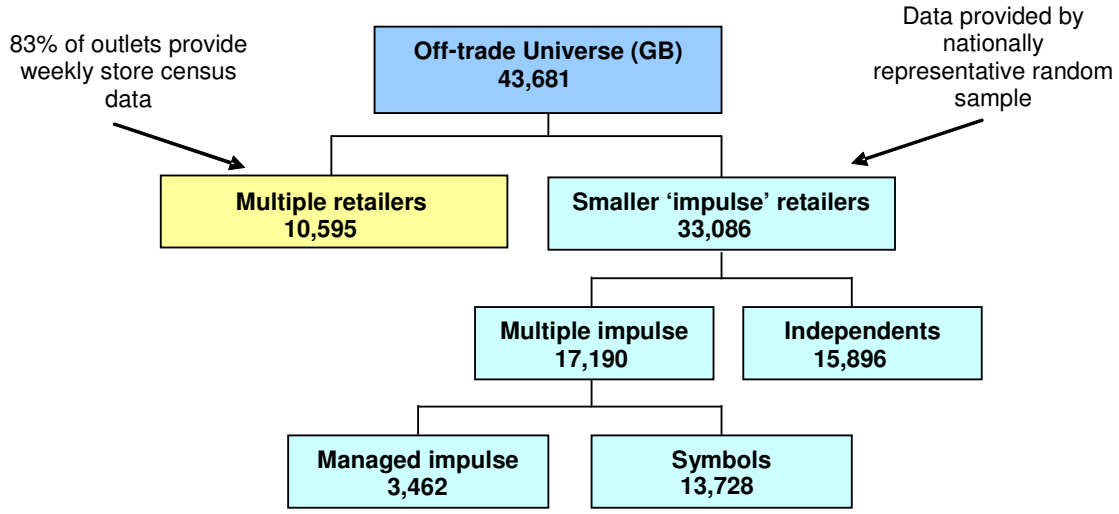
Maintenance of off-trade universe and sample of impulse outlets

The off-trade universe is updated continually for larger multiple retailers using automatically provided data, and at least annually for impulse outlets using various trade sources. Any changes in the universe of impulse outlets is reflected in the impulse sample using similar procedures to CGA.

[vii] In this context, fascia refers to retail fascia. For example, Tesco has multiple stores but different fascia: Tesco Metro, Tesco Superstore, Tesco Express. Information on shop frontage length and signage may also be collected.

[viii] TV regions in Great Britain, as defined by Nielsen, are: London; South & South East England; East England; Central England; South West England; Wales & West England; Lancashire; Yorkshire; North East England and English Border; and Scotland.

Figure 4: Nielsen's off-trade universe, 2010.



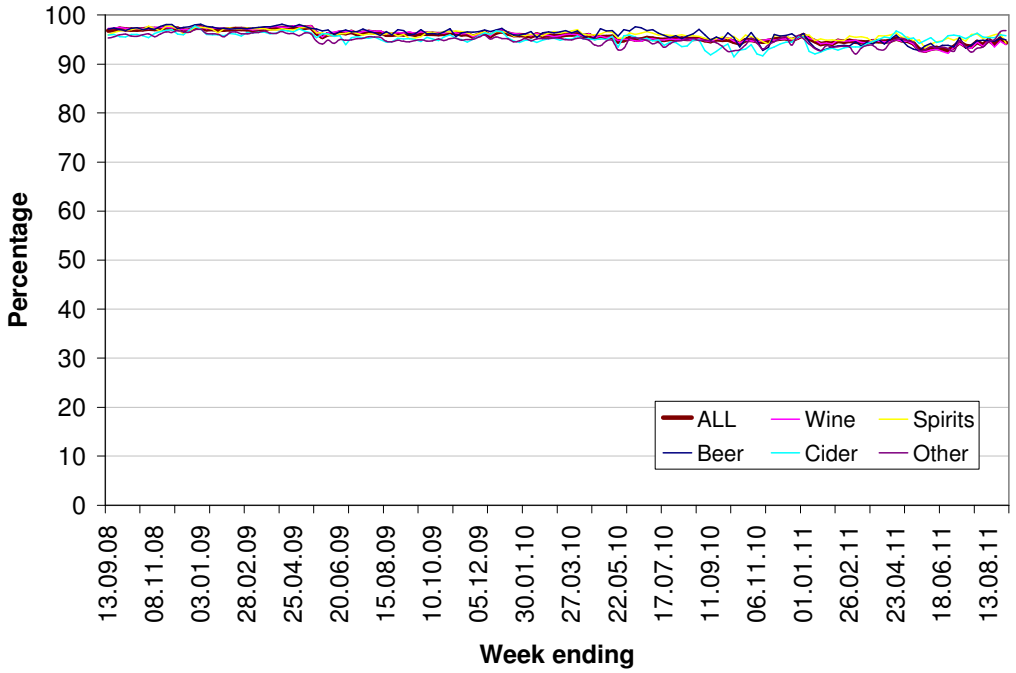
Source: Nielsen. Notes: '**Multiple retailers**' are retailers with 10 or more retail shops operating under common ownership. '**Impulse retailers**' are retailers in which the consumer mainly uses the store for impulse or top-up purchases i.e. not the main grocery shop. '**Independents**' are single enterprises with less than 10 outlets under common ownership. '**Symbols**' include both fee-paying and non-fee paying organisations of independent retailers who buy supplies through a specific wholesaler which are then delivered direct to the shop. This enables them to get large quantity discounts that might only be possible for multiple shops. The major symbol groups are Spar, Mace, Londis and Costcutter.

Loss of data on discounted retailers

Two of the major 'discounted retailers' in GB - Aldi and Lidl - have a policy of non-cooperation with market research companies. Nielsen therefore applies statistical models to actual sales data from another discounted retailer with a similar trading profile (Netto) to estimate sales by these retailers. In September 2011, Asda completed an acquisition of Netto. Although Nielsen still receives Netto store data, its trading profile has changed from its original discounter style. Thus, no data are available to provide statistically robust sales estimates by Aldi and Lidl. A commercial decision was therefore taken to redefine the off-trade coverage of Nielsen sales estimates to "Off-trade excluding Aldi and Lidl" from 3rd September 2011 onwards.

Based on a comparison of off-trade sales that either include or exclude Aldi and Lidl, it is estimated that these two discounted retailers accounted for approximately 5% of total off-trade alcohol sales in Scotland in the 12 month period to week ending 3rd September 2011 (**Figure 5**). However, this varies by drink category and, based on recent trends, may increase in future years. Clearly, this has implications for the reporting and interpretation of off-trade alcohol sales data from 2011 onwards, which will be discussed in more detail in future MESAS reports. Furthermore, discounted retailers are more likely to sell cheaper alcohol and may therefore be most likely to be affected by policies that increase the price of cheaper alcohol.[56]

Figure 5: Off-trade alcohol sales (L) excluding Aldi and Lidl as a percentage of total off-trade volume sales (L) over a 136-week period to week ending 3rd September 2011 in Scotland.

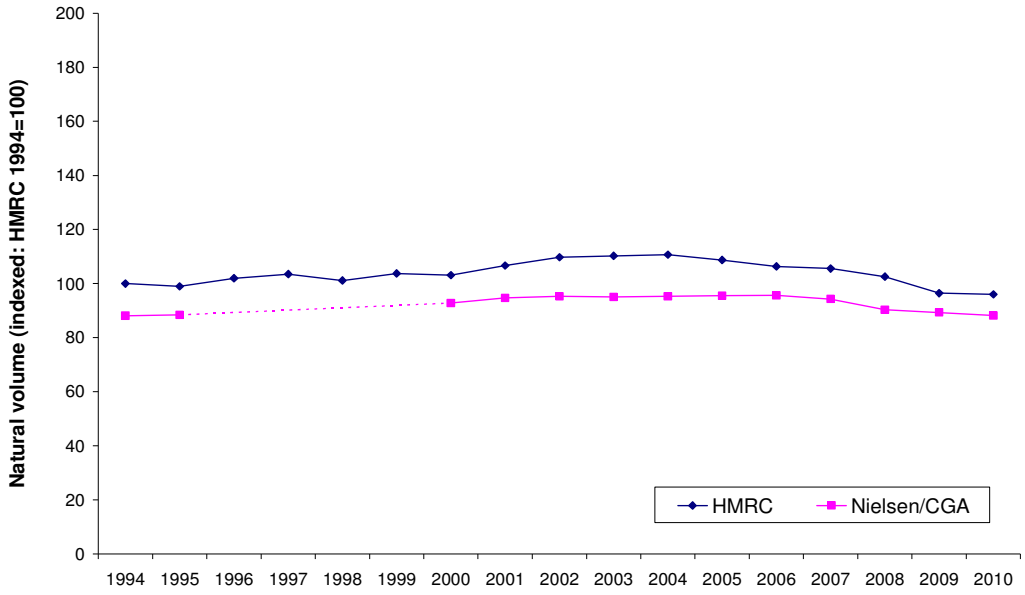


Source: Nielsen.

