# The CIE

# NSW Container Deposit Scheme

Impacts on beverage expenditure and consumption

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# *Executive summary*

The NSW Container Deposit Scheme commenced on December 1st 2017. This scheme pays a ten-cent refund to consumers who return an eligible drink container, with the payments funded by a levy on suppliers of containers. The purpose of this report is to estimate whether the introduction of this scheme has had an impact on:

- the quantity of beverages purchased for consumption in NSW
- the amount of money spent by consumers on beverages in NSW
- the market shares of large and small retailers in NSW.

This report follows the same approach as a draft report released in September 2018. It includes new data up to the end of October 2018.

This work has been commissioned by the Independent Pricing and Regulatory Tribunal of NSW and is designed to complement other analysis into the impacts of the CDS on prices paid by NSW consumers of beverages.

## Datasets used

This analysis is conducted using two primary data sources:

- the Nielsen Homescan Panel — this provides data for households who scan their individual purchases of products, providing transaction data for each beverage purchased by the households. The household coverage is across all of Australia. The time period coverage is from January 2016 to October 2018
- administrative data from Exchange for Change — this provides containers sold by material type (aluminium, glass and plastic) for each first supplier. The time period covered is December 2016 to September 2018. This dataset was made available to the CIE under strict confidentiality conditions

## Estimated impacts of the CDS on expenditure and consumption

The results presented in this report are updated results from our draft report in September 2018, which analyses new data to the end of October 2018. This report utilises a more complete dataset, with eleven months of observations in which the CDS has been in force.

- There is a significant amount of variation in the underlying consumption data used for the analysis. This makes it more challenging to identify the impacts of the CDS versus the impacts of other factors

- There are strong seasonal effects (beverage consumption is typically higher through summer) which coincides with the introduction of the CDS, and different seasonal patterns across states.

Bearing this in mind, the main results from the analysis in this report are shown in table 1.

### 1   Summary of conclusions

| Sector | Consumption | Expenditure |
|---|---|---|
| Non-alcoholic beverages | Estimated reduction of 6.7 per cent or 950 mL per household per month<br>The largest impacts (by volume) are from soft drinks, followed by water<br>Evidence of larger impacts for multi-pack products rather than single bottles | Estimated increase of 3.2 per cent or 63 cents per household per month. |
| Alcoholic beverages | No clear evidence of impacts | No clear evidence of impacts |

*Source:* The CIE.

Our estimates show that the CDS has had an impact on the levels of consumption and expenditure in the non-alcoholic beverage market.

- The CDS has reduced **consumption** of non-alcoholic drinks by around 950mL (~6.7 per cent) per household per month. This is primarily driven by reductions in soft drink and bottled water (table 2). This result (at the aggregate level) is statistically significant and robust to changes in model specification.
- These results are driven primarily by lower consumption of multipacks, rather than single beverages.

### 2   Estimated impact of the CDS on consumption of non-alcoholic beverage types

| | Water | Soft drinks | Fruit juices | Total |
|---|---|---|---|---|
| Estimated impact (Litres) | -0.26 | -0.59*** | -0.1 | -0.95*** |
| Standard error | 0.17 | 0.17 | 0.07 | 0.25 |
| Implied percentage change | -9.3% | -7.1% | -3.3% | -6.7% |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE calculations.

- The CDS has increased **expenditure** on non-alcoholic drinks by around 63 cents (3.2 per cent) per household per month (table 3). This result is only significant at the 10 per cent significance level.

### 3   Estimated impact of the CDS on expenditure on non-alcoholic beverage types

| | Water | Soft drinks | Fruit juices | Total |
|---|---|---|---|---|
| Estimated impact ($) | 0.18 | 0.37 | 0.09 | 0.63* |
| Standard error | 0.11 | 0.25 | 0.14 | 0.31 |
| Implied percentage change | 7.8% | 3.2% | 1.6% | 3.2% |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE calculations.

■ **Evidence suggests that consumers have reduced consumption to avoid spending more on beverages due to CDS pass-through**

Throughout the year, there is strong evidence that consumption has fallen as a result of the CDS, whilst expenditure is less likely to have changed. Chart 4 describes the net difference between the year on year change in consumption in NSW and Victoria. As can be seen, consumption in NSW has fallen in every month relative to the counterfactual (which is a similar state with no CDS). These falls are matched by the estimate from the econometric model.

**4  Difference in differences – year on year change in consumption (non-alcoholic)**
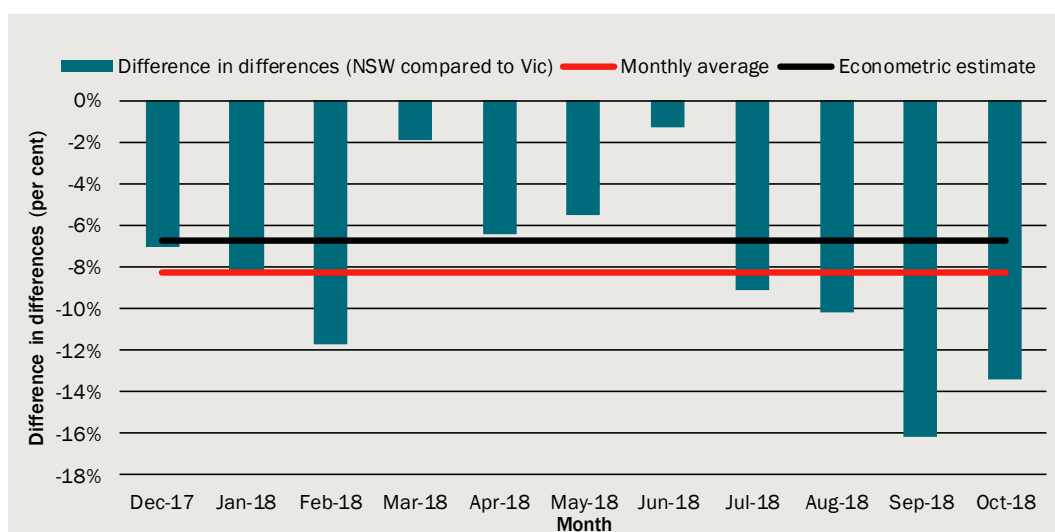


*Data source:* CIE analysis, Nielsen Homescan.

Similarly, chart 5 describes the net difference between the year on year changes in expenditure across the two states. Unlike consumption, the monthly changes for expenditure are not as consistent. In our draft report, which analysed data up to June, we found evidence of an increase in expenditure. Since then this trend has reversed and, while both states have experienced rises in expenditure in recent months, the growth in expenditure in Victoria has been stronger. These changes have led to a smaller overall impact on expenditure for the year, as well as a less statistically significant finding for an expenditure increase.

This result for expenditure suggests that consumers have taken time to adjust to the price increase. However, this could also reflect other non-CDS related factors that cannot be accounted for in the analysis

**5   Difference in differences – year on year change in expenditure (non-alcoholic)**
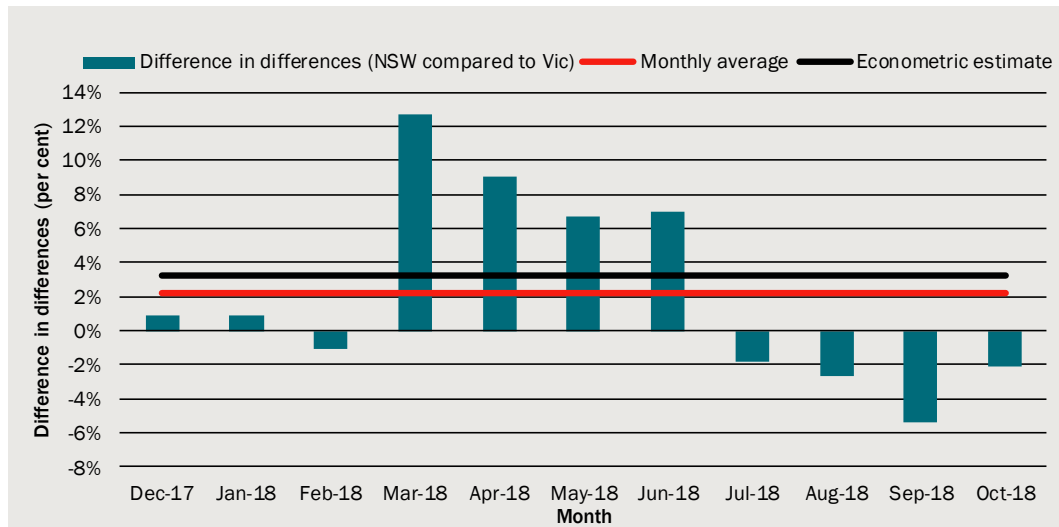


*Data source:* CIE analysis, Nielsen Homescan.

Taken together, the changes in consumption and expenditure make it reasonable to conclude that most consumers have changed their behaviour as a result of the CDS. The price increases caused have led consumers to reduce their consumption, rather than maintain their pre-CDS consumption levels, absorb the CDS price passthrough and spend more on beverages. In essence, the fall in consumption largely offsets the impact more expensive beverages would have on household budgets[1].

We would also expect that for consumers with high participation in 'earn and return', the CDS price increases would not constitute 'real' price increases, since a refund is available. These customers may be more likely to maintain their consumption patterns and increase their expenditure at retailers, knowing that this increase will be compensated by container refunds.

*Reliability of the results*

One way to test the reliability of the main conclusions above is estimate the impact of the CDS using different modelling assumptions. This report conducts a sensitivity analysis with respect to:

- whether to use Victorian households as the 'control group' in the regression, or include all Australian states and territories
- whether to allow seasonal trends that vary by state, and
- whether to fit a linear or logistic model.

The range of estimates generated by changing these assumptions is shown in chart 6. This shows that the estimates regarding non-alcoholic consumption are relatively robust to the changes in model specification, while the results for alcoholic beverages are quite sensitive. This provides further reason to interpret the alcohol results with caution.

