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Alcohol Problems in Europe: The Good, the Bad, the Chunder…

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Abstract: This research is a brief insight into analysing and modelling alcohol consumption, and an alcohol-related outcome (road traffic incidents), to advice policy makers on protecting public health. A panel data methodology is employed using fixed-effect, random-effect, and feasible generalised least squares estimation from 2000-2016 for European Union members (including the U.K.). The research confirms an overall robust pro-cyclical nature for alcohol consumption and road traffic incidents; implying they behave in association with the economic cycle of booms and busts. The results also suggest that, following redistribution policies from the top 10% of earners to the bottom 10% of earners, policy makers should consider mitigating a predicted net-increase in alcohol consumption to account for the negative health effects of the drug. Furthermore, the findings are in favour of a unilateral 18+ drinking age law across the European Union which in turn would generate more consistency across the union.

JEL classification: I100; E320; I180

1. INTRODUCTION

The crash of financial markets in 2008 provoked a worldwide economic downturn, increasing unemployment rates, bankruptcies and caused tighter credit markets. The economic downturn re-emerged discussions amongst economists and health-related academics into the affects macroeconomic conditions have on health factors. In fact, following the 2008 financial crash The World Health Organisation (WHO) developed a framework in order to examine health outcomes associated with an economic crisis. An important area of interest to emerge from the WHO's health impact assessment was alcohol consumption due to its extensive international usage, its recognised sensitivity to economic changes and the major health effects it is responsible for. The WHO recognises alcohol as a "toxic and psychoactive substance with dependence-producing properties" (WHO, 2018a). Worldwide, 5.3% of all deaths every year are of a direct result of the use of alcohol, in fact the harmful use of alcohol is attributed to more than 200 diseases and injury conditions including, but not limited, to violence, burns, road traffic incidents, cirrhosis, and psychological issues (Rehm, *et al*, 2003). Therefore, the importance of identifying factors associated with alcohol-related outcomes is pivotal in improving well-being and mortality.

This study will research how changes in the macroeconomy influence alcohol consumption using country-level data from 2000 to 2016 for all European Union members; 28 members including the UK (See **Appendix A**). This research will consider alcohol consumption in terms of litres of pure alcohol consumed per capita as the dependent variable. The main independent variables will be the growth of Gross Domestic Product (GDP) per capita; the key economic variable to explain alcohol consumption. Furthermore, the analysis will be expanded to consider another alcohol-related outcome, namely road traffic incidents per 100,000 people resulting in death or injury. In fact, 40.7% of all road traffic fatalities are attributed to alcohol use (Papalimperi, *et al*, 2019), and alcohol was the most commonly found substance in serious injuries from road traffic incidents (Bogstrand, *et al*, 2012). In addition, the unemployment rate will be used as an alternative proxy of the economic climate for robustness checks.

This research will set out to address three important questions:

1. Are alcohol-related outcomes pro-cyclical, counter cyclical or neither?
2. Is there a significant difference between EU member's alcohol consumption based on geographical location and relative incomes? What does this imply for policymakers?
3. How does the redistribution of income affect alcohol consumption and are particular policies more effective at reducing alcohol-related outcomes?

The strategy for explaining these questions will be to employ econometrics to estimate random-effects models using panel data from the WHO, the World Bank, and the World Inequality Database. Once an appropriate model has being built, the investigation will be expanded to specifically answer the research questions.

The structure of this research is as follows: first an overview of the relevant existing literature, an insight into the model specification and data set, analysis of the econometric findings, then finally a general discussion, and conclusion.

2. LITERATURE REVIEW

2.1 Pro-cyclical findings focused on the United States

Previous research into the associations of macroeconomic conditions on alcohol consumption is relatively limited, most work tends to take a national focus as opposed to an international perspective, and most literature is centred in United States. The general debate amongst the researchers on this topic is whether alcohol consumption is pro-cyclical, countercyclical or neither. A countercyclical variable moves in the opposite direction to the business cycle and vice versa with a pro-cyclical variable (Gordon 2013, pp. 251).

Early prominent research was conducted, using panel data methods, in Ruhm (1995). This study used 48 contiguous states in the United States from 1975 to 1988 to investigate the relationship between macroeconomic conditions and two alcohol-related outcomes – liquor consumption and highway vehicle fatalities (Ruhm, 1995). The main theme highlighted throughout this academic paper was to shift the reasonably logical theorem that drinking and intoxicated motor vehicle use rises during economic downturns, as one might justify through the proposal of a coping mechanism and or a greater willingness to partake in risky behaviour when times are tough. Ruhm (1995) acknowledges that although liquor maybe used as self-medication to cope with increased stress during an economic downturn, in the aggregate, this is counteracted by lower incomes and changes in relative prices. The major unearthing from Ruhm (1995) found that alcohol consumption is associated with unemployment in a pro-cyclical manner, suggesting that, at the aggregate level, the opportunity cost from substituting away from alcohol consumption is lower during economic downturns. In addition, Ruhm (1995) found that highway vehicle fatalities involving alcohol are also pro-cyclical, and a noteworthy finding that spirits are more sensitive to macroeconomic changes compared to that of beer and wine. In fact, the fixed-effect models estimated a 1% increase in the unemployment rate corresponds with a 1.1% fall in the predicted consumption of spirits compared to beer and wine which was around a 0.4% fall (Ruhm 1995, p.p:595). Ruhm (1995) concluded by suggesting policymakers should intensify their efforts to tackle drunk-driving and treating alcohol related issues during periods of rapid economic growth.

Freeman (1999) was an expansion on the creditworthy work carried out in Ruhm (1995). Likewise, to Ruhm (1995), Freedman used panel data methods on the same 48 contingent states from 1971-1995 to conclude similar findings. Freedman however recognised that the time series data for alcohol consumption and state level economic conditions contained unit-roots; thus, Ruhm's coefficients were spurious. The follow up study re-estimated the model using the logarithmic first differences to render the data stationary. Freedman (1999) also impressively recognises, unlike Ruhm (1995), the habit-forming characteristics of alcohol consumption, commented on in previous medical literatures, by including the lags for alcohol consumption whereby current consumption is correlated with past consumption, and therefore correlated with the past error terms. Freeman (1999), having correctly re-examined Ruhm (1995)'s model, concludes the original findings of pro-cyclical alcohol consumption, however, the results were robust. An exceptional comment was made by Freedman for further researchers to consider how a decline in aggregate alcohol consumption maybe concealing the impact on vulnerable individuals prone to alcohol abuse as they may constitute a small proportion of the total demand for alcohol products, this would later become a focal point in the literature.

Ettner (1997) recognised that aggregate state-level data was a limitation for the analysis as it omitted the individual-specific characteristics, noted by Freedman (1999). Ettner (1997) used cross-sectional data from the 1988 National Health Interview Survey in the United States to research if unemployment affected the average daily consumption of alcohol and alcohol dependence. There was an issue of possible reverse causality, where the dependent variable is influencing the explanatory variable(s), as heavy drinkers maybe more likely to lose their jobs (Ethner, 1997). Ordinary regression of alcohol outcomes on unemployment showed that there was a correlation between involuntary unemployment and alcohol outcomes, therefore Ordinary Least Squares estimation would be bias and inconsistent due to endogeneity. To address this issue, Ettner (1997) uses two-stage instrumental variable estimation as alcohol outcomes were not significantly correlated with the explanatory variable "not working" (unemployed or not in the labour force). Instrumental variable regression was used to control for the potential reverse causality yielding statistically consistent estimates of the causal effects (Ettner, 1997). Interestingly, the outcomes reported gave mixed results, the study showed a significant negative effect of declined employment on alcohol consumption and dependence, which is probably attributed to income effects thus, a pro-cyclical relationship. However, the study also showed that alcohol consumption does increase with an increase in involuntary unemployment which would suggest a countercyclical relationship. There were some shortcomings with the interpretation of the results. Firstly, alcohol dependency and consumption maybe subject to errors-in-variable bias as respondents maybe likely to report incorrectly due to the sensitive natural of personal information. In addition, another shortcoming of the research is that the model assumes a person's area doesn't directly affect their drinking habits unless they become unemployed, however if a person lives in a place of high unemployment this could cause an employed person to drink more in fear of unemployment or drink less due to expected income reductions (Ettner, 1997). In conclusion, Ettner (1997) suggested that the findings were somewhat inconclusive, and that subsequent research should consider other measures of alcohol abuse to fathom discrepancies between involuntary unemployment and alcohol consumption.

Ruhm and Black (2002) made an important contribution to the literature, the study explored the relationship between macroeconomic conditions and drinking from 1987 to 1999 in 45 U.S states. Telephone interviews were used to conduct the (BRFSS) "Behavioral Rick Factor Surveillance System" which collects various information on alcohol habits used by Ruhm and Black (2002). The literature analyses how "light" and "heavy" drinkers respond to macroeconomic changes, how alcohol use adjusts to these changes, and how cyclical fluctuations differ across different subgroups (Ruhm, Black, 2002). The methods of estimation used were OLS estimation, Probit for the dichotomous dependent variables, and Weighted Least Squares estimators to account for heteroskedasticity. Ruhm and Black (2002) argues that stress-induced rises in alcohol consumption are countermanded at the aggregate level due to falls in alcohol consumption from the adverse macroeconomic environment, thus a pro-cyclical overall relationship. Interestingly, the study shows that a 1% rise in the unemployment rate leads to a proportionally larger decrease of 10% in heavy drinking, suggesting that heavy drinkers consumption fall significantly more during downturns in comparison to recreational drinkers. Subsequently, Ruhm and Black (2002) conclude that alcohol abuse is pro-cyclical. Additionally, other factors such as drink driving falls by 3.3% and total drinking participation falls by 0.3%. Nevertheless, the research only includes a relatively short time period of 13 years, which is a downfall, however this is longer than other research concluded before this paper.

Dee (2001) considered the relationship between alcohol abuse and economic conditions using 700,000 participants in the United States who participated in the Centre of Disease Control and BRFSS, likewise to Ruhm and Black (2002), over the period 1984-1995. Accordingly, Dee (2001) uses fixed-effect panel data estimation to model drinking participation, volume, and binge drinking where White standard errors (White, 1980) are used to account for heteroskedasticity. The findings suggested alcohol use is pro-cyclical, however it provided robust evidence that binge drinking is strongly countercyclical even for individuals that are employed. In fact, the paper found that a 5% increase in the unemployment rate would correspondingly lead to an 8% rise in the probability of binge drinking (Dee, 2001). Subsequently, the main finding of the research was that recessions induce large increases in the prevalence of binge drinking, this is likely caused by an increased in leisure time combined with economic stress. Dee (2001) is a complete contrast to the findings of Ruhm and Black (2002) regarding the effect of changes in the macroeconomy on binge drinking. Likewise, to Ruhm and Black (2002), the study only considers a short time span specifically 11 years, and the BRFSS only provides one quantitative measure for alcohol consumption where the other 3 measures are binary which does not allow for magnitude to be expressed. In addition, the previously mentioned issues with asking a respondent "if they have consumed over 5 or more drinks in a row within the last month" for example could lead a respondent to give a false response causing in-variable bias (Dee, 2001).

2.2. Countercyclical findings

Literature arguing that a rise in unemployment leads to a countercyclical reaction in alcohol usage generally focuses on people attempting to reduce stress through a self-medicated mechanism (Helble, Sato, 2011). Baker (1985) was an early theoretical study looking into stress in the workplace. The study highlighted that stressors could cause self-destructive behaviours such as smoking and substance abuse, where a stressor is a physical or physiological strain such as the fear of unemployment during economic downturns. A later study by Fenwick and Tausig (1994), a US panel data study using the 1973-1977 Quality of Employment Survey data, investigated links between the macroeconomy and stress. A key result that arose from this article was that higher unemployment rates corresponded to increased stress and lowered life satisfaction, which was demonstrated through reduced freedom and increased job demands (Fenwick, Tausig, 1994).

