Convergence in Alcoholic Beverage Consumption Patterns among OECD Countries

Alexander J. Holmes (BEc)

Principal supervisor: Dr. Kym Anderson
Co-supervisor: Dr. Firmin Doko Tchatoka

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Declaration

Except where appropriately acknowledged, this thesis is my own work, has been expressed in my own words and has not previously been submitted for assessment.

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Abstract

In this thesis, we test Stigler and Becker's identical tastes hypothesis using cross-country alcohol consumption data. Using several new measures of convergence, we first explore trends in global consumption patterns since 1961. The data suggest that a major convergence has occurred in the alcohol consumption mix across countries, but at a slower pace in traditionally wine- and spirits-consuming countries. We then use the Rotterdam system demand model to test the Stigler and Becker hypothesis and determine whether a common demand equation can be used across the sample of 26 countries. Controlling for differences in income and beverage preferences, we test the hypothesis and the results suggest that the identical tastes hypothesis does not apply to alcoholic beverages.

Keywords: alcohol consumption, convergence, demand elasticity, identical tastes hypothesis, Rotterdam model

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1. Introduction

> *Stand by ready to pour for those who want to drink. We cannot have a party every night. Still because I am moderate in my use of honeyed wine, I reach my house before I think of soothing sleep, and I make clear how divine a beverage for man is wine.*
>
> - Theognis of Megara 650 BC

Alcohol is widely traded and consumed across the world and its consumption has far-reaching consequences for society. Globally, there are two billion alcohol consumers (Fogarty (2010)) and, for governments, alcohol consumption is a matter of concern due to the deleterious effects of over-consumption and substantial external costs associated with drinking. Since tax revenue is necessary to remedy these costs, alcohol consumption is typically subject to excise and sometimes import taxes. However, in the debate over alcohol policy, policy-makers rely on imperfect information to address this problem, which detracts from the effectiveness of their efforts. Analyses of trends in alcohol consumption internationally and estimates of price and income elasticities of consumer demand can improve our understanding of the effects of market development and tax changes on alcohol consumption.

With increasing globalisation and cross-fertilization between cultures, countries are converging in many ways. In recent times, policy-makers have taken interest in the extent to which consumer behaviour is converging across countries, the degree of similarity in consumption patterns between regions, and the factors that are driving these patterns (Smith and Solgaard (2000)). The market for alcoholic beverages has changed dramatically at the hands of this worldwide phenomenon. Historically beer-drinking nations have rapidly shifted to substitute beverages, particularly wine and spirits. The United Kingdom, for example, is now predominantly a wine-consuming nation, despite its reputation as a beer-focused culture for centuries previously (Aizenman and Brooks (2008)). Since beer, wine and spirits consumption is often associated with different countries and cultures, the evolving consumption of alcoholic beverages provides a useful case study of the effects of globalisation.

One way to illustrate the differences in national alcohol consumption mixes is by plotting the alcohol consumption shares in an equilateral triangle. The structure of this triangle is presented below in Figure 1.1, which has been adapted from that used by Campbell and Fogarty (2006) and Leamer (1987). The axes on each side of the triangle respectively represent the share of alcohol market consumption by beer, wine or spirits, respectively. The labels for the three alcohols are placed at the apex corresponding to 100 percent share of that beverage in alcohol consumption. Points in the bottom left kite reflect countries where beer's share of total alcohol consumption, in litres of alcohol (LAL), is greater than 50 percent; points in the bottom right kite indicate countries where over 50 percent of alcohol consumption is from spirits; and, finally, points in the top kite represent countries where wine's share of alcohol consumption is more than 50 percent.

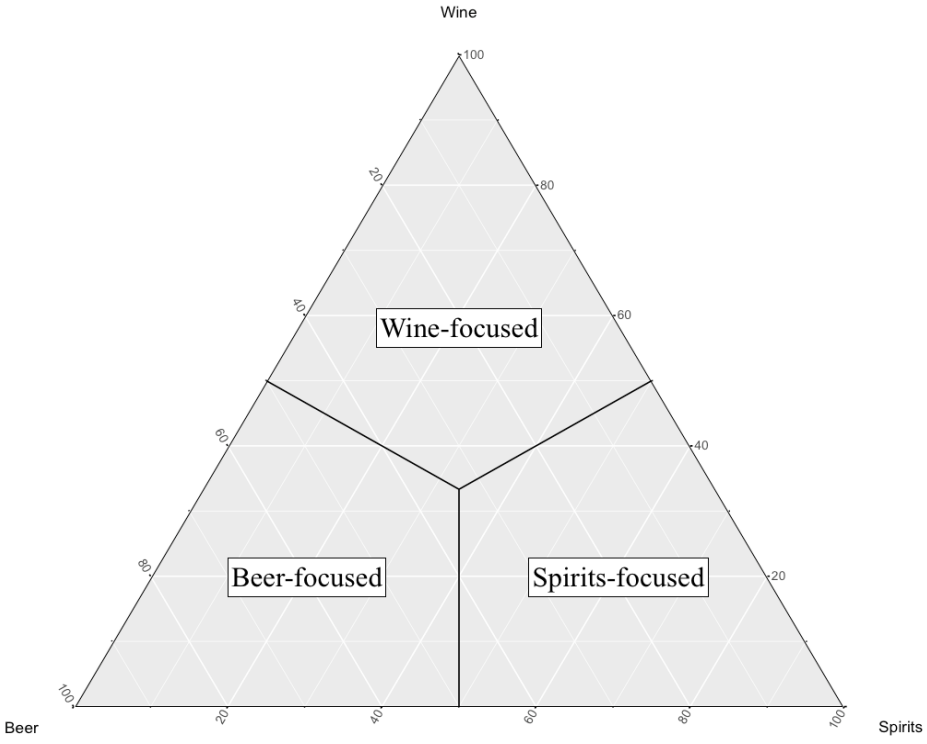

Figure 1.1: Alcohol consumption share triangle

This triangle is presented below with six countries plotted, in addition to the world average. Arrows are used to indicate the movement of consumption shares for each country, with inward pointing arrows reflecting the fact that a country's consumption mix is transitioning toward a more equal mix. In the period from 1961 to 2014 we find that changing alcohol consumption patterns have moved countries towards similar consumption mixes. This widespread convergence in alcohol consumption has been pronounced, however countries have shifted to different extents from the beverage of choice in 1961 toward other beverages, while the world average

has not changed markedly over this period.

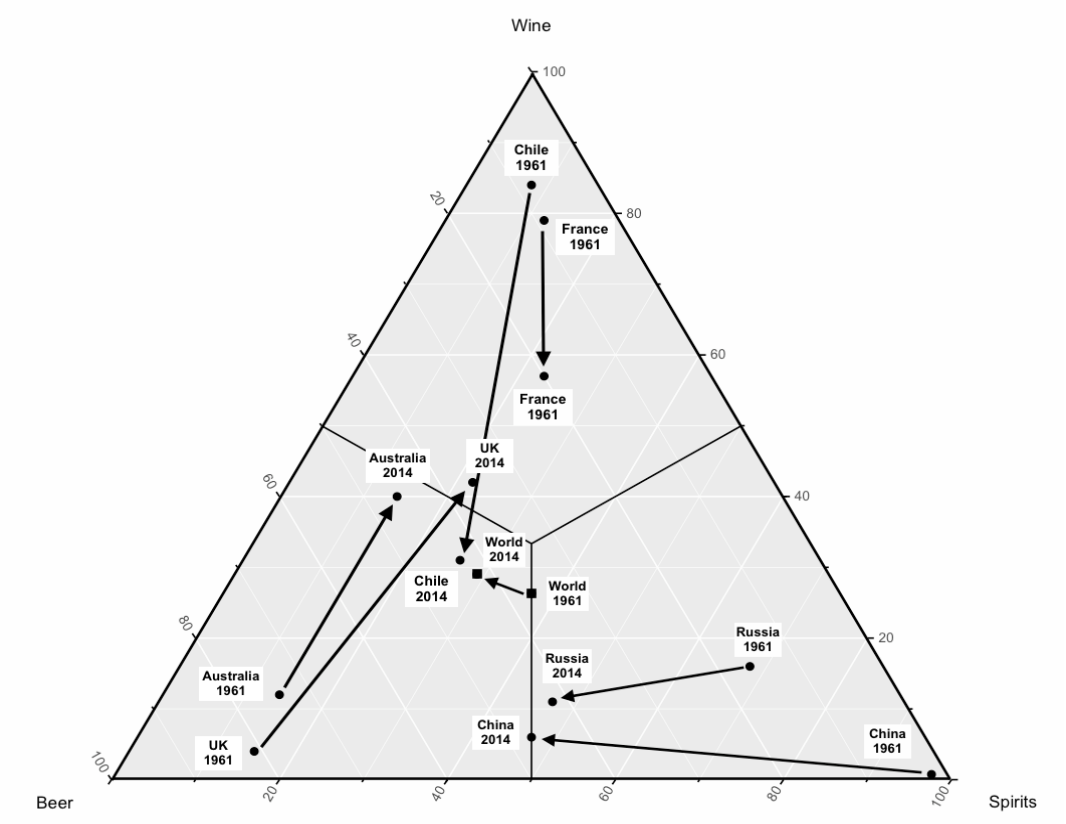

Figure 1.2: The geometry of the alcohol consumption mix

One measure that can be utilised to study these effects and changes in consumption patterns can be found through a comparison of the effects of prices and incomes on the consumption of goods. This analysis is made possible by system demand analysis, a technique that employs a set of equations to show the importance of prices and incomes on consumer demand for different goods and services. Separate equations show how the demand for a good changes with the prices of substitute goods and varying levels of income. The results are useful for informing economic policy questions, such as what effect an increase in taxes on one good will have on the demand for that good and substitutes or complements. These equations therefore gain a more comprehensive understanding of the effects of a policy change on consumers.

Critics of globalisation have suggested that it leads to the homogenization of cultures (Aizenman and Brooks (2008)). If this is the case, then it is somewhat revealing as differences in tastes between consumers may be less acute than believed; as globalisation lessens the differences between countries, prices and incomes, consumer preferences could simply have been influenced by those standard economic

forces instead of varying fundamentally for other reasons. Stigler and Becker (1977) formalised this idea in their hypothesis of identical tastes. They argued that tastes are stable and identical across individuals with differences in the level and share of consumption between individuals influenced by prices and incomes.

This paper aims to serve two purposes. The first is to analyse the evolution of alcohol consumption levels and mixes in a number of different countries to test the hypothesis of convergence in beverage preferences. The second is to test whether Stigler and Becker's hypothesis of identical tastes can explain this convergence in preferences, which is formally tested using the Rotterdam demand model. Furthermore, the contribution of this paper to the existing literature is twofold: first, through the application of two new indicators to study convergence in alcohol consumption patterns between the three main alcohol types; and, second, by extending and widening the system demand analysis of alcohol by almost two decades and to new countries to identify how income and price elasticities of demand have shifted since 1961.

The results we present lead us to two main findings. First, national alcohol consumption patterns are generally converging, and with greater speed in traditionally beer- and spirits-consuming countries. Those countries that have predominantly consumed wine over the past decade, have not converged as quickly because wine's share of alcohol consumption has not declined as rapidly for them as for the rest of the world. Second, the identical tastes hypothesis does not appear to apply to alcohol consumption when it is disaggregated into beer, wine and spirits commodity groups.

This paper adopts a similar methodology to Selvanathan and Selvanathan (2007). They use the Rotterdam demand model to analyse alcohol consumption patterns in 10 high-income industrialised countries and test the identical tastes hypothesis. Selvanathan found that pooling the data across the countries selected, and then testing the pooled model against the models for each individual country, led to a rejection of the pooled model in favour of the alternative and therefore a dismissal of the identical tastes hypothesis. This conclusion has been challenged recently by Fogarty (2010) who questioned how representative a sample of only 10 high-income countries could be.

The remainder of this thesis will proceed as follows. In Chapter 2, we first consider the empirical literature on convergence in consumption patterns and alcohol demand, and provide a brief explanation of the Stigler and Becker (1977) identical

tastes hypothesis. Chapter 3 provides descriptive statistics and introduces two new measures that indicate the extent of convergence in consumption patterns. The results of the convergence analysis motivate the chapter that follows, where we introduce the Rotterdam model and present the implied demand elasticities for a large sample of countries. This thesis then tests the Stigler and Becker hypothesis using this sample to determine whether a common demand equation can be used for the sample as a whole. Those results are documented in Chapter 5, and the final chapter provides a discussion of areas for further research and a summary of findings, before concluding.

2. Literature Review

This chapter outlines the existing literature and details the contribution that this thesis makes within this body of literature. It begins by providing an overview of recent studies into trends and convergence in alcohol consumption patterns. This chapter then explains the system wide estimation method, including recent applications to alcoholic beverage consumption. These applications focus on testing Stigler & Becker's 1997 identical tastes hypothesis, which is briefly explained with reference to the focus of this thesis, alcohol demand, and forms the basis of the tests used in Chapter 5.

2.1 Alcohol consumption patterns

Although the estimation of demand relationships for alcohol has received much attention in the literature, less consideration has been given to the prospect of convergence in alcohol consumption patterns across countries. However, a number of recent studies have identified strong evidence of convergence in the alcohol consumption mix of a number of countries. In most cases, the authors have either tended to limit the scope of their analysis to a specific region and class of high-income countries or a single type of alcohol. This can largely be attributed to the lack of comprehensive data on average alcohol prices and per-capita consumption volume and expenditure, which restricts the extent to which convergence in the relative shares of beer, wine and spirits can be tested.

The increasing trade of alcoholic beverages and blurring of both physical and cultural borders between countries has meant that a key point of interest in the existing literature is the effect of globalisation on alcohol consumption. Smith and Solgaard (2000) explored this idea by looking at trends and convergence in alcohol consumption in European countries from 1960 to 2000. They found that the market shares for traditional beverages had declined while shares of substitute alcohols had grown; for example, in the Nordic countries where spirits were predominantly consumed in 1960, both the beer wine shares increased over the four decades. This transition has been accompanied by a switch by consumers towards higher quality

beverages containing less alcohol.

In contrast, Bentzen et al. (2001) used time series techniques to study alcohol consumption convergence in European countries. Using unit root tests, they found less evidence that absolute convergence is occurring between pairs of countries, while their results suggested more strongly that the differences in alcohol consumption levels are diminishing. The authors recognised that the share of wine consumption, in particular, was increasing considerably, which was attributed to consumers transitioning toward a common preference structure.

Continuing on the theme studied by Smith and Solgaard (2000), Aizenman and Brooks (2008) also studied the effects of globalisation on taste convergence across a large sample of countries that included OECD and middle-income countries, focusing specifically on beer and wine. To analyse convergence, the authors examine the movement of consumption shares of beer and wine for each country relative to the sample mean from 1963 to 2000, and find evidence of strong sigma convergence.

Aizenman and Brooks (2008) present a theoretical overlapping-generations model to explain habit formation that provides results consistent with the convergence hypothesis. While their model provided results that align with empirical observations, it can be considered incomplete without the inclusion of the other main category of alcohol, spirits. They concluded that, for the case of beer and wine, the relative market shares for these beverages are converging across countries. This could be viewed as evidence consumers see at least beer and wine as similar goods that are becoming increasingly substitutable (Fogarty (2010)).

A more recent study by Colen and Swinnen (2016) analysed beer consumption, and its relationship with globalisation, across a large sample of both high- and low-income countries. Echoing the conclusions of Smith and Solgaard (2000), Colen and Swinnen (2016) found that in many traditional beer drinking countries the relative share of beer in total alcohol consumption is declining and that of wine increasing. Conversely, in traditional wine drinking countries, the share of wine is declining and that of beer increasing substantially. Overall, the authors found that countries appear to be converging in their alcohol consumption, but again spirits were omitted.

Colen and Swinnen (2016) utilised a fixed effects panel data model to estimate the relative shares of beer, wine and spirits consumption between countries. This method, despite its limitations, was utilised due to the lack of data on alcohol prices. The authors were forced to generate proxy indicator variables for prices using unit

import values, which prevented useful analysis using system demand estimation techniques. Their results suggest that the relationship between beer consumption and income is such that beer consumption increases in emerging countries with rising incomes but falls with higher levels of income, and this inverted "U" shape is confirmed by the empirical evidence. The implication of this result is that rising incomes affect the income elasticity of demand for beer, eventually resulting in beer consumption peaking at a certain level.

2.2 System wide demand analysis

The convergence in alcohol consumption across countries, which has been identified in the literature, raises the question of what the determinants of alcohol consumption are that are driving this pattern. One possible explanation is that suggested by Stigler and Becker (1977), namely, that tastes are constant across countries and it is only incomes and prices that explain differences in consumption mixes. In order to test this hypothesis, system demand estimation, specifically the Rotterdam model, has been used by Selvanathan and Selvanathan (2007). The hypothesis of constant preferences can be tested by estimating demand equations for different countries and then, through pooling the data, testing whether a common demand equation is suitable.

