Modelling the alcohol consumption patterns of Australian households

Selvanathan, E. A. ; Jayasinghe, Maneka; Selvanathan, Saroja

Published in:
Economic Analysis and Policy

DOI:
10.1016/j.eap.2024.12.038

Published: 01/03/2025

Document Version
Publisher's PDF, also known as Version of record

Economic Analysis and Policy 85 (2025) 754–767

Contents lists available at ScienceDirect

Economic Analysis and Policy

journal homepage: www.elsevier.com/locate/eap

Modelling Economic Policy Issues

Modelling the alcohol consumption patterns of australian households

Eliyathamby A Selvanathan [a], Maneka Jayasinghe [b,*], Saroja Selvanathan [a]

[a] Griffith Business School, Griffith University, Nathan Campus, Queensland 4111, Australia
[b] Charles Darwin University, Faculty of Arts and Society, Darwin NT0800, Australia

ARTICLE INFO

JEL Codes:
C51
D12

Keywords:
Working's model
conditional income elasticities
marginal shares
generalised model
alcohol consumption, household

ABSTRACT

Consumers allocate their budget in two stages. Firstly to broad commodity groups and then the group budget to commodities within each group. Conditional demand analysis provides in-depth insights on the second stage budget allocation. Using the Conditional Generalised Working's Model, we analyse the Australian alcohol demand at two stages, namely total alcohol and alcohol sub-groups: beer, wine, spirits and others using the latest *ABS HES 2015–2016* data. The results show that there are noticeable differences in Australian alcohol consumption patterns at the disaggregated level by states, household location, income groups, gender and age. In general, beer and spirits are luxuries while wine and others are necessities.

1. Introduction

Understanding alcohol consumption patterns and the factors that affect the level of alcohol consumption is crucial for policymakers in the Australian state and federal governments and for the alcohol industry. Of further interest is understanding alcohol demand behaviour in relation to the health issues and societal impact of alcohol misuse. The Australian alcohol consumption patterns have changed significantly over the last decade owing to changing affordability, evolving alcohol pricing and taxation policies and increasing public awareness of the health and wellbeing implications of alcohol consumption.

A majority of Australians are changing the way they consume alcohol in terms of frequency and intensity. *DrinkWise Australia* (2017) reports that Australian drinkers who drink excessively (usually consume five or more standard drinks per day, where a standard drink consists of 12.5ml of pure alcohol) has fallen from 24% in 2007 to 16% in 2017, while the proportion of people who drink modestly (usually consume no more than two standard drinks) has increased from 48% in 2007 to 63% in 2017. About 63% of people drink alcohol at home while enjoying a meal or BBQ or watching TV, or relaxing (DrinkWise Australia, 2017). Relatedly, based on the *National Drug Strategy Survey*, the AIHW (2020) revealed that the proportion of ex-drinkers in Australia increased from 7.6% to 8.9% during 2016–2019. In addition, the number of people cutting back on alcohol consumption by reducing the number of alcoholic drinks consumed at any one time has increased from 28% in 2016 to 31% in 2019.

Despite this, in 2019, 25% of Australians drank at a risky level on a single occasion at least monthly, while about 16.8% of people exceeded the lifetime risk guideline (AIHW, 2020). Of further concern is the increasing level of societal problems associated with alcohol consumption (for example, see DrinkWise Australia, 2017; Selvanathan et al., 2020). According to the AIHW (2023a), the estimated tangible and intangible social cost of alcohol consumption in 2017–2018 was $66.8 billion. Of the tangible social cost, an

* Corresponding author.
E-mail addresses: e.selvanathan@griffith.edu.au (E.A. Selvanathan), maneka.jayasinghe@cdu.edu.au (M. Jayasinghe).

https://doi.org/10.1016/j.eap.2024.12.038
Received 12 August 2024; Received in revised form 15 December 2024; Accepted 30 December 2024
Available online 31 December 2024

estimated cost of $4 billion is due to workplace costs (where $3.6 billion is due to absenteeism). This was followed by crime ($3.1 billion), total health care costs ($2.8 billion) and road traffic crashes ($2.4 billion). The premature death of $25.9 billion and loss in quality of life of $20.7 billion contributed most to the intangible social cost of alcohol consumption in Australia (Whetton et al., 2021).

Consequently, the demand for alcohol has always been an area of greater interest for policymakers and researchers. Some notable theoretical and applied research that uses aggregate time-series data to analyse the alcohol consumption patterns of Australian drinkers include Anderson (2020a, 2020b), Clements (1982), Clements and Johnson (1983), Clements and Selvanathan (1991), Doran et al. (2010), Doran et al. (2013), Holmes and Anderson (2017), Clements et al. (1997), Howard et al. (2014), Livingston and Dietze (2016), Loxley et al. (2005), Selvanathan (1993), Selvanathan and Selvanathan (2004; 2005; 2006), and Stockwell (2004). As published time-series data on alcohol consumption and price are readily available, most existing research on alcohol demand in Australia is based on time-series data. Very few studies have used the household expenditure survey data to analyse Australian alcohol consumption. Byrnes et al. (2016) and Haque (1990) represent the limited body of literature on alcohol demand in Australia based on household survey data. Clements et al. (2022) discuss the potential implications of different data types on demand elasticity estimates.

At the household level, consumers usually allocate their income using a two-step procedure. In the first step, they allocate their income into broad commodity groups, such as food, alcohol, energy, health, etc.[1] Given their allocation to a broad commodity group, the next question (step 2) is, how is this expenditure on the group allocated to the commodities within the group (for example, beer, wine and spirits within the alcohol group)? This can be answered using conditional demand analysis (Theil and Clements, 1987).

Working's (1943) model expresses the budget share of a commodity as a linear function of the logarithm of income of the consumer, implying that the marginal share and the corresponding budget share of a commodity differ by a constant. Working's model can also be considered as the income part of the well-known Almost Ideal Demand System (AIDS) introduced by Deaton and Muellbauer (1980). Laitinen et al. (1983) proposed an extension to Working's model to give a class of demand models based on a single parameter generalisation, which allows the marginal share to be a linear function of the corresponding budget share and showed that Working's model can be derived as a special case of that single parameter generalisation. Clements et al. (1985) derived the conditional (within a group of goods) version of Working's (1943) model under the assumption of unitary income elasticity of the group. Several studies have applied various forms of Working's model (1943) and the Generalised Working's model of Laitinen et al. (1983) for various applications in relation to the demand for consumer goods; see, for example, Rajapakse (2011), Clements and Si (2018), Jayasinghe et al. (2019) and Clements et al. (2022). Selvanathan et al. (2021) derived the conditional version of the generalised Working's model of Laitinen et al. (1983).

This paper utilises the new extension by Selvanathan et al. (2021) to analyse the Australian household alcohol consumption patterns at two levels: (1) demand for alcoholic beverages as a group, and (2) within alcohol, demand for beer, wine and spirits and other alcoholic beverages, using the data from the latest Household Expenditure Survey 2015–2016 Expanded Confidential Unit Record Files (CURF) conducted by the Australian Bureau of Statistics (ABS).

This study uses the latest theoretical development to model alcohol consumption at the most disaggregated level, such as by beverage type, states and territories, remoteness of location and income level, gender, and age group. By doing so, this study makes a significant contribution to the limited body of literature on alcohol demand based on household-level data, especially on Australian alcohol consumption patterns. The results are expected to provide valuable insights to policymakers, researchers and alcohol industry stakeholders.

2. Review of literature: Demand for alcohol in Australia

There has been some previous research that analyses the demand for alcohol (see, for example, Clements and Johnson, 1983; Clements and Selvanathan, 1987; 1988; 1991; Selvanathan, 1991; Selvanathan and Selvanathan, 2004; 2005; 2017; Chang et al., 2002) and taxation and alcohol pricing (see, for example, Clements, 1982; Anderson, 2020a; 2020b; Sharma et al., 2014; Sharma et al., 2017) in Australia. Much of the literature on alcohol demand in Australia is based on time-series data. Clements and Selvanathan (1991) analysed consumption patterns of beer, wine and spirits from 1955/56 to 1985/86 for Australia using the Rotterdam model. The estimated own-price elasticity was −0.15 for beer, −0.32 for wine and −0.61 for spirits. The estimated income elasticity was 0.73 for beer, 0.61 for wine and 2.51 for spirits. The study concluded that beer and wine are necessities, spirits are a strong luxury, and beer and spirits are specific complements in Australia. Using time-series data on retail price indexes and apparent per capita consumption of alcoholic beverages for Australia for the period 1975/76 to 1998/99 and the Almost Ideal Demand System approach, Chang et al. (2002) found that the demand for beer and wine are price inelastic and that both beer and wine are luxury goods.