Arkes (2007) examined how changes in the economy influence teenage drug and alcohol use. The study used data from the National Longitudinal Survey of Youths; a sample of American youth aged between 12 and 17 years old when they were first interviewed between 1996-2004. Arkes (2007, pp:28) found a countercyclical relationship between the unemployment rate and substance use, specifically a 1% rise in the rate of unemployment corresponds to a predicted rise in the number of days in which alcohol had been used in the last 30 days by approximately 16.4%. The findings of this study are at a complete contrast to Ruhm's (1995), Ruhm and Black's

(2002) and Dee's (2001) findings of alcohols overall pro-cyclical relationship with macroeconomic conditions. Although, Arkes (2007) is in some ways similar to Dee (2001) with binge drinking been counter-cyclical. Importantly, the age group being studied will likely have a large effect on these findings as adolescents can react differently to changes in the macroeconomy compared to adults (Arkes, 2007). In addition, Arkes (2007) exposes somewhat of a flaw with the economic state recorded data being too broad and not capturing the true conditions an individual is facing.

Dávalos *et al* (2012) investigated how changes to macroeconomic conditions in the United States impacts a risky behavior: excess alcohol consumption. The study estimates fixed-effect models using panel data from the National Epidemiological Survey of Alcohol and Related Conditions (NESARC); a survey of 46,500 American adults. Dávalos *et al* (2012) finds that state unemployment rates are positively related with a rise in the probability of binge drinking, similarly to that of Dee (2001). The study also suggests that the combination of self-mediation, economic distress, and increased leisure time are all factors that outweigh the income effect of a rise in unemployment. Dávalos *et al* (2012) was the first study to use full fixed-effects models and individual-level panel data to conclude an overall countercyclical relationship between alcohol use and the macroeconomy, which opposes the conclusions found in Ruhm (1995), Freeman (1999) and Ruhm and Black's (2002). However, a drawback from this study is that it did not consider the effects of the severity and length of the recessions when conducting the research which could potentially lead to an ambiguous result.

There are some studies, Charles and Decicca (2008) and Jiménez-Martín *et al* (2006), that indicate there is no statistically significant relationship between macroeconomic conditions and alcohol consumption. Charles and Decicca (2008) examined the relationship between labour market conditions (MSA-level unemployment rates) and several health measures along with behaviours such as binge drinking for the 58 largest metropolitan areas in the United States. The results found that labour market fluctuations on the prevalence of binge drinking were not statistically significant (Charles and Decicca, 2008). In addition, Jiménez-Martín *et al* (2006) used BRFSS data for the United States, as previously used by Ruhm and Black (2002) and Dee (2001), over the period 1987 to 2003 to test whether macroeconomic conditions affect alcohol consumption. The author found no significant relationship between the unemployment rate and various alcohol consumption measures.

2.3. Research outside the United States, Recessions, and Cohort data

The literature is not isolated to the United States, there has been a recent surge in publications such as Beard *et al* published in 2019. The research article used cross-sectional household computer-assisted interview data between March 2014 and April 2018 gathering information on participants drinking behaviours, demographic characteristics (age, gender, and ethnicity) and socio-economic status referred to as SES. Beard *et al* (2019) used 6 measures of SES: social-grade (classification of an individual's job profession), gross annual household income, education level (based on English qualifications), car ownership, working status (for example part-time or retired), and housing tenure (the arrangement in which someone lives in a house). The survey received 57,807 alcohol drinking participants commenting on their alcohol habits and consumption. Following this, linear and ridge regression models were conducted both indicating that social-grade, tenure, and educational achievements were significantly better predictors compared to income, car ownership and employment status (Beard *et al*, 2019). The researcher concluded that the professional-managerial occupational category had more drinking occasions than the lowest two occupational categories of social grade (e.g. semi-skilled and unskilled manual workers. In addition, Beard *et al* (2019) found that binge drinking had a higher frequency for individuals whose highest qualification was an A-level compared to those with a university qualification, although the robustness of the results are questionable given the short time span.

Another recent study outside of the US, Berg *et al* (2020), examines how applicable booms, recessions, and labour market status are on alcohol use in youth and middle-aged individuals. The author used survey data comprised of two groups from the same town in Northern Sweden, one group born in 1965 (cohort65, boom group) and another group born in 1973 (cohort73, recession group), this isolation of two specific groups is to directly see the effects of booms and recessions on alcohol use. In the mid-1980s and the early 1990s the Swedish economy would boom and enter a recession respectively; the birth years of the cohort has been selected to ensure each group would be aged 21 years old during the macroeconomic events. All participants completed the last grade of compulsory schooling with 1083 surveyed pupils graduating in 1981 (cohort 65) and 898 surveyed pupils graduating in 1989 (cohort 73). In 2008 cohort 65, now aged 43 years old, and in 2012 cohort73, now aged 39 years old, completed a revised questionnaire of the same survey they took when aged 21 years old to investigate changed in the individual's behaviours. The sample numbers obviously diminished with some individuals not responding or who had passed away, however there was still 1001 individuals from cohort65 and

686 individuals from cohort 73. The longitudinal cohort survey data, similar to Arkes (2007), allowed the researcher to directly see changes in individuals not apparent at the aggregate level. The analysis of Berg *et al* (2020) considered interactions in repeated measures ANVOAs (analysis of variance) and heavy episodic drinking was analysed using likelihood ratio tests. The results of the study showed that woman aged 21 during the recession consumed more alcohol and were more likely to be heavy episodic drinkers compared to woman aged 21 during the boom whereas there was no difference between the male cohorts (Berg *et al*, 2020). In addition, the study also found cohort65 increased their alcohol consumption at midlife compared to cohort 73 whose consumption fell, also alcohol use for unemployed individuals did not fluctuate between cohorts (Berg *et al*, 2020). However, the external validity of this study is in question.

Katikireddi (2017) uses cohort data in its analysis, likewise to Berg *et al* (2020), from the Scottish Health Surveys which collects cross-sectional records of the adult population in Scotland. The study investigated the relationship between alcohol-attributed harm and socioeconomic status measures (education level, social class, household income and air-based deprivation) using a sample from 8 cohort surveys from 1995 to 2012. The cohort samples had relatively more female participants (28,459) than male participants (21,777) which corresponds to 429,986 person-years of follow up (Katikireddi, *et al*, 2017). Katikireddi (2017) used survival models, specifically Cox proportional hazard models. The main findings show that alcohol-attributed harms, alcohol consumption and binge drinking are greater in disadvantaged social groups, those with a lower socioeconomic status, regardless of which socioeconomic measure was used (Katikireddi, *et al*, 2017). Katikireddi (2017) had many strengths, the study ensured the risk of in sample-bias was mitigated through data linkage which prevented those who were sampled in the survey and experiencing harm to be randomly selected. In addition, potential reverse causality was minimised by excluding those participates with past alcohol-attributed harms and robustness was assessed using prespecified outcomes (Katikireddi, *et al*, 2017). Nevertheless, there are some notable limitations of the study such as a proportion of the most severally disadvantaged individuals are excluded due to non-consent for data linkage which systematically under-represents some groups most at risk. In addition, alcohol consumption is only considered as a snapshot at different points in time rather than over a lifetime, so it is harder to discount anomalies. Furthermore, the survey only focused on the entire cohort and didn't consider specific age groups which Arkes (2007) and Ruhm (1995) highlight affect alcohol use, the mean age at interview for both male and female was 48.1 years old (Katikireddi, *et al*, 2017).

Research into the impact of economic recessions on alcohol use has been conducted in the UK by Harhay *et al* (2013). The article used seven waves of the Health Survey for England from 2004 to 2010 with a sample size of 36,525 non-institutionalised white individuals aged 20-60 years old (Harhay *et al*, 2013). The aim of the paper was to assess the trends in alcohol use before, during and after the recession with respect to unemployment and socio-demographic factors including dummy variables for different regions of the UK (e.g. East Midlands). Harhay (2013) used the most compatible type of regression for each independent variable, binge drinking was examined using logistic regression models, ordinary least squares and quantile regression was used to analysis alcohol consumption in the last 7 days and Poisson and OLS regression was used to analysis the number of days an individual drank in the past 7 days. Not surprisingly Harley (2013) found that during England's recession from 2008-2010, the majority of people drank less and drank less often, however, interestingly Harley (2013) found unemployed individuals were more likely to binge than another group (counter-cyclical) suggesting that employment status is an important dependent variable in explaining alcohol consumption.

Similarly, Goeij *et al* (2015) conducted research into how an economic crisis affects alcohol consumption and alcohol-related health problems by comparing evidence extracted from 87 studies from medical, psychological, social and economic databases of which 47 were deemed relevant based on meta-analysis (Goeij *et al*, 2015). The relevant studies are then deciphered into a 5 possible mechanism categories of how they lead to a changes in alcohol consumption for examples M2: Job losses cause adverse psychological distress leading to a possible coping mechanism with alcohol or M3: Income reductions causing a tighter budget constraint thus reduced spending on alcoholic beverages falls (Goeij *et al*, 2015). Following this, distinctions are made between the studies according to the extent they matched to a specific mechanism category, the coverage of evidence and study design (Cross-sectional or Longitudinal) (Goeij *et al*, 2015). Interestingly, the majority of the examined studies use cross-sectional data and most fit with the mechanism framework appropriately. Accordingly, each study's characteristics are analysed in a table to conclude findings for each assessed country in regard to how well it corresponds to each mechanism. Goeij *et al* (2015) found there was strong evidence, that individuals drank more when they are under phycological distress, this appeared in 31 of the 47 studies. This can be triggered by unemployment, income reductions or altered working arrangements such as lower wages or reduced hours. In addition, Goeij *et al* (2015) also found that a reduction in income during times of financial hardship leads to less consumption of alcoholic beverages, this follows the economic theory that less money will be spent on normal goods, this appeared in 22 of the 47 studies. Consequently, Goeij *et al* (2015) concluded that the two opposing mechanisms may occur during a crisis, notably a reduction in alcohol consumption due to income effects and a rise in harmful drinking due to psychological distress. However, from the array of studies which consider how an individual's gender at birth affects their alcohol consumption, this leads Goeij *et al* (2015) to conclude that the overall impact for men, following an economic crisis, is an increase in harmful drinking suggesting a gender-related health inequality. Nevertheless, Goeij *et al* (2015) had some shortcomings notably the lack of longitudinal data analysis which therefore reduces the magnitude of the causal relationships and the study didn't acknowledge that alcohol use could also be causing the psychological distress not just psychological distress causing alcohol use.

Helble and Sato (2011) investigates the relationship between macroeconomic conditions and alcohol consumption for 159 countries across the world from 1961 to 2004 (Helble, Sato, 2011). The paper used the WHO's comprehensive alcohol and health database and data from the World Bank to construct fixed and random effects panel data regression models with the aim of analysing differences in alcohol consumption between countries with different incomes. Helble and Sato (2011) carried out various robustness tests on their models such as only using countries with a complete dataset to ensure a balanced panel and including lags of GDP per capita growth as the authors believed that for some individuals, due to the addictive nature of alcohol, drinking habits change slowly even when people are facing deteriorating economic conditions. The main findings of the research were that high-income countries demonstrate a pro-cyclical behaviour, middle and low-income countries also demonstrate this to a lesser extent (Helble, Sato, 2011). Furthermore, the results imply that low-income countries drinking behaviour remains largely unchanged by macroeconomic shocks and the paper also demonstrates different alcoholic beverages have different sensitivities to economic changes, spirits are the most sensitive whereas beer and wine consumption is less elastic (Helble, Sato, 2011).