The popularity of system-wide models has seen this approach supersede the older single log-log equation approach. Of the various system-wide demand models found in the applied microeconomics literature, the most popular and well developed specifications as surveyed by Fogarty (2010) appear to have been the Rotterdam model, which was developed by Barten (1964) and Kloek and Theil (1965), and the AIDS model attributed to Deaton and Muellbauer (1980). Barnett and Seck (2008) suggest that the popularity of these models can be explained by the fact that they are linear in their parameters, and the simplicity with which the theoretical demand constraints placed on the system can be tested. The benefits of the differential approach used in demand estimation were further listed by Barnett and Seck (2008) to be its strong link with economic theory of consumer behaviour, attractive aggregation properties, generality and simplicity.

System-wide models have generally been used to study consumption with the focus being the estimation of income and price elasticities but few researchers have compared income and price elasticities across countries. In their study, Selvanathan and Selvanathan (2007) examined consumption across ten high income, high alcohol-

consuming, OECD countries. The time dimension for each country covered was not even – it covered national time series as long as 43 years,[1] in Australia's case, and as little as 16 years for Finland.[2] Due to the potential presence of time-unique disturbances, this feature of their study detracts from its use for meaningful comparison of elasticities between countries. Using the results of their system demand analysis, the authors tested the Stigler and Becker (1977) proposition that tastes are homogeneous across countries by pooling the data. This technique was first used by Pollak and Wales (1987) to test the identical tastes hypothesis. They looked specifically to see whether the demand for consumption goods varied significantly across Belgium, the USA and the UK and rejected this hypothesis. Conversely, Selvanathan and Selvanathan (1993) pooled data across 15 high-income OECD countries and 10 commodity groups and found that consumers in these 15 countries had similar tastes. Finally, Chen and Clements (1999) looked at consumption of food, clothing, housing and other commodities across a large group of countries of varying income levels and found evidence in support of the notion that tastes were similar, if not identical, across the group.

In their study on alcohol consumption, Selvanathan and Selvanathan (2007) compared the pooled demand system results to the individual country results by means of a likelihood ratio test and rejected the conclusion that the data could be pooled and estimated. This result has been questioned by Fogarty (2010) who conducted a meta-regression analysis of the alcohol demand literature. Fogarty (2010) rejected the Selvanathan and Selvanathan (2007) conclusion on the basis that there was no consideration of issues such as pooling across a small sub-sample of countries and beverages, or the potential for outlier countries to affect the result.

The results obtained by Fogarty (2010) provide evidence in favour of the application of the Stigler and Becker (1977) hypothesis and its application to alcoholic beverages. Despite concluding that little support is found suggesting that the demand for alcohol varies significantly between countries, Fogarty (2010) does find evidence that wine may be an exception to this rule. Therefore, he suggests that a single classification for the good wine may not be suitable when analysing the demand for wine as it is a less homogeneous good when compared to beer and spirits.

[1]The data used for Australia spanned the period from 1956 to 1999.
[2]The data used for Finland spanned the period from 1969 to 1985.

2.3 Stigler and Becker's hypothesis

The identical tastes hypothesis was proposed by Stigler and Becker in their 1977 paper *De Gustibus Non Est Disputandum*, where the authors argued that "no significant behavior has been illuminated by assumptions of differences in tastes." Their theory suggests that tastes should be taken to be stable over time and identical across countries. Therefore they submit that tastes should be taken to be exogenous and homogeneous across countries, with differences in actions fully explained in terms of differences in perceived opportunities and utility-maximizing behaviour (Vriend (1996)). If differences in incomes and prices between countries are adjusted for, then consumption patterns are more or less the same internationally. When applied to the current study, the hypothesis therefore suggests that, for example, the determinants of wine consumption should primarily be wine prices, income and the prices of substitute alcohols such as beer and spirits. Previous studies have relied on this hypothesis and used a common system of demand equations for cross-country consumption analysis.[3] The appropriateness of this method is not clear when considering alcohol consumption and the hypothesis is formally tested in this paper with the results presented in Chapter 5.

[3]For example, Chen and Clements (1999); Kravis Irving et al. (1978); Selvanathan and Selvanathan (1993); Theil and Clements (1987); Theil et al. (1981)

3. Descriptive Statistics

In this chapter, we explain the sources of the alcohol consumption and price data for our sample countries and the methods used to construct the data-set. Following this, we identify trends in alcohol consumption using three indicators to illustrate trends in alcohol consumption patterns since 1961.

3.1 Data sources

This paper primarily uses beer, wine and spirits consumption volume and price data sourced from a new annual database of Global Wine Markets, 1835 to 2015.[1] The database is a panel data-set detailing basic and derived consumption variables for 47 important wine-producing and -consuming countries from 1835 to 2015. From this large sample of countries considered in the convergence analysis that follows we selected a smaller sample of 26 OECD and EU28 countries for demand analysis for which consumer price data were available.

To construct unit prices for beer, wine and spirits for each country, the method used by Selvanathan and Selvanathan (2007) was employed, whereby per-capita beverage expenditure was divided by the per-capita consumption volume, to obtain the average beverage price for each year. Price indexes for beer, wine and spirits were then used to derive prices up to 2014 for each country. For a large number of the European countries in the sample, Euromonitor International (2016) aggregate expenditure and consumption data were used to derive prices where data on average prices was not available.

Using wine import unit value, a proxy price index for wine was created for Japan spanning the period from 1963-1969. Over that time period, between 60% and 80% of wine consumed in Japan was imported, making the unit import value a suitable proxy variable.[2] For the remainder of the countries in our sample, average price

[1] I assisted the authors, Kym Anderson and Vincente Pinilla, in assembling this database, which has made this analysis possible.

[2] Japan has import and excise taxes on wine, but their ad-valorem equivalent is quite small at

data are taken from Selvanathan & Selvanathan (2007) and combined with updated consumption and price index data. Price indices for beer, wine and spirits were compiled primarily from Eurostat for European Union countries; the Australian Bureau of Statistics for Australia; the Bureau of Labor Statistics for the United States; Statistics Japan for Japan; Statistics New Zealand for New Zealand; and Statistics Canada for Canada. Other key statistics that have been used are compiled from the World Health Organisation, OECD Stat and the World Bank. As data collection and manipulation was an important part of this paper, a detailed explanation of the data sources is contained in Section A.2 of the appendix.

Where possible, the same year was selected across countries to take a single point estimate of the average beverage price in that year. The year chosen was 1996 as for the majority of countries in our sample, the price index data starts in 1996.[3] We then extrapolated for all future years using the price series. One issue inherent in deriving prices from dividing expenditure by the corresponding consumption volume is that quality changes are built into the prices (e.g. in trending away from non-premium and toward premium wines). The consumer price indexes are simply derived from these average price data. Therefore, the consumer price index for these beverages is not independent of quality changes. Without more detailed price data, this problem must be recognised but cannot be solved for the purposes of our analysis.

A sample of 26 countries was selected for the system demand estimation that follows. They are Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Romania, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. Summary statistics for the level of alcohol consumption in litres of alcohol (LAL) and share of overall alcohol consumption in these countries is provided in Table 3.1. The sample mean per-capita consumption level is higher for all alcohol types than the global mean and this is a consequence of the greater availability of alcohol data for countries with higher levels of consumption. A complete summary, including the time dimension of the data available for each country and conditional budget shares for each alcoholic beverage, can be found in the Appendix in Table A.1 and Table A.2.

only 5% as estimated by Anderson et al. (2014) Anderson (2014) and thus can be ignored.

[3]This is the case for all Eurostat price indexes and thus for all EU countries.

Table 3.1: Sample country group summary 1961-2014 (mean)

	Per capita consumption (LAL)				Share in total (%)			
Country	Beer	Wine	Spirits	Total	Beer	Wine	Spirits	Total
Australia	5.1	2.3	1.1	8.5	59.5	27.2	13.3	100
Austria	5.3	3.7	1.4	10.4	51.1	35.1	13.8	100
Belgium	5.7	3.8	1.4	10.9	52.2	35.1	12.7	100
Bulgaria	2.6	2.3	3.1	8.0	32.3	29.2	38.5	100
Canada	3.4	0.9	2.2	6.6	52.2	14.9	32.9	100
Croatia	2.6	4.9	1.6	9.1	28.5	54.1	17.4	100
Denmark	5.0	2.2	1.3	8.6	59.0	25.9	15.1	100
Finland	2.8	0.9	1.4	5.1	55.6	17.6	26.8	100
France	2.0	8.9	2.3	13.2	15.0	67.8	17.2	100
Germany	6.4	2.6	2.4	11.3	56.4	22.7	20.9	100
Greece	1.8	3.8	2.4	7.9	22.4	47.4	30.2	100
Hungary	3.7	3.5	3.5	10.6	34.4	33.1	32.5	100
Ireland	5.5	0.9	1.7	8.2	67.7	11.4	20.9	100
Italy	1.0	8.2	1.2	10.5	9.9	78.4	11.7	100
Japan	1.7	0.1	4.0	5.8	29.1	2.3	68.6	100
Netherlands	3.6	1.7	1.9	7.3	49.8	23.9	26.3	100
New Zealand	4.8	1.5	1.3	7.6	62.7	20.1	17.2	100
Norway	2.7	1.0	1.6	5.3	50.0	19.7	30.3	100
Portugal	2.2	8.3	0.6	11.1	19.6	75.1	5.4	100
Romania	2.2	2.9	1.7	7.0	32.0	43.0	25.0	100
Spain	2.9	4.9	2.6	10.5	27.7	47.5	24.7	100
Sweden	2.5	1.5	1.9	5.8	43.0	24.9	32.1	100
Switzerland	3.3	4.9	1.8	10.0	32.9	49.2	17.9	100
Turkey	0.3	0.1	0.3	0.7	49.3	10.0	40.7	100
United Kingdom	4.6	1.5	1.5	7.6	60.3	20.0	19.7	100
United States	3.5	0.9	2.5	6.9	51.4	12.7	36.0	100
Sample mean	3.4	2.8	1.8	7.9	44.1	31.5	24.4	100
Global mean	1.0	0.7	1.1	2.8	35.3	22.7	42.0	100

In terms of total alcohol consumption, France is the highest ranked country whereas Turkey has the lowest level of total consumption. There is some variation in the level and share of each alcohol consumed in the countries in the sample. The information detailed in Table 3.1 reveals a diverse group of countries, while the majority appear to be historically beer-consuming. However, as will be shown in the convergence indexes that follow, beer's share of consumption has dropped appreciably in nearly all of these countries. There is a slightly smaller group of wine-focused nations and several spirits-focused. Overall, each country's alcohol consumption mix has followed its own respective path over the past half century in spite of any historical alcohol consumption patterns that existed.

Figure 3.1 graphically represents the relationship between total alcohol consumption against the level of real per-capita income from 1961 to 2014 for the 47 countries and confirms the non-linear, inverted U-shape found by Colen and Swinnen (2016). The sub-sample of 26 countries that feature in the system demand analysis in Chapter 4 are shown by the orange points, which reveal that this group appears to feature high-income, high-alcohol consuming countries.

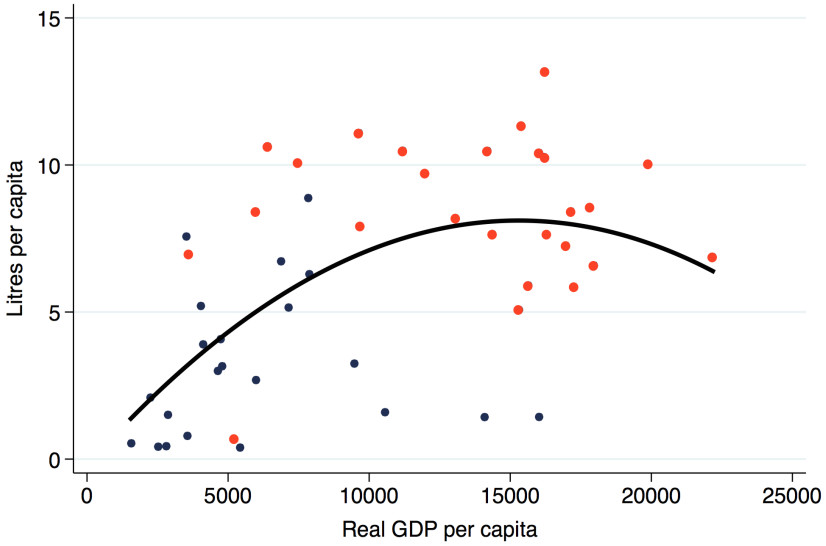

Figure 3.1: Alcohol consumption per capita (mean) vs. income per capita (mean) comparison (1961-2014)

The difference in the level of alcohol consumption between this sub-sample and the remaining countries might not be as acute as it appears Reed (2015) showed that alcohol consumption tends to be under-reported in low-income countries and the level of recorded alcohol consumption increases with incomes. The lack of variation in income levels between countries in our sub-sample is a consequence of the aforementioned data limitations for non-OECD countries. While constructing price proxy variables to increase the sample size was an option, as noted by Colen and Swinnen (2016), who faced the same problem in an analysis of beer demand across a large sample of countries, this would lead to larger measurement errors in the budget shares of each alcohol and thus in the overall estimation method.

3.2 Trends and Convergence

To study convergence in the individual country consumption mix, a number of different indicators have been employed. First, the coefficient of variation will be presented as a preliminary indicator of convergence in consumption. The intensity and similarity indexes adapted by Anderson (2014) to study wine grape variety patterns across countries and regions will be applied to beverage consumption to measure convergence in each individual country's consumption mix towards the world average. Bentzen et al. (2001) used a similar measure to analyse the structure of alcohol consumption by looking at wine's share of total alcohol consumption. The forthcoming analysis goes beyond that to examine the shares of wine, beer and spirits, and for a larger sample of countries and over a longer time period.

As a preliminary indicator of convergence, the coefficient of variation was calculated across countries at annual intervals for each alcohol's consumption share. The coefficient of variation (CoV) measures the concentration of data around the mean value and provides a way of measuring sigma convergence. It is calculated by taking the level of consumption per capita for a given year across countries and dividing the standard deviation of the series, σ_t, by the mean value of the sample, $\bar{X}_t$:

$$CoV_t = \frac{\sigma_t}{\bar{X}_t} \tag{3.1}$$

Since 1961, the coefficient of variation has fallen for all three beverage groups, which illustrates a certain degree of sigma convergence. This can be seen in Figure 3.2 where the coefficient of variation for the 47 countries is provided for beer, wine and spirits. The sample standard deviation of the beer shares is 0.27 in 1961, and declines to 0.18 in 2014, while the sample standard deviation of the wine shares is 0.29 in 1961, and declines to 0.19 in 2014. Finally, the sample standard deviation of the spirits shares is 0.28 in 1961, and declines to 0.21 in 2014. For wine, the coefficient of variation is highest of the three due to the inclusion of countries with high proportions of wine consumption, such as France, and outliers that have very low consumption consisting of predominantly Asian countries.[4] The coefficient of variation is also plotted for the sample of 26 countries in Figure 3.3.

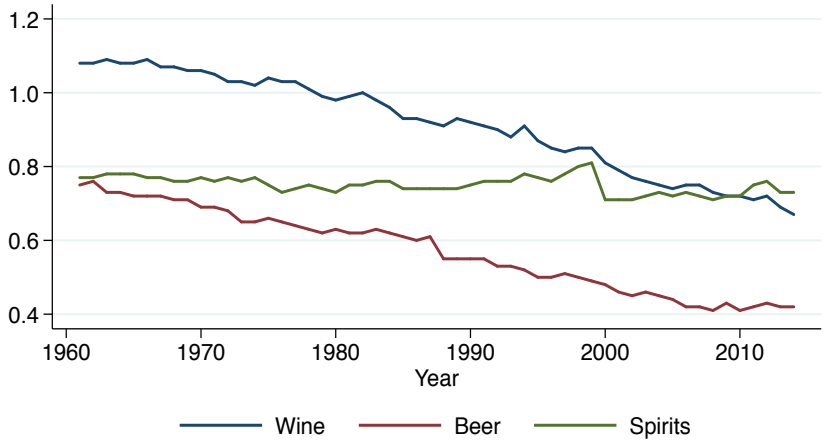

Figure 3.2: Coefficient of variation of shares of each beverage in total alcohol consumption

[4]In 2014, wine's share of consumpton was 4.48% in China while in India it was only 0.02%.