Using time-series data between 1956 and 1999 for Australia, Selvanathan and Selvanathan (2004) found similar results that beer (0.73) and wine (0.61) are necessities and spirits is a luxury and that the demand for beer and wine is price-inelastic while that of spirits is price elastic. Although there are slight differences in the magnitude of the income elasticity estimates, studies such as Clements and Selvanathan (1988); Clements and Johnson (1983); and Selvanathan (1991) found that, overall, beer and wine are necessity goods and spirits is a luxury good in Australia. However, under system-wide approach, Selvanathan and Selvanathan (2005) found wine to be a luxury item in addition to spirits, while beer is a necessity.

Jiang and Livingston (2015) investigated the dynamic responses of alcohol consumption to changes in alcohol prices and

[1] A number of previous studies in the literature have found that broadly defined commodities such as food, clothing, alcohol, housing etc. are separable in consumers' utility function and other implications of separability likely to be satisfied in practice (for example see, Clements and Selvanathan, 1991; Clements et al., 2022).

affordability in Australia, using time series data between 1974 and 2012. The analysis based on the Vector Autoregressive model and impulse response analysis revealed a negative relationship between alcohol consumption and price. In particular, a 10% increase in the alcohol price was associated with a 2% decrease in alcohol consumption in the following year. On the other hand, an increase in alcohol affordability was associated with increased per-capita alcohol consumption over the following six years. The study concluded that although increasing alcohol prices or taxes can be used as an effective tool to reduce alcohol consumption, the pricing policies need to consider the implications of increasing income to ensure the effectiveness of alcohol control policies.

A paper by Srivastava and Xueyan (2010), which uses data from the National Drug Strategy Household Survey (NDSHS) between 1991 and 2007, presents some descriptive data analysis explaining alcohol consumption against various drinkers' characteristics. The study, however, does not undertake an in-depth economic or econometric modelling to identify the factors that determine alcohol consumption and does not provide elasticity calculations. Another study by Yang et al. (2016) also uses NDSHS 2001, 2004, 2007, and 2010 data and estimates a system of probit equations and corresponding marginal effects under various probability conditions.

Srivastava et al. (2014) estimated price and expenditure elasticities of demand for 12 disaggregated alcoholic beverages in Australia using monthly *ScanTrack Liquor Service* data obtained through A. C. Nielsen Australia for state-level consumption for 14 alcoholic beverage types between 2004 and 2010. The data, however, excludes on-premises consumption of alcohol. The elasticity estimations were derived using a semiflexible Almost Ideal Demand System (AIDS) model. The study estimated expenditure elasticities of 1.12 for beer, 1.01 for wine and 0.86 for spirits. The authors noted that their elasticity estimates are generally higher than those of previous estimates, such as those of Clements and Johnson (1983) and Selvanathan and Selvanathan (2005), which use more aggregated level data. However, Srivastava et al. (2014) consider only off-premises alcohol consumption and exclude on-premises alcohol consumption. The authors note that although on-premises alcohol consumption is a significant component of Australian total alcohol consumption, it cannot be captured by using scanner data.

Clements et al. (2022) provide a detailed discussion of potential differences in demand elasticities between Clements and Selvanathan (1991) and Srivastava et al. (2014). The study highlights the nature of the data used; the former used annual aggregate level time-series, and the latter used monthly data that tracks sales at supermarkets, grocery/convenience stores and liquor chains and the fact that the latter data excluded the on-premises alcohol consumption as key factors for such differences.

Haque (1990) is one of the first studies to analyse demand for alcoholic beverages in Australia using household survey data. Haque (1990) used the 1975–76 Household Expenditure Survey (HES) data to estimate expenditure elasticities for three alcoholic beverages: beer, wine and spirits, using the double and semi-log Engel functional forms. The results indicate that beer had the lowest elasticity of 0.93, suggesting beer is a necessity. The elasticities for wine and spirits were much higher (2.77 and 1.13, respectively), placing them in the 'luxury' category. Byrnes et al. (2016), using the National Drug Strategy Household Surveys of 2001, 2004 and 2007 and a double-hurdle quantile regression approach, estimated the price elasticity of demand for alcohol. The results reveal that heavy drinkers are more responsive to alcohol prices compared to lighter drinkers and that the demand for alcohol from the lightest drinkers is perfectly inelastic.

Jian et al. (2016) estimated the own- and cross-price elasticities of alcohol demand for 11 alcoholic beverage types and on- or off-premises supply, using a dataset collected in 2013 from 1730 telephone interviews where survey participants were asked to recall their alcohol consumption for the past 6 months. The study utilised the Tobit model approach. The results revealed that demand for most alcoholic beverages was highly responsive to their own price changes, except for on-premises spirits and ready-to-drink spirits. The demand for off-premises beverages is more strongly sensitive to their own price changes than the same beverages in on-premises settings. Harmful drinkers and lower income groups demonstrated greater responsiveness to alcohol price changes than the moderate drinkers and higher income groups. The study, however, does not estimate any demand system.

Overall, the studies based on time-series data dominate the literature on Australian alcohol demand, while the current study is based on cross-sectional data, the latest household expenditure survey (HES) data. In addition, the current study is also substantially different from the existing studies based on cross-sectional data as HES data include on- and off-premises alcohol consumption information. For example, Srivastava and Xueyan (2010) and Yang et al. (2016) do not conduct economic modelling to identify the determinants of alcohol consumption or elasticity calculations for the disaggregated alcohol types. The current study uses a completely different dataset and methodology from Jiang et al (2016), which also does not provide elasticity estimates. While the current study places a significant emphasis on comparing the elasticity estimates of Srivastava et al. (2014) in the analysis, the two studies use entirely different types of data (scanner data vs household survey data) for the empirical analysis. In particular, Srivastava et al. (2014) exclude on-premises alcohol consumption from their analysis. On the other hand, the current study is based on very comprehensive data to capture alcohol consumption patterns at the household level and uses a dataset that includes both on-premises and off-premises alcohol consumption. This is an important aspect of Australian alcohol consumption that is not considered by Srivastava et al. (2014). Such exclusion may result in biased income and price elasticities. Hence, the current paper aims to obtain income elasticities of alcohol as a whole and beer, wine, and spirits for consumers at varying income levels, age groups, and their location - state/region. Although Clements et al. (2022) use more recent time-series data, our study differs from theirs as we use more recent cross-sectional data at the household level where we are able to analyse alcohol consumption by varying household characteristics such as income levels, age group and location they live - state/region. These elasticities are very useful for the alcohol industry in the marketing of alcohol products and for the Australian government in deciding on policies based on consumer characteristics.

Therefore, this paper contributes significantly to new knowledge on alcohol consumption in Australia. The following section provides an overview of Australian alcohol consumption patterns over time at the aggregate level.

3. Trends in Australian alcohol consumption

First, to compare Australian alcohol consumption with the rest of the developed world, in Table 1, we present the per capita pure alcohol consumption in selected OECD countries for selected years from 1991–2022. As can be seen, over the last three decades, alcohol consumption has been fluctuating in most of the selected OECD countries. In 2021, in these selected countries, alcohol consumption is in the range of 6.6 to 10.7 litres of pure alcohol per capita. Looking at the year 2021, Australia is one of the highest alcohol-consuming countries among the OECD countries.

Australian drinkers mostly consume beer, wine, spirits, cider and Ready to Drink (RTD) pre-mixed beverages. Table 2 presents Australia's total volume and per capita consumption of pure alcohol for beer, wine and spirits[2], for selected years during 1961–2020. According to AIHW (2023a), in 2020, Australians consumed 203.6 million litres of pure alcohol or 9.81 litres of pure alcohol for every person in Australia aged 15 years and over. It can be noted in Table 2 that in the COVID-19 pandemic year 2020, there was a slight drop in the consumption of beer and wine, but the consumption of spirits has increased slightly. Figs. 1 and 2 plot the complete data presented in Table 2. Fig. 1 plots the total volume of pure alcohol consumption and per capita pure alcohol consumption. As can be seen, while the total volume of pure alcohol consumption in Australia has continued to increase gradually over the last six decades, the per capita pure alcohol consumption has increased until the mid-1970s but has been declining since then. Fig. 2 plots the apparent consumption of total volume of pure alcohol consumption and per capita consumption of each alcoholic beverage. As can be seen, while beer consumption has been on the decline since the mid-1970s, wine and spirits consumption has been continuously increasing. Per capita wine consumption has increased about three-fold, spirits have increased two-fold, and beer consumption has nearly halved.

4. Conditional generalised working's model (CGWM)

The CGWM introduced by Selvanathan et al. (2021) can be used to analyse how households allocate their budget on the commodities within the group condition to the total budget allocation for that group. In this study, we adapt CGWM to analyse household budget allocation on alcoholic beverages, beer, wine, spirits and other alcoholic beverages conditional upon their total budget allocation on alcohol group. This section presents the theoretical background of the CGWM model.