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1   If the fall in consumption exactly offsets the price increase, then this is known as a unit elastic demand curve.

**6   The sensitivity of the main results to different modelling assumptions**
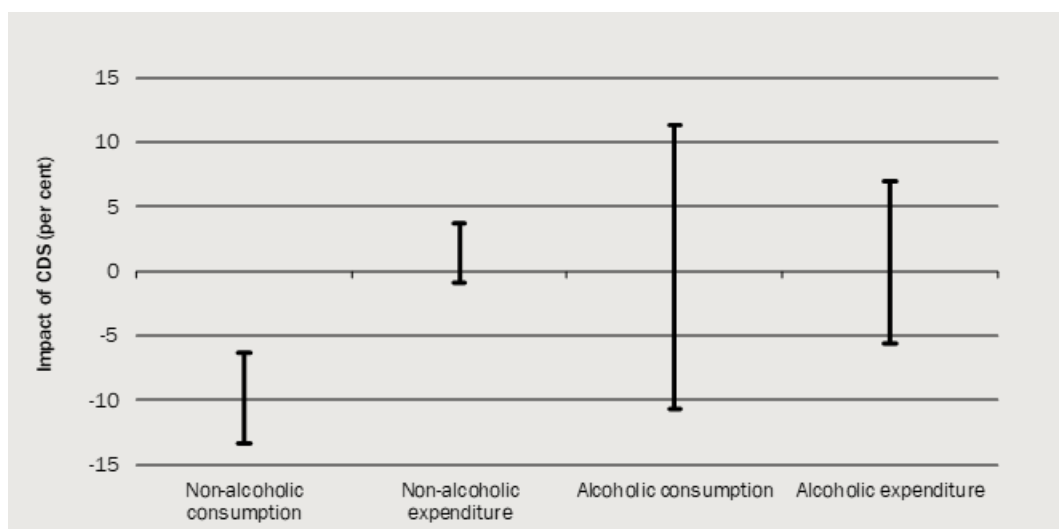


*Data source:* CIE calculations.

## *More detailed estimates*

In addition to the average estimates of the CDS that are reported above, this report also estimates the impact of the CDS across a variety of market categories, including:

- the impact of the CDS by month since the CDS was introduced
- the impact by beverage category
- the impact for large and small retailers and for larger and small suppliers
- the impact in metropolitan versus regional areas

While these estimates provide interesting insight into what is occurring in the NSW beverage market, they are conducted using smaller sample sizes and are typically less reliable than the main estimates.

We find no evidence of differences in impacts for large or small retailers or large or small suppliers.

# 1    Introduction

The NSW Container Deposit Scheme (CDS), Return and Earn, commenced on
1 December 2017. This scheme allows for containers returned to collection points to earn
a 10-cent refund and for containers recycled by materials recovery facilities (MRFs) to
also receive a refund that will be shared between MRFs and local councils. The cost of
the scheme, including the refund, is paid for at the point of (and by any entity responsible
for) first beverage supply into NSW.

## What the CIE has been asked to do?

The Independent Pricing and Regulatory Tribunal of NSW (IPART) has been asked by
the Premier to monitor and report on the impact of the implementation of the Container
Deposit Scheme (CDS) on container beverage prices. In particular, IPART will monitor
and report on:

1   the effect of the CDS on prices of beverages supplied in a container,

2   the effect of the CDS on competition for beverages and the performance and conduct
    of suppliers, and

3   any other market impacts on consumers that arise from the commencement of the
    CDS, for the period from 1 November 2017 to 1 December 2018 (monitoring period).

To inform this reporting process, IPART NSW has asked the Centre for International
Economics to conduct a quantitative analysis of beverage consumption data that
identifies:

- the impact of the CDS on consumer spending on alcoholic and non-alcoholic
  beverages, including:
  - whether there is an observed change in quantity consumed and/or money spent on
    beverages in each section of the beverage market
  - whether this varies by geographic region
  - whether this varies by beverage category, or between different sizes of beverages.
- the extent to which the CDS has impacted on the market share of small retailers
  relative to large retailers.

This analysis is conducted using two data sources:

- the Nielsen Homescan Consumption Panel, which tracks the consumption behaviour
  of a representative sample of Australian households.
- administrative data from Exchange for Change, which includes the total quantity of
  each type of beverage sold in NSW by each supplier.

The analysis contained in this report is designed to complement other analysis being conducted for the IPART review of the CDS. For instance, IPART is conducting an analysis of price changes that have occurred following the CDS.

## Expected impacts of the CDS

The aim of the container deposit scheme is to incentivise the return of beverage containers on the part of consumers in the form of a 10-cent refund per bottle. As this mechanism is funded on an industry levy, first suppliers of beverages in NSW effectively pay for the refund (although this cost may be passed onto customers). With respect to consumer behaviour, consumers may change their patterns of beverage consumption as a result of the CDS. These changes will be driven by:

- The extent to which the CDS levy is passed through the beverage supply chain to consumers
- The extent to which these price increases are perceived as real price increases – i.e. to what extent is the retail price increase of beverages offset by the refund from container returns.

The interactions between these two forces could lead to unique outcomes regarding overall demand for beverages in NSW. Under a scenario with full participation in 'Return and Earn', any passthrough of the CDS charge would be largely offset by the refunds. In this case, the price increase would be neutralised, and it would be reasonable to expect little change in consumer patterns regarding beverages. Alternatively, for customers who do not participate in Return and Earn, CDS passthrough would constitute a real price increase, and, depending on overall sensitivity to price increases, this could lead to a decrease in demand for beverages. This could be the case for households who find it costly to participate in Return and Earn due to a lack of nearby collection facilities.

### Changes in overall beverage consumption vs expenditure

Theoretically, we would expect that:

- the CDS would increase the price of beverages, as some part of the CDS levy is passed through to consumers
- in response, consumers would reduce the amount of consumption of CDS-eligible products
- the overall impacts of the CDS on a household's expenditure on beverages could go up or down depending on which of the above impacts is larger
  - if the reduction in consumption is proportionally larger than the increase in prices, then expenditure would fall. For example, if prices increase by 5 per cent and quantity consumed falls by 10 per cent, the expenditure on beverages will fall
  - if the reduction in consumption is proportionally the same as the increase in prices, then expenditure would remain the same

– if the reduction in consumption is proportionally smaller (inelastic, but not perfectly inelastic) than the increase in prices, then expenditure would increase

This suggests that, overall, we would expect to find stronger results for impacts on consumption. In practice, however, the impacts expenditure and consumption can vary and will depend on the relative strengths of price sensitivity and participation in Return and Earn (chart 1.1).

**1.1   Different impacts on consumption and spending**

| Elastic | Inelastic | Unit elastic |
|---|---|---|
| Decreased consumption | Decreased consumption | Decreased consumption |
| Decreased spending | Increased spending | Unchanged spending |

*Source:* CIE Illustration.

The changes in consumer purchasing patterns may not occur immediately. There may also be complicated responses to the CDS within beverage types. For example, people may substitute to larger products, because these have a lower proportional CDS levy — a 1.5L soft drink has the same CDS charge as a 0.5L soft drink.

Within different regions there could also be different effects. This could partly reflect the income levels or demographic characteristics that vary between regional and metropolitan areas.  However, it could also reflect design elements of the CDS. For instance, if people in regional areas were typically further away from a collection depot, then they may be more likely to reduce consumption following the introduction of the CDS. For areas on the border, it could also reflect people being able to purchase product from neighbouring states that does not have a CDS levy added into the price.

## *The empirical approach*

The main empirical approach used in this report to estimate the impact of the CDS is a fixed effects regression model using household level consumption and expenditure data from the Nielsen Homescan Consumer Panel (box 1.2).

The intuition behind this approach is that it compares the behaviour of households before and after the introduction of the CDS in New South Wales and in a control group (Victoria in the main specification). If the typical household in NSW reduces consumption (compared to the control group) following the introduction of the CDS, then the model will identify this change as the impact of the CDS. Likewise, if the control group increases consumption whilst NSW does not, this would also reflect an impact of the CDS.

The main challenges with this approach are:

■ noisy underlying consumption data: This is particularly the case with alcohol consumption data which has significantly fewer observations than non-alcoholic consumption data

■ seasonal trends in beverage consumption: There is a strong seasonal trend in beverage consumption that coincides with the introduction of the CDS (people tend to drink

more in summer). If this is not adequately accounted for, then it will impact on the estimated impact of the CDS.

These issues have been better accounted for since the draft report in September 2018. Almost a full year of observations have allowed for better treatment of seasonal effects. The improvements however, do not extend to the alcoholic beverage data due to a smaller sample.

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### 1.2　The fixed effects regression model

The impact of the CDS on beverage consumption is estimated using a fixed effects regression model. The main specification of this model is:

$$Y_{it} = \alpha_i + \beta_{1t} + \beta_{2t} + cds*nsw_{it} + u_{it}$$

Where:

- $Y_{it}$ is the predicted variable, which include monthly expenditure, monthly consumption (in litres), log of consumption and log of income.
- $\alpha_i$ is a household level fixed effect that estimates the different level of demand at the household level
- $\beta_{1t}$ is a time-based fixed effects that capture general trends in consumption of beverages across Australia.
- $cds*nsw_{it}$ captures the effect of the CDS. It is a dummy that occurs among household in NSW after the start of the CDS.
- $u_{it}$ is the error term

The model is estimated on a monthly household panel which is generated from the Nielsen data, and is estimated independently on each beverage type.

A variety of alternative specifications were tested, including fitting a log model, incorporating seasonal trends (in addition to time fixed effects), and using all of Australia rather than Victoria as the control group. The main results from these specifications are shown in Appendix A.