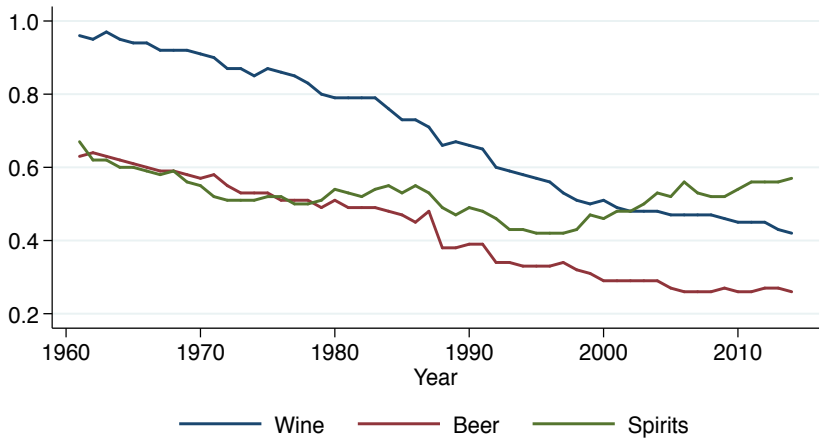

Figure 3.3: Coefficient of variation of shares of each beverage in total alcohol consumption (sample)

While this measure appears to show the coefficient of variation for wine and beer declining in a parallel fashion, the same clear trend cannot be said for spirits. One possible explanation for the source of this pattern can be attributed to the small number of spirits-consuming countries in the sample, including outlier countries such as Japan, where spirits' share of consumption has actually increased by 4 percent between 1961 and 2014. The downward shift in the coefficient of variation for spirits from 1999 to 2000 is a consequence of upward shifts in spirits' share of consumption in a number of eastern European countries, which reduced the standard deviation across the 47 country group.[5] In Figure 3.3, the sample group appears to be representative as it demonstrates similar trends with a declining coefficient of variation for beer and wine, while for spirits we find that there is not the same distinct downward trend.

3.2.1 Consumption Intensity Index

To analyse the consumption mix of each country in greater detail, we adapt two indexes that have previously been applied to evaluate wine grape varietal mixes. The first is the consumption intensity index, which reflects the importance of one type of alcohol to a country relative to that same alcohol's significance in worldwide consumption in a particular year. It is a function of the consumption share in a country for one type of beverage divided by the world average consumption share for the same beverage that year. We denote the consumption intensity index for

[5]The share of spirits consumption in total alcohol consumption increased by 28.6% and 20.9% in Georgia and Romania alone. Spirits data for Moldova begins in 2000 and with 36.3% of alcohol consumption devoted to spirits, this is close to the world average of 44% for that year, which would have also contributed somewhat to a decline in the coefficient of variation.

country i by the following:

$$V_{in} = \frac{f_{in}}{f_n} \tag{3.2}$$

Where there are $i = 1, ..., 47$ countries and $n = 1, 2, 3$ corresponding to beer, wine and spirits. We define f_{in} is the share of beer, wine or spirits consumption in the total alcohol consumption in country i such that $0 \leq f_{in} \leq 1$ and $\sum_{n=1}^{3} f_{in} = 1$. This is divided by the world consumption share for the same alcohol, f_n, with $0 \leq f_n \leq 1$ and $\sum_{n=1}^{3} f_n = 1$.

3.2.2 Country Similarity Index

The second indicator we use is the Similarity Index, modified by Anderson (2010) Anderson (2010) from the approach introduced by Griliches (1979) and Jaffe (1986), to measure the extent to which the wine varietal mix of one region or country matches that of another region or country or the world. It can also be adapted for the purposes of this paper to compare the consumption mix of a country over time.

The index uses vector representation to project combinations of variables with lengths determined by the shares of beer, wine and spirits in a country's consumption mix. The vector f_{im} has the same definition as above and is the share of beer, wine or spirits consumption in the total alcohol consumption in country i. The index is defined as:

$$\omega_{ij} = \frac{\sum_{m=1}^{M} f_{im} f_{jm}}{\Big(\sum_{m=1}^{M} f_{im}^2\Big)^{1/2} \Big(\sum_{m=1}^{M} f_{jm}^2\Big)^{1/2}} \tag{3.3}$$

where $i = 1, ..., 47, \quad j = 1, ..., 47 \quad \text{and} \quad M = 3.$

In a hypothetical two beverage case, where country i has 50% of its consumption consisting of beer and country j has 30% devoted to beer consumption, then the index of consumption similarity is the cosine of the angle between the two vectors in Figure 3.4. Therefore, differences can be judged by the angular separation, or uncentered correlation, of the vectors f_i and f_j for the two countries (Jaffe (1986)).

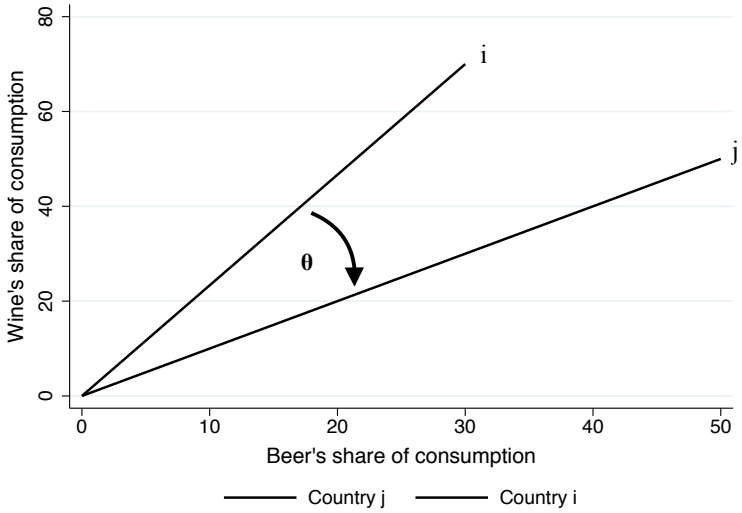

Figure 3.4: Similarity vector plot

3.2.3 Patterns of Convergence in Alcohol Consumption

The Consumption Volume Similarity Index is plotted for our overall country sample of 47 countries in Figure 3.5 for the period from 1961 until 2014. Plotted on this graph are three groups for beer, wine and spirits-intensive countries, respectively. The three groups were constructed according to which of the 3 beverages had the highest share in their national mix in the period from 1961-64. These groups are detailed in Table A.3 of the appendix. The Similarity Index for our 26 country sample is also included in Figure 3.5 to indicate how representative it is overall. The line is situated close to the beer- and spirits-focused groups reflecting the fact that our sample contains a larger proportion of the countries from these groups, and less from the wine-focused group.

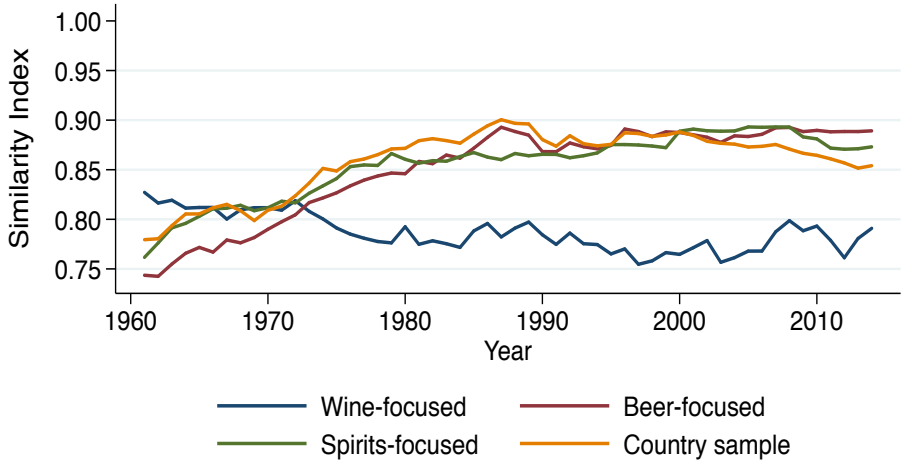

Figure 3.5: Consumption volume similarity index

The beer- and spirits-intensive groups appear to have converged rapidly towards the world average (that is, the indexes have approached 1.0) from 1961 to the mid-1980s before slowing in the past two decades. On the other hand, the consumption mix of the wine-intensive group does not appear to be converging in a similar fashion. This indicates that many of the wine-intensive countries have reduced their wine share less than has occurred globally. This conclusion is supported by inspecting the intensity index for wine in Figure 3.6.

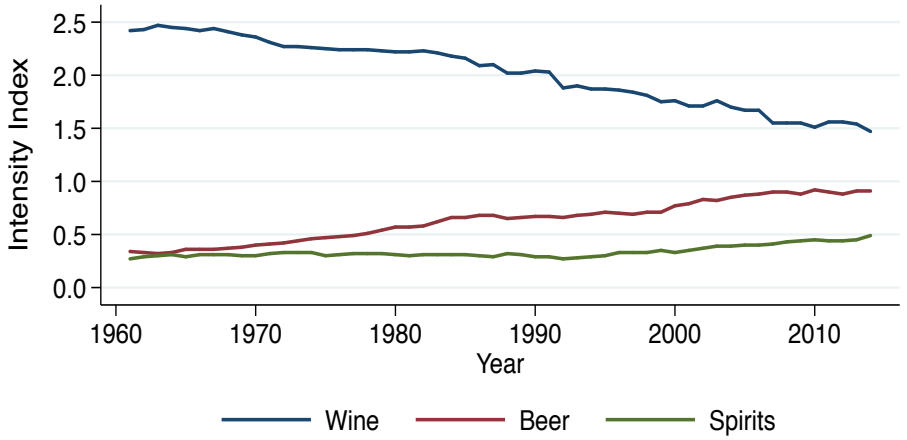

Figure 3.6: Wine intensity index

A rapid increase has occurred in the share of wine consumption in a number of countries as can be noted from the increasing intensity indexes for the beer group. For example, wine's share of consumption was only 9.1% in Sweden in 1961, however by 2014 this number was 49%. The wine group appears to be converging and distinctly reducing its share of wine consumption relative to the global average. The rate at which wine's share of consumption is dropping in this group has not been swift enough given that in 1961 the share of wine in alcohol consumption was significantly higher relative to the world average. In countries such as France, where wine's share of consumption was 79% in 1961, as of 2014 it was still 57%. That change is of a much smaller magnitude than the corresponding increase in countries where wine was traditionally not popular. Aizenman (2008) attributes this slow adjustment in the consumption mix of wine-drinking countries to habit formation.

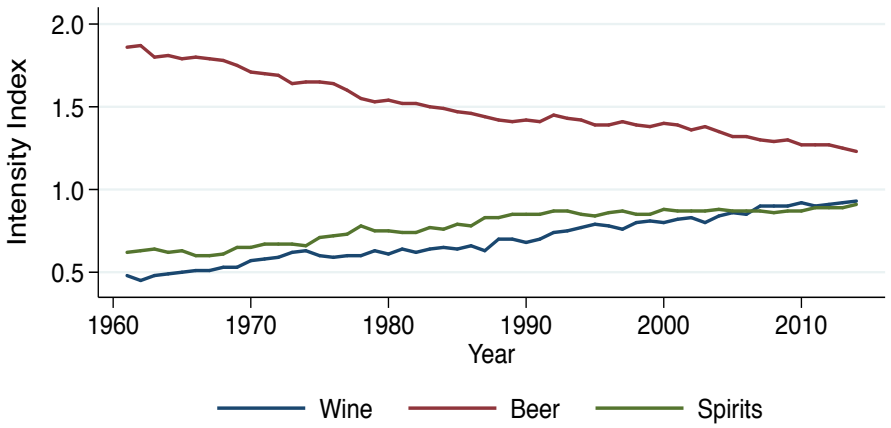

Figure 3.7: Beer intensity index

The beer intensity indexes reveal the strongest pattern of convergence across the three beverage intensity indexes. All three groups appear to be moving towards the world average, with the beer-focused group showing the most rapid convergence, as each country sees beer's share of consumption decline. This is not surprising as there has been a significant shift away from beer in countries such as the United Kingdom, Ireland, Australia and New Zealand, where beer's share of alcohol consumption has dropped between 28 and 45 percentage points respectively between 1961 and 2014. Conversely, in countries where beer was relatively less popular initially, it is being consumed in increasing quantities. For example, Finland has seen beer's share of total alcohol consumption increase by 23 percentage points since 1961.

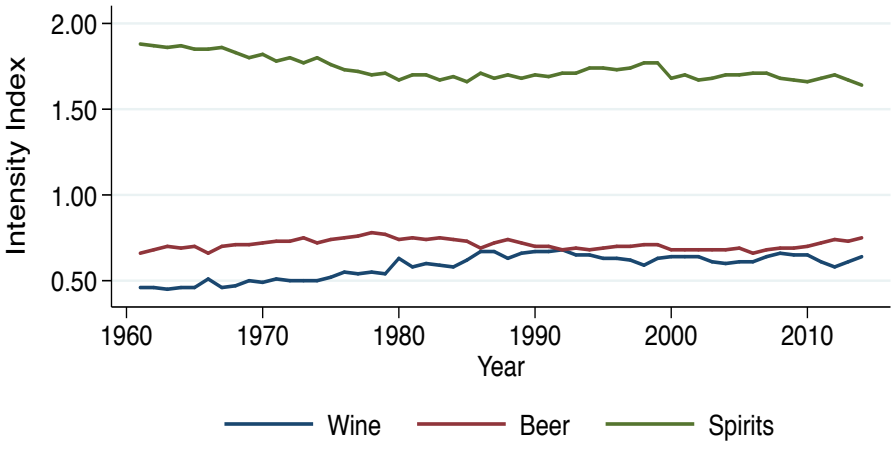

Figure 3.8: Spirits intensity index

Finally, the spirits intensity index is shown in Figure 3.8. While the spirits group has converged somewhat downwards, it is still above the world average. Spirits' share of total alcohol consumption in countries such as Sweden and Finland, where it was once the beverage of choice, has dropped markedly since 1961 by 38

and 27 percentage points respectively, however this does not appear to have had a large impact on the group overall. This could be due to the presence of outliers, including Japan where spirits' share of consumption has increased from an already high share in 1961 (64%) in stark contrast to other countries. There also appears to be little upwards movement in spirits' share of consumption for the wine- and beer-focused groups relative to the world average and this pattern was evident in Figure 1.1. The wine-focused group index is lower than the beer-focused group as, on average, spirits' share of consumption is lowest in these countries and well below the world average.

Overall, we find that there is convergence in the country groups to the world average. This indicates that the consumption mix in those countries has shifted dramatically over the past half century. This pattern of convergence in preferences has been analysed previously by Aizenman and Brooks (2008) and Colen and Swinnen (2016), which focused specifically on wine and beer consumption, respectively. The lesser degree of convergence in spirits' share of consumption found in Figure 3.8 has to the author's knowledge not been acknowledged in the existing literature.

For the sample of countries for which we have price data, it is also possible to construct the similarity index for conditional budget shares to study whether countries are more similar in terms of volume or value shares relative to the sample average.

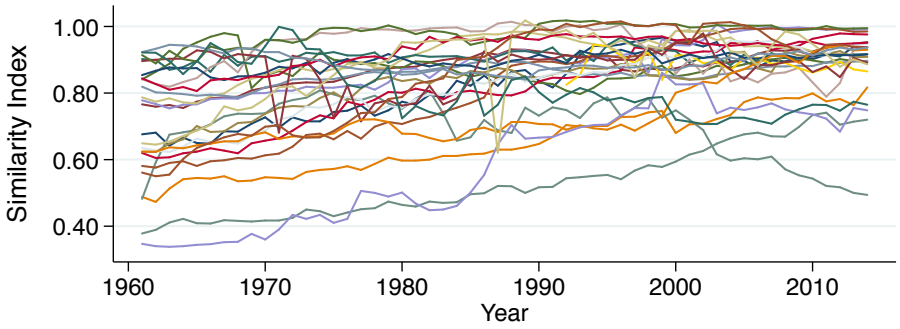

Figure 3.9: Sample consumption volume similarity index

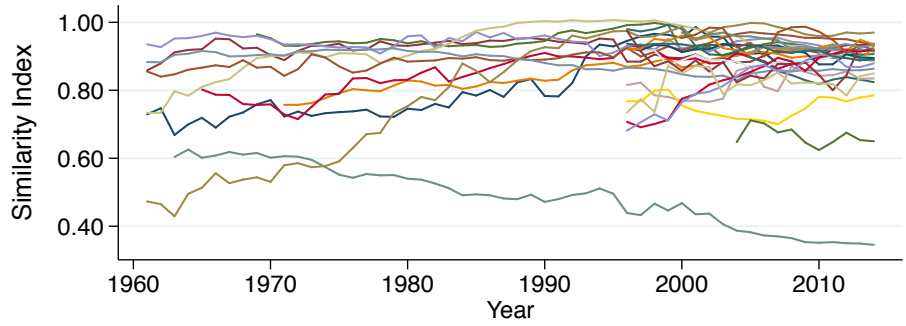

Figure 3.10: Sample consumption value similarity index

Figure 3.9 and Figure 3.10 detail the similarity index for volume and value shares for the sample group of countries, respectively. It can be seen that since 1961 there appears to be a general trend in these countries towards the world average (1.0). While it's not immediately clear in the figures above, the extent of convergence in volume and value terms does differ in the sample. This is shown by Figure 3.11 which plots the standard deviation for the volume and value similarity indexes.