Let p_i and q_i be the price and quantity of good i (=1,2, …, n). Then $M = \sum_{i=1}^{n} p_i q_i$ is the total expenditure ('income' for short) on the n goods. The budget share w_i of good i is then given by $w_i = p_i q_i / M$.

Working's Model

Working's (1943) model (WM) specifies that the n budget shares w_1, w_2, …, w_n are linear functions of the logarithm of total expenditure M:

$$w_i = \alpha_i + \beta_i \log(M), \quad i = 1, 2, \cdots, n \tag{1}$$

where α_i and β_i are constants satisfying the conditions

$$\sum_{i=1}^{n} \alpha_i = 1 \text{ and } \sum_{i=1}^{n} \beta_i = 0 \tag{2}$$

By writing w_i as $p_i q_i / M$ in (1) and multiplying both sides by M, we can easily show that the marginal share θ_i of good i can be written as

$$\theta_i = \frac{\partial (p_i q_i)}{\partial M} = w_i + \beta_i \tag{3}$$

Equation (3) implies that the marginal share θ_i is a linear function of the budget share w_i. The income elasticity η_i of good i of Working's model (1) is given by

$$\eta_i = \frac{\theta_i}{w_i} = \frac{w_i + \beta_i}{w_i} = 1 + \frac{\beta_i}{w_i} \tag{4}$$

Conditional Working's Model (CWM)

Suppose that if we divide the n goods into G groups, namely, S_g, $g = 1,2,\ldots,G$ such that each good belongs to only one group. Let the expenditure on group S_g, $M_g = \sum_{i \in S_g} p_i q_i$, then $w_i' = p_i q_i / M_g$ is the conditional budget share of $i \in S_g$. The group budget share is defined as $W_g = \sum_{i \in S_g} w_i$ or $W_g = M_g / M$. Smith and Clements (1984) showed that the conditional version of the Working's model (CWM) (that is, conditional demand for a good $i \in S_g$, g=1,2,…,G) can be derived under certain conditions exactly in the same form as the Working's model (1) – (2) given by

$$w_i' = \alpha_i' + \beta_i' \log M_g, \quad i \in S_g, \ g = 1, 2, \cdots, G \tag{5}$$

where the coefficients α_i' and β_i' satisfy,

[2] In Table 2 and Figs. 1 and 2, spirits include spirits, cider and RTDs.

Table 1
Pure Alcohol consumption (in litres per capita aged 15 and over) in selected OECD countries, 1991–2022.

OECD economies	1991	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Australia	10.1	9.8	10.2	10.5	10.4	10.1	10.1	10.2	10.3	10.0	10.9	10.7	10.4
Canada	8.2	7.4	7.6	8.0	8.4	8.0	8.1	8.2	8.2	8.0	8.1	8.3	8.1
France	15.4	14.5	13.9	12.9	12.3	11.9	11.7	11.7	11.6	11.4	10.4	10.5	N/A
Germany	13.9	13.4	12.9	11.7	11.6	11.1	11.0	10.9	10.5	10.7	10.2	10.0	N/A
Japan	8.9	8.9	8.6	8.5	7.3	7.2	7.2	7.4	7.2	7.1	6.7	6.6	N/A
Netherlands	10.0	9.8	10.1	9.6	9.1	8.3	8.2	8.3	8.3	8.2	7.8	8.1	N/A
New Zealand	9.9	9.3	8.9	9.3	9.6	8.7	8.9	8.8	8.8	8.8	8.7	8.8	8.7
South Korea	8.8	8.9	8.9	9.0	8.9	9.1	8.7	8.7	8.5	8.3	7.9	7.7	N/A
UK	9.4	9.3	10.4	11.4	10.1	9.5	9.5	9.7	9.8	9.7	9.7	10.0	N/A
US	8.7	8.1	8.2	8.5	8.6	8.8	8.9	8.9	8.9	9.0	9.2	9.5	N/A

Note: N/A not available.
Source: World Bank (2023); Statista (2023); AIHW (2023b)

Table 2
Total volume and Per capita consumption of pure alcohol and alcoholic beverages, Australia, Selected years, 1961 - 2020.

Year (1)	Total volume of pure alcohol ('000 litres)				Per capita consumption of pure alcohol (litres)			
	Beer (2)	Wine (3)	Spirits, RTDs and Cider (4)	Total alcohol (5)	Beer (6)	Wine (7)	Spirits, RTDs and Cider (8)	Total alcohol (9)
1961	51,184	8430	8089	67,703	7.06	1.16	1.12	9.34
1965	59,486	9626	10,562	79,674	7.54	1.22	1.34	10.10
1970	73,552	15,746	12,653	101,951	8.35	1.79	1.44	11.58
1975	92,238	22,428	16,284	130,950	9.22	2.24	1.63	13.09
1980	92,745	30,891	14,817	138,453	8.52	2.84	1.36	12.72
1985	81,188	39,749	18,764	139,701	6.79	3.33	1.57	11.69
1990	86,019	37,727	21,629	145,375	6.52	2.86	1.64	11.02
1995	76,602	40,433	22,934	139,969	5.46	2.88	1.63	9.81
2000	76,097	48,624	24,869	149,590	5.08	3.25	1.66	10.22
2005	75,075	57,275	34,996	167,346	4.67	3.56	2.18	10.50
2010	79,732	71,478	35,825	187,035	4.51	4.04	2.03	10.44
2015	72,654	73,474	34,400	180,528	3.79	3.83	1.79	10.11
2016	74,507	80,698	35,438	190,643	3.83	4.15	1.82	10.10
2017	73,125	85,686	35,473	194,284	3.70	4.33	1.79	10.24
2018	74,578	88,004	38,123	200,705	3.71	4.38	1.90	10.28
2019	74,492	90,441	40,130	205,063	3.64	4.42	1.96	10.04
2020	72,416	86,977	44,199	203,592	3.49	4.19	2.13	10.85

Note: The year 1961 refers to the financial year 1960/1961.
Source: ABS (2018) and AIHW (2023b).

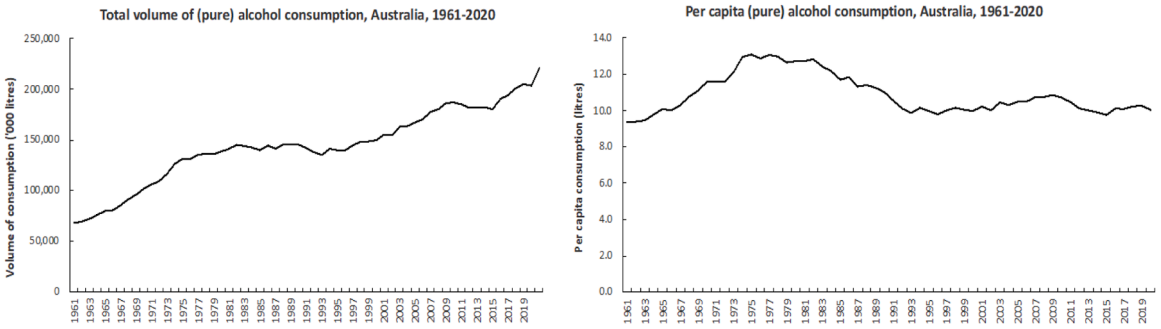

Fig. 1. Total volume and per capita consumption of pure alcohol, Australia, 1961–2020.

$$\sum_{i\in S_g}\alpha'_i = 1 \text{ and } \sum_{i\in S_g}\beta'_i = 0 \tag{6}$$

They also derived the demand equation for the group g as

$$W_g = A_g + B_g logM \quad g = 1, 2, \cdots, G. \tag{7}$$

Clements et al. (1985) further showed that the conditional income elasticity η'_i of good $i \in S_g$ and income elasticity for the group η_g can be calculated as

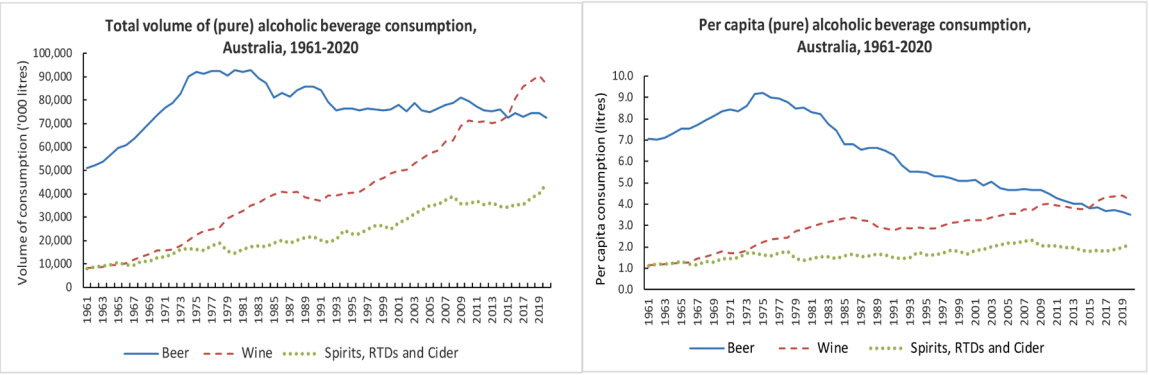

Fig. 2. Total volume and per capita consumption of Beer, Wine and Spirits, Australia, 1961 – 2020.