3. MODEL SPECIFICATION AND DATA

3.1. Data Source

Since alcohol has significant effects on the health of a population, the WHO has a large database on, the dependent variable of this research, recorded alcohol per capita consumption for all European Union members (28-member states), where it measures per capita (15 + years old) alcohol consumption in litres of pure alcohol (WHO, 2020b). This data has been recorded since 1961 however more recent inputs are more comprehensive thus data before the year 2000 has not been included (Helble, Sato, 2011).

The WHO samples this data by triangulation of 3 methods. Firstly, retail sales tax, which provides an accurate prediction of alcohol consumption for countries with a relatively small informal sector, however developing countries generally have larger informal sectors so this method alone is not sufficient. Secondly through estimating alcohol consumption based on alcohol industry sources such as the trade of alcoholic beverages. Thirdly, estimating alcohol consumption through national population surveys for example the BRFSS which studies such as Ruhm and Black (2002) and Dee (2001) used (Helble, Sato, 2011). The benefit of using population surveys are they can provide information on behavioural patterns however they tend to be expensive to conduct, plus the questioning of personal topics in surveys such as "how much does an individual drink?" can encourage the respondent to provide an inaccurate response especially if they know their response is distant from the population mean. A major unreliability of using alcohol data is that cultural (religious) or political reasons may motivate countries to inaccurately record or report zero alcohol consumption. This includes countries such as Libya where there is a complete ban on alcohol sale and consumption, Pakistan where only non-Muslims can drink or Iran which reported zero alcohol consumption following a political change in 1979. Fortunately, all European Union members have an inclusive set of alcohol consumption data for the studied period.

Similarly, the WHO collect data on road traffic incidents per 100,000 people since 1970 for all European union countries (WHO, 2020d). The word incident is preferred to accident as it is more general and does not imply the situation happened just by chance, or error or was unintentional. Since 2002 this data had been collected from the United Nations Economic Commission for Europe (UNECE), they specifically report on statistics of road traffic incidents in Europe. Before 2002 the data was compiled through multiple national reports such as in Luxembourg by police reports, in Germany by the German Health Monitoring System or in Slovenia by the Ministry of the Interior Slovenia. Fortunately, again, all present European Union members have an inclusive set of road traffic incident data for the studied period.

The main explanatory variables to proxy the macroeconomic conditions will be the growth of GDP per capita and unemployment rate data for the 28 EU members.

The organisation for Economic Cooperation and Development (OECD) and the World Bank have large databases on recorded unemployment rates and GDP per capita data respectively for all the EU member states. Additionally, while the focus of this research is centred around modelling alcohol consumption, I will also model road traffic accidents, using WHO data, as the two issues are closely linked.

Members joined the union at different times for example Croatia joined in 2013 compared to France which was one of the 12 countries to sign the Maastricht Treaty in 1992 effectively forming the European Union. Therefore, only considering the EU28 would lead to non-existent data for some countries prior to certain dates, thus the panel would be unbalanced. However, for the purpose of the analysis it will be assumed that all 28 countries currently in the EU (exception of the UK technically) have been a member since 2000.

In addition, economic variables will be included such as inflation and export growth. Inflation accounts for the rate prices are changing in the economy and export growth proxies a countries outward orientation, thus accounting for the impact foreign markets or cross-cultural influences have on alcohol consumption (Helble, Sato, 2011). Both population growth and life expectancy (socio-economic variable) are included as it is expected that these indicate the relative size and longevity of the population that consume alcohol or drive vehicles (Helble, Sato, 2011).

Additionally, the regressions will be augmented with further socio-economic variables which include the share of income for both the top 10% and bottom 10% of income earners, the gross school tertiary enrolment ratio, the number of hours worked per year per capita, the drinking age, alcohol tax and a variable to account for recessions. Firstly, the share of income is included to factor in the inequality in each country and the effect changing the income share through redistribution will have on alcohol consumption, which is new proposal to the literature. Secondly, the gross school tertiary enrolment ratio is the number of students, regardless of age, that enrol onto anything above compulsory secondary level education, regardless of whether the student completes the course. Tertiary education refers to not only colleges, sixth forms or trade schools but also higher education such as undergraduate and postgraduate programmes (Collins English Dictionary, n.d.). The gross school tertiary enrolment ratio is included to consider how different levels of education in an economy affect alcohol-related outcomes due to Beard *et al* (2019)'s findings that the education level has a strong association with alcohol consumption. Thirdly, the number of hours worked per year in a country is used to proxy stress for individuals in the economy as highlighted as an important factor by Fenwick and Tausig (1994), Ruhm and Black (2002), Dee (2001) and specifically in Baker (1985). Following this, a dummy variable for the drinking age (specifically the age alcohol can be purchased), whereby 1 represents a drinking age below 18 years old and 0 represents a drinking age above 18 (**Appendix A**). An alcohol tax is incorporated as spotlighted in Ruhm (1995) for its direct effects on alcohol consumption and vehicle mortality (Ruhm, 1995). Finally, another dummy variable is integrated where a value of 1 implies a negative growth of GDP per capita that year and vice versa for a value of zero, this allows for recessions to be absorbed into the model as underlined in Dee (2001), Dávalos *et al* (2012) and explicitly in both Harhay *et al* (2013) and Berg *et al* (2020). All descriptions and sources for all variables can be found in **Appendix B**.

3.2. Methodology

All the econometric analysis will be conducted throughout this research using the software Stata. A panel data regression equation is represented by:

$$y_{it} = \alpha + \chi'_{it}\beta + a_i + \varepsilon_{it} \qquad i = 1,...,N \qquad t = 1,...,T \tag{1}$$

where the cross-sectional dimension is denoted by subscript *i*, the time-series dimension is denoted by subscript *t*, χ_{it} is a K-dimensional row vector of explanatory variables, α is the intercept, a_i is the individual-specific effects and ε_{it} is the idiosyncratic error term with $\varepsilon_{it} \sim$ i. i. d $(0, \sigma^2)$ (Stock, Watson, 2020, pp. 362-367). The model has K-dimensional column vector parameters. The literature commonly applies a single one-way error component for the disturbances (Baltagi, 2008):

$$u_{it} = a_i + \varepsilon_{it}$$

The strategy when modelling panel data should first be to decipher whether a pooled OLS, fixed-effect (FE) or random-effect (RE) model is more appropriate.

"To pool or not to pool the data" (Baltagi, 2008)

The pooled OLS ignores the panel structure of the data and the individual effects average out. As later explained, pooled OLS yields consistent estimators if the disturbance term u_{it} is uncorrelated with , like RE models.

The fixed effect models eliminate the fixed effects through mean-differencing from (1):

$$\ddot{y}_{it} = \ddot{\chi}'_{it}\beta + \ddot{\varepsilon}_{it} \qquad i = 1,...,N \qquad t = 1,...,T$$

*where; $\ddot{y}_{it} = y_{it} - \bar{y}_i$, $\ddot{\chi}_{it} = x_{it} - \bar{x}_i$, and $\ddot{\varepsilon}_{it} = \varepsilon_{it} - \bar{\varepsilon}_i$. Note that the time average are calculated as $\bar{y}_i = 1/T\,\Sigma_{t=1}^{T}\, y_{it}, \bar{x}_i = 1/T\,\Sigma_{t=1}^{T}\, x_{it}$ and $\bar{\varepsilon}_i = 1/T\,\Sigma_{t=1}^{T}\,\varepsilon_{it}$ respectively and the intercept has also cancelled out (Woolridge, 2014, pp. 388).

This property is useful for estimation as OLS will still lead to consistent estimates of when is correlated with χ_{it}. Essentially, fixed-effect estimation assumes constant variance across individuals whilst accounting for cross-sectional unit differences by including individual specific intercepts (a_i) (Woolridge, 2014, pp. 387-389).

The random effect model estimates error variance related to cross-sectional units (Park, 2011), thus, can be included into the composite error term:

$$y_{it} = \alpha + \chi'_{it}\ \beta + u_{it} \qquad i = 1,...,N \qquad t = 1,\ ...,T$$

*where; $u_{it} = a_i + \varepsilon_{it}$

The random effect model implies we assume the classical Gauss-Markov assumptions regarding the nature of the error structure are satisfied; applied to panel data. This is with respect to the correlation and homoscedasticity of the idiosyncratic error term. The assumptions made are as followed:

i) $E(\varepsilon_{it} \mid X_i, a_i) = 0$ for all $t = 1,\ldots,T$.
In addition, $E(a_i \mid X_i) = \alpha$ where α is the intercept

ii) $Var(\varepsilon_{it} \mid X_{it}, a_i) = Var(\varepsilon_{it}) = \sigma_\varepsilon^2$ for all $t = 1,\ldots,T$.
In addition, Var $(a_i \mid X_i) = \sigma^2_a$

iii) $Cov(\varepsilon_{it}, \varepsilon_{is} \mid X_i, a_i) = 0$ for all $t \neq s$
Where $X_i \equiv X_{i1}, X_{i2}, \ldots X_{iT}$ in all assumptions.

The common assumptions that the explanatory variables do not have a perfect linear relationship, the data is randomly sampled from the cross section and each explanatory variable varies over time (for some) are assumed (Wooldridge, 2013, pp:509).

The first assumption is of strict exogeneity such that the expected value of the idiosyncratic error is uncorrelated with the covariates in all time periods and also the random effect . In addition, the expected value of given all explanatory variables is constant, this is the key assumption of the random effect model that in all time periods is uncorrelated with each explanatory variable, this allows for time constant variables in (Wooldridge, 2014, pp: 395). The second and third assumptions are those needed for OLS analysis to be valid, this consists the idiosyncratic error been homoscedastic and serially uncorrelated over time (Wooldridge, 2014, pp: 389). Specifically, the second assumption implies not only that each observation of each idiosyncratic error is drawn from a distribution possessing a constant population variance but also that the variance between the unobserved effect and the explanatory variable is constant (Dougherty, 2016, p.p:117). The third assumption indicates that for all $t \neq s$ the idiosyncratic errors are serially uncorrelated (Wooldridge, 2013, pp:509).

When these assumptions hold, the random effect estimator will be consistent and asymptotically efficient. This implies that as the sample size increases the random effect estimators have smaller standard errors than that of the corresponding pooled OLS estimator (Wooldridge, 2013, pp. 510).

3.3. Econometric model

The basic models are as followed:

$$\ln Alc_{it} = \alpha + \chi'_{it}\,\beta + Z'_{it}\,\gamma + u_{it} \tag{2}$$

and

$$\ln Rti_{it} = \alpha + \chi'_{it}\,\beta + Z'_{it}\,\gamma + u_{it} \tag{3}$$

*where; $u_{it} = a_i + \varepsilon_{it}$. Note that for simplicity the models are denoted using the same symbols as they represent the same terms, however it does not assume they are equal.

Where Alc_{it} and Rti_{it} are the logarithmic values of the dependent variables (alcohol consumption per capita and road traffic incidents per 100,000 people respectively) for country *i* in year *t*, χ is the measure of economic conditions (GDP per capita or unemployment rate) for country *i* in year *t*, *Z* a vector of other covariates for country *i* in year *t* (seen in **Table 3**) and *u* is a composite error term for country *i* in year *t* (Helble, Sato, 2011, pp. 7-8).