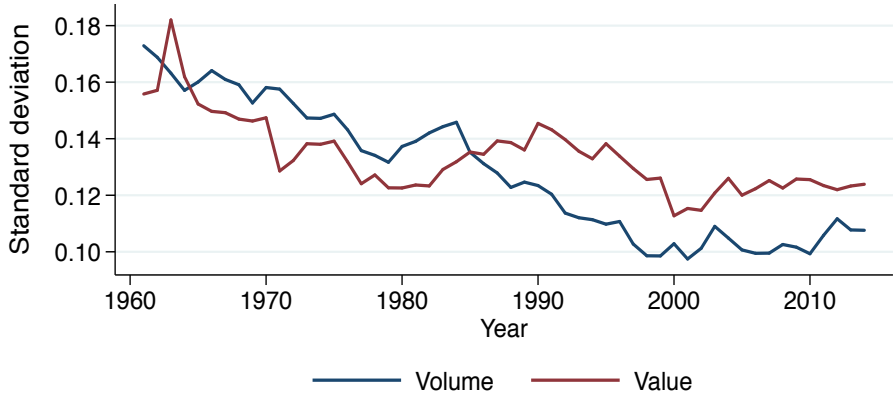

Figure 3.11: Standard deviation for volume and value similarity indexes for sample countries

While it has not been the case for the whole period from 1961 to 2014, the sample countries are now more similar in terms of volume shares than conditional budget (value) shares, as the standard deviation across the sub-sample is smaller for the volume similarity indexes. The results of regressing the standard deviations against a time trend are that the annual decline in standard deviation is found to be -0.0014 for volume and -0.0006 for value. Both coefficients are significant with a p-value of 0.000. This further dimension of similarity between countries, namely similarity in the shares of alcohol expenditure allocated to beer, wine and spirits, has not been analysed in detail in the existing literature and provides a question requiring further analysis.

4. Estimation

In this chapter, we introduce the Rotterdam demand model and its parameters. The Rotterdam model was first established by Barten (1964) and Kloek and Theil (1965) and consists of a system of demand equations that utilise the differential approach. This model was selected over alternatives, such as the Almost Ideal Demand System, for the same reasons given by Clements and Selvanathan (1988), who used the Rotterdam model to study alcohol demand. Namely that the model gives a first-order approximation to any arbitrary demand system and is therefore roughly compatible with a range of underlying utility functions. This characteristic renders the model more appropriate for our proceeding analysis.

The chapter begins by first introducing the model and outlining the parameters to be estimated and their interpretation. The subsequent chapter tests the demand theory hypotheses of homogeneity, Slutsky symmetry and preference independence to confirm that our results do not violate the theoretical constraints. The homogeneity- and symmetry-constrained results for beer, wine and spirits demand in the sample of countries for all years and the sub-period from 1996 to 2014 are then presented. Finally, the chapter concludes by testing the identical tastes hypothesis through estimation of the pooled data to compare the results with those at the individual country level.

Let q_{it} be the annual per capita consumption in litres of alcohol of beverage i and p_{it} be the price per litre. We define alcohol consumption expenditure to be M_{At} such that $M_{At} = \sum_{i=1}^{3} p_{it}q_{it}$. The conditional budget share of beverage i, which represents the proportion of total alcohol consumption expenditure devoted to a particular beverage, is calculated by $w_{it}^{'} = \frac{p_{it}q_{it}}{M_{At}}$. The arithmetic average of the conditional budget share between years t and $t-1$ is therefore represented by $\bar{w}_{it}^{'} = 1/2(w_{i,t-1}^{'} + w_{i,t}^{'})$.

Let $Dq_{it} = lnq_{it} - lnq_{it-1}$ and $Dp_{it} = lnp_{it} - lnp_{it-1}$ be the quantity and price log-changes of beverage i. The Divisia price index is defined as $DP_{At} = \sum_{i=1}^{3} \bar{w}_{it}^{'} Dp_{it}$ and the quantity index is $DQ_{At} = \sum_{i=1}^{3} \bar{w}_{it}^{'} Dq_{it}$. When multiplied by 100, these indices are interpreted as the average annual growth in consumption volume and prices.

Following a similar method adopted by Selvanathan and Selvanathan (2007) to outline the model, the relative price version of the Rotterdam model is given by:

$$\bar{w}_{it}^{'} Dq_{it} = \theta_i^{'} DQ_{At} + \sum_{j=1}^{3} v_{ij}^{'} (Dp_{jt} - DP_{At}^{'}) \tag{4.1}$$

$i = 1, 2, 3, \quad t = 1, ..., T$

where the conditional marginal share for each beverage is given by $\theta_i^{'}$. These shares must satisfy $\sum_{i=1}^{3} \theta_i^{'} = 1$. The difference term on the right-hand-side given by $(Dp_{jt} - DP_{At}^{'})$ is the change in the deflated price of j with the Frisch price index for alcohol denoted $DP_{At}^{'} = \sum_{i=1}^{3} \theta_i^{'} d(logp_i)$.

The other part of this term is $v_{ij}^{'}$ which satisfies $\sum_{j=1}^{3} v_{ij}^{'} = \phi \eta_A \theta_i^{'}$ where $\phi = [\partial(log\lambda)/\partial(logM)]^{-1}$ is the income flexibility term, which is the inverse of the income elasticity of the marginal utility of income, and η_A is the alcohol income elasticity. This price coefficient is comprised of $v_{ij}^{'} = (\lambda / M\bar{W}_A) p_i u^{ij} p_j$, where λ is the marginal utility of income and u_{ij} is taken from the inverse of the Hessian of the utility function. Finally, $\bar{W}_A$ is the budget share of the alcoholic beverages group.

The form of equation 4.1 expresses expenditure on beverage i as a function of two components: the first term on the right-hand-side, which is total alcohol consumption given by DQ_{At}, and the second term, expressed by $(Dp_{jt} - DP_{At}^{'})$, which gives the relative prices of beer, wine and spirits. In this second term, the Frisch price index, $DP_{At}^{'}$, acts to deflate these prices. Thus, the effect of real expenditure on alcohol on the demand for beverage i is given by the first term in equation 4.1. The second term on the right-hand side of equation 4.1 deals with the effect of changes in the Frisch-deflated price of beverage j. We know that $\sum_{j=1}^{3} v_{ij}^{'} = \phi \eta_A \theta_i^{'}$ and it can therefore be shown that the substitution term is given by the difference between $\sum_{j=1}^{3} v_{ij}^{'} Dp_{jt}$, the specific substitution effect of the three prices, and $\phi \eta_A \theta_i^{'} DP_{At}^{'}$, the general substitution effect.

The model to be estimated is the absolute price version of the Rotterdam model:

$$\bar{w}_{it}^{'} Dq_{it} = \alpha_i + \theta_i^{'} DQ_A t + \sum_{j=1}^{3} \pi_{ij}^{'} Dp_{jt} + \varepsilon_{it} \tag{4.2}$$

$i = 1, 2, 3, \quad t = 1, ..., T$

The only difference in this version of the Rotterdam model is that the Slutsky coefficient is written as $\pi_{ij}^{'} = v_{ij}^{'} - \phi\eta_A\theta_i^{'}\theta_j^{'}$. For maximum likelihood estimation we express equation 4.2 as the following, where $y_{it} = \bar{w}_{it}Dq_{it}$:

$$y_{it} = \alpha_i + \theta_i DQ_t + \sum_{j=1}^{3} \pi_{ij}^{'} Dp_{jt} + \varepsilon_{it} \tag{4.3}$$

This can be expressed in vector form as:

$$\boldsymbol{y_t} = \boldsymbol{g(v_t, \gamma)} + \boldsymbol{\varepsilon_t} \tag{4.4}$$

where $\boldsymbol{y_t} = (\bar{w}_{1t}DP_{1t}, \bar{w}_{2t}DP_{2t}\bar{w}_{3t}DP_{3t})'$, $\boldsymbol{v_t} = (DQ_t, Dp_{1t}, Dp_{2t}, Dp_{3t})'$, $\boldsymbol{\varepsilon_t} = (\varepsilon_{1t}$, $\varepsilon_{2t}, \varepsilon_{3t})'$ and $\boldsymbol{\gamma}$ is the vector of unknown parameters, θ_i and π_{ij}, to be estimated. Assuming that the $\varepsilon_{it}^{'}s$ are normally distributed with zero mean and non-singular covariance matrix Ω, the log-likelihood function is:

$$logL(\gamma, \Omega) = -\frac{(2)T}{2} log(2\pi)|\Omega| - \frac{1}{2}\sum_{t=1}^{T}[(y_t - g(v_t, \gamma))'\Omega^{-1}(y_t - g(v_t, \gamma))] \tag{4.5}$$

This is maximized with respect to the parameters in $\boldsymbol{\gamma}$ and the covariance matrix, $\boldsymbol{\Omega}$. After estimating the model parameters, we obtain the the ith conditional income elasticity by dividing both sides of equation 4.2 by $\bar{w}_{it}^{'}$:

$$\eta_i = \frac{\theta_i^{'}}{\bar{w}_{it}^{'}} \tag{4.6}$$

and the (i, j)th conditional Slutsky price elasticity:

$$\eta_{ij} = \frac{\pi_{ij}^{'}}{\bar{w}_{it}^{'}} \tag{4.7}$$

The model is estimated subject to three constraints to ensure that it accords with demand theory. The first is Engel aggregation, which requires that the sum of the product of the beverage shares and income elasticities must always sum to one:

$$\sum_{i=1}^{3} \theta_i^{'} = 1 \tag{4.8}$$

The second is linear homogeneity, which requires that the demand functions are homogeneous of degree zero. Therefore an equiproportionate change in prices will have no effect on the level of quantity demanded for beer, wine or spirits.

$$\sum_{i=1}^{3} \pi_{ij}^{'} = 0 \tag{4.9}$$

Finally, we impose Slutsky symmetry, that is, the substitution effects of price changes are symmetric between beverages. This requires that the effect of a price change in beverage j on beverage i is the same for an equal change in price for beverage i on j given that income effects resulting from these price changes are compensated equally:

$$\pi_{ij}^{'} = \pi_{ji}^{'} \tag{4.10}$$

We therefore have a symmetric Slutsky matrix of the following form:

$$S = \begin{bmatrix} \pi_{11} & \pi_{12} & \pi_{13} \\ \pi_{21} & \pi_{22} & \pi_{23} \\ \pi_{31} & \pi_{32} & \pi_{33} \end{bmatrix}$$

This matrix must be negative semi-definite and, with homogeneity imposed, the rank of the Slutsky matrix S is $n-1$. In our three-beverage case, for beer, wine and spirits, this requires that:

$$\pi_{11} < 0$$

$$det \begin{bmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{bmatrix} = \pi_{11}\pi_{22} - \pi_{12}\pi_{21} > 0 \tag{4.11}$$

If we impose Engel aggregation and symmetry, then the system of 3 equations can be estimated with one equation deleted as its parameters can be recovered by summing the 2 equations and using the three constraints of Engel aggregation, homogeneity and symmetry. In this model the algebraic form of the utility function is not specified. Instead, preferences are accounted for through restrictions on the slopes of the demand equations. An assumption implicit in the model is that the consumer's preferences are such that utility is the sum of M sub-utility functions, each involving the quantities of only one group:

$$u(q) = \sum_{m=1}^{M} u_m(q_m) \tag{4.12}$$

This form of the utility function is referred to as preference independence, and the marginal utility of good i is independent of good j for $i \neq j$. The Rotterdam model becomes non-linear in its parameters when the preference independence constraint

is imposed. While this form is a simple structure of preferences, the case in support of additive utility was made in Clements et al. (1997). The assumption has a higher chance of success when commodities are broad aggregates, however Clements et al. (1997) showed that preference independence also cannot be rejected for narrowly-defined groups and used the example of beer, wine and spirits to show this.

We were faced with two possible estimation methods. The first was the seemingly unrelated regression estimation (SURE) technique proposed by Zellner (1962) that can be implemented using the *sureg* command in STATA (StataCorp (2013)). The other option is to use the Demand Analysis Package 2000 written by Clements, et al (1989) in the matrix programming language GAUSS (Aptech Systems Inc (2014)) which is superior in a number of ways as it was designed for applied demand analysis.[1] We chose the latter technique which utilises the full information maximum likelihood procedure and Newton's iterative method to estimate a system of linear equations.

[1]This method was used by Selvanathan and Selvanathan (2007) and, before using it to estimate the results presented in this paper, the results of their paper were replicated to ensure the method was accurate.

5. Results

In this chapter we first outline the results from testing for the validity of the constraints to ensure that our system demand results accord with demand theory. We then present the estimated coefficient results and implied income, demand and cross-price elasticities, before finally pooling the data and testing Stigler and Becker's constant tastes hypothesis.

5.1 Demand theory tests

We first test the demand theory hypotheses that motivate the constraints placed on the system for estimation. The results for the full sample are presented in Table 5.1. To test the symmetry restriction given homogeneity, we adopt the method used by Laitinen (1978) and use a test statistic that follows an asymptotic chi-squared distribution. Testing for symmetry requires us to test parameter restrictions across the three equations. The test for demand homogeneity is conducted using the exact Hotelling's T^2 test, which was developed by Laitinen (1978) for multivariate hypothesis testing in samples with few degrees of freedom. While symmetry tests restrictions across equations, testing for homogeneity may be tested equation by equation, as the restrictions are within each equation.

Finally, we test the preference independence assumption using the method adopted by Selvanathan and Selvanathan (2003) of a likelihood ratio statistic $\lambda = -2(L_r - L_u)$ where L_r is the restricted log-likelihood value and L_u is the corresponding value for the unrestricted model with Slutsky symmetry imposed. The restriction placed on the model is that the Slutsky coefficient is $\pi_{ij}^{'} = \phi\eta_A\theta_i^{'}\theta_j^{'}$ and therefore $v_{ij} = 0$ for $i \neq j$ and $v_{ij} = \phi\theta_i$ for $i = j$. We substitute this for π_{ij} in equation 4.2. Under the null hypothesis, the test statistic, λ, has an asymptotic χ^2 distribution with $n + \frac{(n-1)(n-2)}{2}$ degrees of freedom. The results of these tests are displayed below in Table 5.1.

Table 5.1: Demand theory results

	Symmetry		Homogeneity		Preference independence	
Country	Test statistic	Critical value	Test statistic	Critical value	Test statistic	Critical value
Australia	0.69	3.84	2.03	6.46	0.64	5.99
Austria	0.28	3.84	9.90	10.42*	5.54	5.99
Belgium	0.35	3.84	2.94	8.42	6.99	9.21*
Bulgaria	0.02	3.84	1.08	8.69	1.29	5.99
Canada	0.08	3.84	0.79	6.43	1.13	5.99
Croatia	0.30	3.84	5.75	17.36	3.80	5.99
Denmark	0.94	3.84	0.34	8.42	0.34	5.99
Finland	2.73	3.84	9.45	10.65*	0.13	5.99
France	0.02	3.84	1.53	6.69	0.84	5.99
Germany	0.14	3.84	3.20	8.42	2.37	5.99
Greece	0.02	3.84	0.56	8.42	0.74	5.99
Hungary	0.33	3.84	0.48	10.03	0.74	5.99
Ireland	0.05	3.84	6.36	8.42	0.33	5.99
Italy	0.22	3.84	3.47	8.42	0.49	5.99
Japan	1.19	3.84	0.09	6.55	0.76	5.99
Netherlands	0.85	3.84	0.76	8.42	5.88	5.99
New Zealand	0.02	3.84	4.00	6.58	3.54	5.99
Norway	4.23	6.63*	1.44	6.53	4.35	5.99
Portugal	3.68	3.84	6.57	8.42	0.06	5.99
Romania	0.62	3.84	1.91	10.03	0.37	5.99
Spain	2.45	3.84	5.23	8.42	5.44	5.99
Sweden	0.09	3.84	3.64	6.53	4.40	5.99
Switzerland	0.09	3.84	0.28	18.52	6.54	9.21*
Turkey	0.05	3.84	1.13	8.42	4.30	5.99
United Kingdom	0.08	3.84	3.79	6.46	5.83	5.99
United States	0.02	3.84	10.12	10.15*	5.73	5.99

Note: Critical value at 1% level is denoted by an asterisk.