Comparison of different sources of alcohol sales data

Comparing estimates of alcohol sales based on Nielsen/CGA retail data with taxation data enables an indirect assessment of concurrent validity. Although each data source may be liable to the same biases and other sources of under- and overestimation (see **Section 3**), similar levels and trends between different sources provides some reassurance that the data are representative and measuring what they purport to measure. The most appropriate way to compare estimates is using natural alcohol volumes; conversion to pure alcohol volumes requires multiplication by an estimated strength (i.e. %ABV), and the strengths used by the various data producers are likely to differ slightly due to different methodological approaches. However, due to commercial sensitivity, it is not possible to publish absolute natural volume estimates provided by Nielsen/CGA. **Figures 6-10** therefore show trends in natural volume sales indexed to HMRC estimates in the base year (1994).

Figure 6: Estimates of alcohol sales in the UK (HMRC taxation data) and GB (Nielsen/CGA retail sales data), 1994-2010.



Source(s): Nielsen/CGA; BBPA Statistical Handbook[49].

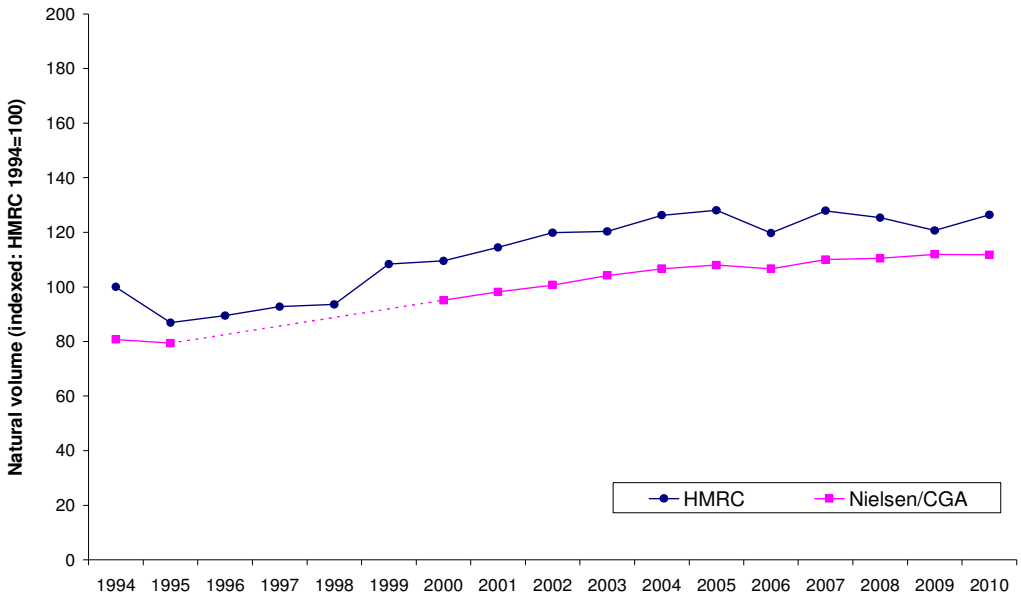
Figure 6 shows the total estimated volume of alcohol sold in the UK based on taxation data and in GB based on retail sales data. As expected, HMRC estimates are consistently higher than Nielsen/CGA estimates due to the inclusion of data pertaining to alcohol sales in Northern Ireland and alcohol sold through certain sales outlets not captured by Nielsen/CGA (e.g. certain internet sites, music festivals, military establishments; see **Section 3.2.2**). Nonetheless, the trend over time between sources is similar, with Nielsen/CGA estimates accounting for approximately 90% of HMRC estimates at each time point. This consistency over time is reflected by the strong correlation (r=0.93) and acceptable statistical agreement (see **Appendix II**) between measures. Furthermore, by applying the volume of alcohol sold per adult in Scotland to the adult population of Northern Ireland, it can be crudely estimated that the Nielsen/CGA retail sales estimates account for approximately 95% of HMRC estimates for the UK as a whole (94% if data for England & Wales are applied to the Northern Ireland population).

The similarity in sales volumes and trends is also evident at drink category level. Over the time period analysed, retail sales estimates of spirits accounted for, on average, 87% of HMRC clearances (with a high correlation between the annual estimates r=0.95; **Figure 7**). Volume sales of wine based on Nielsen/CGA data accounted for the lowest average percentage of comparative HMRC estimates (mean=82%) suggesting that this drink category was subject to the greatest underestimation, but the trend over time was very similar (r=0.98; **Figure 8**). Estimates of beer sales at UK level are also available from the British Beer and Pub Association (BBPA), who collect invoiced sales from their members. **Figure 9** shows that estimates from the BBPA, HMRC and Nielsen/CGA all follow similar time trends. On average, Nielsen/CGA accounted for 91% of HMRC clearances

(r=0.96) and 92% of BBPA sales estimates (r=0.98). Finally, estimates of the volume of cider/perry on retail sales data accounted for an average of 84% of estimates derived from taxation data. The National Association of Cider Makers (NACM) also publishes data on the volume of cider/perry sold in the UK, derived from invoiced sales. Although Nielsen/CGA estimates are for GB, they were, on average, 4% higher than those based on NACM data (**Figure 10**). However, changes over time in estimates of cider/perry sales were similar across all three data sources (Nielsen/CGA vs HMRC, r=0.98; Nielsen/CGA vs NACM, r=0.89).

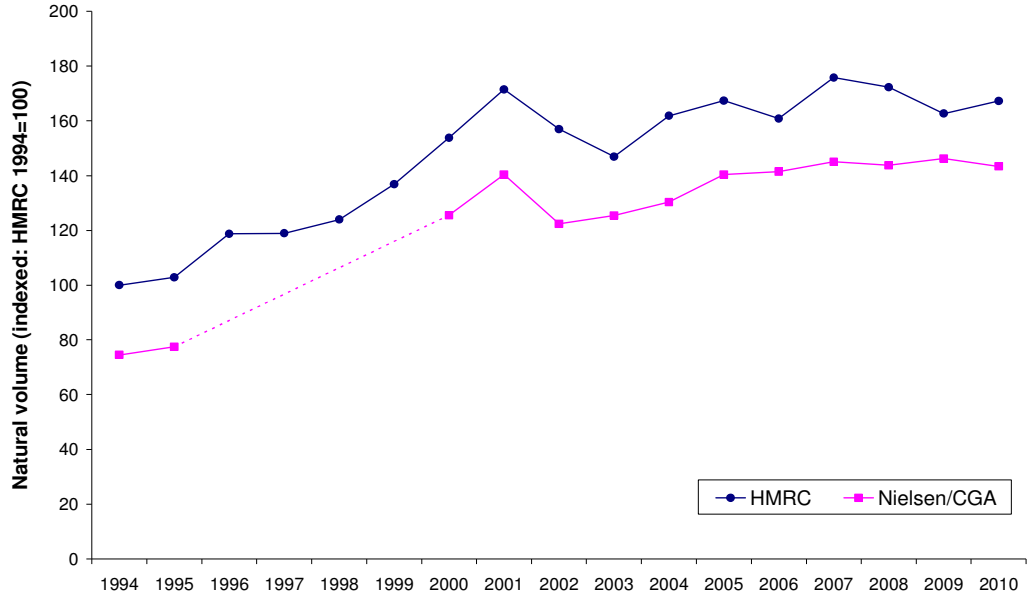
Thus, although different methodologies are used by Nielsen/CGA and other data sources to estimate alcohol sales, the similar estimates presented here provide reassurance that the Nielsen/CGA data are valid, and that their use in monitoring trends in alcohol consumption is justified.

Figure 7: Estimates of spirits sales in the UK and GB using data derived from HMRC and Nielsen/CGA, 1994-2010.