$$\eta_i' = 1 + \frac{\beta_i'}{w_i'}. \tag{8}$$

$$\eta_g = 1 + \frac{B_g}{W_g}. \tag{9}$$

Generalized Working's Model (GWM)

Laitinen *et al* (1983) proposed the following generalisation of the Working's model (GWM) with a single parameter λ in the form

$$w_i = \alpha_i M^{\lambda} + \beta_i \frac{(M^{\lambda} - 1)}{\lambda} = a_i + b_i M^{\lambda} \quad i = 1, 2, \cdots, n \tag{10}$$

where

$$a_i = -\frac{\beta_i}{\lambda} \text{ and } b_i = \alpha_i + \left(\frac{\beta_i}{\lambda}\right), \tag{11}$$

with

$$\sum_{i=1}^{n} \alpha_i = 1, \quad \sum_{i=1}^{n} \beta_i = -\lambda, \quad \sum_{i=1}^{n} a_i = 1, \quad \sum_{i=1}^{n} b_i = 0$$

The income elasticity based on (10) is given by

$$\eta_i = (1 + \lambda) + \frac{\beta_i}{w_i}.$$

Conditional Generalised Working's Model (CGWM)

The conditional version of GWM given by (10), the CGWM, for a good *i* within a group of goods S_g, derived in Selvanathan et. al. (2021), can be written in the form of (12) – (13).

$$w_i' = \alpha_i' M_g^{\lambda} + \beta_i' \frac{\left(M_g^{\lambda} - 1\right)}{\lambda} = a_i' + b_i' M_g^{\lambda}, \quad i \in S_g, \; g = 1, 2, \cdots, G \tag{12}$$

where $a_i' = -\frac{\beta_i'}{\lambda}$; $b_i' = \alpha_i' + \frac{\beta_i'}{\lambda}$

$$\sum_{i \in S_g} \alpha'_i = 1 \quad \sum_{i \in S_g} \beta'_i = -\lambda \quad \sum_{i \in S_g} a'_i = 1 \quad \text{and} \sum_{i \in S_g} b'_i = 0 \tag{13}$$

The generalised group model (GGM) derived in Selvanathan et. al. (2021) from (10) is given by

$$W_g = A_g^* + B_g^* M^{\lambda} \tag{14}$$

where $W_g = M_g / M$ is the group budget share, M_g is the consumer expenditure on group S_g, and $A_g^* = \sum_{i \in S_g} a_i = -\frac{B_g}{\lambda}$, $B_g = \sum_{i \in S_g} \beta_i$ and $B_g^* = \sum_{i \in S_g} b_i$. Noting the fact that $W_g = M_g / M$ and multiplying both sides of (14) by M, and differentiating both sides of the equation with respect to M to get the group marginal share,

$$\theta_g = \frac{\partial M_g}{\partial M} = A_g^* + (1+\lambda)B_g^* M^{\lambda} = (1+\lambda)W_g - \lambda A_g^*$$

In addition, Selvanathan et al. (2021) also showed that the implied group GGM given by (14) and conditional income elasticity for the CGWM given by (12) are given by

$$\eta_g = (1+\lambda) + \frac{B_g}{W_g} = (1+\lambda) - \frac{\lambda A_g^*}{W_g} \tag{15}$$

$$\eta_i' = (1+\lambda) + \frac{\beta_i'}{w_i'} = (1+\lambda) - \frac{\lambda \alpha_i'}{w_i'} \mathrm{i} \quad \in \mathrm{Sg},\ g = 1, 2, \cdots, \mathrm{G} \tag{16}$$

When $\lambda \to 0$, equations (12)-(16), which correspond to the GWM, are the exact group versions (5)-(9) of CWM, derived in Clements et al. (1985). Another special case, when $\lambda \to 1$, equations (10) and (12) will express the budget shares as linear functions of the corresponding expenditures.

We use CGWM given by equations (12)–(16) to model Australian alcohol consumption patterns utilising the latest Australian Household Expenditure Survey (HES) data.

5. Data and model specification

5.1. Data description: Household expenditure survey (HES), Australia

This study uses the latest 2015/16 Australian HES data (ABS, 2016) to analyse Australian alcohol consumption patterns based on the CGWM model given in equations (12) - (16). The survey, conducted form July 2015 to July 2016, followed a stratified, multistage cluster design. The sample consists of residents of private dwellings in urban and rural areas of Australia (comprising 97% of the Australian population). Households containing non-Australian military staff and foreign diplomats and those in very remote areas were excluded from the scope of the survey. Of the households selected for the survey, 66 % responded with adequate information to be included in the final estimates. This survey provides comprehensive data on demographic characteristics and weekly household expenditure on food, alcoholic beverages group, and non-food items. The alcoholic beverages group consists of four beverage types: beer, wine, spirits and other alcoholic beverages (all alcoholic beverages other than beer, wine and spirits combined).

Table 3 presents the household budget share on various commodities. The top part of the table presents the expenditure shares of various food and non-food items as a percentage of total household expenditure, and the lower part presents the conditional budget shares of beer, wine, spirits and other alcoholic beverages. As can be seen, on average, households allocate about 18.4% of their total expenditure on food and non-alcoholic beverages, 2% on alcoholic beverages, 1.4% on tobacco and the remaining 78.2% on non-food items. Among the non-food items, the highest expenditure share is allocated to housing (22.1%), followed by transport (12%) and recreation (11.3%). As can be seen from the lower part of Table 3, an average household spends 33.5% of their alcohol expenditure on beer, 33.1% on wine, 13.6% on spirits and the remaining 19.8% on all other types of alcoholic beverages.

Table 4 presents a budget share on alcoholic beverages by state (or territory) of residence, area remoteness, by income group, gender and age group of the household reference person.[3] As can be seen, while drinkers living in Tasmania and Northern Territory (NT) spend around 2.5–2.6% of their total income on alcohol, drinkers living in New South Wales (NSW), Victoria (VIC), Queensland (QLD), South Australia (SA) and Western Australia (WA) spend 2.2% and those in Australian Capital Territory (ACT) spends only 1.8% of their income on alcohol. Within alcohol, expenditure share on beer varies between 28.5% (ACT) and 42.5 % (NT), wine varies between 24.1% (QLD) and 33.7% (VIC), spirits vary between 11.3% (NT) and 17.5% (ACT), and other alcoholic beverages varies between 17% (VIC) and 25.9% (SA).

Considering the remoteness of location, drinkers living in major cities and outer regions allocate 2.1–2.2% of their income on alcohol, while drinkers in the inner regional and remote Australia allocate 2.4–2.5% of their income on alcohol. Within alcohol, while drinkers in the outer region allocate 43.6% of their alcohol expenditure on beer, drinkers in the major cities allocate only 32.9% on beer. Considering the expenditure share of wine, the outer region drinkers allocate only 21.5% of their alcohol expenditure on wine, while drinkers in the major cities allocate 31.8%. For spirits, remote Australians allocate only 11.7% of their alcohol expenditure, while inner regional drinkers allocate 16.7%. Overall, drinkers living in the city spend nearly an equal share on beer and wine, while drinkers in other areas spend a much larger budget share on beer than wine. Australians allocate much less share of their income to spirits than beer or wine, regardless of the location of their residence.

By income groups, while low-income drinkers allocate only 1.7% of their total income on alcohol, high-income drinkers allocate

[3] The selection criteria, which is applied to all household members aged 15 and over, to identify a single appropriate household reference person, in the order listed, are the "a) person with the highest tenure when ranked as follows: owner without a mortgage, owner with a mortgage, renter, other tenure, b) one of the partners in a registered or de facto marriage, with dependent children, c) one of the partners in a registered or de facto marriage, without dependent children, d) a lone parent with dependent children, e) the person with the highest income and f) the eldest person" (ABS, 2017).

[4] The plots between alcohol budget share and income indicate that all slope coefficients of the predicted line across 10 deciles are negative, except 5th and 7th deciles. However, only for the 3rd and 10th decile slope coefficients are statistically significant. This indicates there is some support for the hypothesis that when income increases budget share of alcohol falls.

Table 3
Expenditure Share on commodities[4].