Overall, we fail to reject the null hypothesis of Slutsky symmetry at the 5% level for all countries except Norway, where the hypothesis is found to be acceptable at the 1% level with critical value of 6.63. The tests for homogeneity reveal that it is an acceptable assumption at the 5% level of significance for all countries except for Austria, Finland and the United States. For these countries the hypothesis is acceptable at the 1% level of significance. Preference independence is only rejected for Belgium and Switzerland at the 5% level, however it is accepted at the 1% level of significance. The results of testing preference independence using Monte Carlo simulations are also displayed in the appendix in Table A.4 and confirm that preference independence is generally accepted across the country group. These tests construct the empirical distribution of the test statistic by estimating its value 1000 times, and then the observed value of the test statistic is compared to this distribution to test for preference independence (Selvanathan and Selvanathan (2005)). This test allows us to overcome potential problems of asymptotic tests, namely that these tests use a moment matrix that could be singular with insufficient data (Barten (1977)). At the 5 percent level we reject preference independence if the rank of the statistic is

greater than 950. The rank of the test statistic is found to be lower than 950 for all countries.

5.2 Demand elasticity estimates

The parameter estimates for the constant terms and conditional marginal shares are shown in Table 5.2. Following this, the Slutsky coefficients, including the own-price and cross-price coefficients, are shown in Table 5.3. For these estimates, the level of significance is indicated using asterisks.

Table 5.2: Constrained demand model parameter estimates (1)

	Constants			Marginal shares		
Country	Beer	Wine	Spirits	Beer	Wine	Spirits
Australia	-0.46*	0.34	0.11	0.40***	0.37***	0.23***
Austria	0.23*	-0.75**	0.52*	0.01	0.41***	0.59***
Belgium	-0.22	0.44	-0.23	0.48***	0.28***	0.24**
Bulgaria	0.73	-1.39	0.66	0.26***	0.38*	0.36**
Canada	-0.01	0.28***	-0.27***	0.05***	0.06***	0.90***
Croatia	-0.03	0.25	-0.22	0.02	0.97***	0.01
Denmark	-1.41***	1.42***	-0.01	0.15**	0.72***	0.13***
Finland	0.22	0.45	-0.67**	0.37***	0.20***	0.43***
France	0.22	-0.62***	0.40**	0.23***	0.24***	0.53***
Germany	0.10	0.13	-0.23	0.70**	0.05	0.25
Greece	-0.25	1.04**	-0.79*	0.02	0.87***	0.11
Hungary	-0.10	-0.07	0.17	0.17**	0.55***	0.29***
Ireland	-1.16**	0.98***	0.18	0.52***	0.19***	0.29***
Italy	0.24	-0.84**	0.59	0.13***	0.50***	0.37***
Japan	0.05	0.06*	-0.11	0.04*	-0.01	0.96***
Netherlands	-0.06	0.54***	-0.49***	0.43***	0.40***	0.17**
New Zealand	-0.54**	0.74***	-0.20	0.51***	0.24***	0.26***
Norway	0.22	0.63***	-0.85***	0.22***	0.23***	0.55***
Portugal	-0.52*	0.03	0.49	0.03	0.63***	0.34***
Romania	1.55***	-0.05	-1.50	0.22***	0.41***	0.38***
Spain	-0.01	-0.57**	0.57	-0.07	0.05*	1.03***
Sweden	-0.02	0.79***	-0.77***	0.35***	0.16***	0.49***
Switzerland	0.36***	-0.63**	0.27	0.39***	0.43*	0.19
Turkey	-0.03	-0.06	0.09	0.47***	0.01	0.51***
United Kingdom	-0.45***	0.59***	-0.14*	0.42***	0.21***	0.37***
United States	-0.07	0.11***	-0.04	0.37***	0.11***	0.52***
Mean (unweighted)	-0.05	0.14	-0.09	0.26	0.33	0.40
Pooled	-0.04	0.09	-0.05	0.22***	0.32***	0.46***

Note: *$P < 0.10$, **$P < 0.05$, ***$P < 0.01$

The constant terms confirm the pattern of shifting alcohol consumption shares found in our preceding analysis of convergence. The constant terms for beer in traditionally beer-drinking countries, such as the United Kingdom and New Zealand are negative, reflecting a shift by consumers in those countries away from beer towards substitutes such as wine and spirits. For Australia, the constant term for beer is negative, while the wine and spirits constants are both positive. This corresponds to

a shift in consumption towards these beverages and away from beer, however only the beer constant term is significant. Similarly, in typically beer-drinking countries such as the United Kingdom and the United States, the constant terms reflect a strong trend towards wine and away from other alcohols. Of the three alcohols, in our sample group the mean constant term for wine is positive indicating that wine's share of consumption has grown over the sample period, while the share devoted to beer and spirits has declined in the sample group.

The conditional marginal shares presented in the last three columns of Table 5.2 are all positive, sum to one across the three beverages, and can be interpreted as the shares that would be spent on each beverage if there was an increase in alcohol expenditure. For example, on average across the period from 1955 to 2014 in Australia 40.1% of any increase in alcohol consumption expenditure was spent on beer, whereas only 37.3% and 22.6% were spent on wine and spirits, respectively.

The own-price and cross-price Slutsky coefficients are presented below in Table 5.3. As the Slutsky matrix is symmetric by virtue of the symmetry constraint, only half of the estimated cross-price coefficients are presented. The own-price elasticity coefficients are predominantly negative and less than one in absolute value. The cross-price elasticity coefficients are positive in most cases indicating that consumers consider beer, wine and spirits to be substitutes.

There is a small sub-sample of countries for which the cross-price coefficients are negative, however, suggesting complementarity between particular alcohols. Of these negative cross-price coefficients, only the cross-price coefficient between beer and wine in Spain is significant at the 5% level. The sample mean presented in the last row of Table 5.3 shows that the mean own-price coefficient is negative for beer, wine and spirits and the three beverages are substitutes as the cross-price coefficient is positive for all beverage pairs.

Table 5.3: Constrained demand model parameter estimates (2)

	Slutsky own-price and cross-price coefficients (x100)					
Country	BB	BW	BS	WW	WS	SS
Australia	-0.05	-0.01	0.06	-0.01	0.02	-0.07*
Austria	-0.03*	0.04**	-0.01	-0.16***	0.11***	-0.11**
Belgium	0.05	-0.33	0.28*	-0.04	0.37*	-0.65***
Bulgaria	0.07	-0.32	0.13	0.45	0.01	-0.13
Canada	-0.01	0.02	-0.01	-0.04***	0.02**	-0.02
Croatia	-0.16	0.00	0.16*	0.06	-0.06*	-0.10
Denmark	-0.18**	0.17**	0.01	-0.30***	0.13***	-0.13***
Finland	-0.21***	0.07*	0.13***	-0.13**	0.06**	-0.20***
France	-0.04	0.03	0.01	-0.01	-0.01	0.00
Germany	0.12	-0.15*	0.03	0.02	0.13	-0.16
Greece	-0.15	0.10	0.05	-0.23***	0.12*	-0.17**
Hungary	0.01	-0.05	0.03	0.01	0.03	-0.06
Ireland	-0.19*	0.05	0.14	-0.11	0.06	-0.20**
Italy	0.15	0.08	-0.23	0.09	-0.18	0.40
Japan	-0.05***	0.00	0.05***	-0.01	-0.01	-0.04**
Netherlands	-0.08*	-0.03	0.11***	-0.05	0.08*	-0.19***
New Zealand	-0.12**	0.04	0.08***	-0.12***	0.08***	-0.16***
Norway	-0.12***	0.01	0.11***	-0.01	0.01	-0.12***
Portugal	-0.04	0.02	0.03	-0.17	0.15	-0.19
Romania	-0.25*	0.04	0.21	-0.10	0.06	-0.27
Spain	0.08	-0.22**	0.13	-0.03	0.25***	-0.38**
Sweden	-0.02	-0.03	0.05	-0.07**	0.10***	-0.15***
Switzerland	-0.17*	0.40**	-0.24*	-0.38	-0.02	0.26
Turkey	0.02	-0.05*	0.03	0.01	0.04**	-0.06
United Kingdom	-0.16***	0.08***	0.08***	-0.09***	0.01	-0.09***
United States	-0.03*	0.03***	0.01	-0.02***	-0.01	0.00
Mean (unweighted)	-0.06	0.01	0.05	-0.05	0.06	-0.12
Pooled	-0.07***	0.02**	0.05***	-0.04***	0.02*	-0.07***

Note: $*P < 0.10$, $**P < 0.05$, $***P < 0.01$

To find the income and compensated price elasticities of demand, we divide the marginal shares and Slutsky coefficients by $\bar{w}_{it}^{'}$, the arithmetic average of the conditional budget share for beverage i. Using the parameter estimates we present the implied demand elasticities at sample means divided into two tables. The first, Table 5.4, details the income and own-price elasticities. The cross-price elasticities for beer, wine and spirits are then presented in Table 5.5. The elasticities presented here are in conditional (within the alcoholic beverages group) Slutsky form and evaluated at the sample means. The unconditional income elasticities will be greater or less than the conditional estimates depending on whether the income elasticity for the total alcohol group is greater or less than unity (Fogarty (2010)).

Table 5.4: Implied demand elasticities (1)

	Income elasticity			Own-price elasticity			
Country	Beer	Wine	Spirits	Beer	Wine	Spirits	Alcohol
Australia	0.69***	1.51***	1.31***	-0.08	-0.02	-0.40*	-0.64***
Austria	0.03	0.87***	1.90***	-0.15*	-0.34***	-0.34**	0.01
Belgium	0.67***	1.02***	2.59**	-0.46	-0.82	-2.06***	-0.21***
Bulgaria	0.99***	1.32*	0.81**	-0.04	0.53	-0.26	-0.52***
Canada	0.36***	0.51***	1.18***	-0.06	-0.33***	-0.02	-0.57***
Croatia	0.09	1.47***	0.06	-0.70	0.09	-0.88	-0.35***
Denmark	0.37**	1.76***	0.72***	-0.44**	-0.73***	-0.77***	-0.02
Finland	0.85***	0.99***	1.19***	-0.47***	-0.65**	-0.52***	-0.36***
France	1.33***	0.60***	1.23***	-0.22	-0.03	0.00	-0.49***
Germany	1.32**	0.25	0.96	0.23	0.11	-0.62	-0.44***
Greece	0.07	2.12***	0.32	-0.58	-0.55***	-0.50**	-0.40***
Hungary	0.57**	1.88***	0.68***	0.06	0.05	-0.15	-0.30***
Ireland	0.89***	1.11***	1.19***	-0.33*	-0.60	-0.84**	-0.20***
Italy	0.41***	0.95***	2.36***	0.46	0.18	2.58	-0.51***
Japan	0.31*	-0.16	1.12***	-0.39***	-0.07	-0.05**	-0.47***
Netherlands	0.85***	1.72***	0.66**	-0.15*	-0.22	-0.74***	-0.27***
New Zealand	1.01***	0.81***	1.25***	-0.23**	-0.40***	-0.79***	-0.29***
Norway	0.48***	1.02***	1.70***	-0.27***	-0.05	-0.37***	-0.82***
Portugal	0.08	1.20***	2.29***	-0.13	-0.32	-1.20	-0.38***
Romania	0.52***	1.31***	1.42***	-0.59*	-0.32	-1.01	-0.59***
Spain	-0.17	0.27*	2.70***	0.19	-0.20	-1.01**	-0.34***
Sweden	1.08***	0.65***	1.15***	-0.07	-0.27**	-0.35***	-0.40***
Switzerland	1.05***	0.96*	0.99	-0.45*	-0.86	1.34	-0.47***
Turkey	0.85***	0.29	1.29***	0.04	0.15	-0.16	-0.34***
United Kingdom	0.82***	0.89***	1.49***	-0.30***	-0.39	-0.36***	-0.26***
United States	0.75***	1.06***	1.28***	-0.06*	-0.18***	0.00	-0.19***
Mean (unweighted)	0.64	1.03	1.31	-0.20	-0.25	-0.37	-0.39
Pooled	0.54***	1.25***	1.36***	-0.17***	-0.16***	-0.20***	-

Note: *$P < 0.10$, **$P < 0.05$, ***$P < 0.01$

We find that the income elasticities vary across the three beverages. Beer appears to be a necessity in most countries as the beer income elasticities are less than unity. In those countries where beer is a luxury, the income elasticity is only marginally greater than unity. Wine does not appear to fall into either the necessity or luxury good category with an average income elasticity of 1.03 across the sample. While it is firmly a luxury in Australia, Greece and Denmark, in contrast wine consumption falls with rising incomes and therefore it is considered an inferior good in Japan. The variation in income elasticities for wine in the sample countries and mean value of approximately unity (1.03) confirms the Fogarty (2010) observation that wine is a borderline case, varying between necessity and luxury across countries. Finally, spirits has the highest income elasticity of the three alcoholic beverages, reflecting its status as the most luxurious alcohol of the three types.

The elasticity estimates for the pooled data are similar to the mean values for the sample, however the suitability of this method will be tested. The own-price elasticities are generally less than one in absolute value, meaning that we can conclude

that the demand for alcoholic beverages is price inelastic. This is confirmed by the results presented in the final column of 5.4 where we find that the mean own-price elasticity of alcohol is -0.39.

Table 5.5: Implied demand elasticities (2)

	Cross-price elasticity					
Country	BW	BS	WB	WS	SB	SW
Australia	-0.02	0.09	-0.04	0.06	0.32	0.09
Austria	0.18**	-0.04	0.09**	0.25***	-0.03	0.37***
Belgium	1.13	2.36*	-0.55	3.14*	0.47	1.27
Bulgaria	-0.47	0.51	-0.46	-0.07	0.31	-0.04
Canada	0.11	-0.06	0.13	0.20**	-0.01	-0.02**
Croatia	0.01	0.69*	0.01	-0.09*	1.42*	-0.54*
Denmark	0.42**	0.02	0.42	0.31***	0.04	0.72***
Finland	0.16*	0.31***	0.34*	0.31**	0.38***	0.18**
France	0.15	0.07	0.07	-0.03	0.03	-0.03
Germany	-0.29	0.06	-0.73	0.62	0.12	0.50
Greece	0.40	0.18	0.25	0.30*	0.13	0.37*
Hungary	-0.16	0.10	-0.16	0.11	0.07	0.08
Ireland	0.08	0.25	0.27	0.34	0.60	0.25
Italy	0.26	-0.72	0.16	-0.33	-1.46	-1.12
Japan	0.03	0.36***	0.33	-0.26	0.06***	-0.01
Netherlands	-0.06	0.22***	-0.13	0.35*	0.43***	0.31*
New Zealand	0.07	0.16***	0.13	0.27***	0.40***	0.39***
Norway	0.01	0.25***	0.03	0.02	0.35***	0.02
Portugal	0.05	0.08	0.03	0.29	0.17	1.03
Romania	0.09	0.49	0.14	0.18	0.80	0.21
Spain	-0.49**	0.29	-1.24**	1.43	0.35	0.66
Sweden	-0.09	0.16	-0.12	0.39	0.12	0.23
Switzerland	1.10**	-0.65*	0.91**	-0.05	-1.24*	-0.10
Turkey	-0.08*	0.04	-0.87*	0.72**	0.06	0.10**
United Kingdom	0.15***	0.15***	0.34***	0.05	0.31***	0.05
United States	0.05***	0.01	0.24***	-0.06	0.01	-0.02
Mean (unweighted)	0.03	0.21	-0.02	0.32	0.16	0.21
Pooled	0.08**	0.15***	0.05**	0.06*	0.12***	0.07*

Note: $^{*}P < 0.10$, $^{**}P < 0.05$, $^{***}P < 0.01$

As expected, the cross-price elasticities for the three alcoholic beverages are positive and therefore they are generally seen as substitutes. We find several exceptions however. While Clements and Selvanathan (1991) found evidence suggesting complementarity between spirits and beer consumption in Australia, our results find the opposite and instead support the notion that this relationship is found between wine and beer. Beer and wine are also complements in Germany, Spain and Sweden, although the only cross-price elasticity that is significant is that for Spain. Our estimation also reveals that beer and spirits are complements in Austria and Italy. Finally, we find that wine and spirits are complements in the traditionally wine-consuming countries of France and Italy, in addition to Japan and the United States.