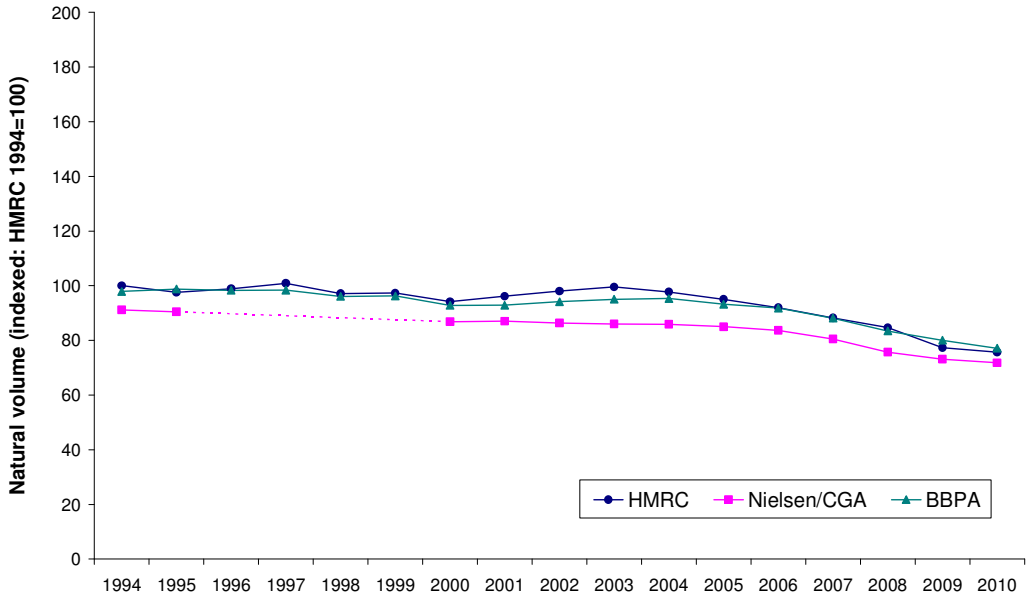
Sources: Nielsen/CGA; BBPA Statistical Handbook[49].

Figure 8: Estimates of wine sales in the UK and GB using data derived from HMRC and Nielsen/CGA, 1994-2010.



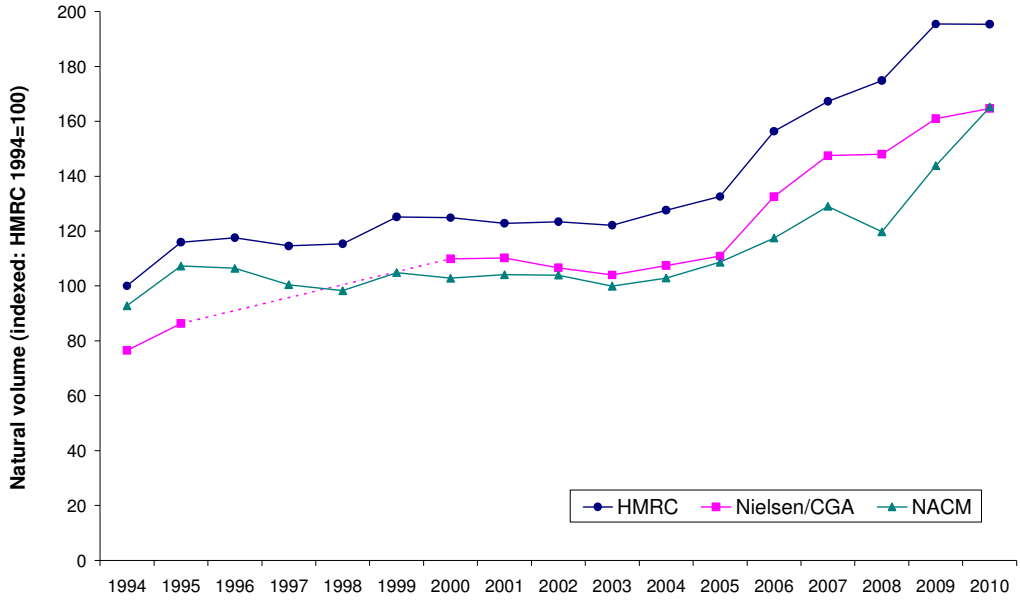
Sources: Nielsen/CGA; BBPA Statistical Handbook[49]. Notes: Wine volumes include fortified wines.

Figure 9: Estimates of beer sales in the UK and GB using data derived from HMRC, Nielsen/CGA and the British Beer and Pub Association (BBPA), 1994-2010.



Sources: Nielsen/CGA; BBPA Statistical Handbook[49].

Figure 10: Estimates of cider/perry sales in the UK and GB using data derived from HMRC, Nielsen/CGA and the National Association of Cider Makers (NACM), 1994-2010.



Sources: Nielsen/CGA; BBPA Statistical Handbook[49]. Notes: An error was identified in previously published 1994 and 1995 cider/perry estimates derived from Nielsen/CGA data. The estimates used in the above chart have been derived using corrected data.

3.3.2 Non-response bias (m)

On-trade

Of the small sample of non-responding on-trade outlets, the majority are Independent Free Trade outlets (CGA, personal communication). Differences between the characteristics of responders and non-responders are not routinely explored. However, only a very small proportion of outlets do not respond. Thus, besides updates to reflect changes in the on-trade universe, CGA's brand index sample remains highly consistent over time. Furthermore, as CGA's estimates of on-trade alcohol sales are derived from data on the volume of different products sold by, and/or delivered to, c.57,000 outlets, non-response bias is unlikely to have an impact.

Off-trade

Although not quantified, non-response in the off-trade predominantly applies to small independent retailers and, like CGA, differences between the characteristics of responders and non-responders are not known (Nielsen, personal communication). Non-response bias is therefore possible within this market channel. However, because about three-quarters of all alcohol sold through the off-trade is captured by the store-census data that Nielsen collect, it is unlikely to have an impact on alcohol sales estimates, particularly as MESAS reports at drink category and country level.

3.3.3 Measurement error (I. m, n)

Measurement error may arise from a number of sources including sampling variation and inaccurate estimation of the strength (%ABV) of specific drink types. These are described in more detail below, alongside a summary of the methods used by CGA/Nielsen to quality assure and check the data.

Sampling variation

Any use of a sample statistic to estimate a population parameter is subject to some degree of sampling variation. The standard error is a statistic that can be calculated and used to indicate the degree of uncertainty around an estimate. The standard error is most commonly reported as a confidence interval at the 95% level. This '95% confidence interval' provides a range of estimates derived from the sampling process within which the 'true' value of the population parameter would be expected to be found 95 times out of 100.

On-trade sampling variation

To provide an example of the uncertainty around Rate of Sale estimates (i.e. the estimated average volume of alcohol sold in a given time period by a specific outlet type), derived from Electronic Point of Sale volume pool data, CGA provided NHS Health Scotland with standard error estimates of the 20 best-selling beer/cider, spirits, and wine brands at GB level over a 4-week period. These are shown in **Table 9** (figures for the top 20 brands in each category have been averaged to protect commercial sensitivity).

Table 9: Estimates of the average Rate of Sale of the 20 best-selling beer/cider, spirits, and wine brands in GB over a 4-week period in 2010, including estimates of standard error and 95% confidence intervals.

Category	Number of outlets in EPoS volume pool selling top 20 brand	Mean Rate of Sale in 4-week period	Standard error[1]	95% confidence interval[2]		
				Lower	Upper	+/-
	n	*ml*	*ml*	*ml*	*ml*	*%*
Beer/cider	1,611	401,524	8184	385,484	417,564	4.2
Spirits	3,149	2,395	48	2302	2489	3.5
Wine	673	56,708	2139	52,516	60,899	6.4

Source: CGA Strategy. Notes: Data for the top 20 brands in each category have been averaged to protect commercial sensitivity and are therefore for illustrative purposes only. Thus, values in the table may be different to those calculable.[1]The standard error (SE) of the mean was calculated using the following formula: SE=Standard deviation/√(sample size). The standard deviation was provided by CGA. [2]The 95% confidence interval (CI) was calculated using the following formula: CI_{lower}=Mean RoS–(1.96 x SE); CI_{upper}=Mean RoS+(1.96 x SE).