Commodity (1)	Expenditure share (2)
All commodities (as a % of total household expenditure)	
Food and non-alcoholic beverages	18.4
Alcoholic beverages	2.1
Tobacco	1.2
Non-food items	78.2
Housing	21.4
Transport	12.8
Recreation	11.1
Medical care and health expenses	6.3
Fuel and power	3.8
Communication	3.9
Household furnishing and equipment	3.7
Household services and operation	3.0
Clothing and footwear	2.8
Education	1.7
Personal care	1.9
Miscellaneous	5.5
Alcoholic beverages (as a % of total alcohol expenditure)	Conditional expenditure share
Beer	33.5
Wine	33.1
Spirits	13.6
Other alcoholic beverages	19.8

Notes: 'Other' alcoholic beverages include any other alcoholic beverages reported other than, beer, wine and spirits.

Table 4
Expenditure share on alcohol by state, remoteness of location and income groups.

Household	Alcoholic beverages (as a % of total alcohol expenditure)				Total alcohol (as a % of total household expenditure)
	Beer	Wine	Spirits	Other	
State/Territory					
NSW	35.2	30.7	11.8	22.3	2.2
VIC	34.2	33.7	15.1	17.0	2.2
QLD	37.6	24.1	16.9	21.4	2.2
SA	29.5	32.8	11.8	25.9	2.2
WA	38.2	28.4	15.5	17.9	2.2
TAS	37.2	25.9	15.6	21.3	2.5
NT	42.5	24.8	11.3	21.4	2.6
ACT	28.5	33.3	17.5	20.7	1.8
Level of remoteness					
Major Cities	32.9	31.8	13.6	21.7	2.1
Inner Regional	40.0	27.6	16.7	15.7	2.4
Outer Region	43.6	21.5	14.1	20.8	2.2
Remote Australia	41.8	24.5	11.7	22.0	2.5
Income group					
1st quartile	37.1	35.3	14.3	13.3	1.7
2nd quartile	39.3	28.2	13.8	18.7	2.2
3rd quartile	36.4	28.0	14.4	21.2	2.2
4th quartile	31.2	30.6	14.2	24.0	2.4
Gender					
Male	38.8	25.9	14.3	21.0	2.2
Female	29.2	36.9	13.8	20.1	1.9
Age group					
18–34	40.3	17.3	16.1	26.3	2.1
35–49	35.7	28.3	15.0	21.1	2.0
50–64	33.9	32.4	13.6	20.5	2.5
65 and above	31.7	41.5	11.5	15.3	2.3

2.4% of their income on alcohol. Within alcohol, while all income groups allocate about 14% of their alcohol expenditure on spirits, low-income drinkers allocate more of their alcohol expenditure on beer and wine. In contrast, low to middle-income group drinkers spend a major portion of their alcohol expenditure on beer. High-income group drinkers spend about one-third of their alcohol expenditure on both beer and wine. Compared to other income groups, high-income group drinkers allocate a much bigger share on other alcoholic beverages.

Considering gender, male drinkers allocate a slightly higher percentage of their income (2.2% compared to 1.9% for females) on

alcohol group. Mostly, male drinkers allocate a higher percentage (about 39%) of their alcohol expenditure on beer, followed by wine (26%), while female drinkers show the opposite pattern. Both male and female drinkers allocate more or less equal budget share on spirits (14%) and 21% on all other beverages.

By age, the 50–64-year-old age group allocates the highest (2.5%) expenditure share on alcohol, while the 35–49-year-old age group allocate the lowest 2% on alcohol. Within alcohol, the younger age groups allocate most of their alcohol expenditure on beer (40%), followed by other alcoholic beverages (26%), wine (17%) and spirits (16%). The over-65-year-old age group allocate 42% of the alcohol expenditure on wine, 32% on beer, 15% on other alcoholic beverages and 12% on spirits.

5.2. Model specification and estimation

Using the Australian HES data, we estimate equation (14) for the group (alcohol as a whole) and conditional demand equation (12) for individual alcohol sub-categories, beer, wine, spirits and other alcoholic beverages, within the alcohol group.

Model (M1)

For estimation, we write the group demand equation (14) in the form (see Selvanathan et. al. 2021, for details),

$$W_g = A_g^* + B_g^* M^{\lambda} + \epsilon_g$$

and the resulting group income elasticity given in (15) as

$$\eta_g = (1+\lambda) - \frac{\lambda A_g^*}{W_g}$$

where $W_g = M_g / M$ is the budget share of the alcohol group, M_g is the consumer expenditure on alcohol group S_g and M is the total expenditure on all goods. The parameter λ is Box-Cox transformation parameter that adjusts the M to per adult equivalent expenditure for possible economies of scale in consumption (Deaton and Muellbauer 1980).

Model (M2):

For estimation, we write the conditional demand equation (12) for beverage i in the form (see Selvanathan et al. 2021, for details),

$$w_i' = a_i' + b_i' M_g + \varepsilon_i$$

and the resulting conditional income elasticity for beverage i as in (16)

$$\eta_i' = (1+\lambda) - \frac{\lambda a_i'}{w_i'}.$$

where w_i' is the conditional budget share on alcohol beverage i (1=beer, 2=wine, 3=spirits, and 4=other), M_g is the consumer expenditure on alcohol group S_g. The parameter λ is Box-Cox transformation parameter that adjusts M_g to per adult equivalent alcohol expenditure for possible economies of scale in consumption (Deaton and Muellbauer, 1980). The conditional demand equations for beer, wine and spirits were estimated as a system of equations, and the parameters of the demand equation for 'other' were recovered using the adding-up restrictions. 'Other' refers to all alcoholic beverages combined, other than beer, wine and spirits. The estimated coefficients were then used to calculate the income elasticities for the alcohol group and conditional income elasticities for beer, wine, spirits and other, as specified in Models (M1) and (M2).

In the literature, household demographic factors, such as age, gender, level of education, geography, and income level, have been identified to considerably influence alcohol expenditure (see, for example, Collins, 2016; Clements and Selvanathan, 1991; Yen and Jensen 1996). In order to identify the differences in expenditure elasticities by household socio-economic and demographic characteristics, we estimate Models (M1) and (M2) for different population sub-groups and compute corresponding implied elasticities. When modelling household alcohol consumption, an important aspect that needs to be considered is the high percentage of households with zero expenditure, a common observation in micro-data sets with highly disaggregated information. In our sample, about 50% of households reported zero expenditure on alcohol. As discussed in Madden (2008), there are several econometric approaches to

Table 5
Estimation results, and group and conditional implied income elasticities of alcoholic beverages, Australia.

Beverage (i)	Constant A_g	Income coefficient B_g	Income elasticity η_i
(1)	(2)	(3)	(4)
Total alcohol	-0.005 (0.033)	0.007 (0.001)	1.246 (0.122)
Beer	-0.085 (0.056)	0.246 (0.038)	1.125 (0.017)
Wine	0.537 (0.055)	-0.128 (0.037)	0.938 (0.017)
Spirits	-0.078 (0.041)	0.137 (0.028)	1.158 (0.030)
Other	0.627 (0.089)	-0.255 (0.005)	0.781 (0.045)
	λ (Group Equation corresponds to M) = 0.197 (0.010)		
	λ (Conditional Equations corresponds to M_g) = 0.0997 (0.008)		

Note: Standard errors are given in parenthesis. Number of observations is 9191.

incorporate zero expenditures into modelling, and in this study, the results have been estimated using the Heckman (1976) sample selection approach.

6. Results and discussion

6.1. Estimation results

Table 5 presents the maximum likelihood estimation results using the group and conditional demand equations of the CGWM Models (M1) and (M2) above and the corresponding implied income elasticities given by the formulas in Models (M1) and (M2). The first row of the table gives the results for the group demand equation, and the next four rows give the results for the conditional demand equations for each beverage estimated as a system. The table also presents the estimates of λ for the total expenditure M that were obtained using the Box-Cox transformation and λg for the group expenditure. As can be seen, in general, almost all the estimated coefficients are statistically significant at the 5% level. The income elasticity of alcohol as a group is 1.25 (>1), meaning that alcohol as a group is a luxury. The elasticity estimates are in line with those obtained by Clements et al. (1985). The income elasticity of beer is 1.13 (>1), spirits is 1.16 (>1), and wine is 0.94 (<1), respectively, indicating beer and spirits are luxuries and wine is a necessity. The income elasticity of other alcoholic beverages is 0.78 (<1), indicating that other alcoholic beverages are necessities.

Table 6 presents the group and conditional income elasticities for alcoholic beverages by various characteristics of the household (household reference person): State or Territory, remoteness level, income group, gender and age group. As can be seen at the State level, a similar pattern can be seen across some of the states and territories, that is, (1) alcohol as a whole is a luxury in NSW, QLD, SA and NT while it is a necessity in VIC, WA, TAS, ACT (2) beer and spirits are luxuries and wine and other (alcoholic beverages) are necessities.