As previously mentioned, I first test whether a fixed or random effects model is more appropriate using a Hausman test. Following, the Breusch and Pagan Lagrangian multiplier test for random effects is used to check whether pooled OLS is a better model. Next, violations to the Gauss-Markov assumptions will be tested using the Woolridge and Baltagi autocorrelation tests and a likelihood-ratio test for heteroskedasticity. Finally, robustness checks (changing the economic conditions measure and transforming the functional form of the dependent variable) will be completed for confirmatory analysis.

Following this, summary statistics are generated where the dataset has been purged of outliers as country-level data has a wide range of variation.

4. EMPIRICAL RESULTS

4.1. Descriptive information

Table 1 presents a detailed account of basic summary statistics for alcohol consumption for all 28 EU members. Using this data, **Figure 1** shows that Sweden consumed the least amount of Alcohol in terms of litres of pure alcohol per capita from 2000 to 2016, whereas Lithuania drank the most over the period. Additionally, the average consumption of alcohol for all EU members from 2000 to 2016 was 10.6 litres of pure alcohol. **Table 1** also allows for fluctuations in drinking habits to be seen. Estonia has the largest deviation about their mean alcohol consumption compared to France which has the least fluctuation. It is worth noting that **Table 1** has outlier omitted. Removing outliers has the obvious benefit of removing values with are inconsistent when considering the rest of the data (Lind, *et al*, 2012, p.p:107). This is crucially important when suggesting policy recommendations or discussing variables that are influencing the dependent variable as it may lead to a bias conclusion. An outlier is defined as "a value that is more than 1.5 times the interquartile range smaller than quartile 1 or larger than quartile 3" (Lind, *et al*, 2012, pp. 107).

Figure 1: Mean Alcohol Consumption of EU members (2000-2016)

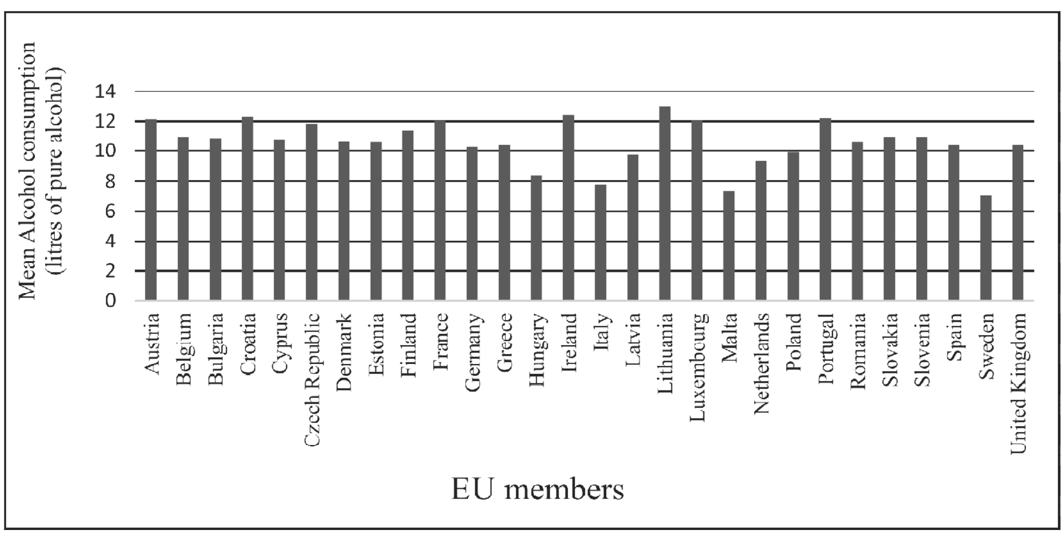

Table 1: Alcohol consumption for European Union members (outliers omitted)

Members	*Obs*	*Mean*	*Std. Dev*	*Min*	*Max*
Austria	16	12.144	0.463	11.300	13.200
Belgium	16	10.997	0.930	10.090	13.430
Bulgaria	17	10.899	0.362	10.080	11.490
Croatia	17	12.317	1.401	9.890	14.830
Cyprus	16	10.820	1.069	9.040	13.030
Czech Republic	17	11.847	0.940	10.090	13.060
Denmark	16	11.309	2.684	7.900	16.380
Estonia	15	11.796	3.176	8.590	16.960
Finland	17	11.396	2.082	8.430	13.890
France	17	12.056	0.340	11.610	12.910
Germany	17	10.304	1.167	8.670	11.990
Greece	15	10.631	2.637	6.640	13.280
Hungary	12	9.053	2.000	6.710	11.350
Ireland	17	12.401	1.190	10.640	14.060
Italy	16	7.889	1.081	6.840	9.780
Latvia	17	9.742	1.581	6.680	12.120
Lithuania	17	12.952	1.683	9.870	15.150
Luxembourg	17	12.078	0.540	11.220	13.140
Malta	13	7.622	0.608	6.660	9.030
Netherlands	16	9.319	0.594	8.030	10.060
Poland	17	9.876	1.057	7.740	11.400
Portugal	17	12.231	1.237	10.350	14.210
Romania	16	10.596	0.376	9.850	11.430
Slovakia	17	10.946	0.763	9.870	12.800
Slovenia	17	11.020	0.776	9.530	12.350
Spain	17	10.291	1.406	8.26	12.35
Sweden	14	7.056	1.036	6.600	7.340
United Kingdom	17	10.564	0.695	9.650	11.550

Similarly, **Table 2** presents a detailed account of basic summary statistics for road traffic incidents (fatalities or injuries) per 100,000 people for all 28 EU members. Using this data, **Figure 2** shows that Slovenia has the highest number of road traffic accidents per 100,000 people from 2000 to 2016, whereas Denmark has the lowest. Additionally, the average number of traffic accidents for all EU members from 2000 to 2016 was 307.40 per 100,000 people. **Table 2** also allows for fluctuations in traffic accidents to be seen. Slovenia has the largest deviation about their mean road traffic accidents compared to Denmark which has the least fluctuation in traffic accidents. It is worth noting again that **Table 2** has outlier omitted using the identical method as before.

Table 2: Road traffic incidents for European Union members (outliers omitted)

Members	*Obs*	*Mean*	*Std. Dev*	*Min*	*Max*
Austria	16	630.606	61.967	542.980	713.180
Belgium	16	537.506	69.294	423.980	677.290
Bulgaria	16	125.386	11.645	106.790	144.460
Croatia	16	478.693	83.874	341.410	604.570
Cyprus	16	306.394	150.238	117.680	532.870
Czech Republic	16	293.619	43.164	239.460	361.560
Denmark	13	114.456	47.915	58.710	179.680
Estonia	16	183.218	47.862	135.790	275.690
Finland	13	155.601	21.759	120.850	181.600
France	13	178.076	60.239	115.280	288.240
Germany	16	522.877	50.696	458.450	622.430
Greece	16	191.069	43.662	135.920	300.440
Hungary	16	246.524	33.651	197.470	290.730
Ireland	13	218.363	49.513	154.770	333.600
Italy	16	544.933	86.410	412.450	675.570
Latvia	16	253.998	37.179	195.360	311.720
Lithuania	16	199.906	55.292	133.270	278.310
Luxembourg	15	254.280	22.498	226.570	303.320
Malta	16	291.731	50.674	187.430	360.050
Netherlands	14	179.444	73.254	66.080	296.160
Poland	16	161.165	29.604	111.080	203.710
Portugal	15	463.705	74.673	369.220	598.580
Romania	15	130.174	58.179	41.060	198.350
Slovakia	16	178.734	39.825	120.740	222.460
Slovenia	16	640.134	177.823	403.080	962.340
Spain	13	316.234	50.202	251.880	387.210
Sweden	15	266.643	36.084	183.440	308.450
United Kingdom	16	416.633	92.505	300.840	568.900

Figure 2: Mean Road Traffic Incidents for EU Members (2000-2016)

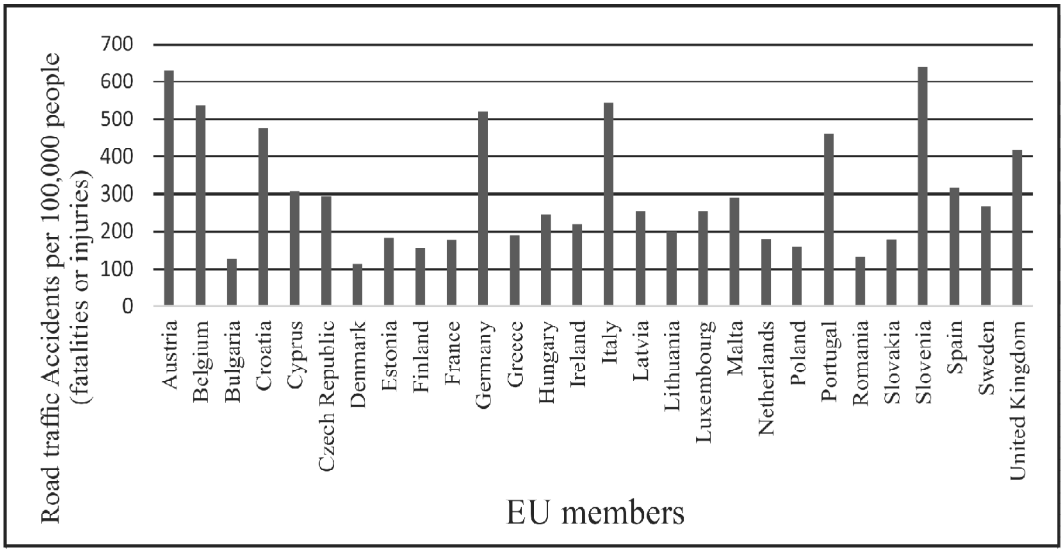

Table 3 highlights extensive summary statistics for the main variables which will be used in the regression models. Notably, some variables have been monotonically transformed (preserved ordering) using a logarithmic transformation. This has only occurred with variables that are strictly positive to attempted to mitigate heteroskedastic or skewed distributions (Wooldridge, 2014, pp:157). In addition, using a logarithmic transformation of the dependent variable helps to satisfy the Classical Linear Model assumptions more closely than level values (Wooldridge, 2014, pp:157). **Table 3** shows that the mean logarithm of alcohol consumption over the period 2000-2016 for all EU members is 2.34 which corresponds to 10.60 litres of pure alcohol per capita (accounting for rounding). Similarly, the mean rate of GDP per capita and number of road traffic incidents (per 100,000 people) over the period for all EU members was 2.28% and 5.57 respectively, which corresponds to 307.40 road traffic incidents per 100,000 people (accounting for rounding). Interestingly, the table also indicates that outliers have been omitted from the narrow ranges, small variances (and small standard deviations) and most importantly most variables are fairly symmetrical or only moderately skewed shown by the software skewness coefficient. Moreover, this value can range from -3 to 3 whereby as both negative and positive skewness values become closer to zero the distribution becomes less skewed and more symmetrical (Lind, *et al*, 2012, p.p:109).