The standard error of the mean and confidence interval around an estimate depend on the sample size. In general, the larger the sample size, the smaller the standard error and confidence interval. This is evident in **Table 9**. The widest confidence interval is for wine (±6.4%), which has the lowest average sample size in terms of outlets providing EPoS volume pool data. In contrast, the narrowest

confidence interval is for spirits (±3.5%), which is the category with the highest average number of outlets providing EPoS data. Thus, as the volume of different products sold is aggregated to category level, as received by NHS Health Scotland, the standard errors will reduce, resulting in more precise estimates. Similarly, as 4-weekly data are aggregated to produce annual estimates, the precision of the estimates increase because the standard error reduces.

Unfortunately, it is not possible to calculate specific standard errors and confidence intervals around estimates of the mean volume of alcohol sold in different strata of the brand index sample. This is because data from the volume pool are used to apportion volume sales to outlets in the brand index sample to provide more reliable, unbiased estimates. In other words, volume data are not collected directly from the outlets in the brand index sample, which would enable the variation of sales for different geographies and outlet types to be calculated. CGA therefore adopt a different approach to estimate the expected uncertainty around their sales estimates. This is based on the largest possible standard error if calculating the standard error of a proportion, and is explained in more detail in **Appendix III**.[ix] As expected, as alcohol sales estimates are broken down by different sample strata, the standard errors and confidence intervals vary depending on the number of brand index outlets sampled (**Table 10**).

Table 10: Estimated variation around CGA on-trade estimates by area and tenure type, 2011.

	London	Meridian	Anglia	Westward	Harlech	Central	Granada	Yorkshire	Tyne Tees	Scotland	GB
Free											
Universe	13,887	7,050	5,748	7,872	4,907	9,759	9,512	6,578	3,497	8,617	**77,427**
Sample	314	166	104	197	105	215	231	175	96	257	**1,860**
SE (%)	2.8	3.8	4.9	3.5	4.8	3.4	3.2	3.7	5.0	3.1	**1.1**
95%CI (±%)	5.5	7.5	9.5	6.9	9.5	6.6	6.4	7.3	9.9	6.0	**2.2**
Managed											
Universe	5,089	1,653	946	991	614	2,560	1,964	1,655	731	1,186	**17,389**
Sample	511	183	84	107	73	222	177	133	69	121	**1,680**
SE (%)	2.1	3.5	5.2	4.6	5.5	3.2	3.6	4.2	5.7	4.3	**1.2**
95%CI (±%)	4.1	6.8	10.2	9.0	10.8	6.3	7.0	8.2	11.2	8.4	**2.3**
Non-managed											
Universe	3,765	2,676	2,592	2,543	1,157	4,560	4,048	3,027	1,150	1,265	**26,784**
Sample	360	203	157	195	61	311	323	210	86	113	**2,019**
SE (%)	2.5	3.4	3.9	3.4	6.2	2.7	2.7	3.3	5.2	4.5	**1.1**
95%CI (±%)	4.9	6.6	7.6	6.7	12.2	5.4	5.2	6.5	10.2	8.8	**2.1**
All											
Universe	22,741	11,379	9,286	11,406	6,678	16,879	15,524	11,260	5,378	11,068	**121,600**
Sample	1,185	552	345	499	239	748	731	518	251	491	**5,559**
SE (%)	1.4	2.1	2.6	2.2	3.2	1.8	1.8	2.1	3.1	2.2	**0.7**
95%CI (±%)	2.8	4.1	5.2	4.3	6.2	3.5	3.5	4.2	6.0	4.3	**1.3**

Source: CGA Strategy.

Off-trade sampling variation

Nielsen has provided NHS Health Scotland with standard errors of sales estimates at Scotland level (as correct in April 2011), broken down by the two main off-trade channels: multiple retailers and impulse retailers (**Table 11**). As outlined previously, most multiple retailers provide census data, while most of the impulse input is by sample, explaining the large differences in their standard

[ix] In the absence of the data required to calculate the *actual* standard error, this approach has been deemed acceptable to enable a crude estimate to be calculated.

errors. Similarly, the standard error for 'Total Scotland' (i.e. including both multiple and impulse retailers) is weighted towards the standard error for multiple retailers because this trade channel accounts for the majority of all alcohol sold through the off-trade.

Table 11: Estimated variation around Nielsen off-trade estimates in Scotland, by trade channel, 2010.

	Scotland			England & Wales		
	Multiple retailers	Impulse retailers	**Total**	Multiple retailers	Impulse retailers	**Total**
Standard error	1.0	10.7	**2.0**	0.3	3.2	**0.6**
95% CI (±%)	1.9	20.9	**4.0**	0.5	6.3	**1.1**

Source: Nielsen. Notes: The standard errors are based on standard statistical formulae and take into account sample sizes, distribution and measures of sales variation. The exact formulae were not provided by Nielsen as it is considered intellectual property.

The standard errors for off-trade estimates only change significantly when there has been a large change in the sample size. In recent years there have been a few such instances, specifically concerning impulse outlets (**Table 12**). In January 2010, Nielsen increased the sample size of impulse outlets, thereby reducing the standard error. The sample size was reduced slightly in September 2010 and further in April 2011, resulting in larger standard errors. Apart from these relatively large changes, sample fluctuations will not affect the standard errors.

Table 12: Impact of changes in sample size on estimates of standard error in Scotland.

	Standard error (%)	
	Total Scotland	Impulse retailers
Jan-Dec 2009	1.9	7.5
Jan-Aug 2010	1.9	7.2
Sep 2010 - Mar 2011	1.9	7.3
Apr 11 onwards	2.0	10.7

Source: Nielsen.

Impact of sampling variation on per adult alcohol sales estimates

As recommended by the World Health Organization[4], NHS Health Scotland reports estimates of alcohol sales in terms of litres of pure alcohol sold per adult. **Table 13** shows the 95% confidence intervals around estimates of the volume of pure alcohol sold in Scotland and England & Wales, by trade channel, in 2010.

Table 13: 95% confidence intervals around annual estimates of pure alcohol sales in Scotland and England & Wales, by trade sector, 2010.

	Scotland			England & Wales		
	On-trade	Off-trade	Combined	On-trade	Off-trade	Combined
1000L						
Estimate	16,957	34,113	51,070	148,728	284,272	433,001
Lower 95% CI	16,224	32,763	48,987	146,728	281,159	427,887
Upper 95% CI	17,691	35,463	53,154	150,728	287,386	438,114
L per adult (≥16 years)						
Estimate	3.93	7.91	11.85	3.31	6.33	9.64
Lower 95% CI	3.76	7.60	11.37	3.27	6.26	9.52
Upper 95% CI	4.10	8.23	12.33	3.36	6.40	9.75

Source: CGA/Nielsen; NHS Health Scotland analysis of alcohol sales data. Notes: The most recent standard error estimates for Scotland, based on 2011 sampling, were used to calculate the confidence interval around 2010 volume sales estimates (see **Table 10 and Table 11**).

Quality assurance and validity checking

On-trade

CGA conduct a number of comprehensive quality assurance and validation routines when collecting, collating and processing data sampled from the on-trade. Data collected from outlets in the brand index sample, and from volume pool sources, are automatically checked during processing to identify 'exceptional' data, or extreme outliers. Price (derived from the brand index sample) and average Rate of Sale (derived from the volume pool) are the two key measures for estimates weighted up from the brand index sample and so are validated at the individual outlet and brand level to identify outliers at the root cause. Tolerance thresholds in relation to changes over time are also used to identify potentially spurious data points that lie outside expected limits (defined by CGA as values that are above or below two standard deviations from the mean). Once the volume pool data have been profiled against the brand index sample and weighted, estimates are compared with data from external sources for further validation, including the British Beer and Pub Association and ex-factory sales (sales by alcohol manufacturers).

Off-trade

Extensive validation procedures are carried out at every stage of the Nielsen production process. Briefly, basic checks are initially performed on data received, such as electronic file size compared to previous weeks. In addition, tables are produced that compare outlet- and item- level data for the current period against previous periods. Statistical tests are performed by an automated system and the results of these are compared to pre-defined parameters to highlight if any outlets have extreme outliers or other data issues that need resolving (e.g. if vodka sales have increased by 35% in one retailer, is a similar change apparent in other retailers?). Similar statistical inspections are performed when data are aggregated to different geographies and brand/category levels. Prior to final processing, a test database is produced to enable a final inspection to ensure that there are no data issues. Estimates are also compared with those from other data sources, including the HMRC, British Beer and Pub Association and ex-factory sales.