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## *Interpreting the results*

This report estimates the impact of the CDS on a range of outcomes in the beverage market and some of these results are more reliable than others. In general, results are more reliable where they are:

- **Statistically significant**. Estimates in the report are reported with a measure of statistical significance. This is a technical measure of whether the estimate is likely to be a systematic impact of the CDS, as opposed to being generated by chance. Our report measures the magnitude of significance at the 10 per cent (*), 5 per cent (**) and 1 per cent (***) significance levels. An estimate will be statistically significant if most households show impacts in the same direction. While statistical significance is a very useful measure of model accuracy, it does have limitations. For instance, the

statistical significance of a result is typically driven by the sample size, and so it is much more likely that the estimates will be statistically significant for larger consumption categories, even if the impact was the same across categories. A statistically significant result could be found (or not found) also depending on whether there was another factor omitted from the analysis that occurred at the same time as the CDS. For example, if there was particularly hot weather since the CDS was introduced that led to greater beverage consumption across a lot of households, then this could show up as a statistically significant increase from the CDS.

- **Robust to modelling assumptions:** The estimation of the impact of the CDS is conducted using a fixed effects regression, and the estimated impact of the CDS can be impacted by the setup of this model. The appendix to this report tests the sensitivity of the main results to these modelling choices.

- **Relatively stable across time periods**. This report estimates the impact of the CDS by month. If the estimates are relatively stable across the analysis period, it is a sign that the estimates are relatively reliable.

- **Consistent with economic theory.** In some cases, the model generates results that are at odds with economic theory (for instance, in the alcohol section, the modelling suggests that the CDS is responsible for a statistically significant increase in beer consumption). In such cases, it is highly likely that the result is due to noise in the underlying data, rather than the CDS resulting in an increase in beer consumption.

The results in this report are typically better estimated for non-alcoholic beverages, while smaller sample sizes mean that the estimates for alcoholic beverages and analysis of smaller market categories is typically less reliable.

# 2    Data sources

This report analyses the impact of the CDS using two primary data sources. This chapter describes those data sources in detail and identifies their strengths and weaknesses.

## Nielsen Homescan Consumer Panel

The Nielsen Homescan Panel survey collects data on household consumption for 10 000 households across a wide variety of product categories. Survey participants scan the barcode of the products that they purchase which are combined with retail price data to create a panel dataset of consumption data.

For this study, the transaction level data for all beverage products purchased from January 2016 – October 2018 have been used. This data includes:

- a detailed description of the product purchased (e.g. Coca Cola Value Pack 30x375ml)
- the price that was paid
- the retailer
- the data of the transaction
- the location of the transaction (broken down into 14 regions within Australia)

For this study, these transactions were grouped into six categories, which include Beer, Wine, Spirits, Water, Soft drinks and Juice.

The Homescan survey is designed to capture products that are purchased at a retail outlet for consumption at home. Therefore, the data does not contain information on beverages purchased through other channels, including:

- beverages purchased through the hospitality sector (such as bars and cafes)
- beverages purchased and consumed away from home (such as a drink purchased at a petrol station)
- beverages purchased by groups other than households (such as businesses)
- beverages consumed but not scanned for any other reason.

## *Administrative data from exchange for change*

Exchange for Change maintains an administrative dataset on 758 first suppliers registered with the scheme. This dataset maintains monthly historical information on container volume supply dating back to September 2016, as well as recent records during the CDS billing period up to September 2018. Further, information on container volumes are specified by container type, including containers made from:

- Aluminium
- Glass
- PET
- HDPE
- LPB
- Steel
- Other plastics
- Other materials

This dataset was made available to the CIE under strict confidentiality conditions. Using this information at the supplier level, it is possible to track changes in overall supply across the different container types, as well as by alcoholic and non-alcoholic beverages to measure changes in supplier market share since the introduction of the CDS.

# 3    Impacts on consumers of non-alcoholic beverages

**Key points**

■ Econometric modelling of the individual non-alcoholic beverage categories is supportive of the CDS reducing the consumption (in litres) and increasing expenditure. The noise in the data means that measured impacts are not always statistically significant. The reduction in consumption is a consistent finding across different model specifications. This pattern is also consistent across the different months since the CDS has applied, as well as the range of container types such as multipacks.

■ The estimated magnitude of the reduction in consumption across all non-alcoholic beverages is ~6.7 per cent

■ The most consistent finding is impacts for soft drinks, which showed statistically significant falls in consumption. These results were robust to sensitivity tests and different model specifications.

■ The impacts of the CDS were estimated at the container size level. As large multi-packs of beverages are typically cheaper per beverage, the CDS is a larger proportional share of the original product price and may therefore be more impacted. Evidence suggests that the largest reductions in consumption occurred for multi-packs of soft drinks.

■ The impacts of the CDS were measured across regions of NSW. The estimates imply reduced consumption and increased expenditure across Sydney and regional NSW, although the estimates for regional NSW were not all statistically significant. There is limited evidence to suggest that the CDS has had different impacts across different parts of NSW.

## Changes in average household expenditure and consumption

Utilising a panel dataset on household spending and consumption patterns, it is possible to track a sample of households across different geographic locations in NSW over time. By comparing the behaviour of households in NSW to another state such as Victoria, which has not since implemented a similar scheme to the CDS, it is possible to analyse differences in average household behaviour towards non-alcoholic beverages since the introduction of the CDS in NSW.

As can be seen, expenditure and consumption levels on non-alcoholic beverages in NSW has fluctuated over time (chart 3.2 and 3.1). Most notable is the similarity in the profiles of households in NSW with households in Victoria, including during seasonal months such as December, which is associated with a yearly peak in spending and consumption

followed by falls in January. The time series track closely together over time, suggesting that Victorian households represent a good 'control group' for the estimation of the impact of the CDS.

Since the introduction of the CDS, expenditure and consumption of non-alcoholic beverages has fallen in both NSW and Victoria following the typical seasonal trend in beverage consumption.

### 3.1    Average household consumption of non-alcoholic beverages – 2016-18
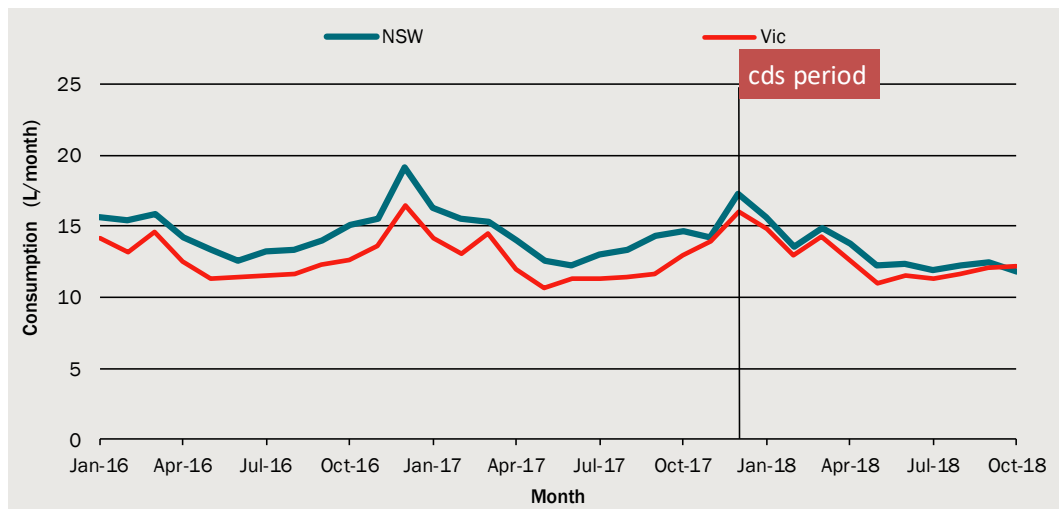


*Data source:* Nielsen Homescan.

### 3.2    Average household expenditure on non-alcoholic beverages – 2016-18
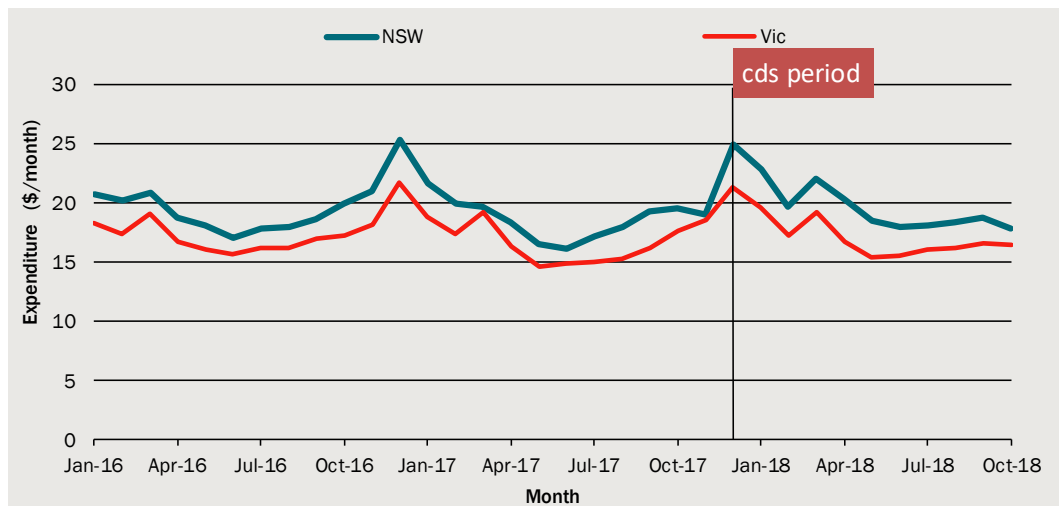


*Data source:* Nielsen Homescan.

The time series indicates that Victoria is a good control group for this analysis. Looking at the year on year changes in non-alcoholic beverage consumption between the two states provides compelling evidence of a CDS impact in NSW. Chart 3.3 is the net difference between the year on year change in consumption in NSW and Victoria. For example, in December 2017, consumption in NSW fell by 10 per cent, whilst consumption in Victoria fell by 3 per cent, the net difference is a 7 per cent fall. On

average, this analysis suggests a that consumption is around 8 per cent lower than the previous year since the introduction of the CDS.