Table 3: Summary Statistics for European Union (Outliers Omitted)

Variables	*Obs*	*Mean*	*Med*	*Min*	*Max*	*Var*	*Std. Dev*	*Skewness*
lnalcoh	460	2.343	2.378	1.783	2.731	0.040	0.199	-0.778
lnrti	427	5.570	5.553	3.715	6.869	0.334	0.578	-0.237
gdpcaprate	422	2.282	2.074	-3.668	8.137	5.648	2.377	0.141
unemp	453	8.317	7.647	1.805	17.865	11.563	3.400	0.811
inflation	443	2.148	1.936	-2.352	6.903	2.751	1.659	0.540
lnalcohtax	387	6.263	6.253	2.482	9.586	2.172	1.474	-0.085
popgrowth	450	0.232	0.267	-1.477	1.852	0.436	0.661	0.090
lngdpcap	470	10.011	10.077	7.893	11.685	0.571	0.756	-0.417
p0p10	339	0.030	0.031	0.015	0.042	0.000	0.006	-0.278
p90p100	466	0.297	0.292	0.222	0.375	0.001	0.030	0.248
lnhrsworked	391	7.411	7.428	7.217	7.623	0.009	0.094	-0.078
lnlifeexp	476	4.355	4.365	4.252	4.423	0.002	0.042	-0.652
lneduc	409	4.137	4.154	3.503	4.734	0.050	0.223	-0.442
expgrowth	430	5.846	5.309	-7.802	19.409	23.815	4.880	0.294

4.2. Baseline Regression: Analysis

Regression equation (1) considers , which represents an individual effect as a fixed effect or a random effect. Considering the baseline regression output in **Table 4**, columns (I) and (III) represent fixed effect models denoted as FE, likewise columns (II) and (IV) represent random effect models denoted as RE. Logarithmic transformations of variables are used with exception to variables of rates of change, percentage shares or dummy variables. In columns (I) and (II) one of our main explanatory variable, growth of per capita GDP, was independently used to observe that in both cases the coefficient was significant at the 10% level suggesting that income growth was indeed related to alcohol consumption and thus an appropriate foundation. Furthermore, in columns (III) and (IV) the foundation is expanded to include additional economic variables, notably GDP per capita, export growth, inflation, and population growth. Though not causally related (directly) to alcohol consumption, these variables paint a picture of how the performance of the macroeconomy impacts alcohol consumption. Most strikingly export growth is negatively correlated to alcohol consumption thereby providing a negative coefficient throughout, however, the impact on the model is relatively unsubstantial, consequently it can be assumed of having a neutral impact. Conversely, inflation and the growth of per capita GDP remain significance throughout all models without any dramatic changes in magnitude.

Applying the Hausman specification test to model (I) against model (II) and model (III) against model (IV), I find in both cases insignificant P-values of Prob>chi2 = 0.4795 and Prob>chi2 = 0.2924 respectively which suggests that the random effect model is more of a consistent estimator (Hausman, 1978). The current specification hypothesises that the individual-level effects are adequately modelled using random-effects model cannot be rejected, therefore the alternative hypothesis of a fixed-effects model being more appropriate is rejected (Stata Corp1, 2019, pp. 478-481). So, the implications is that models (II) and (IV) are valid.

In addition to the economic variables introduced previously, columns (V), (VI) and (VII) also include 8 socio-economic variables and alcohol influencing variables of which are: life expectancy, hours worked per year, alcohol tax, education, the income share held by the lowest 10% and highest 10%, dummy variables to factor in drinking age and recessions. The importance of including socio-economic variables was predominantly seen in Ruhm (1995), since alcohol consumption cannot solely be determined by just economic factors alone. It is worth noting that, due to a plausible endogeneity problem, I must remove the variable GDP per capita when including the share of income in the analysis.

The Breusch and Pagan Lagrangian multiplier test was applied to models (V) and (VI) to indicate whether pooled OLS is more appropriate than random effects. A P-values of Prob>chibar2 = 0.0000 is obtained, which is small enough to reject the null hypothesis that all individual specific variance components are zero implying a random effect model is preferred (Breusch, Pagan, 1980).

4.3. Testing the structure of the disturbance term

Further to conjecture that the random effect model is most appropriate I must consider the diagnostics of our random effect model. Firstly, the Wooldridge test for autocorrelation in panel data indicates that the model is suffering from autocorrelation as Prob> F = 0.034, thus the null hypothesis of no first-order autocorrelation is rejected (Wooldridge, 2002). In order to clarify this, Baltagi-Li (1991)'s test for serial correlation and random effects was used, it could not reject the null hypothesis of serial correlation where Pr>chi2(1) =0.310 (Baltagi, Li, 1991).

In order to check for heteroskedasticity in a random effect model, I must use a likelihood-ratio test after estimation which has the null hypothesis of homoscedasticity (StataCorp2, 2019, p.p:1338-1349). From this test I can conclude heteroskedasticity is present, Prob>chi2 = 0.0000, as we reject the null hypothesis of homoskedasticity.

The model suffers from both heteroskedasticity and serial correlation so I will use feasible generalised least squares (FGLS) to produce consistent estimators which are more efficient than clustered standard errors alone (Wooldridge, 2014, pp: 396). Given the other assumptions hold, we can obtain GLS estimators which are asymptotically efficient with standard errors which are asymptotically valid (Wooldridge, 2014, pp: 357). The proof that the GLS transformation eliminates serial correlation can be found in Wooldridge (2002, pp:257-262), however this is beyond the scope of this paper.

> FGLS allows "*estimation in the presence of AR (1) autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels*." (Aparaschivei, 2012, pp. 17)

4.4. Baseline Regression: Pro-cyclical nature of drinking

Overall, the final estimation shown in column (VII), which accounts for heteroskedasticity and autocorrelation, addresses the research question as it indicates that there is indeed a positive (pro-cyclical) relationship between the rate of GDP per capita and consumption of alcohol. Moreover, the estimation also gives an insight into the of shares of incomes as an important factor which too has a prominent positive relationship with alcohol consumption. The model specifically estimates that a 1% rise in the lowest decile's share of income leads to an estimated increase in alcohol consumption by the exponential of 10.574 litres of pure alcohol. One may instinctively question the magnitude of this coefficient; however, it must be remembered the size of a 1% increase in the share of income. For an example take the UK's GDP per capita in 2016 which was £1,995,478 million (ONS, 2020a). Therefore, using data from the world inequality database, referenced in **Appendix: A**, we know that the bottom 10% controlled 2.8% of the income in the economy in 2016. This implies a 1% rise in the share of income accounts for £19,954.78 million: a large increase. In 1969, the earliest record for the UK, the World Bank recorded the income share of the bottom 10% as 3.2% (World Bank, 2020g). Thus, fluctuations in the income share of bottom 10% have been relatively limited over the past 50 years which implies careful interpretation of the model in **Table 4**. A more sensible interpretation would be a 0.1% increase in the share of income of the bottom 10%. Given in 2016, the UK's population was 65,648,000 people (ONS, 2020b), a 0.1% increase implies an increase of £303.97 per person which corresponds to an increase of 2.879 litres of pure alcohol per capita; more realistic. This is also a notable analysis point when analysing life expectancy which grows relatively slowly.

Table 4: Baseline regression excluding outliers

Variable	*(I)*	*(II)*	*(III)*	*(IV)*	*(V)*	*(VI)*	*(VII)*
gdpcaprate	0.005*	0.005*	0.010**	0.008***	0.017*	0.007	0.017*
	(0.003)	(0.003)	(0.004)	(0.004)	(0.009)	(0.006)	(0.009)
lngdpcap			0.065***	0.052**	-	-	-
			(0.023)	(0.022)	-	-	-
expgrowth			-0.001	-0.001	-0.008**	-0.003	-0.008**
			(0.002)	(0.002)	(0.03)	(0.002)	(0.003)
inflation			-0.017***	-0.017***	-0.028**	-0.012	-0.028***
			(0.005)	(0.005)	(0.011)	(0.008)	(0.011)
popgrowth			0.085***	0.070***	0.070**	0.034	0.070**
			(0.022)	(0.021)	(0.033)	(0.025)	(0.032)
lnlifeexp					-1.876**	-2.179***	-1.876***
					(0.637)	(0.757)	(0.614)
p0p10					10.574***	4.141	10.574***
					(2.593)	(4.207)	(2.496)
p90p100					2.668***	-0.298	2.668***
					(0.543)	(0.681)	(0.523)
lneduc					-0.066	-0.227**	-0.066
					(0.079)	(0.101)	(0.076)
lnhrsworked					0.284	0.296	0.284
					(0.191)	(0.370)	(0.184)
drkage					0.114***	0.188**	0.114***
					(0.036)	(0.085)	(0.034)
lnalcohtax					-0.039**	0.001	-0.039**
					(0.018)	(0.029)	(0.017)
timedum					-0.023	-0.001	-0.023
					(0.040)	(0.026)	(0.039)
constant	2.334***	2.335***	1.609***	1.761***	7.883**	10.573**	7.883**
	(0.009)	(0.031)	(0.234)	(0.244)	(3.425)	(4.937)	(3.297)
No. of obs	406	406	355	355	177	177	177
No. of groups	28	28	28	28	-	22	22
Estimation	FE	RE	FE	RE	POOLED OLS	RE	GLS
F-statistic	2.71	-	4.51	-	8.51	-	-
Wald chi2	-	3.09	-	19.38	-	49.22	110.25
R-squared	0.011	0.011	0.062	0.095	0.3838	0.2268	-
Standard errors in parentheses							

* significance at 10%; ** significance at 5%; *** significance at 1%GLS log likelihood = 88.311

4.5. Dummy variables, relative incomes, and lags

Following this, I next consider our second research question which investigates whether EU members have differences in alcohol consumption based on their geographical location and relative incomes compared to each other (**Table 5**). To achieve this the EU countries were firstly arranged using the United Nations "geoscheme" (unstats.un.org, 2020), this was used to generate dummy variables (shown in columns (I) and (II)) for East, North, South and West Europe where the latter was the base category against which the others are compared. Similarly, dummy variables (shown in columns (III) and (IV)) were generated by assorted EU members into quartiles based on the country's GDP per capita where the first quartile (0% to 25%) was used as the base category.

Since only dummy variables were added to our baseline model, violations to our random effect Gauss-Markov assumptions still remain. To account for this columns (I) and (III) both have cluster-robust standard errors by panel, which yield consistent estimators. However, likewise to before, to account for both serial correlation and heteroskedasticity, feasible generalised least squares estimation will be used in columns (II) and (IV).

Overall, the final estimations shown in columns (II) and (IV), which accounts for heteroskedasticity and autocorrelation, address the research question regarding differences in alcohol consumption based on geographical location and level of income per capita. Column (II) suggests that Western EU members tend to drink more than both Northern and Eastern EU members however the southern dummy was not statistically significant. Likewise, Column (IV) suggests that the relatively poorer EU countries in terms of GDP per capita consume less alcohol in comparison to the second quartile (25% to 50%) and third quartile (50% to 75%) however the relatively richest EU countries were not statistically significant. Therefore, I have concluded, perhaps unsurprisingly, that there are differences in alcohol consumption across the EU members based on geographical location and the level of income per capita. This is important nevertheless as it implies that there is not likely one uniform policy across the European Union that would tackle alcohol consumption. In addition, both GDP per capita, which remains pro-cyclical, and the share of incomes are still significant.