Quantification of the percentage alcohol by volume (%ABV) of different beverages (and of any unrecorded alcohol)

Annualised estimates of the natural volume (Litres) and value (£) of alcohol sold are provided across eight drink categories: spirits, light wine, beer, cider, ready to drink beverages (RTDs), perry, fortified wine and 'other'. Conversion of the natural volume of alcohol sold (litres) into the volume of pure alcohol sold (L pure alcohol) is based on category-specific strengths, measured as % alcohol by volume (ABV). The ABV indicates the typical strength of drinks sold in a category and is provided by the data suppliers. The ABVs used by Nielsen/CGA enable natural volumes to be calculated, which are considered commercially sensitive, and so are not specified in this report. However, it should be noted that they are similar to those used by national population surveys[57], in the academic literature[58] and also by the HMRC to convert alcohol clearances to pure alcohol volumes.[49]

Spirits

Standard ABVs are applied to each individual product depending on its type (i.e. vodka, whisky, gin etc). Although there can be variation within spirit types, Nielsen/CGA review the biggest selling brands to ensure the most appropriate ABV is used.

Wine

Due to the complexity of the wine market, and the number of different types sold, wine (including table wine, sparkling wine and champagne) is assumed to have a standard ABV, chosen specifically to represent the mean ABV of all wine sold based on expert market knowledge.

Fortified wine/RTDs/Perry

Fortified wine, RTDs and perry are assumed to have standard ABVs, chosen specifically to represent the mean ABV of alcohol sales within each category based on expert market knowledge.

Beer

Individual beers are categorised based on their strength: non/low strength alcohol (0-1.2% ABV); commodity (1.3-3.3% ABV); standard (3.4-4.2% ABV); premium (4.3-7.5% ABV); super strength (>7.5% ABV). Each category is allocated a single ABV, informed by market knowledge of the biggest selling brands.

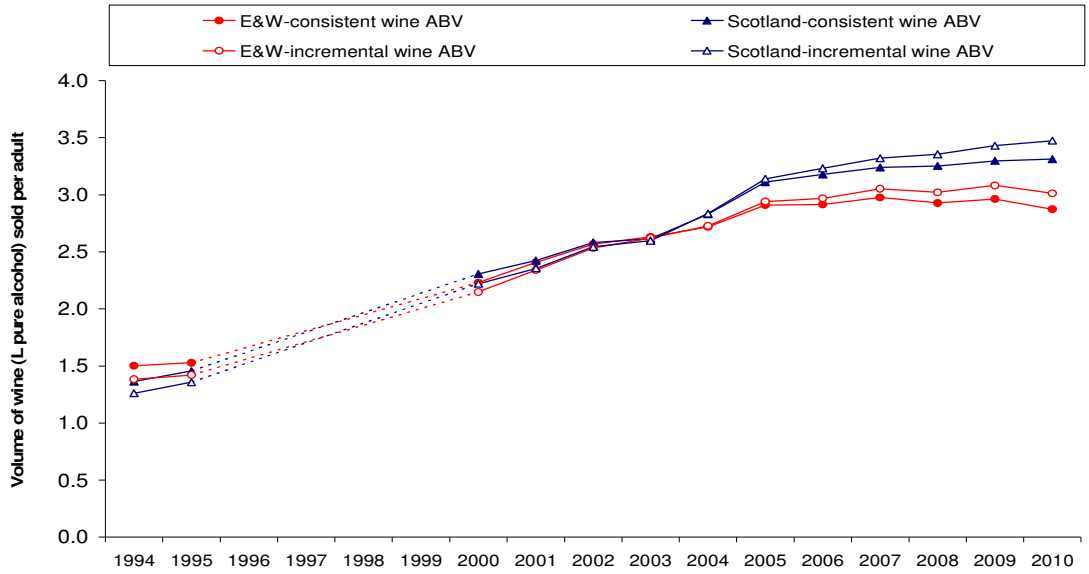
Cider

Individual ciders are also categorised according to their strength into regular (<6.1% ABV) and white/strong (≥6.1% ABV). Each category is allocated a single ABV, informed by market knowledge of the biggest selling brands.

The potential for under or over-recording of per capita consumption due to inaccuracies in the recording of the strength of different beverages has been highlighted in a number of studies. Particular concerns about the alcohol content of wine are illustrated in an example from Australia.[59] The Australian Bureau of Statistics (ABS) releases annual estimates of per capital alcohol consumption in Australia based on a combination of import clearance, excise, alcohol retail sales and survey data. Over the last two decades there has been an increase in wine

sales as a proportion of the Australian alcohol market as well as a gradual increase in the ABV of most wines. The result is that the Australian per capita alcohol consumption has been increasing rather than maintaining stability as had previously been thought.[59] The HMRC reviewed their estimates of the average strength of table wine in 2008 using new methodology. This methodology uses quality assured HMRC trade data on the country of origin of wines to estimate average strengths.[60] This is different to the method used by Nielsen based on market knowledge of the most popular brands of wine. However, the two methods give broadly similar results and trends (as noted earlier). Furthermore, if the ABV of wine is assumed to have increased over time, in accordance with the findings from HMRC, the impact on Nielsen/CGA estimates of the volume of pure alcohol sold as wine per adult in Scotland and England & Wales is small (**Figure 11**).

Figure 11: Impact of applying a consistent ABV versus an increasing ABV on Nielsen/CGA estimates of the volume of pure alcohol sold as wine per adult in Scotland and England & Wales, 1994-2010.



Source: NHS Health Scotland analysis of Nielsen/CGA data.[17]

Other research has found variability in the alcohol content of wine, beer and spirits sold in the US market.[61-63] However, issues identified as contributing to the fluctuating trends, such as variability in the proportion of fortified and dessert wines sold and fluctuating ABV of beers are not of concern for the accuracy of the Nielsen/CGA sales data due to the classifications used (fortified wines are considered in a separate category to table wines and beers are classified by strength).

Therefore, although changes in the ABV of different alcoholic beverages have been highlighted as a concern by various researchers, it is unlikely to be an important source of bias for these sales data. However, comparison with countries outside the UK may be less reliable should the methods of estimating per adult alcohol consumption in other countries be affected by this source of bias.

4 Summary of the validity and reliability of alcohol retail sales data in Scotland

Table 14 summarises the potential sources of bias in using alcohol retail sales data as a means of estimating per adult alcohol consumption in Scotland in 2010. The largest potential sources of bias are sources of underestimation due to unrecorded alcohol (1.7L per adult (15+ population)) and wastage/spillage (estimated at <1.2L per adult). These dwarf the potential overestimation due to biases such as tourism and the non-resident student population. The uncertainty in the estimate of per adult sales related to sampling variability (i.e. random error) is estimated at ±0.5L. This uncertainty relates to the calculation of sales in a single year and is much less when considering trends over time. The lack of significant year-on-year variability, and the similarity between point estimates and trends derived from retail sales data compared to other data sources, emphasises the precision of the estimates.

No data are available on the extent to which stockpiling (or the use of stockpiled alcohol) might impact on the per adult estimates. For it to have a large impact on the interpretation of either the estimate for a particular year or the trends over time, the proportion of alcohol sold which is stockpiled, or the rate of use of an alcohol stockpile, would need to change radically (and the proportion of alcohol stockpiled rather than used would need to be very high) to be relevant to the use of the data. This may be important when considering particularly expensive alcohol (such as expensive whisky or wine) or when considering short-term fluctuations around the time of price/legislation changes, but is otherwise unlikely to challenge the validity or reliability of the use of retail sales data to estimate per adult alcohol consumption.