### 3.3    Difference in differences – year on year change in consumption
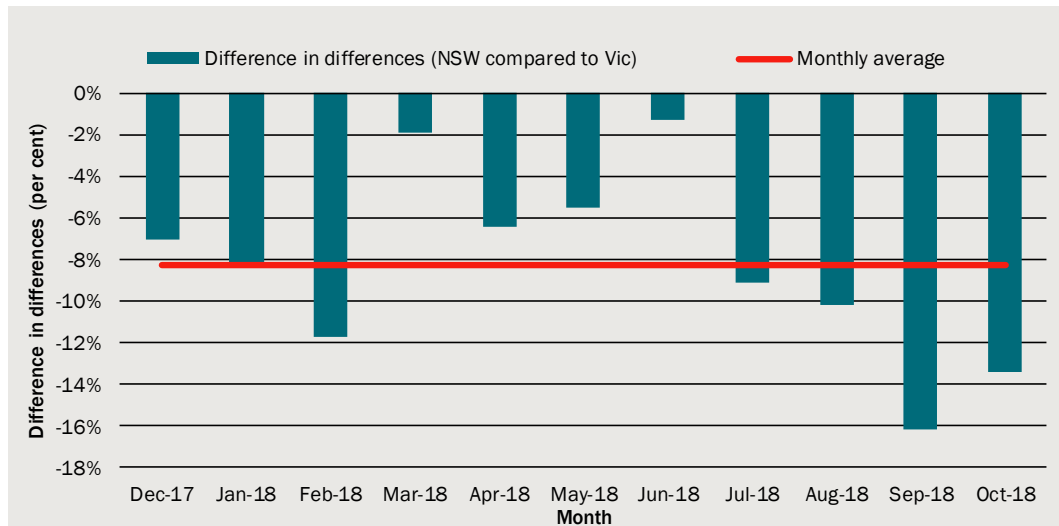


*Data source:* CIE analysis, Nielsen Homescan.

Similarly, chart 3.4 presents the difference in differences for non-alcoholic expenditure. Overall, there are less months where expenditure in NSW has increased relative to Victoria, except for the period March-June 2018. On average, this analysis suggests that expenditure is around 2 per cent higher than the previous year since the introduction of the CDS.

### 3.4    Difference in differences – year on year change in expenditure
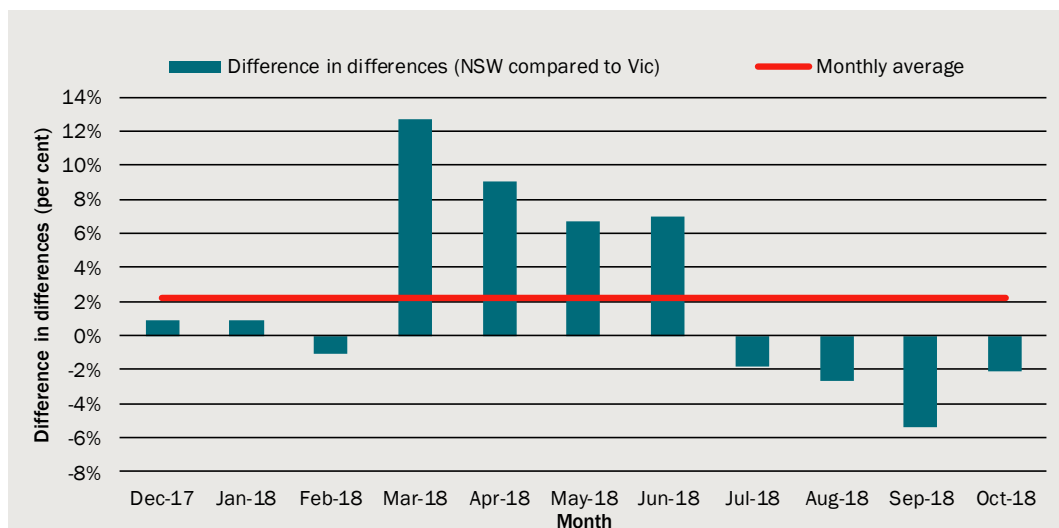


*Data source:* CIE analysis, Nielsen Homescan.

This graphical analysis provides an overview of the trends in beverage consumption in NSW and Victoria. However, on its own, it is unclear whether the changes in consumption are due to the CDS or just due to natural variation in the underlying data. It is also possible that the impact of the CDS could be obscured by changes in household composition, or by aggregation of beverages (some of which are not included in the CDS). The formal analysis in the following section is based on the same intuition as this graphical analysis, but is designed to better isolate the impact of the CDS through more rigorous statistical tests.

## Changes in household spending and consumption by beverage type

This section presents the main modelling results of the impact of the CDS on non-alcoholic beverage consumption and expenditure in NSW. The results are reported by month, and by beverage category. They are also estimated as the change in dollars (expenditure) and change in litres (consumption), which can be compared to the average household consumption in chart 3.5).

### 3.5    Average NSW consumption and expenditure on non-alcoholic beverages

| Product category | Expenditure | Consumption |
|---|---|---|
|  | $/household/month | L/household/month |
| Fruit juices | 5.5 | 3.0 |
| Soft drinks | 11.6 | 8.3 |
| Water | 2.3 | 2.8 |

*Source:* CIE analysis based on Nielsen Homescan data.

The reported impact of the CDS is based on the 'preferred' model, which is described in box 2.2, and includes household and time fixed effects, and estimates the impact of the CDS separately in each month. Various alternative specifications were tested, with the results from the models presented in Appendix A.

### Summary of estimates for the CDS period

The CDS has reduced consumption of non-alcoholic drinks by around 950mL (~6.7 per cent) per household per month. This is driven by reductions in soft drink (table 3.6). This considers the impact of the CDS since its introduction on average, rather than with a different month-to-month effect.

### 3.6    Estimated impact of the CDS on consumption of non-alcoholic beverage types

|  | Water | Soft drinks | Fruit juices | Total |
|---|---|---|---|---|
| Estimated impact (Litres) | -0.26 | -0.59*** | -0.1 | -0.95*** |
| Standard error | 0.17 | 0.17 | 0.07 | 0.25 |
| Implied percentage change | -9.3% | -7.1% | -3.3% | -6.7% |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.

The CDS has increased expenditure on non-alcoholic drinks by around 63 cents (3.2 per cent) per household per month, driven mainly by increases in soft drink expenditure (table 3). This result is only significant at the 10 per cent significance level (compared to 5 per cent significance in our draft report). An unchanged expenditure level and lower consumption would imply a unit elastic response to price increases.

By using the estimated changes in consumption and expenditure, it is possible to infer the change in price of non-alcoholic beverages. This can be determined based on the mechanics of price elasticity of demand, which measures the percentage change in consumption that results from a given percentage change in price:

- A unit elastic customer would decrease consumption by the same proportion as the increase in price. Under these conditions, the estimated price impact would equal to 6.7 per cent (which is the estimated fall in consumption).

- If expenditure also increased however, this would suggest some degree of price inelasticity (a less than proportionate change in consumption for a given change in price). If customers were perfectly inelastic (unchanged consumption and increased expenditure), then we would interpret the 3.2 per cent increase in expenditure as the full price effect.

- Taking into consideration both a change in consumption and expenditure, the sum of reduced consumption (6.7 per cent) and increased expenditure (3.2 per cent) would imply that the price effect must be ~9.9 per cent.

The degree of price inelasticity (as given by consumption and expenditure moving in opposite directions) could be due to the price offsets experienced by households that participate in container returns. This is because households that receive a refund from container returns do not perceive the price increase of a beverage as a full price increase and therefore do not change their consumption patterns.

### 3.7 Estimated impact of the CDS on expenditure on non-alcoholic beverage types

|  | Water | Soft drinks | Fruit juices | Total |
|---|---|---|---|---|
| Estimated impact ($) | 0.18 | 0.37 | 0.09 | 0.63* |
| Standard error | 0.11 | 0.25 | 0.14 | 0.31 |
| Implied percentage change | 7.8% | 3.2% | 1.6% | 3.2% |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE calculations.

If we model the impact of the CDS on aggregate non-alcoholic beverage consumption and expenditure, using different model specifications (see Appendix A), the reduction in consumption is robust to model specification changes (chart 3.8). The impacts on expenditure range from positive to near zero across the different models tested.

### 3.8    Impacts of the CDS on non-alcoholic beverages across different models
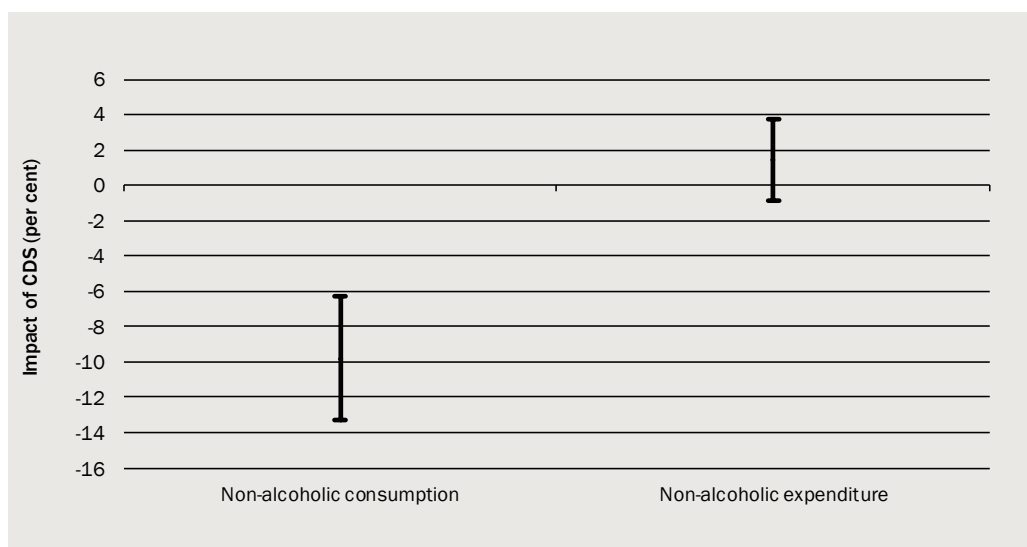


*Data source:* CIE.