I previously found differences in alcohol consumption across the EU members due to their different relative incomes, **Table 6** presents models of alcohol consumption for the top and bottom 50% of income countries (based on GDP per capita). Since we are effectively sorting the data based on a measure of income, the

Table 5: Dummy Variables for Geographical location and Relative incomes

Variables	*(I)*	*(II)*	*Variables*	*(III)*	*(IV)*
gdpcaprate	0.007	0.018**	gdpcaprate	0.007	0.018**
	(0.007)	(0.009)		(0.006)	(0.009)
expgrowth	-0.004*	-0.008**	expgrowth	-0.004	-0.009***
	(0.002)	(0.003)		(0.002)	(0.003)
inflation	-0.013	-0.041***	inflation	-0.012	-0.028***
	(0.008)	(0.011)		(0.008)	(0.010)
popgrowth	0.031	0.063**	popgrowth	0.035	0.049**
	0.026	(0.030)		(0.026)	(0.034)
lnlifeexp	-2.246**	-3.660***	lnlifeexp	-2.097**	-3.242***
	0.836	(0.779)		(0.832)	(0.768)
p0p10	4.923	14.072***	p0p10	4.600	10.015***
	(4.266)	(2.743)		(4.455)	(2.857)
p90p100	0.254	2.307***	p90p100	0.383	2.879***
	(0.682)	(0.515)		(0.706)	(0.548)
lneduc	-0.228**	-0.226**	lneduc	-0.228**	-0.232**
	(0.104)	(0.102)		(0.104)	(0.098)
lnhrsworked	0.559	0.754***	lnhrsworked	0.299	0.151***
	(0.459)	(0.248)		(0.451)	(0.220)
drkage	0.145*	0.091***	drkage	0.193**	0.094***
	(0.086)	(0.035)		(0.092)	(0.034)
lnalcohtax	-0.001	-0.039**	lnalcohtax	-0.001	-0.042**
	(0.029)	(0.018)		(0.034)	(0.020)
timedum	-0.001	-0.046	timedum	-0.001	-0.024
	(0.026)	(0.037)		(0.026)	(0.038)
dumeast	-0.193	-0.272***	dum25to50	0.030	0.239***
	(0.133)	(0.057)		(0.132)	(0.056)
dumnorth	-0.070	-0.138***	dum50to75	0.006	0.192***
	(0.102)	(0.036)		(0.143)	(0.073)
dumsouth	-0.079	-0.078	dum75to100	0.044	0.112
	(0.130)	(0.051)		(0.141)	(0.073)
constant	8.977	12.109***	constant	10.246*	14.191***
	(5.884)	(4.081)		(5.620)	(3.816)
No. of obs	177	177	No. of obs	177	177
No. of groups	22	22	No. of groups	22	22
Estimation	RE	GLS	Estimation	RE	GLS
Wald chi2	50.93	153.21	Wald chi2	48.69	129.79
R-squared	0.2928	-	R-squared	0.2183	-

Standard errors in parentheses* significance at 10%; ** significance at 5%; *** significance at 1%GLS (II) Log likelihood = 100.647, GLS (IV) Log likelihood = 94.135

variables for the shares of income are omitted as there is likely to cause an endogeneity problem. Similarly, I cannot include GDP per capita as this would be even more likely to suffer from this problem.

Initiatively one may conjecture that due to the addictive nature of alcohol, as discussed in Ruhm (1995), Freeman (1999) and Helble and Sata (2011), it might be reasonable to assume that past alcohol consumption influences future alcohol consumption. Moreover, Becker and Murphy (1988) developed theoretical models for rational addiction:

> *"Strong addiction to a good requires a big effect of past consumption of the good on current consumption" (Becker, Murphy, 1988, pp:675)*

In order to account for this, I must include lags of our dependent variable, this will violate the strict exogeneity assumption, hence FGLS estimation must be used. In **Table 6** columns (I) and (III) represent the top 50% of countries based on relative income in the EU and vice versa for columns (II) and (IV) been the bottom 50%.

Since I have split the data into two separate subsets it is important to test for the typical econometric problems (heteroskedasticity and autocorrelation) even though I know from the past models that I expect both models to likely display symptoms. Since I have included the lag of the dependent variable, we can assume that both models will almost certainly have autocorrelation. Next, heteroskedasticity was tested using the likelihood-ratio test which concluded that the null hypothesis of homoscedasticity is rejected as both indicate Prob>chi2 = 0.0000. As a result, the random effect models in columns (I) and (II) have clustered standard errors however do not account for autocorrelation like columns (III) and (IV).

Overall, the final estimations shown in columns (III) and (IV), which accounts for heteroskedasticity and autocorrelation, address alcohol consumption for the top and bottom 50% of income EU members. Interestingly, I find that the rate of GDP per capita is pro-cyclical for both the top and bottom 50% of income EU members, however the coefficient on GDP per capita growth for the relatively poorer countries suggests the effects are not significant. This implies that relatively poorer countries do not adjust their drinking habits with respect to macroeconomic conditions, at least in comparison to relatively richer countries. Unsurprisingly, the lag of the logarithm of alcohol consumption is statistically significant and positive. In regard to selecting the appropriate lag length the Levin-Lin-Chu unit-root test, an augmented dickey-fuller test but for panel data, was used on the logarithm of alcohol consumption (StataCorp3, 2020). STATA allows the user the option to automatically select the optimal lag length based on three information criteria: Akaike (AIC), Bayes (BIC) or Hannan-Quinn (HQIC). The AIC suggests 2.36 lags (2nd lag), the BIC suggests that 1.89 lags (2nd lag) and the HQIC suggests 2.64 lags (3rd lag). Generally, the Bayes information criterion is seen as the most appropriate as it more heavily penalises larger model orders than the AIC and HQIC; which implies it is less likely to overestimate the number of lags (Stock, Watson, 2020, pp:578-582). This would

Table 6: Bottom 50% and Top 50% incomes

Variables	*(I)*	*(II)*	*(III)*	*(IV)*
gdpcaprate	0.015***	0.005	0.017*	0.004
	(0.006)	(0.006)	(0.009)	(0.008)
lnalcoh (L.1)	0.885**	0.836**	0.885***	0.836***
	(0.423)	(0.412)	(0.280)	(0.245)
inflation	-0.004	-0.008	-0.008	-0.004
	(0.008)	(0.007)	(0.016)	(0.008)
popgrowth	0.044**	0.038	0.080**	0.057*
	(0.020)	(0.037)	(0.037)	(0.032)
lnlifeexp	-0.787**	-0.392*	-0.796**	-0.458**
	(0.387)	(0.231)	(0.373)	(0.214)
lneduc	-0.044	-0.018**	-0.127*	-0.018**
	(0.090)	(0.090)	(0.076)	(0.070)
drkage	0.068	0.034	0.126***	0.096***
	(0.098)	(0.063)	(0.039)	(0.034)
lnalcohtax	-0.023	-0.009	-0.064***	-0.015
	(0.024)	(0.023)	(0.016)	(0.011)
timedum	-0.022	-0.031	-0.040**	-0.042**
	(0.024)	(0.026)	(0.019)	(0.018)
constant	3.662**	3.326**	3.438***	2.949**
	(1.737)	(1.558)	(1.677)	(1.352)
No. of obs	147	115	147	115
No. of groups	13	14	13	14
Estimation	RE	RE	GLS	GLS
Wald chi2	82.33	32.31	147.04	50.71
R-squared	0.3131	0.0342	-	-

Standard errors in parentheses * significance at 10%; ** significance at 5%; *** significance at 1%GLS (III) Log likelihood = 76.05, GLS (IV) Log likelihood = 58.52

lead one to assume 2 lags would be appropriate but when using 2 lags the sign of the second lag was negative, which is not expected and maybe a sign of multicollinearity. Hence, only 1 lag for alcohol consumption was used which indicated a positive significant coefficient in all models in **Table 6**.

Finally, another key interpretation was that the time dummy, which factors in recessions, was indeed significant and negative for both the top and bottom 50% of income EU members. Additionally, relatively poorer countries, column (IV), have a slightly more negative coefficient implying that recessions have a greater impact on alcohol consumption in relatively poorer countries. One may assume a contradiction between the coefficient of the income rate been insignificant, yet the recession dummy been significant for the bottom 50% of income EU members. However, this implies that relatively poorer countries do not see much change in alcohol consumption unless there is a recession compared with relatively richer countries whose alcohol consumption more closely follows trend in the business cycle. This too was found by Helble and Sato (2011) and is likely attributed to the habit-forming nature of alcohol.

4.6. Road traffic Incidents: Pro-cyclical

Considering output in **Table 7**, columns (I) and (II) represent one of our main explanatory variable, the growth of per capita GDP, which was independently used to observe that in both cases the coefficient was significant at the 1% level suggesting that income was indeed related to road traffic incidents and thus an appropriate foundation. Furthermore, in columns (III) and (IV) the foundation is expanded to include two additional economic variables (inflation and population growth) and two socioeconomic variables (education and alcohol tax) expected to influence road traffic incidents. Most strikingly education, inflation, and the growth of GDP per capita remain significant at the 1% level and alcohol tax is significant at the 5% level in both FE and RE models all without any dramatic changes in magnitude. However, population growth is surprisingly insignificant, though is positive as expected, and it is worth noting the inclusion of this variable is simply to paint a picture of the overall macroeconomy, so its insignificance is somewhat irrelevant.

Applying the Hausman specification test to model (III) against model (IV), I find an insignificant P-value of Prob>chi2 = 0.9610 which suggests that the random effect model is more of a consistent estimator (Hausman, 1978). The current specification hypothesises that the individual-level effects are adequately modelled using random-effects model cannot be rejected, therefore the alternative hypothesis of a fixed-effects model being more appropriate is rejected (StataCorp1, 2019, pp. 478-481).

Following this, dummy variables for location were added along with a dummy variable for whether the drinking age is below 18 years old however the latter appears to be insignificant as does the Eastern European dummy. Nevertheless, the main explanatory variable, inflation, education, and dummies south and west remain significant.

The Breusch and Pagan Lagrangian multiplier test was applied to model (V) to indicate whether pooled OLS is more appropriate than random effects. The null hypothesis that all individual specific variance components are zero are rejected due to a P-value of Prob>chibar2 = 0.0000, thus implying a random effect model is preferred compared to a pooled OLS model (Breusch, Pagan, 1980).

Next, I must consider the diagnostics of our random effect model. Firstly, the Wooldridge test for autocorrelation in panel data indicates that the model is suffering from autocorrelation as Prob> F = 0.0000 (F(1,25)=36.15)), thus the null hypothesis of no first-order autocorrelation is rejected (Wooldridge, 2002). In order to clarify this Baltagi-Li (1991) test for serial correlation and random effects was used, it could not reject the null hypothesis of serial correlation where Pr>chi2(2) =0.2067 (Baltagi, Li, 1991).

In order to check for heteroskedasticity in a random effect model, I must use a likelihood-ratio test after estimation which has the null hypothesis of homoscedasticity (StataCorp2, 2019, p.p:1338-1349). From this test I can conclude heteroskedasticity is present as Prob>chi2 = 0.0000 as I reject the null hypothesis of homoskedasticity. The model suffers from both heteroskedasticity and serial correlation, in this case clustering at the panel level will produce consistent estimates of the standard errors as highlighted in Baltagi (1991, pp:69). However, using another estimator such as a FGLS estimator would produce more efficient estimates which is more important when analysing the general casual effects, i.e. what is affecting road traffic incidents.

Overall, the final estimation shown in column (IV), which accounts for heteroskedasticity and serial correlation, address the research question as it indicates that there is indeed a positive (pro-cyclical) relationship between the rate of GDP per capita and the number of road traffic incidents. Additionally, the output in **Table 7** addresses another research question considering factors/policies that may reduce the quantity of road traffic incidents. Clearly the model shows a 1% increase in the number of individuals enrolling onto tertiary education would lead to a predicted fall in road traffic incidents of -0.521%. Moreover, the estimation also specifically finds that a fall in alcohol consumption reduces road traffic incidents, such that a 1% change in the logarithm of alcohol consumption would lead to a 0.253% change in the number of road traffic incidents. Column (IV) also suggests that Western and Southern EU members have more road traffic incidents relative to Northern EU members. Conversely Eastern EU members have less road traffic incidents relative to Northern EU members. This again is important nevertheless as it implies that policies to reduce road traffic incidents cannot be designed as a "one shoe fits all" measure, they must be specifically tailored to the unique EU members.