By remoteness of the household location, alcohol is a luxury item for households in major cities, inner regional and outer regional areas, while it is a necessity for households in remote Australia. At the individual beverage level, beer and spirits are luxuries across all locations, while wine is a necessity. The other alcoholic beverages are a necessity in most areas, except in outer regional Australia, where they are luxury items.

When considering the implied elasticise by income group, alcohol, as a whole, is a luxury for households in all income groups. At the individual beverage level, beer and spirits are luxuries, while wine and other alcoholic beverages are necessities. The same pattern can be observed by the gender of the household reference person.

Some variations in income elasticities emerge by the age group of the household reference person. Alcohol, as a whole, is a luxury for most households, except for those who are in the 50–64-year-old age group where alcohol is a necessity. Beer is a necessity for

Table 6
Group and conditional income elasticities of alcoholic beverages by State/Territory of household.

Household	Alcoholic beverages				Total alcohol	Sample size
	Beer	Wine	Spirits	Other		
State/Territory						
NSW	1.180 (0.033)	0.905 (0.009)	1.134 (0.037)	0.775 (0.084)	1.473 (0.027)	2088
VIC	1.141 (0.032)	0.855 (0.035)	1.235 (0.029)	0.796 (0.107)	0.910 (0.521)	2183
QLD	1.083 (0.041)	0.927 (0.059)	1.177 (0.026)	0.796 (0.111)	1.453 (0.066)	1352
SA	1.234 (0.054)	0.913 (0.014)	1.279 (0.037)	0.726 (0.075)	1.036 (0.953)	1159
WA	1.120 (0.046)	0.866 (0.061)	1.126 (0.083)	0.846 (0.156)	0.815 (0.851)	1113
TAS	1.247 (0.055)	0.760 (0.078)	1.110 (0.094)	0.781 (0.152)	0.899 (0.335)	677
NT	1.014 (0.070)	0.947 (0.116)	1.116 (0.174)	0.970 (0.212)	1.432 (0.724)	316
ACT	1.076 (0.109)	0.906 (0.097)	1.116 (0.136)	0.955 (0.238)	0.959 (0.099)	283
Level of remoteness						
Major Cities	1.129 (0.002)	0.860 (0.025)	1.198 (0.030)	0.770 (0.046)	1.280 (0.352)	6680
Inner Regional	1.169 (0.036)	0.865 (0.051)	1.121 (0.065)	0.676 (0.146)	1.116 (0.821)	1520
Outer Region	1.162 (0.046)	0.911 (0.084)	1.023 (0.101)	1.100 (0.143)	1.343 (0.114)	817
Remote Australia	1.211 (0.030)	0.778 (0.167)	1.127 (0.279)	0.792 (0.241)	0.689 (0.061)	148
Income group						
1st quartile	1.432 (0.010)	0.561 (0.010)	1.359 (0.020)	0.688 (0.039)	2.318 (0.031)	2886
2nd quartile	1.259 (0.035)	0.758 (0.048)	1.294 (0.071)	0.605 (0.112)	2.259 (0.144)	2374
3rd quartile	1.124 (0.032)	0.840 (0.042)	1.124 (0.061)	0.914 (0.088)	1.686 (0.103)	2065
4th quartile	1.026 (0.029)	0.963 (0.308)	1.108 (0.046)	0.950 (0.394)	1.450 (0.143)	1866
Gender						
Male	1.135 (0.018)	0.868 (0.025)	1.163 (0.037)	0.800 (0.052)	1.493 (0.353)	5237
Female	1.106 (0.031)	0.909 (0.027)	1.211 (0.051)	0.867 (0.076)	1.162 (0.570)	3934
Age group						
18–34	0.987 (0.036)	0.813 (0.065)	1.122 (0.067)	1.068 (0.081)	1.110 (0.084)	1514
35–49	1.128 (0.029)	0.813 (0.036)	1.339 (0.052)	0.793 (0.077)	1.237 (0.340)	2465
50–64	0.967 (0.029)	1.011 (0.031)	0.990 (0.054)	1.044 (0.079)	0.829 (0.449)	2663
65 and above	0.954 (0.035)	1.023 (0.031)	0.960 (0.071)	1.068 (0.128)	1.387 (0.165)	2529

Note: Standard errors are given in parenthesis. We have pooled the data across states to test the similarity in taste using a Likelihood ratio test. The value of the test statistic is 242.3 and the critical value is 14.1. Therefore, we reject the null hypothesis of identical taste across states.

households in most age groups, except those in the 35–49-year-old age group, where beer is a luxury. Wine is a necessity for age groups 18–34-year-old and 35–49-year-old, while it is a luxury for age groups 50–64 and 65 and above. Spirits is a luxury for age groups 18–34-year-old and 35–49-year-old, while for age groups 50–64-year-old and 65-year-old and above, it is a necessity. Other beverages are a necessity for all age groups, except for the 35–49yrs age group.

6.2. Discussion

In Table 7, we provide a comparison of the elasticity estimates (for alcohol as a whole and beer, wine and spirits, separately) of the current paper with the income elasticities obtained in Clements and Selvanathan (1991) and Srivastava et al. (2014), two studies based on time-series data, and Haque (1990), a study based on the 1975–76 Australian HES.

A comparison of the two cross-sectional studies indicates that our study (based on Australian HES 2015/16) and Haque (1990) (based on 1978/79 Australian HES) give similar results that alcohol as a whole is a luxury, and spirits are also a luxury. While we found that wine is a necessity, Haque (1990) found that wine is a luxury and beer is the opposite. One of the reasons for the difference between Haque (1990) and our elasticity estimates is that the consumption patterns of beer, wine and spirits in Australia have substantially changed between 1975/76 and 2015/16. For example, Figs. 1 and 2 clearly show that per capita total alcohol consumption and per capita beer consumption increased until the mid-70s and declined thereafter, while per capita consumption of wine and spirits continued to increase. Even though Clements and Selvanathan (1991) and Srivastava et al. (2014) are both time-series studies, they have used different types of data belonging to different time periods. Clements and Selvanathan (1991) used annual aggregated time-series data for beer, wine and spirits for 1955–1985, while Srivastava et al. (2014) used disaggregated monthly scanner data (only off-premises) for the period 2004–2010. As discussed, due to the differences in the nature of the data used and demand modelling approaches, the estimation results of the current study are slightly different to those of Clements and Selvanathan (1991) and Srivastava et al. (2014). However, the estimated income elasticity of alcohol across the three studies indicates that alcohol as a whole is a luxury. The income elasticity of wine and beer in the current study is closer to that of Srivastava et al. (2014).

As presented in Table 8, we also compared the findings of the current study with global results on income elasticities of alcoholic beverages and found some similarities as well as differences. For example, Macedo et al. (2020), in a study based on time-series data on 40 countries, found that beer (0.95) has an income elasticity of less than 1 (but very close to 1). Similar results were found in Fogarty (2010), Nelson (2013) and Selvanathan and Selvanathan (2007). However, similar to the current study, Bentzen et al. (1997) and Sabuhoro et al. (1996) found beer is a luxury with income elasticity greater than 1.

Most of the published research suggests that the income elasticity of wine is (slightly) greater than 1 (see, for example, Pearce (1986) for New Zealand, Quek (1988) for Canada, and Selvanathan (1988) for the UK). However, Clements and Selvanathan (1987), Macedo et al. (2020), and Sabuhoro et al. (1996), similar to the current study, found that wine is a necessity with an income elasticity of less than 1. The majority of the existing studies, including the current study, found that spirits are luxury (see, for example, Macedo et al., 2020), although some studies found spirits are necessity or borderline (see, for example, Sabuhoro et al., 1996; Nelson, 2013). Therefore, the findings of the current study largely align with the findings of international findings on income elasticity of alcoholic beverages. However, the sensitivity of elasticity estimates for data type used, time period of analysis and methodology adopted is highly acknowledged in the literature (Fogarty, 2010; Nelson, 2013).

7. Concluding comments

In this paper, we used the conditional version of the generalized Working's (CGWM) model to model the Australian alcohol consumption patterns using most recent available data from ABS Household Expenditure Survey 2015–2016 (ABS, 2016) Expanded Confidential Unit Record Files (CURF). We also provided estimates for the income elasticities of alcohol – total alcohol and beer, wine, spirits and other alcoholic beverages, individually. The results show that for Australia, the income elasticity of the alcoholic beverages group is 1.25, meaning that alcohol as a whole is a luxury. The estimated conditional income elasticity of beer is 1.13, and spirits is 1.16, indicating that beer and spirits are luxuries, and income elasticity of wine is 0.94 and all other alcoholic beverages is 0.78, indicating that they are necessities.