## *Month-by-month estimates*

The estimated impact of the CDS on non-alcoholic beverage consumption and expenditure is presented on a month-by-month basis is shown in table 3.9 and 3.10.[2] the estimates show consistent falls across the months in consumption and rises in expenditure (followed by non-significant falls in expenditure after July), although most of the statistically significant changes are for soft drinks. Of interest is the fall in consumption during November 2017, one month prior to when the CDS was introduced. Whilst this could reflect some degree of 'anticipation impact', it is more likely a feature of the volatility in monthly estimates (e.g. due to the sampling periods in any one month comprising an additional weekend compared to other months). The results for soft drinks are more robust than for water and juice, which comprise relatively lower shares of the sample.

### 3.9    Estimated impacts on non-alcoholic beverage consumption

|         | Soft drinks | | Water | | Juice | |
|---------|-------------|----------|---------|----------|---------|----------|
|         | L/month | Per cent | L/month | Per cent | L/month | Per cent |
| Nov-17  | -1.08*** | -13.0 | -0.6** | -26.2 | -0.04 | -1.2 |
| Dec-17  | -0.45 | -5.4 | -0.41* | -17.7 | 0.15 | 4.8 |
| Jan-18  | -0.43 | -5.2 | -0.51* | -22.0 | -0.04 | -1.3 |
| Feb-18  | -0.74*** | -8.9 | -0.22 | -9.5 | -0.12 | -3.8 |
| Mar-18  | -0.92*** | -11.1 | -0.23 | -10.2 | 0.04 | 1.3 |
| Apr-18  | -0.27 | -3.3 | -0.27 | -11.7 | 0.08 | 2.7 |
| May-18  | -0.12 | -1.5 | -0.1 | -4.4 | -0.27** | -9.0 |

---

2    Note that the average of the monthly estimates for December 2017 to June 2018 will be close to the impacts of the CDS on average, although not necessarily the same.

| | | | | | |
|---|---|---|---|---|---|
| Jun-18 | -0.52* | -6.2 | -0.3 | -13.2 | -0.14 | -4.5 |
| Jul-18 | -0.76*** | -9.1 | 0.05 | 2.0 | -0.23** | -7.7 |
| Aug-18 | -0.83*** | -10.0 | -0.08 | -3.4 | -0.19* | -6.3 |
| Sep-18 | -0.9*** | -10.8 | -0.42* | -18.3 | -0.23** | -7.6 |
| Oct-18 | -1.22*** | -14.7 | -0.72*** | -31.5 | -0.19* | -6.3 |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE analysis based on Nielsen Homescan data.

### 3.10 Estimated impacts on non-alcoholic beverage expenditure

| | Soft drinks | | Water | | Juice | |
|---|---|---|---|---|---|---|
| | $/month | Per cent | $/month | Per cent | $/month | Per cent |
| Nov-17 | -1.37*** | -11.8 | -0.41*** | -17.8 | -0.13 | -2.4 |
| Dec-17 | 0.83* | 7.2 | 0.11 | 4.8 | 0.42** | 7.6 |
| Jan-18 | 0.66 | 5.7 | 0.2 | 8.7 | 0.16 | 2.9 |
| Feb-18 | 0.04 | 0.3 | 0.19 | 8.3 | 0.13 | 2.4 |
| Mar-18 | 0.13 | 1.1 | 0.31* | 13.5 | 0.34 | 6.1 |
| Apr-18 | 1.06** | 9.1 | 0.12 | 5.2 | 0.43** | 7.8 |
| May-18 | 1.04** | 9.0 | 0.11 | 4.8 | -0.27 | -4.9 |
| Jun-18 | 0.13 | 1.1 | 0.12 | 5.2 | 0.03 | 0.5 |
| Jul-18 | 0.11 | 0.9 | 0.25 | 10.9 | -0.17 | -3.1 |
| Aug-18 | -0.19 | -1.6 | 0.45** | 19.6 | -0.07 | -1.3 |
| Sep-18 | -0.12 | -1.0 | -0.07 | -3.0 | -0.06 | -1.1 |
| Oct-18 | -0.51 | -4.4 | -0.07 | -3.0 | -0.13 | -2.4 |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE analysis based on Nielsen Homescan data.

## *Changes in household spending and consumption by container type*

Another potential impact of the CDS is to generate substitution between beverage categories. This may occur because the CDS levy is charged at the same rate for different bottle sizes and will therefore increase the relative attractiveness of larger bottles, and because multi-packs are typically cheaper per beverage and hence are proportionally more impacted by the CDS levy. For instance, it is possible that people will consume fewer 30 packs of soft drinks (which are charged the CDS levy 30 times) and consume more large bottles of soft drink (which are charged the CDS levy once).

The majority of consumption of water and soft drinks is either single beverages or 10-24 packs (table 3.11).

### 3.11   Consumption by product type

| | Soft drink | | Water | |
|---|---|---|---|---|
| | Volume | Expenditure | Volume | Expenditure |
| | L/household/month | $/household/month | L/household/month | $/household/month |
| Single | 4.4 | 4.9 | 1.1 | 1.3 |
| 2-9 | 0.4 | 1.3 | 0.2 | 0.2 |
| 10-24 | 2.3 | 3.5 | 1.5 | 0.8 |
| 25-40 | 1.2 | 2.0 | 0.0 | 0.0 |
| **Total** | **8.3** | **11.6** | **2.8** | **2.3** |

*Source:* CIE based on Nielsen Homescan data.

To test for this effect, the fixed effects model is re-run with products differentiated by different container sizes. Due to limitations on the number of observations across the beverage types, this analysis is limited to soft drinks and bottled water and is estimated as an average intercept across the seven months of the CDS (table 3.12).

Of note is the relatively stronger impact on larger multipack products for soft drinks of 10-24 packs and 25-40 packs. Consumption is estimated to have fallen by ~13 and ~20 per cent respectively (at the 1 cent significance level).

### 3.12   Estimated impact of the CDS by container size

| | Soft drinks (level change) | Soft drinks (percentage change) | Water (level change) | Water (percentage change) |
|---|---|---|---|---|
| | L/household/month | Per cent | L/household/month | Per cent |
| **Consumption** | | | | |
| Single pack | -0.02 | -0.6 | 0.01 | 0.6 |
| 2-9 pack | -0.02 | -3.6 | -0.02 | -8.7 |
| 10-24 pack | -0.31*** | -13.8 | -0.27* | -18.4 |
| 25-40 pack | -0.24*** | -19.7 | na | na |
| **Expenditure** | $/household/month | Per cent | $/household/month | Per cent |
| Single pack | 0.24 | 4.9 | 0.06 | 4.7 |
| 2-9 pack | 0.08 | 6.1 | 0.03 | 14.4 |
| 10-24 pack | 0.11 | 3.2 | 0.07 | 8.8 |
| 25-40 pack | -0.06 | -3.1 | na | na |

*Note:* \*\*\* for 1% significance, \*\* for 5% significance and \* for 10% significance.
*Source:* CIE calculations.

## *Changes in household spending and consumption by region*

An additional consideration with respect to the impact of the CDS is geographic coverage. The degree of price change and sensitivity to such price changes may differ across the state. Also, given that participation in Return and Earn is a determinant of whether price increases are neutralised, proximity to collection facilities across the state

could differ. This is particularly relevant to regional areas, which may involve longer travel times to collection facilities.

Due to there being fewer observations in the dataset in regional areas, the impacts of the CDS were not separated by month, but rather as all periods covered by the CDS. The estimates therefore will provide a measure of how expenditure and consumption across the different non-alcoholic beverage categories has changed since the introduction of the CDS in total (chart 3.13)

Overall, the sign and magnitude of changes across NSW are very similar, with many estimates not statistically significant. The one point of difference is a slightly larger fall in consumption of soft drinks in Southern NSW compared to Sydney. On the balance, however, there is no compelling evidence to suggest that different regions of NSW were impacted differently by the CDS.

### 3.13  Estimated impacts on non-alcoholic beverages by region – average over months

| | Sydney | | Northern NSW | | Southern NSW | |
|---|---|---|---|---|---|---|
| | L/household/month | Per cent | L/household/month | Per cent | L/household/month | Per cent |
| **Consumption** | | | | | | |
| Soft drink | -0.54*** | -6.6 | -0.57 | -6.5 | -0.74*** | -8.9 |
| Water | -0.39* | -13.5 | -0.26 | -8.6 | 0.05 | 1.9 |
| Juices | -0.1 | -3.2 | -0.1 | -3.3 | -0.1 | -3.4 |
| **Expenditure** | $/household/month | Per cent | $/household/month | Per cent | $/household/month | Per cent |
| Soft drink | 0.52* | 4.6 | 0.18 | 1.5 | 0.16 | 1.4 |
| Water | 0.05 | 2.1 | 0.24 | 10.2 | 0.43** | 21.1 |
| Juices | 0.04 | 0.7 | 0.18 | 3.3 | 0.11 | 2.0 |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE analysis based on Nielsen Homescan data.

# 4    Impacts on consumers of alcoholic beverages

**Key points**

- The container deposit scheme applies differently to some types of alcohol. The scheme covers beer sold in bottles and cans, and ready to drink spirits. However, it does not cover bottles of spirits or wine.

- Average household expenditure and consumption of alcoholic beverages is more volatile compared to non-alcoholic beverages. This is partially due to there being fewer observations in the dataset on alcoholic beverages, increasing the difficulty of obtaining robust estimates for the impacts of the CDS.

- There are no clear conclusions on the impact of the CDS that can be drawn for alcoholic beverages.