Table 7: Road traffic incidents

Variables	*(I)*	*(II)*	*(III)*	*(IV)*	*(V)*	*(VI)*
gdpcaprate	0.036***	0.038***	0.023***	0.024***	0.024***	0.021***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.008)
lnalcoh			0.213**	0.220**	0.212**	0.253**
			(0.099)	(0.100)	(0.098)	(0.107)
inflation			0.039***	0.039***	0.040***	0.035*
			(0.010)	(0.010)	(0.009)	(0.019)
popgrowth			0.035	0.021	0.024	0.022
			(0.039)	(0.040)	(0.038)	(0.065)
lneduc			-0.535***	-0.557***	-0.535***	-0.521**
			(0.103)	(0.104)	(0.102)	(0.240)
dumeast					-0.222	-0.144*
					(0.243)	(0.081)
dumwest					0.535**	0.426***
					(0.257)	(0.082)
dumsouth					0.606***	0.690***
					(0.231)	(0.200)
constant	5.466***	5.504***	7.316***	7.447***	7.110***	6.105***
	(0.093)	(0.019)	(0.516)	(0.513)	(0.5718)	(0.723)
No. of obs	379	379	290	290	290	290
No. of groups	28	28	27	27	27	27
Estimation	RE	FE	RE	FE	RE	GLS
F-statistic		38.05		29.94		
Wald chi2	34.01		163.27		180.92	186.82
R-squared	0.0123	0.0123	0.0116	0.0051	0.3553	-
Standard errors in parentheses						

* significance at 10%; ** significance at 5%; *** significance at 1%GLS (VI) Log likelihood = 102.19

5. ROBUSTNESS TESTS

5.1. Pro-cyclical nature of drinking: unemployment

Robustness tests are used due to the uncertainty when specifying an empirical model as the 'true model' remains unknown when the researcher is testing plausible alternative specifications (Neumayer, Plümper, 2017, pp. 2). For one to capture the true nature of a data set in a complex world one must know not only all relevant and irrelevant variables, all the correct measures (without systematic error) and functional forms but too the dynamics, structural breaks and spatial dependence (autocorrelation) etc (Neumayer, Plümper, 2017, pp:5). An empirical robustness check should examine how the core regression coefficients behave with a new specification, generally adding, removing, or changing regressors (Lu, White, 2014, pp:194).

Considering the baseline regression output in **Table 4**, it is an obvious robustness test to change the main explanatory variable (rate of GDP per capita) to another variable which can accurately depict the macroeconomy as well. The chosen candidate variable was the unemployment rate as it was also included in Ruhm (1995), Ettner (1997), Ruhm and Black (2002), Arkes (2007) and Dávalos *et al* (2012) as a main explanatory variable. In 1962, Arthur Okun found that a 1 percentage fall in the U.S. unemployment rate lead to an approximate 3 percent rise in real Gross National Product (roughly a 2% rise in GDP), specifically when the unemployment rate was between 3-7.5 percent (Okun, 1962).

"*A Keynesian explanation of unemployment*" (Knoester,1986, pp:664)

Moreover, this linear inverse relationship between the percentage change of unemployment and output is named Okun's Law. Essentially, this macroeconomic relationship implies the sign on the unemployment coefficient should be negative, if the robustness test is to have any validity. In other words, the law would lead us to assume a rise the unemployment rate should reduce alcohol consumption (and road traffic incidents).

Table 8 is similar to that of **Table 4** in columns (I) to (II) denoting the baseline random effects model and GLS model, respectively. Additionally, **Table 8** is also similar to **Table 5** in columns (III) and (IV) whereby the geographical location and relative income dummy variables are included. The same approach was taken regarding the Hausman test, which concluding the random effects model as before, and testing for autocorrelation and heteroskedasticity which were both present also as before.

Overall, **Table 8** still displays the pro-cyclical nature of drinking where in this case when the unemployment rate increases, the economy is deteriorating, and due to the income effect at the aggregate level people consume less alcohol. The magnitude in the unemployment coefficient is relatively similar (within 0.005) to that of the rate GDP per capita coefficient in **Table 5**, which is not very surprising. If we consider **Appendix C,** we see that the unemployment for most EU members inversely matches the growth of GDP, thus they tend to follow the same business cycle trend. Another notable mention from **Table 8** is the magnitude of the bottom 10% share of income, which is significantly larger than in **Table 5**. As previously mentioned, it is not unrealistic to assume this coefficient will be large but nearly 18 litres per capita is definitely unrealistic. Though again it is worth mentioning that there is no data outside of a narrow range for the bottom 10% share of income, which maybe contributing to this concern.

Therefore, the robustness check holds up relatively strongly given some changes in coefficient values, however these differences are mostly relatively small.

Table 8: Alcohol consumption – Robustness unemployment

Variables	*(I)*	*(II)*	*(III)*	*Variables*	*(IV)*
unemp	-0.008*	-0.012***	-0.013***	unemp	-0.013***
	(0.005)	(0.003)	(0.003)		(0.003)
expgrowth	-0.002	-0.007**	-0.007**	expgrowth	-0.007**
	(0.002)	(0.003)	(0.003)		(0.003)
inflation	-0.01	-0.024**	-0.034***	inflation	-0.026***
	(0.008)	(0.011)	(0.011)		(0.011)
popgrowth	-0.021	0.079**	0.078**	popgrowth	0.067*
	(0.034)	-0.033	(0.032)		(0.036)
lnlifeexp	-1.177	-2.003***	-3.468***	lnlifeexp	-2.459***
	(0.773)	(0.609)	(0.801)		(0.708)
p0p10	4.777	14.052***	17.744***	p0p10	14.046***
	(4.235)	(2.83)	(3.095)		(3.135)
p90p100	0.057	2.829***	2.540***	p90p100	2.837***
	(0.671)	(0.513)	(0.513)		(0.528)
lneduc	-0.302***	-0.128*	-0.205**	lneduc	-0.167*
	(0.099)	(0.076)	(0.101)		(0.087)
lnhrsworked	0.363	0.220	0.624**	lnhrsworked	0.163**
	(0.366)	(0.185)	(0.249)		(0.232)
drkage	0.136	0.106***	0.082***	drkage	0.096***
	(0.084)	(0.033)	(0.034)		(0.033)

contd. table 8

Variables	*(I)*	*(II)*	*(III)*	*Variables*	*(IV)*
lnalcohtax	-0.022	-0.045***	-0.027**	lnalcohtax	-0.034***
	(0.029)	(0.017)	(0.013)		(0.014)
timedum	0.018	-0.046	-0.035	timedum	-0.047
	(0.024)	(0.034)	(0.032)		(0.034)
dumeast			-0.118**	dum25to50	-0.212***
			(0.05)		(0.052)
dumwest			0.127***	dum50to75	0.185***
			(0.037)		(0.07)
dumsouth			0.045	Dum75to100	0.108
			(0.049)		(0.068)
constant	6.141	9.041***	12.244***	constant	11.156***
	-4.893	-3.267	(4.199)		(3.645)
No. of obs	177	177	177	-	177
No. of groups	22	22	22	-	22
Estimation	RE	GLS	GLS	-	GLS
Wald chi2	39.78	97.34	128.98	-	102.18
R-squared	0.1778	-	-	-	-

Standard errors in parentheses

* significance at 10%; ** significance at 5%; *** significance at 1%

GLS (III) log likelihood = 85.129, GLS (IV) log likelihood = 86.677

5.2. Relative incomes, Lags, and unemployment

Secondly **Table 8**, alcohol consumption for the top and bottom 50% of income countries (based on GDP per capita), we see the same findings as in **Table 5** given some slight changes in coefficient sizes. Once again, the robustness test reinforces the validity of the original results obtained.

Table 8: Bottom 50% and Top 50% incomes - Robustness unemployment

Variables	*(I)*	*(II)*	*(III)*	*(IV)*
unemp	-0.012***	-0.001	-0.017*	-0.001
	(0.005)	(0.002)	(0.009)	(0.002)
lnalcoh (L.1)	0.885**	0.850**	0.885***	0.851***
	(0.411)	(0.376)	(0.286)	(0.222)
inflation	-0.004	-0.001	-0.009	-0.001
	(0.005)	(0.004)	(0.015)	(0.004)
popgrowth	0.041**	0.019	0.086**	0.069*
	(0.019)	(0.014)	(0.043)	(0.040)

contd. table 8

Variables	*(I)*	*(II)*	*(III)*	*(IV)*
lnlifeexp	-0.888**	-0.600**	-0.985**	-0.596*
	(0.421)	(0.303)	(0.406)	(0.317)
lneduc	-0.023	-0.026	-0.116*	-0.025**
	(0.130)	(0.028)	(0.07)	(0.012)
drkage	0.192*	0.018*	0.118***	0.091***
	(0.112)	(0.010)	(0.044)	(0.034)
lnalcohtax	-0.010	-0.004	-0.098**	-0.014
	(0.007)	(0.006)	(0.040)	(0.010)
timedum	-0.017	-0.048**	-0.038**	-0.048***
	(0.012)	(0.015)	(0.017)	(0.015)
constant	4.083**	3.753**	4.083**	3.251**
	(1.882)	(1.314)	(1.817)	(1.263)
No. of obs	147	132	147	132
No. of groups	13	14	13	14
Estimation	RE	RE	GLS	GLS
Wald chi2	65.78	14.14	168.07	80.07
R-squared	0.2995	0.077	-	-

Standard errors in parentheses * significance at 10%; ** significance at 5%; *** significance at 1%GLS (III) Log likelihood = 76.05, GLS (IV) Log likelihood = 58.52

5.3. Pro-cyclical Road traffic Incidents: unemployment

Overall, **Table 9** still displays the pro-cyclical nature of road traffic incidents where in this case when the unemployment rate decreases, the economy improving. The magnitude in the unemployment coefficient and education coefficient are relatively large (within 0.02) compared to that of the rate GDP per capita and previous education coefficient in **Table 7**. However, alcohol consumption more closely resembles that of **Table 7** suggesting that it does have an important effect on road traffic incidents.