Considering the drinkers' location by states and territories, we found alcohol as a whole is a luxury in NSW, QLD, SA and NT and is a necessity in VIC, WA, Tasmania and ACT. Across states and territories, beer and spirits are luxuries; wine and other beverages are necessities. By income level, alcohol is a necessity at all income levels; beer and spirits are luxuries, while wine and other beverages are necessities. By gender, alcohol as a whole is a luxury; beer and spirits are luxuries; and wine and other beverages are necessities. By age group, alcohol is a luxury for all age groups except for 50–64yrs, where it is a necessity. For the 18–34yrs age group, beer and wine are necessities while spirits and other beverages are luxuries; for the 35–49yrs age group, beer and spirits are luxuries while wine and other beverages are necessities; for 50–64yrs and over 65yrs age groups beer and spirits are necessities while wine and other beverages are luxuries. There is a noticeable difference in the elasticity estimates of the alcohol group and individual beverages across different characteristics of the drinkers such as level of remoteness, income level, age, and gender which is an appealing result for marketing purposes of the alcohol industry as well as for the state and federal governments for policy development.

The results presented in this paper provide valuable insights into how Australian households allocate their household budget on alcoholic beverages and how their geographical location, age, gender and income level affect such decision-making. The study also highlighted the differences in elasticity estimates based on different types of data, which may be of policy relevance. For example, the elasticity estimates of the current study provide valuable insights if the alcohol industry wants to know how people across the country would adjust their alcohol consumption when income increases by 10% to target their advertising strategies. In particular, our

Table 7
Comparison of elasticity estimates, Australia.

Commodity (1)	Time-series data		Cross-sectional data Household Expenditure Survey	
	Clements & Selvanathan (1991) (based on 1955–1985 annual aggregate data) (2)	Srivastava et. al. (2014) (based on monthly 2004–2010 ScanTrac data) (3)	Haque (1990) (based on 1975/76 Australian HES) (4)	Current study (based on 2015/16 Australian HES) (5)
Alcohol	1.01	N/A	1.13	1.25
Beer	0.73	1.12	0.93	1.13
Wine	0.61	1.01	2.77	0.94
Spirits	2.51	0.86	2.04	1.16
Other	-	-	-	0.78

Note: The Srivastava et al. (2014) elasticities are calculated in Clements et al. (2022). Column (5) reproduces the elasticity estimates from Table 5 where we considered 4 demand equations, one for each beverage, beer, wine, spirits and other.

Table 8
International comparison of elasticity estimates.

Author (1)	Country (2)	Time period (3)	Beer (4)	Wine (5)	Spirits (6)
Pearce (1986)	New Zealand	1966–1982	0.85	1.14	1.31
Clements & Selvanathan (1987)	US	1949–1982	0.75	0.46	1.34
Quek (1988)	Canada	1953–1982	0.77	1.12	1.20
Selvanathan (1988)	UK	1955–1985	0.55	1.23	1.83
Sabuhoro et al. (1996)	Canada	1979–1987	1.61	0.26	0.13
Bentzen et al. (1997)	Denmark	1955–1994	1.28	1.15	1.31
Nelson (2013)	182 countries	Meta analysis studies published as of October 2012	0.5	1.00	1.00
Macedo et al. (2020)	40 cross-country study	2010–2015	0.95	0.98	1.08
Current study	Australia	2015/16	1.13	0.94	1.16

estimated elasticities indicate that when the income of drinkers in Australia increases by 10%, the drinkers in major cities increase their alcohol consumption would increase by 12.8%, inner regional drinkers increase by 11.6%, outer regions by 13.4% and from remote Australia increase only 6.9%. Similarly, for a 10% increase in income, the younger age group 18–34 increase their alcohol consumption by 11.1%, the 35–49 age group by 12.4%, the 50–64 age group by only 8.3% and the seniors 65 and above increase the consumption by 13.9%. These elasticities are also useful to the government as to what happens to the alcohol tax revenue when they give additional dollars into drinkers' pocket. Such information is also useful for designing certain alcohol control policies to see the responsiveness of alcohol consumption for an increase in income of the drinkers. In addition, the elasticities obtained in this paper can also be used as key inputs for policy modelling/analysis purposes, such as input-output analysis, Computable General Equilibrium (CGE) modelling at the macro level to simulate different tax policy scenarios.

This study is, however, not without limitations. One of the significant limitations is the unavailability of price data. Price data is unavailable in most cross-sectional studies based on household expenditure surveys, including in the Australian HES data. Therefore, price elasticities could not be calculated. Consequently, the future direction for research is to focus on developing methods to calculate price elasticities in the absence of price data, and currently, such work is in progress. Another limitation is the quality of the HES data. Household expenditure survey data based on diary records are known be about 20% underestimated and suffer from diary fatigue (Battistin et al., 2023).

Data availability

The data used in the empirical analysis of this are available from the Australian Bureau of Statistics. Data are available at https://www.abs.gov.au/ with the permission of the Australian Bureau of Statistics.

CRediT authorship contribution statement

Eliyathamby A Selvanathan: Writing – original draft, Software, Funding acquisition, Data curation. **Maneka Jayasinghe:** Writing – original draft, Validation, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Saroja Selvanathan:** Writing – review & editing, Validation, Project administration, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

None.

Acknowledgement

The authors gratefully acknowledge the research the funding support of the Griffith Asia Institute (GAI) at Griffith University and the Faculty of Arts and Society at Charles Darwin University, Australia. The authors would like to thank the team in the Customised and Mocrodata Delivery, Australian Bureau of Statistics, for providing access to HES data. The authors wish to thank the anonymous referees for their constructive feedback for the previous version of the paper.