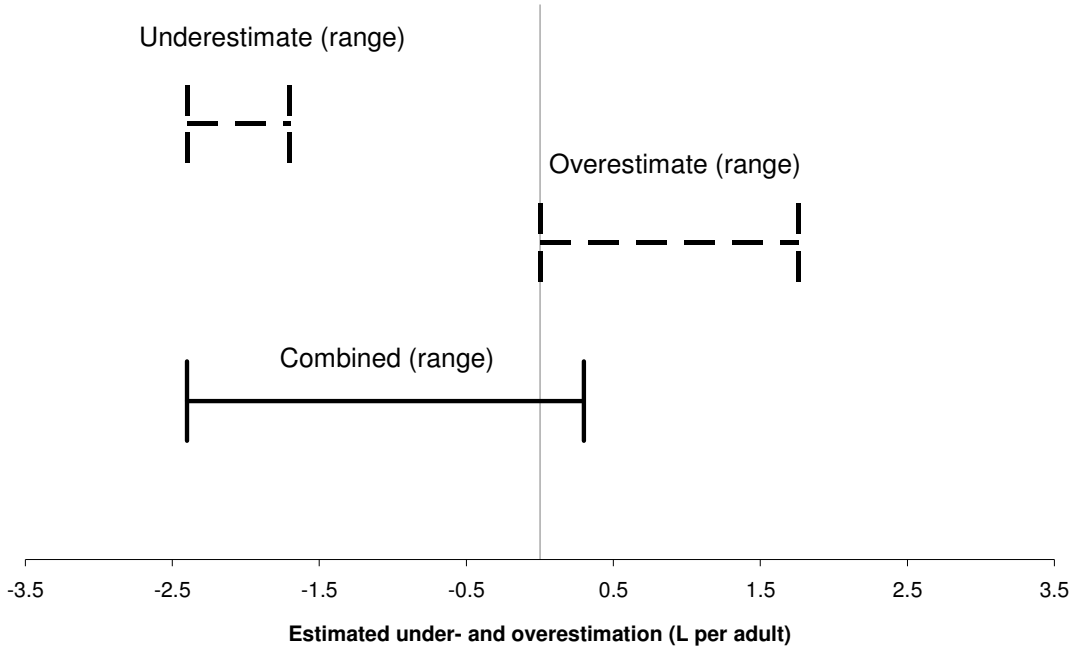
No data are available on the sales of alcohol through outlets not captured by CGA/Nielsen (including certain internet sales, music festivals and, in the future, discount retailers such as Aldi and Lidl). This is therefore a source of underestimation of per adult consumption. The extent to which this affects current comparisons between Scotland and England & Wales is limited because it impact on both (although the impact may be larger in one than the other, and may change if alcohol pricing polices diverge).

Overall, considering all the possible sources of overestimation and underestimation, and taking into account the potential for sampling variability to impact on the results, the range of uncertainty in the per adult alcohol sales estimates in 2010 was from an overestimate of 0.3L to an underestimate of 2.4L (**Figure 12**). This excludes the impacts of stockpiling (which are likely to be minor) and alcohol sold through non-included outlets (which is likely to be a further source of underestimation which would impact on both Scotland and England & Wales estimates). On balance, there is therefore far greater scope for the retail sales data to be an underestimate of per adult alcohol consumption than an overestimate.

Table 14: Potential sources of bias and uncertainty in using retail sales data to estimate per adult alcohol consumption in Scotland and their estimated magnitude (based on per adult alcohol consumption estimate in 2010).

Sources of bias in estimation of per adult alcohol consumption	Litres per adult (range (±) around the 2010 estimate)		Comments
	Underestimation of consumption	Overestimation of consumption	
Student population	0	≤0.1	Overestimation is likely to be even smaller because there are no data on the numbers of Scottish residents studying internationally or at colleges in England & Wales.
Net effect of visitors coming into Scotland and Scottish residents making trips elsewhere	0.2	0.2	There are no data on the average number of nights spent by Scottish residents on international visits. Underestimation assumes Scottish residents spend an average of 9 nights on international visits; the resultant total estimated consumption is more than that of visitors to Scotland. Overestimation assumes Scottish residents spend an average of 1 night on international visits; the resultant total estimated consumption is less than that of visitors to Scotland.
Stockpiling of alcohol	Unknown	Unknown	Only likely to impact on time trends rather than differences between Scotland and England & Wales. Impact should be apparent on monthly sales data.
Wastage/spillage	0	<1.2	Based on industry estimate of <10%.
Sampling variation	0.5	0.5	
Non-inclusion of some outlets	Unknown	0	
Unrecorded alcohol	1.7	0	Based on estimate from the World Health Organization for UK population aged ≥15 years.
Total of known estimates	1.7 to 2.4	0 to 2.0	
Net estimate	-2.4 (underestimate) to 0.3 (overestimate)		Excludes the impact of stockpiling and alcohol sold through non-included outlets.

Figure 12: Potential impact of sources of under- and overestimation on per adult alcohol consumption estimates (derived from retail sales data) in Scotland, 2010.



Notes: Per adult alcohol consumption in Scotland in 2010 was estimated at 11.8L per adult. This corresponds to '0' on the x-axis. Chart excludes the impacts of stockpiling (which is likely to be minor) and alcohol sold through non-included outlets (which is likely to be a further source of underestimation).

Appendix I International Passenger Survey (IPS) and United Kingdom Travel Survey (UKTS)

The IPS is an annual survey of passengers at all main air, sea and tunnel ports for the UK. Ninety five percent of passengers entering or leaving the UK have the chance of being sampled in the survey. It excludes night time travel, travel from some ports which are very small or very expensive to sample and, until this year, data on cruise ships. Face-to-face interviews are conducted with respondents recruited via a random sample of passengers. The overall response rate for 2010 was 81%. Data from completed visits to the UK by international travellers and UK residents returning to the UK are used to compile the annual Travel Trends publication; it therefore uses information about events that have occurred rather than projections of what respondents expect to happen. Modelling is used to take account of areas that are not sampled and data are weighted accordingly to give national estimates. In 2010, 300,000 interviews were conducted (0.2% of travellers). Confidence intervals are given for data at UK level and in 2010 these were +/- 594,000 (2%) for the number of visits into the UK and +/- 661,000 (1.2%) for the numbers of trips abroad by UK residents. For Scotland, 95% confidence intervals for the number of visits to the region by overseas residents are much higher at +/- 282,000 (12%) due to a smaller sample size.

Prestwick and Liverpool airports were added into the sampling frame in 2005, Doncaster, Bournemouth and Southampton airports in 2008 and Aberdeen and Belfast airports in 2009. It is likely that the addition of an airport increases the numbers of passengers sampled from residents of areas near to that airport. In addition, the methodology changed in 2007 with a new, more discriminating, method of coding UK towns, in 2009 due to a new data processing method (with resultant downward impact on estimates) and in 2010 with the inclusion of some cruise ships. Comparisons over time are likely to be inaccurate as a result of these changes, especially on a regional basis.[31]

The UKTS is a survey of around 100,000 interviews per year where respondents report on all trips within the last 4 weeks. Interviewing takes place continuously throughout the year except the 2 weeks either side of Christmas. Again, there is some difficulty in making comparisons over time due to significant changes to the survey in 2005. Ninety-five percent confidence intervals for the number of trips and nights in Scotland are +/-6.5% and +/-9.2% respectively for the 2010 data.[33]

Appendix II Estimating the variation around on-trade alcohol retail sales estimates

Volume data are not collected directly from outlets in CGA's brand index sample, which would enable the variation of sales for different geographies and outlet types to be calculated. Instead, data from a larger volume pool are used to apportion average volume sales to outlets in the brand index sample. This process provides more reliable, unbiased estimates. However, it means that it is not possible to calculate specific standard errors and confidence intervals around estimates of the mean volume of alcohol sold in different strata of the brand index sample. CGA therefore adopt the following process to estimate the expected uncertainty around their sales estimates at each break of the brand index sample.

Estimating the standard error

The variation around CGA's estimates of mean on-trade alcohol sales is unknown (see **Section 3.3.3**). Calculating the standard error of the mean estimates is therefore not possible. To overcome this limitation, CGA instead calculate the standard error of a proportion, assuming an estimated proportion of 50%. This provides the widest possible standard error, which is used to calculate a 95% confidence interval as a percentage range (e.g. ± 5%). This is applied to on-trade sales estimates at different strata breaks to give a crude, but conservative, estimate of uncertainty (see **Table 10** in **Section 3.3.3**).

Example

In 2010, the volume of alcohol sold in managed outlets in Scotland was 23,677,000L.[x] What was the uncertainty around this estimate?

Step 1: Calculate standard error

$$\text{Standard error} = \sqrt{\frac{p(1-p)}{n}}$$

where n = sample size (i.e. the number of managed outlets in Scotland within CGA's brand index sample = **121**)

p = estimated proportion, assumed to be **50%**

$$\text{Standard error} = \sqrt{\frac{0.5(1-0.5)}{121}} = 0.45 = \mathbf{4.5\%}$$

[x] Arbitrary value.