When we test Stigler & Becker's identical tastes hypothesis in the following section, we pool the country data for estimation over all of the years available and the sub-period from 1996 to 2014. This period was selected for two reasons: first, a large number of the countries in our sample are European countries for which data was only available from Eurostat for the period from 1996 onwards; second, in the latter 1980s to early 1990s, the volume of wine exported globally as a percentage of world wine production grew in an unprecedented fashion from 15 to 25 percent, led by rapid globalization of the world's wine markets (Anderson and Nelgen (2011)). We control for this phenomenon by estimating the demand parameters for each country after this period with the demand elasticities presented in Table 5.6 and Table 5.7 below. Results for the demand theory tests and parameter estimates are provided in Tables A.5, A.6 and A.7 in the Appendix.

Table 5.6: Implied demand elasticities 1996-2014 (1)

	Income elasticity			Own-price elasticity			
Country	Beer	Wine	Spirits	Beer	Wine	Spirits	Alcohol
Australia	0.76***	1.35***	0.83***	-0.10	0.79*	-0.40	-0.51***
Austria	-0.20*	0.66***	2.59***	0.02	-0.46*	0.11	-0.31***
Belgium	0.67***	1.02***	2.59***	-0.46	-0.82	-2.06***	-0.21***
Bulgaria	0.99***	1.32*	0.81**	-0.04	0.53	-0.26	-0.52***
Canada	0.50***	0.68**	1.27***	0.57**	0.42	0.01	-0.48***
Croatia	0.09	1.47***	0.06	-0.70	0.09	-0.88	-0.35***
Denmark	0.37***	1.76***	0.72***	-0.44**	-0.73***	-0.77***	-0.02
Finland	0.72***	0.97***	1.64***	-0.93**	-1.38**	-0.45**	-0.47***
France	1.78**	1.03**	0.58***	-0.98*	-0.27	-0.43*	-0.49***
Germany	1.32**	0.25	0.96	0.23	0.11	-0.62	-0.44***
Greece	0.07	2.12***	0.32	-0.58	-0.55**	-0.50**	-0.40***
Hungary	0.57**	1.88***	0.68***	0.06	0.05	-0.15	-0.30***
Ireland	0.89***	1.11***	1.19***	-0.33*	-0.60	-0.84**	-0.20***
Italy	0.41***	0.95***	2.36***	0.46	0.18	2.58	-0.51***
Japan	0.12	0.48	1.13***	-0.91***	-2.16**	-0.02	-0.28***
Netherlands	0.85***	1.72***	0.66**	-0.15*	-0.22	-0.74***	-0.27***
New Zealand	1.72***	0.39**	1.06***	-1.64**	-0.47	-2.00	-0.34***
Norway	0.89***	1.31***	0.64***	-0.20	-0.79**	-0.93***	-0.97***
Portugal	0.08	1.20***	2.29***	-0.13	-0.32	-1.20	-0.38***
Romania	0.52***	1.31***	1.42***	-0.59*	-0.32	-1.01	-0.59***
Spain	-0.17	0.27*	2.70***	0.19	-0.20	-1.01**	-0.34***
Sweden	1.35***	0.60***	1.21**	0.20	-0.82*	-2.01*	-0.49***
Switzerland	1.05***	0.96*	0.99	-0.45*	-0.86	1.34	-0.47***
Turkey	0.85***	0.29	1.29***	0.04	0.15	-0.16	-0.34***
United Kingdom	0.58***	1.35***	1.21***	-0.14	0.02	0.27	-0.01
United States	1.05***	0.81*	1.00**	-0.14	0.10	0.10	-0.16***
Mean (unweighted)	0.69	1.05	1.24	-0.27	-0.34	-0.43	-0.38
Pooled	0.56***	1.15***	1.41***	-0.18*	-0.15*	-0.23**	-
Difference	0.05	0.02	-0.07	-0.07	-0.09	-0.01	0.01

Note: $^{*}P < 0.10$, $^{**}P < 0.05$, $^{***}P < 0.01$

The mean income and own-price elasticities reveal a similar pattern to that observed for the complete sample. We find that spirits has the highest income

elasticity of 1.31 and is considered a luxury. The income elasticity for wine is slightly greater than unity, which was similarly found for the complete sample, while consumers perceive beer to be a necessity on average. Spirits has the lowest own-price elasticity of the three beverages with a mean own-price elasticity of -0.43. To compare the changes in these parameters between the complete sample and this sub-period, the difference between the mean elasticity values in the sub-period and the complete sample are included in the final row of Table 5.6.

Table 5.7: Implied demand elasticities 1996-2014 (2)

	Cross-price elasticity					
Country	BW	BS	WB	WS	SB	SW
Australia	-0.82*	0.98	-0.74*	-1.07*	0.32	-0.41*
Austria	0.28	-0.28*	0.25	0.18	-0.27*	0.18
Belgium	1.13	2.36*	-0.55	3.14*	0.47	1.27
Bulgaria	-0.47	0.51	-0.46	-0.07	0.31	-0.04
Canada	-0.45**	-0.03	-0.49**	0.01	-0.08	0.04
Croatia	0.01	0.69*	0.01	-0.09*	1.42*	-0.54*
Denmark	0.42***	0.02	0.42	0.31***	0.04	0.72***
Finland	1.30**	0.35	0.77**	0.10	0.17	0.08
France	0.17	0.35**	0.29	0.09	0.69**	0.10
Germany	-0.29	0.06	-0.73	0.62	0.12	0.50
Greece	0.40	0.18	0.25	0.30*	0.13	0.37*
Hungary	-0.16	0.10	-0.16	0.11	0.07	0.08
Ireland	0.08	0.25	0.27	0.34	0.60	0.25
Italy	0.26	-0.72	0.16	-0.33	-1.46	-1.12
Japan	2.97**	0.04*	0.59**	-0.02	0.33*	-0.81
Netherlands	-0.06	0.22***	-0.13	0.35*	0.43***	0.31*
New Zealand	0.53	2.15*	0.65	-0.15	0.99*	-0.06
Norway	0.28	-0.07	0.23	0.99***	-0.03	0.51***
Portugal	0.05	0.08	0.03	0.29	0.17	1.03
Romania	0.09	0.49	0.14	0.18	0.80	0.21
Spain	-0.49**	0.29	-1.24**	1.43	0.35	0.66
Sweden	-0.29	0.22	-0.37	1.79**	0.17	1.12**
Switzerland	1.10**	-0.65*	0.91**	-0.05	-1.24*	-0.10
Turkey	-0.08*	0.04	-0.87*	0.72**	0.06	0.10**
United Kingdom	0.15*	0.01	0.13*	-0.28**	0.01	-0.17**
United States	0.32	0.09	0.09	-0.19*	0.05	-0.42*
Mean (unweighted)	0.24	0.29	-0.02	0.33	0.17	0.17
Pooled	0.07	0.15***	0.05	0.08	0.12***	0.08
Difference	0.21	0.08	0.00	0.01	0.01	-0.04

Note: $^{*}P < 0.10$, $^{**}P < 0.05$, $^{***}P < 0.01$

Surprisingly, the income and own-price elasticities for the post-1996 period are only marginally different to the complete sample despite changes in the average income level across the group of countries. While this observation is for the mean and therefore is not reflective of individual country changes, it does not agree completely with the findings of Gil and Molina (2009) and Colen and Swinnen (2016), namely that income elasticities vary with income, although their studies were confined to beer consumption. The mean own-price elasticity of alcohol is marginally more elastic in the sub-period than the complete sample and this is consistent with the

observation made by Fogarty (2010) that in recent years there has been a gradual movement towards more elastic own-price elasticity estimates.

Of the cross-price elasticity estimates presented above in Table 5.7, the substitutability between beer and wine increased significantly for the sub-sample relative to the complete sample. This shift can largely be attributed to the increase in the cross-price elasticity between beer and wine for Finland and Japan, which appear to be outliers, whereas previously the two beverages were only marginally substitutes in these countries. We find that generally the cross-price elasticity for the other beverage pairs are similar to the complete sample.

5.3 Testing Stigler & Becker's hypothesis

To test the identical tastes hypothesis we first pool the data for estimation. There are clear benefits in pooling the data as it increases both sample size and the range of variation of relative prices and income (Pollak and Wales (1987)), however this is only valid if the demand system parameter values are similar across countries. To pool data across countries, two techniques have generally been used: the first is to transform the data using exchange rates to convert prices into a common currency; whereas the second utilises purchasing power parities to change prices into comparable units.[1] These two approaches are problematic in the sense that the former is generally unstable and the latter requires assumptions, for example that the law of one price holds. To circumvent the problems inherent in these approaches, we adopt the Selvanathan (1989) method and, instead of using the variables in level form, we convert them to log-changes. Expressing the variables in this way converts them to unit-free form, allowing us to pool the data across countries.

We first conduct this test for all countries in our sample and for all years available. When we estimate the demand system separately for each country, we have 182 free parameters. This is calculated by summing the different parameters. We have 26 x 2 constant terms $\alpha_i's$ as, of the three $\alpha_i's$, one is constrained by $\alpha_1+\alpha_2+\alpha_3=0$. There are 26x2 marginal share terms $\theta_i's$ as, once again, one θ_i' is constrained by $\theta_1'+\theta_2'+\theta_3'=1$. Finally, there are 26x3 Slutsky coefficient terms with the constraints on the coefficients, $\sum_{i=1}^{3}\pi_{ij}^{'}=0$, $\sum_{j=1}^{3}\pi_{ij}^{'}=0$ and $\pi_{ij}^{'}=\pi_{ji}^{'}$. When we pool the data for estimation, the estimation method is similar to that for a single country; the model is estimated with two constant terms, two marginal share terms and three Slutsky coefficients. Summing these parameters gives us seven parameters to be estimated. Thus in pooling the data we will have put 175 (182 - 7) restrictions in place.

[1] For example, this method was used in Pollak and Wales (1987) to pool food consumption data

We estimate the demand system for the pooled data and obtain a restricted log-likelihood value, denoted L_r. This value is combined with the unrestricted log-likelihood value, L_u, which is found by summing the likelihood values obtained for each country after estimation, to find a test statistic and conduct a likelihood ratio test. The null hypothesis for our test is that pooling the data is a valid estimation method, which corresponds to testing whether tastes are homogeneous. The test statistic is calculated by finding $-2(L_r - L_u)$ and has an asymptotic $\chi^2(0.05, 175)$ distribution. The unrestricted log-likelihood value is calculated as 5186.9, whereas the restricted value is 4276.7. The value of the test statistic is 1820.5, while the critical value $\chi^2(0.05, 175) = 206.9$. This leads us to reject the null hypothesis that the data can be pooled and conclude that our sample does not agree with Stigler and Becker's identical tastes hypothesis. This is consistent with the results of Selvanathan and Selvanathan (2007), despite our study using more recent data and a wider sample of countries.

The same method outlined above is adopted to test the identical tastes hypothesis by pooling the data with respect to income and beverage groups, respectively, across two time periods. We pool the countries into three groups according to the level of real GDP per capita over the time period. Studying beer demand specifically, Colen and Swinnen (2016) found that rather than remaining constant–as the vast majority of authors assume–income elasticities of demand change with the level of income. In grouping countries according to the level of income per-capita, we control for this effect on the demand elasticities, and test whether tastes are identical.

The countries are also divided into beer-, wine- and spirits-focused groups according to whichever beverage comprises the greatest share of alcohol consumption. The rationale behind this choice is that countries where consumers exhibit common preferences for alcoholic beverages should have similar demand parameters and thus pooled estimation could be acceptable. The list of the countries in each sample group is detailed in Table A.8 of the Appendix. The results for testing pooling in different combinations of countries and time periods are outlined in Table 5.8 below.

Table 5.8: Likelihood ratio test results

Sample group	Time period	Test Statistic	Critical Value	Conclusion
All countries	Complete	1820.5	206.9	Reject
All countries	1996-2014	1349.9	206.9	Reject
Beer-focused	Complete	1056.4	137.7	Reject
Wine-focused	Complete	201.1	58.1	Reject
Spirits-focused	Complete	265.4	14.1	Reject
Beer-focused	1996-2014	768.6	137.7	Reject
Wine-focused	1996-2014	248.4	58.1	Reject
Spirits-focused	1996-2014	129.8	14.1	Reject
Low-income	Complete	344.5	66.3	Reject
Middle-income	Complete	627.7	74.5	Reject
High-income	Complete	594.6	74.5	Reject
Low-income	1996-2014	323.6	66.3	Reject
Middle-income	1996-2014	355.3	74.5	Reject
High-income	1996-2014	362.3	74.5	Reject

Despite controlling for the level of income and beverage preference, we reject the identical tastes hypothesis in each of the sample groups at the 5% level. Thus we can conclude that a common demand equation for all countries is not appropriate and Stigler & Becker's (1977) identical tastes hypothesis does not apply to the demand for beer, wine and spirits in our country group. This is a striking result given that we found that countries are tending toward similar alcohol consumption mixes in Chapter 3.

6. Discussion

The analysis presented in this paper provides a number of interesting results. Our results agree with the existing empirical literature on alcohol consumption convergence and demand estimation, yet the breadth of our analysis allows us to draw some important conclusions that, until now, had not been found. As past studies have tended to focus on only two alcohol types, this paper has extended the analysis to the consumption mix for the three main alcohol types and, through the use of two new indicators of convergence, found that the alcohol consumption mix of typically beer- and spirits-consuming countries are converging at a faster rate than wine-focused countries, and further research is needed to explain the specific factors underlying this trend. While Aizenman and Brooks (2008) attempted to explain this using the overlapping generations framework, a study similar to Colen and Swinnen (2016) but focusing on the level and share of wine consumption would be more appropriate to find the specific factors motivating this trend in wine consumption and the magnitude of their effect.

A significant result found for the sample of 26 OECD countries for which price data is available is that they are more similar in terms of volume shares than value shares. This is one aspect of convergence that has not been considered in the literature; namely, the prospect of convergence in beverage consumption patterns in terms of value shares in contrast to volume shares. As taking an average price of wine has been questioned by Fogarty (2010) due to the heterogeneity in wine products compared to beer or spirits, quality changes could be one factor that is not exposed in considering convergence in terms of volume shares as this paper has done. With no known comparable analysis done in this area, it must be considered a vital step towards a complete understanding of convergence in alcoholic beverage consumption patterns.

The demand elasticity estimates presented in this thesis confirm a number of empirical regularities that have been identified in the literature. With regard to own-price elasticities, we find that beer generally has a lower own-price elasticity than wine, while spirits has generally higher elasticities. This has been noted also

by Clements et al. (1997) and Cook and Moore (2000). We do find outliers, such as Italy's own-price elasticity for spirits which, in contrast to the rest of the countries in our sample, appears to be price elastic. Due to the lack of comparable studies, that country requires further analysis to explain the reasons behind this exception. Further, we could not locate elasticity estimates for alcoholic beverages in Bulgaria, Romania or Croatia in the literature for comparison. However, the results we obtain for the three countries align with the general observations across countries presented in the Gallet (2007) and Fogarty (2010) meta-regression analyses.

With regard to Stigler & Becker's 1977 identical tastes hypothesis, despite the observation made by Fogarty (2010) that the hypothesis "is not a bad starting assumption" when considering alcohol demand, we have found that this is not supported by cross-country alcohol data for the 26 OECD countries in our sample. Controlling for income levels and grouping countries by beverage preferences does not alter the results as the hypothesis is rejected. Therefore, using common demand equations for cross-country studies is not appropriate to estimate the demand elasticities. As aforementioned, a tentative explanation is that, while the demand elasticities for beer and spirits tend to be similar among countries, the income and own-price elasticities for wine are less consistent. Fogarty (2010) suggests that wine is a less homogeneous good than beer and spirits, and therefore using average prices might not be appropriate and this exception could bias tests of the identical tastes hypothesis towards rejection.

The clear rejection of the hypothesis in all cases is surprising as other studies concerning OECD countries found it to be an acceptable explanation of consumption patterns. However, these studies concerned consumption data for broadly defined goods including clothing and housing (Chen and Clements (1999)). For these reasons, it might be more appropriate to aggregate wine, beer and spirits, and instead test the hypothesis with respect to the broader category of alcohol. This approach was used previously by Selvanathan (2006) looking at a sample of 8 industrialized countries. Selvanathan tested whether the elasticities for alcohol are the same across countries and found that there is some evidence to support this conclusion.

Despite our rejection of the identical tastes hypothesis, we do find some evidence to suggest that the demand elasticities for alcoholic beverages do not change significantly over time. The mean own-price and cross-price elasticities for the sample in the period from 1996 to 2014 only differ marginally from those for the complete sample. In contrast to the observation made by Colen and Swinnen (2016), changing incomes do not appear to also imply dynamic income elasticities, although this

observation is only tentative as it is for the sample mean and requires further examination.