References

ABS, 2016. *Household expenditure survey 2015-2016*: Expanded confidential unit record files (CURF). DataLab, Australian Bureau of Statistics. Findings based on use of ABS Microdata.
ABS, 2017. 6503.0 - Household expenditure survey and survey of income and housing. User guide, Australia, 2015-16, Australian Bureau of Statistics. Available from. https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/6503.0~2015-16~Main%20Features~Sampling~13.
ABS, 2018. Apparent consumption of alcohol, Australia methodology. Australian Bureau of Statistics. Available from. https://www.abs.gov.au/methodologies/apparent-consumption-alcohol-australia-methodology/2017-18.
Anderson, K., 2020a. Consumer taxes on alcohol: An international comparison over time. J. Wine Econom. 15 (1), 42–70.
Anderson, K., 2020b. Evolving from a rum state: A comparative history of Australia's alcohol consumption. Austral. J. Agric. Res. Econom. 64 (3), 724–749.
AIHW, 2020. National drug strategy household survey 2019. Drug statistics series no. 32. PHE 270. Australian Institute of Health and Welfare, Canberra AIHW.
AIHW (2023a). Economic impact. Australian Institute of Health and Welfare, Accessed on 20th July 2023. Available from https://www.aihw.gov.au/reports/alcohol/alcohol-tobacco-other-drugs-australia/contents/impacts/economic-impacts.
AIHW, 2023b. Alcohol, tobacco & other drugs in Australia. Web Report: Australian Institute of Health and Welfare, 10 July 2024. Available from. https://www.aihw.gov.au/reports/alcohol/alcohol-available-for-consumption-in-australia/data.
Battistin, E., De Nadai, M., Krishnan, N., 2023. The insights and illusions of consumption measurements. J. Dev. Econ. 161, 102991.
Bentzen, J., Smith, V., Nannerup, N., 1997. Alcohol consumption and drunken driving in the Scandinavian countries. Discussion Paper No. 97-1. Department of Economics, University of Aarhus.
Byrnes, J., Shakeshaft, A., Petrie, D., Doran, C.M., 2016. Is response to price equal for those with higher alcohol consumption? Europ. J. Health Econom. 17, 23–29.
Chang, H.S., Griffith, G., Bettington, N., 2002. The demand for wine in Australia using a systems approach: Industry implications. Australas. Agribusiness Rev. 10, 2–12.
Collins, S.E., 2016. Associations between socioeconomic factors and alcohol outcomes. Alcohol Res. 38 (1), 83–94.
Clements, K.W., 1982. Taxation of alcohol in Australia. Economics Discussion /Working Papers 82-24. The University of Western Australia, Department of Economics.
Clements, K.W., Goldschmidt, P.S., Theil, H., 1985. A conditional version of Working's model. Econom. Lett. 18, 97–99.
Clements, K.W., Mariano, M.J.M., Verikios, G., Wong, B., 2022. How elastic is alcohol consumption? Econ. Anal. Policy. 76, 568–581.
Clements, K.W., Johnson, L.W., 1983. The demand for beer, wine, and spirits: A system-wide analysis. J. Business 56 (3), 273–304.
Clements, K.W., Selvanathan, E.A., 1987. Alcohol consumption. Chapter 5. In: Theil, H., Clements, K.W. (Eds.), Applied demand analysis: Results from system-wide approaches. Ballinger Publishing Company, Cambridge, Mass, pp. 185–264.
Clements, K.W., Selvanathan, E.A., 1988. The Rotterdam demand model and its applications in marketing. Market. Sci. 7 (1), 60–75.
Clements, K.W., Selvanathan, S., 1991. The economic determinants of alcohol consumption. Austral. J. Agric. Econom. 35 (2), 209–231.
Clements, K.W., Si, J., 2018. Engel's law, diet diversity, and the quality of food consumption. Am. J. Agric. Econ. 100 (1), 1–22.
Clements, K.W., Yang, W., Zheng, S.W., 1997. Is utility additive? The case of alcohol. Appl. Econ. 29 (9), 1163–1167.
Deaton, A., Muellbauer, J., 1980. An almost ideal demand system. Am. Econom. Rev. 70 (3), 312–326.
Doran, C.M, Byrnes, J.M., Cobiac, L.J., Vandenberg, B., Vos, T., 2013. Estimated impacts of alternative Australian alcohol taxation structures on consumption, public health and government revenues. Med. J. Austral. 199 (9), 619–622.
Doran, C.M., Hall, W.D., Shakeshaft, A.P., Vos, T., Cobiac, L.J., 2010. Alcohol policy reform in Australia: what can we learn from the evidence. Med. J. Austral. 192 (8), 468–470.
DrinkWise Australia, 2017. A snapshot: Australian drinking habits 2007 vs 2017. DrinkWise Australia, Melbourne. Available from: www.drinkwise.org.au/.
Fogarty, J., 2010. The demand for beer, wine and spirits: a survey of the literature. J. Econ. Surv. 24, 428–478.
Haque, M.O., 1990. The demand for alcohol in Australia. Drug Alcohol Rev. 9 (1), 43–52.
Heckman, J.J., 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. Annals Econom. Soc. Measurement 5 (4), 475–492.
Holmes, A., Anderson, K., 2017. Convergence in national alcohol consumption patterns: new global indicators. J. Wine Econom. 12 (2), 117–148.
Howard, S.J., Gorden, R., Jones, S.C., 2014. Australian alcohol policy 2001-2003 and implications for public health. Public Health 14, 1–13.
Jayasinghe, M., Selvanathan, E.A., Selvanathan, S., 2019. An intertemporal analysis of expenditure elasticities under three expenditure specifications for Sri Lanka. Appl. Econ. 51 (59), 6376–6392.
Yen, S.T., Jensen, H.H., 1996. Determinants of household expenditures on alcohol. J. Consumer Affairs 30 (1), 48–67.
Jiang, H., Livingston, M., 2015. The dynamic effects of changes in prices and affordability on alcohol consumption: an impulse response analysis. Alcohol and Alcoholism 50 (6), 631–638.
Laitinen, K., Theil, H., Raparla, T., 1983. A generalization of Working's model. Econom. Lett. 13, 97–100.
Livingston, M., Dietze, P., 2016. National survey data can be used to measure trends in population alcohol consumption in Australia. Austral. New Zealand J. Public Health 40 (3), 233–235.
Loxley, W., Gray, D., Wilkinson, C., Chikritzhs, T., Midford, R., More, D., 2005. Alcohol policy and harm reduction in Australia. Drug Alcohol Rev. 24, 559–568.
Macedo, A., Gouveia, S., Rebelo, J., 2020. The global demand for alcoholic beverages, 2010–2015: Price and expenditure elasticities. J. Int. Food Agribusiness Market. 33 (4), 398–422.
Madden, D., 2008. Sample selection versus two-part models revisited: the case of female smoking and drinking. J. Health Econ. 27 (2), 300–307.
Nelson, J.P., 2013. Robust demand elasticities for wine and distilled spirits: meta-analysis with corrections for outliers and publication bias. J. Wine Econom. 8 (3), 294–317.
Pearce, D., 1986. The demand for alcohol in New Zealand. Economics Discussion /Working Papers 86-02. The University of Western Australia, Department of Economics.
Quek, K.E., 1988. The demand of Alcohol in Canada: An econometric study. Economics Discussion /Working Papers 88-08. The University of Western Australia, Department of Economics.
Rajapakse, S., 2011. Estimation of a complete system of nonlinear Engel curves: further evidence from Box-Cox Engel curves for Sri Lanka. Appl. Econ. 43 (3), 371–385.
Sabuhoro, J.B., Larue, B., Lariviere, E., 1996. Advertising expenditures and the consumption of alcoholic beverages. J. Int. Food Agribusiness Market. 8 (3), 37–55.
Selvanathan, E.A., 1988. Alcohol consumption in the UK, 1955–85: a system wide analysis. Appl. Econ. 20 (8), 1071–1086.
Selvanathan, E.A., 1991. A Cross-Country Alcohol Consumption Comparison: an Application of the Rotterdam Demand System. Appl. Econ. 23 (10), 1613–1622.
Selvanathan, E.A., 1993. Alcohol consumption in Australia, in *economics of drug abuse*. In: Collins, David, Lapsley, Helen (Eds.), National Campaign Against Drug Abuse Monograph. AGPS, pp. 1–42.

Selvanathan, E.A., Selvanathan, S., 2004. Economic and demographic factors in the Australian alcohol consumption: A growth-accounting analysis. Appl. Econ. 36 (21), 2405–2417.
Selvanathan, E.A., Selvanathan, S., Jayasinghe, M., 2020. Nexus between drinking patterns, gender and life satisfaction: Some evidence from Indigenous Australians. Austral. J. Soc. Issues 55, 396–417.
Selvanathan, S., Selvanathan, E.A., 2017. The demand for alcohol, tobacco and marijuana: International evidence. Routledge.
Selvanathan, S., Selvanathan, E.A., 2005. Empirical regularities in cross-country alcohol consumption. Econom. Record 81, 128–142.
Selvanathan, S., Selvanathan, E.A, 2006. Consumption patterns of food, tobacco and beverages: A cross-country analysis. Appl. Econ. 38 (13), 1567–1584.
Selvanathan, S., Selvanathan, E.A., 2007. Another look at the identical tastes hypothesis on the analysis of cross-country alcohol data. Empir. Econ. 32 (1), 185–215.
Selvanathan, S., Selvanathan, E.A., Jayasinghe, M., 2021. A new approach to analyse conditional demand: An application to Australian energy consumption. Energy Econ. 93 (C).
Sharma, A., Sinha, K., Vandenberg, B., 2017. Pricing as a means of controlling alcohol consumption. Br. Med. Bull. 123 (1), 149–158.
Sharma, A., Vandenberg, B., Hollingsworth, B., 2014. Minimum pricing of alcohol versus volumetric taxation: which policy will reduce heavy consumption without adversely affecting light and moderate consumers? PLoS. One 9 (1), e80936.
Smith, D.M., Clements, K.W., 1984. Estimates of the generalised Working's model. Econom. Lett. 16, 171–175.
Srivastava, P., McLaren, K.R., Wohlgenant, M., Zhao, X., 2014. Disaggregated econometric estimation of consumer demand response by alcoholic beverage types. Austral. J. Agric. Res. Econom. 59 (3), 412–432.
Srivastava, P., Xueyan, Z., 2010. What do the bingers drink? Micro-unit evidence on negative externalities and drinker characteristic of alcohol consumption by beverage types. Econom. Papers 29 (2), 229–250.
Statista, 2023. Total Alcohol consumption – Australia. Accessed on 20th August 2023. Available from. https://www.statista.com/forecasts/1141537/per-capita-alcohol-consumption-forecast-in-australia.
Stockwell, T., 2004. Australian alcohol policy and the public interest: a brief report card. Drug Alcohol Rev. 23 (4), 377–379.
Theil, H., Clements, K.W., 1987. Applied demand analysis: Results from system-wide approaches. Cambridge, Ballinger.
Whetton, S., Tait, R.J., Gilmore, W., Dey, T., Agramunt, S., Abdul Halim, S., McEntee, A., Mukhtar, A., Roche, A., Allsop, S., Chikritzhs, T., 2021. Examining the social and economic costs of alcohol use in Australia: 2017/18. National Drug Research Institute, Curtin University, Perth, WA.
Working, H., 1943. Statistical laws of family expenditure. J. Am. Statist. Assoc. 38, 43–56.
World Bank, 2023. World Development Indicators – Total Alcohol Consumption. Accessed on 20th August 2023. Available from. https://data.worldbank.org/indicator/SH.ALC.PCAP.FE.LI.
Yang, O., Xueyan, Z., Srivastava, P., 2016. Binge drinking and antisocial and unlawful behaviours in Australia. Economic Record 92, 222–240.