Step 2: Calculate finite population correction factor

CGA's on-trade sample is relatively large in comparison with the on-trade universe. A finite population correction (fpc) is therefore applied.[xi]

Finite population correction factor = $\sqrt{\frac{N-n}{N-1}}$

where n = sample size (i.e. the number of managed outlets in Scotland within CGA's brand index sample = **121**)

N = population size (i.e. the total number of managed outlets in Scotland = **1186**)

Finite population correction factor = $\sqrt{\frac{1186-121}{1186-1}}$ = **0.948**

Step 3: Apply finite population correction factor to standard error

Standard error x fpc = 4.5% x 0.948 = **4.3%**

Step 4: Calculate 95% confidence interval

95% confidence interval = z-value x standard error x fpc

where z = the z score associated with the confidence level required (95%) = **1.96**

95% confidence interval = 1.96 x 4.3%

= **8.4%**

Step 5: Calculate 95% confidence interval (CI) of sales estimate

95% CI of sales estimate = sales estimate ± 95% CI

= 23,677,000L ± 8.4%

⇒ **We can be 95% confident that the volume of beer sold in managed outlets in Scotland in 2010 was between 21,677,283L and 25,676,717L, with a best estimate of 23,677,000L.**

[xi] Berenson ML, Levine DM, Krehbiel TC. Basic Business Statistics (12th ed). New Jersey: Pearson/Prentice Hall; 2011.

Appendix III Comparing two methods of measurement: Bland and Altman limits of agreement

The high correlation coefficients presented in **Section 3.3.1** provide support that there is a strong association between alcohol sales estimates derived from retail sales data and those derived HMRC taxation data. However, a strong association does not necessarily denote good agreement. For example, if Nielsen/CGA estimates were consistently 50% lower than HMRC estimates, there would be perfect correlation (r=1) but poor agreement.

To assess agreement, Bland and Altman[64] have proposed an alternative approach that involves plotting the difference between results from two methods against their mean. Unlike a traditional scatterplot, this enables discrepancies between methods to be visually examined, giving a clear indication of whether or not there is any bias (i.e. the mean difference between measurements). More importantly, Bland-Altman plots reveal the variability of differences, which should not be patterned by the size of the estimate.

Figure A1 shows the Bland-Altman plot that compares Nielsen/CGA and HMRC estimates of total alcohol sales between 1994 and 2010 (plots for the major drink categories are shown in **Figures A2-A5**). The y-axis shows the difference between the two measurements at each time point; the x-axis shows the mean of the two measurements at each time point; the horizontal line in the middle represents the mean; and the upper and lower horizontal lines represent the 95% limits of agreement (the range within which the 'true' value of the difference (i.e. bias) between methods would be expected to be found 95 times out of 100).

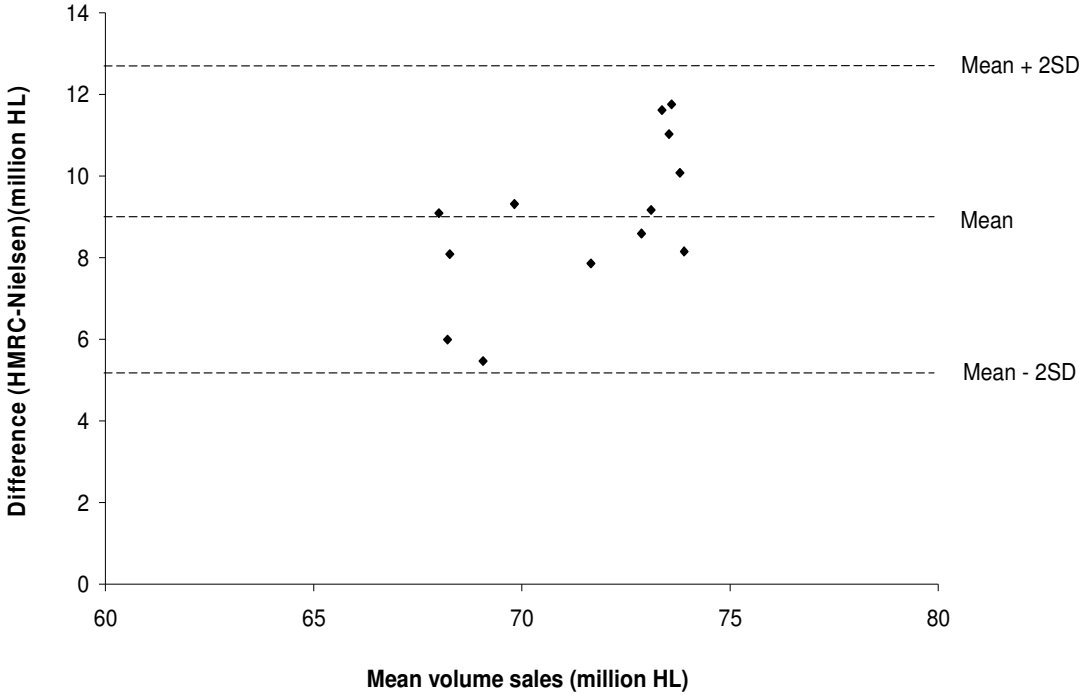
The chart shows that the mean difference between the two data sources is 8.9 million hectolitres. In other words, total alcohol sales estimates derived from Nielsen/CGA data are, on average, 8.9 million hectolitres (or 11%), lower than those based on HMRC data. This is expected because the estimates relate to different geographies (HMRC estimates are for the UK; Nielsen/CGA are for GB) and the fact that Nielsen/CGA estimates do not include sales through certain outlets. The upper and lower limits of agreement are approximately 7.5 million hectolitres apart. This means that 95% of Nielsen/CGA estimates would be expected to be between 6-17% lower than HMRC estimates. This range is small enough for us to be confident that, despite the known biases, there is good agreement between sources.

However, **Figure A1** also reveals a pattern that suggests the difference between the two sources is related to the underlying measurement, with the differences being larger as the estimate of alcohol sales increases. The limits of agreement may therefore be too narrow for larger estimates and too wide for lower estimates. Although logarithmic transformation can overcome this problem, it is unlikely that the pattern is strong enough to conclude

unacceptable agreement. More importantly, this patterning is unsurprising. As HMRC alcohol sales estimates increase at UK level, it is expected that sales in Northern Ireland and sales through those outlets not included in Nielsen/CGA estimates will also increase, thereby increasing the difference between sources (and vice versa).

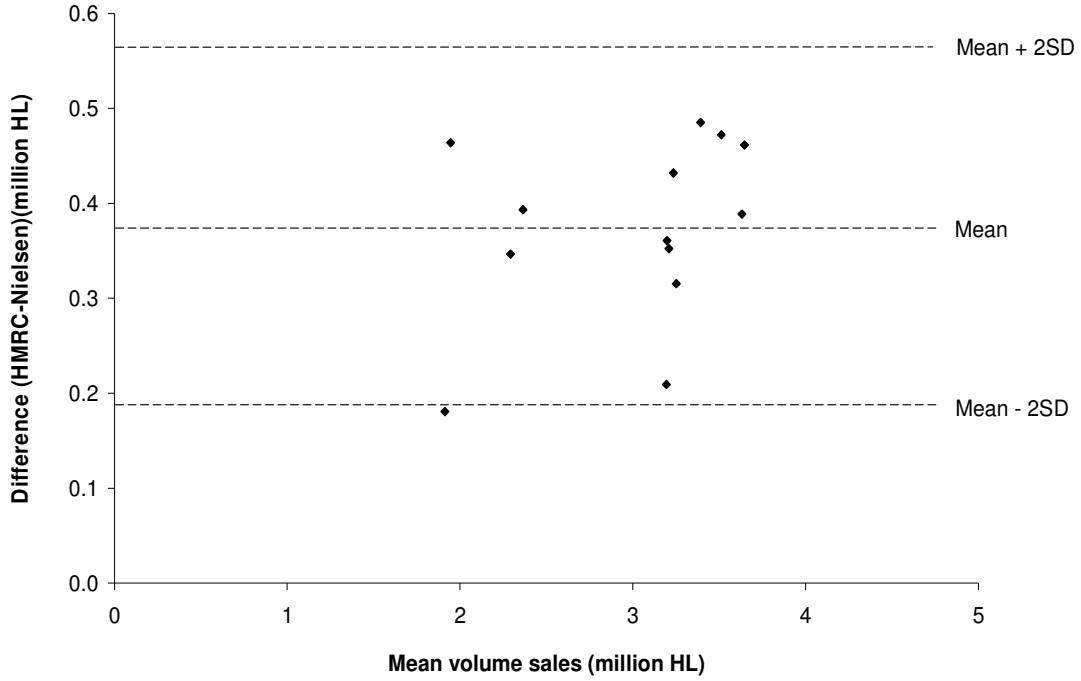
In summary, the Bland-Altman analyses provide support that, despite the expected bias, there is acceptable agreement between the different estimates of alcohol sales data.