## *Changes in average household expenditure and consumption*

As can be seen in charts 4.1 and 4.2, consumption and expenditure on alcoholic beverages in NSW have fluctuated over time and follow a seasonal trend. While these trends are somewhat followed by Victoria, the series track much less well than the non-alcoholic beverage data. This means that Victoria is less likely to provide an appropriate control group to estimate the impact of the CDS.

**4.1    Average household consumption of alcoholic beverages – 2016-18**
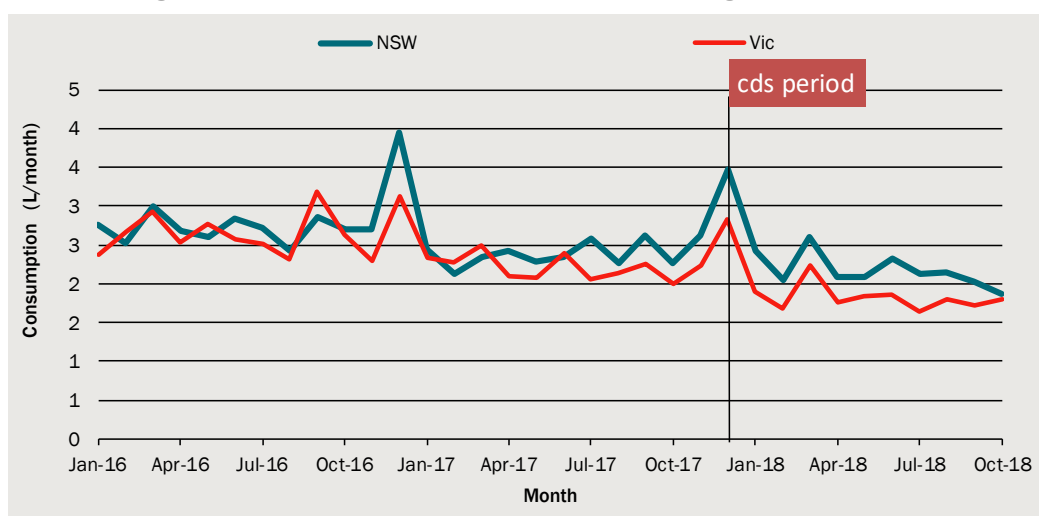


*Data source:* CIE analysis based on Nielsen Homescan data.

## 4.2     Average household expenditure on alcoholic beverages – 2016-18
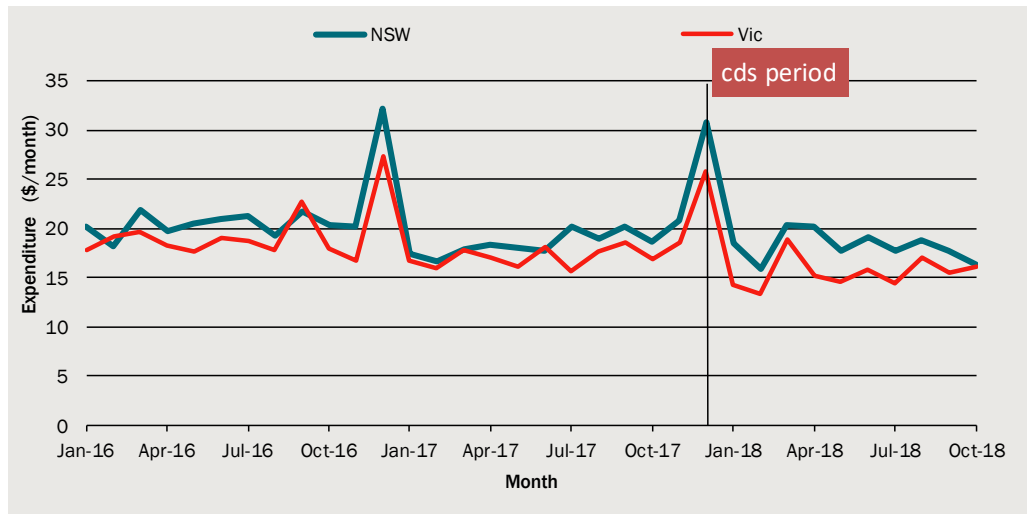


*Data source:* CIE analysis based on Nielsen Homescan data.

The appropriateness of Victoria as a control group is further challenged by the year on year changes in alcoholic beverage consumption (chart 4.3). Victoria (which has not since had a similar scheme to the CDS implemented) shows large falls in alcoholic beverage consumption. These falls are often much larger than those experienced by NSW. It is difficult to identify an impact of the CDS from these headline data and it is most likely driven by the very small proportion of alcoholic beverage observations in the dataset causing high variation.

## 4.3     Year on year changes in alcoholic beverage consumption – NSW and Vic
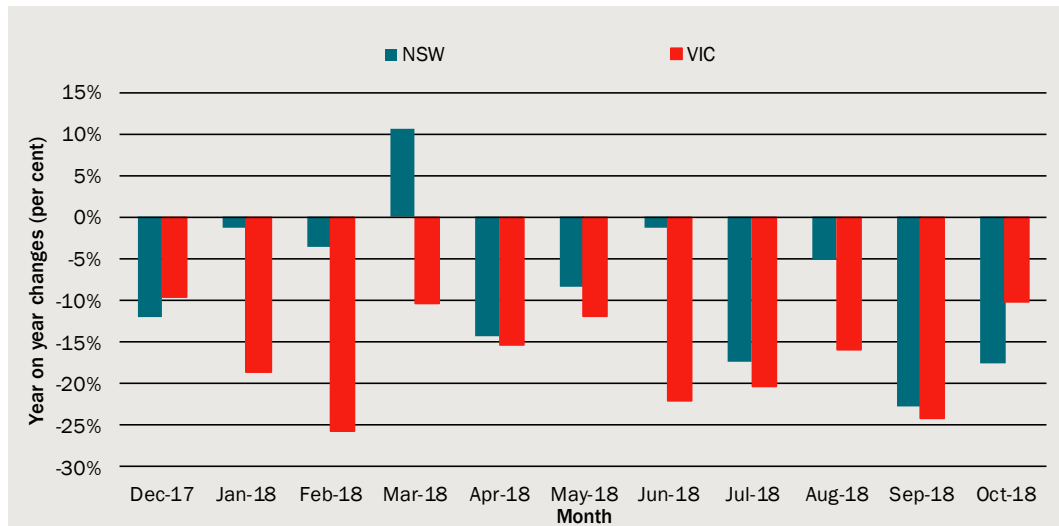


*Data source:* CIE analysis based on Nielsen Homescan data.

## *Changes in household spending and consumption by beverage type*

As was the case for non-alcoholic beverages, the impact of the CDS is estimated using a fixed effects regression model. The dataset indicates average household monthly expenditure on alcoholic beverages between 6 to 7 dollars (table 4.4). The most consumed alcoholic beverage is beer, at 1.3 litres per household per month. It is important to note that consumption of alcoholic beverages at licensed venues is not accounted for in this dataset, which only measures consumption within the home. As such, these averages are most likely to understate actual beverage consumption and expenditure.

### 4.4    Average household expenditure and consumption of alcoholic beverages

| Product type | Expenditure | Consumption |
|---|---|---|
|  | $/household/month | L/household/month |
| Beer | 6.32 | 1.28 |
| Wine | 6.85 | 0.96 |
| Spirits | 6.40 | 0.23 |

*Source:* CIE analysis based on Nielsen Homescan data.

### *Modelled estimates – total CDS period*

The estimated impact of the CDS on alcohol consumption and expenditure are reported in tables 4.5 and 4.6.

The coefficient estimates for the impact of the CDS across the months show no statistically significant impact for beer or spirits (which are covered by the CDS). Likewise, wine (which is exempt from the CDS) has also not changed. The point estimates themselves do not move in the predicted direction, with alcoholic beverage consumption and expenditure estimated to have increased quite strongly since the introduction of the CDS. Whilst not statistically significant, these estimates highlight the challenges presented by a small sample.

### 4.5    Estimated impacts on alcoholic beverage consumption

|  | Beer | Wine | Spirits | Total |
|---|---|---|---|---|
| Estimated impact (Litres) | 0.26 | 0.01 | 0.03 | 0.29 |
| Standard error | 0.15 | 0.05 | 0.03 | 0.16 |
| Implied percentage change | 21% | 1% | 11% | 12% |

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE analysis based on Nielsen Homescan data.

### 4.6    Estimated impacts on alcoholic beverage expenditure

|  | Beer | Wine | Spirits | Total |
|---|---|---|---|---|
| Estimated impact ($) | 1.19 | 0.38 | 0.18 | 1.4 |
| Standard error | 0.7 | 0.43 | 0.45 | 0.87 |

| Implied percentage change | 19% | 6% | 3% | 7% |
|---|---|---|---|---|

*Note:* *** for 1% significance, ** for 5% significance and * for 10% significance.
*Source:* CIE analysis based on Nielsen Homescan data.

This analysis would suggest that there is insufficient evidence that the CDS has impacted alcoholic beverage consumption and expenditure. Given the smaller sample and greater volatility however, these findings should not be taken as conclusive.

## *Robustness across different models*

The estimates of the impacts on alcoholic consumption and expenditure in total are much more sensitive to model specification than for non-alcoholic beverages (chart 4.7).