6. DISCUSSION

This study, through the application of panel data methods, has found a significant positive association between macroeconomic conditions, namely the growth of GDP per capital and the unemployment rate, and two alcohol-related outcomes – alcohol consumption and road traffic incidents. Furthermore, it has contributed to the current literature on the health economics regarding alcohol use in several ways. Firstly, this

Table 9: Road traffic incidents – Robustness unemployment

Variable	*(I)*	*(II)*	*(III)*	*(IV)*	*(V)*	*(VI)*
unemp	-0.042***	-0.042***	-0.029***	-0.029***	-0.030***	-0.040***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.009)
lnalcoh			0.156**	0.189**	0.169*	0.205***
			(0.073)	(0.091)	(0.091)	(0.097)
inflation			0.034***	0.034***	0.034*	0.035*
			(0.009)	(0.009)	(0.009)	(0.019)
popgrowth			0.062	0.075*	0.075*	0.040
			(0.044)	(0.045)	(0.043)	(0.051)
lneduc			-0.606***	-0.626***	-0.606***	-0.265**
			(0.093)	(0.094)	(0.092)	(0.126)
dumeast					-0.249*	-0.161*
					(0.244)	(0.073)
dumwest					0.426***	0.328***
					(0.258)	(0.076)
dumsouth					0.601***	0.715***
					(0.233)	(0.065)
constant	5.914***	5.594***	8.041***	8.179***	7.870***	6.790***
	(0.110)	(0.043)	(0.516)	(0.513)	(0.523)	(0.650)
No. of obs	406	406	306	306	306	306
No. of groups	28	28	27	27	27	27
Estimation	RE	FE	RE	FE	RE	GLS
F-statistic		72.36		37.15		
Wald chi2	72.67		185.49		180.92	222.56
R-squared	0.0404	0.0404	0.0352	0.0328	0.3553	-
Standard errors in parentheses						

* significance at 10%; ** significance at 5%; *** significance at 1%GLS (VI) Log likelihood = 103.74

research fills a gap in the literature investigating the relationship for a related group of countries, European Union, whereas past studies tend to focus only on a national or domestic level. Secondly, the study shows that there are substantial differences in consumption of alcohol and road traffic accidents between EU members in accordance to their geographical location and relative incomes. Additionally, regarding alcohol consumption, relatively poorer countries did not appear to react to economic booms in comparison to relatively richer countries who demonstrated a clear-cut pro-cyclical nature. Thirdly, this is the only study that makes a notable inclusion of income inequality, through the share of income variables, finding that it indeed significantly impacts alcohol consumption. This is an important conclusion to make and shows that n*et al*cohol consumption does increase following redistribution, which is useful information for policymakers. Finally, the study briefly attempts to show how specific policies, raising alcohol tax or the number of individuals in tertiary education, impact alcohol-related outcomes.

This study supports findings of pro-cyclical behaviour and thus confirms Ruhm's hypothesis that during times of economic downturn individuals spend less across the whole economy on alcohol and that recessions have a positive effect on traffic accidents (Ruhm, 1995). Specifically, I found that a 1% increase in the growth of GDP per capita corresponds to an approximate increase in alcohol consumption by 2.12%, ceteris paribus. Likewise, a 1% fall in the unemployment rate yielded an approximate 1.31% increase in consumption, ceteris paribus These estimates are in line with the findings of Helble and Sato (2011, pp:10), who estimated for 38 high income countries across the world, to finding a 1% rise in per capita growth leads to a 1.40% increase in alcohol consumption. Additionally, our findings were in line with Ruhm's findings considering highway vehicle fatalities for the USA, a 1% increase in the unemployment rate corresponded to a -3.92% fall whereas Ruhm (1995) found a -3% fall. These findings are not to be interpreted that recessions are good for public health as downturn generally causes numerous other impacts on an individual's health such as stress. Therefore, it should not be assumed that during recessions less should be spent on health or the police.

What the findings do conclude however is that the drinking age has a significant effect on alcohol use such that a non-existent or a drinking age below 18 could increase consumption by approximately 10%. Therefore, this suggests that a unilateral drinking age across the European Union would be a sensible policy recommendation in regard to reducing alcohol consumption in those countries without an alcohol purchasing law above 18 years old.

Finally, another key finding of this research is that redistribution policies lead to a net increase in alcohol consumption. Importantly, even though the income is been transferred to a lower income group we cannot assume they are increasing alcohol consumption alone. More likely is the retribution causes a Keynesian multiplier in the economy and lots of people consume more as lower income households spend proportionally more of their income relative to higher income households (OECD, 2020b, 4.1). Nevertheless, this is a critical finding for policy makers. Though it is not suggesting redistribution is negative and should not be pursued. It suggests that policy makers should consider ways to mitigate the predicted increase in consumption. Moreover, this paper recommends increased funding into the education system in order to promote tertiary education and or a rise in the alcohol tax, which both negatively consumption.

As with all models these findings are not without drawbacks. Applying cross-sectional data for entire economies fails to account for individual's behaviour and only focus on herd behaviour. This is detrimental when concluding pro-cyclical trends as there might be sensitive groups (income, age, gender, employment status ect) in the economy which react differently to macroeconomic conditions similar to that in Arkes (2007). However, microdata findings have not been as conclusive as aggregate data for example Harley (2013) concluded higher unemployment leads to more binge drinking whereas Ettner (1997) found involuntary unemployment to be inconclusive. Additionally, Berg *et al* (2020) concluded that woman drink more than men during recessions conversely Goeij *et al* (2015) concluded gender inequality where harmful drinking is more prevalent in men.

Similarly, estimating with data where some variables contained unit-roots yields biased and inconsistent estimators due to non-stationarity, thus first differencing is required (Freedman, 1999).

Another downfall comes with the assumption that people consume pure alcohol when in fact individuals more commonly consume alcoholic beverages such as beer, wine, and spirits. This analysis can provide insight into income elasticities and the degree to which a beverage is pro-cyclical at the aggregate level. In addition, the duration at which the alcohol is been consumed is also another important factor to consider as highlighted in Dee (2001).

7. CONCLUSION

Alcohol consumption is a key ingredient in various illnesses as highlighted by the WHO and such studies as this attempted to better our understanding of alcohol-related outcomes following changes in a complex array of determinants in the economy. More so now than ever the affect an economic crisis has on such a dangerous legal substance is crucial for policymakers in order protect public health.

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Appendix A: List of Eu Countries, Accession Date and Drinking Age

Members	*Accession date*	*Drinking age (years)*
Austria	1995	16
Belgium	1957	16
Bulgaria	2007	18
Croatia	2013	18
Cyprus	2004	17
Czech Republic	2004	18
Denmark	1973	16
Estonia	2004	18
Finland	1995	18
France	1957	18
Germany	1957	16
Greece	1981	17
Hungary	2004	18
Ireland	1973	18
Italy	1957	18
Latvia	2004	18
Lithuania	2004	20
Luxembourg	1957	16
Malta	2004	17
Netherlands	1957	18
Poland	2004	18
Portugal	1986	16
Romania	2007	18
Slovakia	2004	18
Slovenia	2004	18
Spain	1986	18
Sweden	1995	18
United Kingdom	1973-2020	18

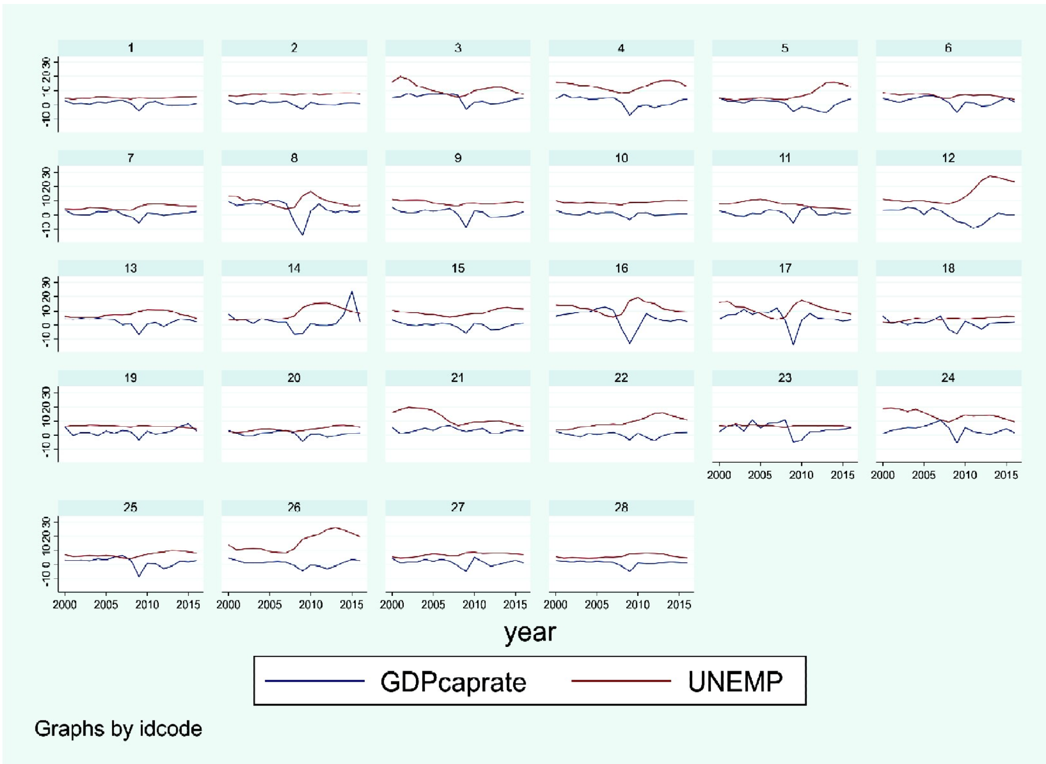
Appendix B: Description of Variables

Variables	*Descriptions*	*Source*
ALCOH	All types of Alcohol, Alcohol, recorded per capita (15+) consumption (in litres of pure alcohol)	(WHO, 2020b)
UNEMP	Unemployment rate, total % of labor force	(World Bank, 2020a)

Variables	*Descriptions*	*Source*
p90p100	Pre-tax national income share, top 10%. Percentage share of income or consumption is the share that accrues to subgroups of population indicated by deciles or quintiles.	(World Inequality Database, 2020)
drkage	Dummy variable for drinking age (purchase age) where 1 = drinking age under 18 or no drinking age and 0 = drinking age 18 or above	(Juliff, 2019)
lifeexp	Life expectancy at birth, total (years)	(World Bank, 2020b)
expgrowth	Exports of goods and services (annual % growth)	(World Bank, 2020c)
GDPcap	GDP per capita (current US$). GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.	(World Bank, 2020d)
GDPcaprate	GDP per capita growth (annual %). Annual percentage growth rate of GDP per capita based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	(World Bank, 2020e)
educ	School enrollment, tertiary (% gross). Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Tertiary education, whether or not to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level.	(World Bank, 2020f)
inflation	Inflation, GDP deflator (annual %). Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.	(World Bank, 2020g)

p0p10	Income share held by lowest 10%. Percentage share of income or consumption is the share that accrues to subgroups of population indicated by deciles or quintiles.	(World Inequality Database, 2020)
hrsworked	Average annual hours worked per worker is defined as the total number of hours actually worked per year divided by the average number of people in employment per year. Actual hours worked include regular work hours of full-time, part-time and part-year workers, paid and unpaid overtime, hours worked in additional jobs, and exclude time not worked because of public holidays, annual paid leave, own illness, injury and temporary disability, maternity leave, parental leave, schooling or training, slack work for technical or economic reasons, strike or labour dispute, bad weather, compensation leave and other reasons. The data cover employees and self-employed workers. This indicator is measured in terms of hours per worker per year. The data are published with the following health warning: The data are intended for comparisons of trends over time; they are unsuitable for comparisons of the level of average annual hours of work for a given year, because of differences in their sources and method of calculation.	(OECD, 2020a)
timedum	Dummy variable for recessions where if the rate of GDP per capita is greater than 0, dummy is 0, if the rate of GDP per capita is less than 0, dummy is 1	Authors calculations
alcohtax	Annual revenues from alcohol excise tax in millions of US$	(WHO, 2020c)
popgrowth	Population growth (annual %)	(World Bank, 2020h)
RTI	People killed or injured in road traffic incidents per 100 000	(WHO, 2020d)

Appendix C: Unemployment rare and GDP per capita rate for all 28 EU countries over time



Austria	Belgium	Bulgaria	Croatia	Cyprus	Czechia	Denmark	Estonia	Finland	France
1	2	3	4	5	6	7	8	9	10
Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembou	Malta	Netherlands
11	12	13	14	15	16	17	18	19	20
Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden	United Kingdom		
21	22	23	24	25	26	27	28		