Figure A1: Bland-Altman plot of the difference against the mean for alcohol sales (total) estimates derived from Nielsen/CGA and HMRC data.



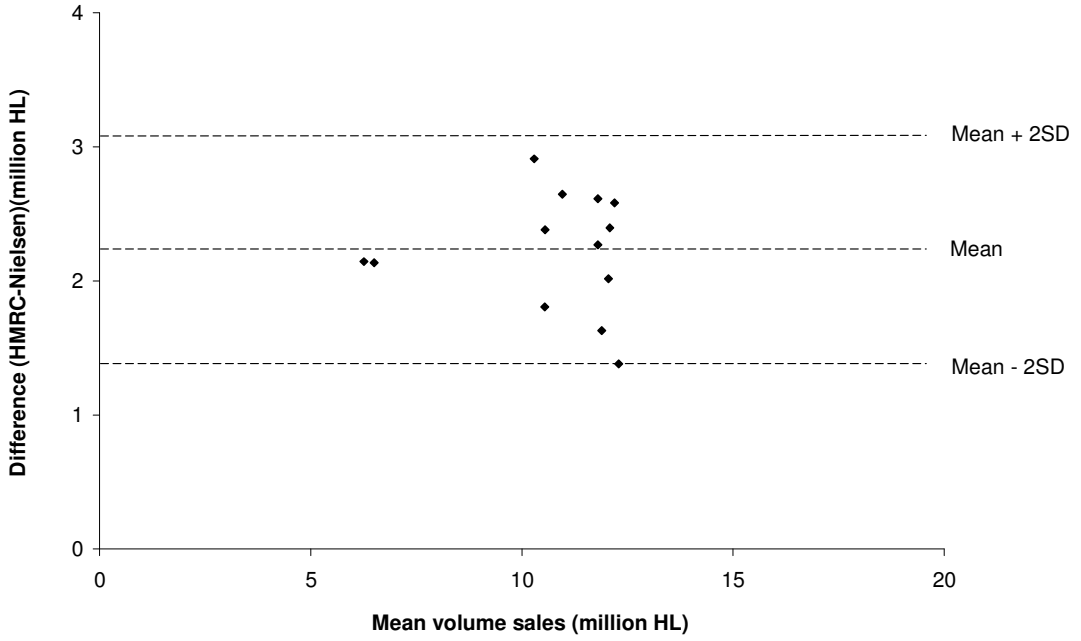
Source: Nielsen/CGA; BBPA Statistical Handbook[49].

Figure A2: Bland-Altman plot of the difference against the mean for estimates of spirits sales derived from Nielsen/CGA and HMRC data.



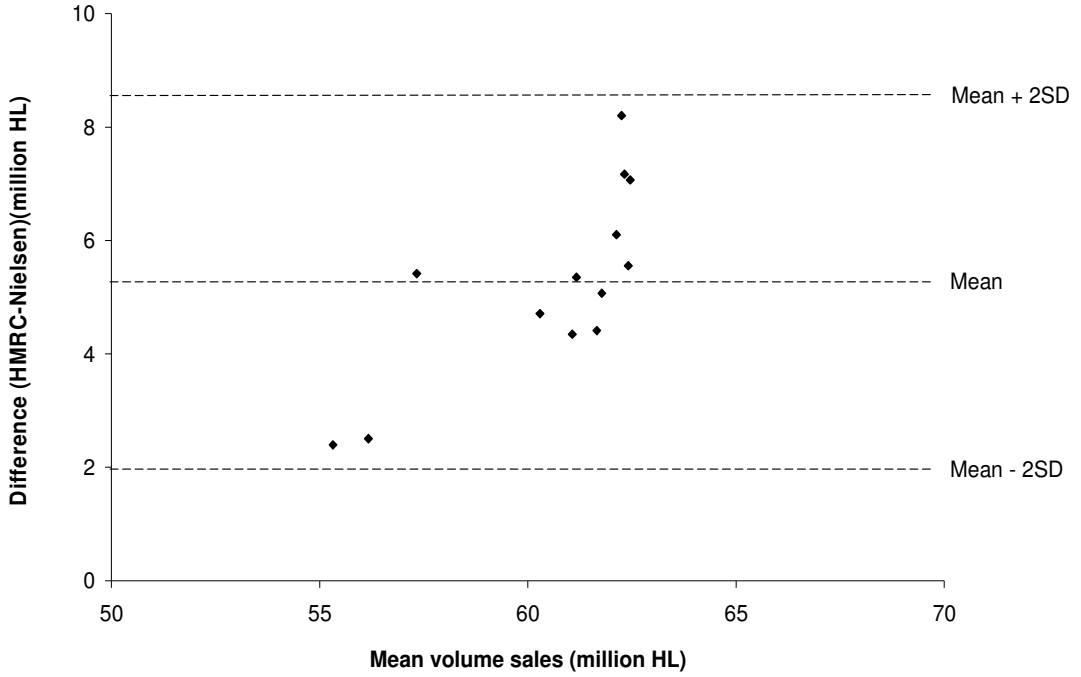
Source: Nielsen/CGA; BBPA Statistical Handbook[49].

Figure A3: Bland-Altman plot of the difference against the mean for estimates of wine sales derived from Nielsen/CGA and HMRC data.



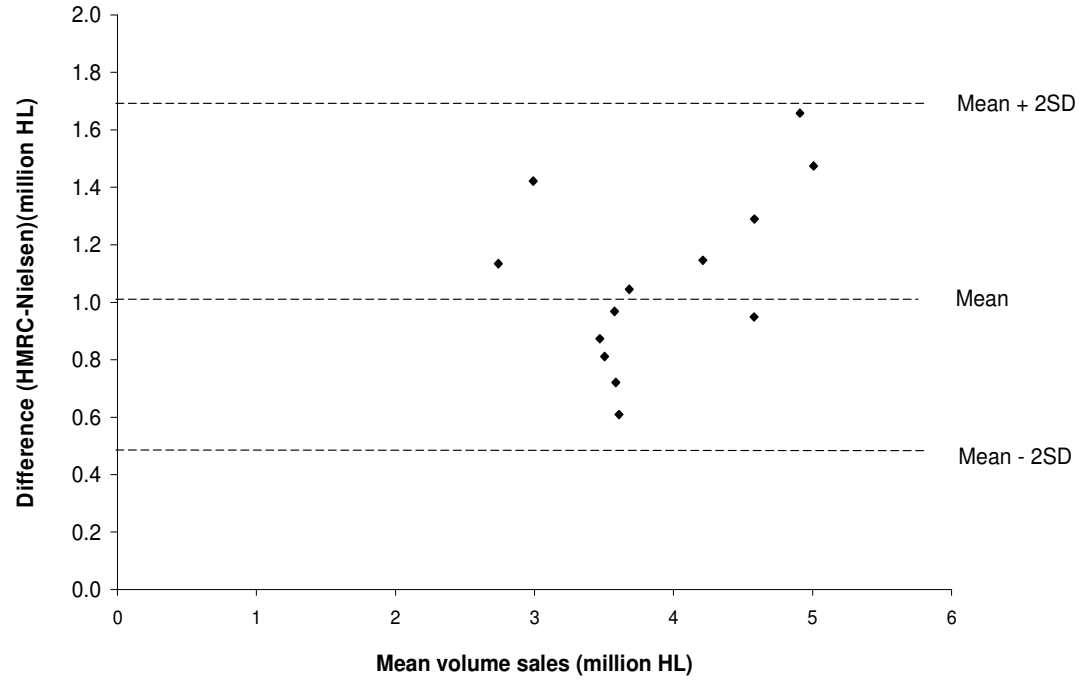
Source: Nielsen/CGA; BBPA Statistical Handbook[49].

Figure A4: Bland-Altman plot of the difference against the mean for estimates of beer sales derived from Nielsen/CGA and HMRC data.



Source: Nielsen/CGA; BBPA Statistical Handbook[49].

Figure A5: Bland-Altman plot of the difference against the mean for estimates of cider/perry sales derived from Nielsen/CGA and HMRC data.



Source: Nielsen/CGA; BBPA Statistical Handbook[49].

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All web links were verified as working on 6th March 2012

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