### 4.7 Impacts of the CDS on alcoholic beverages across different models
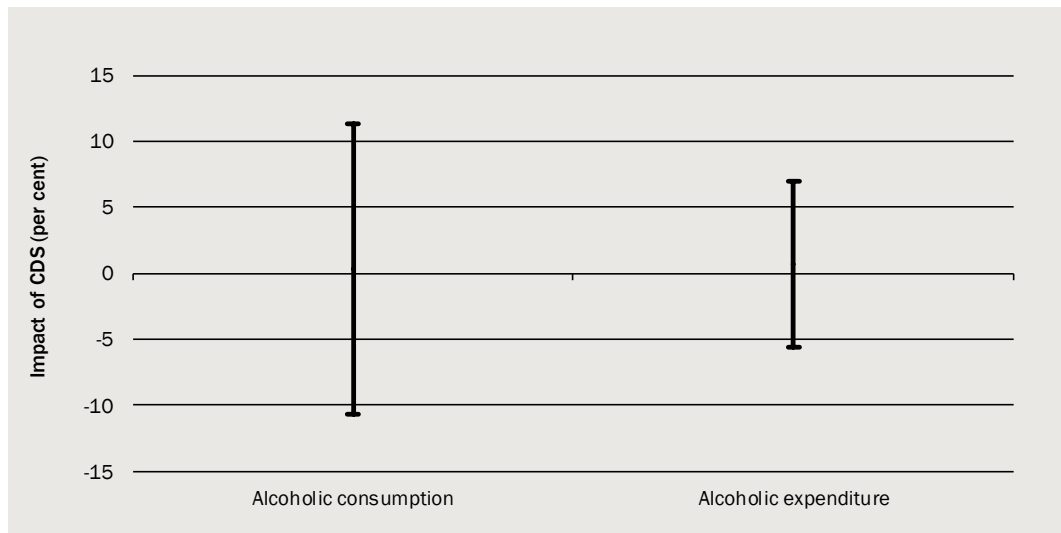


*Data source:* The CIE.

# 5    Impacts of the CDS on market shares

**Key points**

- Beverage supply in the later months of 2018 is lower compared to a year earlier, however these changes could not be statistically proven to be different to the usual volatility of beverage supply.

- There is no clear evidence that market shares between large and small suppliers have been impacted by the CDS.

## The role of first suppliers under the CDS

As of the most recent data provided to IPART by the NSW EPA, the container deposit scheme covers 758 first suppliers across both alcoholic and non-alcoholic beverages. Under the scheme, first suppliers are defined as those who are responsible for supplying beverages into the state. A first supplier can have any role in the supply chain including:[3]

- manufacturers who produce and bottle beverages in NSW

- wholesalers responsible for the delivery of beverages into NSW

- retailers located in NSW responsible for the delivery of beverages into NSW as well as retailers outside of NSW who sell to consumers in NSW (via online, etc…).

Suppliers of beverages that use containers covered by the CDS must register each individual beverage product supplied into NSW and these container. The container types covered by the scheme are predominantly glass, PET and aluminium.

### Levy charged on first suppliers

The operation of the container deposit scheme is funded by a levy on all first suppliers. The fee charged to first suppliers includes:[4]

- the costs of refunds paid to customers

- the costs of refunds paid to MRFs for containers collected in the kerbside recycling system

- network fees to be paid to the network operator TOMRA-Cleanaway (which are determined by competitive tender and offset by the value of the collected recyclable materials)

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3   NSW EPA, NSW First Supply Approach

4   Calculated from the sensitivity tables from the Source: Estimated costs and methodology on the NSW EPA website: http://www.returnandearn.org.au/suppliers

- an Administration Fee paid to the scheme coordinator Exchange for Change (determined by competitive tender)
- a scheme compliance fee paid to the EPA.

The fees paid by each first supplier are proportional to the share of eligible containers sold by the supplier. For example, if a supplier sells 10 per cent of eligible containers under the scheme, they are billed for 10 per cent of the total scheme costs. Whilst different fees apply for different material types, there is no further difference in fees based on factors such as geographic location, likelihood that a product is recycled, or likelihood that a product enters the litter stream.

As the cost structure of the scheme changes, so too will the levies on first suppliers. A large part of this will be due to the recovery rate of containers, which was assumed by the EPA to be at 100 per cent in the first period and 80 per cent by the third period. It is likely that the recovery rate will fall from this initial projection, which means that the levies on suppliers will reduce in the future.

### *Pathways of CDS impacts across different sized suppliers*

The levies charged on first suppliers as a result of the CDS resemble the effects of a tax on supply, which ultimately raises the costs of supplying beverages in NSW. Some important considerations with respect to the impacts on first suppliers relate to:

- the extent to which first suppliers can past through cost increases to end users
- whether these cost increase are bourn more easily by larger suppliers which benefit from economies of scale, and
- whether any asymmetries in these effects across different businesses lead to changes in market share of beverage suppliers.

The extent to which any individual supplier can pass through the costs of the CDS to end users depends on the overall level of market concentration. In general, a greater degree of market power will imply a smaller proportion of the cost increase being passed through to customers. This occurs because in the absence of a tax, a monopolist will be able to charge a higher price than in a competitive market, and a levy such as the CDS reduces the ability of a supplier to extract monopoly rent. Effectively, a monopolist is already charging as high a price as possible and charging any higher would reduce its revenue.

In contrast, in a competitive market a full passthrough of the levy on first suppliers would occur. This is because a condition of competitive markets is that no individual supplier would be able to vary their prices above the competitive level and retain market share since their customers would buy from other suppliers at lower prices. In this instance, the effect of the CDS levy raises the marginal cost of supplying beverages and prices fully adjust to reflect this, with no changes to market share.

## *Impacts on NSW total beverage supply*

A large number of beverages are supplied to NSW each month, with over 2.8 billion individual beverage containers supplied since the start of the scheme[5]. On average, the beverage industry has been charged $25 million each month since the scheme was implemented[6]. To put this into perspective, this equates to around $300 million in CDS levies in annualised terms, which is 9 per cent of the value of manufactured and imported beverages in NSW (chart 5.1).

### 5.1    CDS beverages by sector NSW, based on manufacture and import value

| Sector | Revenue | Share of revenue |
|---|---|---|
|  | $m | Per cent |
| **Alcoholic beverages** | **1 385** | **42** |
| Liquor retailers | 721 | 22 |
| Licensed venues | 425 | 13 |
| Other (exports) | 239 | 7 |
| **Non-alcoholic beverages** | **1 933** | **58** |
| Supermarkets | 1 206 | 36 |
| Consumed at point-of-sale (e.g. cafes) | 504 | 15 |
| Other (on-line, convenience stores) | 222 | 7 |

*Note:* Revenue shares and revenue numbers are calculated as the shares of manufactured and imported beverages supplied to each sector. The revenue is the revenue for the manufacturer and import cost, and does not include wholesale and retail margins. Wine and spirits have been excluded.

*Source:* The CIE, based on data from MCAAY & Curtin University: A guide to the alcohol industry, major alcohol companies in Australia: producers and distributors and IBISWorld.

In light of these cost increases on the part of beverage first suppliers, it is of interest to see if the overall total volume of beverage supply in NSW has decreased as a result. Of most relevance are beverage containers made from Aluminium, Glass and PET as these are used to bottle most beverages across the alcoholic and non-alcoholic variety. Most notably, the time series on total beverage supply indicates:

■ seasonal peaks in beverage supply in the months of December, which is generally associated with greater beverage consumption over the holiday/festive period.

■ seasonal falls in the months of January, indicating typically reduced supply following the end of the festive season.

The year on year changes in beverage supply provide a better indication of the differences between supply in the CDS billing months compared to non-CDS billing months a year earlier. From this chart it is clear that changes in beverage supply are quite volatile. Large falls in supply December and January were offset by rises in March and April. Beverage supply also appears to have fallen more strongly in the months of August and September.

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5    Exchange for change first supplier market share dataset, November 2018

6    Exchange for change (NSW) Pty Ltd – Newsletter October 2018.

### Changes in total beverage supply

The high volatility of the beverage supply data means that it is difficult to draw conclusions about the impact of the CDS on beverage supply. Large (and even negative) changes in supply detected in the CDS period could be part of the usual fluctuations in beverage supply experienced in NSW, and not necessarily related to the CDS. One way to account for this is to use formal statistical tests, specifically the t-test. The t-test is able to discern whether, on average, individual suppliers are supplying more or less beverages during the CDS months compared to the same month a year earlier.

The results show the year on year changes in average beverage supply. For instance, a beverage supplier in December 2017 supplied on average, fewer containers compared to December 2016. The t-test, however, says that this movement is typical for suppliers and is thus not a statistically significant change. This is the case for most of the months, with the exception of March 2018 which showed a statistically significant increase (at the 5 per cent level) of Glass containers and August 2018, which showed a statistically significant fall (at the 10 per cent level) of Aluminium containers.

On the balance, these tests provide weak evidence that beverage supply has changed materially since the CDS has been implemented.

This test can further be narrowed to test differences between the beverage supply of alcoholic and non-alcoholic beverages. This is a useful exercise as it will allow impacts that might be unique to certain types of beverages to separated. The results however, lead to the same conclusion of weak evidence to suggest any changes in beverage supply over the year.

## Number and size of supply changes across suppliers

Although there is a lack of evidence to suggest total beverage supply in NSW has changed since the introduction of the CDS, it might be possible that different beverage suppliers have made individual supply changes in response to the CDS. This is especially important once considering the different size of suppliers, since the individual supply decisions of smaller beverage suppliers will be masked by larger suppliers when looking at headline totals.

One indicator of different impacts across suppliers is analysing the number of supply increases relative to decreases year on year (chart 5.2). According to this measure, more suppliers decreased their supply relative to increasing supply on average over the CDS months between December 2017 and September 2018 compared to the same period a year earlier. This is especially true for Glass and PET, which are major container types used to bottle beverages.

### 5.2    Number of supply increases and decreases – 2016-18

|          | Aluminium | Glass | HDPE | PET | LPB | Steel | Other Plastics | Other Materials | Aggregate |
|----------|-----------|-------|------|-----|-----|-------|----------------|-----------------|-----------|
|          | No. | No. | No. | No. | No. | No. | No. | No. | No. |
| Increase | 92 | 106 | 14 | 95 | 23 | 8 | 7 | 4 | 209 |
| Decrease | 82 | 171 | 21 | 121 | 38 | 12 | 9 | 4 | 250 |

*Source:* CIE analysis based on Exchange for Change data.