The main policy implication of our results is that when considering beer, wine and spirits demand across countries, consumer demand is influenced by factors aside from purely economic forces; differences in prices, as a consequence of taxes or other country-specific features, and incomes, cannot solely explain the variation in the share of beer, wine and spirits in overall alcohol consumption. Other explanations, such as habit formation and cultural forces, cannot be ignored when modelling consumer demand for alcoholic beverages. Thus, when designing alcohol policy, it behoves policy-makers to consider determinants other than a simple formula of prices and incomes. As Deconinck and Swinnen (2015) showed, in the case of Russia for example, the transition from spirits to beer consumption was influenced to a large extent by peer effects, while prices and incomes played only a minor role.

There is scope for further research into the application of the identical tastes hypothesis to the less disaggregated category of alcohol, and across a larger country group, ideally considering low-to-middle-income and spirits-focused countries, which were under-represented in the sample considered in this paper and did not feature at all in Selvanathan and Selvanathan (2007). As a robustness measure, this research could estimate the elasticities for individual years for each country and test for structural breaks in the elasticities of demand for countries and then use the results to pool across periods where the demand parameters have remained relatively constant.

7. Conclusion

An extensive study of alcoholic beverage consumption patterns has been presented in this paper. Changing alcohol consumption trends across countries are forcing us to question pre-existing notions alcoholic beverage preferences. Nations are transitioning away from alcohols that have been popular for decades. This rapid change now sees the French drinking less wine while the British are drinking more. Using data for 47 countries over the period of 1961 to 2014, we find evidence that there is a general trend towards a common alcohol consumption structure, although wine- and spirits-focused countries have not reduced the share of consumption of these alcohols to the same degree that beer-focused countries have decreased consumption of beer.

The demand elasticities for beer, wine and spirits were estimated using the Rotterdam model and presented for a sample of 26 countries. Using the results, we tested and rejected one explanation of the pattern of convergence: Stigler and Becker's 1977 hypothesis of identical tastes. While prices and incomes are certainly influential in determining the level and share of alcoholic beverage consumption, a common demand equation for all countries in our sample is not suitable. Finally, grouping countries by incomes and beverage preferences over two different periods did not alter our conclusion.

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A. Appendix

A.1 Summary statistics

Table A.1: Summary statistics (1)

	Consumption per capita (LAL)				Volume shares (%)		
Country	Beer	Wine	Spirits	Alcohol	Beer	Wine	Spirits
Australia (1955-2014)	5.02	2.11	1.03	8.16	62	26	13
Austria (1961-2014)	2.91	4.98	2.59	10.48	28	48	25
Belgium (1996-2014)	5.70	3.83	1.38	10.91	52	35	13
Bulgaria (1997-2014)	3.03	1.91	3.92	8.86	34	22	44
Canada (1951-2014)	3.31	0.85	2.04	6.20	53	14	33
Croatia (2004-2014)	4.01	4.89	1.06	9.96	40	49	11
Denmark (1996-2014)	4.13	3.57	1.26	8.96	46	40	14
Finland (1969-2014)	3.21	0.99	2.33	6.53	49	15	36
France (1971-2014)	1.99	7.95	2.24	12.18	16	65	18
Germany (1996-2014)	5.55	2.66	1.97	10.18	55	26	19
Greece (1996-2014)	1.95	3.73	1.85	7.53	26	50	25
Hungary (2000-2014)	3.57	3.34	3.38	10.29	35	32	33
Ireland (1996-2014)	5.67	1.83	1.96	9.46	60	19	21
Italy (1996-2014)	1.43	5.03	0.76	7.22	20	70	11
Japan (1963-2014)	1.74	0.14	2.20	4.08	43	3	54
Netherlands (1996-2014)	3.86	2.51	1.45	7.82	49	32	19
NZ (1965-2014)	4.75	1.37	1.29	7.41	64	18	17
Norway (1961-2014)	2.67	1.04	1.56	5.27	50	20	30
Portugal (1996-2014)	2.96	6.11	0.93	10	30	61	9
Romania (2000-2014)	3.75	2.68	1.62	8.05	47	33	20
Spain (1996-2014)	3.83	2.73	2.47	9.04	42	30	27
Sweden (1961-2014)	2.51	1.46	1.87	5.84	43	25	32
Switzerland (2004-2014)	2.72	4.15	1.56	8.43	32	49	19
Turkey (1996-2014)	0.58	0.06	0.38	1.02	57	6	37
UK (1955-2014)	4.44	1.29	1.36	7.09	63	18	19
USA (1950-2014)	3.37	0.79	2.40	6.56	51	12	37

Table A.2: Summary statistics (2)

	Conditional budget shares (%)			Unconditional budget shares (%)			
Country	Beer	Wine	Spirits	Beer	Wine	Spirits	Alcohol
Australia (1955-2014)	60	22	18	2.48	0.89	0.75	4.12
Austria (1961-2014)	23	46	31	2.05	5.34	3.10	10.49
Belgium (1996-2014)	57	30	13	2.70	1.50	0.60	4.80
Bulgaria (1997-2014)	27	28	45	2.13	2.35	3.51	7.99
Canada (1951-2014)	46	16	38	1.10	0.45	0.88	2.43
Croatia (2004-2014)	23	66	11	3.42	10.02	1.67	15.11
Denmark (1996-2014)	42	41	17	2.40	2.27	0.99	5.66
Finland (1969-2014)	44	21	36	3.00	1.00	3.00	7.08
France (1971-2014)	17	40	43	1.00	3.00	3.00	7.68
Germany (1996-2014)	53	21	26	1.87	0.72	0.91	3.50
Greece (1996-2014)	25	41	34	1.41	2.31	1.91	5.63
Hungary (2000-2014)	29	29	42	2.39	2.44	3.343	8.173
Ireland (1996-2014)	58	18	24	4.86	1.27	1.90	8.03
Italy (1996-2014)	32	53	15	0.80	1.35	0.40	2.55
Japan (1963-2014)	13	1	85	1.55	0.16	10.4	12.11
Netherlands (1996-2014)	51	23	26	1.58	0.7	0.81	3.09
NZ (1965-2014)	50	29	21	3.72	2.50	1.50	7.72
Norway (1961-2014)	45	22	33	2.00	1.00	1.00	4.74
Portugal (1996-2014)	32	53	15	1.68	2.77	0.78	5.23
Romania (2000-2014)	43	31	27	1.74	1.37	1.31	4.42
Spain (1996-2014)	44	17	39	2.50	1.06	2.21	5.77
Sweden (1961-2014)	32	25	43	1.14	0.85	1.42	3.41
Switzerland (2004-2014)	37	44	19	1.07	1.30	0.56	2.93
Turkey (1996-2014)	55	5	39	1.09	0.09	0.77	1.95
UK (1955-2014)	52	23	25	2.95	1.46	1.40	5.81
USA (1950-2014)	49	11	40	0.93	0.20	0.82	1.94

A.2 Data sources

Country	Data source
Australia	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price index data from 1970 to 2014 was obtained from the Australian Bureau of Statistics (ABS) for beer (Series ID: A2328861F), wine (Series ID: A2328906X) and spirits (Series ID: A2328951K). Prices for 1955-1998 were sourced from Selvanathan and Selvanathan (2007).
Austria	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price index data was found in Eurostat and the Annual Database of Global Wine Markets. Aggregate alcoholic beverage expenditure data was obtained from Euromonitor. Total household consumption expenditure data was sourced from the World Bank.
Belgium, Croatia, Denmark, Germany, Greece, Hungary, Ireland, Italy, Netherlands Portugal, Romania, Spain, Switzerland, Turkey	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Total household consumption expenditure data was sourced from the World Bank. Price index data was found in the Eurostat HICP series (http://ec.europa.eu/eurostat/web/hicp/data/database) and combined with aggregate alcoholic beverage expenditure data obtained from Euromonitor.
Canada	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price index data was obtained from Statistics Canada and average price data between 1953-1999 from Selvanathan and Selvanathan (2007). Total household consumption expenditure data was sourced from the World Bank.
Finland	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Total household consumption expenditure data was sourced from the World Bank. Price index data was obtained from the Statistical Year Book of Finland published by the Central Statistical Office of Finland and average prices from 1969-1985 were used from Selvanathan (2007).
France	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price indexes for beer, wine and spirits were obtained from Eurostat and average prices for 1971-1995 from Selvanathan and Selvanathan (2007). Total household consumption expenditure data was sourced from the World Bank.

Japan	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price indexes for beer, wine and spirits were constructed from data found in the National Statistics Bureau Japan and Selvanathan and Selvanathan (2007). Average prices were found using Euromonitor aggregate alcohol consumption and expenditure data. Total household consumption expenditure data was sourced from the World Bank.
New Zealand	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price indexes were sourced from Statistics New Zealand (Table reference: CPI013AA) and average prices for 1965-1982 from Selvanathan and Selvanathan (2007). Total household consumption expenditure data was sourced from the World Bank.
Norway	Per capita consumption data was sourced from the World Health Organisation and per capita real income data was taken from the Annual Database of Global Wine Markets. Price indexes for beer, wine and spirits were constructed from data in Eurostat and average prices for 1962-1996 were obtained from Selvanathan and Selvanathan (2007). Total household consumption expenditure data was sourced from the World Bank.
Sweden	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price indexes were sourced from Eurostat and average prices for 1961-1999 from Selvanathan and Selvanathan (2007). Total household consumption expenditure data was sourced from the World Bank.
United Kingdom	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price indexes were sourced from Eurostat and average prices for 1955-2002 from Selvanathan and Selvanathan (2007). Total household consumption expenditure data was sourced from the World Bank.
United States	Per capita consumption and per capita real income data was taken from the Annual Database of Global Wine Markets. Price indexes were sourced from the Bureau of Labor Statistics for beer (Series ID: CUSR0000SEFW01), wine (Series ID: CUSR0000SEFW03) and spirits (Series ID: CUSR0000SEFW02). Average prices for 1950-2000 were obtained from Selvanathan and Selvanathan (2007). Total household consumption expenditure data was sourced from the World Bank.

A.3 Table of consumption shares

Table A.3: Shares of beer, wine and spirits in total alcohol consumption

Country	1961-64			2014		
	Beer	Wine	Spirits	Beer	Wine	Spirits
Algeria	28.3	**63.8**	7.9	**43.4**	38.6	18.0
Argentina	3.3	**83.9**	12.9	**47.1**	45.1	7.8
Australia	**75.0**	11.7	13.3	**46.1**	39.7	14.1
Austria	**54.6**	30.5	14.9	**50.7**	35.5	13.8
Bel-Lux	**76.8**	12.6	10.6	**51.9**	34.3	13.8
Brazil	37.3	22.1	**40.6**	**63.6**	3.7	32.7
Bulgaria	17.4	**47.7**	34.9	**36.0**	24.0	40.0
Canada	**60.0**	5.9	34.1	**48.7**	25.6	25.6
Chile	7.4	**84.6**	7.9	**42.8**	30.9	26.3
China	1.7	0.6	**97.7**	47.6	4.5	**48.0**
Denmark	**77.0**	7.9	15.2	37.8	**45.5**	16.7
Finland	20.2	14.7	**65.1**	**54.0**	21.4	24.6
France	9.7	**77.7**	12.7	20.5	**57.1**	22.3
Germany	**57.4**	18.3	24.3	**53.1**	28.1	18.8
Greece	23.3	**46.0**	30.6	27.7	**52.5**	19.8
Hong Kong	36.8	1.9	**61.3**	**48.7**	36.6	14.7
Hungary	28.4	**48.0**	23.5	**35.8**	30.2	34.0
India	1.8	0.0	**98.2**	15.0	0.0	**84.9**
Ireland	**76.3**	5.1	18.5	**51.8**	28.3	19.9
Italy	2.7	**87.4**	10.0	22.9	**65.7**	11.4
Japan	41.9	0.9	**64.0**	22.8	6.3	**70.9**
Korea	33.1	0.0	**66.9**	2.6	2.9	**94.5**
Malaysia	**64.9**	2.3	32.8	**69.9**	10.4	19.7
Mexico	**66.6**	4.2	29.1	**74.1**	4.4	21.5
Morocco	21.1	**57.8**	21.1	37.2	**48.8**	14.0
Netherlands	**47.5**	9.4	43.1	**48.1**	34.6	17.3
New Zealand	**77.9**	4.4	17.6	**41.9**	39.5	18.6
Norway	47.0	5.4	**47.6**	**45.0**	37.1	17.9
Philippines	47.1	0.1	**52.8**	24.6	0.4	**74.9**
Portugal	2.0	**95.5**	2.5	28.2	**63.3**	8.5
Romania	12.8	**64.2**	23.0	**55.1**	30.8	14.1
Russia	14.9	16.2	**69.0**	42.4	11.3	**46.3**
Singapore	**70.1**	2.1	27.8	**70.9**	15.1	14.0
South Africa	13.2	42.9	**43.9**	**69.9**	21.2	8.9
Spain	8.6	**70.7**	20.7	**48.5**	22.6	28.8
Sweden	39.2	9.2	**51.6**	37.0	**49.3**	13.7
Switzerland	39.8	**42.9**	17.3	33.3	**48.2**	18.5
Taiwan	6.6	0.0	**93.4**	44.1	3.5	**52.4**
Thailand	5.5	0.0	**94.5**	26.0	0.3	**73.7**
Tunisia	26.3	**68.4**	5.4	**68.8**	27.5	3.6
Turkey	26.3	**38.7**	35.0	**57.6**	9.0	33.3
United Kingdom	**80.9**	4.2	15.0	36.2	**42.2**	21.5
United States	**48.4**	7.8	43.7	**47.5**	17.9	34.6
Uruguay	25.0	**68.8**	8.7	32.2	**51.9**	15.9
Global mean	29.6	35.1	35.3	43.5	15.5	41.0

Note: The bold numbers indicate which beverage has the highest share in total alcohol consumption.

A.4 Monte Carlo tests for preference independence

Table A.4: Preference independence tests using Monte Carlo simulations

Country	Observed likelihood ratio	Number of trials	Rank	Conclusion
Australia	0.64	1000	221	Accept
Austria	5.54	1000	922	Accept
Belgium	6.99	1000	946	Accept
Bulgaria	1.29	1000	387	Accept
Canada	1.13	1000	419	Accept
Croatia	3.80	1000	658	Accept
Denmark	0.34	1000	114	Accept
Finland	0.13	1000	62	Accept
France	0.84	1000	341	Accept
Germany	2.37	1000	639	Accept
Greece	0.74	1000	273	Accept
Hungary	0.74	1000	229	Accept
Ireland	0.33	1000	124	Accept
Italy	0.49	1000	173	Accept
Japan	0.76	1000	271	Accept
Netherlands	5.88	1000	895	Accept
New Zealand	3.54	1000	806	Accept
Norway	4.35	1000	862	Accept
Portugal	0.06	1000	23	Accept
Romania	0.37	1000	132	Accept
Spain	5.44	1000	881	Accept
Sweden	4.40	1000	880	Accept
Switzerland	6.54	1000	849	Accept
Turkey	4.30	1000	818	Accept
United Kingdom	5.83	1000	939	Accept
United States	5.73	1000	931	Accept

A.5 Demand theory results for 1996-2014 sample

Table A.5: Demand theory results (1996-2014)

	Symmetry		Homogeneity		Preference independence	
Country	Test statistic	Critical value	Test statistic	Critical value	Test statistic	Critical value
Australia	0.00	3.84	2.03	8.42	2.61	5.99
Austria	0.17	3.84	1.66	8.42	2.79	5.99
Belgium	0.35	3.84	2.94	8.42	6.99	9.21*
Bulgaria	0.02	3.84	1.08	8.69	1.29	5.99
Canada	0.13	3.84	4.77	8.42	3.88	5.99
Croatia	0.30	3.84	5.75	17.36	3.80	5.99
Denmark	0.94	3.84	0.34	8.42	0.34	5.99
Finland	1.28	3.84	1.34	8.42	4.25	5.99
France	0.13	3.84	0.37	8.42	0.94	5.99
Germany	0.14	3.84	3.20	8.42	2.37	5.99
Greece	0.02	3.84	0.56	8.42	0.74	5.99
Hungary	0.33	3.84	0.48	10.03	0.74	5.99
Ireland	0.05	3.84	6.36	8.42	0.33	5.99
Italy	0.22	3.84	3.47	8.42	0.49	5.99
Japan	0.18	3.84	0.96	8.42	6.85	9.21*
Netherlands	0.85	3.84	0.76	8.42	5.88	5.99
NZ	3.46	3.84	1.45	8.42	0.70	5.99
Norway	7.87	6.63*	0.29	8.42	5.64	5.99
Portugal	3.68	3.84	6.57	8.42	0.06	5.99
Romania	0.62	3.84	1.91	10.03	0.37	5.99
Spain	2.45	3.84	5.23	8.42	5.44	5.99
Sweden	1.21	3.84	0.74	8.42	5.11	5.99
Switzerland	0.09	3.84	0.28	18.52	6.54	9.21*
Turkey	0.05	3.84	1.13	8.42	4.30	5.99
United Kingdom	0.60	3.84	2.09	8.42	4.62	5.99
United States	0.48	3.84	2.66	8.42	2.82	5.99