## Market share of beverage suppliers

Taking into consideration the fact that different sized suppliers may respond differently to the cost increases caused by the CDS, it is important to consider supply changes of these different sized suppliers independently.

### Non-alcoholic beverages

The CIE performed significance tests for market share in the non-alcoholic beverages market. These tests were unable to detect any evidence of changes in market share between different sized suppliers, irrespective of container type (for the purposes of this exercise, large suppliers were assigned as having a share of total beverage supply of at least 10 per cent, whilst other suppliers had less than this amount). On average, large suppliers supplied 8.6 per cent less containers in the CDS period compared to a year earlier whilst other suppliers decreased supply by 9.3 per cent. These movements however, are characteristic of the typical level of variation in the dataset and are not statistically significant.

### Alcoholic beverages

Significance tests for market share changes in alcoholic beverages also shows weak evidence to suggest any change in beverage supply between different sized suppliers. This is the case for all of the different beverage container types, noting that alcoholic beverages using PET containers were too few to estimate robustly.

# A   Full econometric results and sensitivity checks

This report estimates the impact of the CDS on household consumption and expenditure using Nielsen Homescan Data and a fixed effects econometric model. However, when running econometric analysis, there are typically a number of modelling assumptions that need to be made. In this project, the main modelling decisions were:

- whether to use Victorian households as the 'control group' in the regression, or include all Australian states and territories.
- whether to allow seasonal trends that vary by state.[7]
- whether to fit a linear or logistic model.

In each case, there are arguments for and against each modelling decision. While the CIE believe that the main specification of the model is the best single estimate of the impact of the CDS, it is still informative to test whether the main results are robust to different modelling choices. To that end, this appendix contains the results from five alternative model specifications[8]:

- Model 1 is the main model used in the report. It includes time and household fixed effects, and is estimated using data from NSW and Victoria.
- Model 2 uses the same specification as model one, but includes data from households in all Australian states and territories.
- Model 3 uses data from NSW and Victoria, but uses a state specific seasonal trend to account for potential variation in seasonality across states.
- Model 4 uses data from all states and territories, and state specific seasonal trends.
- Model 5 estimates the impact of the CDS using a log model, which estimates the impact of the CDS as a percentage change. This is converted to an absolute change in the table below to allow for a comparison between models.
- Model 6 is a log model using data from all states and territories

In each case, the models were run for the aggregated categories of alcoholic beverages (beer, wine and spirits) and non-alcoholic beverages (water, soft drink and juice).

A summary of the point estimates from the alternative model specifications are shown in chart A.1. It should also be noted that this chart only shows the point estimate from these models, and does not show associated estimated confidence intervals. Adding this

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[7]   There data appears to show different seasonal trends in different states. However, allowing different seasonal trends in the model runs the risk of 'over-specifying' the model.

[8]   A seventh model was also tested using a Poisson regression. Poisson regression assumes the dependent variable has a Poisson distribution. The results of this model appeared robust, although the interpretation of the coefficients is less obvious and was omitted from the analysis.

'within model' variation would further increase the range of possible estimates generated by the models.

**A.1    Estimates of the impact of the CDS under different model specifications**
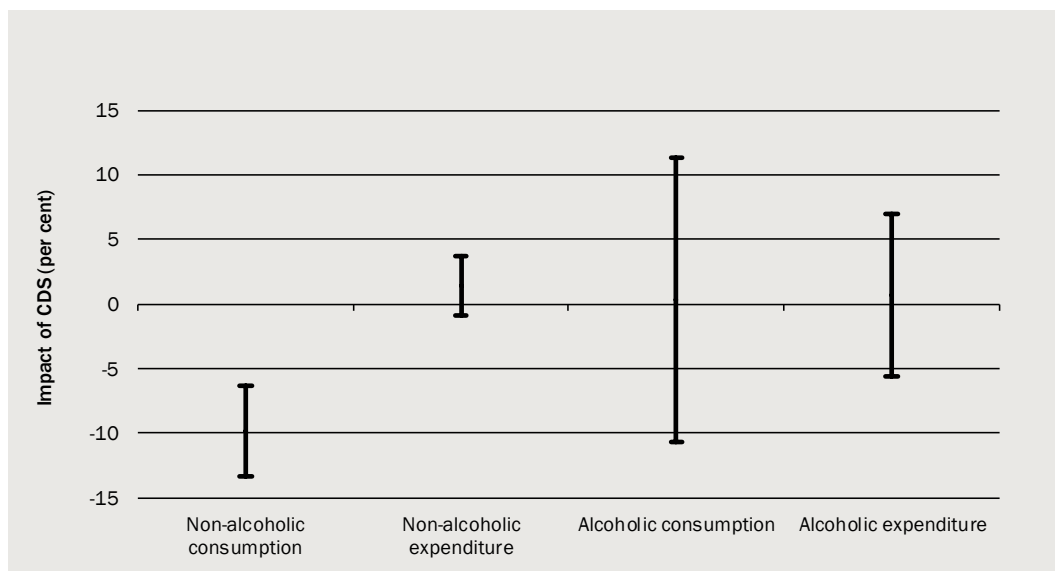


*Data source:* CIE Calculations.

Chart A.1 shows that:

- The result that the CDS has reduced consumption of non-alcoholic beverages is robust to options of model specification
- Expenditure on non-alcoholic beverages is consistently positive for all specifications
- The results regarding alcoholic beverages are highly sensitive to model specification.

This interpretation is strengthened by observing the extended output from the 6 models in tables A.2 and A.3. This shows that the impact on non-alcoholic beverage consumption is negative and statistically significant in most models. The impact on expenditure consumption of alcoholic beverages and expenditure on alcoholic beverages are not statistically significant.

**A.2    Sensitivity analysis – non-alcoholic beverages**

|  | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
|  | L/month | L/month | L/month | L/month | per cent | per cent |
| **Consumption** |  |  |  |  |  |  |
| CDS impact | -0.95*** | -0.91*** | -1.35*** | -1.35*** | -13.3*** | -13.3*** |
| Standard error | 0.25 | 0.21 | 0.18 | 0.18 | 0.04 | 0.03 |
| Percentage change | -6.60 | -6.31 | -9.37 | -9.37 | na | na |
| Constant | 15.36 | 15.70 | 14.85 | 14.87 | 7.84 | 7.90 |
| Household fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Month | Month | State-specific | State-specific | Month | Month |

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| | L/month | L/month | L/month | L/month | per cent | per cent |
| Comparison groups | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus |
| F-statistic | 43.83 | 79.56 | 59.17 | 59.18 | 50.97 | 43.83 |
| F-test p-value | ~0 | ~0 | ~0 | ~0 | ~0 | ~0 |
| N | 169 497 | 290 848 | 169 497 | 290 848 | 169 497 | 290 848 |
| | $/month | $/month | $/month | $/month | per cent | per cent |
| **Expenditure** | | | | | | |
| CDS impact | 0.63** | 0.73*** | 0.37* | 0.37* | -0.91 | -0.91 |
| Standard error | 0.31 | 0.26 | 0.23 | 0.23 | 0.02 | 0.01 |
| Percentage change | 3.22 | 3.74 | 1.91 | 1.91 | na | na |
| Constant | 20.12 | 20.57 | 19.80 | 19.71 | 2.34 | 2.37 |
| Household fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Month | Month | State-specific | State-specific | Month | Month |
| Comparison groups | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus |
| F-statistic | 48.59 | 83.83 | 71.90 | 71.90 | 74.16 | 136.60 |
| F-test p-value | ~0 | ~0 | ~0 | ~0 | ~0 | ~0 |
| N | 169 497 | 290 848 | 169 497 | 290 848 | 169 497 | 290 848 |

*Note:* \*\*\* for 1% significance, \*\* for 5% significance and \* for 10% significance.
*Source:* CIE Calculations.

## A.3    Sensitivity analysis – alcoholic beverages

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| | L/month | L/month | L/month | L/month | per cent | per cent |
| **Consumption** | | | | | | |
| CDS impact | 0.29* | 0.1 | -0.28*** | -0.28*** | 0.17 | 0.17 |
| Standard error | 0.16 | 0.09 | 0.06 | 0.06 | 0.03 | 0.03 |
| Percentage change | 11.31 | 3.99 | -10.71 | -10.71 | na | na |
| Constant | 1.78 | 1.76 | 1.66 | 1.51 | 1.29 | 1.19 |
| Household fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Month | Month | State-specific | State-specific | Month | Month |
| Comparison groups | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus |
| F-statistic | 9.15 | 14.20 | 14.26 | 14.26 | 28.25 | 43.55 |
| F-test p-value | ~0 | ~0 | ~0 | ~0 | ~0 | ~0 |
| N | 169 497 | 290 848 | 169 497 | 290 848 | 169 497 | 290 848 |
| | $/month | $/month | $/month | $/month | per cent | per cent |
| **Expenditure** | | | | | | |
| CDS impact | 1.4 | 0.7 | -1.12*** | -1.12*** | 0.15 | 0.15 |
| Standard error | 0.87 | 0.54 | 0.42 | 0.42 | 0.02 | 0.01 |
| Percentage change | 6.98 | 3.50 | -5.57 | -5.57 | na | na |

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| | L/month | L/month | L/month | L/month | per cent | per cent |
| Constant | 13.64 | 12.99 | 12.90 | 11.91 | 0.60 | 0.56 |
| Household fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Month | Month | State-specific | State-specific | Month | Month |
| Comparison groups | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus | NSW/Vic | NSW/Aus |
| F-statistic | 12.86 | 20.37 | 18.76 | 18.76 | 27.88 | 42.98 |
| F-test p-value | ~0 | ~0 | ~0 | ~0 | ~0 | ~0 |
| N | 169 497 | 290 848 | 169 497 | 290 848 | 169 497 | 290 848 |

*Note:* \*\*\* for 1% significance, \*\* for 5% significance and \* for 10% significance.
*Source:* CIE Calculations.