Note: Critical value at 1% level is denoted by an asterisk

A.6 Coefficient results for 1996-2014 sample

Table A.6: Constrained demand model parameter estimates (1996-2014)

	Constants			Marginal shares		
Country	Beer	Wine	Spirits	Beer	Wine	Spirits
Australia	-0.77(0.39)	1.06(0.33)	-0.27(0.16)	0.17(0.04)	0.26(0.04)	0.06(0.02)
Austria	0.01(0.39)	-0.75(0.57)	0.73(0.65)	-0.07(0.05)	0.21(0.07)	0.86(0.09)
Belgium	-0.22(0.42)	0.44(0.66)	-0.23(0.61)	0.48(0.08)	0.28(0.12)	0.24(0.11)
Bulgaria	0.73(0.98)	-1.39(2.59)	0.66(1.82)	0.26(0.10)	0.38(0.25)	0.36(0.18)
Canada	-0.26(0.08)	0.65(0.16)	-0.38(0.18)	0.09(0.03)	0.14(0.07)	0.76(0.08)
Croatia	-0.03(0.46)	0.25(0.42)	-0.22(0.18)	0.02(0.06)	0.97(0.06)	0.01(0.01)
Denmark	-1.41(0.29)	1.42(0.36)	-0.01(0.17)	0.15(0.08)	0.72(0.09)	0.13(0.05)
Finland	0.12(0.54)	0.27(0.91)	-0.39(0.51)	0.35(0.06)	0.27(0.11)	0.37(0.06)
France	0.39(0.37)	-0.15(0.41)	-0.24(0.24)	0.38(0.15)	0.38(0.17)	0.25(0.09)
Germany	0.09(0.45)	0.13(0.16)	-0.23(0.39)	0.70(0.29)	0.05(0.10)	0.25(0.25)
Greece	-0.25(0.28)	1.04(0.54)	-0.79(0.52)	0.02(0.05)	0.87(0.09)	0.11(0.09)
Hungary	-0.096(0.34)	-0.07(0.48)	0.17(0.28)	0.17(0.08)	0.55(0.12)	0.29(0.07)
Ireland	-1.16(0.63)	0.98(0.28)	0.18(0.46)	0.52(0.12)	0.19(0.05)	0.29(0.09)
Italy	0.24(0.32)	-0.84(0.42)	0.59(0.57)	0.13(0.05)	0.50(0.08)	0.37(0.09)
Japan	-0.54(0.17)	0.00(0.10)	0.54(0.23)	0.01(0.05)	0.01(0.03)	0.98(0.07)
Netherlands	-0.06(0.22)	0.54(0.21)	-0.49(0.18)	0.43(0.11)	0.39(0.11)	0.17(0.09)
NZ	-0.56(0.59)	0.61(0.53)	-0.05(0.35)	0.64(0.11)	0.18(0.10)	0.18(0.07)
Norway	-0.64(0.36)	0.86(0.38)	-0.22(0.10)	0.39(0.12)	0.48(0.13)	0.12(0.04)
Portugal	-0.52(0.33)	0.03(0.84)	0.49(0.79)	0.03(0.04)	0.63(0.22)	0.34(0.12)
Romania	1.55(0.72)	-0.05(1.71)	-1.50(1.89)	0.22(0.06)	0.41(0.14)	0.38(0.15)
Spain	-0.01(0.53)	-0.57(0.26)	0.57(0.51)	-0.07(0.07)	0.05(0.04)	1.03(0.07)
Sweden	-0.77(0.60)	1.45(0.31)	-0.68(0.47)	0.44(0.17)	0.25(0.09)	0.311(0.13)
Switzerland	0.36(0.14)	-0.63(0.34)	0.27(0.30)	0.39(0.12)	0.43(0.27)	0.19(0.24)
Turkey	-0.03(0.64)	-0.06(0.31)	0.09(0.79)	0.47(0.10)	0.01(0.05)	0.51(0.13)
United Kingdom	-0.97(0.26)	0.95(0.23)	0.02(0.14)	0.24(0.08)	0.49(0.07)	0.27(0.04)
United States	-0.51(0.15)	0.24(0.08)	0.27(0.13)	0.57(0.16)	0.12(0.08)	0.32(0.13)

Note: Standard errors are in parentheses

Table A.7: Constrained demand model parameter estimates (1996-2014)

	Slutsky own-price and cross-price coefficients (x100)					
Country	BB	BW	BS	WW	WS	SS
Australia	-0.02(0.16)	-0.17(0.12)	0.07(0.07)	0.15(0.11)	-0.08(0.05)	-0.03(0.06)
Austria	0.01(0.09)	0.09(0.08)	-0.09(0.06)	-0.15(0.09)	0.06(0.08)	0.04(0.10)
Belgium	0.05(0.25)	-0.33(0.22)	0.37(0.24)	-0.04(0.32)	0.37(0.24)	-0.65(0.25)
Bulgaria	0.07(0.18)	-0.32(0.30)	0.13(0.13)	0.45(0.79)	0.01(0.35)	-0.13(0.25)
Canada	0.11(0.05)	-0.09(0.05)	-0.02(0.05)	0.09(0.11)	0.01(0.11)	0.01(0.12)
Croatia	-0.16(0.21)	0.00(0.18)	0.16(0.09)	0.06(0.18)	-0.06(0.04)	-0.09(0.09)
Denmark	-0.18(0.09)	0.17(0.10)	0.01(0.03)	-0.30(0.12)	0.13(0.04)	-0.13(0.02)
Finland	-0.45(0.20)	0.37(0.18)	0.08(0.06)	-0.39(0.19)	0.02(0.08)	-0.10(0.05)
France	-0.21(0.13)	0.06(0.14)	0.15(0.08)	-0.10(0.19)	0.04(0.13)	-0.18(0.13)
Germany	0.12(0.28)	-0.15(0.10)	0.03(0.25)	0.02(0.12)	0.13(0.14)	-0.16(0.26)
Greece	-0.15(0.15)	0.10(0.09)	0.05(0.07)	-0.23(0.10)	0.12(0.09)	-0.17(0.09)
Hungary	0.02(0.09)	-0.05(0.09)	0.03(0.07)	0.01(0.13)	0.03(0.08)	-0.06(0.08)
Ireland	-0.19(0.18)	0.05(0.10)	0.14(0.12)	-0.11(0.11)	0.06(0.06)	-0.20(0.09)
Italy	0.15(0.27)	0.08(0.18)	-0.23(0.36)	0.09(0.30)	-0.18(0.37)	0.40(0.61)
Japan	-0.10(0.03)	0.07(0.03)	0.04(0.03)	-0.05(0.03)	-0.02(0.02)	-0.02(0.04)
Netherlands	-0.08(0.06)	-0.03(0.07)	0.11(0.04)	-0.05(0.10)	0.08(0.06)	-0.19(0.06)
NZ	-0.61(0.34)	0.24(0.23)	0.37(0.25)	-0.21(0.22)	-0.03(0.16)	-0.34(0.29)
Norway	-0.09(0.10)	0.10(0.11)	-0.01(0.03)	-0.29(0.13)	0.19(0.05)	-0.18(0.03)
Portugal	-0.04(0.08)	0.02(0.06)	0.03(0.10)	-0.17(0.19)	0.15(0.18)	-0.18(0.20)
Romania	-0.25(0.16)	0.04(0.25)	0.21(0.18)	-0.10(0.57)	0.06(0.48)	-0.27(0.50)
Spain	0.08(0.26)	-0.22(0.11)	0.13(0.21)	-0.03(0.07)	0.25(0.09)	-0.38(0.20)
Sweden	0.06(0.27)	-0.12(0.13)	0.06(0.21)	-0.34(0.20)	0.46(0.21)	-0.52(0.27)
Switzerland	-0.17(0.12)	0.40(0.16)	-0.24(0.16)	-0.38(0.47)	-0.02(0.41)	0.26(0.41)
Turkey	0.02(0.05)	-0.05(0.03)	0.03(0.05)	0.01(0.02)	0.04(0.02)	-0.06(0.06)
United Kingdom	-0.06(0.05)	0.06(0.04)	0.00(0.03)	0.01(0.04)	-0.06(0.03)	0.06(0.05)
United States	-0.07(0.09)	0.05(0.04)	0.03(0.07)	0.01(0.04)	-0.06(0.04)	0.03(0.07)

Note: Standard errors are in parentheses

A.7 Unconstrained demand elasticity results (complete)

Table A.8: Implied demand elasticities (1)

	Income elasticity			Own-price elasticity			
Country	Beer	Wine	Spirits	Beer	Wine	Spirits	Alcohol
Australia	0.70	1.52	1.26	-0.07	0.09	-0.39	-0.54
Austria	-0.06	0.89	1.99	-0.31	-0.37	-0.11	-0.42
Belgium	0.78	1.41	1.07	0.20	-1.82	-4.72	-0.47
Bulgaria	0.94	1.37	0.81	0.27	1.63	-0.29	-0.52
Canada	0.35	0.49	1.19	-0.02	-0.39	0.01	-0.49
Croatia	0.07	1.49	0.01	0.85	-0.03	-0.33	-0.50
Denmark	0.37	1.71	0.82	-0.47	-0.97	-0.75	-0.22
Finland	0.78	1.05	1.24	-0.68	-0.43	-0.60	-0.43
France	1.35	0.63	1.19	-0.18	-0.06	0.33	-0.37
Germany	1.31	0.24	0.97	-0.17	-0.12	0.51	-0.49
Greece	0.05	2.13	0.32	-0.49	-0.56	-0.55	-0.51
Hungary	0.59	1.89	0.66	-0.05	0.08	0.04	-0.48
Ireland	0.88	1.03	1.26	-0.37	-1.29	-0.83	-0.44
Italy	0.28	1.01	2.44	0.12	0.22	2.18	-0.50
Japan	0.32	-0.09	1.12	-0.47	-0.03	-0.06	-0.51
Netherlands	0.81	1.64	0.82	-0.20	-0.62	-0.58	-0.49
NZ	1.02	0.82	1.19	-0.17	-0.39	-0.86	-0.37
Norway	0.59	0.91	1.63	-0.16	-0.02	-0.51	-0.86
Portugal	0.15	1.21	2.10	-0.66	-0.18	6.54	-0.54
Romania	0.54	1.39	1.29	-0.50	0.34	-1.89	-0.49
Spain	-0.19	0.78	3.11	-2.51	-1.30	0.69	-0.49
Sweden	1.22	0.55	1.11	-0.03	-0.35	-0.42	-0.44
Switzerland	0.99	1.26	0.43	-0.57	-0.74	4.00	-0.50
Turkey	0.89	0.36	1.23	0.04	0.08	-0.15	-0.29
UK	0.87	0.80	1.45	-0.25	-0.45	-0.38	-0.27
USA	0.81	1.09	1.21	-0.01	-0.16	-0.11	-0.28

Table A.9: Implied demand elasticities (2)

	Cross-price elasticity					
Country	BW	BS	WB	WS	SB	SW
Australia	-0.02	0.16	0.25	-0.11	-0.13	-0.08
Austria	0.03	-0.28	0.12	0.21	0.06	0.53
Belgium	-0.48	0.55	-1.67	0.79	3.11	3.88
Bulgaria	-1.19	0.46	-0.99	0.02	0.45	-0.28
Canada	0.09	-0.19	0.11	0.13	-0.01	0.04
Croatia	0.28	0.82	-0.59	-0.23	1.79	-0.40
Denmark	0.46	0.09	0.54	0.23	-0.15	1.21
Finland	0.18	0.28	-0.25	0.45	0.96	0.02
France	0.13	0.04	0.09	-0.37	-0.02	-0.003
Germany	-0.21	-0.50	-0.97	0.65	1.13	0.52
Greece	0.66	0.17	0.13	0.34	0.20	0.19
Hungary	-0.28	0.14	0.11	-0.19	-0.04	0.14
Ireland	0.25	0.19	0.08	0.51	0.82	0.33
Italy	0.10	-2.37	-0.01	0.78	-0.21	-0.95
Japan	0.09	0.36	-0.23	0.02	0.08	-0.01
Netherlands	0.11	0.12	-0.15	0.39	0.54	0.33
NZ	0.08	0.18	0.14	0.29	0.22	0.37
Norway	-0.16	0.48	0.04	-0.22	0.19	0.24
Portugal	-0.09	-0.55	0.69	-1.50	-1.02	0.84
Romania	0.17	0.68	-0.25	0.68	1.09	-0.67
Spain	-0.21	0.59	-0.20	-1.48	4.15	1.74
Sweden	-0.02	0.37	-0.13	0.25	0.10	0.22
Switzerland	1.03	-0.28	1.42	-1.50	-2.22	4.00
Turkey	-0.14	0.04	-0.92	0.73	0.06	0.19
UK	0.20	0.17	0.26	0.02	0.28	0.01
USA	0.08	0.09	0.26	-0.00	-0.06	-0.06

A.8 Stigler & Becker hypothesis sample groups

Sample group	Time Period	Countries
All countries	Complete	Australia (1955-2014) Belgium (1996-2014), Canada (1953-2014), Denmark (1996-2014), Germany (1996-2014), Ireland (1996-2014), Netherlands (1996-2014), NZ (1965-2014), UK (1955-2014), USA (1950-2014), Finland (1969-2014), Norway (1961-2014), Sweden (1961-2014), Hungary (2000-2014), Romania (2000-2014), Spain (1996-2014), Turkey (1996-2014), Bulgaria (1997-2014), Japan (1963-2014), Austria (1961-2014), Croatia (2004-2014), France (1971-2014), Greece (1996-2014), Italy (1996-2014), Portugal (1996-2014), Switzerland (2005-2014)
All countries	1996-2014	Australia, Belgium, Canada, Denmark, Germany, Ireland, Netherlands, NZ, UK, USA, Finland, Norway, Sweden, Hungary (2000-2014), Romania (2000-2014), Spain, Turkey, Bulgaria (1997-2014), Japan, Austria, Croatia (2004-2014), France, Greece, Italy, Portugal, Switzerland
Beer-focused	Complete	Australia (1955-2014), Belgium (1996-2014), Canada (1953-2014), Denmark (1996-2014), Germany (1996-2014), Ireland (1996-2014), Netherlands (1996-2014), NZ (1965-2014), UK (1955-2014), USA (1950-2014), Finland (1969-2014), Norway (1961-2014), Sweden (1961-2014), Hungary (2000-2014), Romania (2000-2014), Spain (1996-2014), Turkey (1996-2014)
Wine-focused	Complete	Austria (1961-2014), Croatia (2004-2014), France (1971-2014), Greece (1996-2014), Italy (1996-2014), Portugal (1996-2014), Switzerland (2005-2014)
Spirits-focused	Complete	Bulgaria (1997-2014), Japan (1963-2014)
Beer-focused	1996-2014	Australia, Belgium, Canada, Denmark, Finland, Germany, Hungary (2000-2014), Ireland, Netherlands, NZ, Norway, Sweden, Turkey, UK, USA, Austria, Spain
Wine-focused	1996-2014	Croatia (2004-2014), France, Greece, Italy, Portugal, Romania (2000-2014), Switzerland (2005-2014)
Spirits-focused	1996-2014	Bulgaria (1997-2014), Japan
Low-income	Complete	NZ (1965-2014), Portugal (1996-2014), Greece (1996-2014), Croatia (2004-2014), Hungary (2000-2014), Bulgaria (1997-2014), Turkey (1996-2014), Romania (2000-2014)
Middle-income	Complete	Norway (1961-2014), France (1971-2014), Sweden (1961-2014), Canada (1953-2014), Finland (1969-2014), Australia (1955-2014), Japan (1963-2014), Austria (1961-2014), UK (1955-2014)
High-income	Complete	Switzerland (2005-2014), Denmark (1996-2014), Spain (1996-2014), Ireland (1996-2014), Belgium (1996-2014), Netherlands (1996-2014), USA (1950-2014), Germany (1996-2014), Italy (1996-2014)
Low-income	1996-2014	Spain, Portugal, Greece, Hungary, Croatia (2004-2014), Bulgaria (1997-2014), Turkey, Romania (2000-2014)
Middle-income	1996-2014	Austria, Ireland, Belgium, Finland, Japan, France, Germany, Italy, NZ
High-income	1996-2014	USA, Norway, Canada, Switzerland (2005-2014), Australia, Denmark, Netherlands, Sweden, UK